UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

FINAL ENVIRONMENTAL IMPACT STATEMENT
PERSONAL WATERCRAFT RULEMAKING

GLEN CANYON NATIONAL RECREATION AREA

Arizona and Utah

Lead Agency: Department of the Interior, National Park Service, Intermountain Region

This final environmental impact statement evaluates three alternatives for managing the use of personal watercraft at Glen Canyon National Recreation Area. Two alternatives would allow personal watercraft use under defined conditions. The third alternative would eliminate personal watercraft use within the recreation area.

Alternative A would allow personal watercraft use identical to that before September 2002 under a special regulation. Personal watercraft use would be authorized for all areas of the recreation area above Glen Canyon Dam except where prohibited by the *Superintendent's Compendium, 2002*. A lake management plan that would comprehensively consider all lake uses would be developed to manage the effects on resources by all watercraft use.

Alternative B (modified preferred alternative) would allow personal watercraft use in the recreation area under a special regulation with additional management restrictions. Personal watercraft use would be prohibited in portions of the Colorado, Escalante, Dirty Devil, and San Juan Rivers to increase protection of environmental values and reduce visitor conflict. To further reduce visitor conflict and improve visitor experience, speed restrictions would be imposed in a section of the Escalante River. Under this alternative, all personal watercraft two-stroke carbureted engines would be prohibited at the end 2012. Educational programs and materials would be enhanced to provide more information to visitors on watercraft use and safety as well as recreation area resources. Development of a monitoring program to evaluate the effects of personal watercraft use on recreation area resources would be emphasized. A lake management plan that would comprehensively consider all lake uses would be developed to manage the effects on resources by all watercraft use.

Under Alternative C, the no action alternative, all personal watercraft use within the recreation area would be prohibited, based on the year 2000 National Park Service personal watercraft rule. A lake management plan would be developed under the no action alternative to address the cumulative effects of all watercraft use on Lake Powell.

The potential environmental consequences of the actions are addressed under each alternative, including impacts on natural resources, cultural resources, visitor experience and safety, socioeconomic resources, and management and operations.

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EXECUTIVE SUMMARY
FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE PERSONAL WATERCRAFT RULEMAKING
GLEN CANYON RECREATION AREA

Glen Canyon National Recreation Area encompasses 1,254,306 acres of land and water in northern Arizona and southeastern Utah. Its southern boundary is contiguous with the Navajo Nation. Other boundaries adjoin Grand Canyon National Park, Capitol Reef National Park, Canyonlands National Park, and Rainbow Bridge National Monument, all managed by the National Park Service (NPS). The recreation area also adjoins areas administered by the Bureau of Land Management that include Grand Staircase – Escalante National Monument, Vermilion Cliffs National Monument, and Paria Canyon Wilderness.

Lake Powell is the predominant physical feature. At full pool (3,700 feet above sea level), it occupies about 163,000 surface acres, stores approximately 27 million acre-feet of water, and has about 1,960 miles of shoreline. More than 2 million people visit Glen Canyon National Recreation Area each year.

PURPOSE AND SIGNIFICANCE OF GLEN CANYON NATIONAL RECREATION AREA

National park system units are established by Congress to fulfill specific purposes, based on the unit's unique and "significant" resources. A unit's purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing "for the enjoyment of future generations." The purpose and significance of Glen Canyon National Recreation Area and its broad mission goals are derived from its enabling legislation and are summarized the recreation area's *General Management Plan* (NPS 1979a) and *Strategic Plan* (NPS 2000g).

Glen Canyon National Recreation Area was established in 1972 (PL 92-593) "to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto . . . and to preserve scenic, scientific, and historic features contributing to public enjoyment of the area." The recreation area's primary management objective, as established in the *General Management Plan* (NPS 1979a), is "to manage the recreation area so that it provides maximal recreational enjoyment to the American public and their guests."

The recreation area's enabling legislation states:

> The secretary shall administer, protect, and develop the recreation area in accordance with the provision of the [Organic Act] . . . and with any other statutory authority available to him for the conservation and management of natural resources (16 *United States Code*, Section 459f-5(a)).

This act also specifies that "nothing . . . shall affect or interfere with the authority of the Secretary . . . to operate Glen Canyon dam and reservoir" for the purposes of the *Colorado River Storage Project Act*, the achievement of which is the responsibility of the Bureau of Reclamation.

As stated in the *General Management Plan* (NPS 1979a) and *Strategic Plan* (NPS 2000g), Glen Canyon National Recreation Area is significant because:

> It offers a tremendous diversity of both water-based and land-based recreational opportunities.

It contains Lake Powell, the second largest man-made lake in North America, which provides both a unique opportunity for recreation in a natural environment and a transportation corridor to remote backcountry areas of Glen Canyon National Recreation Area.

It is in the heart of the Colorado Plateau region, which offers a unique combination of water and desert environments. It offers a natural diversity of rugged water and wind carved canyons, buttes, mesas, and other outstanding physiographic features.

The climate and physical features have created local environments favorable to the preservation of scientifically important objects, sites, populations, habitats, or communities that are significant in and of themselves or provide opportunities to add to our understanding of past or ongoing events.

It possesses evidence of 10,000 years of human occupation and use of resources, which provides a continuing story of the prehistoric, historic, and present-day affiliation of humans and their environments.

It constitutes a significant part of the outstanding public lands of the Colorado Plateau.

The recreation area offers a diversity of land and water-based recreational opportunities. The area's major recreational resource is Lake Powell, a 186-mile-long reservoir at full pool that was created when the Colorado River was dammed. Boating is very popular on the lake, including the use of personal watercraft, houseboats, powerboats, tour boats, canoes, kayaks, and sailboats. Other popular activities include fishing, camping, waterskiing, hiking, photography, and driving for pleasure.

PURPOSE AND NEED FOR ACTION

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for the management of personal watercraft use at Glen Canyon National Recreation Area. The goal is to ensure the protection of recreation area resources and values while offering recreational opportunities as provided for in the recreation area's enabling legislation, purpose, mission, and goals. Upon completion of this process in accordance with the *National Environmental Policy Act*, the National Park Service may take action to adopt special regulations to manage personal watercraft use at Glen Canyon National Recreation Area. Alternately, it may discontinue personal watercraft use at this unit, as allowed for in the National Park Service March 21, 2000 personal watercraft rule.

More than one million personal watercraft are estimated to be in operation today in the United States (NMMA 2001b). Sometimes referred to as "jet skis" or "wet bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment and are capable of speeds in the 60-mph range. The Personal Watercraft Industry Association believes that through the 2002 model year the output on a limited number of higher rated models was around 155 and 165 hp (PWIA 2002b). National personal watercraft ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 and dropped slightly in 1999, 2000 and 2001. While personal watercraft use remains a relatively new recreational activity, it has occurred in 32 of 87 national park system units that allow motorized boating.

Studies in Everglades National Park showed that personal watercraft use resulted in damage to emergent and submerged aquatic vegetation, adversely impacted shorebirds, and disturbed the life

cycles of other wildlife. As a result, the National Park Service prohibited personal watercraft use by a special regulation at Everglades National Park in 1994.

In recognition of its duties under its *Organic Act* and NPS management policies, as well as increased awareness and public controversy about personal watercraft use, the National Park Service subsequently reevaluated its methods of personal watercraft regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, personal watercraft use was allowed when a unit's superintendent's compendium allowed the use of other vessels. Later the National Park Service closed seven units to personal watercraft use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998 the Bluewater Network filed a petition urging the National Park Service to initiate a rulemaking process to prohibit personal watercraft use throughout the national park system. In response to the petition, the National Park Service issued an interim management policy requiring superintendents of units where personal watercraft use could occur but had not yet occurred to close the unit to such use until the rule was finalized.

The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts of personal watercraft use before authorizing the use. On March 21, 2000, the National Park Service issued a final regulation prohibiting personal watercraft use in most units and required 21 units to determine the appropriateness of continued personal watercraft use. Specifically, the regulation allowed the National Park Service to designate personal watercraft areas and to continue their use by promulgating a special regulation in 11 units and by amending the units' superintendent's compendium in 10 units, including Glen Canyon National Recreation Area (36 CFR 3.24(b), 2000). The National Park Service based the distinction between designation methods on each unit's degree of motorized watercraft use.

In response to the personal watercraft final regulation, Bluewater Network sued the National Park Service, challenging NPS's decision to allow continued personal watercraft use in 21 units. In response to the suit, the National Park Service negotiated a settlement. Each of those units desiring to continue long-term personal watercraft use must promulgate a unit-specific special regulation. Consistent with this agreement, personal watercraft use at Glen Canyon National Recreation Area would have been suspended after September 15, 2002 until a recreation area-specific special regulation was completed.

However, the proposed September 16, 2002, prohibition of personal watercraft at Glen Canyon was averted with the execution of a stipulated modification to the settlement agreement. The modified settlement agreement was approved by the court on September 9, 2002, and extended unrestricted personal watercraft use in selected NPS units until November 6, 2002. Following this date, personal watercraft are prohibited in the recreation area until such time the final rule is published.

On January 17, 2003, the National Park Service published a draft rule for the operation of personal watercraft at Glen Canyon National Recreation Area. The draft rule for personal watercraft use is based on Alternative B (the preferred alternative) in the *Draft Environmental Impact Statement*. The 60-day public comment period on the draft rule ran from January 17 to March 18, 2003.

The settlement stipulates that the National Park Service must evaluate its decision to issue a unit-specific special regulation to allow personal watercraft use through an environmental analysis conducted in accordance with the *National Environmental Policy Act*. The *National Environmental*

Policy Act analysis at a minimum, according to the settlement, must evaluate personal watercraft impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

OBJECTIVES AND SCOPE OF ANALYSES

Objectives were established to determine whether alternatives for managing personal watercraft use at Glen Canyon National Recreation Area would be successful. All action alternatives had to substantially meet all of the objectives and also had to resolve the purpose of and need for action. Objectives for managing personal watercraft use were developed from the Glen Canyon National Recreation Area enabling legislation, mandates, and direction in the general management plan, strategic plan, and other management documents. All objectives are compatible with the purpose and significance statements of Glen Canyon National Recreation Area presented above.

The scope of the environmental analysis is to examine a range of management alternatives for personal watercraft use at Glen Canyon National Recreation Area.

Motorboats and other watercraft have been used in Glen Canyon National Recreation Area since its establishment in 1972. Personal watercraft use has emerged at the recreation area only since the introduction of this type of vessel in the 1980s. Prior to 2000, personal watercraft use was allowed throughout Glen Canyon National Recreation Area except in areas below Glen Canyon Dam that were closed to personal watercraft use in the superintendent's compendium. In March 2000, the waters below the dam were closed by provisions of the NPS personal watercraft rule. Therefore, waters below the dam are not considered in this environmental impact statement.

Those waters of the recreation area above the dam where personal watercraft use could occur in any capacity, as identified in the *Superintendent's Compendium* (NPS 2002c), are within the scope of this analysis. These areas include Lake Powell and the Colorado, San Juan, Dirty Devil, and Escalante Rivers from Lake Powell upstream to the boundary of the recreation area.

The National Park Service acknowledges that other watercraft may affect resources. However, other watercraft were not the subject of the March 21, 2000 rule, and were not part of the Bluewater Network lawsuit and subsequent settlement agreement. Therefore, other watercraft will not be included in any upcoming rule-making, and are not a primary focus of this impact assessment. None-the-less, for each impact topic, the effects of other watercraft are evaluated in the cumulative effects analysis.

IMPACT TOPICS REQUIRED UNDER THE SETTLEMENT AGREEMENT

Under provisions of the settlement agreement, the *National Environmental Policy Act* analysis at a minimum must evaluate personal watercraft impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety. The national and Glen Canyon National Recreation Area-specific issues relative to each impact topic are summarized below.

Water Quality

Water quality issues from the national perspective are that personal watercraft engines (especially the widely used, carbureted, two-stroke engines) discharge up to 30% of their fuel as uncombusted constituents into surface waters during operation. In sufficient concentrations, these constituents can adversely affect human health and aquatic organisms. Chemical constituents of particular concern include benzene, ethylbenzene, toluene, xylenes, polycyclic aromatic hydrocarbons, and methyl tertiary-butyl ether.

These concerns are relevant in the recreation area, particularly because of the potential to affect or degrade water quality for fish and other aquatic life, agricultural water supply, livestock watering, drinking water, and recreation uses. There also is concern that the introduction of human waste into Lake Powell by personal watercraft users who do not have access to toilets may contribute to water quality degradation.

Air Quality

Air quality issues from the national perspective are that personal watercraft engines (especially the widely used, carbureted two-stroke engines) discharge large amounts of air pollutants, such as nitrogen oxides, carbon monoxide, particulate matter, and volatile organic compounds. All of these emissions can adversely affect air quality. In areas with high personal watercraft use, there was concern about air quality degradation.

From the recreation area perspective, issues included visibility effects that may occur from the discharge of exhaust smoke into the air, especially at marinas and popular launch facilities. Photochemical transformations of the engine emissions that could affect visibility conditions in the recreation area also were a concern.

Soundscape

Nationally, many recreationists who do not use personal watercraft find the noise from these vessels to be annoying. Sounds from personal watercraft are identified as being more disturbing than sounds from other watercraft because of numerous changes in pitch associated with frequent turns and changes in speed. Other issues are related to the potential for personal watercraft noise to disturb wildlife, including waterfowl and nesting birds.

In the recreation area, there is concern that personal watercraft produce noise that could affect recreation area soundscapes and visitor experiences. The maximum noise level allowed in NPS units, including Glen Canyon National Recreation Area, is 82 decibels at 82 feet at full acceleration.

Wildlife and Wildlife Habitat

Nationally, personal watercraft use has been described as adversely affecting wildlife (principally birds) through harassment and disturbing nesting colonies of terns. Disturbance can be deliberate or incidental to the use of personal watercraft (such as noise). Impacts on wildlife habitat could occur through crushing or uprooting of submerged and near-shore vegetation.

In the recreation area, concern was expressed that personal watercraft operations may affect wildlife, causing alarm or flight, or avoidance of personal watercraft activity areas. Areas indicated as being of particular concern include the recreation area's shallow-water, narrow side-canyons.

Shoreline Vegetation

Nationally, the effects of personal watercraft on shoreline and aquatic plant communities have not been fully studied, and scientists disagree about whether personal watercraft adversely impact aquatic vegetation. Most concern arises from the shallow draft of personal watercraft, allowing them to use shallow areas that conventional motorboats cannot reach. Personal watercraft may crush or uproot grasses and other submerged aquatic vegetation that occurs in shallow water.

In the recreation area, there are few areas of submerged aquatic vegetation, which limits the concern regarding this impact topic. Many areas of Lake Powell have unsuitable shoreline substrates, steep shoreline slopes, high water velocities in tributary river reaches, or large seasonal fluctuations of water surface elevations. Together, these factors preclude the development of submerged aquatic and shoreline vegetation.

Visitor Conflicts and Visitor Safety

Nationally, some data suggest that personal watercraft have higher accident rates than other watercraft. Conflicts with other recreationists can arise because of the noise produced by personal watercraft, their ability to operate in shallow water, and the inconsiderate or aggressive behavior sometimes exhibited by some personal watercraft operators.

In the recreation area, many concerns about conflicts with personal watercraft use focus on visitors who do not use motorboats, such as swimmers, fishermen, and rafters and kayakers. Conflicts also can arise with land-based users, such as those who are seeking solitude in the recreation area's Natural Zone. Safety issues include the number and severity of accidents involving personal watercraft.

ALTERNATIVES

This environmental impact statement evaluates three alternatives concerning the use of personal watercraft at Glen Canyon National Recreation Area.

Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation

Alternative A would allow the management and regulation of personal watercraft use, as provided for in the recreation area's *Superintendent's Compendium* (NPS 2002c), under a special regulation. This is considered the "baseline" condition against which the other management strategies, including closure of the recreation area to personal watercraft use, were compared.

Under alternative A, personal watercraft use would be authorized in all areas of Lake Powell, except where specifically prohibited in the *Superintendent's Compendium* (NPS 2002c). Location restrictions would include:

Upstream travel on the Dirty Devil River from the point where measurable downstream current is encountered;

Upstream travel on the Escalante River upstream from the confluence with Coyote Creek;

Upstream travel on the San Juan River upstream from the Clay Hills pullout; and

Upstream travel on the Colorado River upstream from the base of Imperial Rapid.

Downstream travel through these areas by personal watercraft would be allowed.

Alternative A would also include a three-year pilot study to identify the techniques and area restrictions that would be most effective in reducing conflicts between watercraft and other visitors. The pilot study would support the development of a lake management plan which would comprehensively consider all lake uses to better protect recreation area resources, improve visitor safety, and reduce conflicts.

Alternative B (NPS Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions

Alternative B would be similar to alternative A. However, it would include additional geographic restrictions on personal watercraft use and would implement additional flat-wake zones. Under this alternative all carbureted two-stroke personal watercraft would be prohibited after 2012. In addition, alternative B also would include strategies to better protect recreation area resources, improve visitor safety, and reduce conflicts. Some of these strategies would include preparation of a lake management plan and conduct of a three-year pilot study to identify the techniques that would be most effective in reducing conflicts.

Location restrictions would include closing the following river areas to all personal watercraft use, including both upstream and downstream travel:

Dirty Devil River upstream of Utah Highway 95 Bridge;

Escalante River upstream of the confluence of Coyote Creek;

San Juan River upstream from the Clay Hills pullout; and

Colorado River upstream from Sheep Canyon.

Wake restrictions would be implemented on the:

Escalante River from the confluence of Cow Canyon to the confluence with Coyote Creek.

Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)

Alternative C is the no-action alternative. The National Park Service would not take action to promulgate a special regulation that would allow personal watercraft use. Therefore, under the provisions of the March 21, 2000 final rule, all personal watercraft use would be permanently eliminated from the recreation area.

Preferred and Environmentally Preferred Alternative

The environmentally preferred alternative is the alternative that will promote the *National Environmental Policy Act*, as expressed in section 101 of the act. The preferred alternative and the environmentally preferred alternative is alternative B. This alternative was designed to meet the general management objectives of the National Park Service for protecting recreation area resources and values, while providing the opportunity for personal watercraft operators to enjoy water-based recreation.

Alternative B would have impacts on recreation area resources and visitor use and experience at Glen Canyon National Recreation Area that were very similar to conditions that existed prior to September 2002. However, it would prohibit the use of carbureted two-stroke personal watercraft after 2012 and further restrict personal watercraft use within portions of the Dirty Devil, Escalante, San Juan, and Colorado Rivers. These restrictions would reduce adverse effects on water quality, air quality, and soundscapes relative to alternative A while allowing for a wider range of recreational uses than alternative C. This alternative would emphasize recreational opportunities for visitors while enhancing protection of sensitive natural and cultural resources.

ENVIRONMENTAL CONSEQUENCES

Impacts of the three personal watercraft management alternatives were assessed in accordance with *Director's Order 12 and Handbook: Conservation Planning, Environmental Impact Analysis and Decision Making*. This handbook requires that impacts on park resources be analyzed in terms of their context, duration, and intensity. The analysis provides the public and decision-makers with an understanding of the implications of personal watercraft management actions in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists.

For each impact topic, methods were identified to measure the change in recreation area resources that would occur with the implementation of each personal watercraft management alternative. Three field programs were conducted by Glen Canyon National Recreation Area in the summer of 2001 to collect data on water quality, air quality, and noise from high, low, and moderate personal-watercraft-use areas. The results were used to evaluate potential impacts of each alternative, using modeling techniques. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial.

Each personal watercraft management alternative was compared to a baseline to determine the context, duration, and intensity of resource impacts. The baseline is the condition that resulted from management of personal watercraft use under the *Superintendent's Compendium* (NPS 2002c) and is represented by alternative A.

The table ES-1 summarizes the results of the impact analysis for the impact topics that were assessed. The analysis considered a 10-year period from the end of 2002 through 2012.

TABLE ES-1: COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
Water quality	Under alternative A, personal watercraft have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Effects would be long term because they would recur during each summer heavy-use season. Cumulatively, the lake loadings from all vessels also would have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Alternative A would not result in the impairment of the water quality of Lake Powell or any other waters.	Localized, long-term benefits to water quality would occur in the four tributaries where personal watercraft use would be restricted. However, because these areas have low rates of use, the intensity would likely be negligible. Prior to the end of 2012, effects to water quality would be the same as those described for alternative A. This is anticipated because boat usage and engine type distribution are assumed to be the same as in alternative A. After implementation of clean technology personal watercraft restrictions, pollutant loadings from personal watercraft would decrease. However, changes in water quality may be difficult to quantify. The continued contribution of personal watercraft to pollutant loading in Lake Powell would result in long-term, adverse effects to water quality of negligible to minor intensity. Cumulative effects from all watercraft would be similar to alternative A until 2005. A decrease in pollutant loading with implementation of personal watercraft engine type restrictions at the end of 2012 and other water quality improvement projects would result in long-term negligible benefits. Alternative B would not result in the impairment of the water quality of Lake Powell or any other waters.	Alternative C would eliminate personal watercraft pollutant loadings in Lake Powell compared to alternatives A and B, both in the short-term and long-term. This would produce a negligible to minor, direct, beneficial, long-term effect on the water quality of the lake. The four tributary inlets would also experience localized, long-term benefits, but due to their low personal watercraft use rates, these would be negligible. Alternative C would not result in the impairment of the water quality of Lake Powell.
Air quality	Personal watercraft management under alternative A would have the following effects on air quality. Emission levels of carbon monoxide, hydrocarbons, and volatile organic compounds would decrease between 2004 and 2012. Hydrocarbon plus nitrogen oxide emissions, which are the principal constituents of ozone, would also decrease by 2012. All of this change would be attributable to increased proportions of low-emission engines on the lake. However, these pollutants would continue to be emitted by personal watercraft at volumes exceeding 100 tons per year. As a result, alternative A would	Effects of alternative B would be similar to those of alternative A in 2004. Conversion of carbureted two-stroke personal watercraft to cleaner engines under the modified alternative would have the following effects on air quality. There would be sizeable reductions in volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide emissions. There would also be reduction in particulates (PM_{10} and $PM_{2.5}$) and carbon monoxide emissions. Human health effects would be adverse and moderate for volatile organic compounds, carbon monoxide, hydrocarbons, and hydrocarbons plus	Under the no-action alternative, the air quality condition in the recreation area would continue to be below national ambient air quality standards. SUM06 ozone measurements in the recreation area would remain below 15 parts per million per hour. No change in class II airshed status would be expected because historical motorized boating activity has not resulted in a violation of any national air quality standard. The no-action alternative would have long-term, negligible to moderate, beneficial impacts on air quality related values and human health. These would result from the elimination of personal watercraft emissions of hydrocarbons, volatile

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	have moderate, long-term, direct, adverse impacts on human health and air quality related values. Particulate matter emissions from personal watercraft would decrease by 2012 to between 46 to 67 tons per year. These levels of particulate matter would continue to cause locally degraded visibility from personal watercraft exhaust during peak use periods in high-use areas. This would be a direct, long-term, negligible to minor, adverse effect on human health and air quality related values. Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect). SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect). No change in class II airshed status would result from this alternative (negligible effect). The cumulative effect on air quality related values and human health from all motorized vessel would be direct, long-term, adverse, and minor to moderate. This alternative would not result in an impairment of the air quality resource or related values.	nitrogen oxides. Some beneficial effects would occur after 2012 from the elimination of carbureted two-stroke personal watercraft engine emissions as hydrocarbon, carbon monoxide, volatile organic hydrocarbons, and particulate matter emissions are reduced. Adverse impacts to air quality-related values would be reduced from minor levels in 2004 to negligible to minor in 2012. Particulate matter reductions would contribute to an improvement in visibility, and the reduced ozone production would contribute to a reduced potential for plant damage. Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect). SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect). No change in class II airshed status would result from this alternative (negligible effect). The cumulative effect on air quality related values and human health from all motorized vessels would be direct, long-term, adverse, and minor to moderate. This alternative would not result in an impairment of the air quality resource or related values.	organic compounds, carbon monoxide, nitrogen oxide, and particulate matter in the recreation area. In the short-term, total vessel operating hours would be reduced as personal watercraft would be prohibited from the park. In 2004, there would be sizeable reductions in the cumulative emissions of carbon monoxide, volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide when compared with alternative A. Particulates (PM_{10} and $PM_{2.5}$) would be reduced from minor to moderate levels under alternative A to negligible under the alternative C, the no-action alternative. In the long-term visitors would replace personal watercraft with a different variety of motorized vessel and other vessels usage would continue. This would offset the benefits to air quality from elimination of personal watercraft. Considering that ambient air quality standards would continue to be met, moderate, long-term, adverse impacts on human health and air quality related values would occur from carbon monoxide, nitrogen oxide, hydrocarbon, and volatile organic compound emissions associated with all motorized boating activity. The long-term, adverse impacts on human health and visibility associated with particulate matter emissions would be negligible to minor. Implementation of this alternative would not result in an impairment of the air quality resource.
Soundscapes	During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. Given this level of impact, and the amount of use that occurs during peak seasons, mitigation takes the form of education and enforcement of the existing regulations and compendium. Noise-producing behaviors are regulated to the greatest possible	Alternative B would have overall noise impacts similar to those described under alternative A. During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in	Due to the elimination of personal watercraft noise in alternative C, impacts on the natural soundscape would be reduced compared to noise levels produced in alternatives A or B. This represents a beneficial impact on the natural soundscape – eliminating an adverse impact judged as minor to moderate at high use times of the year. Compared to low use times of the year, the level of beneficial impact would not be considered as great in magnitude by eliminating a negligible to minor adverse impact. Alternative C

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	extent, and use of newer technologies that reduce noise are encouraged. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in Natural and Cultural Zones. In the Natural and Cultural Zones, alternative A would produce negligible to moderate adverse effects on the soundscape within a mile of the lakeshore, depending on the level of boating use in nearby waters at various times of the year. During high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. These areas consist of about 16,000 acres covering 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected. All of these effects would be adverse, both short and long term, and direct. Alternative A would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.	Natural and Cultural Zones. In the Natural and Cultural Zones, under alternative B during high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. The area affected would be 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected. All of these effects would be adverse, both short and long term, and direct. Alternative B would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.	would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area.
Wildlife and wildlife habitats	Personal and other watercraft uses with alternative A would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Population numbers, population structure, genetic variability, and other demographic factors for species may experience small, short-term changes, but long-term characteristics of wildlife and wildlife habitat within the area of analysis would remain stable and viable.	Impacts on wildlife and wildlife habitats due to alternative B would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Prohibiting carbureted two-stroke personal watercraft engines at the end of 2012 would indirectly benefit wildlife and wildlife habitat. Alternative B would not contribute to deterioration of the recreation area's wildlife resource to the extent that the recreation area's purpose could	Alternative C would have a negligible, short-term, beneficial impact on wildlife and wildlife habitat from a reduction in boat-days that initially would result from eliminating personal watercraft use on the lake. By the end of the analysis period in 2012, the number of boat-days would have returned to levels within the range predicted for alternatives A and B. Because the effects on wildlife and wildlife habitats from personal watercraft and other types of motorcraft are similar, the long-term effect of alternative C on wildlife and wildlife habitats would be negligible. Alternative C would not result in impairment of fish and wildlife species or their supporting habitats.

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	Operations of personal watercraft would not adversely impact special-interest wildlife concentration or high-quality wildlife habitat areas because such resources are not present in the recreation area. Special-interested wildlife features (such as active peregrine falcon nest sites) are present in the recreation area and many occur in areas visited by personal watercraft and other types of motorized watercraft. Alternative A would not contribute to deterioration of the recreation area's fish or wildlife resources to the extent that the recreation area's purpose could not be fulfilled as established in its enabling legislation. It would not affect resources key to the recreation area's natural integrity or opportunities for enjoyment or affect the wildlife or wildlife habitat resource, whose conservation is identified as a goal in the recreation area's general management plan. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.	not be fulfilled as established in its enabling legislation. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.	
Threatened and endangered species	Alternative A would not adversely affect any ecological, biological, or physical processes associated with endangered fish critical habitats. Continuing the location restriction on upstream portions in the Colorado, San Juan, Dirty Devil, and Escalante Rivers would provide some protection of critical habitat for endangered fish. Compared to current conditions, alternative A would have negligible effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo or their critical habitats within Lake Powell and its tributaries in the recreation area. Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment to threatened or endangered species or their designated critical habitats would occur from the implementation of alternative A.	Restrictions on access and designation of flat-wake speeds along sections of river shorelines would produce short-term, direct, negligible benefits to habitats of endangered fishes in the inflow areas. These would occur because fewer personal watercraft would use these areas, and the remaining vessels would operate at lower speeds, producing less site disturbance. These effects would not change ecological function or structure of critical habitat and would probably be indistinguishable from the range of environmental variation that occurs under natural conditions. The availability, use, and location of suitable endangered fish habitat would be more extensively affected by reservoir operations and annual river runoff patterns than by operation of personal watercraft. Therefore, the impacts on endangered fish species and their designated critical habitat with alternative B would be similar to alternative A. Endangered fish would benefit indirectly with the prohibition of carbureted two-strike personal watercraft engines at the end of	Negligible improvements to endangered fish habitat would be expected, resulting in short-term, direct beneficial impacts on endangered fish and their designated critical habitats in the inflow areas. The bald eagle, American peregrine falcon, southwester willow flycatcher, and yellow-billed cuckoo might experience some negligible short-term beneficial direct impacts from reduced disturbance incidents during the two to three years when the total number of boat days are expected to decline. Alternative C would be unlikely to adversely affect endangered fish or birds or their critical habitat, special-concern species or state-sensitive species known to use critical habitats or frequent near-shore uplands and riparian habitats within the recreation area. Cumulative impacts are negligible and not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment would be expected to endangered,

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		2012 which would reduce the amount of fuel discharge into the water in subsequent years. There would be no distinguishable adverse effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo. As a result, this alternative would be unlikely to adversely affect these species in the recreation area. Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment would be expected to endangered, threatened, or special-concern species or their designated critical habitats with this alternative.	threatened, or special-concern species or their designated critical habitats from this alternative.
Shoreline vegetation	Personal watercraft use would have negligible, adverse, direct and indirect impacts, for both short and long terms. This would occur because there would be no perceptible changes to shoreline, riparian, aquatic, or wetland community size, integrity, or continuity. Alternative A would not result in any substantial or noticeable physical change of submerged, riparian, or wetland shoreline vegetation. Past, current, and future use of personal watercraft and other motorized watercraft also would not produce any noticeable effect on shoreline vegetation. Therefore, cumulative effects would also be short-term, direct, and negligible. Alternative A would not result in impairment of shoreline vegetation at Glen Canyon National Recreation Area.	Restricting access to upper portions of the Colorado, Escalante, Dirty Devil, and San Juan Rivers would provide negligible beneficial protection of riparian shoreline vegetation. Impacts on shoreline vegetation in the vicinity of the four main marinas would be similar to those described for alternative A and would result primarily from minor short-term foot traffic associated with users of personal watercraft and other watercraft when landing on lake shorelines. Limiting personal watercraft operations to flat-wake speeds on a portion of the Escalante River would reduce wave production but because of the lack of existing shoreline vegetation no benefits to shoreline vegetation would be expected. Past, current, and future personal watercraft use would not produce any noticeable effect on submerged aquatic, riparian and wetland vegetation. Therefore, cumulative effects would remain similar to alternative A and would be short-term, direct, and negligible. Alternative B would not result in impairment of shoreline vegetative resources.	Alternative C would not result in any substantial or noticeable adverse physical change of riparian, submerged aquatic, or wetland vegetation. The lakeshore does not support extensive areas of submerged aquatic vegetation. Short-term and localized negligible improvements to shoreline vegetation would be expected as a result of implementing this alternative. Past, current, and future motorcraft use would not produce any noticeable effect on submerged aquatic, riparian, and wetland vegetation. Therefore, cumulative effects would be similar to alternative A and would be short-term, direct, and negligible. Alternative C would not result in impairment of shoreline vegetative resources.
Visitor use and experience	Alternative A would have negligible effects on visitor use and experience because the number of personal watercraft using Lake Powell and their management would not change. The effect on the	Most effects of alternative B would be similar to those described for alternative A. Most effects would be long-term and negligible to minor because of the presence of other motorcraft. An	In the short term, visitors who use personal watercraft as a primary vessel or who consider personal watercraft to be of central importance to their visit would experience direct, major, adverse

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	visitor experience for personal watercraft users would continue to be beneficial, while experiences for visitors seeking quiet and solitude would continue to be adversely affected. Cumulative effects would be either adverse or beneficial, depending on the visitor's goals. However, in either case impacts would be negligible.	additional flat-wake zone and closed areas would produce negligible to minor, long-term, direct effects. Perceptions of individual visitors would determine if the effects were adverse or beneficial. Improvements in visitor education would result in negligible to minor, indirect, long-term, beneficial effects. Cumulative effects on visitor experience would be long-term, indirect, and moderate because there would be detectable change on certain portions of the lake. Perceptions of individual visitors would determine if effects were adverse or beneficial.	short- and long-term effects from alternative C. Other users of personal watercraft, such as those who use them in conjunction with houseboats, would experience short-term, minor to moderate, adverse effects that would decrease to negligible in the long term. Visitors who did not use personal watercraft would generally perceive minor to moderate, short-term benefits from reduced conflicts and reduced noise. These benefits would decline to negligible in the long term.
Visitor conflicts and visitor safety	Alternative A would have negligible impacts on visitor conflicts and visitor safety. Improvements in visitor protection staffing would result in long-term minor beneficial effects on visitor conflicts and safety. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.	Compared to alternative A, alternative B would have direct and indirect, long-term, minor, beneficial impacts on both visitor conflicts and visitor safety. Cumulatively, the improved education components of this alternative would have indirect, long-term, beneficial, negligible to minor effects on visitor conflicts and visitor safety.	In the short term, alternative C would have a direct, beneficial, moderate effect on visitor safety. However, as visitors returned in other watercraft, which have higher accident rates on Lake Powell than personal watercraft, the long-term effect on safety would be adverse and negligible to minor. Visitor conflicts would be reduced in the long term and improvements in visitor protection staffing would produce both direct and indirect, minor, beneficial effects. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.
Cultural resources	Effects on cultural resources from the implementation of alternative A would be adverse and mostly long-term. While most personal watercraft users would be conscientious about protecting the recreation area's cultural resources, a few would engage in destructive actions such as illegal collecting of artifacts or vandalism. The effects of this behavior would be most noticeable in the narrow, steep-walled canyon areas that are inaccessible by most other types of motorcraft, but that can be traveled in a downstream direction by personal watercraft under alternative A. In these areas, impact intensities mostly would be negligible to minor. Impact intensities from personal watercraft users would be of similar magnitude in other areas, but would be	Compared to alternative A, alternative B would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic sites along the river canyons. Effects on traditional practices would be beneficial and negligible to moderate in intensity. In other areas, the effects of alternative B may be beneficial compared to alternative A, but the intensity would be negligible. Cumulative effects would be similar to alternative A. Alternative B would not result in impairment of the cultural resources of the recreation area.	Compared to alternative A, alternative C would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic resources, and negligible to moderate, beneficial effects on traditional practices in the river canyons in the recreation area. It also would have direct, long-term, negligible to minor, beneficial effects on traditional practices that are conducted within a mile of the lake shore. In the short term, the reduced visitation that would follow implementation of alternative C would result in a negligible, short-term reduction in disturbances to cultural sites. This condition would end by 2012 if visitor use of the recreation area increases due to natural growth in visitation, to

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	indistinguishable from the adverse effects caused by the relatively few destructive visitors who used other transport methods to access the sites. Cumulatively, direct, adverse, long-term effects on the cultural resources in the recreation area would vary in intensity from negligible to moderate, depending on individual site vulnerability and accessibility. Negligible to minor, adverse, indirect effects on near-shore cultural sites would continue from the wave action caused both by boats and wind. The contribution of personal watercraft under alternative A to wave-caused effects would be negligible. Overall, the direct effect within the recreation area would be adverse and minor. Regionally, the effect from activities that occur outside of the recreation area would continue to be adverse and moderate. The contribution of alternative A to the regional effects would be negligible. Alternative A would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.		visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Other cumulative effects would be similar to alternative A. Alternative C would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.
Socioeconomic environment	Alternative A would have a negligible socioeconomic effect by itself and cumulatively with other actions.	Alternative B would have a negligible socioeconomic effect by itself and cumulatively with other actions.	Alternative C would cause a major, adverse, long-term effect on the economy of Page. Other communities in the counties surrounding the recreation area would experience less intense adverse effects. The effects would be both direct and indirect as reduced demand for sales and service related to personal watercraft-based recreation rippled through the economy. Cumulative effect on the regional economy would be moderate. In the long term, the economy would recover to previous levels, except for businesses that had focused on personal watercraft sales and rentals. Therefore, the long-term effect on the local economy would be moderate to major.
National recreation area management and operations	Use of personal watercraft in the recreation area under alternative A would have negligible, short- and long-term effects on operations. Increased funding for visitor protection staff would offset some of the long-term impacts to visitor protection	Alternative B primarily would affect the enforcement, interpretation, and facilities maintenance components of recreation area operations. Short-term impacts would be minor, as staff resources were committed to marking	Alternative C would cause short-term, direct, minor, adverse effects on recreation area operations, primarily because of time commitments needed to inform visitors about the ban on personal watercraft. In the long term,

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	services. The cumulative effects on management and operations of personal watercraft use in conjunction with other activities at existing levels also would be negligible.	newly restricted areas and developing and implementing new educational programs. In the long term, most of these effects would decrease to negligible levels. Increased funding for visitor protection staff would lead to long-term, minor benefits to visitor protection services. Effects on recreation area staff from restrictions on carbureted two-stroke personal watercraft at the end of 2012 would be negligible as most watercraft would already be compliant with EPA emission standards and distribution of education materials would inform users well in advance of the restriction. Without additional funding, staff requirements for additional monitoring could have long-term, negligible to minor, adverse effects on operations of the resource management division. Cumulatively, all recreation area visitors would benefit from the improved education and visitor protection services that would be implemented with alternative B. These could reduce the need to respond to emergencies and improve the ability to focus recreation area services on the protection of resources and the safety of visitors. These would be beneficial, negligible to minor, direct and indirect, long-term effects on recreation area operations.	these effects would decline to negligible levels. Law enforcement requirements on the lake initially would be reduced, as the number of visitors decreased in association with the ban. However, the long-term effect on law enforcement activities would be negligible if visitor use of the recreation area increases due to natural growth in visitation, to visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Increased funding for visitor protection staff would offset some of the long-term impacts on visitor protection services. There would not be any additional cumulative effect from alternative C.

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PURPOSE OF AND NEED FOR ACTION
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INTRODUCTION

Glen Canyon National Recreation Area encompasses 1,254,306 acres in northern Arizona and southeastern Utah (see figure 1, the Glen Canyon National Recreation Area Region). It includes parts of four counties in Utah and one county in Arizona. As shown in figure 2, Glen Canyon National Recreation Area Vicinity, its southern boundary is contiguous with the Navajo Nation. Other boundaries adjoin Grand Canyon National Park, Capitol Reef National Park, Canyonlands National Park, and Rainbow Bridge National Monument, all managed by the National Park Service (NPS). The recreation area also adjoins areas administered by the Bureau of Land Management that include Grand Staircase – Escalante National Monument, Vermilion Cliffs National Monument, and Paria Canyon Wilderness.

Glen Canyon National Recreation Area was established in 1972 "to provide for public outdoor recreation use and enjoyment of Lake Powell and adjacent lands, and to preserve and protect the scenic, scientific, and historic features contributing to public enjoyment of the area." The recreation area's primary management objective, as established in the *General Management Plan* (NPS 1979a), is "to manage the recreation area so that it provides maximal recreational enjoyment to the American public and their guests."

More than two million people visit Glen Canyon National Recreation Area each year. The recreation area offers a tremendous diversity of land and water-based recreational opportunities. The area's major recreational resource is Lake Powell, a 186-mile-long reservoir at full pool that was created when the Colorado River was dammed. Boating is very popular on the lake, including the use of personal watercraft, houseboats, powerboats, tour boats, canoes, kayaks, and sailboats. Other popular activities in the recreation area include fishing, camping, waterskiing, hiking, photography, and driving for pleasure.

More than one million personal watercraft[1] are estimated to be in operation today in the United States (National Marine Manufacturers Association [NMMA] 2001b). Sometimes referred to as "jet skis" or "wet bikes," these vessels have inboard, internal combustion engine powering a water jet pump as its primary source of propulsion.

Personal watercraft are used for enjoyment, particularly for touring and maneuvers such as wave jumping, and they are capable of speeds in the 60-mph range. National personal watercraft ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001.

---

1. Personal watercraft, as defined in 36 CFR §1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

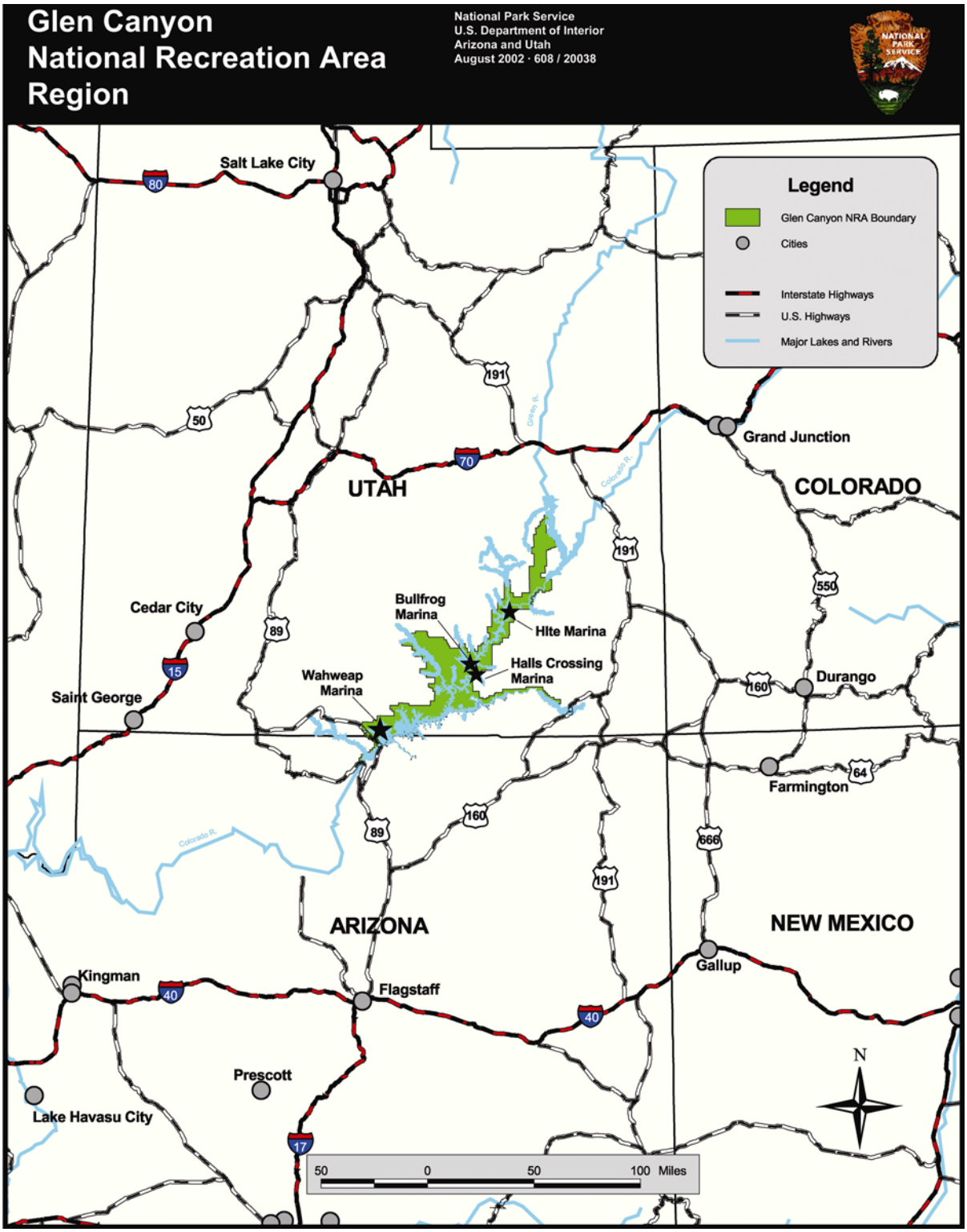

FIGURE 1: GLEN CANYON NATIONAL RECREATION AREA REGION

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FIGURE 2: GLEN CANYON NATIONAL RECREATION AREA VICINITY

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Back of Figure 2

Personal watercraft emerged and gained popularity in park units before the National Park Service could initiate and complete "a full evaluation of the possible impacts and ramifications." Although personal watercraft use remains a relatively new recreational activity, it has occurred in 32 of 87 park units that allow motorized boating (NPS 2000e).

The National Park Service first began to study personal watercraft in Everglades National Park. The studies showed that personal watercraft use over emergent vegetation, shallow grass flats, and mud flats commonly used by feeding shore birds damaged the vegetation, adversely impacted the shore birds, and disturbed the life cycles of other wildlife. Consequently, managers at Everglades National Park determined that personal watercraft use was inconsistent with the resources, values, and purposes for which the park was established. In 1994, the National Park Service prohibited personal watercraft at Everglades National Park by a special regulation (59 *Federal Register* [FR] 58781).

Other public entities have taken steps to limit, and even to ban, personal watercraft use in certain waterways as national researchers study more about the effects of personal watercraft use. At least 34 states have either implemented regulations or considered regulating the use and operation of personal watercraft (63 FR 49314). Several federal agencies, including the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, have managed personal watercraft differently than other classes of motorized watercraft.

When the National Oceanic and Atmospheric Administration regulated the use of personal watercraft in most national marine sanctuaries, it was sued by the Personal Watercraft Industry Association (PWIA). As a result, the Court of Appeals for the District of Columbia declared such personal watercraft-specific management to be valid. In Personal Watercraft Industry Association v. Department of Commerce, 48 F.3d 540 (D.C. Cir. 1995), the court ruled that an agency can discriminate and manage one type of vessel (specifically, personal watercraft) differently than other vessels if the agency explains its reasons for the differentiation.

In February 1997, the Tahoe Regional Planning Agency, the governing body charged with ensuring no derogation of Lake Tahoe's water quality, voted unanimously to ban all vessels using two-stroke, internal combustion engines, including personal watercraft, because of their adverse effects on water quality. Lake Tahoe's ban began in 2000.

In 1998, San Juan County, Washington became the first local government in the country to successfully ban the use of personal watercraft in its waters. In January 1996, the county passed an ordinance placing a two-year ban on personal watercraft while studies of their effects were conducted. Personal watercraft proponents sued, and late that year the Superior Court found the ordinance to be unconstitutional. The basis was the distinction made between personal watercraft and other vessels while no such distinction is made in the state's boat licensing rules. The county appealed, and in July 1998 the Washington Supreme Court reversed the trial court and upheld the county's authority. Based on this ruling and the results of the studies, the county made the ban permanent. Since then, other jurisdictions have banned personal watercraft with ordinances based on San Juan County's.

Historically, the National Park Service grouped personal watercraft with all other vessels. Thus, people could use personal watercraft within a park service unit when the unit's superintendent's compendium allowed the use of other vessels. However, by 1998 the National Park Service had closed seven units to personal watercraft use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park. At that time, the National Park Service was reevaluating its methods of personal

watercraft regulation, based on its responsibilities under the NPS *Organic Act of 1916* and increased public awareness and controversy.

In May 1998, the Bluewater Network, a private, independent, non-profit organization, filed a petition urging the National Park Service to initiate a rule-making process to prohibit personal watercraft use throughout the national park system. In response to the petition, the National Park Service issued an interim management policy requiring superintendents of units where personal watercraft use can occur, but where they have not been used, to close the unit to personal watercraft until the rule was finalized. In addition, the National Park Service proposed a specific personal watercraft regulation premised on the notion that personal watercraft differ from conventional watercraft in terms of design, use, safety record, controversy, visitor impacts, resource impacts, horsepower-to-vessel ratio, and thrust capacity (63 FR 49312-49317, September 15, 1998).

The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts of personal watercraft use before authorizing their use. The preamble to the servicewide regulation calls the regulation a "conservative approach to managing personal watercraft use" that considered resource concerns, visitor conflicts, visitor enjoyment, and visitor safety. During a 60-day public comment period, the National Park Service received nearly 20,000 comments on the proposed regulation.

As a result of public comments and further review, the National Park Service promulgated an amended regulation (36 CFR 3.24(a), 2000; 64 FR 15077-15090, March 21, 2000). It prohibited personal watercraft use in most park units and required the remaining units to determine personal watercraft appropriateness for continued use. Specifically, the regulation allowed the National Park Service to designate personal watercraft areas and to continue their use by promulgating a special regulation in 11 units and by amending the units' superintendent's compendium in 10 units, including Glen Canyon National Recreation Area (36 CFR 3.24(b), 2000). The National Park Service based the distinction between designation methods on the units' degree of motorized watercraft use.

In response to the personal watercraft final regulation, Bluewater Network sued the National Park Service under the *Administrative Procedures Act* and the *Organic Act*. The organization challenged the NPS's decision to allow continued personal watercraft use in 21 units while prohibiting personal watercraft use in other units. In addition, the organization disputed the NPS decision to allow 10 units to continue personal watercraft use after 2002 by making entries in superintendent's compendiums, which would not require the opportunity for public input through a notice and a comment rule-making process. Further, the Bluewater Network claimed that because personal watercraft cause water and air pollution, increase noise levels, and pose public safety threats, the National Park Service acted arbitrarily and capriciously when making the challenged decisions.

In response to the suit, the National Park Service and the Bluewater Network negotiated a settlement. The settlement agreement, signed by the judge on April 12, 2001, changed portions of the NPS rule. While the 21 units could continue personal watercraft use in the short term, each of those parks desiring to continue long-term personal watercraft use had to promulgate a park-specific special regulation. In addition, the settlement stipulated that the National Park Service must base each decision to issue a park-specific special regulation to continue personal watercraft use on an environmental impact analysis conducted in accordance with the *National Environmental Policy Act*. Each environmental analysis must, at a minimum, according to the settlement, evaluate personal watercraft impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

In 2001, the National Park Service adopted its new servicewide policy for personal watercraft. As stated in section 8.2.3.3 of *Management Policies 2001* (NPS 2000d), "personal watercraft use is prohibited unless it has been identified as appropriate for a specific park." Personal watercraft use can only be authorized based on "an evaluation of the park's enabling legislation, resources and values, other visitor uses, and overall management objectives [that] confirms that personal watercraft use is appropriate and consistent" with other NPS management goals and objectives.

As the settlement deadline approached and the park units were preparing to prohibit personal watercraft use, the National Park Service, Congress, and personal watercraft user groups sought legal methods to keep the parks open to this activity. However, no method was successful. On April 22, 2002, the following units closed for personal watercraft use: Assateague Island National Seashore; Big Thicket National Preserve; Pictured Rocks National Lakeshore; Fire Island National Seashore; and Gateway National Recreation Area. On September 15, 2002, eight other park units scheduled to close to personal watercraft. Park units that prepare an environmental assessment to analyze personal watercraft use alternatives and then select an alternative to continue such use will have to draft a special regulation to authorize that use in the future.

The proposed September 16, 2002 prohibition of personal watercraft was averted with the execution of a stipulated modification to the settlement agreement. The modified settlement agreement was approved by the court on September 9, 2002, and extended unrestricted personal watercraft use in some selected National Park Service units until November 6, 2002.

PURPOSE OF AND NEED FOR ACTION

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies to manage personal watercraft use at Glen Canyon National Recreation Area. The goal is to ensure the protection of recreation area resources and values while offering recreation opportunities as provided for in the recreation area's enabling legislation, purpose, mission, and goals. Upon completion of the *National Environmental Policy Act* process, the National Park Service may either adopt a special regulation to manage personal watercraft use at the recreation area, or continue the current ban on personal watercraft use at this national park unit that went into effect in September 2002, in accordance with the National Park Service March 21, 2000 rule.

This environmental impact statement evaluates three alternatives for managing the use of personal watercraft at Glen Canyon National Recreation Area. Two of the alternatives would allow personal watercraft use under specified conditions.

> Alternative A would allow personal watercraft use, consistent with the *Superintendent's Compendium* (NPS 2002c), under a special regulation.
>
> Alternative B, the modified preferred alternative, would promulgate a special regulation to allow personal watercraft use with additional management restrictions.

In accordance with the requirements of the *National Environmental Policy Act*, the alternative of no federal action also was evaluated. All personal watercraft use in the recreation area would be eliminated after November 6, 2002. Alternative C would make this condition permanent. This would occur because the National Park Service would not promulgate a special regulation allowing for continued personal watercraft use.

SCOPE OF THE ANALYSIS

Motorboats and other watercraft have been used in Glen Canyon National Recreation Area since its establishment in 1972. Personal watercraft use has emerged at the recreation area only since the introduction of this type of vessel in the 1980s.

The scope of this analysis is to examine a range of management alternatives for personal watercraft use at Glen Canyon National Recreation Area in support of possible personal watercraft rule-making for this unit.

Prior to 2000, personal watercraft use was allowed throughout Glen Canyon National Recreation Area except in areas below Glen Canyon Dam that were closed to personal watercraft use in the superintendent's compendium. In March 2000, the waters below the dam were closed by provisions of the NPS personal watercraft rule. Therefore, waters below the dam are not considered in this draft environmental impact statement and the rule-making it supports.

Those waters of the recreation area above the dam where personal watercraft use could occur in any capacity, as identified in the *Superintendent's Compendium* (NPS 2002c), are within the scope of this analysis. (A copy of the parts of the *Superintendent's Compendium* (NPS 2002c), that are applicable to personal watercraft is provided in appendix A.) These areas include Lake Powell within Glen Canyon National Recreation Area and the Colorado, San Juan, Dirty Devil, and Escalante Rivers from Lake Powell upstream to the boundaries of the recreation area.

The National Park Service acknowledges that other watercraft may affect resources. However, other watercraft were not the subject of the March 21, 2000 rule, and were not part of the Bluewater Network lawsuit and subsequent settlement agreement. Therefore, other watercraft will not be included in the upcoming rule-making, and are not a primary focus of this impact assessment. None-the-less, for each impact topic, the effects of other watercraft are evaluated in the cumulative effects analysis.

Glen Canyon National Recreation Area recognizes the need for a comprehensive lake management plan to more thoroughly explore all water-based recreation. The objectives of the lake management plan would be to determine the management of Lake Powell and provide for the long-term protection of lake resources while allowing a range of visitor recreational opportunities. The implementation of a lake management plan would allow the recreation area to take any additional affirmative action to reduce effects on recreation area resources by all types of watercraft users. This would enhance the protection and preservation of the recreation area for use by future generations.

PURPOSE AND SIGNIFICANCE OF GLEN CANYON NATIONAL RECREATION AREA

National park system units are established by Congress to fulfill specific purposes, based on the unit's unique and "significant" resources. A unit's purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing "for the enjoyment of future generations."

The purpose and significance of Glen Canyon National Recreation Area and its broad mission goals are derived from its enabling legislation and are summarized in the recreation area's proposed *General Management Plan* (NPS 1979a) and *Strategic Plan* (NPS 2000g). Excerpts that are relevant to personal watercraft management in the recreation area are provided below.

Establishment: Congress established Glen Canyon National Recreation Area in 1972 (PL 92-593). The enabling legislation states:

> In order to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto . . . and to preserve scenic, scientific, and historic features contributing to the public enjoyment of the area, there is established the Glen Canyon National Recreation Area " (Title 16 U.S.C., section 460dd 1972).

Administration: The recreation area's enabling legislation states:

> The secretary shall administer, protect, and develop the recreation area in accordance with the provision of the [Organic Act] . . . and with any other statutory authority available to him for the conservation and management of natural resources (16 U.S.C., section 459f-5(a)).

This act also specifies that "nothing . . . shall affect or interfere with the authority of the Secretary . . . to operate Glen Canyon dam and reservoir" for the purposes of the *Colorado River Storage Project Act*, the achievement of which is the responsibility of the Bureau of Reclamation.

Purpose of Glen Canyon National Recreation Area: As stated in the recreation area's enabling legislation and restated in the *General Management Plan* (NPS 1979a) and *Strategic Plan* (NPS 2000g), the purpose of the recreation area is "to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto . . . and to preserve scenic, scientific, and historic features contributing to public enjoyment of the area."

Significance: As stated in the *General Management Plan* (NPS 1979a) and *Strategic Plan* (NPS 2000g), Glen Canyon National Recreation Area is significant because:

> It offers a tremendous diversity of both water-based and land-based recreational opportunities.
>
> It contains Lake Powell, the second largest man-made lake in North America, which provides both a unique opportunity for recreation in a natural environment and a transportation corridor to remote backcountry areas of Glen Canyon National Recreation Area.
>
> It is in the heart of the Colorado Plateau region, which offers a unique combination of water and desert environments. It offers a natural diversity of rugged water and wind carved canyons, buttes, mesas, and other outstanding physiographic features.

The climate and physical features have created local environments favorable to the preservation of scientifically important objects, sites, populations, habitats, or communities that are significant in and of themselves or provide opportunities to add to our understanding of past or ongoing events.

It possesses evidence of 10,000 years of human occupation and use of resources, which provides a continuing story of the prehistoric, historic, and present-day affiliation of humans and their environments.

It constitutes a significant part of the outstanding public lands of the Colorado Plateau.

The recreation area's purpose and significance are linked to the concept of impairment, which is discussed in section 1.4.5 of *Management Policies 2001* (NPS 2000d). That section defines what constitutes impairment of park resources and values, and establishes guidelines for recognizing impairment. Those guidelines have been incorporated into the analysis methods for each impact topic evaluated in this environmental impact statement. Additional information on impairment is included in section entitled "*Organic Act* and *Management Policies*."

BACKGROUND

ORGANIC ACT AND MANAGEMENT POLICIES

In the NPS *Organic Act of 1916*, Congress directed the Department of the Interior and the National Park Service to manage units "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (Title 16 U.S.C., section 1 1972). Congress reiterated this mandate in the *Redwood National Park Expansion Act of 1978* by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically directed by Congress" (Title 16 U.S.C., section 1a-1 1972).

Within these mandates, the *Organic Act* and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts, Congress "empowered [the National Park Service] with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt*, 82 F.3d 1445, 1453 [9th Cir. 1996]).

Courts have consistently interpreted the *Organic Act* and its amendments to elevate resource conservation above visitor recreation. For example:

> *Michigan United Conservation Clubs v. Lujan*, 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation."
>
> The *National Rifle Ass'n of America v. Potter*, 628 F. Supp. 903, 909 (D.D.C. 1986) states, "In the *Organic Act* Congress speaks of but a single purpose, namely, conservation."

In *Management Policies 2001* (NPS 2000d), the National Park Service recognizes that resource conservation takes precedence over visitor recreation. Section 1.4.3 states "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant."

Because conservation is predominant, the National Park Service seeks to avoid or to minimize adverse impacts on park resources and values. In addition, section 1.4.3 of *Management Policies 2001* (NPS 2000d) recognizes that the National Park Service has discretion to allow negative impacts when necessary. However, as discussed further in section 1.4.3, the National Park Service cannot allow an adverse impact that constitutes resource impairment.

The *Organic Act* prohibits actions that permanently impair park resources unless a law directly and specifically allows for such actions (Title 16 U.S.C., section 1a-1 1972). According to section 1.4.5 of *Management Policies 2001* (NPS 2000d), an action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts."

Park units vary based on their enabling legislation, missions, and natural and cultural resources. Therefore, the recreational activities appropriate for each unit and for areas within each unit vary. An action appropriate in one unit could impair resources in another unit. Thus, this environmental impact statement analyzes the context, duration, and intensity of impacts related to personal watercraft use at Glen Canyon National Recreation Area, as well as the potential for resources impairment. The environmental impact statement conforms with the guidelines presented in *Director's Order 12 and Handbook: Conservation Planning, Environmental Impact Analysis and Decision-Making* (NPS 2001b).

SUMMARY OF NATIONAL INFORMATION ON THE EFFECTS OF PERSONAL WATERCRAFT

National personal watercraft ownership increased every year between 1991 and 1998. The rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001 (see table 1).

Environmental groups, personal watercraft users and manufacturers, and land managers express differing opinions about the environmental consequences of personal watercraft use, and about the need to manage or to limit this recreational activity. The following section is a summary of national research conducted over two decades on the effects of personal watercraft use on natural resources and human health and safety. Results of studies on personal watercraft use related to water quality, air quality and soundscapes conducted at Glen Canyon National Recreation Area are presented in the "Affected Environment" chapter of this environmental impact statement.

TABLE 1: NATIONAL PWC REGISTRATION TREND[a]

Year	No. of Boats Owned	No. of Personal Watercraft Owned	Boat Ownership Trend (percentage change)	Personal Watercraft Ownership Trend (percentage change)
1991	16,262,000	305,915	—	—
1992	16,262,000	372,283	0	21.7
1993	16,212,000	454,545	0	22.1
1994	16,239,000	600,000	0	32.0
1995	15,375,000	760,000	-5	26.7
1996	15,830,000	900,000	3	18.4
1997	16,230,000	1,000,000	3	11.1
1998	16,657,000	1,100,000	3	10.0
1999	16,773,000	1,096,000	1	-0.4
2000	16,965,000	1,078,400	1	-1.6
2001		1,053,560		-2.4

Source: M. Schmidt, USCG, email comm., September 4, 2001; National Marine Manufacturers Association (NMMA) 2002.

a. Estimates provided by the National Marine Manufacturers Association (M. Schmidt, USCG, pers. comm., Sept. 4, 2001).

Water Quality

The majority of personal watercraft in use today are powered by conventional two-stroke carbureted engines, which discharge as much as 30% of their fuel directly into the water (California Environmental Protection Agency, Air Resources Board [CARB] 1999a, NPS 1999c). Hydrocarbons, including benzene, ethylbenzene, toluene, and xylenes, are released as part of this uncombusted fuel mixture along with gasoline additives, such as methyl tertiary-butyl ether. Some polycyclic aromatic hydrocarbons are released as part of the uncombusted fuel mixture, but the combusted fraction of emissions releases larger amounts of polycyclic aromatic hydrocarbons.

In 1996, the U.S. Environmental Protection Agency (EPA) promulgated a rule to reduce exhaust emissions from new marine engines, including outboards and personal watercraft. Emission controls provided for increasingly strict standards beginning in model year 1998 (61 FR 52087-52106, October 4, 1996a). As stated in the rule-making, the agency expects a 52% reduction in hydrocarbon emissions from marine engines from present levels by 2010 and a 75% reduction in hydrocarbon emissions by 2030, based on phasing out polluting machines. The 1997 EPA rule delayed implementation by one year (EPA 1996a, 1997a).

A typical conventional (i.e., carbureted) two-stroke personal watercraft engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999c; CARB 1999a). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999c). According to data from the California Air Resources Board, two-stroke personal watercraft engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). (As described in appendix C, an estimated discharge rate of 3 gallons per hour is used in the water quality impact calculations.) The Personal Watercraft Industry Association notes that direct-injection engines have been available in personal watercraft for four years; and three personal watercraft manufacturers introduced four-stroke engines for the 2002 model year (PWIA 2002a). The Environmental Protection Agency assumes that the existing two-stroke engine models would not be completely replaced by newer personal watercraft technology until 2050 (40 CFR 89, 90, 91).

The average operating life of a personal watercraft is 5 to 10 years, depending upon the source. The formula for determining the operating life of personal watercraft was published in the *Federal Register* on October 4, 1996 (EPA 1996a). Based on this formula, the National Park Service expects that by 2012, most boat owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes the typical operating life of a personal watercraft rental is three years and approximately five to seven years for a privately owned vessel (PWIA 2002a).

The amount of pollution attributable to personal watercraft compared to other motorboats and the degree to which personal watercraft affect water quality are uncertain. Data from one study of personal watercraft and outboard motorboats show that personal watercraft represented one third of the watercraft but emitted 80% of the hydrocarbons (CARB 1998a). Other factors that affect pollutants' impacts are intrinsic to each water body, and include water temperature, air temperature, water mixing, motorboating use, and winds (ODEQ 1999).

Discharges of methyl tertiary-butyl ether and polycyclic aromatic hydrocarbons are particularly of concern because of their potential to adversely affect the health of people and aquatic organisms. Additional studies are needed to determine the distribution of polycyclic aromatic hydrocarbons and their ecotoxicity on a variety of biota (Allen et al. 1998). Long-term studies are required on the effect

on organisms or human health of repeated exposure to low levels of polycyclic aromatic hydrocarbons and methyl tertiary-butyl ether (Asplund 2000).

The sources, fates, and effects of hydrocarbon contaminants in aquatic systems are examined in the *Oil in the Sea* report (Ocean Studies Board, Marine Board, and Transportation Research Board 2002), which was first produced in 1985. This report focuses primarily on marine ecosystems, but also includes information on freshwater systems. It identifies petroleum consumption as the source of the overwhelming majority of the petroleum that enters marine systems, and names carbureted, two-stroke engines as an important source of water pollutants.

Air Quality

Personal watercraft emit various compounds that pollute the air. In the two-stroke engines commonly used in personal watercraft, the lubricating oil is used once and is expelled as part of the exhaust; and the combustion process results in emissions of air pollutants such as volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO).

In August 2002, the Environmental Protection Agency proposed additional rules that would further reduce boating emissions. The proposal includes evaporative emission standards for all boats and would reduce emissions from fuel tanks by 80% (67 FR 157, August 14, 2002, pp. 53049-53115).

It is assumed that the 1996 EPA rule concerning marine engines will reduce air emissions from personal watercraft in the future.

Soundscapes

Personal watercraft generated noise varies from vessel to vessel. No literature was found that definitively described scientific measurements of personal watercraft noise. Some literature stated that all recently manufactured watercraft emit fewer than 80 decibels at 50 feet from the vessel, while other sources attributed levels as high as 102 decibels without specifying distance. None of this literature fully described the method used to collect noise data.

The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris Miller Miller & Hanson, Inc. 2002). The results show that maximum personal watercraft noise levels at 82 feet ranged between 68 to 76 decibels on the A-weighted scale. Noise levels for other motorboat types measured during that study ranged from 65 to 86 decibels at 82 feet.

Noise limits established by the National Park Service require vessels to operate at less than 82 dB at 82 feet from the vessel. Personal watercraft may be more disturbing than other motorized vessels because of rapid changes in acceleration and direction of noise. More detail on this study is provided in the "Affected Environment" chapter under "Soundscapes."

Personal watercraft users tend to operate close to shore or in confined areas, and often travel in groups. These factors make noise more noticeable to other recreationists. Motorboats speeding back and forth in one area or spinning around in small inlets also generate noise complaints. However, most motorboats tend to operate away from shore and to navigate in a straight line, which reduces the perception of noise (Vlasich 1998). The Personal Watercraft Industry Association (PWIA) believes

that through the 2002 model year, the personal watercraft output on a limited number of higher rated models was around 155 and 165 horsepower (PWIA email to NPS dated September 23, 2002b).

Most studies on the effects of noise on soundscapes and human receptors have focused on highway and airport noise. Komanoff and Shaw (2000) used the analytical approaches of these studies to perform a noise-cost analysis of personal watercraft. They concluded that the cost to beachgoers from personal watercraft noise was more than $900 million per year. The cost per personal watercraft was estimated to be about $700 per vessel each year or $47 for each 3-hour "personal watercraft day." They concluded that the cost per beachgoer was highest at secluded lake sites, where beachgoers had a higher expectation of experiencing natural quiet and usually invested a larger amount of time and personal energy in reaching the area. However, because there are many more visitors available to be affected at popular beaches, noise costs per personal watercraft were highest at crowded sites (Drowning in Noise: Noise Costs of Jet Skis in America [Komanoff and Shaw 2000]).

Wildlife and Wildlife Habitat

Few studies have examined personal watercraft effects on wildlife. Based on observations, some wildlife disturbance and harassment likely occurs. It can be deliberate (such as attempts to run over shorebirds or birds resting on the water) or incidental to the use of the craft (such as noise). Nesting colonial birds appear to be particularly susceptible to disturbance (Burger 1998). However, the extent, duration, and magnitude of biological impacts because of personal watercraft operations versus other motorboats remain unknown.

Burger (2000) examined the behavior of common terns in relation to personal watercraft use and other boats and noted that personal watercraft users traveled faster and came closer to banks, resulting in more flight response in terns and contributing to lower reproductive success.

Shoreline Vegetation

The effects of personal watercraft on aquatic communities have not been fully studied, and scientists disagree about whether personal watercraft adversely impact aquatic vegetation. Most concern arises from the shallow draft of personal watercraft, allowing them access to shallow areas that conventional motorboats cannot reach. Like other vessels, personal watercraft may crush or uproot grasses that occur in shallow water (Stevenson and Dennison 2000; Asplund 2000).

Anderson (2000) studied the effect of personal watercraft wave-wash on shallow salt marsh vegetation and found that although the waves from personal watercraft are not different from those generated by other boats, personal watercraft can enter marsh channels and create sediment suspension problems in these areas.

Health and Safety Concerns

Personal watercraft industry representatives report that personal watercraft accidents decreased in some states in the late 1990s, but other research does not support their contention. Two national studies of personal watercraft accidents and injuries report that personal watercraft pose a health and safety risk, primarily to operators (Branche et al. 1997; National Transportation Safety Board [NTSB] 1998). Industry representatives report that personal watercraft accidents decreased in some states in

the late 1990s. The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents. In the same year personal watercraft operators accounted for more than 41% of people injured in boating accidents. Personal watercraft operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998).

Increased personal watercraft use in recent years has resulted in more concern about the health and safety of operators, swimmers, snorkelers, divers, and other boaters. A 1998 National Transportation Safety Board study revealed that while recreational boating fatalities have been declining in recent years, personal watercraft-related fatalities have increased (NTSB 1998). Nationwide personal watercraft accident statistics provided by the U.S. Coast Guard (USCG) supports the increase in personal watercraft-related fatalities however, since a peak of 84 personal watercraft-related fatalities in 1997, accidents, injuries, and fatalities involving personal watercraft have decreased (see table 2) (M. Schmidt, USCG, pers. comm., Sept. 4, 2001). The U.S. Coast Guard's Office of Boating Safety studied exposure data to assess boating risks. This method allows for a comparison between boat types based on comparable time in the water. Personal watercraft use ranked second in boat type for fatalities per million hours of exposure in 1998, with a 0.24 death rate per million exposure hours.

TABLE 2: NATIONWIDE PERSONAL WATERCRAFT ESTIMATES AND ACCIDENT STATISTICS

Year	Recreational Boats Owned*	Personal Watercraft Owned[a]	No. of Personal Watercraft in Accidents	No. of Personal Watercraft Injuries	No. of Personal Watercraft Fatalities	No. of All Boats Involved in Accidents	Percentage of Personal Watercraft Involved in Accidents
1987	14,515,000	N/A	376	156	5	9,020	4.2
1988	15,093,000	N/A	650	254	20	8,981	7.2
1989	15,658,000	N/A	844	402	20	8,020	10.5
1990	15,987,000	N/A	1,162	532	28	8,591	13.5
1991	16,262,000	305,915	1,513	708	26	8,821	17.2
1992	16,262,000	372,283	1,650	730	34	8,206	20.1
1993	16,212,000	454,545	2,236	915	35	8,689	25.7
1994	16,239,000	600,000	3,002	1,338	56	9,722	30.9
1995	15,375,000	760,000	3,986	1,617	68	11,534	34.6
1996	15,830,000	900,000	4,099	1,837	57	11,306	36.3
1997	16,230,000	1,000,000	4,070	1,812	84	11,399	35.7
1998	16,657,000	1,100,000	3,607	1,743	78	11,368	31.7
1999	16,773,000	1,096,000	3,374	1,614	66	11,190	30.2
2000	16,965,000	1,078,400	3,282	1,580	68	11,079	29.6
Total			**33,851**	**15,238**	**645**		

Source: M. Schmidt, USCG, e-mail comm., Sept. 4, 2001.

a. Estimates provided by the National Marine Manufacturers Association (M. Schmidt, USCG, pers. comm., Sept. 4, 2001).

PERSONAL WATERCRAFT USE AND REGULATION AT GLEN CANYON NATIONAL RECREATION AREA

Glen Canyon National Recreation Area was established for recreation and conservation purposes in 1972. Its major recreational resource is Lake Powell, which was created when the Colorado River was dammed in 1963. Use of motorboats occurred shortly after as Lake Powell began to fill. Personal watercraft use at the recreation area is thought to have begun in the late 1980s when the machines were first manufactured, although their use initially was limited. Data have not been collected in the recreation area to determine changes in personal watercraft use over time.

Glen Canyon National Recreation Area is managed according to resource zones that were established in the recreation area's proposed *General Management Plan* (NPS 1979a). Lake Powell, which constitutes 186,000 acres (13%) of the 1,254,306 acres in the recreation area, is part of the Recreation and Resource Utilization Zone. Within this zone, recreational activity such as personal watercraft use is permitted.

In the year 2001, use of all types of watercraft in Glen Canyon National Recreation Area totaled 831,079 boat days and the watercraft operating hours totaled 3,121,114. A boat day equals one watercraft on the lake during a 24-hour period and operating hours are the average number of hours a vessel is underway during a 24-hour period. Use of Lake Powell by personal watercraft and all other types of vessels is highest in the summer months, from June through September.

In 2001, personal watercraft accounted for 26% of all boat days, or about 229,377 boat days, and 18% of all operating hours (559,480 hours). Based on national and state trends in personal watercraft sales and registration, as well as eight-year trends in recreation area visitation, the proportion of personal watercraft boat days and operating hours in the total watercraft population is expected to remain constant through 2012.

Personal watercraft are more maneuverable and can access more areas than most other types of motorized watercraft. However, they are intended to be short-distance recreational vehicles and are generally used within localized areas. Personal watercraft use on Lake Powell is concentrated in areas associated with entry ports and marinas such as Bullfrog, Wahweap, Hite, and Halls Crossing; and launch ramps such as Antelope Point and Stateline.

In Glen Canyon National Recreation Area, personal watercraft are often used in conjunction with houseboats and other powerboats. Fueling stations enable these larger boats to access any location on the lake. As a result, personal watercraft are used throughout the lake, including remote areas well away from launch points or other developed facilities.

The *Superintendent's Compendium* (NPS 2002c), for Glen Canyon National Recreation Area (36 CFR 1.7 (b), 3.6) permits the use of personal watercraft in Glen Canyon National Recreation Area on Lake Powell and in the upper Colorado, Escalante, Dirty Devil, and San Juan Rivers. Personal watercraft users in the recreation area must comply with regulations set forth by Arizona and laws and rules set forth by Utah while operating on the waters within these states.

OBJECTIVES IN TAKING ACTION

Objectives were established to determine whether alternatives for managing personal watercraft use at Glen Canyon National Recreation Area would be successful. All action alternatives selected for detailed analysis had to substantially meet all of the objectives and also had to resolve the purpose of and need for action.

Objectives for managing personal watercraft use were developed from the Glen Canyon National Recreation Area enabling legislation, mandates and direction in the general management plan and strategic plan, and other management documents. All objectives are compatible with the purpose and significance statements of Glen Canyon National Recreation Area presented above. For each impact topic, the recreation area objectives as defined in the general resource management plans (NPS 1979a, 1986) and the objectives for management of personal watercraft are presented in table 3.

TABLE 3: OBJECTIVES FOR RECREATION AREA MANAGEMENT AND PERSONAL WATERCRAFT MANAGEMENT

Impact Topic	Recreation Area Management Objective	Personal Watercraft Management Objective
Water quality	Encourage the maintenance of high water quality in all bodies and sources of water and perpetuate the natural flow of free water.	Manage personal watercraft emissions that enter the water in accordance with water quality protection policies and goals. Protect aquatic organisms from personal watercraft effects, including those related to emissions and sediment. Manage human wastes associated with personal watercraft use in accordance with water quality protection policies and goals.
Air quality	No objective identified.	Manage personal watercraft activity so that exhaust emissions do not appreciably degrade ambient air quality.
Soundscapes	No objective identified.	Manage the effects of personal watercraft on soundscapes in a manner consistent with recreation area management zones.
Wildlife and wildlife habitat	No objective identified.	Protect fish and wildlife (including endangered or threatened species) and their habitats from personal watercraft disturbances. Protect fish and wildlife from the potential adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.
Threatened and endangered species	Protect all known populations of endangered fish species from impacts of human activities in the Glen Canyon National Recreation Area. Protect river inflow as native species habitat.	Protect endangered or threatened species (both fauna and flora) and their habitats from personal watercraft disturbances.
Shoreline vegetation	No objective identified.	Manage personal watercraft use to protect native vegetation at or near the shoreline from personal watercraft user activity and access.
Visitor experience and conflict	Manage the recreation area so that it provides maximal recreational enjoyment to the American public and their guests.	Manage personal watercraft use to enhance the quality of the visitor experience. Reduce potential conflicts associated with personal watercraft use and other uses of Glen Canyon National Recreation Area.
Visitor safety	No objective identified.	Reduce the potential for personal watercraft user accidents.
Cultural resources	Interpret historical and archeological resources and the culture of aboriginal societies while centering interpretive themes around outdoor recreation.	Manage personal watercraft use and access to enhance protection of cultural resources.

Impact Topic	Recreation Area Management Objective	Personal Watercraft Management Objective
Socioeconomic environment	No objective identified.	Minimize adverse effects of personal watercraft-related management policies within the recreation area on water-recreation-based businesses.
Federal/state cooperation and recreation area operations	Maximize the efficiency and effectiveness of the management of the recreation area and adjacent lands. Cooperate with the Bureau of Reclamation in their management of the reservoir. Cooperate with the Navajo Tribe in managing and developing the southern shoreline of Lake Powell for recreational use.	Maintain cooperation with state entities that regulate personal watercraft use and protect quality of air and water. Provide sufficient staffing levels as funding allows to adequately manage personal watercraft use and to resolve personal watercraft user-related conflicts.

IMPACT TOPICS AND ISSUES RELATED TO PERSONAL WATERCRAFT USE

IMPACT TOPICS EVALUATED IN THIS ENVIRONMENTAL IMPACT STATEMENT

Many of the impact topics associated with personal watercraft use at Glen Canyon National Recreation Area were identified in the settlement agreement with the Bluewater Network. The settlement requires that, at a minimum, the effects of personal watercraft use be analyzed for:

Water quality;

Air quality;

Soundscapes;

Wildlife and wildlife habitat;

Shoreline vegetation;

Visitor conflicts; and

Visitor safety.

Impact topics and issues within each impact topic also were identified during scoping meetings with NPS staff, through consultation with other federal and state agencies, and as a result of public comments. Impact topics beyond those required by the settlement agreement that were considered in this environmental impact statement included:

Endangered or threatened species;

Wetlands and submerged aquatic vegetation, which were combined with the consideration of shoreline vegetation;

Visitor use and experience;

Cultural resources;

Socioeconomic effects; and

National recreation area operations.

ISSUES RELATED TO PERSONAL WATERCRAFT USE IN GLEN CANYON NATIONAL RECREATION AREA

Personal watercraft issues specific to Glen Canyon National Recreation Area are briefly summarized below. The relevant current conditions of impact topics are discussed in detail in the "Affected Environment" chapter. Impacts associated with each of the personal watercraft management alternatives are described in the "Environmental Consequences" chapter.

Water Quality

As described earlier in the section entitled "Summary of National Information on the Effects of Personal Watercraft," two-stroke, carbureted personal watercraft engines discharge as much as 30% of their fuel directly into the water. Release of these chemical compounds into surface waters may degrade water quality for multiple uses, including aquatic life, drinking water, and agricultural water supplies.

Some research shows that polycyclic aromatic hydrocarbons, including those from personal watercraft emissions, adversely affect water quality via harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). Phytoplankton and zooplankton are important components of the aquatic food chain.

Personal watercraft do not have portable toilets on-board. This condition may contribute to water quality degradation as a result of the introduction of human waste into the lake.

Air Quality

Personal watercraft emit nitrogen oxides, volatile organics, and other compounds that may adversely affect air quality. Visibility effects may occur from the discharge of exhaust smoke into the air. Photochemical transformations of the engine emissions may affect visibility conditions in the recreation area.

Soundscapes

The noise from personal watercraft may be more disturbing than sounds from other watercraft because of numerous changes in pitch associated with frequent changes in speed.

Wildlife and Wildlife Habitat

Personal watercraft uses may affect fish and wildlife, which could include alarm or flight, avoidance of disturbed areas, degradation of habitat, and effects on reproductive success. Wildlife effects may be caused by personal watercraft noise and their ability to access shallow water areas and riparian habitats.

Endangered or Threatened Species

Concerns about personal watercraft effects on endangered or threatened wildlife would be similar to those described above for other wildlife in the recreation area. Personal watercraft use represents a concern to endangered or threatened plant species because the craft can go ashore on beaches and side canyons, providing access to plant habitats.

Shoreline Vegetation

Personal watercraft users may go ashore on beaches and side canyons, allowing visitors to access shoreline areas where they may trample vegetation. Effect on submerged aquatic vegetation would be limited because in most areas, unsuitable shoreline substrates, steep shoreline slopes, or large seasonal fluctuations of water surface elevations would preclude development of submerged aquatic vegetation.

Visitor Experience and Visitor Conflicts

Personal watercraft characteristics such as noise, odors, safety hazards, and operational style may affect the experience for some other recreation area visitors. Personal watercraft speed, operator behavior, and proximity to other lake users can pose conflicts and safety hazards. Inexperience in launching personal watercraft, combined with congestion in the launch ramp area, may result in conflicts between personal watercraft users and other motorcraft users.

Visitor Safety

Surveys conducted in 2001 to characterize boating use in Glen Canyon National Recreation Area indicated that personal watercraft comprised about 26% of the total vessel use (NPS unpublished data 2001d). In 2001, personal watercraft were involved in approximately 13% of all boating accidents (NPS unpublished data 2001e). Health and safety risks to personal watercraft operators and passengers could also occur because of the vessels' emissions of carbon monoxide.

Cultural Resources

Personal watercraft use may provide visitors with access to the sites of historic and archeological resources, and traditional cultural properties that are listed on or are eligible for listing on the National Register of Historic Places. However, many of these sites are located at considerable distances from areas that are easily accessible via personal watercraft, which may limit the potential for adverse effects.

Socioeconomic Effects

Personal watercraft sales and rentals and other expenditures by personal watercraft users represent an important segment of the local and regional recreation-based economy. Some businesses may be affected by actions related to a change in personal watercraft management.

Recreation Area Operations

Personal watercraft operating regulations, laws, and rules are different between Arizona and Utah, leading to some visitor confusion, and making enforcement difficult on occasion. Concern has been expressed that current recreation area staffing levels may not be adequate to manage personal watercraft-related issues or to enforce new personal watercraft management actions.

IMPACT TOPICS ELIMINATED FROM FURTHER CONSIDERATION

Director's Order 12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision Making (NPS 2001b) lists 13 impact topics that must be considered in an environmental impact statement. If any are judged to be not applicable to the federal action being evaluated, they should be identified as being dismissed from detailed evaluation. The reason should be provided.

The impact topics identified below have been dismissed from further consideration because the range of personal watercraft management alternatives would have no effect on these resources or because the impacts have been evaluated within another impact topic.

Possible Conflicts with Land Use Plans, Policies, or Controls — Plans and policies associated with lands adjacent to Lake Powell or the recreation area were reviewed. It was determined that the alternatives to manage personal watercraft use in the recreation area would not involve actions that would affect these lands. Therefore, the management of personal watercraft within the recreation area would not conflict with any land use plans, policies, or controls.

Urban Quality, Historic and Cultural Resources, and Design of the Built Environment — Historic and cultural resources were included as an impact topic that was considered in detail in this environmental impact statement. Urban quality and design of the built environment were eliminated from further consideration because the recreation area is not in an urban setting and there is little or no development that would be affected by personal watercraft management actions.

Socially or Economically Disadvantaged Populations — Executive Order 12898, "General Actions to Address Environmental Justice in Minority and Low-Income Populations," directs agencies to address environmental and human health conditions in minority and low-income communities so as to avoid the disproportionate placement of any adverse effects from federal policies and actions on these populations. This topic was dismissed from further analysis because NPS actions to manage personal watercraft use at the recreation area would not displace personal watercraft use to minority or low-income communities. Local residents may include low-income populations; however, these populations would not be disproportionately affected by any of the proposed alternatives. The decision to dismiss was supported by notification received from the Navajo Nation Historic Preservation Department, Traditional Cultural Program that the Navajo Nation does not currently have any concerns with the proposed project.

Floodplains — The alternatives do not involve development that would change water surface elevations or cause flooding that would affect human safety, health, or welfare. None of the personal watercraft or related activities identified in the alternatives would cause effect on floodplains.

Prime and Unique Agricultural Lands — There are no prime or unique agricultural lands located within areas of Glen Canyon National Recreation Area that would be affected by personal watercraft management.

Ecologically Critical Areas, Wild and Scenic Rivers, or Other Unique Natural Resources — The areas of Glen Canyon National Recreation Area that would be affected by management of personal watercraft use do not contain ecologically critical areas, wild and scenic rivers, or other unique natural resources, as referenced in 40 CFR 1508.27.

Indian Trust Resources — Indian trust assets are assets that the United States holds and administers for Indian tribes. The federal Indian trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to American Indian and Alaska Native tribes. Indian trust resources would not be affected by personal watercraft management. Therefore, this impact topic was eliminated from further consideration.

RELATIONSHIPS TO OTHER PLANS, POLICIES, AND ACTIONS

Numerous National Park Service, federal, and state plans, policies, and actions could affect the alternatives or cumulative impacts analysis for personal watercraft management. These plans and policies are also considered in the analyses of cumulative effects. From newest to oldest, the most relevant include the following.

Bureau of Reclamation Reservoir Operations Plan, Updated Annually. The Bureau of Reclamation is required by section 602 of the *Colorado River Basin Project Act* to prepare an operations plan each year. The plan establishes:

> The operation of reservoirs on the Colorado River under the year's anticipated hydrologic and climatic conditions;
>
> The quantity of water requiring storage;
>
> The water available for delivery and whether water consumptive users will be normal, surplus or shortage; and
>
> Whether water apportionments not used could be allocated to other downstream beneficial users.

Glen Canyon Dam is managed primarily to meet statutory water delivery obligations, with consideration to maintaining or improving instream flow for aquatic resources. Within these obligations, release restrictions for maximum and minimum flows are established.

Antelope Point Marina and Ramp Development Plan, 2002. This plan would increase visitor use by adding up to 300 boat slips, a marina, hotel, and boat launch. Although the marina would not provide personal watercraft rentals, a portion of the increased visitor use would come from personal watercraft operations.

Strategic Plan for Glen Canyon National Recreation Area and Rainbow Bridge National Monument, October 1, 2000 – September 30, 2005. This plan translated servicewide mission goals into objectives with specific targets to be accomplished at Glen Canyon National Recreation Area. Some of the objectives that could be relevant to personal watercraft management include:

> Protecting water quality by ensuring that all discharge permit requirements are met and that the recreation area would not be subject to any notices of violations;
>
> Improving the protection of at least two endangered or threatened fish species;
>
> Protecting and improving the condition of archeological resources so that at least 30% of the non-inundated sites would meet the classification for good condition;
>
> Ensuring a 95% visitor satisfaction rate; and
>
> Protecting visitor safety with an accident rate that does not exceed the level in the early 1990s.

Grazing Management Plan, Glen Canyon National Recreation Area, 1999. This plan described the resource protection and grazing administrative responsibilities of the National Park Service and

Bureau of Land Management; assessed range conditions; established the goals, objectives, and recommendations for grazing practices and management actions; and established the maximum grazing intensities to ensure compatibility with the recreation area. The plan included establishment of a monitoring plan for the protection of water resources, vegetation (including riparian resources), and cultural resources.

Glen Canyon National Recreation Area Fish Management Plan, 1996. This plan provided long-range planning and management for endangered and native fish species within the recreation area. It included coordination of inter-agency efforts for habitat protection and management, and for providing adequate inflow. Policies were established that would maintain or enhance forage conditions to allow adequate nutrition of all fish in Lake Powell, and to improve nursery habitat by providing adequate vegetative cover. Another goal of the plan was to understand and minimize the impacts of dam operation on native and sport fish population.

Environmental Assessment and Management/Development Concept Plans for Lake Powell's Accessible Shorelines, 1988. These plans provided management strategies for all shoreline areas and site-specific strategies to resolve specific problems. Goals included reducing resource impacts and visitor conflicts, and improving shorelines for recreation use. It included monitoring actions to evaluate the effectiveness of management strategies.

Water Resource Management Plan, 1987. This document provided a 10-year water resource management plan for Glen Canyon National Recreation Area. Its goal was to provide adequate management to ensure public use and recreation enjoyment. It covered Lake Powell, its tributaries, and the waters of adjoining lands, including springs, seeps, ephemeral streams, and groundwater.

Glen Canyon Natural Resource Management Plan, 1986. This plan addressed research, monitoring, and actions to manage the natural resources of the recreation area. The plan specified eight resource areas and ranked the management areas for inventory and analysis. It also set a recommended course of action for protection of resources from impacts of human activities.

Development Concept Plan for Hite Marina, 1982. This plan established guidelines for development of facility infrastructure for the next 10 years. It included improved parking and traffic circulation, housing, camping, boating, and day use facilities.

Glen Canyon National Recreation Area General Management Plan, **1979**. The most recent *General Management Plan* for the recreation area, including Lake Powell, was completed in 1979 and reprinted in 1991. Much has changed since this document was written, including visitor use patterns and the emergence of personal watercraft as a popular recreation vessel. The plan established management zones, including the Recreation and Resource Utilization Zone on the lake surface, and the land-based Natural, Cultural, and Development Zones. The plan recognized that the shoreline of Lake Powell fluctuates with the water level and established that the boundaries between the Recreation and Resource Utilization Zone and the land-based zones would change with the shoreline. This action was important because it defined the limits of the Recreation and Resource Utilization Zone within which watercraft could be used.

Glen Canyon National Recreation Area Act of 1972 (PL 92-593 Appendix 1). Congress established Glen Canyon National Recreation Area for public outdoor recreation use and enjoyment of the lake and lands adjacent to it and to preserve scenic, scientific, and historic features for public enjoyment. The act specifies that there shall be no effect or interference with the authority of the

Secretary of the Interior to operate Glen Canyon Dam and Lake Powell for the *Colorado River Storage Project Act* as administered by the Bureau of Reclamation.

Section 6 of the Enabling Legislation Public Law 92-593. Grazing is administered by the Bureau of Land Management. The National Park Service and the Bureau of Land Management coordinate and promote the effective management of livestock grazing with other resource management.

Memorandum of Agreement, September 17, 1965 between the Bureau of Reclamation and the National Park Service. This document related to the administration and development of lands and facilities at the Glen Canyon Unit of the Colorado River Storage Project. It specified the transfer of the Glen Canyon reservoir area to the National Park Service, which would develop and manage the area for recreational purposes. It established cooperative management procedures, objectives, and activities for using the structures, lands, and water resources. It had several attachments, including:

> **Memorandum of Understanding** between the National Park Service and Bureau of Land Management in Utah. This joint agreement covers the portion of the recreation area in Utah. It delineates geographic areas of common concern, including development, maintenance, planning, annual operations, and approval plans. To promote efficiency of operations and service to the public, land use management plans are jointly reviewed for any adjustments in boundaries or management responsibility. This joint analysis and review includes cooperation on all *National Environmental Policy Act*, wildlife, grazing, mineral leasing, and watershed management compliance.
>
> **Memorandum of Understanding** between the National Park Service and the Bureau of Land Management in Arizona. This joint agreement covers the portion of the recreation area in Arizona. It provides a joint agreement to determine grazing zones and procedures for grazing permits, developments, and improvements.
>
> **Memorandum of Agreement** between the National Park Service and the Navajo Tribe. This agreement involves joint administration for "Parcel "B" lands, including lands below elevation 3,720 feet northeast of Antelope Creek and within the recreation area contiguous to the Navajo Indian Reservation. The agreement covers the construction of all recreation facilities and utilities in accordance with a long-range management and development plan for the recreation area.

Exchange Act of September 2, 1958 (72 Stat. 1686). Under this act, "Parcel B" lands were transferred to the federal government. Such lands are not to be used for public recreational facilities without the approval of the Navajo Tribal Council.

Colorado River Storage Project Act of April 11, 1956 (PL 84-485). This act authorized the construction of Glen Canyon Dam. It directs the purposes and policies for using Lake Powell for river regulation, irrigation, flood control, and generation of hydroelectric power.

Arizona Statute Title 3, Chapter 7 (Article 1, Section 3-903). This law authorizes the director of the Arizona Department of Agriculture to establish and maintain a list of state-protected native plants. The statute provides for protection of native plants on both publicly and privately owned lands. It also defines the terms and conditions for investigations of native plants and authorizes the state to determine where protected species occur.

The Utah State Lands Endangered and Threatened Plant Species Statute (Title 65A-2-3). This state law defines the terms and conditions of the state status of endangered or threatened plant species.

The State Lands Division may make determinations concerning the management, protection, and conservation of plant species officially designated as endangered or threatened under the federal *Endangered Species Act of 1973*, as amended, on state lands.

Federal, Arizona, and Utah Boating Laws. The boating laws of all three jurisdictions apply to all or part of the waters of Lake Powell. Regulations, laws, and rules are enforced by several agencies, including the National Park Service, U.S. Coast Guard, Utah State Parks and Recreation, Utah Department of Natural Resources, and Arizona Game and Fish Department.

EPA Final Rule for Gasoline Spark-Ignition Marine Engines. As directed under section 213 of the *Clean Air Act*, as amended in 1990 (CAA 1990), the Environmental Protection Agency passed a regulation on December 3, 1996 (EPA 1996b), to regulate exhaust emissions from new spark-ignition gasoline marine engines (including outboard engines, personal watercraft engines, and jet boat engines) because exhaust emissions from spark-ignition gasoline marine engines cause or contribute to ozone in more than one ozone nonattainment area (an area that does not meet the national ambient air quality standards for ozone). Once the program is fully implemented, the manufacturers of these engines must demonstrate to the Environmental Protection Agency that hydrocarbon emissions are reduced by 75% from present levels through testing engines representative of the product line before sale and after use. The result of these regulations will be a new generation of cleaner gasoline marine engines that will be available to boaters.

The emission standards were phased in beginning with the 1998 model year and will be fully implemented in the 2006 model year. The emission standard is being phased in to provide time to develop new technology.

ALTERNATIVES

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Three alternatives were evaluated for the management of personal watercraft at Glen Canyon National Recreation Area. At a minimum, all three alternatives satisfied the need for the project, described in the "Purpose of and Need for Action" chapter, met most of the project objectives that were presented in table 3, and were judged to be implementable. Proposed alternatives or actions that did not meet these criteria are described at the end of this section under the heading "Alternatives Eliminated from Further Consideration."

The alternatives analyzed in this document in accordance with the *National Environmental Policy Act* are the result of agency and public scoping input. The action alternatives (alternative A and alternative B) would provide for use of personal watercraft under a special regulation. The no-action alternative (alternative C) would make permanent the ban on personal watercraft use that took effect in November 2002.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Alternative A would involve issuing a special regulation that specifically authorized the use of personal watercraft in Glen Canyon National Recreation Area. The use would be identical to that occurring before September 15, 2002 without further modifications, mitigations, or restrictions. A summary of the features of alternative A is provided in table 4. Key components are illustrated on the alternative A maps (figures 3, 4, and 5).

Alternative A recognizes that market and regulatory factors outside of NPS control will change personal watercraft use within the recreation area. This includes a 1996 EPA regulation for the manufacture of cleaner-technology engines. On October 4, 1996, the Environmental Protection Agency published a final rule that established emission standards for new spark ignition marine engines (EPA 1996a). The applicable emission standards are being phased-in, beginning in the 1998 model year, and will be fully implemented in the 2006 model year. This rule requires each manufacturer of personal watercraft and other spark ignition boat engines to meet a corporate fleet average emission level that reduces hydrocarbon emissions by 75%, compared to their corporate fleet average emissions prior to the rule (EPA 1996a).

The EPA action is expected to produce lower levels of hydrocarbon emissions, smoke, fumes, and noise compared to engines currently in use (EPA 1996b). Implementation of the new regulation will, over time, change the types of personal watercraft used in the recreation area, as personal watercraft users replace old engines with new, cleaner models.

LOCATION RESTRICTIONS

Personal watercraft use would be authorized in all areas, except where specifically prohibited in the *Superintendent's Compendium* (NPS 2002c) (36 CFR 1.7 (b)).

Under alternative A, personal watercraft would be prohibited from traveling upstream along portions of the Escalante, San Juan, Colorado, and Dirty Devil Rivers, as stated in the *Superintendent's Compendium* (NPS 2002c) (36 CFR 1.7 (b), section 3.6) and summarized below. Downstream travel through the areas identified below would be allowed.

TABLE 4: SUMMARY OF ALTERNATIVES

Features	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B Modified Preferred Alternative: Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
Personal watercraft engine technology	Glen Canyon National Recreation Area would not institute any restrictions on personal watercraft engine technology.	Personal watercraft would need to meet the 2006 EPA marine engine emission standards by the end of 2012 and in subsequent years. Personal watercraft not meeting the standards would no longer be permitted to operate within Glen Canyon National Recreation Area beginning in 2013.	Personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Location restrictions	Personal watercraft travel upstream on the Dirty Devil River would be prohibited upstream from the point where measurable downstream current is encountered (about 9 miles).	Personal watercraft use in either direction on the Dirty Devil River would be prohibited upstream from the Utah Highway 95 Bridge (about 19 river miles).	Personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
	Personal watercraft travel upstream on the Escalante River would be prohibited upstream from the confluence with Coyote Creek (about 41 miles).	Personal watercraft use in either direction on the Escalante River would be prohibited upstream from the confluence with Coyote Creek (about 41 river miles).	Personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
	Personal watercraft travel upstream on the San Juan River would be prohibited upstream from the Clay Hills pullout (about 38 miles).	Personal watercraft use in either direction on the San Juan River would be prohibited upstream from the Clay Hills pullout (about 38 river miles).	Personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
	Personal watercraft travel upstream on the Colorado River would be prohibited upstream from the base of Imperial Rapid (about 2 miles).	Personal watercraft use in either direction on the Colorado River would be prohibited upstream from Sheep Canyon (about 25 river miles).	Personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Wake restrictions	Flat-wake speed or speeds below 5 miles per hour would be required at harbors, mooring areas, flat-wake areas, and other "flat-wake" buoyed areas.	Same as alternative A. In addition: Flat-wake speed would be required from Cow Canyon upstream to the confluence of Coyote Creek on the Escalante River (about 7 river miles).	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.

Features	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B Modified Preferred Alternative: Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
Launch restrictions	Personal watercraft could be launched and retrieved in the following locations only: • Public launch ramps • Beach areas in Lone Rock off-road use area • Beach areas at Stanton Creek, Upper Bullfrog North, and Upper Bullfrog South primitive camping areas that are legally accessible by motor vehicles • Take-out area on the San Juan River at Clay Hills Crossing • Red Canyon area • Paiute Farms area • Hite from 300 feet upstream of the public launch ramp to 300 feet upstream of the marina houseboat loading dock • Farley Canyon area • White Canyon area.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Age restrictions and certification requirements	• Personal watercraft users would have to comply with state regulations, laws, and rules. • Arizona regulations state that children younger than 12 can operate personal watercraft when accompanied by an adult and that children older than 12 can operate personal watercraft alone. • Utah laws and rules state that children aged 12 to 15 can operate personal watercraft after completing a mandatory boating education course if they remain within visual parental supervision, and that children ages 16 and 17 must complete a mandatory boating education course and carry the certificate to operate without supervision.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.

Features	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B Modified Preferred Alternative: Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
Safety restrictions			
Flotation devices	Personal watercraft operators would have to wear personal floatation devices.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Lanyard cut-off	In Arizona, personal watercraft operators would have to fasten a lanyard cut-off device to the rider if the personal watercraft has one installed.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Daylight restrictions	Personal watercraft users would have to comply with state regulations, laws, and rules. • In Arizona, riders can operate a personal watercraft between sunset and sunrise only if the personal watercraft has lights installed. • In Utah, riders cannot operate personal watercraft between sunset and sunrise.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Speed restrictions	Personal watercraft users would have to comply with state regulations, laws, and rules. • Based on Arizona regulations, a rider could not operate a personal watercraft at a speed that was unreasonable for existing conditions or above flat-wake speed within 60 feet of another vessel. • Utah laws and rules state that a person cannot operate above flat-wake speed when within 150 feet of another vessel, a person in or floating on the water, a waterskier, a shore fisherman, a launching ramp, a dock, or a designated swimming area.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Operating restrictions	Personal watercraft users would have to comply with state regulations, laws, and rules. In Arizona, a personal watercraft operator who commits two or more of the following acts simultaneously is considered reckless or negligent: • Operating closer than 60 feet to another vessel unless both are flat-wake; • Obstructing the visibility of another vessel	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.

Features	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B Modified Preferred Alternative: Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	operator; • Jumping wake within 60 feet of a vessel and causing half of the personal watercraft to leave the water; and/or • Maneuvering quickly, turning sharply, or swerving within 60 feet of a vessel unless to avoid a collision. In Utah, a person who operates in a reckless manner with regard to injury or property commits a misdemeanor.		
Alcohol and drugs	To comply with Arizona and Utah law, it would be illegal to operate a personal watercraft with a blood alcohol content of 0.08% or more, while impaired, or while under the influence of drugs.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Carrying capacity	Under Arizona regulations, a personal watercraft operator could not carry more passengers or cargo than recommended by manufacturer.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Noise	In Arizona, no personal watercraft may be operated in a manner that causes it to emit a sound level in excess of 86 decibels when measured from a distance of 50 feet or more. In Utah, a personal watercraft may not be operated in a manner that will cause it to emit more than 75 decibels of noise at the shoreline.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Insurance requirements	In Utah, personal watercraft owners or operators would have to carry evidence of insurance with them while operating a personal watercraft.	Same as alternative A.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Enforcement	Personal watercraft would be permitted on Lake Powell. Personal watercraft would have to comply with all applicable provisions of 36 CFR as well as regulations, laws, and rules pertaining to personal watercraft prescribed by the states of Arizona and Utah while operating on their respective waters.	Enforce federal and state regulations, laws, and rules, similar to alternative A. Seek additional funding to increase enforcement capability, and enhance visitor contact to reduce visitor conflicts. Work cooperatively with Arizona and Utah in an attempt to develop unified laws for personal	Enforcement would focus on other uses of the recreation area. Seek additional funding to increase enforcement capability.

Features	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B Modified Preferred Alternative: Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	Seek additional funding to increase enforcement capability.	watercraft operations within the recreation area boundaries.	
Education	No education enhancements would be included in this alternative.	Improve and enhance materials to educate visitors on personal watercraft regulations and safe operating procedures. Provide materials that highlight areas of the lake where visitors can experience natural quiet and solitude.	Educate visitors on the personal watercraft ban at the recreation area.
Sanitation	Continue to evaluate locations for additional portable toilets.	Same as alternative A.	Same as alternative A.
Monitoring and sampling	Continue current monitoring program for bacteriological contamination near beaches.	Continue bacteriological contamination monitoring. Implement new air and water monitoring and sampling program for hydrocarbon contamination. Implement a program to monitor noise related to personal watercraft use, as funds allow.	Not applicable – personal watercraft use would be prohibited in Glen Canyon National Recreation Area.
Lake management plan	A lake management plan would be prepared, as funds allow. A three-year pilot study would be conducted to support lake management planning. The study would test whether selected management actions could mitigate conflicts between watercraft users.	Same as alternative A.	Same as alternative A.

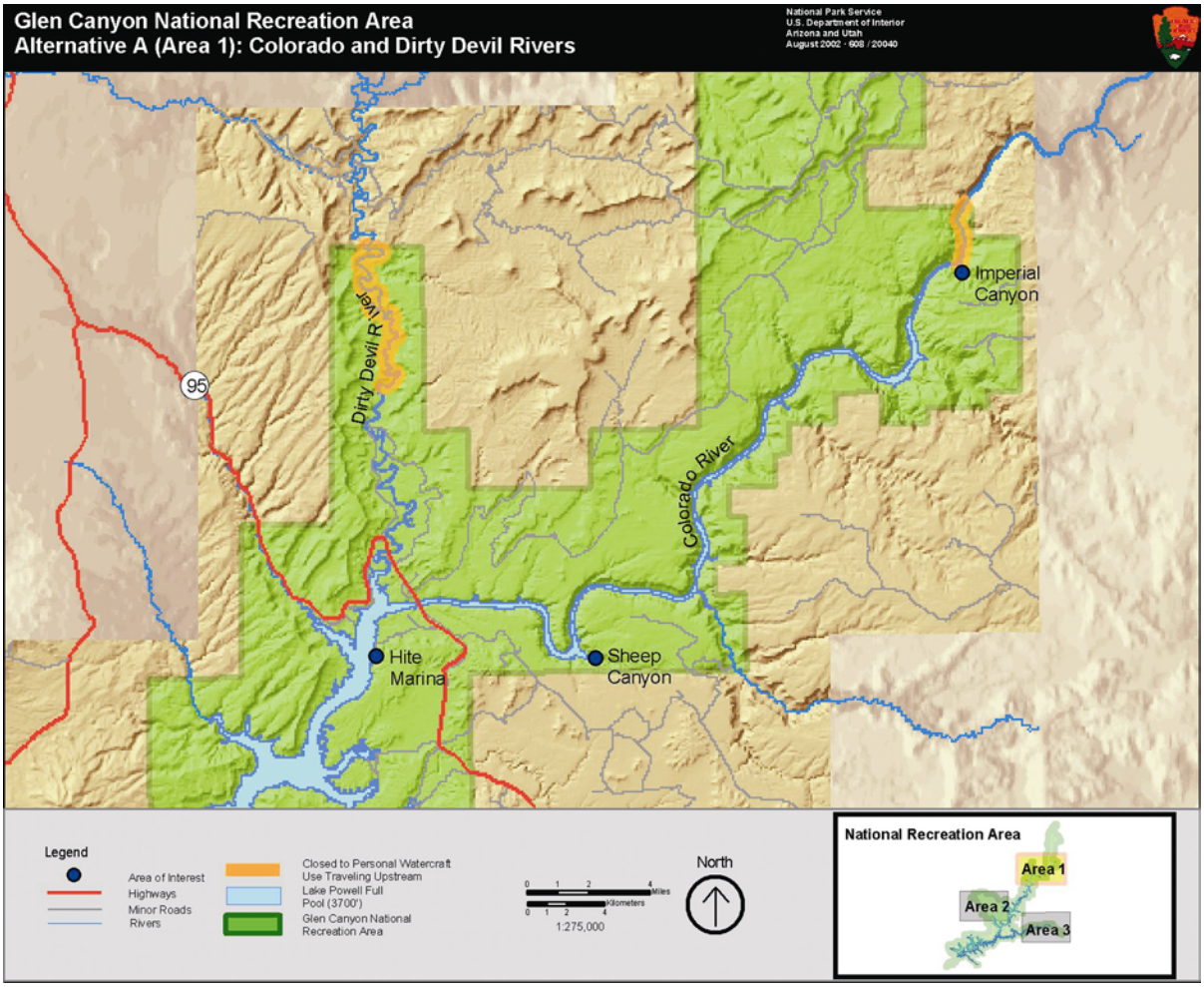

FIGURE 3: GLEN CANYON ALTERNATIVE A (AREA 1) — COLORADO AND DIRTY DEVIL RIVERS

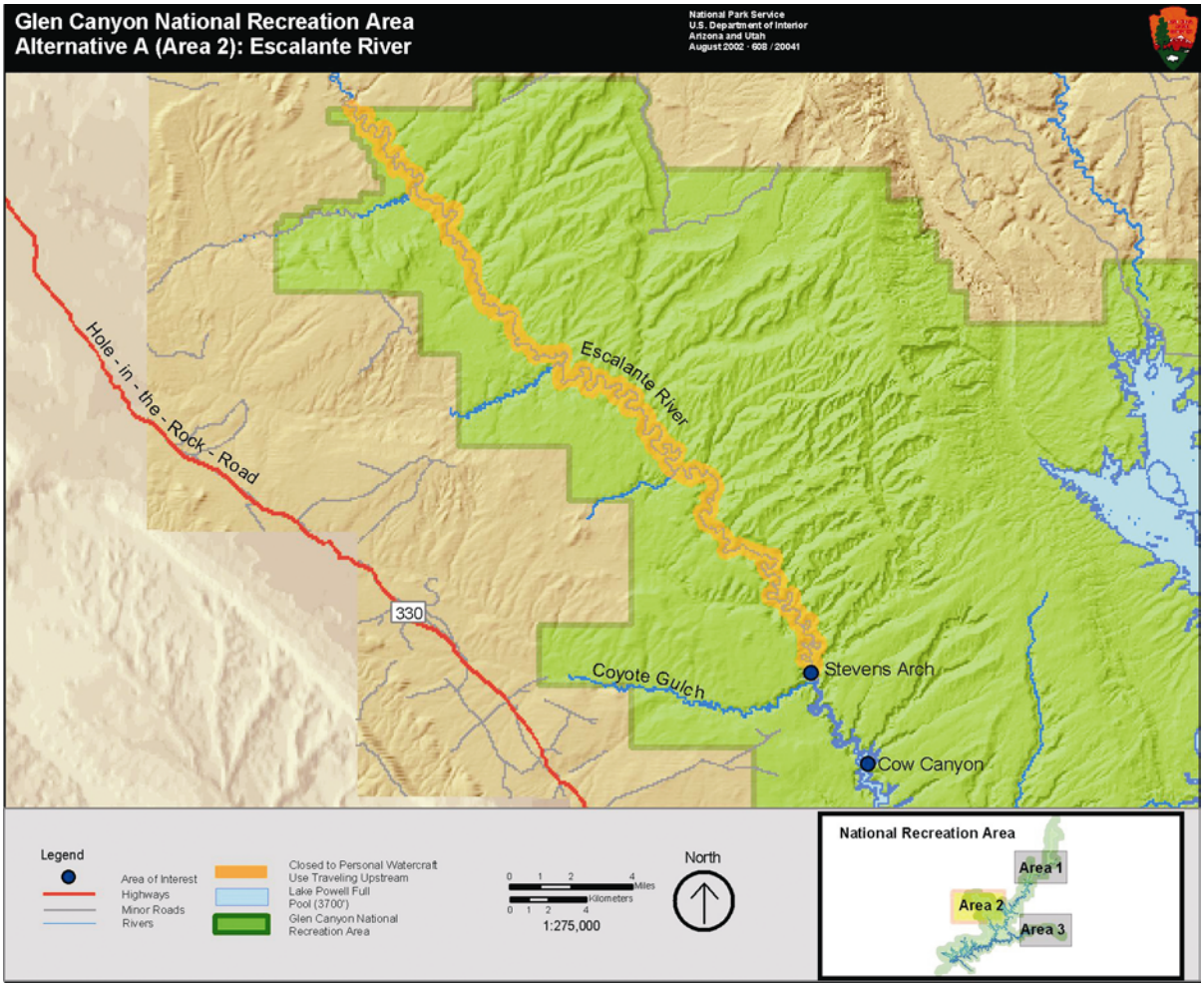

FIGURE 4: GLEN CANYON ALTERNATIVE A (AREA 2) — ESCALANTE RIVER

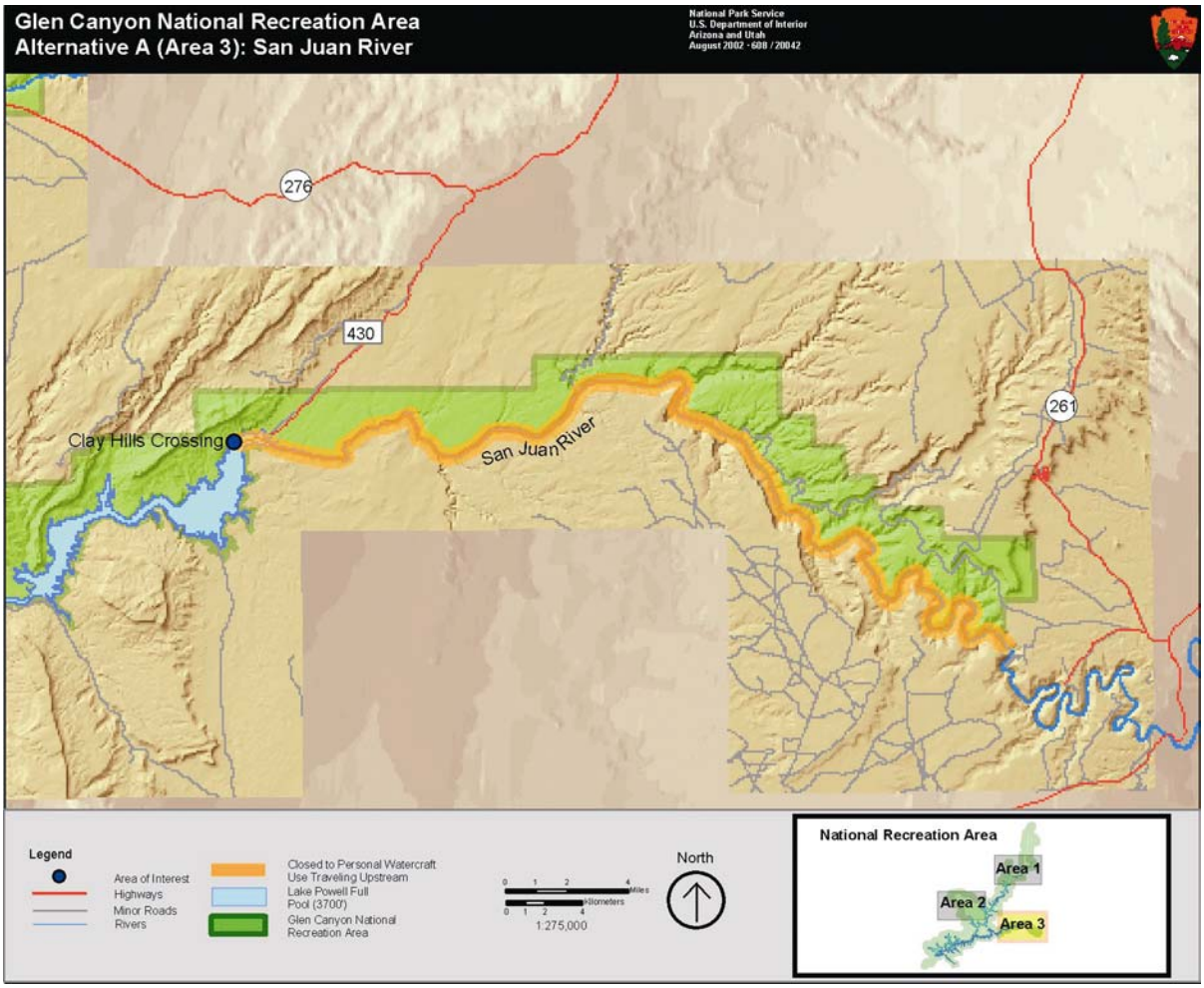

FIGURE 5: GLEN CANYON ALTERNATIVE A (AREA 3) — SAN JUAN RIVER

On the Escalante River, personal watercraft would be prohibited from upstream travel upstream from the confluence of Coyote Creek. Allowing personal watercraft to be operated as far as the Coyote Creek confluence would provide personal watercraft users reasonable access to view Stevens Arch, a popular geological landmark and sightseeing attraction, as well as to hike nearby canyons, including Coyote Gulch. Prohibiting upstream travel by personal watercraft upstream of the confluence with Coyote Creek would maintain an atmosphere of quiet and solitude, qualities that backpackers and other backcountry hikers desire while visiting the area.

Upstream travel on the Dirty Devil River would be prohibited upstream from the point where measurable downstream current was encountered.

Personal watercraft would be prohibited from upstream travel on the Colorado River upstream from the base of Imperial Rapids. Upstream motorized running of rapids is an advanced boating skill that most visitors to the recreation area do not possess. Restricting personal watercraft users to areas below these rapids would prevent visitors from endangering themselves.

Upstream travel by personal watercraft on the San Juan River upstream of Clay Hills would be prohibited. Clay Hills is the traditional termination and pullout retrieval point for rafting parties

on the San Juan River. Prohibiting personal watercraft upstream use above this point would prevent recreational use conflicts.

WAKE AND LAUNCH RESTRICTIONS

Visitor safety would be protected through the implementation of wake and launch area restrictions. All of the restrictions contained in the *Superintendent's Compendium* (NPS 2002c) would be in the special regulation and would remain in effect for both the short and long term. These would include the following.

A personal watercraft operator cannot operate at speeds in excess of 5 miles per hour or create a wake when operating within harbors, mooring areas, flat-wake areas, and other "flat-wake" buoyed areas (36 CFR 1.7 (b), section 3.6).

Operators could launch and retrieve personal watercraft only in areas designated by the *Superintendent's Compendium* (NPS 2002c). These sites are listed in table 4. During periods of low water, a dock may be placed in Glen Canyon National Recreation Area at the boundary with Rainbow Bridge National Monument to facilitate visitor access to the monument.

ENFORCEMENT OF FEATURES REGULATED BY THE STATES OF ARIZONA AND UTAH

Arizona and Utah regulate several aspects of personal watercraft use that are not included in the superintendent's compendium. These include, but may not be limited to:

Age restrictions and certification requirements;

Use of a lanyard cutoff;

Operation of a personal watercraft during the period between sunset and sunrise;

Speed restrictions;

Operational restrictions, including such factors as alcohol, drugs, distance from other vessels, number of passengers, and noise levels; and

Proof of insurance requirements.

Under alternative A, personal watercraft users would continue to comply with regulations, laws, and rules set forth by the states of Arizona and Utah while operating on the waters within these states. Summaries of the applicable regulations within each of these categories are provided in table 4. The state watercraft regulations are included in appendix B.

Glen Canyon National Recreation Area is proprietary jurisdiction, which mean that the states have primary law enforcement jurisdiction and authority. Within the recreation area, personal watercraft users are required to comply with all federal (36 CFR, Part 3; 36 CFR 7.70; 33 CFR, United States Coast Guard) and state boating laws and regulations. Alternative A would maintain the requirement to enforce both Arizona and Utah watercraft regulations, laws, and rules.

During summer high-use periods, the recreation area employs up to 38 law enforcement officers. Water patrols and enforcement would occur on a regular basis. During high-use periods, land-based users within the recreation area often place heavy demands on enforcement personnel, which limits their ability to effectively patrol the lake (Mayer 2002). To provide additional enforcement of the existing watercraft regulations on the lake, the superintendent would vigorously seek funding to increase the law enforcement capability on Lake Powell, particularly during high-visitation periods. Enhanced boat patrols would have the added advantage of increasing the number of visitor contacts on the lake to prevent unsafe actions that could result in injuries and visitor use conflicts.

EDUCATION

Personal watercraft users visiting Glen Canyon National Recreation Area would be informed of the watercraft regulations that apply on Lake Powell and would be provided with general safety information. Literature containing information about watercraft safety would be provided to visitors at the entrance gates, visitor centers, and recreation area headquarters in the form of the recreation area's newspaper and brochure, in displays, and on the recreation area website.

It would continue to be the responsibility of the watercraft user to know the applicable state and federal regulations that apply on Lake Powell. These regulations would be available to the personal watercraft user at the recreation area headquarters, in the recreation area newspaper and brochure, in displays, as launch ramp information, and through personal contacts made on the lake. This information could also be obtained prior to arrival at the recreation area on the recreation area's website.

Visitors would continue to be provided with information regarding the different types of resources that can be experienced at Glen Canyon National Recreation Area. This information would be available at the recreation area visitor centers and headquarters, and on the recreation area website, and would be provided during contacts with or presentation by interpretive rangers.

No written information is currently provided to the visitor that specifically identifies areas on the lake that can be accessed to experience natural quiet and solitude (NPS, Gossard, pers. com., April 2002f). This situation would continue under alternative A.

SANITATION

Sanitation would continue to be addressed by continuing to operate and maintain both portable and permanent toilets and pump-out stations. The recreation area currently has eight floating restrooms with pump-out facilities for use by boaters. Land-based sanitary facilities are available at marinas. Personal watercraft users that are associated with powerboats and houseboats in general have access to facilities on the larger vessel. The recreation area would continue to evaluate areas to install new portable facilities for recreational users, including personal watercraft users. The goal would be to reduce adverse water quality effects from human waste and reduce the risk of transmission of water-borne diseases.

MONITORING AND SAMPLING PROGRAMS

Under alternative A, the National Park Service would continue its participation in the program to monitor water quality. This program is being conducted in conformance with the "Strategic Plan to Protect Water Quality at Lake Powell" that was entered into in 1996 by the National Park Service and the Arizona and Utah Departments of Environmental Quality. The goal of this program is to protect human health and prevent water-borne diseases by improving and protecting the water quality of Lake Powell. Under this program, water samples are collected to monitor bacteriological contamination near beaches. Federal and state water quality standards would remain in place and annual monitoring would be conducted. No additional sampling or monitoring efforts would be implemented with alternative A.

LAKE MANAGEMENT PLAN

Under all alternatives including alternative A, the superintendent would seek funding for the development of a lake management plan to address the overall use of the recreation area. The objectives of this plan would be to improve the management of Lake Powell and to provide for the long-term protection of lake resources while allowing a range of visitor recreational opportunities. Even though the plan is proposed as part of alternative A, a separate *National Environmental Policy Act* assessment would be prepared to evaluate its effects.

The lake management plan would comprehensively consider all uses on the lake. It would also address management issues that are not being adequately addressed or resolved in other planning efforts. These issues relate to recreational use of the lake, visitor conflicts and safety, and potential impacts on recreation area resources from water-related recreation.

A soundscape management study would also be a component of the lake management plan. The sound analysis would (1) describe the baseline natural ambient sound environment in qualitative and quantitative terms; (2) identify sound sources and sound levels consistent with park legislation and purposes; (3) identify the level, nature, and origin of internal and external noise sources; (4) articulate desired future soundscape conditions; and (5) recommend the approaches or actions to achieve those conditions or otherwise mitigate noise impacts.

The lake management plan would consider visitor use patterns and management options. It would provide guidance on future infrastructure improvements, concessions and commercial services (such as watercraft rentals), recreation area operations, and educational or informational services.

To support preparation of the lake management plan, a three-year pilot study would be conducted. The study would test whether selected management actions could mitigate conflicts between watercraft users and other visitors. A description of the pilot study is provided in appendix C.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Alternative B is the NPS modified preferred alternative. Under alternative B, the National Park Service would issue a special regulation to specifically authorize the use of personal watercraft in Glen Canyon National Recreation Area.

As shown in table 4, many of the management features of alternative B would be identical to those of alternative A. However, this alternative would implement additional geographic restrictions on personal watercraft use and define an additional flat-wake zone. It also would include strategies to better protect recreation area resources, improve visitor safety, and reduce recreational use conflicts. Features of alternative B are described below and summarized in table 4. Key components are illustrated on the alternative B maps (figures 6, 7, and 8).

In addition, personal watercraft in the recreation area would be required to meet the 2006 EPA marine engine emission standards by the end of 2012 and in subsequent years. Under this alternative, carbureted two-stroke engines would be phased out over the next 10 years. This 10-year timeframe takes into consideration the typical life span of personal watercraft. The formula for determining the operating life of personal watercraft was published in the *Federal Register* on October 4, 1996 (EPA 1996a). Based on this formula, the National Park Service expects that by 2012, most personal watercraft owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes the typical operating life of a personal watercraft rental is three years and approximately five to seven years for a privately owned vessel (PWIA 2002a). Therefore, the average operating life of a personal watercraft is 5 to 10 years, depending upon the source. The 10-year phase-out period for the carbureted two-stroke engine provides a reasonable timeframe for personal watercraft users to comply with the management objectives. If, in 2013, park visitors have personal watercraft that do not meet these strict emission standards, they would not be able to operate that personal watercraft on Lake Powell.

LOCATION RESTRICTIONS

Under alternative B, about 25 miles of the Colorado River upstream from Sheep Canyon would be closed to all personal watercraft use. In addition, those portions of the Escalante, San Juan, and Dirty Devil Rivers that currently are closed to upstream personal watercraft travel, as described under alternative A, would be closed to personal watercraft use in either direction, upstream or downstream. Specifically, alternative B would prohibit personal watercraft use on the:

Dirty Devil River upstream of Utah Highway 95 Bridge (alternative B, figure 6).

Escalante River above the confluence of Coyote Creek (alternative B, figure 7).

San Juan River above the Clay Hills pullout (alternative B, figure 8).

All of these closures would increase the protection of environmental values and reduce conflict among visitor use activities. At all of these sites, the recreation area would install new buoys or other markers to delineate the boundaries above which no personal watercraft use would be permitted.

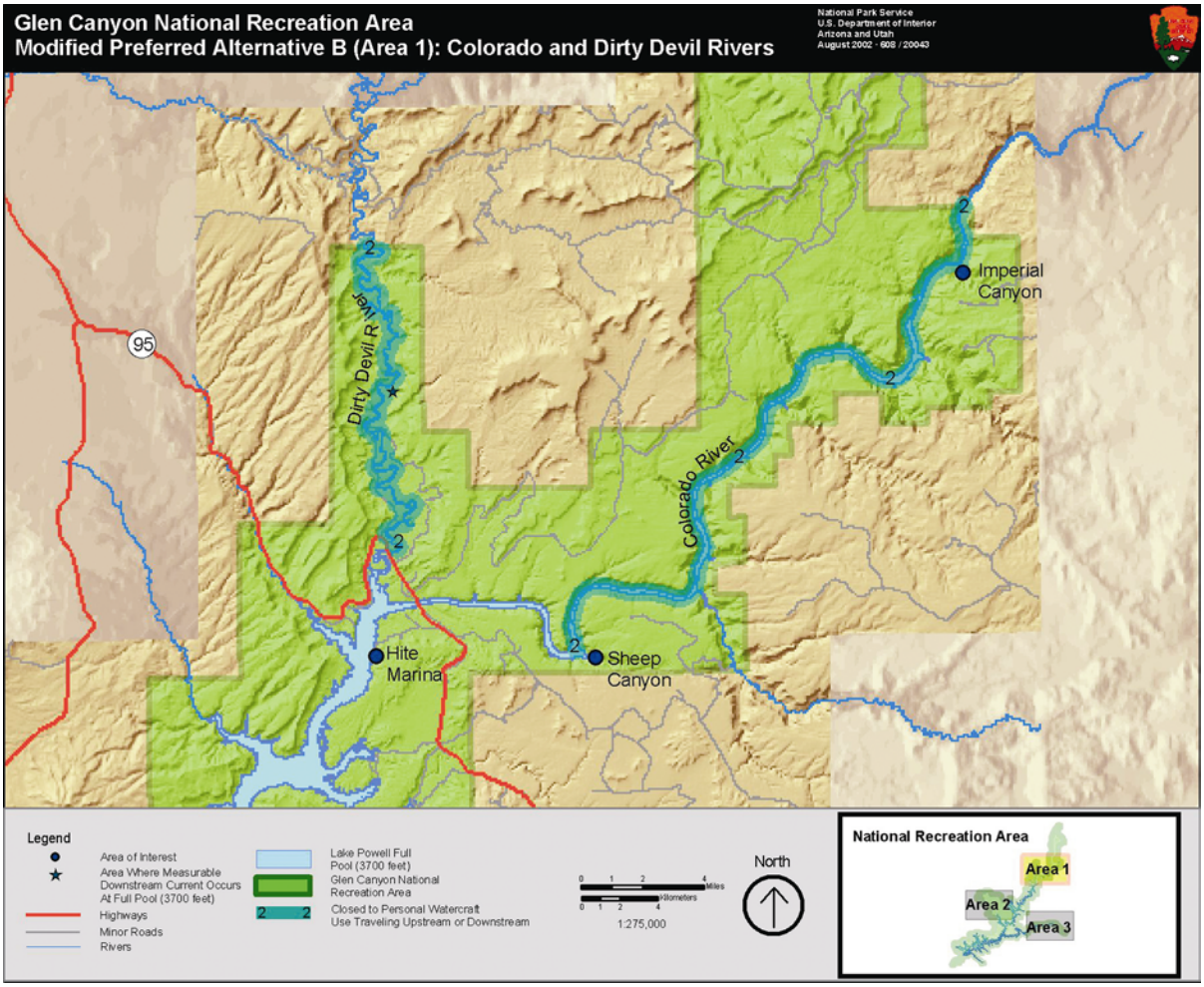

FIGURE 6: GLEN CANYON ALTERNATIVE B (AREA 1) — COLORADO AND DIRTY DEVIL RIVERS

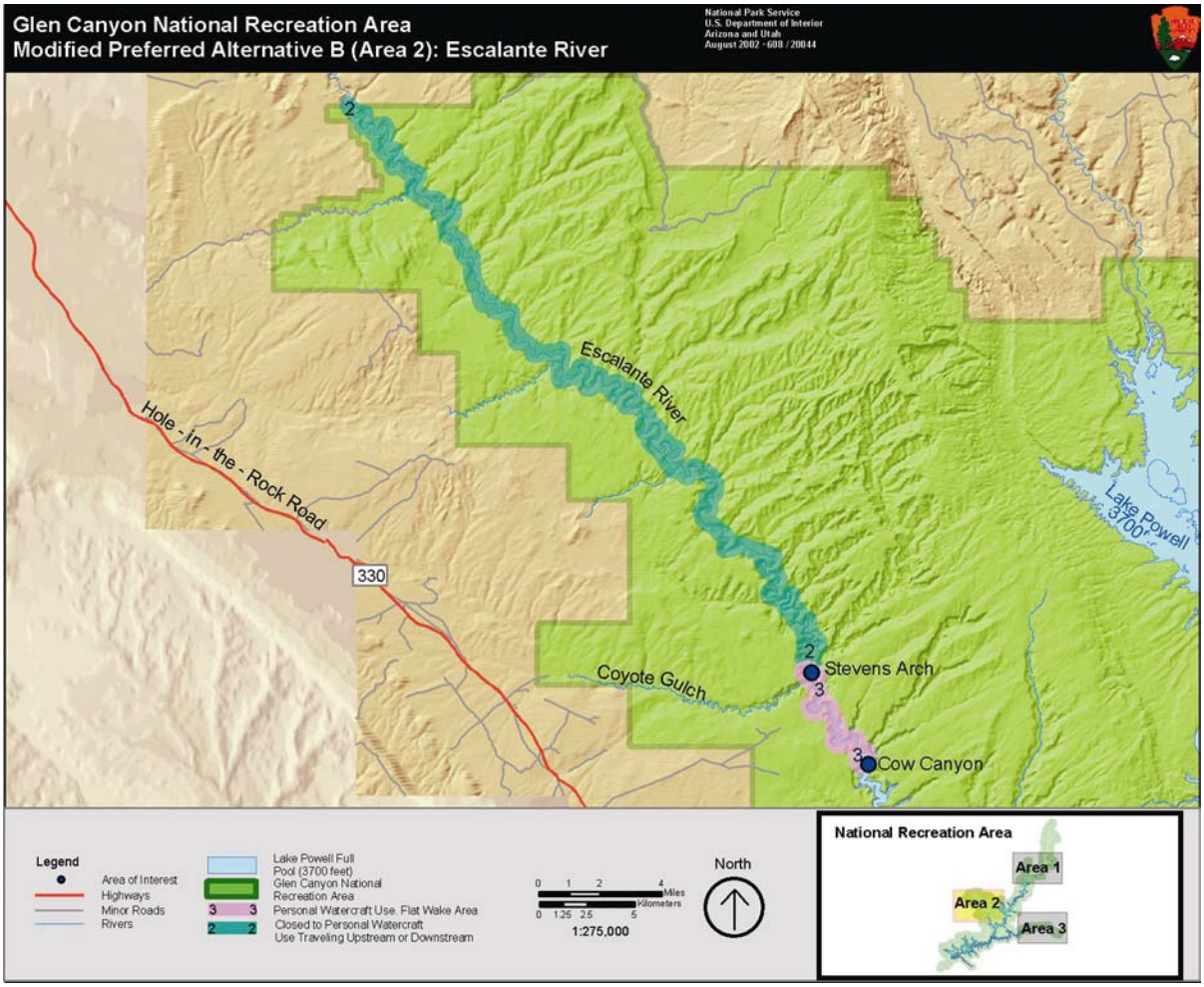

FIGURE 7: GLEN CANYON ALTERNATIVE B (AREA 2) — ESCALANTE RIVER

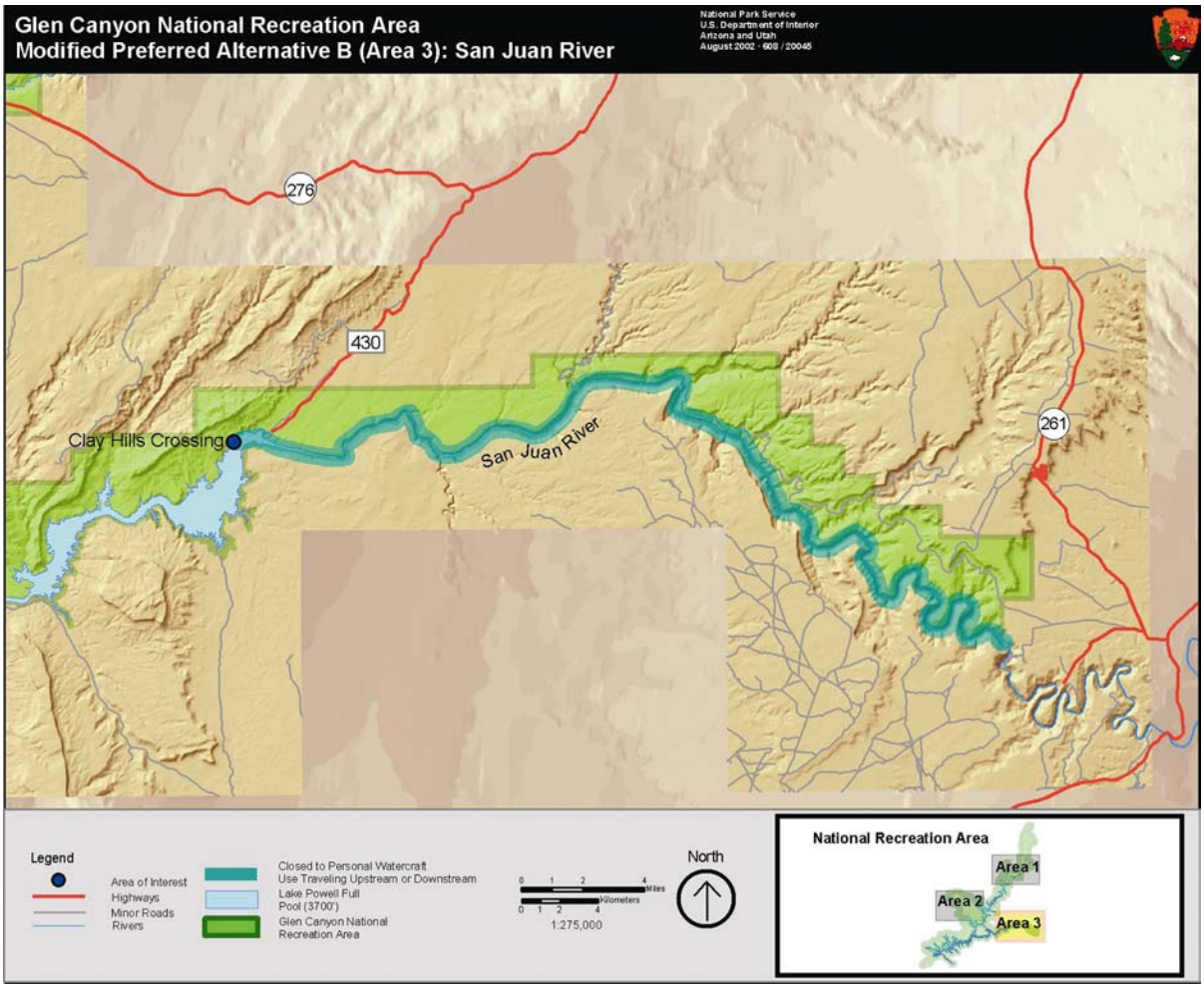

FIGURE 8: GLEN CANYON ALTERNATIVE B (AREA 3) — SAN JUAN RIVER

The intent of the personal watercraft closure on the San Juan River would be to provide an opportunity for visitors to enjoy quiet and solitude. Establishing the closure at the Clay Hills pullout would allow continued opportunity to access the lake from this remote site when the lake level is above an elevation of 3,675 feet. At the same time, it would protect a rare visitor experience for San Juan River travelers above this point.

Personal watercraft use would be prohibited on the Dirty Devil River above Utah Highway 95 Bridge (alternative B, figure 6). This requirement would have two benefits.

> Because of the transition from lake to river conditions, personal watercraft operation upstream from the bridge is significantly different than operation below this point. The Dirty Devil Canyon is very narrow with tight, blind bends, and becomes increasingly hazardous upstream because of shallow and murky water, floating debris, uncertain currents, and shifting sandbars. Restricting this area to personal watercraft use would help protect the safety of visitors.
>
> The Dirty Devil River is a popular destination for fishing, including both trolling and fishing from stationary boats. High-speed maneuvering with personal watercraft is disruptive to this

traditional visitor activity. Visitor conflicts would be eliminated with closure of this area to personal watercraft.

Alternative B would prohibit personal watercraft use on the Colorado River upstream from Sheep Canyon (alternative B, figure 6). This action would have two benefits.

Cataract Canyon upstream of Sheep Canyon is a popular white-water rafting destination that provides a recreational experience that is not available in other parts of Glen Canyon National Recreation Area. Closure of the Colorado River upstream from Sheep Canyon would preserve this locally unique visitor experience for Colorado River white-water river runners.

Because of the transition from lake to river conditions, personal watercraft operation upstream from Sheep Canyon is substantially different than operation below this point. Beginning in Cataract Canyon, conditions become increasingly hazardous because of conflicts between traditional rafting uses and use of personal watercraft. The river's uncertain currents and shifting sandbars can force both groups to use a common river channel. The presence of standing waves also produces a high potential for collision. Closing this area to personal watercraft use would help protect the safety of visitors.

Implementing these closures to all personal watercraft use would strengthen the NPS intent to maintain areas of quiet and solitude on portions of the rivers; to reduce the potential for conflict between motorized and traditional nonmotorized users; and to promote visitor enjoyment in those areas. In addition, prohibiting personal watercraft use on portions of the rivers where the operation of such a craft is made hazardous by natural features such as rapids and narrow, confined canyons would help to ensure visitor safety.

The recreation area may consider other location restrictions, which would be implemented as part of a lake management plan that is described under alternative A and is common to all alternatives. To support the decision to implement other restrictions, a three-year pilot study would be conducted. The study would examine the effectiveness of location restrictions and other management actions in reducing visitor conflicts associated with motorized vessels, including personal watercraft, in the recreation area. Details of the pilot study are provided in appendix C. The pilot study could be implemented after the record of decision for this personal watercraft rule-making was completed and after appropriate compliance and public participation had taken place.

WAKE AND LAUNCH RESTRICTIONS

Launch restrictions under alternative B would be the same as those for alternative A (see table 4). However, the visitor experience would be improved through the implementation of additional wake restrictions under alternative B.

All of the wake restrictions pertaining to personal watercraft use contained in the *Superintendent's Compendium* (NPS 2002c) (36 CFR 1.7 (b), section 3.6) would be in the alternative B special regulation. These would include requirements that a personal watercraft operator cannot operate at speeds in excess of 5 miles per hour or create a wake when operating within harbors, mooring areas, flat-wake areas, and other "flat-wake" buoyed areas. To further reduce visitor conflict, enhance visitor safety and experience, and protect soundscapes, alternative B would prohibit operation of personal watercraft above flat-wake speed on portions of the Escalante River.

The 4.4-river-mile stretch of the Escalante River between Cow Canyon and the confluence of Coyote Creek (alternative B, figure 7) would be designated as flat-wake for personal watercraft. This stretch of the Escalante River is a popular float stream and hiking area. In most years, travel upstream by personal watercraft from Cow Canyon is precluded by low water levels and insufficient stream flow. However, when lake levels are sufficiently high, the natural quiet of this area is often disturbed by noise from personal watercraft. Limiting personal watercraft use to flat-wake speeds above Cow Canyon would help maintain a more natural sound quality in this portion of the Escalante River and Coyote Gulch area.

ENFORCEMENT OF FEATURES REGULATED BY THE STATES OF ARIZONA AND UTAH

As in alternative A, boating regulations, laws, and rules for both Arizona and Utah, as well as applicable federal regulations (36 CFR, Part 3; 36 CFR 7.70; 33 CFR, United States Coast Guard), would continue to be enforced. A summary of the state regulations is included in table 4. Appendix B includes the full text of the Arizona and Utah regulations, laws, and rules that apply to personal watercraft use.

Glen Canyon National Recreation Area is proprietary jurisdiction, which means that the states have primary law enforcement jurisdiction and authority. Like current conditions, users would have to comply with the regulations, laws, and rules pertaining to personal watercraft prescribed by the states of Arizona and Utah while operating on their respective waters. However, under alternative B, the National Park Service would work cooperatively with both states in an attempt to develop unified laws for personal watercraft operations within the boundaries of the recreation area.

The level of law enforcement at the recreation area is insufficient to adequately patrol activities on the land and on Lake Powell during peak-use seasons. To provide additional enforcement of the existing watercraft regulations on the lake, the superintendent would vigorously seek funding to increase the law enforcement capability on Lake Powell, particularly during high-visitation periods. Enhanced boat patrols would have the added advantage of increasing the number of visitor contacts on the lake to prevent unsafe actions that could result in injuries and visitor use conflicts.

EDUCATION

Alternative B would improve education to provide more information to visitors regarding regulations pertaining to personal watercraft use and safety. The goal would be to avoid or reduce accidents, visitor conflicts, and adverse effects on recreation area resources. Features of the improved education program could include the following.

> The National Park Service would improve interpretive contacts and programs to incorporate relevant personal watercraft safety information. Coordination with local and regional media could be used to convey information to users.
>
> The recreation area would provide literature to visitors at entrance stations on personal watercraft safety and regulations. This literature would highlight the regulations that are most commonly violated by personal watercraft users, such as speed and proximity, underage operator, and wake speed, that result in the issuance of citations or warnings.

The National Park Service would coordinate with concessioner and other Lake Powell Water Safety Council members to disseminate information to recreation area visitors about the safe use of personal watercraft.

Conflicts sometimes occur between personal watercraft users and those visitors who come to the recreation area to experience natural quiet and solitude. To reduce these conflicts, alternative B would include enhanced educational materials and interpretive programs to emphasize areas of the recreation area that offer this experience.

SANITATION

The sanitation features of alternative B would be the same as that described under alternative A. The recreation area would continue to evaluate areas to install new portable facilities for recreational users, including personal watercraft users. The goal would be to reduce adverse water quality effects from human waste and reduce the risk of transmission of water-borne diseases.

MONITORING AND SAMPLING PROGRAMS

The alternative B monitoring and sampling program for contamination by human waste would include all of the features described for alternative A. In addition, alternative B would include new air and water quality monitoring and sampling programs for hydrocarbon contamination. The recreation area would also conduct noise monitoring in association with personal watercraft use, as funds allow.

An important element of this alternative would be protecting water quality and air quality from chemical pollutants emitted from personal watercraft, and protecting natural soundscapes from personal watercraft noise. An adequate baseline description of noise and chemical pollution produced by personal watercraft engines has not been established within Glen Canyon National Recreation Area. Under this alternative, water quality, air quality, and noise sampling and monitoring would be conducted to establish baseline conditions and resource trends from which to detect changes and develop a management and protection program. These efforts would allow recreation area staff to make management decisions based on recreation area-specific data and would improve protection of recreation area resources, as funds allow.

A lakewide monitoring program for gasoline constituents, including hydrocarbons in Lake Powell water and sediments, would be developed based on data and methods of studies that are currently taking place or planned in the recreation area. These studies are focused on determining the chemical content of sediment at the main inflow areas of selected rivers and examining the dynamics of sediment resuspension and reworking at selected river inflows. The monitoring program would consider the most likely places for contamination, such as marinas and areas downstream from major sediment depositional zones. The monitoring plan development would be guided by the Technical Advisory Committee that was formed in 1996 by the National Park Service and the Utah and Arizona Departments of Environmental Quality Water Quality Divisions and other interested organizations and agencies (including the Environmental Protection Agency) to protect Lake Powell water quality. The Technical Advisory Committee provides an excellent vehicle for establishing standards and protocols for Lake Powell that are acceptable to Utah and Arizona, congruous with their regulations, and developed under authority of the *Clean Water Act*. Benthic population sampling and bioassay may be included in the monitoring plan as determined to be appropriate by the Technical Advisory Committee.

All monitoring programs would be based on approved monitoring plans that would identify, describe in detail, and provide the procedural steps required for major work elements. The plans would be reviewed and approved by the National Park Service, State of Utah Department of Environmental Quality, and State of Arizona Department of Environmental Quality.

LAKE MANAGEMENT PLAN

The features of the lake management plan would be the same as those described under alternative A. In addition, a three-year pilot study would be conducted to support preparation of the lake management plan. The study would test whether selected management actions could mitigate conflicts between watercraft users and other visitors. A description of the pilot study is provided in appendix C.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Under alternative C, the National Park Service would not take any rule-making action to authorize personal watercraft use in Glen Canyon National Recreation Area. Based on the NPS rule that was published on March 21, 2000, personal watercraft use would have been prohibited after September 15, 2002; however, a stipulated modification to the settlement agreement approved by the court extended the closure date until November 6, 2002. Alternative C would make the ban permanent. This alternative allows for the comparison of impacts of the rule-making actions with conditions that would occur in the absence of a rule that allowed for personal watercraft use.

LOCATION RESTRICTIONS

No unit-specific rule would be developed to allow the use of personal watercraft in the recreation area. Therefore, the ban on personal watercraft use in Glen Canyon National Recreation Area that went into effect in November 2002 would be permanent.

WAKE AND LAUNCH RESTRICTIONS

With a ban on personal watercraft under this alternative, speed restrictions on personal watercraft would not be applicable. Prohibition of personal watercraft use under this alternative would preclude the launching of personal watercraft anywhere in the recreation area. However, current speed and launch restrictions for other types of watercraft would remain in effect.

ENFORCEMENT OF PERSONAL WATERCRAFT BAN

Under this alternative, law enforcement personnel would be responsible for enforcing the ban on personal watercraft. Initially, increased enforcement staff time may be needed at marinas and launch sites to restrict personal watercraft use of Lake Powell and the tributaries. However, this need would decrease as visitors became familiar with the elimination of personal watercraft use.

In addition, the superintendent would vigorously seek funding to increase the law enforcement capability on Lake Powell, particularly during high-visitation periods, to provide additional enforcement of the existing watercraft regulations on the lake.

EDUCATION

Alternative C would require the preparation and distribution of materials informing the public of the ban on personal watercraft use in the recreation area. This would involve developing information for new recreation area exhibits, hand-outs, community outreach and special programs, and updates to the recreation area website.

Initially, increased interpretive staff time would be needed to educate visitors of the ban on personal watercraft use, particularly at launch ramps and marinas. However, this need would decrease as visitors became familiar with the elimination of personal watercraft use.

Education to enhance watercraft safety or to highlight areas of the lake where visitors can experience natural quiet and solitude would occur only as part of the recreation area's ongoing education program.

SANITATION

Sanitation facilities around the recreation area would continue to be used by other boating and land-based recreation users. Sanitation would be addressed by continuing to operate and maintain both portable and permanent toilets and pump-out stations. The recreation area would continue to evaluate areas to install new portable facilities for recreational users. The goal would be to reduce adverse water quality effects from human waste and reduce the risk of transmission of water-borne diseases.

MONITORING AND SAMPLING PROGRAMS

Monitoring and sampling programs would be the same as those described for alternative A. This would include continued water quality monitoring to conform with the "Strategic Plan to Protect Water Quality at Lake Powell" that was entered into in 1996 by the National Park Service and the Arizona and Utah Departments of Environmental Quality. No additional sampling or monitoring efforts would be implemented with alternative C.

LAKE MANAGEMENT PLAN

Under alternative C, the superintendent would seek funding for the development of a lake management plan to address the overall use of the recreation area. The lake management plan would be similar to that described for alternative A and B, except that it would not include personal watercraft, since their use would not be allowed in the recreation area. A pilot study to support lake management planning would be conducted to test whether selected management actions could mitigate conflicts between watercraft use and other visitors.

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

During the planning process, several actions or mitigation techniques were considered but eliminated as alternatives or components of alternatives to managing personal watercraft in Glen Canyon National Recreation Area. This section explains why these alternatives or actions were not considered further.

Limit personal watercraft use to the main channel of Lake Powell. This action would be inconsistent with the objectives of the recreation area as defined in its enabling legislation. The objectives of the recreation area are to manage the area so that it provides maximum recreational enjoyment to the American public and its guests, maximizes the number of opportunities for enjoying the recreation area, and accommodates many varieties of use with an emphasis on water-oriented recreation. Lake Powell is managed according to resources and appropriate visitor use, as part of the Recreation and Resource Utilization Zone. Motorized watercraft use, including the use of personal watercraft, is a designated activity throughout this zone. Limiting use only to the main channel would not provide the full recreational benefit of this zone.

Establish special-use areas or zones to accommodate high-density personal watercraft use, designate special play areas, or increase watercraft support services. These alternatives were dismissed because of concerns over visitor safety and conflicts. Confining high numbers of users to smaller areas would potentially increase the number of visitor accidents and conflicts.

Implement a permit system or allow only four-stroke engines. The immediate restriction on carbureted two-stroke personal watercraft was eliminated from further consideration in this document. However, alternative B would phase out carbureted two-stroke personal watercraft over the next 10 years. By the end of 2012 and in subsequent years, all personal watercraft operating in the recreation area would be compliant with the EPA marine engine emission standards. The lake management plan could allow the recreation area to implement a more comprehensive permit system directed at all vessels and engine types, not just personal watercraft.

ALTERNATIVES SUMMARY

Table 5 provides a brief summary of the effects of each of the alternatives on the impact topics that were retained for analysis. More detailed information on the effects of the alternatives is provided in the "Environmental Consequences" chapter.

TABLE 5: COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
Water quality	Under alternative A, personal watercraft have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Effects would be long term because they would recur during each summer heavy-use season. Cumulatively, the lake loadings from all vessels also would have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Alternative A would not result in the impairment of the water quality of Lake Powell or any other waters.	Localized, long-term benefits to water quality would occur in the four tributaries where personal watercraft use would be restricted. However, because these areas have low rates of use, the intensity would likely be negligible. Prior to the end of 2012, effects to water quality would be the same as those described for alternative A. This is anticipated because boat usage and engine type distribution are assumed to be the same as in alternative A. After implementation of clean technology personal watercraft restrictions, pollutant loadings from personal watercraft would decrease. However, changes in water quality may be difficult to quantify. The continued contribution of personal watercraft to pollutant loading in Lake Powell would result in long-term, adverse effects to water quality of negligible to minor intensity. Cumulative effects from all watercraft would be similar to alternative A until 2005. A decrease in pollutant loading with implementation of personal watercraft engine type restrictions at the end of 2012 and other water quality improvement projects would result in long-term negligible benefits. Alternative B would not result in the impairment of the water quality of Lake Powell or any other waters.	Alternative C would eliminate personal watercraft pollutant loadings in Lake Powell compared to alternatives A and B, both in the short-term and long-term. This would produce a negligible to minor, direct, beneficial, long-term effect on the water quality of the lake. The four tributary inlets would also experience localized, long-term benefits, but due to their low personal watercraft use rates, these would be negligible. Alternative C would not result in the impairment of the water quality of Lake Powell.
Air quality	Personal watercraft management under alternative A would have the following effects on air quality. Emission levels of carbon monoxide, hydrocarbons, and volatile organic compounds would decrease between 2004 and 2012. Hydrocarbon plus nitrogen oxide emissions, which are the principal constituents of ozone, would also decrease by 2012. All of this change would be attributable to increased proportions of low-emission engines on the lake. However, these pollutants would continue to be emitted by personal watercraft at volumes exceeding 100 tons per year. As a result, alternative A would	Effects of alternative B would be similar to those of alternative A in 2004. Conversion of carbureted two-stroke personal watercraft to cleaner engines under the modified alternative would have the following effects on air quality. There would be sizeable reductions in volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide emissions. There would also be reduction in particulates (PM_{10} and $PM_{2.5}$) and carbon monoxide emissions. Human health effects would be adverse and moderate for volatile organic compounds, carbon monoxide, hydrocarbons, and hydrocarbons plus	Under the no-action alternative, the air quality condition in the recreation area would continue to be below national ambient air quality standards. SUM06 ozone measurements in the recreation area would remain below 15 parts per million per hour. No change in class II airshed status would be expected because historical motorized boating activity has not resulted in a violation of any national air quality standard. The no-action alternative would have long-term, negligible to moderate, beneficial impacts on air quality related values and human health. These would result from the elimination of personal watercraft emissions of hydrocarbons, volatile

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	have moderate, long-term, direct, adverse impacts on human health and air quality related values. Particulate matter emissions from personal watercraft would decrease by 2012 to between 46 to 67 tons per year. These levels of particulate matter would continue to cause locally degraded visibility from personal watercraft exhaust during peak use periods in high-use areas. This would be a direct, long-term, negligible to minor, adverse effect on human health and air quality related values. Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect). SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect). No change in class II airshed status would result from this alternative (negligible effect). The cumulative effect on air quality related values and human health from all motorized vessel would be direct, long-term, adverse, and minor to moderate. This alternative would not result in an impairment of the air quality resource or related values.	nitrogen oxides. Some beneficial effects would occur after 2012 from the elimination of carbureted two-stroke personal watercraft engine emissions as hydrocarbon, carbon monoxide, volatile organic hydrocarbons, and particulate matter emissions are reduced. Adverse impacts to air quality-related values would be reduced from minor levels in 2004 to negligible to minor in 2012. Particulate matter reductions would contribute to an improvement in visibility, and the reduced ozone production would contribute to a reduced potential for plant damage. Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect). SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect). No change in class II airshed status would result from this alternative (negligible effect). The cumulative effect on air quality related values and human health from all motorized vessels would be direct, long-term, adverse, and minor to moderate. This alternative would not result in an impairment of the air quality resource or related values.	organic compounds, carbon monoxide, nitrogen oxide, and particulate matter in the recreation area. In the short-term, total vessel operating hours would be reduced as personal watercraft would be prohibited from the park. In 2004, there would be sizeable reductions in the cumulative emissions of carbon monoxide, volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide when compared with alternative A. Particulates (PM_{10} and $PM_{2.5}$) would be reduced from minor to moderate levels under alternative A to negligible under the alternative C, the no-action alternative. In the long-term visitors would replace personal watercraft with a different variety of motorized vessel and other vessels usage would continue. This would offset the benefits to air quality from elimination of personal watercraft. Considering that ambient air quality standards would continue to be met, moderate, long-term, adverse impacts on human health and air quality related values would occur from carbon monoxide, nitrogen oxide, hydrocarbon, and volatile organic compound emissions associated with all motorized boating activity. The long-term, adverse impacts on human health and visibility associated with particulate matter emissions would be negligible to minor. Implementation of this alternative would not result in an impairment of the air quality resource.
Soundscapes	During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. Given this level of impact, and the amount of use that occurs during peak seasons, mitigation takes the form of education and enforcement of the existing regulations and compendium. Noise-producing behaviors are regulated to the greatest possible	Alternative B would have overall noise impacts similar to those described under alternative A. During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in	Due to the elimination of personal watercraft noise in alternative C, impacts on the natural soundscape would be reduced compared to noise levels produced in alternatives A or B. This represents a beneficial impact on the natural soundscape – eliminating an adverse impact judged as minor to moderate at high use times of the year. Compared to low use times of the year, the level of beneficial impact would not be considered as great in magnitude by eliminating a negligible to minor adverse impact. Alternative C

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	extent, and use of newer technologies that reduce noise are encouraged. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in Natural and Cultural Zones. In the Natural and Cultural Zones, alternative A would produce negligible to moderate adverse effects on the soundscape within a mile of the lakeshore, depending on the level of boating use in nearby waters at various times of the year. During high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. These areas consist of about 16,000 acres covering 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected. All of these effects would be adverse, both short and long term, and direct. Alternative A would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.	Natural and Cultural Zones. In the Natural and Cultural Zones, under alternative B during high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. The area affected would be 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected. All of these effects would be adverse, both short and long term, and direct. Alternative B would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.	would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area.
Wildlife and wildlife habitats	Personal and other watercraft uses with alternative A would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Population numbers, population structure, genetic variability, and other demographic factors for species may experience small, short-term changes, but long-term characteristics of wildlife and wildlife habitat within the area of analysis would remain stable and viable.	Impacts on wildlife and wildlife habitats due to alternative B would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Prohibiting carbureted two-stroke personal watercraft engines at the end of 2012 would indirectly benefit wildlife and wildlife habitat. Alternative B would not contribute to deterioration of the recreation area's wildlife resource to the extent that the recreation area's purpose could	Alternative C would have a negligible, short-term, beneficial impact on wildlife and wildlife habitat from a reduction in boat-days that initially would result from eliminating personal watercraft use on the lake. By the end of the analysis period in 2012, the number of boat-days would have returned to levels within the range predicted for alternatives A and B. Because the effects on wildlife and wildlife habitats from personal watercraft and other types of motorcraft are similar, the long-term effect of alternative C on wildlife and wildlife habitats would be negligible. Alternative C would not result in impairment of fish and wildlife species or their supporting habitats.

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	Operations of personal watercraft would not adversely impact special-interest wildlife concentration or high-quality wildlife habitat areas because such resources are not present in the recreation area. Special-interested wildlife features (such as active peregrine falcon nest sites) are present in the recreation area and many occur in areas visited by personal watercraft and other types of motorized watercraft. Alternative A would not contribute to deterioration of the recreation area's fish or wildlife resources to the extent that the recreation area's purpose could not be fulfilled as established in its enabling legislation. It would not affect resources key to the recreation area's natural integrity or opportunities for enjoyment or affect the wildlife or wildlife habitat resource, whose conservation is identified as a goal in the recreation area's general management plan. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.	not be fulfilled as established in its enabling legislation. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.	
Threatened and endangered species	Alternative A would not adversely affect any ecological, biological, or physical processes associated with endangered fish critical habitats. Continuing the location restriction on upstream portions in the Colorado, San Juan, Dirty Devil, and Escalante Rivers would provide some protection of critical habitat for endangered fish. Compared to current conditions, alternative A would have negligible effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo or their critical habitats within Lake Powell and its tributaries in the recreation area. Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment to threatened or endangered species or their designated critical habitats would occur from the implementation of alternative A.	Restrictions on access and designation of flat-wake speeds along sections of river shorelines would produce short-term, direct, negligible benefits to habitats of endangered fishes in the inflow areas. These would occur because fewer personal watercraft would use these areas, and the remaining vessels would operate at lower speeds, producing less site disturbance. These effects would not change ecological function or structure of critical habitat and would probably be indistinguishable from the range of environmental variation that occurs under natural conditions. The availability, use, and location of suitable endangered fish habitat would be more extensively affected by reservoir operations and annual river runoff patterns than by operation of personal watercraft. Therefore, the impacts on endangered fish species and their designated critical habitat with alternative B would be similar to alternative A. Endangered fish would benefit indirectly with the prohibition of carbureted two-strike personal watercraft engines at the end of	Negligible improvements to endangered fish habitat would be expected, resulting in short-term, direct beneficial impacts on endangered fish and their designated critical habitats in the inflow areas. The bald eagle, American peregrine falcon, southwester willow flycatcher, and yellow-billed cuckoo might experience some negligible short-term beneficial direct impacts from reduced disturbance incidents during the two to three years when the total number of boat days are expected to decline. Alternative C would be unlikely to adversely affect endangered fish or birds or their critical habitat, special-concern species or state-sensitive species known to use critical habitats or frequent near-shore uplands and riparian habitats within the recreation area. Cumulative impacts are negligible and not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment would be expected to endangered,

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
		2012 which would reduce the amount of fuel discharge into the water in subsequent years. There would be no distinguishable adverse effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo. As a result, this alternative would be unlikely to adversely affect these species in the recreation area. Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area. No impairment would be expected to endangered, threatened, or special-concern species or their designated critical habitats with this alternative.	threatened, or special-concern species or their designated critical habitats from this alternative.
Shoreline vegetation	Personal watercraft use would have negligible, adverse, direct and indirect impacts, for both short and long terms. This would occur because there would be no perceptible changes to shoreline, riparian, aquatic, or wetland community size, integrity, or continuity. Alternative A would not result in any substantial or noticeable physical change of submerged, riparian, or wetland shoreline vegetation. Past, current, and future use of personal watercraft and other motorized watercraft also would not produce any noticeable effect on shoreline vegetation. Therefore, cumulative effects would also be short-term, direct, and negligible. Alternative A would not result in impairment of shoreline vegetation at Glen Canyon National Recreation Area.	Restricting access to upper portions of the Colorado, Escalante, Dirty Devil, and San Juan Rivers would provide negligible beneficial protection of riparian shoreline vegetation. Impacts on shoreline vegetation in the vicinity of the four main marinas would be similar to those described for alternative A and would result primarily from minor short-term foot traffic associated with users of personal watercraft and other watercraft when landing on lake shorelines. Limiting personal watercraft operations to flat-wake speeds on a portion of the Escalante River would reduce wave production but because of the lack of existing shoreline vegetation no benefits to shoreline vegetation would be expected. Past, current, and future personal watercraft use would not produce any noticeable effect on submerged aquatic, riparian and wetland vegetation. Therefore, cumulative effects would remain similar to alternative A and would be short-term, direct, and negligible. Alternative B would not result in impairment of shoreline vegetative resources.	Alternative C would not result in any substantial or noticeable adverse physical change of riparian, submerged aquatic, or wetland vegetation. The lakeshore does not support extensive areas of submerged aquatic vegetation. Short-term and localized negligible improvements to shoreline vegetation would be expected as a result of implementing this alternative. Past, current, and future motorcraft use would not produce any noticeable effect on submerged aquatic, riparian, and wetland vegetation. Therefore, cumulative effects would be similar to alternative A and would be short-term, direct, and negligible. Alternative C would not result in impairment of shoreline vegetative resources.
Visitor use and experience	Alternative A would have negligible effects on visitor use and experience because the number of personal watercraft using Lake Powell and their management would not change. The effect on the	Most effects of alternative B would be similar to those described for alternative A. Most effects would be long-term and negligible to minor because of the presence of other motorcraft. An	In the short term, visitors who use personal watercraft as a primary vessel or who consider personal watercraft to be of central importance to their visit would experience direct, major, adverse

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	visitor experience for personal watercraft users would continue to be beneficial, while experiences for visitors seeking quiet and solitude would continue to be adversely affected. Cumulative effects would be either adverse or beneficial, depending on the visitor's goals. However, in either case impacts would be negligible.	additional flat-wake zone and closed areas would produce negligible to minor, long-term, direct effects. Perceptions of individual visitors would determine if the effects were adverse or beneficial. Improvements in visitor education would result in negligible to minor, indirect, long-term, beneficial effects. Cumulative effects on visitor experience would be long-term, indirect, and moderate because there would be detectable change on certain portions of the lake. Perceptions of individual visitors would determine if effects were adverse or beneficial.	short- and long-term effects from alternative C. Other users of personal watercraft, such as those who use them in conjunction with houseboats, would experience short-term, minor to moderate, adverse effects that would decrease to negligible in the long term. Visitors who did not use personal watercraft would generally perceive minor to moderate, short-term benefits from reduced conflicts and reduced noise. These benefits would decline to negligible in the long term.
Visitor conflicts and visitor safety	Alternative A would have negligible impacts on visitor conflicts and visitor safety. Improvements in visitor protection staffing would result in long-term minor beneficial effects on visitor conflicts and safety. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.	Compared to alternative A, alternative B would have direct and indirect, long-term, minor, beneficial impacts on both visitor conflicts and visitor safety. Cumulatively, the improved education components of this alternative would have indirect, long-term, beneficial, negligible to minor effects on visitor conflicts and visitor safety.	In the short term, alternative C would have a direct, beneficial, moderate effect on visitor safety. However, as visitors returned in other watercraft, which have higher accident rates on Lake Powell than personal watercraft, the long-term effect on safety would be adverse and negligible to minor. Visitor conflicts would be reduced in the long term and improvements in visitor protection staffing would produce both direct and indirect, minor, beneficial effects. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.
Cultural resources	Effects on cultural resources from the implementation of alternative A would be adverse and mostly long-term. While most personal watercraft users would be conscientious about protecting the recreation area's cultural resources, a few would engage in destructive actions such as illegal collecting of artifacts or vandalism. The effects of this behavior would be most noticeable in the narrow, steep-walled canyon areas that are inaccessible by most other types of motorcraft, but that can be traveled in a downstream direction by personal watercraft under alternative A. In these areas, impact intensities mostly would be negligible to minor. Impact intensities from personal watercraft users would be of similar magnitude in other areas, but would be	Compared to alternative A, alternative B would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic sites along the river canyons. Effects on traditional practices would be beneficial and negligible to moderate in intensity. In other areas, the effects of alternative B may be beneficial compared to alternative A, but the intensity would be negligible. Cumulative effects would be similar to alternative A. Alternative B would not result in impairment of the cultural resources of the recreation area.	Compared to alternative A, alternative C would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic resources, and negligible to moderate, beneficial effects on traditional practices in the river canyons in the recreation area. It also would have direct, long-term, negligible to minor, beneficial effects on traditional practices that are conducted within a mile of the lake shore. In the short term, the reduced visitation that would follow implementation of alternative C would result in a negligible, short-term reduction in disturbances to cultural sites. This condition would end by 2012 if visitor use of the recreation area increases due to natural growth in visitation, to

Impact Topic	Alternative A: Continue Personal Watercraft Use as Currently Managed under a Special Regulation	Alternative B (Modified Preferred Alternative): Promulgate a Special Regulation to Continue Personal Watercraft Use with Additional Management Restrictions	Alternative C: No-Action (Personal Watercraft Use Would Be Eliminated)
	indistinguishable from the adverse effects caused by the relatively few destructive visitors who used other transport methods to access the sites. Cumulatively, direct, adverse, long-term effects on the cultural resources in the recreation area would vary in intensity from negligible to moderate, depending on individual site vulnerability and accessibility. Negligible to minor, adverse, indirect effects on near-shore cultural sites would continue from the wave action caused both by boats and wind. The contribution of personal watercraft under alternative A to wave-caused effects would be negligible. Overall, the direct effect within the recreation area would be adverse and minor. Regionally, the effect from activities that occur outside of the recreation area would continue to be adverse and moderate. The contribution of alternative A to the regional effects would be negligible. Alternative A would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.		visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Other cumulative effects would be similar to alternative A. Alternative C would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.
Socioeconomic environment	Alternative A would have a negligible socioeconomic effect by itself and cumulatively with other actions.	Alternative B would have a negligible socioeconomic effect by itself and cumulatively with other actions.	Alternative C would cause a major, adverse, long-term effect on the economy of Page. Other communities in the counties surrounding the recreation area would experience less intense adverse effects. The effects would be both direct and indirect as reduced demand for sales and service related to personal watercraft-based recreation rippled through the economy. Cumulative effect on the regional economy would be moderate. In the long term, the economy would recover to previous levels, except for businesses that had focused on personal watercraft sales and rentals. Therefore, the long-term effect on the local economy would be moderate to major.
National recreation area management and operations	Use of personal watercraft in the recreation area under alternative A would have negligible, short- and long-term effects on operations. Increased funding for visitor protection staff would offset some of the long-term impacts to visitor protection	Alternative B primarily would affect the enforcement, interpretation, and facilities maintenance components of recreation area operations. Short-term impacts would be minor, as staff resources were committed to marking	Alternative C would cause short-term, direct, minor, adverse effects on recreation area operations, primarily because of time commitments needed to inform visitors about the ban on personal watercraft. In the long term,

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	services. The cumulative effects on management and operations of personal watercraft use in conjunction with other activities at existing levels also would be negligible.	newly restricted areas and developing and implementing new educational programs. In the long term, most of these effects would decrease to negligible levels. Increased funding for visitor protection staff would lead to long-term, minor benefits to visitor protection services. Effects on recreation area staff from restrictions on carbureted two-stroke personal watercraft at the end of 2012 would be negligible as most watercraft would already be compliant with EPA emission standards and distribution of education materials would inform users well in advance of the restriction. Without additional funding, staff requirements for additional monitoring could have long-term, negligible to minor, adverse effects on operations of the resource management division. Cumulatively, all recreation area visitors would benefit from the improved education and visitor protection services that would be implemented with alternative B. These could reduce the need to respond to emergencies and improve the ability to focus recreation area services on the protection of resources and the safety of visitors. These would be beneficial, negligible to minor, direct and indirect, long-term effects on recreation area operations.	these effects would decline to negligible levels. Law enforcement requirements on the lake initially would be reduced, as the number of visitors decreased in association with the ban. However, the long-term effect on law enforcement activities would be negligible if visitor use of the recreation area increases due to natural growth in visitation, to visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Increased funding for visitor protection staff would offset some of the long-term impacts on visitor protection services. There would not be any additional cumulative effect from alternative C.

THE ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is defined by the Council on Environmental Quality (1978) as the alternative that best meets the criteria or objectives set out in section 101 of the *National Environmental Policy Act*. The environmentally preferred alternative best meets the following requirements:

> Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
>
> Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
>
> Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
>
> Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
>
> Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
>
> Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

This discussion summarizes the extent to which each alternative meets section 102(1) of the *National Environmental Policy Act*, which asks that agencies administer their own plans, regulations, and laws so that they are consistent with the policies outlined above to the fullest extent possible.

Alternative A would satisfy the majority of the six requirements detailed above. However, alternative A would not ensure aesthetically pleasing surroundings because it would allow personal watercraft use in areas frequented by recreationists engaged in more reflective outdoor activities. Specifically, these include portions of the Colorado, San Juan, Dirty Devil, and Escalante Rivers. Alternative A would not attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences because of the potential impacts of personal watercraft use to visitor experience, air quality, noise, and other recreational opportunities in the recreation area. For this reason, alternative A is not preferred from an environmental perspective.

The modified preferred alternative (alternative B) would have impacts on recreation area resources and visitor use and experience at Glen Canyon National Recreation Area that were similar to those described for alternative A. The selection of alternative B as the environmentally preferred alternative is based on the following.

> Its additional restrictions on the use of personal watercraft within portions of the Colorado, San Juan, Dirty Devil, and Escalante Rivers would improve the protection of natural and cultural resources in these areas. It also would reduce conflicts with other recreationists in these areas and allow for a wide range of recreational uses within the recreation area boundary.

The establishment of an additional flat-wake zone would improve environmental and safety protection.

It provides for resource protection by phasing out carbureted two-stroke personal watercraft engines within the recreation area. The 10-year time frame to phase out the use of carbureted two-stroke personal watercraft engines under this alternative allows for the widest range of beneficial uses of the environment.

Enhanced education programs would benefit all recreation area visitors by increasing user's awareness of regulations pertaining to personal watercraft use and safety. These efforts would reduce visitor conflicts and improve visitor safety.

It would allow for access to many of the area's outstanding geologic and natural amenities by personal watercraft users while accommodating more reflective outdoor recreationists who were enjoying the quiet soundscapes of the recreation area.

This alternative would maintain recreational opportunities for visitors while protecting sensitive natural and cultural resources.

It would include future development of a lake management plan, supported by a three-year pilot study of potential strategies for minimizing visitor conflicts. This plan would help achieve a balance between population and resource uses, would provide high standards of living and wide sharing of life's amenities, and would support diversity and variety of individual choice.

Alternative C, the no-action alternative, would help ensure safe, healthful, productive, and aesthetically and culturally pleasing surroundings for visitors without the noise and safety effects of personal watercraft. The no-action alternative would attain a wide range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences of allowing personal watercraft use. However, the no-action alternative would not maintain an environment that supports diversity and variety of individual choice, nor would it achieve a balance between population and resource use that permits a wide sharing of amenities because it would prohibit recreational opportunities for personal watercraft operators.

Based on this analysis, the modified preferred alternative (alternative B) is the environmentally preferred alternative. It best fulfills NPS responsibilities as trustee of the outstanding natural resources, including critical habitats for threatened and endangered species; ensuring safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and attaining a wider range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

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GENERAL PROJECT SETTING

Glen Canyon National Recreation Area, located in the Colorado Plateau region, extends more than 200 miles from the Green River in southern Utah downstream to Lees Ferry in Arizona. It is a desert region of bare rock and dirt, arid shrublands, grasslands, and low-growing pinyon-juniper woodlands. As shown in the Glen Canyon National Recreation Area vicinity map (figure 2), the recreation area is bordered by Canyonlands National Park to the northeast; the Redrock Plateau to the east; the Henry Mountains to the north; Grand Staircase – Escalante National Monument, Dixie National Forest, and Capitol Reef National Park to the northwest and west; and the Navajo Indian Reservation to the south.

Lake Powell was formed by construction of the Glen Canyon Dam. Congress authorized its construction in the *Colorado River Storage Project Act of 1956* (PL 84-485). The project's primary purposes were to prevent flooding on the Colorado River, create a reservoir to meet downstream water requirements, and generate hydroelectric power. To meet these objectives, the dam was constructed between 1960 and 1963. Incidental to dam construction, the city of Page, Arizona was established about 2 miles from the dam site to provide housing and other services for workers. Page now serves as the largest gateway community to Glen Canyon National Recreation Area.

The 186-mile-long Lake Powell formed along the courses of the Colorado River and three tributaries – the Escalante, San Juan, and Dirty Devil Rivers. Lake Powell is the second largest reservoir in North America. The lake includes parts of Arizona and Utah, and is within the jurisdiction of several agencies. These include the National Park Service, Bureau of Reclamation, and Bureau of Land Management; the Navajo Nation; the states of Utah and Arizona; one Arizona county (Coconino); and four Utah counties (Garfield, Kane, San Juan, and Wayne).

Glen Canyon Dam is managed by the Bureau of Reclamation. It was designed to accommodate lake levels ranging from 3,490 feet to 3,700 feet above sea level. As the water level changes, the surface of Lake Powell varies in size from 52,000 acres to 163,000 acres and the shoreline fluctuates from 990 miles to 1,960 miles in length. Usually, the lake surface is about 160,000 acres, which represents approximately 13% of the recreation area. Annual fluctuations in lake levels typically are about 25 vertical feet.

The lake level rises in the spring as water from snowmelt runoff and spring storms collects behind the dam. It then declines throughout the rest of the year, particularly during summer and early fall as water is released for electrical power generation and irrigation.

The 87% of Glen Canyon National Recreation Area that is not inundated by Lake Powell consists of upland desert incised by deep canyons, dry washes, and steep cliffs. Other areas consist of talus, and clay or slickrock badlands. Much of the lake's shoreline consists of steep slopes and cliff walls. Elevations within the recreation area vary from approximately 3,700 feet to 7,000 feet above sea level. Upland areas generally lack vegetation or supports only scattered grasses, saltbush, and annuals.

In 1972, Congress established Glen Canyon National Recreation Area (PL 92-593) to provide public recreation on Lake Powell and adjacent lands. The National Park Service is responsible for managing all federal lands and waters within the recreation area boundaries (NPS 1987a). Access to Lake Powell within Glen Canyon National Recreation Area is provided at four developed marinas: Wahweap, Bullfrog, Halls Crossing, and Hite; and two launch ramps: Antelope Point and Stateline. Locations of the marinas are shown on the Glen Canyon National Recreation Area Vicinity map (see figure 2).

The recreation area includes 1,254,306 acres of land and water. The recreation area's *General Management Plan* (NPS 1979a) divided the recreation area into four management zones (see figure 9). Specific land and water use activities are allowed or prohibited within each zone.

> The Natural Zone (668,670 acres) is managed to maintain isolated, natural processes, and consumption of renewable resources that are subject to the protection of recreation values of the area. The *General Management Plan* recommended designating all of the lands within this zone as wilderness. Although these lands have never received wilderness designation, they are managed substantially in conformance with such a designation. About half of the Lake Powell shoreline is within the Natural Zone.
>
> The Recreation and Resource Utilization Zone (557,890 acres) is managed to maintain natural processes while allowing mineral leasing, grazing, utility rights-of-way, transportation systems, and recreation activities, including motorized recreation such as scenic touring and boating. The Recreation and Resource Utilization Zone includes the entire surface (up to 163,000 acres) of Lake Powell. The remaining area within this zone (almost 400,000 acres) consists of dry land and includes about half of the lake shoreline. The *General Management Plan* specifically identifies speedboating, waterskiing, and houseboat touring as appropriate in the Recreation and Resource Utilization Zone.
>
> The Cultural Zone (25 acres) focuses on the preservation, interpretation, and restoration of historic and archeological resources. This small zone is composed of several areas located primarily along the Wilson Mesa and the Escalante River.
>
> The Development Zone (19,270 acres) includes the permanent structures and operations necessary to support recreation activities and allows a wide range of recreational use. It includes the areas around Lees Ferry; the complex that includes the Glen Canyon Dam, Carl Hayden Visitor Center, and Wahweap Marina; and the developments at Halls Crossing, Bullfrog, Hite, Dangling Rope, Antelope Point, Llewellyn Gulch, and the Orange Cliffs area.

Glen Canyon National Recreation Area is a major, regional recreation resource. It receives more than 2 million visitors each year, the majority of which are associated with the water-based recreation of the lake. Boating is very popular, and a variety of boats are common on the lake. Visitors can rent houseboats, personal watercraft, canoes, and kayaks, or bring and launch their own boats. Many visitors enjoy fishing, waterskiing, and exploring land-based recreation area features. The large area of the lake and the inaccessibility of the shoreline from roads make boat travel essential in accessing most portions of the lakeshore.

This environmental impact statement focuses on areas of Lake Powell within Glen Canyon National Recreation Area that are used by personal watercraft. The area that was evaluated for most impact topics included:

> All of Lake Powell within Glen Canyon National Recreation Area up to the 3,700-foot water surface elevation;
>
> All lands within 500 horizontal feet of the shore when the Lake Powell surface is at an elevation of 3,700 feet above sea level; and
>
> All of the lands that are intermittently inundated as the lake level fluctuates.

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FIGURE 9: GENERAL MANAGEMENT ZONES MAP

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WATER QUALITY

The drainage basins of the rivers that form Lake Powell in Glen Canyon National Recreation Area cover 111,700 square miles. This large watershed is extremely varied in ecosystem type and land use management (NPS 1987a). Upstream land uses include mining, irrigated crop production, livestock grazing, and urban development. These activities have affected both the chemical and physical characteristics of rivers in the watershed.

The mountains of the watershed in Colorado and Utah receive up to 50 inches of precipitation annually, but the Glen Canyon area is arid, receiving only 6 to 7 inches of rainfall each year. Brief, intense thunderstorms produce the majority of all moisture received locally. Evaporation and transpiration of water by plants greatly exceeds annual precipitation, and Lake Powell loses approximately 500,000 acre-feet of water to the atmosphere each year (NPS 1987a).

Lake Powell contains 27 million acre-feet of water at full pool, or approximately three times the average annual flow of the Colorado River. (One acre-foot equals one acre covered with one foot of water, or 325,829 gallons.) At full pool, the water surface area is 163,000 acres, or 255 square miles. The depth of the reservoir near the dam is 561 feet, and the average depth is 167 feet (NPS 1987a).

The major tributary rivers to Lake Powell are the Colorado, San Juan, Dirty Devil, and Escalante. The Colorado River and its tributary canyons form the body of Lake Powell. The quantity and quality of tributary river flows entering Lake Powell are summarized in table 6 and discussed below.

The rugged terrain, wilderness protection, and variation in the lake level have prevented establishment of a comprehensive stream flow data-gathering network (NPS 1987a). As a result, the U.S. Geological Survey (USGS) has very few gauging stations on the major tributaries within Glen Canyon National Recreation Area. Included in the descriptions of the tributaries, below, are data from the gauging stations nearest each river's confluence with Lake Powell. Data in table 6 are from U.S. Geological Survey monthly streamflow statistics (USGS 2002).

Because all four tributary rivers flow through Utah and enter Lake Powell within the state, Utah surface waters criteria were used to assess the quality of the tributary rivers. To protect the water resources of the state, Utah has outlined designated beneficial uses for state waters, and defined associated water quality criteria for each use. Each of the tributaries serves multiple purposes in the state. These uses are identified by a numeric classification system, and all surface waters of the state are assigned corresponding uses. The four classifications found in the tributaries addressed in this analysis are:

Domestic water supply (1C);

Secondary recreation such as boating (2B);

Nongame fish and aquatic life (also known as warm water fishery) (3B); and

Agricultural purposes (4).

TABLE 6: CHARACTERISTICS OF THE RIVERS UPSTREAM FROM LAKE POWELL

Parameter	Colorado River	San Juan River	Dirty Devil River	Escalante River
Low mean flow (cubic feet per second) and month	4,844 January	1,103 December	56.9 July	7.1 July
High mean flow (cubic feet per second) and month	45,880 June	5,671 June	138 June	23.7 May
Watershed size (square miles)[a]	82,700	23,000	5,000	<1,000
Average annual flow entering Lake Powell (acre-feet)	9.7 million	1.6 million	72,000	8,000
U.S. Geological Survey station location and station number	At Hite, Utah 09335000	Near Bluff, Utah 09379500	Poison Spring Wash, Utah 09333500	Near Escalante, Utah 09337500
State of Utah designated uses[b]	1C 2B 3B 4	1C 2B 3B 4	2B 3B	2B 3B
Water quality issues[c]	Elevated levels of nitrogen from irrigated agriculture return flows, pH and thermal changes due to upstream dams and mining	Elevated levels of copper, lead, zinc, and salinity due to upstream mining and exposure to natural Mancos shale formations	Elevated levels of sediment and total dissolved solids due to exposure to natural Mancos shale	Elevated levels of sediment and total phosphorus due to geologic formations and upstream mining of phosphorus

a. The Colorado River watershed size does not include the drainage basins for the San Juan, Dirty Devil, and Escalante Rivers.

b. State of Utah Administrative Code Rule R317-2.

c. Environmental Protection Agency no date d.

COLORADO RIVER

The Colorado River flows into Lake Powell as a large, wide river, prone to large spring floods. The widest sections of the lake indicate the previous course of the Colorado River above Glen Canyon Dam. Water is released from the reservoir, through Glen Canyon Dam, back into the main stem of the Colorado River. The flow then proceeds west through the Grand Canyon.

The Colorado River contributes approximately 9.7 million acre-feet per year to the reservoir. High flows occur in the spring and early summer, with the mean high flow of 45,880 cubic feet per second occurring in June. As shown in table 6, the mean high monthly flow in June is almost 10 times the low-month flow, which occurs in January.

The river enters the lake from the northeast, upstream of the Hite marina, as a shallow, sediment-laden flow. The sediment load in the Colorado River ranges from 300 parts per million to more than 18,000 parts per million (USGS 2002).

The Colorado River above Lake Powell drains an area that includes the mountains of Colorado and the eastern portions of Utah. Land uses in this area range from wilderness to mining to urban development. The river receives agricultural runoff with a total nitrogen content of up to 9 parts per million (drinking water maximum standard is 10 parts per million), and dissolved metals such as boron, magnesium, and iron (USGS 2002). Warm summer temperatures also can cause water quality concerns, with summer flows that can reach 80°F.

Above Lake Powell, the state of Utah has designated the Colorado River for four uses: domestic water source; secondary recreation such as boating; nongame fish and aquatic life; and agricultural use.

SAN JUAN RIVER

The San Juan River is the largest tributary joining the Colorado River within Glen Canyon National Recreation Area. It enters Lake Powell from the east, just downstream of the confluence with the Grand Gulch drainage.

The San Juan River is smaller than the Colorado River, averaging about 1.6 million acre-feet in annual flow. This river displays a historic flow regimen similar to that of the Colorado, with high spring floods and modest flows throughout the remainder of the year (Utah Division of Wildlife Resources 1996). As shown in table 6, the peak-month flows in June are about five times greater than the flow rates in December.

The San Juan River drains an area in excess of 23,000 square miles that includes the mountains of southwestern Colorado and the arid regions of southeastern Utah. Upstream land uses include mining and agriculture. In general, the San Juan River watershed has not experienced the amount of urban development present in the Colorado River watershed (NPS 1987a).

The San Juan River can carry very heavy loads of suspended sediment. Water quality samples collected since 1990 have exhibited sediment loads ranging from 25 parts per million to 85,000 parts per million. Despite these sediment loads, the San Juan River has been designated for four uses in Utah: domestic water use, secondary recreation, nongame fish and aquatic life, and agriculture.

DIRTY DEVIL RIVER

The Dirty Devil River flows into Lake Powell from the north, upstream from Hite. This small river drains an area of approximately 5,000 square miles and contributes about 72,000 acre-feet per year to the reservoir. The average flow in this stream is 99 cubic feet per second (USGS 2002). Some stretches of this river are frequently dry during summer months. This may be due in part to irrigation diversions that occur along the river coupled with evaporation, or it may be the natural, historic pattern of flow (NPS 1987a).

The Dirty Devil River has two designated uses upstream from the recreation area: secondary recreation such as boating, and nongame fish and aquatic life. In the past, the quality of water in this stream has been affected by high total dissolved solids (salinity) and a heavy sediment load. The state of Utah does not have sediment criteria for water quality. Environmental factors that could account for the high suspended solids and salinity include flashy flows associated with spring runoff, and the bedrock and parent material of the region, which were formed by ancient marine deposits and are high in salt.

ESCALANTE RIVER

The Escalante River enters Lake Powell from the northwest just upstream from Stevens Canyon, near Stevens Arch. The Escalante River watershed is the smallest of those considered in this analysis, with an area of less than 1,000 square miles. This stream carries approximately 8,000 acre-feet of water to

Lake Powell each year. Average flow from 1980 to 1999 was 11.5 cubic feet per second (USGS 2002). Peak flows occur in May, and low flows are in July.

The Escalante River is not dammed upstream of Lake Powell, but withdrawals are made for irrigation during the growing season. Land use practices in the drainage include agriculture and rural development (Utah Division of Wildlife Resources 1996; USGS 2002).

The Escalante River is designated for two beneficial uses above Lake Powell: secondary recreation, and nongame fish and aquatic life. This stream reach from Lake Powell upstream to Calf Creek has had water quality problems in the past, with elevated levels of total phosphorus and sediment.

LAKE POWELL

Hydrology

Glen Canyon Dam formed Lake Powell by impounding the Colorado River. The reservoir environment is dramatically different from the river systems. The waters of the lake are clear, deep, and thermally stratified. This is a stark contrast to the rivers, which are shallow, well-mixed, and often laden with sediment. Water moves slowly through the reservoir, and the lake typically is cooler than the rivers, especially during the summer.

The dam has eliminated natural spring flooding downstream. High spring flows that formerly ranged between 80,000 and 300,000 cubic feet per second are now captured and released throughout the remainder of the year. This management strategy has increased average flows during both the summer and winter to between 8,000 and 12,000 cubic feet per second, up from pre-dam average flows of about 3,000 cubic feet per second. Generally, releases from Glen Canyon Dam are higher in the summer than in winter in response to hydropower demands (Utah Division of Wildlife Resources 1996).

Hydrologic characteristics of Lake Powell are summarized in table 7. Water releases depend on water demands and hydropower production requirements. By law, Glen Canyon Dam must release 8.23 million acre-feet each year, which represents about a third of its holding capacity. Daily releases are highest in the heat of summer (to meet demands for irrigation and electricity production) and on cold winter nights (when hydropower helps meet electricity demand peaks).

Lake Powell is designed to operate between elevation 3,490 and 3,700 feet above mean sea level. The varying water surface elevations are illustrated in the photographs below. As the water level changes, the surface of Lake Powell varies in size from 52,000 acres to 163,000 acres and the shoreline fluctuates from 990 miles to 1,960 miles in length (figure 10).

During summer months, the surface water temperature typically is more than 70°F, and can reach 80°F. Below the surface, at a depth varying from 40 to 150 feet, the lake temperature is notably cooler. This temperature gradient zone between the warm, near-surface water and the colder water of the depths is called the thermocline. The depth to the thermocline changes throughout the year due to lake levels and surface temperatures. Below the thermocline the water is cold and low in oxygen and productivity (which is measured by the concentration of chlorophyll). These cold, deep waters of the lake are called the hypolimnion.

TABLE 7: HYDROLOGIC CHARACTERISTICS OF LAKE POWELL

Parameter	Value (million acre-feet)
Volume at full pool	27
Mean annual inflow[a]	11.4
Minimum annual outflow[b]	8.23
Annual evaporation	0.5

a. Sum of flows from four major tributaries.

b. Releases from Glen Canyon Dam. The minimum level is required by law.

FIGURE 10: WATER LEVELS VARIATIONS, AS INDICATED BY SHORELINE FORMATIONS

Lake Powell does not often experience the twice-annual "turnover" seen in northern lakes, where the top and bottom layers mix whenever the changing seasons produce equal temperatures throughout the water column. Thus, the hypolimnion does not often mix with the upper surface waters, and remains in the deep reaches of the lake, low in nutrients and chlorophyll (Utah Division of Wildlife Resources 1996; NPS, Anderson, pers. com., April 2002e).

The Glen Canyon Dam penstock elevation draws water from the hypolimnion and discharges it to the Colorado River channel downstream from the dam. As a result, the water temperature never exceeds 48°F (Blakeslee 2002).

Prior to 1991, the volume of water released from the dam could vary by 20,000 cubic feet per second within a single day. However, the large flow changes were destructive, eroding the channel and sandbars. They also posed a safety hazard to rafters and could flood out campers on beaches. Therefore, in 1991, the Bureau of Reclamation decided to reduce daily fluctuations. Since then, the amount of water released downstream could not vary by more than 8,000 cubic feet per second in any one day (Blakeslee 2002).

Water Quality

As the tributary rivers enter the reservoir, the energy needed to carry sediment is lost, causing the sediment load to be deposited. As much as 98% of the sediment load is dropped within 25 miles of the river mouth. Only very fine clay particles are found near the dam.

An essential nutrient, phosphorus, adheres to soil particles and is deposited with the sediment on the upstream portions of the reservoir bed (Grand Canyon Monitoring and Research Center, Hueftle, pers. com., April 2002). The absence of this nutrient limits the growth of phytoplankton (algae) within the reservoir body, which produces the clear water that is characteristic of the lake. The areas of the lake with the highest biological productivity are located close to tributary inflows.

Heavy metals such as copper, lead, and zinc also are adsorbed to the soil particles and settle out with the sediment. As these toxic metals are covered by subsequent layers of sediment, they become biologically unavailable.

The Grand Canyon Monitoring and Research Center has been conducting water quality testing in Lake Powell since 1997. However, none of the water quality parameters measured by the center are related to emissions generated by the use of motorized watercraft. The center tests for temperature, pH, dissolved oxygen, phosphorus, nitrogen, salinity, and trace metals. No chronic water quality problems have been identified (Grand Canyon Monitoring and Research Center, Hueftle, pers. com., April 202l). The water quality in Lake Powell is generally described as good. The lake is largely suitable for swimming and fishing.

WATER POLLUTION SOURCES WITHIN GLEN CANYON NATIONAL RECREATION AREA

The quality of the water in Lake Powell is affected by many human activities. Pollutants are introduced directly to the lake during recreation activities. Sources of contamination include emissions from personal watercraft and other motorized watercraft, human waste, and trash.

The National Park Service is responsible for controlling water-polluting activities within recreation area boundaries and meeting state and federal water quality standards. In addition, the National Park Service must comply with state anti-degradation requirements. The designated uses for Lake Powell in Utah and Arizona, the standards for water criteria to be met in accord with those uses, and anti-degradation requirements are discussed later in this section.

Untreated Sewage

Human waste is a threat to recreation area resources because it can be a source of pathogenic bacteria and nutrients in the water. Control of human and pet waste is being addressed by implementing the "Lake Powell Pure" program, which includes education and the enforcement of a sanitary code (NPS 2001g).

Lake Powell water quality has been monitored for human waste since 1988. The monitoring periodically indicated high concentrations of fecal coliform bacteria, which indicate the presence of untreated sewage. In the early 1990s, several beaches were temporarily closed because of high fecal coliform bacteria levels. There were 11 beach closures and the closure of Wahweap Marina in 1995.

In response to these conditions, the National Park Service entered into the *Strategic Plan* to "Protect Water Quality at Lake Powell" with the Arizona Department of Environmental Quality and Utah Department of Environmental Quality. The intent of this plan, which was adopted in July 1996, is to improve and protect the water quality of Lake Powell. Some of the provisions of the program are as follows:

> At vehicle-accessible shorelines, visitors must camp within 200 feet of a vault toilet.
>
> In other areas of the recreation area, anyone camping within a quarter mile of Lake Powell's shoreline must carry and use a device (not plastic bags) for containing solid human waste.
>
> Restrooms and dump/pump stations have been constructed at all launch ramps.
>
> Restrooms and portable toilets are being constructed at selected vehicle-accessible backcountry shoreline camping areas.
>
> Eight floating dump/pump stations and restrooms have been constructed on Lake Powell.
>
> Additional seasonal rangers have been added to the staff to enforce sewage containment regulations.

The water quality initiatives have been highly successful in reducing contamination of Lake Powell by human sewage. The number of beach closures has gradually declined over the years with three closures in 1996, two in 1998, and one in 1999 and 2000 (NPS 2003b).

Personal watercraft use is not believed to contribute substantially to contamination of the lake by human waste. Much personal watercraft use occurs close to marinas or launch ramps where restrooms are available. When personal watercraft are used in conjunction with houseboats, the sanitary facilities of the larger vessels are available to the personal watercraft users. Therefore, none of the personal watercraft alternatives include provisions to manage pollution by human waste, and none of the alternatives would affect the ongoing efforts to protect the lake and visitors from contamination by human wastes.

Fuel Leaks or Spills at Marinas and Launch Sites

Fueling stations at the Hite, Halls Crossing, Bullfrog, Dangling Rope, and Wahweap Marinas sell fuel to boaters. In addition, fueling frequently occurs at launch sites where boaters fill the tanks of small vessels, including personal watercraft, from fuel storage cans. Evidence of pollution can be seen near fueling stations and near launch sites, by even casual observation. The "rainbow sheen" seen on the water surface in these areas is the result of oil and gasoline floating on the water surface. The odor of fuel and combustion can also be detected near these areas.

The National Park Service complies with recommendations and requirements established by the National Park Service Hazardous Waste Management and Pollution Prevention Team to prevent environmental damage resulting from oil spills (NPS 1998c). These plans are required by the Environmental Protection Agency as stated in 40 CFR, Part 112. The National Park Service and all marina operators must comply with these requirements to limit the environmental effects of fueling on the lake. In accordance with this federal regulation, ARAMARK, the concessioner at Glen Canyon National Recreation Area has developed *Spill Prevention Control and Countermeasure Plans* for each

fueling station to prevent discharges of oil to Lake Powell and the environment and to define standards for spill control and countermeasures (ARAMARK, n.d.). The National Park Service and all marina operators must comply with these requirements to limit the environmental effects of fueling on the lake. In addition, placards are displayed at marinas and educational materials are made available to recreation area visitors to inform boat operators about proper fueling of vessels and containers.

Away from areas of high boat traffic, observable evidence of hydrocarbon pollution usually disappears. In portions of the lake with low motorcraft use, the waters are clear and appear clean to the casual observer. No odor from fuel or combustion can generally be detected.

The persistence of gasoline and oil in lake waters depends on the temperature of the water and the amount of mixing. Fuel components volatilize (evaporate) more quickly at warmer temperatures. High rates of mixing increase exposure to the air and hasten volatilization (EPA 1994).

During the summer of 2001, the National Park Service conducted water quality testing at Glen Canyon National Recreation Area to determine the levels of 33 hydrocarbons in Lake Powell. Samples were taken over a 4-day period from June 29th through July 2nd. This period was selected because it represents a high-use period by motorcraft, including personal watercraft.

The summer 2001 water quality sampling does not provide a complete characterization of hydrocarbon contamination of Lake Powell. The results are only a "snapshot" of hydrocarbon levels in the lake's waters on the days of testing. However, in the absence of more complete data, they are useful for indicating current conditions.

Sample areas were chosen to capture different levels of motorboat use. They included:

A busy marina with fueling station at Bullfrog;

A high-boat-use area at Moqui Canyon;

An open-water area in Wahweap Bay; and

An area closed to all motor vessel access (control area) at Knowles Canyon.

Three locations were sampled at each test site, and samples were acquired from two depths. A total of 27 samples were obtained.

A 0.5-meter-deep (about 20 inches) sample was collected to represent the near-surface conditions where lighter-weight contaminants, such as benzene, would presumably concentrate.

A 3-meter-deep (about 10 feet) sample was collected based on research at Lake Tahoe that found complete mixing of polycyclic aromatic hydrocarbon contaminants at this level (NPS, Vanmouwerik, pers. com., May 2002p).

Analyses were performed by the State of Utah, The Woods Hole Group, Inc., and the U.S. Geologic Survey research laboratories. Samples were assayed for benzene, toluene, ethylbenzene, and xylenes; five gasoline additives, including methyl tertiary butyl ether, ethyl tertiary butyl ether, tertiary amyl methyl ether, di-isopropyl ether, and tertiary butyl alcohol; and 24 polycyclic aromatic hydrocarbon compounds (NPS, Vanmouwerik, memo, July 2001h).

Results obtained for the hydrocarbon components that are used in the water quality model in the "Environmental Consequences" chapter are presented in table 8. These hydrocarbons were chosen because the relative content of these components in gasoline is known (Gustafson et al. 1997). Complete results of the values obtained for the 33 pollutants measured in Lake Powell can be found in appendix D.1.

The Environmental Protection Agency drinking water standards are provided in table 8 only for comparative purposes, since Lake Powell water is not used as a drinking water source at any of the sampled sites. However, there are two drinking water intakes within the lake, one near Hite, Utah and one at Glen Canyon Dam that serves the town of Page, Arizona. The intake near Hite is approximately one-half mile north (upstream) of the marina, and floats at a depth of approximately 12 feet. The Glen Canyon Dam intake is under the jurisdiction of the Bureau of Reclamation. The National Park Service has no access to the site, and it not responsible for monitoring at this location. As shown in the table, the maximum concentrations detected from the most heavily used site, Bullfrog Marina, were below the treated drinking water standard or advisory level for all three compounds for which a standard exists.

The presence of these compounds in water indicates the combustion of fossil fuels, and is not specific to two-stroke engines or personal watercraft. All powered watercraft that use gasoline as fuel emit these constituents into the water. According to M. Vanmouwerik of the National Park Service National Resource Stewardship and Science Office (NPS, Vanmouwerik, memo, July 2001h), "For motorboats, each class of boat engine releases different amounts of these contaminants. To complicate matters further, emissions within each engine type class can vary significantly, depending on such factors as each individual engine's tuning and the rpm's it is being operated at."

Discharge of Gasoline, Oil, and Other Chemicals by Personal Watercraft Engines

The vast majority of personal watercraft in use today are powered by conventional two-stroke, carbureted engines, which discharge as much as 30% of their fuel directly into the water (NPS 1999c; CARB 1999a). As a result, an average 2-hour ride on a personal watercraft with a carbureted two-stroke engine will release 3 to 4 gallons of fuel into the water (NPS, Vanmouwerik and Hagemann, 1999e; Bluewater Network 2001). Such a personal watercraft operated for 7 hours produces more smog-forming emissions, including unburned hydrocarbons that are discharged into the water and then evaporate, than a passenger car driven for 100,000 miles (CARB 1999a).

TABLE 8: LAKE POWELL WATER QUALITY, SUMMER 2001

Contaminant	EPA Maximum Contaminant Level for Drinking Water	Detection Limit	Maximum Value and Location	Minimum Value and Location
Benzo(a)pyrene	0.2 µg/L[a]	0.01 µg/L	Below detection limits	Below detection limits
Naphthalene	No standard	0.01 µg/L	Below detection limits	Below detection limits
1-methyl naphthalene	No standard	0.01 µg/L	0.14 µg/L at Bullfrog Marina	Below detection limit at Moqui Canyon, Knowles Canyon, Bullfrog
Benzene	5 µg/L	0.5 µg/L	3.43 µg/L at Bullfrog Marina	Below detection limit at Knowles Canyon
Methyl tertiary-butyl ether	No standard	0.17 µg/L	1.42 µg/L at Bullfrog Marina	Below detection limit at Knowles Canyon

a. µg/L = micrograms per liter, equivalent to parts per billion.

The Personal Watercraft Industry Association notes that direct-injection engines have been available in personal watercraft for four years; and three personal watercraft manufacturers introduced four-stroke engines for the 2002 model year (PWIA 2002a). The Environmental Protection Agency assumes that the existing two-stroke engine models would not be completely replaced by newer personal watercraft technology until 2050 (40 CFR 89, 90, 91).

On October 4, 1996, the Environmental Protection Agency issued a final rule to regulate emissions from new spark-ignition gasoline marine engines, including outboard engines, personal watercraft engines, and jet boat engines. The rule-making was conducted under section 213 of the *Clean Air Act*. The Environmental Protection Agency had determined that these engines contributed to ozone air pollution, and that the technology was available to manufacture cleaner-operating engines. The rule stipulates that by the 2006 model year, the entire fleet of marine engines produced by each manufacturer, including those for personal watercraft, must have a 75% reduction in hydrocarbon emissions compared to the average for the fleet produced by that manufacturer prior to the rule. It also established intermediate target dates for emission reductions.

At its December 1998 meeting, the California Air Resources Board adopted an even more aggressive program for reducing emissions from personal watercraft, outboard, and some jet boat engines. It stipulated that new marine engines would have to meet the 75% reduction goal in 2001 and would have be 90% cleaner in 2008. Four months later, Minnesota-based Polaris Industries, a major manufacturer of personal watercraft, received certification from the Environmental Protection Agency for a direct-injection two-stroke personal watercraft that met the 75% reduction goal (CARB 1999b). Since then, other manufacturers have received certification, and since 2001 only low-emission personal watercraft have been sold in California.

Some manufacturers are using four-stroke engine technology on personal watercraft to reduce emissions and meet regulatory standards (EPA 1996a). Others are using the same approach as Polaris Industries and installing direct-injection two-stroke engines. The 75% reduction standards have been met both by direct-injection two-stroke engines and electronic fuel injection two-stroke engines.

Rather than producing 2006-certified vessels for the large California market (50,000 personal watercraft and outboard units per year) and intermediately clean vessels for use in other states, some manufacturers may be choosing to switch their entire product line to low-emission personal watercraft. As a result, an estimated 12% of personal watercraft used on Lake Powell in June and July 2001 had low-emission engines. Because the low-emission technology has been successfully demonstrated in California, its complete implementation in year 2006 models nationwide appears assured.

In 1996, the Environmental Protection Agency estimated an overall 52% reduction in hydrocarbon emissions from marine engines from present levels by 2010, and a 75% reduction by 2030, based on converting polluting machines. The 1997 EPA rule delayed implementation by one year (EPA 1996a, 1997a).

These milestones could be reached even earlier, based on the effects of the subsequent, more stringent California Air Resources Board (1998a) standards.

The average operating life of a personal watercraft is 5 to 10 years, depending upon the source. The formula for determining the operating life of personal watercraft was published in the *Federal Register* on October 4, 1996 (EPA 1996a). Based on this formula, the National Park Service expects that by 2012, most boat owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes the typical operating life of a personal

watercraft rental is three years and approximately five to seven years for a privately owned vessel (PWIA, pers. com., May 2002a). Water quality conditions associated with the use of personal watercraft and other motorcraft will improve, regardless of the management action selected.

Although overall hydrocarbon emissions will be reduced as a result of implementation of EPA 2006 marine engine standards, the emission of PAH compounds to the water varies by engine type. A recent study by the Tahoe Regional Planning Agency (2003) compared the concentrations of PAH compounds released into the water and found that the two-stroke carbureted outboard engine emitted lower PAH levels into the water than did the two-stroke direct-injected engine. The four-stroke carbureted outboard engine emitted the lowest PAH levels, as well as other gasoline-related contaminants into the water (TRPA 2003; CARB 2001). However, the two-stroke carbureted outboard engine emitted higher levels of benzene than the two-stroke direct-injected engine model (CARB 2001). Personal watercraft engines follow the same patterns of emission rates as outboard engines (CARB 2001). The TRPA (2003) study confirms other findings regarding emissions into the water and does not substantially change NPS conclusions regarding water quality impacts.

CHEMICAL COMPOSITION OF GASOLINE AND COMBUSTION PRODUCTS WITH REGARD TO PERSONAL WATERCRAFT MANAGEMENT

Up to one-third of the fuel delivered to the conventional personal watercraft engine is unburned and discharged into the water. Several groups of chemical compounds are released with the unburned gasoline and oil mixture, or in the combustion emissions.

Uncombusted gasoline contains about 300 hydrocarbon compounds. About 85% of these compounds are highly volatile (low boiling point), short, straight chains consisting of 5 to 12 carbon atoms.

Uncombusted gasoline also includes aromatic hydrocarbons, which have a ring structure consisting of six carbon atoms. These compounds include benzene, toluene, ethylbenzene, and xylenes. These compounds are of concern because they are more soluble in water than other gasoline constituents. As reported by Wiedemeier et al. (1999), benzene, toluene, ethylbenzene, and xylenes constitute about 15% of fresh gasoline, but represents almost 70% of the organic component of gasoline that dissolves in water. In addition, these compounds are more toxic than most other components in gasoline, and benzene is a known carcinogen (causes cancer).

Polycyclic aromatic hydrocarbons are released in engine exhaust, although some polycyclic aromatic hydrocarbons are present in unburned fuel. Polycyclic aromatic hydrocarbons that were analyzed for impacts on water quality in this document include benzo(a)pyrene, naphthalene, and 1-methyl-naphthalene. Polycyclic aromatic hydrocarbon molecules contain two to seven benzene rings. Their environmental fate, persistence, and toxicity are related to this molecular structure and to the number and configuration of attached carbon/hydrogen groups. The smaller, lighter (two- and three-ringed) polycyclic aromatic hydrocarbons compounds are generally more water soluble, more biodegradable, and more volatile. Their solubility makes them more bioavailable (and therefore more of a risk) to aquatic life, but their low persistence also reduces exposure times.

Methyl tertiary-butyl ether is added to gasoline at the refinery to enhance octane rating, increase burning efficiency, and reduce atmospheric emissions. It has been used to improve gasoline performance since 1979 (EPA 2001b). About 30% of gasoline sold in the United States currently

contains methyl tertiary-butyl ether or other octane enhancers. Methyl tertiary-butyl ether is added to gasoline in both Utah and Arizona (Utah Department of Environmental Quality, Taylor, pers. com., 2002c; Arizona Department of Environmental Quality 2002a).

In the 2001 summer water quality sampling program described earlier, the National Park Service targeted five constituents of gasoline and its degradation products for analysis. They included benzo(a)pyrene, naphthalene, 1-methyl naphthalene, benzene, and methyl tertiary-butyl ether.

Benzo(a)pyrene is a polycyclic aromatic hydrocarbon found in exhaust and smoke. It adsorbs to sediment particles, and may be removed from the aquatic system as the sediment is deposited. Benzo(a)pyrene degrades in light (photodegradation) and also can be degraded by microorganisms.

Benzo(a)pyrene may accumulate in some aquatic organisms and may bioconcentrate in aquatic organisms that cannot metabolize this compound. Oysters and bluegills are susceptible to build-up, but mudsuckers and sculpins show no tendency toward accumulation. When it accumulates in aquatic organisms, benzo(a)pyrene can cause reproductive abnormalities and changes at the cellular and DNA level (EPA 2002c). Chronic exposure to benzo(a)pyrene at levels above the maximum contaminant level, 0.002 mg/L, can lead to reproductive difficulties, and a lifetime of exposure above this level has the potential to cause cancer in humans (EPA 2002c).

Naphthalene is released into the air during combustion of oil and coal. It also has been detected in cigarette smoke. Its toxicity to insects is evident in that naphthalene is the primary constituent of mothballs.

Naphthalene is mobile and toxic in the aquatic environment, but is not particularly water soluble. It evaporates easily and breaks down in sunlight. In surface waters, it volatilizes to the atmosphere; which serves as an important pathway for removing this component from the water.

Acute toxicity in fish is rare. However, bioaccumulation is moderate and risks to aquatic life include cancer, liver damage, and kidney damage (NPS 1997). In humans, naphthalene vapors in combination with coal tar have been shown to increase cancer risk. Naphthalene alone is not yet classifiable as a human carcinogen (EPA 2001a).

The compound 1-methyl naphthalene is a component of crude oil and is found in effluents from refineries and petrochemical plants. It is used as an industrial solvent, and also occurs naturally in several food products, including filberts, nectarines, and beans (Spectrum Laboratories n.d.). This compound is slightly heavier than water and readily adheres to sediment. Both of these characteristics serve to remove it from the water column. In addition, 1-methyl naphthalene is degraded in water, by sunlight, and during microbial processes.

There is little toxicological data available for 1-methyl naphthalene. Acute toxicity in aquatic organisms is rare, but damage to embryos and increased tumor development have been reported. It does not strongly bioaccumulate, but can be persistent in amphibian tissues (NPS 1997).

Benzene is a volatile solvent. It evaporates rapidly, and has a half-life of approximately 5 hours. It does not persist in the environment because it is degraded by microbes in soil and water.

Very little benzene is taken up by plants, birds, or fish, and it is not likely to accumulate in aquatic organisms. Once the source of contamination is removed, benzene is quickly cleared from most organisms (NPS 1997).

Benzene poses a greater risk to humans than to other life forms. In humans, short-term exposure can lead to nervous system disorders, immune system depression, and anemia. It is a known human carcinogen (causes cancer). Other effects of long-term exposure may include chromosome aberrations and decreased platelets (EPA 2001c).

As discussed earlier, methyl tertiary-butyl ether is an additive to gasoline. Little is known about the risk to aquatic life from exposure to methyl tertiary-butyl ether. Of organisms tested, algae have been the most sensitive to methyl tertiary-butyl ether exposure. Fish do accumulate methyl tertiary-butyl ether at about 1.5 times the concentration in the water body. Adverse effects on trout have been estimated to occur at 4,600 parts per billion, a far greater concentration than acceptable levels for human exposure (Vanmouwerik and Hagemann 1999).

Methyl tertiary-butyl ether may be a human carcinogen at high doses. The 1997 U.S. Environmental Protection Agency Drinking Water Advisory found that there is insufficient evidence to establish quantitative estimates for health risk, but indicated that methyl tertiary-butyl ether in drinking water will likely cause health effects at concentrations of 20 to 40 parts per billion or less (EPA 2001b). The Environmental Protection Agency is currently developing a *Safe Drinking Water Act* standard for this pollutant (EPA 2002a).

Once in the water, a variety of processes determine the fate of these and other components of gasoline and its emissions. Volatile components can evaporate to the atmosphere and soluble components can dissolve. Normally, some components would be adsorbed to sediment suspended in the water column. However, this is uncommon in Lake Powell, where the sediment carried by tributary rivers is deposited when water velocity slows upon entering the reservoir.

STATE WATER QUALITY STANDARDS

The objective of the *Clean Water Act* is to "restore and maintain the chemical, physical and biological integrity of the nation's waters." The overall goal of the *Clean Water Act* is to produce waters of the United States that are "fishable and swimmable."

A primary means for evaluating and protecting water quality is the establishment and enforcement of water quality standards. Under the *Clean Water Act*, the federal government delegated responsibility for establishing water quality criteria to each state, subject to approval by the Environmental Protection Agency. Water quality standards consist of three parts:

Designated beneficial uses of water (e.g., drinking, recreation, aquatic life);

Numeric criteria for physical and chemical characteristics for each type of designated use; and

An "antidegradation" provision to protect uses and water quality.

In accordance with the *Clean Water Act*, each state has defined the uses for waters occurring within its borders, and each water body must be managed in accordance with its designated uses. Water quality standards have been established for each designated use. Standards must be at least as stringent as those established by the Environmental Protection Agency. In most cases, states have adopted the same standards as the Environmental Protection Agency.

The Environmental Protection Agency has developed recommended water quality criteria for approximately 120 priority pollutants to protect aquatic life and human health (EPA 1999a). These criteria have been adopted as enforceable standards by most states, including Arizona and Utah.

Standards have not yet been set for many pollutants, including some of the compounds introduced to the water by the use of personal watercraft. If a numeric standard for a pollutant has not been determined by the Environmental Protection Agency, each state can establish and enforce its own criteria for protection of people and resources.

In some cases, the Environmental Protection Agency has developed advisory levels. For example, no standard for methyl tertiary-butyl ether has been established to protect human health, but an advisory level has been named because methyl tertiary-butyl ether can be tasted and smelled at 20 to 40 parts per billion. Such advisory levels are not enforceable.

Other pollutants have been less subject to regulation. For these, the potential for concern is indicated by ecotoxicological and human health toxicological benchmarks that can be found in the scientific literature. These benchmarks are informational only and are not subject to enforcement.

Under section 313 of the *Clean Water Act*, the National Park Service and all other federal agencies and departments must comply with all federal, state, interstate, and local requirements regarding the control and abatement of water pollution. This includes management of any activity that may result in the discharge or runoff of pollutants.

The National Park Service manages the water of Lake Powell in accordance with the water quality standards of the states of Arizona and Utah. In cases where water quality criteria differ between governing agencies, the strictest criteria must be met. In addition, the National Park Service must meet state antidegradation provisions, which require that the existing quality of state waters may not be degraded. This ensures that the lake can serve its intended purposes, as defined by the assigned beneficial uses.

Arizona

Arizona has established the following designated uses for the waters of Lake Powell within the state (Arizona Administrative Code, Title 18, Chapter 11 - Water Quality Standards 1996).

> Aquatic and wildlife coldwater – use of a surface water by animals, plants, or other organisms, including salmonids (trout), for habitation, growth, or propagation.
>
> Full-body contact – use of a surface water for swimming.
>
> Domestic water supply – use of a surface water source as a potable water supply. This designation recognizes that treatment processes such as coagulation, sedimentation, filtration, or disinfection may be necessary to yield a finished water suitable for human consumption.
>
> Fish consumption – use of a surface water by human for harvesting aquatic organisms for consumption.
>
> Agricultural irrigation – use of a surface water for the irrigation of crops.

Agricultural livestock watering – use of a surface water as a supply of water for consumption by livestock.

The concentrations of contaminants of concern in Lake Powell compared to the Arizona standards for the lake's designated uses are provided in table 9. Because there are no Arizona standards for 1-methyl naphthalene or methyl tertiary-butyl ether, ecotoxicological and human health benchmarks for these, as well as the other compounds, are provided in table 10.

Benchmarks for benzo(a)pyrene and benzene (EPA 1999a) that are based on the consumption of aquatic organisms, as well as those for consumption of water and aquatic organisms, by humans are used to assess impacts (see "Approach to Evaluating Surface Water Quality Impacts from the Use of Personal Watercraft" in appendix G). The Environmental Protection Agency promulgated new recommended national water quality criteria for these components in November of 2002 (EPA 2002a). Incorporation of the new EPA criteria noted in table 10 below, would not result in changes to the conclusions of the water quality assessment for personal watercraft use at Lake Powell. The state of Utah plans to adopt the new EPA criteria into state water quality standards, effective in the summer of 2003 (Utah Department of Environmental Quality, Water Quality Division, Pherson, pers. com., April 2003b).

TABLE 9: ARIZONA AND UTAH WATER QUALITY STANDARDS FOR SELECTED POLLUTANTS

	Benzo(a) pyrene (µg/L)[a]	Naphthalene (µg/L)	1-methyl naphthalene (µg/L)	Benzene (µg/L)	Methyl tertiary-butyl ether (µg/L)
Maximum concentration detected in 2001 sampling at Glen Canyon National Recreation Area[b]	Below detection limit	Below detection limit	0.14	3.43	1.42
Detection limit	0.01	0.01	0.01	0.5	0.17
Arizona standards for designated uses					
Aquatic and wildlife coldwater, acute	NS[c]	1,100	NS	2,700	NS
Aquatic and wildlife coldwater, chronic	NS	210	NS	180	NS
Full-body contact	0.2	NS	NS	48	NS
Domestic water supply	0.2	NS	NS	5	NS
Fish consumption	0.002	NS	NS	120	NS
Agricultural irrigation and agricultural livestock watering	NS	NS	NS	NS	NS
Utah standards for designated uses					
Class 1C (domestic purposes)	0.0028	NS	NS	1.2[d]	NS
Class 2A (primary contact recreation)	NS	NS	NS	NS	NS
Class 2B (secondary recreation)	NS	NS	NS	NS	NS
Class 3B (warm water species)	0.031	NS	NS	71	NS
Class 4 (agricultural uses)	NS	NS	NS	NS	NS
Environmental Protection Agency recommended criteria for protection of human health[e]	0.0044	NS	NS	1.2[e]	NS

a. µg/L = micrograms per liter, or parts per billion.

b. From table 8.

c. NS = no standard.

d. This criterion for benzene is applicable to waters in the immediate vicinity of public drinking water intakes, and not to general surface waters of the state (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003).

e. Source: EPA 1999a.

TABLE 10: ECOTOXICOLOGICAL AND HUMAN HEALTH BENCHMARKS

Compound	Ecotoxicological Benchmark (μg/L)	Source	Human Health Benchmark (μg/L)	Source
Benzo(a) pyrene	0.014	Suter and Tsao 1996	0.0044[a] 0.049[b]	EPA 1999a
Naphthalene	62	Suter and Tsao 1996		
1-methyl naphthalene	34[c]	U.S. Fish and Wildlife Service 2000		
Benzene	71 warm water fishery	State of Arizona Administrative Code 1996	1.2[a] 71[b]	EPA 1999a
Methyl tertiary-butyl ether (chronic)	18,000 freshwater chronic	Mancini et al. 2001		
Methyl tertiary-butyl ether (acute)			20 to 40, based on odor and taste[d]	EPA 1999a

a. Based on the consumption of water and aquatic organisms. [Note: The EPA recently revised the human health criteria for consumption of water and freshwater organisms for benzo(a)pyrene from 0.0044 μg/L to 0.0038 μg/L and for benzene to 2.2 μg/L to 51 μg/L (2002a). Conclusions regarding water quality impacts presented below based on the 0.0044 and 1.21 μg/L criteria (EPA 1999a) would not change as result of the new criteria.]

b. Based on the consumption of aquatic organisms only. [Note: The EPA recently lowered the human health criteria for water consumption for benzo(a)pyrene from 0.049 μg/L to 0.018 μg/L and for benzene from 71μg/L to 51 μg/L (2002a). Conclusions regarding water quality impacts presented below based on the 0.049 and 71 μg/L criteria (EPA 1999a) would not change as result of the new criteria.]

c. Based on LC_{50}s of 3,400 μg/L for sheepshead minnow (34 μg/L used for freshwater calculations).

d. Human health toxicological information for methyl tertiary-butyl ether is currently under review. There is no Environmental Protection Agency human health benchmark.

As shown in the tables, the maximum concentrations found during the summer 2001 sampling for all five compounds appear to be below the Arizona standards for all of the designated uses that apply to Lake Powell, or below the ecotoxicological and human health benchmarks. However, the detection limit for benzo(a)pyrene was 0.01 μg/L, which is greater than the fish consumption limit of 0.002 μg/L.

Utah

The waters of Lake Powell are designated for the following five uses by the state of Utah (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., April 2002b).

Class 1C – Protected for domestic purposes with prior treatment by processes as required by the Utah Division of Drinking Water.

Class 2A – Protected for primary contact recreation such as swimming.

Class 2B – Protected for secondary recreation such as boating, wading or similar uses.

Class 3B – Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

Class 4 – Protected for agricultural uses including irrigation of crops and stock watering.

The concentrations of contaminants of concern in Lake Powell compared to the Utah standards for the lake's designated uses are provided in table 9. There are no Utah standards for naphthalene, 1-methyl naphthalene, or methyl tertiary-butyl ether.

As shown in the table, the maximum concentration for benzene (3.43 µg/L) found during the summer 2001 sampling exceeds the standard for Class 1C (domestic purposes). However, according to NPS staff, this criterion for benzene is applicable to waters in the immediate vicinity of public drinking water intakes, and not to general surface waters of the state (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a).

As described above in the Arizona discussion, the detection limit for benzo(a)pyrene was 0.01 µg/L, which is greater than the Utah Class 1C (domestic purposes) standard.

Environmental Protection Agency Criteria and Recommendations

The Environmental Protection Agency does not have any recommended water quality criteria, either acute or chronic, for polycyclic aromatic hydrocarbons for the protection of aquatic life. However, as shown in table 10, two of the compounds evaluated here, benzo(a)pyrene and benzene, have Environmental Protection Agency-recommended water quality criteria for protection of human health. As described in the discussion of the Utah standards:

> The criterion for benzene is applicable to waters in the immediate vicinity of public drinking water intakes, and not to general surface waters of the state.
>
> Because the detection limit for benzo(a)pyrene is greater than the recommended criterion of 0.0044 µg/L, conclusions cannot be made regarding the presence of this compound at concentrations at or above this Environmental Protection Agency criterion.

Although there is no federal drinking water standard for methyl tertiary-butyl ether, it is on the "Contaminant Candidate List" for consideration in setting health standards (EPA 2001b). In 2001, a methyl tertiary-butyl ether water criteria work group was established, consisting of representatives from private companies, trade associations, and the Environmental Protection Agency. This partnership generated toxicity data for deriving ambient water quality criteria for methyl tertiary-butyl ether and calculated preliminary freshwater and marine criteria for acute and chronic exposure effects (Mancini et al. 2001). Those criteria are included in table 10.

ANTIDEGRADATION POLICIES

A water quality standard defines water quality goals by designating uses for the water, setting minimum standards to protect the uses, and establishing the intent to prevent degradation of water quality. The intent of a state antidegradation policy is to maintain a water body in a condition suitable to serve its intended purpose. For example, an Arizona water used as a source of fish eaten by humans must meet the strict "fish consumption" standards for benzo(a)pyrene. Actions that would cause levels of this contaminant to exceed the allowable level for the "fish consumption" designation would not be allowed. This would be true even if the water remained of adequate quality to serve other uses for which it was designated, such as a drinking water source or for swimming.

Part of this antidegradation policy (40 CFR 131.12(a)(2)) is to maintain water quality at existing levels, even if it is already better than the minimum standard necessary to protect designated uses. Antidegradation should not be interpreted to mean that "no degradation" can or will occur, as degradation may be allowed for certain pollutants in even the most pristine waters. However, that degradation must be demonstrated to be temporary and short-term in nature (NPS, Rosenlieb, pers. com., June 2002l).

Arizona

Arizona antidegradation guidelines are included in the Arizona Administrative Code, Department of Environmental Quality, R18-11-107, Antidegradation. They closely follow the model provided by Region 8 of the Environmental Protection Agency, with modifications to comply with Arizona water quality standards. These guidelines define degradation as any discharge that significantly increases the pollutant concentration or loading of receiving waters and changes the existing water quality.

Arizona uses a three-tier approach to protect the state waters from degradation.

> Tier 1 is the minimum protection provided to all waters of the state. This is the protection afforded waters that do not meet fishable/swimmable goals.
>
> Tier 2 is applied to waters where existing water quality is better than applicable water quality standards. The existing water quality must be maintained and protected, except that limited degradation may be allowed through a public hearing process.
>
> Tier 3 waters are protected from all degradation.

Guidance to fully address and implement antidegradation has not been adopted. Because of this, characterization of receiving waters does not occur, and permits are written which allow significant increases in pollutant levels. While these increases allow the water body to remain in compliance with numeric water quality standards, they may result in degradations of existing water quality.

Lake Powell is an Arizona Tier 2 water body. As a result, some reduction in water quality is allowed, with public participation and review required. However, as a drinking water supply, Lake Powell must achieve all statutory and regulatory requirements to fulfill this purpose.

Utah

The Utah antidegradation policy is included in the Utah Administrative Code, Rule R317-2, Standards of Quality for the State. It establishes a plan to maintain and improve the quality of the state's waters for public water supplies; the propagation of wildlife, fish, and aquatic life; and agricultural, industrial, recreational, and other legitimate uses. The policy states that no waste will be discharged into any waters of the state that would compromise the beneficial uses of the receiving waters.

Lake Powell has not been designated as a high-quality water, and is not afforded special protection under Utah statues. Some reduction in water quality would be allowable to support vital economic activities, as long as designated beneficial use is not affected.

AIR QUALITY

The Environmental Protection Agency defines ambient air as "that portion of the atmosphere, external to buildings, to which the general public has access" (40 CFR Part 50). In compliance with the 1970 *Clean Air Act* and the 1977 and 1990 *Clean Air Act* Amendments, the Environmental Protection Agency has promulgated national ambient air quality standards and regulations. The standards were enacted for the protection of public health and welfare of the environment. To date, the agency has issued standards for six criteria pollutants, including:

Carbon monoxide;

Sulfur dioxide;

Particles with a diameter less than or equal to a nominal 10 micrometers or 2.5 micrometers;

Ozone;

Nitrogen dioxide; and

Lead.

There are two types of air quality standards: primary and secondary.

Primary standards are designed to protect sensitive segments of the population from adverse health effects, with an adequate margin of safety, which may result from exposure to criteria pollutants.

Secondary standards are designed for the protection of public welfare, including visibility and damage to animals, vegetation, and buildings.

Each state and locality has the primary responsibility for air pollution prevention and control. Under the *Clean Air Act* and the *Clean Air Act* Amendments, state and local air pollution control agencies have the authority to adopt and enforce ambient air quality standards that are more stringent than the national standards.

Arizona and Utah are responsible for regulating air quality in the region where Glen Canyon National Recreation Area is located. Both states have adopted without change the federal national ambient air quality standards, which are shown in table 11.

The air quality standards set forth within the *Clean Air Act* (42 U.S.C. 7401-7671q as amended in 1990) must be maintained. Glen Canyon National Recreation Area partially shares common boundaries with three national parks, all of which are designated as class I airsheds. Class I airsheds are afforded the highest degree of air quality protection under the *Clean Air Act* with little allowance for deterioration of air quality. Glen Canyon National Recreation Area is designated a class II airshed under this law. A class II airshed is defined as an area having moderate to good air quality, with "some deterioration in quality resulting from moderate, well controlled growth." The recreation area's air quality is protected by allowing limited increases (i.e., allowable increments) over baseline concentrations of pollution for sulfur dioxide, nitrogen oxides, and particulate matter.

TABLE 11: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR CRITERIA POLLUTANTS[a]

Pollutant	Averaging Time	Primary Standard	Secondary Standard	Purpose
Carbon monoxide (CO)	1-hour 8-hour	35 ppm[b] (40 mg/m^3) 9 ppm (10 mg/m^3)	— —	Prevent high levels of carboxy-hemoglobin
Nitrogen dioxide (NO_2)	Annual	0.053 ppm (53 ppb)	Same as primary	Prevent breathing difficulties, reduce smog and acid rain formation, and improve visibility
Particulate matter (PM_{10})	24-hour Annual	150 µg/m^3 50 µg/m^3	Same as primary	Prevent chronic diseases of the respiratory tract and improve visibility
Particulate matter ($PM_{2.5}$)	24-hour Annual	65 µg/m^3 15 µg/m^3	Same as primary	Prevent chronic diseases of the respiratory tract and improve visibility
Ozone (O_3)	1-hour 8-hour	0.12 ppm (125 ppb) 0.08 ppm (85 ppb)	Same as primary	Prevent breathing difficulties, eye irritation, and biological effect on sensitive species
Sulfur dioxide (SO_2)	3-hour 24-hour Annual	0.14 ppm (140 ppb) 0.03 ppm	0.50 ppm (500 ppb) — —	Prevent increased respiratory damage, acid rain, and crop damage and to improve visibility
Lead (Pb)	Quarterly average	1.5 µg/m^3	Same as primary	Prevent impaired production of hemoglobin

a. Source: 40 CFR 40, Part 50, July 1991, "Ambient Air Quality Standards."

b. ppm = parts per million
ppb = parts per billion
mg/m^3 = milligrams per cubic meter
µg/m^3 = micrograms per cubic meter.

Glen Canyon National Recreation Area is located within Garfield, Kane, San Juan, and Wayne Counties in Utah; and Coconino County in Arizona. The Environmental Protection Agency has designated these areas as in attainment for all criteria pollutants (EPA 2002a).

The recreation area is located in a remote portion of the Colorado Plateau that has relatively few developments or major sources of air pollutants. The largest urban centers, including Phoenix, Arizona, Salt Lake City, Utah and Las Vegas, Nevada, all are greater than 300 miles away. Thus, air pollutants of recent origin generally come from the few local point sources and the area sources (including mobile) that are adjacent to the recreation area.

Localized sources of air pollution within the recreation area primarily include exhaust from recreational and motor vehicles (NPS 2002r). Campfires can sometimes be an important source of particulates within the recreation area, particularly in popular camping areas.

There are two point sources of substantial size close to the recreation area. They include the Salt River Navajo Generating Station near Page, Arizona (Wahweap area) and the Nuclear Fuel Service Plant near the Bullfrog area in Utah.

The air quality in Glen Canyon National Recreation Area was represented by measurements taken during a short-term study over Labor Day weekend in 2001 (NPS 2002r) and data from a regional monitoring station at the Navajo Generating Station, near Wahweap. The short-term study collected data in the vicinity of Halls Crossing and near the Wahweap area.

The 1-week study over Labor Day weekend only provides a snapshot of the air quality since it does not meet the minimum three-years monitoring time generally required for comparison to the national air quality standards. The data presented here from the week-long study do not define the air quality in every location of such a large NPS unit, but rather provide an impression of the air quality in personal watercraft use locations at a time when a large number of personal watercraft are active. Wahweap represented a high-use area and Halls Crossing reflected air quality conditions at a moderate-use area. At both sites, personal watercraft represented about a quarter of all boat use.

Table 12 presents air quality data for the five criteria pollutants that are produced directly by combustion. The values in the table were estimated during the week-long study in the recreation area and monitored in 2001 by the Salt River Project, Navajo Generating Station, near Wahweap. Based on the data collected in 2001, all ambient air quality levels met the national ambient air quality standards.

Ozone is created by sunlight acting on nitrogen oxides and volatile organic compounds in the air. Ozone measurements recorded at the Salt River Project monitoring station from 1999 through 2001 indicate a three-year average ozone level of 61 parts per billion, which is 72% of the national ambient air quality standard (85 parts per billion).

High concentrations of ozone and/or long-term exposure can cause injury to plants. A cumulative measurement of ozone levels, called the SUM06 (parts per million per hour), looks at extended exposures of greater than 60 parts per billion of ozone that occur 12 hours per day over a three-consecutive-month sampling period. The SUM06 can provide an indication of ozone levels with potential to harm vegetation. Using the Salt River Project monitoring measurements for ozone from 1998 through 2000, the SUM06 measurement was found to be 11.3. This value is 45% lower than the Environmental Protection Agency proposed level (25 parts per million per hour) of ozone associated with injury effects on vegetation (NPS 2002r).

TABLE 12: COMPARISON OF AIR POLLUTANT CONCENTRATIONS FROM 2001 AT GLEN CANYON NATIONAL RECREATION AREA

Pollutants[a]		National Standard	Halls Crossing Study (2001)	% of Standard	Wahweap Study (2001)	% of Standard	SRP[b] Monitoring Data (2001)	% of Standard
Mean								
NO_x	Annual	53 ppb[c]	4.5 ppb	8.5	1.48 ppb	2.8	2.74 ppb	5.2
$PM_{2.5}$	Annual	15 µg/m^3	0.41 µg/m^3	2.7	7.2 µg/m^3	48.0	4.54 µg/m^3	30.3
SO_2	Annual	30 ppb	—	—	—	—	1.04 ppb	3.5
Maximum								
$PM_{2.5}$	24-hour	65 µg/m^3	1.75 µg/m^3	2.7	9.3 µg/m^3	14.3	10.2 µg/m^3	15.7
CO	1-hour	35 ppm	4.92 ppm	14.1	—	—	—	—
SO_2	24-hour	140 ppb	0.6 ppb	0.44	0.84 ppb	0.6	—	—
O_3	Daily 1-hour	125 ppb	84 ppb	67.2	50 ppb	40.0	75 ppb	60.0

a. CO = carbon monoxide.
NO_x = nitrogen oxides.
O_3 = ozone.
$PM_{2.5}$ = articulate matter with a diameter less than or equal to 2.5 micrometers.
SO_2 = sulfur dioxide.

b. SRP = Salt River Project monitoring station near Wahweap.

c. ppm = parts per million; ppb = parts per billion; µg/m^3 = micrograms per cubic meter.

NATURAL SOUNDSCAPES

Recreation area soundscapes include both natural and human components. The natural soundscape is considered a recreation area resource. At Glen Canyon National Recreation Area, the natural soundscape includes sounds produced by such sources as wind, thunder, insects and birds, falling rocks, streams, and wind-caused waves on the shore. It also includes the "natural quiet" that occurs in the absence of natural and human sound sources.

Engines are a primary source of human-caused sound at Glen Canyon National Recreation Area. These include engines on personal watercraft and other vessels, automobiles and trucks, off-road vehicles, aircraft, and generators. Other common sources of human-caused sound in the recreation area include electronic devices such as radios and automobile horns, human vocalizations, barking of dogs, vehicle tires on roads, and wave noise caused by boat wakes.

NATURAL SOUNDSCAPES AND VISITOR EXPERIENCE

The opportunity to experience the natural soundscape is an important part of a positive park experience for some visitors. According to *Director's Order 47* (NPS 2000b), a system-wide survey of park unit visitors revealed that almost as many visitors come to national parks to enjoy the natural soundscape (91%) as come to view the scenery (93%). Popular natural sounds include bird songs, wind, thunder, and natural quiet. Another soundscape-related aspect of the visitor experience is the opportunity to experience solitude and tranquility, primarily in the remote natural parts of the recreation area where that opportunity is expected to be available. Some human-caused sound is considered acceptable in that it is attendant to purposes and uses for which the recreation area, or park, was created. *Director's Order 47* requires park units to determine the level of human-caused sound that is necessary for park purposes, and to achieve that level by reducing noise and restoring the natural soundscape to the greatest possible extent.

SOUND VERSUS NOISE

Sound, in the context of this environmental impact statement, is a physical disturbance in the air created by vibration. Its four primary parameters are:

Amplitude, measured in decibels, which determines loudness;

Frequency, measured in Hertz, which determines pitch; and

Duration, measured in elapsed time units such as seconds or hours.

Audibility, conveying the area or distance through which a human-caused sound, defined using the three previous parameters, is propagated.

Amplitude, frequency, and duration are physical measurements. Loudness and pitch are subjective impressions that depend on the amplitude and frequency of the sound, plus the characteristics of the listener and the listener's environment (U.S. Forest Service 1980). Audibility is a modeled characteristic that is determined using measured or assumed values for amplitude, frequency and duration.

Noise is generally defined as unwanted or intrusive sound. Sound can be perceived as noise because of loudness, pitch, duration, occurrence at unwanted times or from an unwanted source, or because it interrupts or interferes with a desired activity. A sound that is considered neutral or desirable by one person may be considered unpleasant noise by another person because of a perception of inappropriateness or disturbance, and/or unwanted content or meaning.

Komanoff and Shaw (2000) note that the biggest difference between noise from personal watercraft and that from motorboats is that the former continually leave the water, which magnifies noise in two ways. Without the muffling effect of water, the engine noise is typically 15 dB(A) louder and the smacking of the craft against the water surface results in a loud "whoop" or series of them. With the rapid maneuvering and frequent speed changes, the impeller has no constant "throughput" and no consistent load on the engine. Consequently, the engine speed rises and falls, resulting in a variable pitch. This constantly changing sound is often perceived as more disturbing than the constant sound from motorboats.

NATURAL SOUNDSCAPE AT GLEN CANYON NATIONAL RECREATION AREA

Director's Order 47 (NPS 2000b) states that the natural ambient sound level[2] of a park is the basis for determining the affected environment in environmental impact statements and other documents prepared for compliance with the *National Environmental Policy Act*. Three acoustic studies conducted at Glen Canyon National Recreation Area were used to establish the area's natural soundscape. The L_{90} referenced in these studies represents the sound level exceeded 90% of the measuring time. The L_{90} is the sound level descriptor specified in *Director's Order 47* to use in estimating the natural ambient sound level when only a single descriptor is used.

Ambient Sound Monitoring Program for Colorado Plateau Parks (Collaboration in Science and Technology, Inc. 1990) collected data in 1989 and 1990 in Glen Canyon National Recreation Area at Rainbow Bridge and Escalante.

> Hourly L_{90} levels at Rainbow Bridge ranged from 22 to 34 decibels in April, and from 22 to 40 decibels throughout the main visitor season in the summer. Average daily L_{90} levels ranged from 22 decibels in October to 34 decibels in August.
>
> At the Escalante site, the hourly L_{90} levels ranged from 20 to 40 decibels.

These measurements were consistent with other quiet park environments in the region that were measured during the same study. However, the study notes that many of the L_{90} measurements were at the noise floor of the instruments. That is, the meters could not read anything lower than 20 to 22 decibels.

Draft Summary of Measurement Results, Cal Black Memorial Airport (BCS International 1998) reported on data collected at seven sites in the Halls Crossing/Bullfrog area of Glen Canyon National Recreation Area. Measurements were taken from May 22 to June 4, 1998. The goal of this study, conducted for the Federal Aviation Administration, was to measure aircraft and ambient sound levels in the vicinity of the Cal Black Memorial Airport. The L_{90} levels for the seven sites ranged from less

2. The existing sound environment, less all human-caused sound.

than 20 decibels (the noise floor of the instruments) to a high of 55 decibels. The study noted that the higher levels were the result of insect activity, and that during early morning hours the levels were typically below 20 decibels.

Draft Technical Report on Noise: Personal Watercraft and Boating Activities at Glen Canyon National Recreation Area (Harris Miller Miller & Hanson, Inc. 2002) was prepared to support this environmental impact statement. Data were collected during August 2001 at four sites, including one in Crosby Canyon, two in Last Chance Canyon, and one at Rainbow Bridge.

Sound levels in this study were measured at a variety of time periods at different times on several days. The lowest and highest sound levels recorded are indicated as L_{min} and L_{max}. The hourly equivalent level (L_{eq}) represents the energy-average A-weighted sound level for each hour. The L_{90} levels in this study ranged from below 10 decibels to about 40 decibels.

Data from the low-use site at the end of Last Chance Canyon were used to characterize the natural soundscape because at the other sites, the soundscape was heavily influenced by watercraft noise. The daytime median L_{90} measured at the Last Chance Canyon site by the Harris Miller Miller & Hanson, Inc. (2002) study was 13.4 decibels. This value is considered representative of the average natural soundscape at Glen Canyon National Recreation Area that could be affected by the personal watercraft management for the following reasons.

> Personal watercraft and other vessels are active during the daytime. Therefore, it is more appropriate to use the daytime median L_{90} than the nighttime or the 24-hour L_{90}.
>
> During the studies by Collaboration in Science and Technology, Inc. (1990) and BCS International (1998), many of the measurements were at or below the instruments' noise floor of about 20 decibels. Therefore, accurate calculations of L_{90} levels could not be derived from these studies.

Despite the instrumentation limitations of the earlier studies, all three studies confirmed that natural ambient sound levels in the recreation area are typically low to very low. Some of the important natural ambient sound sources at Glen Canyon National Recreation Area include weather such as wind and thunder; insects (at night during the 2001 summer measurements, the sounds of insects substantially raised the natural ambient sound levels compared to daytime levels); wildlife, particularly including birds; and water, including streams, seeps, and wind-caused wave action on the lakeshore.

Factors affecting natural ambient sound levels include location with respect to a noise source, topography and terrain, wind, and vegetation. In vegetated areas, natural ambient sound levels were higher on windy days than on calm days as leaves and branches rustled in the wind. Beaches tended to have higher ambient levels than inland areas because of the sound from wave action (some caused naturally by wind, and some by boat wakes). The lowest natural ambient levels occurred during calm days and nights with little or no wind when other natural sources (especially insects) were quiet (Harris Miller Miller & Hanson, Inc. 2002).

HUMAN SOUNDSCAPE: NOISE FROM PERSONAL WATERCRAFT AND OTHER SOURCES

Noise within the National Recreation Area's Management Zones (Noise Context)

The *General Management Plan* (NPS 1979a) divided Glen Canyon National Recreation Area into four management zones (figure 9, General Management Zones Map). The Recreation and Resource Utilization Zone and the noise-sensitive Natural Zone and Cultural Zone are most relevant with regard to noise from personal watercraft. Because the Cultural Zone is so small (total of 25 acres), it is not addressed separately from the Natural Zone. The land-based Developed Zone does not support personal watercraft use, has a low sensitivity to noise impacts, and has many other human-caused noises that mask personal watercraft noises that are produced on the lake.

The lake surface, where virtually all personal watercraft activity takes place and personal watercraft noise is generated, is in the Recreation and Resource Utilization Zone. Noises from personal watercraft and other vessels are consistent with the purpose and management direction of the Recreation and Resource Utilization Zone. The *General Management Plan* (NPS 1979a) specifically identifies noise-producing activities, including speedboating, waterskiing, and houseboat touring, as appropriate in the Recreation and Resource Utilization Zone.

The number of watercraft operating simultaneously affects the sound level. The noise from multiple watercraft is greater than that of individual watercraft, and can be detected farther from shore. However, based on the study by Harris Miller Miller & Hanson, Inc. (2002), noise from personal watercraft, even multiple machines operating in a small area, usually is not discernable above the natural soundscape in areas of the recreation area more than 1 or 2 miles away from the shoreline.

Personal watercraft use in the Recreation and Resource Utilization Zone occurs during all seasons except winter. Table 13 provides estimates by month of how much of the Lake Powell surface is in general categories of sound. As shown in the table:

TABLE 13: ESTIMATES OF THE PERCENTAGES OF THE LAKE POWELL SURFACE AREA THAT ARE WITHIN GENERAL SOUND CATEGORIES

Month	High Sound Levels (percent)	Medium Sound Levels (percent)	Low Sound Levels (percent)
January	0	0	100
February	0	0	100
March	0	0	100
April	0	8	92
May	12	19	69
June	29	25	46
July	39	38	24
August	48	32	21
September	32	36	32
October	0	28	72
November	0	0	100
December	0	0	100

Low levels of personal watercraft use, and associated noise, prevail annually throughout the lake from November through April. Personal watercraft use accounts for less than 6% of the total amount of watercraft use during these months; November and December are the lowest use months at less than 2% of the total. Personal watercraft use increases, as does general boating use, through the remainder of the year. For each month of May and October, personal watercraft use represents less than 20% of the total monthly watercraft use. In the period of June through September, personal watercraft use ranges from 26% to 38 % of the total. A high amount of boating use, including that by personal watercraft, and noise associated with it occurs over a substantial part of the lake surface from May through September. However, even during these months, visitors can find areas of the lake where sound levels are low. Generally, the personal watercraft noise contribution to the total noise generated is directly related to the proportion of personal watercraft operating in an area at any given time. Tables illustrating the proportion of personal watercraft use are presented in the "Visitor Use and Experience" section of the "Affected Environment" chapter.

Large portions of the lake shore are in the Natural Zone. Personal watercraft noise is obvious in Natural Zone areas near the lake during periods of high boating activity, but there are extended periods when boating noise is not noticeable. These include winter, nighttime, and most of the time in low use areas.

All of the federal lands in the Natural Zone were proposed as wilderness in the proposed *General Management Plan* (NPS 1979a). Motorized recreation is generally prohibited in the Natural Zone, and the management strategy for the Natural Zone includes "maintenance of isolation and natural processes."

Motorized equipment is only permitted in the Natural Zone when it constitutes the "minimum management tool." Motorized equipment is specifically not included in the list of appropriate recreational activities in that zone.

In the Natural Zone, noise from personal watercraft is loudest at or near the shoreline. Watercraft noise diminishes with distance. However, because of the sparse vegetation and exposed rock in many places in the Natural Zone, personal watercraft sound can travel long distances. Noise modeling by Harris Miller Miller & Hanson, Inc. (2002) indicated that noise from individual vessels could be heard about a mile into the Natural Zone. Noise from a single boat with a V-8 engine could be heard about 2 miles.

These distances assume generally open terrain and summer conditions. Terrain features such as cliffs, hills, and buttes close to the lake would tend to shield the area beyond these features from boat noise. Features such as canyons may channel sound so that it travels farther on the water surface. As noted above, personal watercraft sound may be heard one to two miles from the source over a flat surface. But the topography surrounding Lake Powell is not flat. Assuming that a natural barrier to the sound would exist where there is an elevation change of 50 feet (approximate height of a five story building), approximately 15,400 acres would be affected (between 3,700 feet and 3,750 feet elevations). This equals 2.3% of the Natural Zone (668,670 acres). Time of day and season of use would also reduce the level of noise in the Natural Zone as the noise would not be continuous, would be encountered only during daylight hours, and would be minimal between October and May.

Intensity of Noise from Personal Watercraft and Other Sources

Regulations for boating and water use activities established by the National Park Service prohibit vessels from operating at more than 82 decibels measured at 25 meters (82 feet) from the vessel (36 CFR 3.7).

> Arizona regulations are less stringent than those of the National Park Service. They prohibit a vessel from being operated in a manner that causes it to emit a sound level in excess of 86 decibels when measured from a distance of 50 feet (15 meters) or more.
>
> Utah laws and rules are more stringent than those of the National Park Service. They prohibit a vessel from being operated in a manner that will cause it to emit more than 75 decibels of noise at the shoreline.

Several of the other boating regulations, laws, and rules for the states of Arizona and Utah that are summarized in table 4 also relate to sound. These include flat-wake requirements, other speed restrictions, and Utah's limitation of use to daylight hours. Complete information on the Arizona and Utah boating regulations, laws, and rules for personal watercraft are included in appendix B.

The 2001 noise study (Harris Miller Miller & Hanson, Inc. 2002) included measurement of reference pass-bys for a number of vessels, including personal watercraft, and characterization of the noise sources. Measurements were taken from August 14 through August 18, 2001 at Crosby Canyon (a high-watercraft-use site), the middle of Last Chance Canyon (a moderate-use site), the end of Last Chance Canyon (a low-use site), and Rainbow Bridge.

The results of watercraft pass-bys are shown in table 14. These pass-by measurements are for individual machines. Measurements are not 100% additive for multiple machines passing at or about the same time because of the logarithmic relationships involved. However, multiple machines add a complex of sound characteristics that, in general, is perceived by a listener as being louder and of greater duration. Measurements of multiple machines reflect those characteristics. The pass-by recordings were made using a microphone mounted above the front of an instrumented boat (Harris Miller Miller & Hanson Inc. 2002), not on the shoreline. Therefore, the results cannot be interpreted in the context of Utah law regarding noise, which measure sound levels at the shoreline. Analysis of the data for individual watercraft indicated the following.

> Maximum sound levels for personal watercraft at 25 meters (82 feet) ranged from approximately 68 to 76 decibels.
>
> Maximum sound levels at 25 meters for other motorcraft ranged from about 65 to 77 decibels for most motorboats, and up to 86 decibels for boats with V-8 engines.
>
> Except for the boats with V-8 engines, no significant differences were found in the sound levels produced by personal watercraft and the other boats in the study.

As shown in the table 14, personal watercraft sound levels at steady speeds were measured in the 70- to 80-decibel range. However, sound levels varied rapidly as personal watercraft maneuvered and jumped wakes. Figure 11 shows fluctuations over a range of about 5 decibels for two or three personal watercraft circling during a 2-minute period, with a 180-degree turn producing a fluctuation of 10 decibels. (People usually perceive a 10-decibel increase in sound level to be "twice as loud" and a

TABLE 14: WATERCRAFT PASS-BY SOUND LEVELS MEASURED IN GLEN CANYON NATIONAL RECREATION AREA IN AUGUST 2001

Category	Description	No. Passbys[a]	Speed (mph)	Throttle (rpm)	SEL at 50 ft.[b] (15 m) (dBA)	L_{max} at 50 ft. (15 m) (dBA)	L_{max} at 82 ft. (25 (m) (dBA)
V-8 "Muscle"	20 foot Inboard V-8	1	32	—	95.2	90.7	86.4
V-8 "Muscle"	22 foot Inboard V-8	1	35	—	93.9	89.1	84.8
Personal Watercraft	Kawasaki 1100cc (Utah S. P.)	5	48.6	6700	85.0	80.7	76.4
Boats At Any One Time	Yamaha Twin Outboard (Utah S. P.)	2	40.8	—		79.8	75.5
Personal Watercraft	Kawasaki 1100cc (Utah S. P.)	2	37.5	5600	85.1 84.6	77.7	73.4
Personal Watercraft	2001 Sea-Doo Bombardier (visitor)	2	60	—	83.9	79.5	75.2
Boats At Any One Time	20 foot Outboard	1	39	—	83.9	80.8	76.5
Personal Watercraft	2001 Sea-Doo Bombardier (visitor)	2	30	—	83.5	77.5	73.2
Personal Watercraft	Kawasaki 1100cc (Utah S. P.)	2	9	3000	82.8	73.0	68.7
Boats At Any One Time	16 foot Inboard	1	28	—	82.6	74.9	70.6
Personal Watercraft	2001 Sea-Doo Bombardier (rental)	5	38	Full throttle	82.4	73.8	69.5
Boats At Any One Time	Yamaha Twin Outboard (Utah S. P.)	2	27.3	—	81.2	74.4	70.1
Personal Watercraft	Kawasaki 1100c (Utah S.P.)	2	22.5	—	81.2	73.0	68.7
Boats At Any One Time	18 foot Outboard	1	18	—	80.8	75.6	71.3
Boats At Any One Time	18 foot Outboard	1	30	—	80.8	76.6	72.3
Boats At Any One Time	20 foot Inboard	1	32	—	80.4	75.0	70.7
Personal Watercraft	Other Personal Watercraft	1	26	—	80.3	73.6	69.3
Boats At Any One Time	20 foot Outboard	1	21.2	—	79.7	76.7	72.4
Boats At Any One Time	20 foot Outboard	1	23	—	79.7	75.5	71.2
Boats At Any One Time	16 foot Outboard	1	9	—	79.6	67.8	63.5
Personal Watercraft	Sea-Doo Bombardier (rental)	6	25	1/2 throttle	79.2	71.9	67.6
Personal Watercraft	Other Personal Watercraft	1	17	—	79.2	73.0	68.7
Boats At Any One Time	18 foot Inboard	1	23	—	78.0	71.8	67.5
Boats At Any One Time	20 foot Inboard	1	21	—	77.3	71.5	67.1

Source: Harris Miller Miller & Hanson, Inc. 2002.

a. For vehicles with more than one pass-by, similar speeds and throttle settings are grouped, and the table shows average speed and throttle settings, and energy-averaged WEL and L_{max} values.

b. SEL represents the total sound energy of the entire pass-by of each vehicle. L_{max} represents the maximum pass-by sound level.

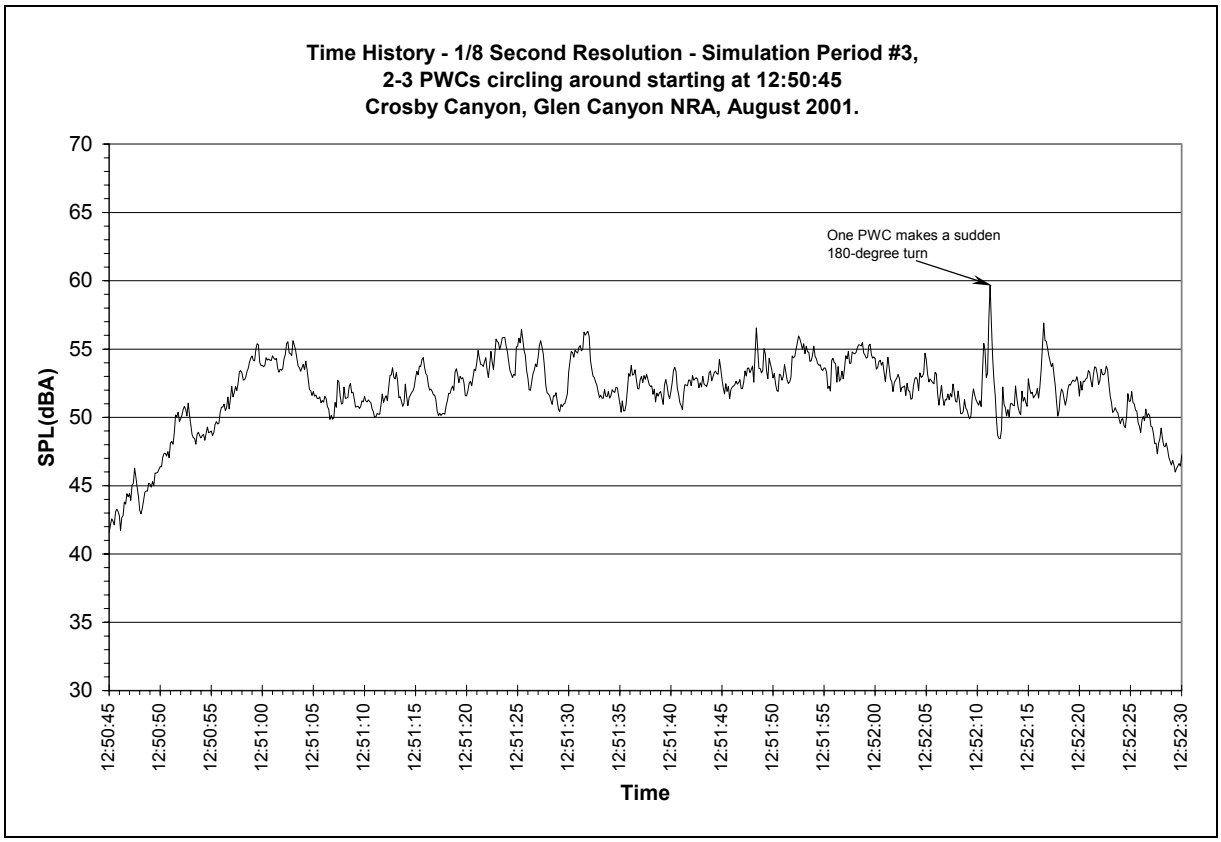

FIGURE 11: A-LEVEL TIME HISTORY

10-decibel decrease to be "half as loud," assuming that the frequency content of the sound does not change.) In contrast, a time history (not included here) of a typical small outboard motorboat showed fluctuations of only a couple of decibels.

Manufacturers' literature indicates that the newer four-stroke personal watercraft are quieter than those with two-stroke engines. In addition, vehicles powered by two-stroke engines may be more noticeable than those powered by four-stroke engines because they tend to have a higher-pitched engine sound. However, because no four-stroke personal watercraft were observed during the 2001 study at Glen Canyon National Recreation Area, no comparative data were collected.

Many factors other than the engine type influence the sound level emitted from a personal watercraft. Some of these include exhaust configuration, muffling, vessel shape, insulation, and engine size. As a result, some two-stroke powered vessels may be quieter than some four-stroke powered vessels. Operator behavior, such as rapid acceleration and deceleration, jumps, and high speed, can have an even larger influence on sound emissions than engine type.

Many watercraft, including personal watercraft, emit their exhaust beneath the vessel into the water, which tends to muffle the sound. However, there are times when the bottom of the personal watercraft is exposed, such as during high-speed turns, when the operator jumps over waves or the wakes of other boats, or when the craft bounces on the water. Such exposure of the bottom of the craft and exhaust can cause noise emissions to fluctuate substantially. Measurements during the 2001 study showed that the fluctuations tended to be greater for personal watercraft than for motorboats.

The 2001 study indicated that use of personal watercraft currently does not exceed existing noise standards. Regardless of future management actions in Glen Canyon National Recreation Area, it is anticipated that noise from personal watercraft may decline from current levels.

> Noise-reducing measures that are being incorporated into the manufacture of vessels, such as the use of more rubber, the reduction of vibrations, and use of quieter four-stroke engine and exhaust technology could contribute to noise reduction assuming that quieter machines become widely used and that usage does not increase. Assertive education programs, by the personal watercraft industry, and regulatory action could help reduce noise by encouraging personal watercraft users to change noise-producing behaviors, or to limit their extent to certain areas. Such behaviors include wake jumping, rapid changes in speed or direction, and excessive revving.

Timing of Noise from Personal Watercraft and Other Sources

In areas of concentrated watercraft use, summertime noise from personal watercraft and other vessels can occur almost constantly from near sunrise to near sunset. During the high-use times, the sound of boats can be continuous in popular parts of the Recreation and Resource Utilization Zone and adjacent parts of the Natural Zone. In low-use areas, noise from personal watercraft usually is intermittent and typically lasts only a few minutes unless an operator chooses to "play" in the area.

Almost all personal watercraft use on Lake Powell occurs during daylight hours. As shown in table 4, Utah laws and rules do not allow the use of personal watercraft between sunset and sunrise. In Arizona, which contains only a small part of the lake, personal watercraft can be used after dark only if they have lighting that is consistent with U.S. Coast Guard requirements.

All other vessels, including both motorized and nonmotorized watercraft, are allowed to operate at night if they meet the lighting requirements of the U.S. Coast Guard. However, very little boating takes place at night. That which occurs primarily is associated with trolling or other fishing activities. Because sound carries well over the water and there is little other noise, engine sounds from boats operating at night often can be heard over long distances. Other human-generated nighttime noises from within the recreation area include generators and electronically amplified music.

The Harris Miller Miller & Hanson study included a practice called "observer source identification logging."[3] This practice enables the scientist to establish real-time links between recorded sounds and sound pressure levels with identified sound sources. Observers note all sounds that are heard during the sampling period, logging human caused sounds such as aircraft, watercraft, wheeled vehicles, radios, and voices. At the same time, they log natural sounds of birds, vegetation in the wind, waves, insects, mammals and other. Logging was accomplished at the sites where all sound data was collected, and at the Rainbow Bridge site. Data from this part of the study allows a characterization of all human-caused sound sources that are ambient in the park soundscape, as follows.

In general, considering all sites together, the sound of personal watercraft was dominant about 5% to 40% of the time, while boats were dominant about 10% to 45% of the time. Personal watercraft and boats together were logged separately, accounting for less than 5% of the time. All aircraft types

3. Draft Technical Report on Noise, pages 27-31.

together were dominant about 0% to 13% of the time. The percent time audible for all sources is displayed, by site, in figure 19 of the draft Harris Miller Miller & Hanson report.

Numerous aircraft operate year-round in the vicinity of Glen Canyon National Recreation Area. These include air tours, military aircraft, high-altitude commercial airliners, general aviation, and NPS aircraft. During the day in the Recreation and Resource Utilization and Developed Zones, aircraft noise mixes with the other human-caused noise. At night and during the winter, the sound of occasional aircraft can dominate the soundscape. In remote parts of the Natural Zone, aircraft produce the only mechanical noise impacting the natural soundscape.

Use of personal watercraft generally ceases during periods of inclement weather, even during the summer. These include periods of cold temperatures or thunderstorms.

WILDLIFE AND WILDLIFE HABITAT

Glen Canyon National Recreation Area provides habitat for many species of mammals, birds, fish, reptiles, amphibians, and invertebrates. Approximately 410 species of wildlife and 20 fish species have been inventoried within the recreation area. This resource characterization only addresses the species that are strongly or moderately associated with the recreation area's lake edge, main water body, river tributary, or shoreline areas for all or a substantial part of their life cycle.

As noted previously, Lake Powell is a very popular destination recreation area, receiving a large number of visitors. Peak visitor-use months are June through September. Human activity and noise from watercraft are common conditions, especially in the marina and campground areas. Wildlife populations have been exposed to these conditions since the recreation area opened for visitor use.

Impounding the Colorado River behind Glen Canyon Dam created a new lacustrine (lake) environment in areas that formerly were canyon bottoms, steep canyon sidewalls, and adjacent uplands. It also created a near-shore environment where the desert climate, wave erosion, highly variable water levels, poor soils, and generally steep shorelines restrict vegetative cover to sparse stands of fast-growing vegetation that is occasionally interspersed with small dense stands of saltcedar.

The wildlife groups that use the lake and near-shore areas are described below.

WILDLIFE GROUPS OF PRIMARY INTEREST

The large seasonal and annual variations in water surface elevation resulting from reservoir operations and management impose substantial environmental constraints on the types of habitats that can develop and persist at near-shore locations. Wildlife species typically associated with the water fluctuation zone are highly adapted to using food, cover, and shelter conditions that may develop and disappear quickly. In many main lake locations, especially where the inundation frequency is high and prolonged, shoreline and near-shore areas consist primarily of unvegetated or sparsely vegetated rock, sand, cobbles, and boulders.

Vegetation and corresponding habitat conditions are different in the tributaries and upper river reaches of the recreation area where water fluctuations generally follow normal seasonal patterns. Such reaches provide riparian vegetation complexes that support different wildlife species assemblages than those encountered along main lake shorelines.

Mammals

Shoreline areas that typically are exposed to personal watercraft uses provide limited habitat to the large, highly mobile mammals of the recreation area. These areas are typically unvegetated and steep. However, shoreline areas may occasionally be briefly occupied by several species of mammals while searching for food or water or while moving through the area. These species include desert bighorn sheep, mule deer, antelope, feral horse, bobcat, mountain lion, gray fox, badger, kit fox, and coyote. However, they spend most of the time in adjacent upland areas.

Sufficient cover and forage opportunity exists in the near-shore environment for rodents. Rodent species that have been documented within the shoreline saltcedar stands include the deer mouse, Ord's

kangaroo rat, little pocket mouse, Arizona pocket mouse, long-tailed pocket mouse, western harvest mouse, canyon mouse, brush mouse, pinyon mouse, northern grasshopper mouse, and desert woodrat.

River otters have been infrequently observed within Last Chance and West Canyon in recent years (NPS, Spence, pers. com., May 2002n). Reasons for the presence of the river otter in these locations have not been determined, but could be related to foraging for food or their normal movement activities.

Birds

Shorebirds, waterfowl, and other water-associated bird species frequently use Lake Powell and its surrounding shoreline during migration for resting, security, and foraging purposes. Groups commonly observed on the lake and near shoreline areas include several species of grebes, cormorants, herons, egrets, coots, and ducks. Waterfowl, shorebirds, wading birds, and other water-associated bird species tend to concentrate in highest number and greatest diversity at Lake Powell in the late-fall, winter, and early spring months during peak migration periods and during the winter months when open water is present (NPS, Spence, pers. com., May 2002n; and NPS, Henderson pers. com., May 2002h).

Wading bird nesting activity and locations are very rare at the recreation area. A few great blue herons attempt to breed around the upper edges of Hall's Creek Bay, but they usually are unsuccessful. Some researchers and interested observers have attributed these breeding failures to the constant disturbance by boats in the area during the nesting and breeding periods. However, the failures more likely are caused by changing water levels (NPS, Spence, pers. com., May 2002n). The birds build their nests in the early spring when lake levels are low. As the water level increases in May and June, the nests are drowned and abandoned. Other than at upper Hall's Creek Bay, there are no known breeding populations of shore birds (NPS, Spence, pers. com., May 2002n). Typically in large reservoir settings, there may be concerns about the presence and location of breeding and nesting colonies of colonial water-associated species such as terns, gulls, and pelicans. Breeding and nesting colonies of such species do not occur in the recreation area (NPS, Spence, pers. com., May 2002n).

Several species of raptors (a wildlife group that includes hawks, owls, eagles, and falcons) are known to use areas adjacent to and proximal to Lake Powell for nesting and foraging.

> Peregrine falcons have been observed nesting in the recreation area, along the shores of Lake Powell and the Colorado River (NPS 1988a).
>
> A pair of golden eagles uses the Wahweap area for foraging (NPS, Spence, pers. com., May 2002n).
>
> In the past, a pair of ospreys has attempted to breed in the upper Hall's Creek Bay area, but has not successfully raised young in recent years (NPS, Spence, pers. com., May 2002n).
>
> Active great horned owl nests are found at many locations along tributary and main lake cliffs and other rock formations within several hundred feet of the water's edge. The distance between these nest sites and the water's edge varies seasonally and annually, depending on the water elevation.

During censuses conducted in 1990 on 14 saltcedar stands located around Lake Powell, 19 bird species were observed. The greatest densities and diversity of species were found within the Wahweap Bay

area and a site due east of Gregory Butte. Species observed during the censuses at these sites included horned lark, several species of swallow, raven, mourning dove, yellow warbler, yellow-headed blackbird, and house finch. Songbird density, abundance, and species richness tend to increase at the upstream reaches of the lake and major tributary streams where stands of cottonwood, willow, saltcedar, and other shrub vegetation have developed. These woody riparian areas provide suitable habitats for a wider variety of species. Riparian corridors and stands of trees also are preferred foraging and security areas for songbirds during spring and fall migration periods.

Fish

The recreation area currently supports an assemblage of fish species that includes those adapted to either lake (lacustrine) or flowing-water (riverine) environments. Most of the lake-adapted species have been introduced intentionally or unintentionally by man through past fish-stocking or bait release programs. These species are more abundant because of the larger abundance of suitable aquatic habitat.

The flowing-water or riverine fish species tend to be native species that are restricted to the flowing portions of the main tributary streams and rivers that flow into the lake. These species are relatively less abundant and more restricted in distribution than the lake-associated fish species.

The creation of Lake Powell changed the riverine habitat formerly found on this stretch of the Colorado River to such an extent that native fish species have been virtually eliminated from the resulting lake environment. As a result of habitat modification and competition by introduced species, many native species are now classified as endangered or threatened. However, native species such as the Colorado pikeminnow, flannelmouth sucker, bonytail, humpback chub, razorback sucker, bluehead sucker, and roundtail chub still occur in extremely limited numbers within the San Juan and Colorado Rivers as well as their interfaces with Lake Powell. (USGS n.d.). The status of endangered or threatened native fish species is discussed in greater detail in the endangered or threatened species section.

Biological productivity for the reservoir is low because of a nutrient deficiency associated with phosphorus settling out close to the river mouths (see the "Water Quality" section). None-the-less, Lake Powell supports a number of introduced game and nongame fish species that form the basis for a popular and regionally important recreational sport fishery. The Lake Powell sport fishery is generally considered to be excellent quality by the states of Utah and Arizona compared to other large reservoir fisheries in each state (Gustaveson 2002). Predominant game fish species include the striped bass and smallmouth bass, which comprise about 80% and 20% of the annual game fish harvest, respectively (Gustaveson 2002). Other game fish species include the largemouth bass, catfish, crappie, and bluegill. These species inhabit the reservoir, and spawn either along shoreline areas or within the tributary rivers when water conditions are suitable for a successful spawn. Spawning habitats vary by species.

Abundant nongame fish species include the common carp, red shiner, and threadfin shad. Game species primarily depend on the threadfin shad as the key forage species, but they shift to bluegill, other sunfish species, and crayfish when threadfin shad become unavailable (Gustaveson 2002). These forage species are typically associated with inflow areas and shorelines.

There are no known fish spawning locations of key or primary importance reported for the reservoir or for the major river and tributary streams that enter the reservoir (NPS, Spence, pers. com., May 2002n). Fish spawning occurs at many locations, with selected locations being determined each year

by the best combinations of a species' spawning habitat requirements, water levels, water flow conditions, and water temperature regime.

There are no documented cases of fish kills or habitat degradation associated with the marinas on Lake Powell that were considered serious enough to adversely affect fish populations (Gustaveson 2002).

Reptiles and Amphibians

Systematic surveys for reptiles or amphibians in Glen Canyon have not been conducted since the construction of the dam (NPS, Spence, pers. com., May 2002n). However, 27 species of reptiles and 7 species of amphibians are known to occur in the recreation area. During censuses conducted on saltcedar stands along the shoreline of Lake Powell, seven species of reptiles were documented, including the desert spiny lizard, side-blotched lizard, desert horned lizard, western whiptail, western rattlesnake, longnose leopard lizard, and Glen Canyon chuckwalla.

Densities of reptiles were 30 times lower in saltcedar stands along the shorelines of Lake Powell than along the Colorado River in the Grand Canyon. Waring (1992) suggested that low biotic productivity within Lake Powell may be a limiting factor for reptile densities in this area.

Amphibians observed or likely to occur within the area of analysis include the leopard frog, red-spotted toad, Woodhouse's toad, and the canyon treefrog. These species are restricted to protected and perennially wet or moist environments, such as springs and perennial streams that occur in the upper reaches of tributary canyons. These areas are generally located at elevations higher than the maximum reservoir pool elevations and remain unaffected by reservoir operations (NPS, Spence, pers. com., May 2002n).

Aquatic Invertebrates

A systematic survey of invertebrates within Glen Canyon National Recreation Area has not been conducted (NPS, Spence, pers. com., May 2002n). Generally, the abundance, location and type of aquatic invertebrates present depend on the water quality and habitat conditions within Lake Powell and the tributary rivers and streams that discharge to the reservoir. Due to the fluctuating water levels of Lake Powell, the shoreline has little to no aquatic vegetation, so little habitat is available for aquatic invertebrate production and support. Thus, the diversity and abundance of aquatic invertebrates along the shoreline is expected to be low. In general, higher abundance, species richness, and species diversity would be expected in portions of tributary rivers, streams, and other relatively shallow-water settings where habitat diversity and flow conditions would favor a larger variety of aquatic invertebrate species.

SEASONAL USE PATTERNS OF WILDLIFE GROUPS OF PRIMARY INTEREST

Understanding the general seasonal movement patterns of wildlife species and groups of interest is useful in evaluating the potential interactions between wildlife and visitors. Such interactions also contribute to the qualitative value of the visitor expereince. Sightings of large mammals are often of particular visitor interest.

Several hundred mule deer use the recreation area for winter range, especially south of the Escalante River. Depending on local terrain conditions, individual deer may be visible from the lake or near-shore area. However, shoreline areas are typically not regular use areas for deer because of the lack of or sparse vegetation conditions. Limited winter use occurs along the San Juan River and below the Orange Cliffs. Most of the deer migrate outside of the recreation area during the summer months (NPS 1979a).

Bighorn sheep are occasionally (every two to three years) observed near the shoreline during the winter months near the Dangling Rope residential area and in the lower San Juan River Canyon (NPS, Spence, pers. com., May 2002n). There are no known important habitat elements for bighorn sheep in this area, and it is thought that the sheep are moving to lower elevations as a retreat from inclement winter weather (NPS, Spence, pers. com., May 2002n).

Seasonal waterfowl and shorebird uses peak during the spring, fall, and winter months as members of these migratory groups are attracted to the large water body. Flocks of species tend to congregate in open water areas, canyons, and shallow bay areas for security, resting, and feeding. Numbers of birds tend to increase during and coincide with the low-use recreation months. Use of the lake and tributary streams by these bird groups occur at levels that are lower than would be expected from such a large reservoir. Important physical factors contributing to the relatively low use levels include the limited number of suitable shallow water areas, general scarcity of wetlands, and absence of lake shore and riparian vegetation. Conflicts between these widlife groups and existing recreation and personal watercraft use are not considered to be an issue (NPS 1998b; NPS, Spence, pers. com., May 2000n).

SPECIAL-INTEREST USE AREAS OR HABITAT FEATURES OF CONCERN

Special-interest use areas or habitat features of concern are elements of the wildlife resource that are of high value for maintaining wildlife species presence, productivity, or quality. These elements are of particular interest because they are especially susceptible to the disturbance or degradation effects from humans or their activities. These areas or features are usually considered important for receiving special consideration in planning, resource management, or protection from adverse effects.

Spawning Areas

Spawning habitat for native fish species may exist within the inflow areas of the Colorado and San Juan Rivers on Lake Powell. Details of these requirements are presented in the “Threatened, Endangered, and Special-Concern Species” section. Under current conditions spawning activities in these areas are presumed to be subject to predation from non-native fish species. It is likely that existing predation is so intense that young have little chance of survival, resulting in no recruitment (Henderson 2002).

Nesting Areas

Colonial nesting areas, whether they are rookeries in trees or ground-nesting colonies on shorelines, are important habitat features because they typically concentrate a large number of breeding individuals in a small area for an especially vulnerable portion of their life cycle. There are currently no known heron or egret nesting rookeries or shoreline nesting colonies within the area of analysis for the main body of the lake. As stated above, a few herons have attempted to next along the shoreline in

the upper Hall's Creek Bay area, but due to fluctuating water levels these attempts have been unsuccessful.

Peregrine falcons nest within the area of analysis, with more than 80 eyries recorded in 2000 (NPS, Spence, pers. com., May 2002n). These nests are normally located on cliffs approximately 100 feet above the level of the water. The falcons have habituated to the presence of watercraft.

There are numerous active nests of the great horned owl located in the rock cliffs and other formations surrounding the lake's and tributary stream's perimeters. Some of these locations may be exposed to the activities of water-based visitors.

Wetlands/Riparian Areas

Wetlands and riparian areas are typically considered to be important wildlife concentration areas for several reasons. These include the availability of good foraging conditions resulting from the high degree of vegetation, water interfaces and interspersion (or edge), and structural diversity typically associated with vegetation conditions in such areas. General wildlife habitat values and uses typically increase as wetland and riparian area size increases.

Because of the physical shoreline conditions and the operational characteristics of the reservoir, wetland sites are limited in number and small in size. Wetlands are typically associated with the upstream reaches of tributary or secondary side canyons where water levels fluctuate less.

Riparian areas are typically found along the shorelines of the four major rivers flowing into the reservoir. The riparian corridors of the Colorado River and San Juan River are often extensive, dense, and well developed.

Areas of High Waterfowl and Shorebird Concentration

During the early, spring waterfowl and shorebirds tend to congregate around the heads of Hall's Creek, Bullfrog, Warm Creek, Wahweap Bays, and Antelope Island (NPS 1998b). These concentrations tend to develop during spring migration months with total bird numbers gradually decreasing as the birds move towards breeding areas. The timing of increased bird numbers and the duration of the congregations are influenced by weather patterns and movements of frontal systems. There are no reported high-use or historical concentration areas for these bird groups in the recreation area.

River Refugia

The perennial tributary rivers flowing into Lake Powell represent examples of the river systems and aquatic environments that existed prior to lake impoundment. These areas are of particular scientific and resource preservation value because of their general scarcity and because they preserve populations and community relationships of previous riverine ecosystem conditions. Relict native fish species still survive within the rivers in limited numbers. Major examples include reaches of the Colorado, San Juan, Escalante, and Dirty Devil Rivers.

SPECIAL-INTEREST SPECIES

The recreation area supports one of the last relict desert bighorn sheep herds in Utah. The most critical areas for the sheep include the Red, White and Gypsum Canyons branching off of the north-eastern portion of Lake Powell. These areas have been identified as possible lambing grounds. The extent of the herd's movement occassionally (every other year) bring them within close proximity of the lake near Dangling Rope and possibly in the lower San Juan River Canyon during the winter months (NPS, Spence, pers. com., May 2002n). In the Dangling Rope area, the sheep have been observed close to existing human-use areas. When close to the lake shoreline, these bighorn sheep are generally not exposed to recreators because visitor use is typically at its lowest annual levels.

The recreation area also supports the Glen Canyon chuckwalla, a Utah state sensitive species. This species is closely associated with the lake, and is predominantly found near cliffs, boulders, or rocky slopes, where they use rocks as basking sites and rock crevices for shelter (Utah Division of Wildlife Resources 2002a).

EXISTING CONFLICTS BETWEEN WILDLIFE AND PERSONAL WATERCRAFT USERS

There are currently no interactions between personal watercraft and wildlife that the recreation area staff is aware of (Spence 2002a), and there have not been any documented incident reports of known conflicts between wildlife and personal watercraft users in Glen Canyon National Recreation Area (NPS, Spence, pers. com., May 2002n).

THREATENED, ENDANGERED, AND SPECIAL-CONCERN SPECIES

SPECIES KNOWN TO OCCUR IN ANALYSIS AREA

In accordance with threatened or endangered species consultation and coordination activities, the U.S. Fish and Wildlife Service identified 13 listed, 1 proposed, and 1 candidate species for portions of Coconino County, Arizona and Kane and San Juan Counties, Utah (U.S. Fish and Wildlife Service, letter, Maddux, May 2002). Habitat for 12 federally listed endangered, threatened and candidate species may occur in the lake or near its shoreline. Database information from the Utah Division of Wildlife Resources and the Arizona Game and Fish Department identified additional state special-status species that may occur within the project area. Information from federal and state agencies were used to prepare the list of federal- and state-listed threatened, endangered, and special-concern species shown in table 15.

The area addressed for this resource characterization includes Lake Powell up to the 3,700-foot water surface elevation, the shoreline zone, and uplands within 500 feet of Lake Powell's 3,700-foot water surface elevation or within 500 feet of river shorelines. Species or potentially suitable habitat likely to be present within this area are identified and discussed below. Species listed by the U.S. Fish and Wildlife Service for which suitable habitat is not present within the recreation area are not discussed further.

PRESENCE OF DESIGNATED CRITICAL HABITATS

Provisions of the *Endangered Species Act* require consideration of both species populations and designated critical habitats for species listed or proposed for listing. Critical habitat is defined as a specific geographic area that is essential for conservation of endangered or threatened species.

Glen Canyon National Recreation Area supports designated critical habitat for four endangered fish species (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). These include the razorback sucker (*Xyrauchen texanus*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and the bonytail (*Gila elegans*). These fish occur in the Colorado River, portions of the lower inlet of the Dirty Devil River, and the San Juan River, including their 100-year floodplains up to the full pool elevation of Lake Powell (50 CFR Part 17, 1994). During the lowest projected lake level, the critical habitat may extend up into Neskahi Canyon along the San Juan River. Designated critical habitats for these federally listed species in the recreation area are shown in table 16.

Critical habitats for the Mexican spotted owl (*Strix occidentalis lucidia*), the southwestern willow flycatcher (*Empidonax traillii extimus)*, the California condor (*Gymnogyps californianus*), and the Navajo sedge (*Carex specuicola*) have been designated by the U.S. Fish and Wildlife Service. None of these designated critical habitats are located within the personal watercraft use area (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a).

Suitable habitats for the listed fish species occurs in limited areas of the recreation area. It fluctuates in location and areal extent in response to lake water levels, river flow conditions, and season of the year. Fluctuation of the reservoir's water surface levels influences the availability of backwater habitat and the length of river channel potentially available for fish use within the recreation area. These fluctuations also affect the presence and availability of spawning habitat within backwaters and side channels of tributary inlets.

TABLE 15: FEDERAL AND STATE-LISTED CANDIDATE, THREATENED, AND ENDANGERED SPECIES BELIEVED TO OCCUR IN THE PERSONAL WATERCRAFT ANALYSIS AREA

Common Name	Scientific Name	Federal Status	State Status	Habitat Present within Analysis Area
Birds				
American peregrine falcon	*Falco peregrinus anatum*	N/L[a]	E	Yes
Bald eagle	*Haliaeetus leucocephalus*	T	E	Yes
Brown pelican	*Pelecanus occidentalis californicus*	E	N/L	No
California condor	*Gymnogyps californianus*	E (exp)	SC	Yes
Mexican spotted owl	*Strix occidentalus lucidia*	T	T	No
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	E	Yes
Western yellow-billed cuckoo	*Coccyzus americanus*	CS	T	Yes
Fish				
Bonytail	*Gila elegans*	E	E	Yes
Colorado pikeminnow	*Ptychocheilus lucius*	E	E	Yes
Humpback chub	*Gila cypha*	E	E	Yes
Little Colorado spinedace	*Lepidomeda vittata*	T	N/L	No
Razorback sucker	*Xyrauchen texanus*	E	E	Yes
Amphibians				
Chiricahua leopard frog	Rana chiricahuensis	PS	N/L	No
Mammals				
Black-footed ferret	Mustela nigripes	E	E	No
Mollusks				
Kanab ambersnail	Oxyloma haydeni kanabensis	E	E	No
Plants				
Brady pincushion cactus	*Pediocactus bradyi*	E	E	No
Fickeisen pincushion cactus	*Pediocactus peeblesianus fickeiseniae*	CS	SC	No
Jones cycladenia	*Cycladenia humilis var. jonessi*	T	T	No
Navajo sedge	*Carex specuicola*	T	T	No
San Francisco Peaks groundsel	*Senecio franciscanus*	T	T	No
Sentry milk-vetch	*Astragalus cremnophylax var. cremnophyla*	E	E	No
Siler pincushion cactus	*Pediocactus sileri*	T	T	No
Ute ladies'-tresses	*Spiranthes diluvialis*	T	T	No
Welshs milkweed	*Asclepias welshii*	T	T	No

a. Abbreviations:
C = species of concern
CS = candidate species
E = endangered
E (exp) = endangered, experimental population
N/L = not listed
PS = proposed species
SC = state species of concern
T = threatened

TABLE 16: LOCATION OF ENDANGERED FISH SPECIES CRITICAL HABITAT

Species	Critical Habitat Location
Razorback sucker	Glen Canyon National Recreation Area razorback sucker habitat includes the 100-year floodplain of the Colorado River extending to Lake Powell's full pool elevation, Lake Powell's arm of the Dirty Devil River extending upstream of North Wash, and the San Juan Rivers 100-year floodplain extending to Lake Powell's full pool elevation near Neskahi Canyon. Specific locations are as follows: Grand, San Juan, Wayne, and Garfield Counties, the Colorado River and its 100-year floodplain from Westwater Canyon in T.20S., R.25E., sec. 12 (Salt Lake Meridian) to full pool elevation, upstream of North Wash and including the Dirty Devil arm of Lake Powell in T. 33S., R.14E., sec. 29 (Salt Lake Meridian). San Juan County, the San Juan River and its 100-year floodplain from the Hogback Diversion in T.29N., R.16W., sec. 9 (New Mexico Meridian) to the full pool elevation at the mouth of Neskahi Canyon on the San Juan arm of Lake Powell in T.41S., R.11E., sec. 26 (Salt Lake Meridian).
Colorado pikeminnow	Glen Canyon National Recreation Area Colorado pikeminnow habitat includes the 100-year floodplain of the Colorado River extending to Lake Powell's full pool elevation, Lake Powell's arm of the Dirty Devil River extending upstream of North Wash, and the San Juan River's 100-year floodplain extending to Lake Powell's full pool elevation near Neskahi Canyon. Specific locations are as follows: Grand, San Juan, Wayne, and Garfield Counties, the Colorado River and its 100-year floodplain from the Colorado River Bridge at exit 90 north off Interstate 70 in T.6S., R.93W., sec. 16 (6th Principal Meridian) to North Wash including the Dirty Devil arm of Lake Powell up to the full pool elevation in T. 33S., R.14E., sec. 29 (Salt Lake Meridian). San Juan County, the San Juan River and its 100-year floodplain from the State Route 371 Bridge in T.29N., R. 13W., sec. 17 (New Mexico Meridian) to Neskahi Canyon in the San Juan arm of Lake Powell in T.41S., R.11E., sec. 26 (Salt Lake Meridian) up to the full pool elevation.
Humpback chub	Glen Canyon National Recreation Area humpback chub habitat includes the 100-year floodplain of the Colorado River along the rapids in Cataract Canyon upstream of Gypsum Canyon. Specific locations are as follows: Garfield and San Juan Counties, the Colorado River from Brown Betty Rapid in T.30S., R.18E., sec. 34 (Salt Lake Meridian) to Imperial Canyon in T.31S., R.17E., sec. 28 (Salt Lake Meridian).
Bonytail	Glen Canyon National Recreation Area bonytail habitat includes the 100-year floodplain of the Colorado River along the rapids in Cataract Canyon upstream of Gypsum Canyon. Specific locations are as follows: Garfield and San Juan Counties, the Colorado River from Brown Betty Rapid in T.30S., R.18E., sec. 34 (Salt Lake Meridian) to Imperial Canyon in T.31S., R.17E., sec. 28 (Salt Lake Meridian).

Sources: FR 50 CFR Part 17 Monday March 21, 1994.

All four fish species are strongly associated with flowing river or stream conditions. Areas that provide deep, swift-running currents along river reaches provide the most desirable conditions. Use of floodplain backwater areas occur during the spawning period. Occasionally, individual fish may drift into the main body of the reservoir near the lake's headwater areas. No adult native endangered species have been captured in Lake Powell since the late 1980s (Utah Division of Wildlife Resources, Gustaveson, pers. com., April 2002b).

Areas where rivers flow into the lake can provide important habitat during certain stages in these species life history if the physical characteristics of the flooded areas are suitable for spawning and rearing of young fish. River inflow areas provide some sand or silt bar habitat. Periodic scouring of substrate caused by flood events create side channel and backwater conditions which are used as spawning, nursery, and rearing areas for young fish. Calmer backwaters adjacent to these swift currents provide shelter and feeding for early to young life stages.

Adult life stages of these species tend to use main channel areas including runs and eddies over a variety of substrates, preferred water depths vary seasonally. Deeper water areas are preferred during

the winter months and shallower water (sometimes as shallow as 1.5 feet deep) are preferred during spawning periods.

Monitoring and enhancement programs for endangered or threatened fish species have been established in the riparian and aquatic habitats of Lake Powell. Recovery efforts for these species focus on establishing self-sustaining populations in the free-flowing river reaches of the Colorado and San Juan Rivers. In 1988, the U.S. Fish and Wildlife Service developed an Interagency Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River. These native fisheries enhancement programs emphasize recovery in locations above Lake Powell. The National Park Service and Utah Division of Wildlife Resources use the recovery implementation program guidelines for recovery efforts in critical habitat river reaches located within the recreation area (Utah Division of Wildlife Resources 1996).

Habitats required for conservation of these species include river channels and flooded, ponded, or inundated riparian areas, especially those where competition from non-native fishes is absent or reduced (U.S. Fish and Wildlife Service 1994). Available habitats are regulated by the water storage requirements and fluctuating water elevation of Lake Powell, which the Bureau of Reclamation manages.

Declining aquatic habitats combined with competition and predation from introduced non-native fishes have contributed to population declines of the endangered fish species and in endemic fish species in general in the Colorado River. Threats to endangered fish habitats include stream flow regulation, habitat modification, and predation by nonnative fisheries, parasitism, hybridization and pesticides or pollutants. Species-specific information relevant to assessment of potential effect on these species is as follows.

Razorback Sucker (*Xyrauchen texanus*) is native to the Colorado River and once occupied the entire range of the river basin. San Juan, Dirty Devil, and Colorado River inflow areas continue to produce some razorback suckers. Eleven adult razorbacks were caught at the San Juan inflow (USGS n.d.). Adult razorback suckers are considered to be the products of native fish recovery programs conducted further upstream of Glen Canyon National Recreation Area (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). Fish tracking studies conducted in Lake Powell from 1995 to 1997 indicated this species primarily used vegetated habitats less than 1.5 feet deep in side canyons and backwaters covering sandy or cobble bottoms and open waters in upper portions of the river inlets. These areas represent less than 1% of the aquatic areas of Lake Powell (Mueller and Karp 2002).

Colorado Pikeminnow (*Ptychocheilus lucius*) is a native migratory fish species of the Colorado River that once was present basin wide. It is no longer present in the lower basin and is considered rare in the upper basin. It is only found upstream of Glen Canyon Dam. Juvenile pikeminnow have been found in off-channel and backwater habitats adjacent to lower reaches of the river inflows into Lake Powell (Utah Division of Wildlife Resources, Gustaveson, pers. com., April 2002b). Some have been found in the San Juan River near Mexican Hat (NPS 1986). A 3.5-pound, 25-inch, Colorado Pikeminnow was captured in the lake in 1999 (Utah Division of Wildlife Resources, Bradswisch, pers. com., April 2003). Limiting factors include loss of habitat.

Humpback Chub (*Gila cypha*) is a native migratory fish species that was once more abundant throughout the Colorado River. It currently exists only in the upper basin near Arizona and near the confluence of the Colorado and Little Colorado Rivers. The humpback chub has not been captured in Lake Powell since the early 1970s. It is assumed to no longer be present in the lake. Habitat

preferences include river channels with deep, fast-moving water and large boulders that are often conditions created in river channels bounded by steep cliffs. Adults typically live in eddy currents of whitewater canyons. Threats to this species include habitat modification and fluctuating water discharges that eliminate preferred current conditions.

Bonytail (*Gila elegans*) is a native fish species that has a historic range that includes the Colorado River and its main tributaries. Currently this species is found from Lake Powell upstream of the Colorado River to its confluence with the Green River. The bonytail is no longer present in the upper basin and is believed to be the most endangered of the four fish species. Prior to 1996, fewer than 10 bonytails were captured in Lake Powell. No individual fish have been observed during annual gill-net surveys conducted in the last 20 years. Some populations may be present in Utah but their relative abundance is unknown. The species prefers pools and eddies of warm, often heavily silted, swift-moving rivers.

Mexican Spotted Owl (*Strix occidentalis lucidia*) uses a variety of habitats including old growth forests, mixed conifer, Ponderosa pine, deciduous riparian, and steep canyons with rocky cliffs. Timber harvesting is the main threat to the Mexican spotted owl. Small populations roost in abandoned nests, tree cavities, or caves along canyon walls. Steep canyon habitats and drainages adjacent to Lake Powell and adjoining rivers may occasionally be used by this species. A juvenile was observed in Cataract Canyon several years ago but none have been sighted in the analysis area since. There are no potential areas of concern located within the analysis area. Known occupied territories are located more than 4 miles from the Lake Powell shoreline (NPS, Spence, pers. com., April 2002m).

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) is associated with low-elevation dense willow, cottonwood and saltcedar communities along streams and rivers. This species has been sighted about 30 miles from Lake Powell up the Escalante River and the San Juan River near Clay Hills Crossing but there is no confirmed nesting or breeding habitat present in the recreation area. (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). In Arizona more than 110 pairs occupy 160 territories including breeding territory along the Colorado River. Smaller populations are known to exist in Utah. Outside the recreation area, breeding habitat typically is present along the larger rivers and lake shorelines at low elevations in areas of dense willow, cottonwood and saltcedar or other woodlands along streams and rivers. Loss of native riparian habitat combined with predation and brown-headed cowbird parasitism have reduced the species' populations.

California Condor (*Gymnogyps californianus*) was reintroduced into the wild by the U.S. Fish and Wildlife Service in Arizona in 1996. There is some evidence that the condor historically was present in Utah. These birds were released on the Vermilion Cliffs in Coconino County near Page, Arizona approximately 20 miles from the Utah border. Roosting habitat includes cliffs, tall evergreens and snags. Their population decline is thought to be related to ingestion of lead or cyanide-contaminated dead carcasses. Possible shootings, removal from wild of eggs, young, and adults for captive breeding, may also have contributed to population declines. Individual birds are known to forage than 100 miles for food. No breeding or nesting habitat is present in the recreation area, but individual birds may infrequently move across the area. A few individuals have been observed at Lake Powell within the last five years (NPS, Spence, pers. com., May 2002n).

Bald Eagle (*Haliaeetus leucocephalus*) habitat is present along the larger rivers in southern Utah. In the recreation area, this includes the San Juan River and the main lake channel upstream from Bullfrog. No nest sites have been observed or recorded along Lake Powell's shorelines.

Bald eagles winter in small numbers throughout the Lake Powell area, with observations most likely along the San Juan River and around Bullfrog (NPS 1986). Annual surveys conducted by the National Park Service report that 18 to 20 bald eagles typically overwinter in the recreation area, but as many as 45 overwintering birds have been observed.

Potentially favorable bald eagle roosting sites along the rivers and shorelines of reservoirs like Lake Powell are monitored (Spence 2002b). There are no known consistently used winter roosting locations in the recreation area. Bald eagles have been observed feeding at Antelope Island and other portions of Lake Powell during the winter months (NPS 2002b).

Western Yellow-Billed Cuckoo (*Coccyzus americanus*) populations have declined throughout this species' range in the western states because of habitat loss. As a result, it is a candidate species currently under study for listing by the U.S. Fish and Wildlife Service. Habitat for this neo-tropical species consists of cottonwood-willow riparian forests.

The presence of the western yellow-billed cuckoo and its breeding habitat are well-documented in Arizona. The bird has been sighted in Utah, but its presence is not well documented. Western yellow-billed cuckoos have been observed on the Colorado River near Lees Ferry below the Glen Canyon Dam and at Clay Hills Crossing on the San Juan River. This bird species has not been observed along the shoreline analysis area of Lake Powell, but has been seen in riparian shrub and woodland areas along some of the river reaches (Spence 2002b).

American Peregrine Falcon (*Falco peregrinus anatum*) was removed from the federal list of endangered and threatened species on August 25, 1999 (64 FR 46542). However, it is still listed as an Arizona special-status species. Threats to this species include loss of habitat and environmental contaminants.

The peregrine falcon often is observed resting on cliff faces in the recreation area and foraging close to the lake shoreline. There are more than 80 known peregrine falcon nesting sites in the recreation area. These nest sites are located along cliffs at higher elevations on the canyon walls above the water surface of the lake (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). Preferred nest sites are located close to riparian and wetland areas.

Navajo Sedge (*Carex specuicola*) is a small grass-like plat that grows in small pockets of sandy to silty moist soil in cool and shady seeps or spring alcoves in the San Juan River Canyon at elevations ranging from 4,301 to 6,004 feet. No designated critical habitat for the Navajo sedge is located in Glen Canyon National Recreation Area (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). Its elevation distribution places it outside the impact analysis area.

Ute Ladies-Tresses (*Spiranthes diluvialis*) is a small, native orchid associated with wet meadows that occur along streams or at spring or seep discharges at elevations ranging from about 4,300 to 7,000 feet above sea level. It typically flowers between late July through August, which is the best time to determine its presence. This species is threatened by loss of habitat, agriculture, uncertain water availability, and urban stream channelization.

Ute ladies-tresses are known to occur in Garfield County and other counties in Utah (U.S. Fish and Wildlife Service, letter, Maddux, May 2002) but it has not been observed or identified on the shoreline or riparian areas along either Lake Powell or any of the river corridors in the recreation area (NPS, Spence, pers. com., May 2002n). Its preferred elevation places it outside of the impact analysis area.

KNOWN CONFLICTS WITH PERSONAL WATERCRAFT USERS

Under current conditions there are no documented or incident reports of known conflicts of federally endangered fish or other species with watercraft or personal watercraft users (NPS, Spence, pers. com., April 2002m). Current watercraft use of any type has not been reported and is not considered to affect any endangered fish species in Lake Powell (Utah Division of Wildlife Resources, Gustaveson, pers. com., April 2002b).

SHORELINE VEGETATION

More than 730 native species of plants have been identified in the recreation area. Shoreline vegetation is considered to include several types of vegetation communities, including submerged aquatic beds, wetlands, riparian areas or zones, beach dunes, and upland vegetation that grows near the shoreline. The shoreline zone as used in this document pertains to areas within 50 horizontal feet from the lake's waterline. The area physically included in this zone changes as reservoir water levels change. The waterline fluctuates 50 feet vertically and 1,000 feet horizontally during a typical water year. Typical shoreline vegetation conditions are shown in figure 12.

SUBMERGED AQUATIC VEGETATION

Areas of submerged aquatic vegetation are generally scarce and poorly developed at the recreation area. Reasons for this condition include unstable water levels associated with reservoir operations for water supply, power generation, and flood storage; poor plant rooting conditions along the lake's shorelines; very steep shoreline slopes; limited availability of low-gradient shorelines; and lack of suitable bottom conditions.

Existing stands (or beds) of submerged aquatic vegetation are restricted to isolated small areas of the reservoir and tributary reaches where water clarity, shoreline slope, water depth, and permanence create conditions suitable for the development and maintenance of species such as leafy pondweed (*Potamogeton foliosus*), horned pondweed (*Zannichellia palustris*), and the exotic, spiny naiad (*Najas marina*). These aquatic species are present along shallow-water gradients on sandy substrate near Wahweap marina. In this area, spiny naiad has become more noticeable in recent years and seems to be slowly increasing its distribution (NPS, Spence, pers. com., May 2002n). There are no reported major or extensive distributions of this or other aquatic species in the recreation area.

FIGURE 12: TYPICAL VEGETATION ALONG LAKE POWELL SHORELINES

UPLAND SHORELINE COMMUNITIES

Shoreline vegetation includes plant species that are associated with upland, beach dune, wetland, hanging-garden, and riparian locations near the land-water interface. Shoreline vegetation occurs along the main reservoir shoreline and along the tributary streams and rivers that flow into the reservoir. Water fluctuation and difficult rooting conditions combined with the desert climate, severely restrict development of shoreline and riparian vegetation. Consequently, most shorelines are either bare rock or unvegetated sand, gravel, or cobbles. The types of shoreline communities present in limited abundance are described below.

Saltcedar (also commonly referred to as tamarisk), Russian thistle (*Salsola kali*), seepwillow (*Baccharis glutinosa*), and numerous weed species grow along the lake shoreline. The cottonwood-willow-saltcedar floodplain association, which is the predominant shoreline vegetation complex that comprises almost 1,850 acres along waterways and sandy washes throughout the recreation area is described in the *General Management Plan* (NPS 1979a). These locations are generally small in size and scattered throughout various side canyons, coves and drainage outlets adjacent to the rivers and marinas. In these locations shoreline vegetation is primarily saltcedar. When the pool elevation of the lake drops and stays lowered for more than a year, some adjacent upland plant species such as Russian thistle and seepwillow invade the previously flooded area along the shoreline.

When the lake level reaches maximum pool elevation, adjacent upland plant communities become part of the shoreline zone. The near-shore plant communities include both upland desert shrub-scrub and small, specialized or relict wetland plant communities called hanging gardens. The dominant species of the desert shrub-scrub community typically include the shrubs shadscale (*Atriplex confertifolia*), blackbrush (*Coleogyne ramosissima*) and sand sage (*Artemisia filifolia*). Some areas include a higher proportion of grass species and a different assemblage of shrub species. Species include Mormon tea (*Ephedra torreyana*), yucca (*Yucca angustissima*), snakeweed (*Xanthocephalum microcephala*), prickly pear (*Opuntia ericacea*), galleta (*Hilaria jamesii*), and Indian ricegrass (*Oryzopsis hymenoides*).

The hanging garden community type is associated with seep seams and alcoves along canyon walls of the river drainages where groundwater seeps and drips from rock walls through cracks, providing a dependable water supply. This unique relict plant community is adapted to cool, wet conditions. Common plant species include maidenhair fern (*Adiantum* sp.), monkey flower (*Mimulus* spp.), white columbine (*Aquilegia* spp.), and California sawgrass (C*ladium californica*). One hanging garden community located on canyon walls near the confluence of the San Juan and the Colorado Rivers has been under consideration as a research natural area. These locations may occasionally become accessible to visitors in watercraft during high water periods.

Lake beaches comprise about 3% of more than 1,900 miles of shoreline. Stabilized dunes support a relatively dense vegetation of sunflower (*Vanclevea stylosa*), mint (*Poliomentha incana*), Mormon tea (*Ephedra viridis*), and Indian ricegrass. Camelthorn (*Alhagi camelorum*), an invasive species, has spread onto the sandy beaches near Clay Hills and Great Bend. Some upland plant communities near the shoreline support desert shrub-scrub vegetation, which include shadscale, blackbrush, and sand sage.

During periods of prolonged low-water, where soil texture and soil depth conditions allow, fast-growing annual and perennial species quickly invade exposed shoreline areas, temporarily increase in number, and extent of ground cover, and later disappear when reservoir water level rises during the next filling or water storage period. These aggressive and fast-growing species are tolerant of such

environmental disturbance and can typically recover within one or two growing seasons. Saltcedar (*Tamarix ramosissima*) is one of the most common of these aggressive shrub species that forms bands along the shoreline. These bands range in density from thickets to isolated individual plants that develop in the water fluctuation zone on the banks of the reservoir in sandy or talus substrates.

Vegetated areas within accessible shoreline areas experience periodic disturbance from visitor use. Vegetated areas located below the 3,700-foot elevation contour are susceptible to the disruptive effects of inundation. Livestock grazing has influenced the distribution of the mixed-desert shrub communities along some shorelines of the San Juan River inlet.

RIPARIAN VEGETATION

Riparian vegetation is considered a type of shoreline plant community. It is relatively rare along the main lake shorelines. Its abundance and distribution increase along river shorelines and in the upper ends of tributary side canyons, particularly where springs and streams are present. Riparian vegetation distribution along the banks of the tributary rivers is intermittent. It occupies portions of the southeastern side of the lake along the banks of the San Juan River near Clay Hills, Copper Canyon, Neskahi, and Paiute Canyon. On the southwestern side of the lake along the banks of the tributary inlets small linear riparian communities occur at Last Chance Canyon, Warm Creek, and Crosby Canyon. Extended flooding, frequent inundation and fluctuating water levels prevent formation of extensive riparian vegetation along the lake shoreline (NPS, Spence, pers. com., April 2002m).

The riparian community is dominated by saltcedar (*Tamarix ramosissima*) with an understory of Russian thistle, horseweed (*Conyza canadensis*) jimsonweed (*Datura metaloides*), with some rubber rabbitbrush (*Chrysothamnus nauseosus*). Alluvial deposits near lower elevations of the river inlets are characterized by shadscale, Mormon tea and Indian ricegrass. Plant cover in alluvial areas ranges from 10% to 15% in shallow wash channels (NPS 1988a). Native riparian species (e.g., cottonwood and willow) are not common along the lake although some may be present in the understory in stands of saltcedar (Waring 1992). More saltcedar is present along the lake shoreline and side canyons where harsher conditions are found (Waring 1992). Although saltcedar is often present along the shoreline below mean water levels, much of the shoreline is comprised of bedrock, which does not support riparian or other shoreline vegetation.

Riverbank vegetation in the canyons consist of native cottonwood (*Populus fremontii*), coyote willow (*Salix exigua*), seepwillow (*Baccharis salicina*), Arctic rush (*Juncus arcticus*), and horsetail (*Equisetum hyemale*) (NPS 1995a). Vegetation densities are higher where there are permanent riparian communities. Other factors that affect the status of this community type include about 1% or 1,000 acres of floodplain area has historically supported permitted livestock grazing (NPS 1979a). Of the scientifically important riparian communities nearly 200 acres are grazed (NPS 1999a). The Bureau of Land Management and National Park Service have jointly developed a grazing management plan to maintain and protect riparian vegetation (NPS 1999a).

WETLANDS

Wetlands communities are uncommon to rarely present along the lake shoreline throughout much of the recreation area. Wetlands associated with nine perennial tributaries and springs along Lake Powell contain more diversity and native species than riparian habitats along the lake shoreline (Waring 1992, Spence 1995a). These wetlands are comprised of dense stands of black willow (*Salix gooddingii*),

coyote willow, cottonwood, boxelder (*Acer negundo*), cattails (*Typha* spp.), with various sedges (*Carex* spp.), and rushes (*Juncus* spp.). Emergent wetlands expand in size or develop in new areas when the lake level is dropped for several years in locations that expose soils with adequate soil moisture allowing colonization by these species.

Small native wetland communities composed of annuals more characteristic of drier soils (such as Russian thistle and horseweed) are located along springs that drain into many of the more protected coves and side canyons such as Ticaboo Creek, Reflection Canyon, Slickrock Canyon, springs in Rock Creek, Oak Bay, Good Hope Bay and areas east of the confluence of Escalante River and south of Llewellyn Canyon (Waring 1992). Some wetlands may also be found along Copper Canyon Neskahi, Paiute Canyon of the San Juan, Crosby Canyon, and Dirty Devil (NPS 1988a).

The development and long-term maintenance of wetland communities are dependent on the suitable combination and distribution of proper bottom or soil materials, bank slope, water depth, and timing of flooding. Lake level fluctuations may either flood or drain areas making them unsuitable for wetlands, even for the most flood or drought tolerant species. Some areas contain high saline soils that limit the development of many wetland species (NPS 1988a).

VISITOR USE AND EXPERIENCE

Glen Canyon National Recreation Area is one of the premier water-based recreation areas in the country. It includes Lake Powell's 160,000 surface acres and 1,960 miles of shoreline. The lake, its 96 major side canyons, and related natural, cultural, and geologic resources are the primary recreation features of Glen Canyon National Recreation Area.

A variety of recreational opportunities exist on and around the lake. Powerboating, using houseboats and personal watercraft, waterskiing, fishing, riding a tour boat, sailing, and kayaking are among the many water sports visitors enjoy. Opportunities also exist for hiking in the surrounding canyon areas, many of which are accessible for most visitors only by water. Visitors can enjoy camping opportunities ranging from remote and undeveloped campsites to fully developed campgrounds. Visitors can also see archeologically and culturally important sites throughout the recreation area.

The lake occupies only about 13% of the recreation area. The remaining 87% offers backcountry experiences in a desert setting that is extraordinarily rugged and beautiful. However, because these experiences would not be affected by personal watercraft management except at locations within a mile or two of the lake, they were not considered in this analysis.

WATERCRAFT USE AND DISTRIBUTION

Boat days and watercraft operating hours were used as a basic unit of measurement of the intensity and impact of watercraft use. A boat day equals one watercraft on the lake during a 24-hour period. Watercraft operating hours are the average number of hours a vessel is underway during a 24-hour period.

A full description of the method used for calculating boat days is included in appendix E. Briefly, total annual boat days on Lake Powell were calculated by multiplying the total number of boats estimated to enter the recreation area by the average length of time boats spend on the lake during a visit (Henderson 2002). Data sources included the following.

> The total number of boats was estimated using boat rental, boat slip, and boat buoy data obtained from ARAMARK (the recreation area concession operator), and from NPS monthly entry and trailer counts gathered at the Wahweap, Lone Rock, Antelope Point, Bullfrog, Halls Crossing, and Hite launch areas.
>
> The average amount of time each watercraft spent on the lake was estimated by a University of Minnesota 2000 visitor survey report, in which watercraft users were asked how many nights they spent on the lake during their stay.

Data was collected from Lake Mead, including vessel ratios and daily operating hours for each type of vessel, to estimate use by engine type on Lake Powell. Data from Lake Mead were obtained during an extensive boat use study in 1999 (Hagler Bailly 1999). The Lake Mead data are appropriate to apply to Lake Powell because the two lakes have very similar volumes, natural and socioeconomic environments, visitor uses, and types of activities (table 17).

TABLE 17: DISTRIBUTION OF ENGINE TYPES AND AVERAGE DAILY OPERATING HOURS PRESENT ON LAKE POWELL

Engine Type a/	Percent of Boat Days	Number of Boat Days	Operating Hours per Boat Day	Total Operating Hours
Outboard Engines				
Carbureted two-stroke	6.1	50,696	2.9	147,018
Direct injection two-stroke	2.3	19,115	2.9	55,434
Electric fuel injection two-stroke	2.3	19,115	2.9	55,434
Carbureted or electric fuel injection four-stroke	4.7	39,061	2.9	113,277
Inboard/Sterndrive				
Carbureted or electric fuel injection four-stroke	52.3	434,654	4.7	2,042,874
Two-stroke carbureted jet drive	3.0	24,932	4.0	99,728
Diesel auxiliary sail	1.6	13,297	3.6	47,869
Personal Watercraft				
Carbureted two-stroke	24.0	199,459	2.4	478,702
Direct Injection two-stroke	1.8	14,959	2.7	40,389
Four-stroke	1.8	14,959	2.7	40,389
Totals	**99.90**	**830,247**	**—**	**3,121,114**

a. Average rated horsepower, percent of trips, hours per trip based upon Lake Mead values developed from the Hagler Bailly Report

Total annual Glen Canyon National Recreation Area watercraft use in 2001 was 831,079 boat days (total boat days reported in table 17 vary from this because the figures in table 17 were derived from rounded boat day percentages). Watercraft were operated on the lake for a total 3,121,114 hours. There are several important characteristics of this use.

Personal watercraft accounted for 26% of all boat days and 18% of all operating hours estimated in 2001.

The visitor survey identified that typically, many watercraft are used by a large group of friends or family, and groups often include more than one boat type. Generally one boat type in the group is the primary watercraft. The most common primary watercraft are powerboats. The second most common primary watercraft are houseboats.

It is common for houseboat and powerboat groups on Lake Powell to bring personal watercraft on their trips. Of all groups traveling on Lake Powell with houseboats, 39% also included at least one personal watercraft and 25% of all powerboat groups included at least one personal watercraft.

Half of all respondents to the summer survey stated that they operated a personal watercraft during their visit.

The distribution of types of watercraft is presented in table 18 (James et al. 2001a).The key points are that visitors have and use multiple types of watercraft, including personal watercraft, during a recreation trip, and personal watercraft use is not restricted to a specific user group.

TABLE 18: TYPES OF WATERCRAFT USED IN GLEN CANYON NATIONAL RECREATION AREA

Vessel Type	All Watercraft on the Lake[a] (percentage)	Groups with Type of Watercraft[b] (percentage)
Powerboat	56	84
Personal watercraft	21	32
Houseboat	20	29
Kayak	1	1
Other	1	1
Inflatable toy	1	1
Sailboat	1	1
Raft (motor)	1	1
Raft (no motor)	Less than 1	Less than 1

a. Values in the column total more than 100% because of rounding.

b. Values in the column total more than 100% because many groups had more than one watercraft.

Watercraft use peaks in the months of May through October. In 2001, this six-month period accounted for 92% of all boat days.

As shown in table 19, personal watercraft use in 2001 accounted for 26% of all boat days. Over the course of the year, personal watercraft use varied relative to other watercraft, from less than 5% of boat days from November through March to a peak of 38% of boat days in September.

Overall boating use in visitor use zones is shown in figure 13. These zones were established for the lake carrying capacity studies completed in the early 1980s (NPS 1987b). The zones are defined generally by areas of physiographic change such as narrowing of the main channel, transition from a large bay segment to a segment of narrower main channel canyon, or major tributary canyons. The zones were developed only to analyze distribution of use on the lake and are not used for other management or enforcement purposes. Use of the lake by zone based on data collected in 2001 is provided in table 20. As shown in table 20:

> The distribution of personal watercraft use, as indicated by the percent use in each zone, is very similar to the distribution of use by other watercraft.
>
> The four zones near the marinas accounted for almost 60% of all watercraft use. These include:
>
> > Wahweap (Zone 1, 26% of total boat days);
> >
> > Bullfrog and Halls Crossing (Zone 11, 12%);
> >
> > Hite (Zone 13, 11%); and
> >
> > Dangling Rope (Zone 6, 10%), which also includes access to Rainbow Bridge National Monument.

TABLE 19: ESTIMATES OF PERSONAL WATERCRAFT AND OTHER WATERCRAFT USE IN GLEN CANYON NATIONAL RECREATION AREA BY MONTH IN 2001[a]

	Other Watercraft		Personal Watercraft		All Watercraft	
Month	Boat Days	Monthly Use (percentage)	Boat Days	Monthly Use (percentage)	Boat Days	Annual Use (percentage)
January	747	96	30	4	777	<1
February	1,059	97	33	3	1,092	<1
March	8,995	97	261	3	9,256	1
April	18,686	94	1,122	6	19,808	2
May	68,444	81	15,771	19	84,215	10
June	137675	74	47,985	26	185,660	22
July	113,984	70	48,600	30	162,584	20
August	126,628	72	49,491	28	176,119	21
September	80,045	62	49,883	38	129,928	16
October	37,658	86	6,336	14	43,994	5
November	11,946	96	445	4	12,391	2
December	5,189	99	67	1	5,256	1
Total	611,056	74	220,023	26	831,079	100

a. Slight variations in some totals occur between table 19, table 20, and the text because of the calculations used to estimate use. However, these variations do not affect any of the percentages or conclusions.

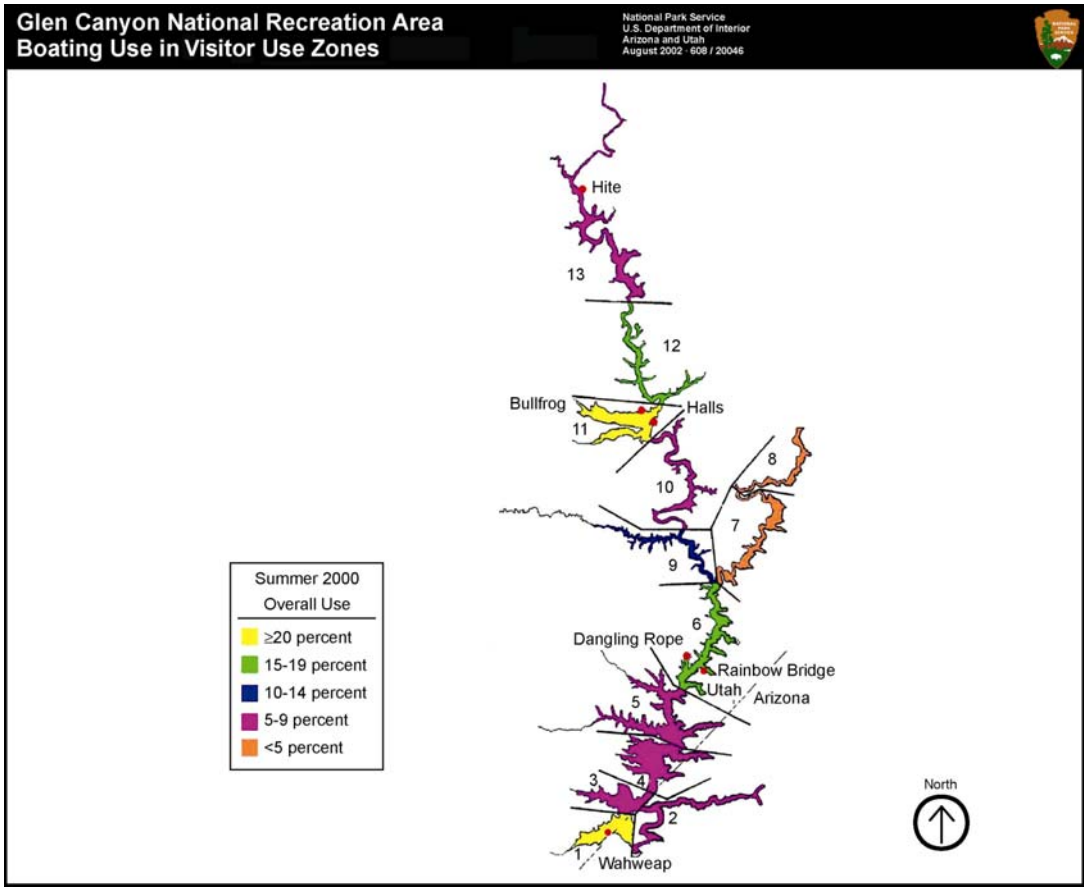

FIGURE 13: BOATING USE IN VISITOR USE ZONES

TABLE 20: ESTIMATES OF PERSONAL WATERCRAFT AND OTHER WATERCRAFT USE BY ZONE IN 2001[a]

	Other Watercraft		Personal Watercraft		Total	
Lake Zone	**Boat Days**	**Percent**	**Boat Days**	**Percent**	**Boat Days**	**Percent**
1 (includes Wahweap Marina)	159,647	26	52,729	24	212,436	26
2	39,622	6	13,922	6	53,549	6
3	48,950	8	16,470	8	65,435	8
4	24,701	4	8,427	4	33,134	4
5	21,098	3	7,636	3	28,734	3
6 (includes Dangling Rope Marina)	63,872	10	23,038	10	86,910	10
7	10,098	2	4,507	2	14,594	2
8	644	1	70	1	716	1
9	28,430	5	12,180	5	40,586	5
10	25,279	4	9,628	4	34,901	4
11 (includes Bullfrog and Halls Crossing Marinas)	73,067	12	29,993	14	103,016	12
12	47,597	8	19,607	9	67,174	8
13 (includes Hite Marina)	68,054	11	21,812	10	89,900	11
Total	**611,056**	**100**	**220,023**	**100**	**831,079**	**100**

a. Slight variations in some totals occur between table 19, table 20, and the text because of the calculations used to estimate use. However, these variations do not affect any of the percentages or conclusions.

The lowest use occurred in Zone 8, which includes the San Juan arm of Lake Powell upstream from Great Bend. This zone experiences fewer than 1,000 boat days of use per year, and accounts for only 70 personal watercraft boat days annually.

Watercraft use of the lake originates primarily from the four marinas at Wahweap, Bullfrog, Halls Crossing, and Hite, and the two launch ramps at Antelope Point and Stateline. From the marinas, watercraft users distribute themselves throughout the lake to popular destinations. As shown in the table 20 data, many visitors remain in the vicinity of the marinas. However, because of the availability of marinas with fueling stations along the length of the lake (including the floating marina at Dangling Rope), houseboats and powerboats have access to and can travel to any point on the lake. Because personal watercraft often are towed or carried by these vessels, personal watercraft also have access to remote areas of the lake.

Use of Tributary Canyons

The National Park Service does not collect data on the distribution of watercraft within each lake zone. Therefore, it was necessary to estimate watercraft use in the upper reaches of the Escalante, San Juan, Dirty Devil, and Colorado Rivers within the recreation area. The distribution of personal watercraft and other watercraft in the upper arms of the rivers was estimated using University of Minnesota summer 2000 survey data, and through conversations with staff from the recreation area, Bureau of Land Management, the Utah Division of Parks and Recreation, and Canyonlands National Park.

Estimates of personal watercraft and other watercraft were made for each river portion of the lake from the point where downstream current is no longer measurable to the points noted in table 21. Additionally, on the Colorado and San Juan Rivers, estimates were made of the number of boats per day entering the recreation area by water from outside of the recreation area boundary.

The estimates in table 21 represent instantaneous counts, rather than a total daily number of vessels visiting each area. For example, during the high-use season, an observer on the Dirty Devil usually would be able to see between 4 and 20 watercraft at a time. Typically, half of these would be personal watercraft. Over the course of a day, perhaps 50 entrances and exits by motorcraft of the observed area may occur, with a very large percentage of those vessels being the same visitors motoring in and out (Schulman 2002b).

Tributary Canyon Use Originating from Outside of the Recreation Area

Boating use originates from outside of Glen Canyon National Recreation Area on the San Juan and Colorado Rivers. Numbers of boats entering Glen Canyon National Recreation Area annually on the Colorado and San Juan Rivers in 2000 and 2001 are shown in table 22. On both rivers, boating use occurs in private and commercial watercraft. Vessels include motorized craft and several types of human powered craft, including whitewater rafts and kayaks.

The Bureau of Land Management issues permits for river trips on the San Juan River. Usually, such trips originate from the Bureau of Land Management's Sand Island Recreation Site (river mile 0) or Mexican Hat (river mile 27). They usually end at Clay Hills Crossing (river mile 84) within Glen Canyon National Recreation Area (Bureau of Land Management, Berkenfield, letter, May 2002).

TABLE 21: ESTIMATED NUMBERS OF WATERCRAFT TYPICALLY OBSERVABLE ON THE TRIBUTARY RIVERS TO LAKE POWELL

		High-Use Season[a]		Low-Use Season[a]	
River Arm of Lake Powell	Location	Personal Watercraft	All Other Watercraft	Personal Watercraft	All Other Watercraft
Upper Colorado River	In Cataract Canyon, upriver from Sheep Canyon	<1	<1	<1	<1
Dirty Devil River	Upriver from the Highway 95 Bridge	2–10	2–10	<1	<1
San Juan River	Upriver from Clay Hills Crossing	<1	<1	<1	<1
Escalante River	Upriver from Cow Canyon	2–10	2–10	<1	<1

a. High season: months of May through October. Low season: months of November through April.

TABLE 22: BOATS PER YEAR ENTERING GLEN CANYON NATIONAL RECREATION AREA ON THE COLORADO AND SAN JUAN RIVERS, 2000 AND 2001

Location	2000	2001
Colorado River – from within Canyonlands National Park to Hite Marina	2,250	2,335
San Juan River – from all points upstream to Clay Hills Crossing	494	564

Canyonlands National Park issues permits for trips on the Colorado River that originate within Canyonlands National Park. Typically, such trips end within Glen Canyon at Hite (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com., January 2003a). Permits are not issued to personal watercraft users, as this use is not permitted on the rivers in Canyonlands National Park.

Personal watercraft are prohibited on the Colorado River within Canyonlands National Park. Personal watercraft are allowed on the San Juan River. However, because they must carry a toilet and a spare means of propulsion and can only travel at flat-wake speed, the use of personal watercraft on this river is highly unusual.

WATERCRAFT USER MOTIVATIONS, SATISFACTION, AND CONFLICTS

Desired Experiences

Personal watercraft users and other watercraft users come to Glen Canyon National Recreation Area with motives for and expectations about their visit. These reflect visitor's desired experiences and indicate the basis for a satisfactory visit.

Respondents to the University of Minnesota summer 2000 watercraft survey (James et al. 2001a) described their motives for visiting the recreation area. Respondents were also asked to rate the importance of experiences they may have had while visiting the area on a scale of 1 through 5. Using this scale, 1 was very unimportant, 2 was unimportant, 3 was neither important or unimportant 4 was important, and 5 was very important. The responses to several of the survey questions are presented in appendix D.2.

According to the survey, little difference exists between the desired experiences of personal watercraft users and other watercraft users. Among the most important were to "enjoy the scenery of Lake Powell," "do something with my family," "get away from the usual demands of life," "be with members of my group," "be with people who enjoy the same things I do," and "experience nature." (table D.2.1 in appendix D).

Trip Satisfaction

Most visitors, including those using personal watercraft and other watercraft, reported that they successfully attained their desired experiences. As a result, visitors overwhelmingly were satisfied with their visit to Glen Canyon National Recreation Area.

Experiences receiving a moderate level of attainment were to "experience solitude," "be away from other people," and "be on my own" (table D.2.2). These results indicate that lake use levels may be too high for some visitors. There were no significant differences in experience attainment found between personal watercraft operators and operators of other types of watercraft (James et al. 2001a).

Perception of Conflict

Visitors who responded to the survey did not experience many problems during their visits (table D.2.3). The four situations that were most frequently identified as problems included "finding a beach campsite," "finding an unoccupied site," "litter on beaches and shoreline," and "people being

inconsiderate." The study noted that although these were the most often identified, the mean rating on a scale of 1 (no problem) to 5 (very serious problem) was 2.1 or lower, indicating a slight problem.

Several questions targeted feelings about the use of personal watercraft and feelings about the use of other types of watercraft. These questions, with the mean responses from all visitors and the separate means for personal watercraft users and users of other watercraft, are shown in table 23. As shown in table 23, the two groups of users responded very similarly to questions relating to all motorcraft. However, when the same questions were asked just about personal watercraft, the users of other types of vessels perceived problems at a statistically significant higher level than did users of personal watercraft.

> The personal watercraft users rated both of the areas of potential conflict relating to personal watercraft as being no problem or a slight problem.
>
> Other motorcraft users perceived personal watercraft as representing a slight to moderate problem for both questions.

The same trend occurred in response to possible management actions. Complete information on responses to questions about possible management actions are provided in table D.2.4 and are summarized in table 24. As shown in the table 24:

> Among potential actions that would apply to all users, the differences in responses between operators of personal watercraft and other watercraft never differed by more than 0.3 points. Both groups almost equally favored providing information about appropriate behavior; enforcing safety rules and regulations; and protecting the environment and sensitive resources, even if it involved controls and "off-limit" zones. Both groups almost equally opposed actions that would limit or prohibit the use of motorized watercraft.
>
> In all three questions involving management of personal watercraft, the answers given by users of other watercraft were 0.8 to 1.0 points higher than those from personal watercraft users. Even so, operators of other watercraft did not want to prohibit the use of personal watercraft on Lake Powell.

TABLE 23: PERCEPTION OF CONFLICT BY USERS OF PERSONAL WATERCRAFT AND OTHER WATERCRAFT

Experience	Overall Mean[a]	Personal Watercraft Operators Mean	Other Watercraft Operators Mean
Relating to all motorcraft			
Unsafe operation of motorized boats	1.7	1.6	1.8
Too many motorized boats on the lake	1.6	1.6	1.7
Relating to personal watercraft			
Unsafe operation of personal watercraft	2.0	1.7	2.4
Too many personal watercraft on the lake	1.9	1.5	2.3

a. 1 = No problem
2 = Slight problem
3 = Moderate problem
4 = Serious problem
5 = Very serious problem.

TABLE 24: SUPPORT FOR POSSIBLE MANAGEMENT ACTIONS BY PERSONAL WATERCRAFT AND OTHER WATERCRAFT USERS

Experience	Overall Mean[a]	Personal Watercraft Operators Mean	Other Watercraft Operators Mean
Relating to all motorcraft			
Provide more information to visitors about appropriate behavior	4.0	3.9	4.1
Aggressively enforce safety regulations, laws, and rules on lake	3.7	3.7	3.8
Use management controls to prevent damage to the environment by visitors	3.7	3.7	3.8
Use management controls to prevent conflicts between lake users	3.3	3.2	3.5
Establish "off-limit" zones to protect sensitive resources	3.2[b]	3.3	3.3
Require visitors to learn about appropriate behavior on the lake (e.g., watch a short video presentation)	3.0	2.9	3.2
Limit number of boats allowed on lake	2.4	2.3	2.4
Limit number of motorized watercraft allowed on lake at any one time	2.4	2.1	2.4
Prohibit motorized watercraft on the lake	1.4	1.4	1.5
Relating to personal watercraft			
Restrict personal watercraft use to designated areas only	2.7	2.2	3.3
Limit number of personal watercraft allowed on lake at any one time	2.6	2.1	2.9
Prohibit personal watercraft on the lake	1.9	1.5	2.3

a. 1 = Strongly oppose
2 = Oppose
3 = Neither support nor oppose
4 = Support
5 = Strongly support.

b. Value was copied accurately from the source (James et al. 2001a), which may have had an averaging error.

Based on the survey, the perception of conflict was slightly higher among users of other motorcraft than among personal watercraft users, and the users of other motorcraft were more likely to favor additional controls on personal watercraft. These differences were statistically significant. However, both groups consider personal watercraft as an appropriate use of the lake and expressed a high level of satisfaction with their visit.

PERSONAL WATERCRAFT AND OTHER WATERCRAFT USE TRENDS

Personal watercraft use trends were developed to define characteristics of personal watercraft activities and to evaluate the effects of management strategies on recreation area resources. Characteristics of other watercraft use patterns were identified to help understand the cumulative effects of both classes of watercraft. Understanding such relationships is important because personal watercraft are often used in conjunction with powerboats and houseboats. Use trends of personal watercraft and other vessels were determined using:

Data available from the recreation area;

Discussions with staff;

Research from the University of Minnesota (James et al. 2001a); and National and state trends.

Pattern of Visitation at Glen Canyon National Recreation Area

Each year, the National Park Service estimates visitation at Glen Canyon National Recreation Area. Data sources include vehicle traffic counts at entry stations and trailer counts at marinas and campgrounds. More than 2 million people visit the recreation area each year.

Personal watercraft and all other watercraft use varies by season. The high-use season includes the months of May through October and the low-use season includes the months of November through April. As shown in table 19, more than 90% of boat days in 2001 occurred during the high-use season. This is a typical use pattern for Lake Powell.

Since 1995, total recreation area visitation for all types of uses has shown an average annual decrease of 1.05%. The average decrease since 1995 for the peak visitor use months of May through October has been slightly higher, at 1.5% annually.

Data are not collected annually that show changes in personal watercraft versus the use of other watercraft. However, because so many visitors use both types of vessels, annual changes probably are similar for these two vessel types (Arizona Game and Fish Department, Harris, pers. com., April 2002).

Many factors could affect future visitation at Glen Canyon National Recreation Area. Some of these could include the economy, the price of gasoline, and climatic conditions that control the volume of water in the lake. Most projections indicate that no changes to recreation area visitation will occur over the next 10 years.

Comparative National Park Visitation Trends

An analysis of use trends within units of the national park system indicates that over the past decade use within NPS units increased on average by 0.3% per year. Parks with characteristics similar to Glen Canyon (e.g., water-based, seashores and lakeshores, recreation areas, western parks, or large popular parks) experience average annual use increases 0.25% over the past decade. Similarly, use at the personal watercraft regulatory units increased by an average 0.26% annually. Use change in these parks ranged from 9.2% average growth at Cape Lookout National Seashore to 4.8% annual decline at Big Horn Canyon National Recreation Area. It is expected, for the purposes of analyses within this document, that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years (see appendix F).

National and State Boating Trends

National personal watercraft sales increased every year between 1991 (68,000 units) and 1995 (200,000 units). They then declined so that only 92,000 units were sold in 2000 (National Marine Manufacturers Association 2001a) Sales for all boats displayed a similar trend.

Regionally, boat registrations grew from 1995 to 1999 for Arizona, Colorado, and Utah, the primary states of origin for Glen Canyon boaters. Annual growth rates ranged from 0.5% in Utah to 3.4% in Colorado (table 25).

TABLE 25: BOAT REGISTRATIONS BY STATE, 1995 THROUGH 1999

State	1995	1996	1997	1998	1999	Average Annual Change (percent)
Arizona	145,156	150,107	155,010	158,726	153,517	1.45
Colorado	88,565	95,140	95,924	98,190	101,137	3.40
Utah	75,748	71,688	74,288	76,346	77,171	0.53

Source: National Marine Manufacturers Association 2000.

According to the National Marine Manufacturers Association (National Association of State Boating Law Administrators 2001a), boating participation on a national level declined slightly from 1997 to 2000. This same source says that that on average, the availability of free time for Americans was in smaller time blocks and, therefore, it was likely that boaters would rely increasingly on water bodies and recreation opportunities that were closer to home and required less travel time.

According to James et al. (2001a), the average length of stay on Lake Powell is 4 nights. Therefore, visits to Glen Canyon National Recreation Area require a substantial commitment of time, both for travel and for time spent at the recreation area. National trends suggest that in the future, some individuals may be less able to commit this amount of time for a trip to Glen Canyon National Recreation Area.

VISITOR CONFLICTS AND VISITOR SAFETY

SAFETY REQUIREMENTS

Within Glen Canyon National Recreation Area, personal watercraft users are required to comply with all applicable federal and state boating laws, rules, and regulations. A summary of the personal watercraft regulations, laws, and rules for Arizona and Utah is provided in table 4. Complete personal watercraft regulations for the two states are provided in appendix B.

Personal watercraft users must comply with regulations of the state in which they are operating. Because about 95% of Lake Powell is in Utah, most personal watercraft users are subject to Utah laws and rules.

NPS rangers enforce watercraft regulations lake-wide. They use the applicable state regulations, provisions of Title 36 CFR Part 7.70, and the United States Coast Guard regulations contained in Title 33 CFR. State enforcement personnel also patrol the waters and enforce their respective state regulations, laws, and rules.

The superintendent's compendium for Glen Canyon National Recreation Area is established under the authority of Title 16 U.S.C., section 3, and Title 36, CFR, Chapter 1, Parts 1 through 7. The compendium establishes a broad range of regulations and restrictions on use activities within the recreation area. Section 3.6 (Prohibited Operations) applies specific regulations related to watercraft safety, and includes the following items within Lake Powell.

Prohibits operating a vessel in excess of 5 miles per hour or creating a wake in the following areas:

Within harbors, mooring areas, and designated flat-wake areas.

Within any other “flat-wake” buoyed area.

Prohibits personal watercraft use:

From further upstream travel along portions of the Escalante, San Juan, Colorado, and Dirty Devil Rivers.

Launching and retrieval of personal watercraft is permitted at the following locations:

All public launch ramps.

The area of beach within Lone Rock off-road use area.

Vessels up to 25 feet at Lone Rock Beach.

The beach areas legally accessible by motor vehicles at the primitive camping area of Stanton Creek, Upper Bullfrog North, and Upper Bullfrog South.

San Juan River take-out at Clay Hills Crossing.

Red Canyon.

Paiute Farms area.

Hite, from 300 feet upstream of the public launch ramp to 300 feet upstream of the marina houseboat loading dock.

White Canyon area.

ACCIDENTS

Watercraft Accidents at Glen Canyon National Recreation Area

Table 26 summarizes watercraft accident records for Glen Canyon National Recreation Area for the three-year period from 1999 through 2001. The percentages can be compared to personal watercraft use, which in 2001 represented 18% of all boat operating hours on Lake Powell. Key features include the following.

There were 811 reported boating accidents in Glen Canyon National Recreation Area over the three-year period, for an average of 270 per year. This is an average of 1.5 boating accidents each day over the six-month high-use period from May through October that accounts for 92% of all boat-use days on Lake Powell.

Personal watercraft represented about 14% of all accidents, or slightly under the proportion of all watercraft operating hours (18% of all watercraft operating hours).

Personal watercraft were involved in only 5% of the property damage accidents.

Personal watercraft users experienced personal injuries at a higher rate (20% of all accidents) than their proportion of accidents (14% of all accidents). However, the injury rate for personal watercraft operators was generally equivalent to the proportion of all watercraft operating hours that are attributed to personal watercraft (18%).

TABLE 26: SUMMARY OF WATERCRAFT ACCIDENT RECORDS FOR GLEN CANYON NATIONAL RECREATION AREA, 1999 THROUGH 2001

	1999		2000		2001		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All accidents	272	—	284	—	255	—	811	—
Personal watercraft	32	12	51	18	32	13	115	14
Other vessels	240	88	233	82	223	87	696	86
Property damage accidents	124	—	136	—	104	—	364	—
Personal watercraft	6	5	7	5	4	4	17	5
Other vessels	118	95	129	95	100	96	347	95
Personal injury accidents	147	—	147	—	150	—	444	—
Personal watercraft	26	18	35	24	28	19	89	20
Other vessels	121	82	112	76	122	81	355	80
Fatal accidents	1	—	1	—	1	—	3	—
Personal watercraft	0	0	1	100	0	0	1	33
Other vessels	1	100	0	0	1	100	2	67

Source: NPS 2001c; U.S. Coast Guard Boating Statistics 2001.

> More than 77% of all personal watercraft accidents resulted in injuries. In contrast, 51% of accidents involving other watercraft resulted in personal injuries.
>
> There was one death of a personal watercraft operator over the three-year period, and two deaths involving other types of vessels. The low total of three fatal accidents for all watercraft over this period precludes meaningful analysis.

Glen Canyon National Recreation Area data collection efforts did not attempt to define reasons for each personal watercraft accident. However, personal watercraft violations relating to accidents included underage operation; unsafe speeds; unsafe proximity to other vessels, objects, and other visitors; and lack of personal flotation devices.

In each of the three years, approximately half of the injury accidents involving personal watercraft required emergency medical service. Comparative data for other watercraft were not available.

National and State Watercraft Accidents

Nationally in 2000, there were 4,355 reported boating accidents that resulted in personal injury (NPS 2002d). Approximately 80% of all reported injuries were associated with the use of open motorboats (44%) and personal watercraft (36%). Broken bones accounted for the highest number of injuries resulting from personal watercraft use.

The same source reported that in 2000, there were 701 reported fatalities associated with boating nationwide. Personal watercraft accounted for 10% of these deaths.

This report may have underreported personal injury accidents. The ratio of personal injury to fatal accidents calculated from this source was 6.2 to 1, compared to a ratio of almost 150 to 1 at Lake Powell. However, the information in this study on the causes and outcomes of accidents are useful for indicating conditions that typically occur with motorcraft use.

Increased personal watercraft use in recent years has resulted in more concern about the health and safety of operators, swimmers, snorkelers, divers, and other boaters. A 1998 National Transportation Safety Board study revealed that while recreational boating fatalities have been declining in recent years, personal watercraft-related fatalities have increased (NTSB 1998). Nationwide personal watercraft accident statistics provided by the U.S. Coast Guard support the increase in personal watercraft-related fatalities (see table 2); however, since a peak of 84 personal watercraft-related fatalities in 1997, accidents, injuries, and fatalities involving personal watercraft have decreased (M. Schmidt, U.S. Coast Guard [USCG], pers. comm., Sept. 4, 2001). The U.S. Coast Guard's Office of Boating Safety studied exposure data to assess boating risks. This method allows for a comparison between boat types based on comparable time in the water. Personal watercraft use ranked second in boat type for fatalities per million hours of exposure in 1998, with a 0.24 death rate per million exposure hours.

Industry representatives report that personal watercraft accidents decreased in some states in the late 1990s.

Two national studies of personal watercraft accidents and injuries report that personal watercraft pose a health and safety risk, primarily to operators (Branche et al. 1997; National Transportation Safety Board 1998). The National Transportation Safety Board (1998) reported that:

In 1996, personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents.

In the same year, personal watercraft operators accounted for more than 41% of people injured in boating accidents.

In 1997, personal watercraft operators accounted for approximately 85% of the people injured in accidents studied.

These rates of accidents and injuries are much higher than those recorded in Glen Canyon National Recreation Area in the 1999 through 2001 period.

Since personal watercraft operators can be as young as 12 in several states, accidents can involve children. The American Academy of Pediatrics (2000) recommends that no one younger than the age of 16 operate personal watercraft. Some manufacturing changes on throttle and steering may reduce potential accidents. For example, on more recent models, Sea-Doo developed an off-power assisted steering system that helps steer during off-power as well as off-throttle situations. This system, according to company literature, is designed to provide additional maneuverability and improve the rate of deceleration (Sea-Doo 2001a).

Personal watercraft accident rates in Utah have declined since 1995 largely due to enactment of laws and rules governing the age of personal watercraft users and implementation of an aggressive education and certification program. Accident data from Utah in the early 1990s indicated that personal watercraft accidents were increasing. In 1994 and 1995, personal watercraft accidents constituted 53% of the total accidents, exceeding the number of traditional boating accidents (Utah Division of Parks and Recreation 2002). In 1995, Utah implemented a new law requiring personal watercraft users between the ages of 12 and 17 possess a personal watercraft education certificate and those between 12 and 15 operate under adult supervision (Utah 73-18-15.2). Since the inception of Utah's personal watercraft specific laws, the number of personal watercraft accidents has declined significantly. Two years following the inception of the new law, personal watercraft accidents declined by 59%. In 2001, personal watercraft made up approximately 6% of the total watercraft registered (79,264) in Utah (Millard 2003). Personal watercraft accidents at this time were 50% lower than those reported in 1995 and constituted 34% of the total boating accidents (Utah Division of Parks and Recreation 2002).

Fatalities Involving Carbon Monoxide

There has been only one reported fatality caused by carbon monoxide poisoning involving a personal watercraft on Lake Powell. An individual on a broken-down personal watercraft died from carbon monoxide poisoning while being towed to shore behind a motorboat (Henderson 2002). Nationally, of the 701 boating fatalities reported in 2000, five deaths were attributed to carbon monoxide. None of these involved personal watercraft use (NPS 2001e).

VISITOR USE SURVEY INFORMATION AND PERCEPTIONS OF USE AND SAFETY

The summer 2000 visitor survey (James et al. 2001a) included visitors' perceptions of safety and identification of safety problems. The results are provided in table D.2.3 in appendix D.

The scores for safety-related questions from the survey are summarized in table 27. As shown in the table, respondents did not experience many problem situations during their visit. The highest-ranked safety concerns were "people being inconsiderate" and "unsafe operation of personal watercraft," both of which scored as "slight" problems. For these and the concern "boats closer to my boat than I like," the difference in responses between personal watercraft users and users of other watercraft was statistically significant. For all three questions, personal watercraft users perceived a lower level of concern than other watercraft users.

Visitors also were asked whether they observed unsafe boating practices, and whether they felt safe during their visit (James et al. 2001b).

> In answer to the question "Did you observe any unsafe boating practices on your most recent visit to Glen Canyon National Recreation Area?" Thirty-five percent of respondents stated seeing unsafe boating practices. Fewer personal watercraft operators reported seeing unsafe boating practices than did other watercraft operators. Unsafe boating practices reported by respondents included excessive speed, traveling too close to other boats or swimmers, jumping wakes, and lack of personal floatation devices.
>
> In answer to the question "Did you feel safe on your most recent visit to Glen Canyon National Recreation Area?" Ninety-two percent of respondents stated that they felt safe during their visit. There was a statistically significant difference between personal watercraft operators and other watercraft operators, with 3% of personal watercraft operators reporting that they felt unsafe compared to 13% of other visitors.

EDUCATION

Personal watercraft users visiting Glen Canyon National Recreation Area are informed of the watercraft regulations that apply to Lake Powell and are provided with general safety information. Literature containing information about general watercraft safety is provided to visitors at the entrance gates, visitor centers, and recreation area headquarters, and on the recreation area website. No information is provided that specifically addresses safety issues for personal watercraft.

TABLE 27: PERCEPTION OF SAFETY CONCERNS BY USERS OF GLEN CANYON NATIONAL RECREATION AREA

Safety Concern	Mean[a]	Serious or Very Serious Problem (percent)
People being inconsiderate[b]	2.0	12
Unsafe operation of personal watercraft	2.0	14
Boats closer to my boat than I like	1.9	12
Unsafe operation of motorized boats	1.7	5
Conflicts with personal watercraft operators on lake	1.7	10
Sufficient navigational aids on Lake Powell	1.5	5
Confusion about rules and regulations	1.5	5

a. Means are based on a 5-point scale:
1 = no problem
2 = slight problem
3 = moderate problem
4 = serious problem
5 = very serious problem.

b. **Bold font** = statistically significant difference in responses between personal watercraft users and users of other watercraft.

CULTURAL RESOURCES

Cultural resources have been divided into:

Prehistoric and historic archeological resources, including resources that were submerged when Lake Powell was filled;

Historic resources, including trails;

Cultural landscapes; and

Ethnographic resources, including traditional cultural properties and Native American concerns.

Museum collections also are a cultural resource. However, because there are no museum collections within the project area or its general vicinity, this topic is not addressed.

"Historic properties" include cultural resources that are listed in, or eligible for listing in, the National Register of Historic Places.

The following sections briefly describe the cultural resources in the area that potentially could be affected by personal watercraft management alternatives.

ARCHEOLOGICAL RESOURCES

The recreation area contains evidence of human occupation during the Paleoindian Period, dating back to about 11,500 years before present. Later Archaic peoples moved across the landscape in a seasonal pattern as they hunted, gathered foodstuffs, and collected specialized subsistence items. During Pueblo II times, the lowland canyon systems were heavily settled, and regional sites include small storage areas and kivas. Parts of the canyonlands region have evidence of frequent use for quarrying, hunting, and other subsistence activities.

The general abandonment of the region coincides with that of the northern Ancestral Pueblo areas in the late A.D. 1200s. Decreases in population in the canyonlands began slightly earlier than in areas further north. These population shifts may have been caused by environmental changes or proto-historic use of the area by Navajo and other Indian groups.

Euro-Americans have lived in this area for more than 200 years. Their archeological remains are discussed in the "Historic Resources" section.

A total of 429 cultural resource sites have been documented within a half mile of the full pool elevation of 3,700 feet above sea level. In addition, three known sites are located below the full-pool line, but are submerged and re-exposed every year as the lake level rises with spring runoff and declines as water is released through the dam.

Of the 429 documented sites, 74 have documented human impacts. Eleven sites have been severely affected, 43 have experienced moderate effects, 9 have minimal (low) effects, and the degree of effects is unknown for 11 sites. However, it is likely that many additional sites have been impacted by visitation for the following reasons.

Many of the sites within the area of potential effect were documented prior to collecting impact data, and most have not been revisited by qualified cultural resource specialists since they were originally documented.

Submerged sites are likely to have had severe impacts from erosion, boat wakes and wave action, repeated wet/dry cycles, boat beaching, and artifact collecting.

Although the exact number is undetermined, historic and prehistoric archeological sites are present on the Navajo Reservation in areas adjacent to the lake. These sites also have been affected by vandalism, unauthorized collecting, and natural causes such as erosion (Navajo Nation, Maltonado, pers. com., April 2002).

HISTORIC RESOURCES

The recreation area's historic resources include historic structures, trails, cultural landscapes (described below), and archeological sites (discussed above). Spanish records document the 1776 journey of Dominguez and Escalante through this general area. A century later, Charles Hall, a skilled carpenter and one of the founders of Escalante, Utah, was one of the first pioneers to settle in southern Utah. In the early 1870s he built a ferry to cross the Colorado River at the Hole-in-the-Rock area, and operated it with his two sons until 1880 when he moved his business 35 miles upstream to the present site of Halls Crossing. The original site continued to be used as a gateway for gold-seekers and explorers into Glen Canyon for many years.

Hole-in-the-Rock is a culturally enhanced natural crevice in the west rim of Glen Canyon. During the late 1870s, few Mormon families had settled in the region east of the Colorado River, so the Mormon Church organized the San Juan Mission to select a site for settlement in this region. The pioneers chose the shortest route, leading first to a rendezvous point at Forty-Mile Spring, south of the town of Escalante, then down the Hole-in-the-Rock and across the Colorado River 2.5 miles below the mouth of the Escalante River.

The short-cut was deceptive, and a six-week journey became a six-month ordeal. Using hand tools and limited quantities of blasting powder, the pioneers worked though the winter of 1879 to enlarge the narrow crack in the canyon wall. Slowly and laboriously they lowered their wagons down the precipitous 25- to 45-degree slopes to cross the Colorado River, only to discover a rough, perilous, uncharted wilderness ahead. Most of the rugged trail is still visible today, both at the Hole-in-the-Rock site and in Cottonwood Canyon.

On the first of his two trips down the Colorado River in 1869, John Wesley Powell and his companions saw and described many of the local features. However the area was largely unknown to most until the construction of the Glen Canyon Dam from 1956 to 1962.

CULTURAL LANDSCAPES

Cultural landscapes represent a complex of cultural resources within a discrete geographic area. Their natural and cultural elements reflect human adaptation and resource use associated with a historic activity, event, or person. Cultural landscapes may be expressed in a variety of ways, such as patterns of settlement or land use, systems of circulation and transportation, buildings and structures, or parks

and open spaces. The National Park Service recognizes four categories: historic designated landscapes, historic vernacular landscapes, ethnographic landscapes, and historic sites.

Ethnographic landscapes are associated with contemporary groups and typically are used or valued in traditional ways. No ethnographic landscapes have been formally identified within the recreation area. However, as discussed under "Ethnographic Resources," the recreation area's geographic features and natural landscapes are important to Native Americans.

The Hole-in-the-Rock area is not formally defined as a cultural landscape. However, it is an important historic site whose broad viewsheds, scarred slopes, and trail remnants connote the hardships and determination of the pioneer Mormon families who traversed this rugged area.

ETHNOGRAPHIC RESOURCES

Ethnographic resources include traditional cultural properties, a class of cultural resource that specifically was addressed in the 1992 amendments to the *National Historic Preservation Act*. Traditional cultural properties or places are locations of special heritage value to contemporary communities (often, but not necessarily, Native American groups) because of their association with the cultural practices or beliefs rooted in the histories of those communities. Thus, they are important in maintaining the communities' cultural identities.

No traditional cultural properties have been formally defined within a half-mile of Lake Powell's full pool elevation of 3,700 feet above sea level. However, many of the recreation area resources are considered sacred by Native Americans. These particularly include the Colorado and San Juan Rivers, their side canyons, and landscapes in which they occur.

Five contemporary Native American tribes are associated with the recreation area. They include the Hopi, Kaibab Paiute, Navajo, San Juan Southern Paiute, and Ute Mountain Ute. Glen Canyon National Recreation Area also deals with several other tribes or bands because of past environmental documents and ethnographic research. These include the Kanosh and Koosharem Bands of the Paiute Indian Tribe of Utah. The Havasupai and Hualapai claim affiliation to the Colorado River below the dam. Each tribe has its own account of its history and relationships with other tribes and groups that can be only partially supplemented by archeological research.

Programmatic agreements have been formalized for several areas within the recreation area. Consultations with tribes are on-going.

NATIONAL REGISTER OF HISTORIC PLACES AND NATIONAL HISTORIC LANDMARK PROPERTIES

There are no National Historic Landmark properties within the area of potential effect. Four features within a half-mile of Lake Powell's full pool elevation of 3,700 feet are listed on the National Register of Historic Places. They include:

The Davis Gulch pictographs;

Defiance House Ruin;

Hole-in-the-Rock; and

The Hole-in-the-Rock Trail.

PAST CULTURAL RESOURCE INVESTIGATIONS

Only about 2% of Glen Canyon National Recreation Area has been surveyed for cultural resources. Most of the surveys have been in canyon areas.

A partial listing of past archeological investigations within Glen Canyon National Recreation Area at 20 shoreline areas that are accessible by automobile is included in the *Environmental Assessment and Management/Development Concept Plans for Lake Powell's Accessible Shorelines* (NPS 1988a). Ethnographic studies (NPS, Sucec, 1996a and 1996b) provide information that has been used to support recreation area planning, research, resource management, and interpretive programs.

SOCIOECONOMIC ENVIRONMENT

Glen Canyon National Recreation Area includes more than 1.25 million acres in southern Utah and northern Arizona surrounding Lake Powell. The city of Page, Arizona, which is about 2 miles from Glen Canyon Dam, is the closest community to the recreation area (see the Glen Canyon National Recreation Area Vicinity map) and is the primary gateway community.

There are essentially no other opportunities for personal watercraft use in areas near Glen Canyon National Recreation Area. The closest alternative is Lake Mead National Recreation Area, which is approximately 300 miles away. Other areas used by personal watercraft include several small water bodies north and east of Glen Canyon National Recreation Area which is nearly 400 miles from Page, Arizona (Utah Division of Parks and Recreation 2003).

The National Park Service contracted for preparation of the report, *Economic Analyses of Personal Watercraft Regulations in Glen Canyon National Recreation Area* (Law Engineering and Environmental Sciences, Inc. 2003). Relevant sections of that report are summarized here.

Visitation to Glen Canyon National Recreation Area ranged between 2.3 and 2.7 million visitors annually from 1995 to 2001. Most recreation area visitors (83%) are from Utah, Colorado, and Arizona (James et al. 2001b).

Glen Canyon National Recreation Area is a very popular destination for personal watercraft use. According to two surveys, up to 50% of visitors operate personal watercraft during their visit (James et al. 2001a; Douglas et al. n.d.). Based on year 2001 visitation of approximately 2.3 million people, about 936,000 people used personal watercraft in Glen Canyon National Recreation Area.

James et al. (2001b) found that only 22% of personal watercraft users identified personal watercraft as their primary watercraft used while in Glen Canyon National Recreation Area. The most common primary watercraft are powerboats. The second most common primary watercraft are houseboats. It is common for houseboat and powerboat groups on Lake Powell to bring personal watercraft on their trips. Of all groups traveling on Lake Powell with houseboats, 39% also included at least one personal watercraft and 25% of all powerboat groups included at least one personal watercraft.

PERSONAL WATERCRAFT OWNERSHIP AND RENTAL

Ownership and rental estimates for personal watercraft used at Glen Canyon National Recreation Area are shown in table 28. The ownership and rental values in the table were calculated by applying survey results from James et al. (2001b), which showed that about 90% of personal watercraft users in the recreation area own their vessel and 10% use rentals, to counts of recreation area visitation and personal watercraft boat days. (A boat day equals one watercraft on the lake during a 24-hour period.) The calculations of boat days assumed that the number of personal watercraft boat days is distributed evenly between rented and personally owned machines. Boat days are defined as the number of vessels multiplied by the number of days spent in the recreation area.

Many visitors trailer personal watercraft to Glen Canyon National Recreation Area from substantial distances. One survey estimated that the average distance traveled by visitors to Glen Canyon National Recreation Area was 255 miles (Douglas et al. n.d.).

TABLE 28: OWNERSHIP AND RENTAL ESTIMATES FOR PERSONAL WATERCRAFT

Ownership of Personal Watercraft	Visitors Using Personal Watercraft	Personal Watercraft Boat Days
Owned by User	842,411	198,113
Rented	93,601	22,013
Total	936,012	220,126

Annual Rental of Personal Watercraft in Gateway Communities

Counts of personal watercraft entrance by area of Glen Canyon National Recreation Area indicated that about 65% of personal watercraft rentals originated in Page (Law Engineering and Environmental Sciences, Inc. 2003). This indicates that there were about 14,300 days of personal watercraft rentals in Page in 2001.

Annual Purchases of Personal Watercraft in Gateway Communities

Douglas and Harpman (n.d.) estimated the number of unique households that visit Glen Canyon National Recreation Area in a year. They used the annual recreation area-wide visitor count and applied values obtained from their survey, including:

> The average number of trips to Glen Canyon National Recreation Area per household per year (4.1385) and
>
> The average number of people per household (4.2358).

For 2001, their calculation suggested that about 133,500 unique households visited Glen Canyon National Recreation Area.

If 40% of the households used personal watercraft and 90% of those used their own vessels, visitors to Glen Canyon National Recreation Area own about 48,000 personal watercraft. Assuming that personal watercraft are replaced every three years, about 16,000 personal watercraft that are used at Glen Canyon National Recreation Area are purchased annually. Based on interviews with local dealerships, it appears that 2% of these personal watercraft, or 320 machines, are purchased in Page.

Businesses Supported by Personal Watercraft Use

The NPS study identified 11 businesses in Page, Arizona that rent, sell, or service personal watercraft. Eight of these businesses rent personal watercraft, three of them sell personal watercraft, and seven provide personal watercraft service. Two rental shops were also identified in Big Water, Utah. Most of these businesses also provide services for activities other than the use of personal watercraft, such as boat rentals, campgrounds, boat and personal watercraft storage, and fuel.

As indicated by the presence of seven businesses that provide maintenance, personal watercraft servicing can be an important economic activity. Because the average visitor travels more than 250 miles to Glen Canyon National Recreation Area, an inoperative personal watercraft either must be serviced locally or cannot be used for the remainder of the visit.

Interviews with local businesses suggest that approximately 95% of all rented personal watercraft used on Lake Powell are rented in the local area, including businesses in Page, Big Water, or marinas on Lake Powell. The remaining 5% come from businesses that are located relatively far away from Glen Canyon National Recreation Area.

A personal watercraft rental shop with business linked to Glen Canyon National Recreation Area was identified in Salt Lake City, Utah (about 390 miles from Glen Canyon Dam). The owner reported that approximately 40% of personal watercraft rentals from his shop are to customers who trailer them to Glen Canyon National Recreation Area. This business indicated that approximately six businesses in the Salt Lake City area rent to customers who take them to Glen Canyon National Recreation Area.

Another rental shop was identified in Phoenix, Arizona, which is about 275 miles from Glen Canyon Dam. Similar to the store in Salt Lake City, the Phoenix shop owner attributed approximately 35% to 40% of his personal watercraft rentals to Glen Canyon National Recreation Area visitors.

The National Park Service contacted a business that rents personal watercraft in St. George, Utah, which is about 150 miles from Glen Canyon Dam. This business indicated that up to 80% of its personal watercraft rental business is related to Glen Canyon National Recreation Area.

All of the businesses in Page and Big Water reported that visitors to Glen Canyon National Recreation Area were the sole source of their business. This was expected, because there are no nearby alternative areas for personal watercraft use.

OTHER EXPENDITURES IN THE PAGE AREA

According to James et al. (2001b), most visitors stay on the lake or at lodging or campgrounds within Glen Canyon National Recreation Area. About 10% of recreation area visitors stay in hotels outside of the recreation area during their visit. Eight hotels in Page account for the majority of hotel stays in the area.

Restaurants in the Page area primarily depend on visitors to recreation area. Their patrons include not only visitors who are staying in Page hotels, but also those who are using camping or lodging facilities inside the recreation area and travel out for a meal. A substantial number of restaurant patrons are in transit between the recreation area and their homes.

Only limited supplies are available at the marinas within Glen Canyon National Recreation Area. Many visitors buy their groceries, gasoline, and other supplies at stores in Page.

DEMOGRAPHY AND ECONOMY

Glen Canyon National Recreation Area includes part of four counties in Utah and one county in Arizona. Selected demographic and economic information for the five counties and two states is provided in table 29.

TABLE 29: DEMOGRAPHIC AND ECONOMIC SUMMARY FOR STATES AND COUNTIES ADJOINING GLEN CANYON NATIONAL RECREATION AREA[a]

	Utah	Garfield Co. Utah	Kane Co. Utah	San Juan Co. Utah	Wayne Co. Utah	Arizona	Coconino Co. Arizona
Population 2000	2,233,169	4,735	6,046	14,413	2,509	5,130,632	116,320
Population 1990	1,722,850	3,980	5,169	12,621	2,177	3,665,339	96,591
Percent change 1990 to 2000	29.6	19.0	17.0	14.2	15.3	40.0	20.4
Ethnic composition							
White	89.2	95.0	96.0	40.8	97.3	75.5	63.1
Native American	1.3	1.8	1.6	55.7	0.4	5.0	28.5
Other backgrounds	9.5	3.2	2.4	3.5	2.3	19.5	8.4
Also Latino or Hispanic heritage	9.0	2.9	2.3	3.7	2.0	25.3	10.9
Per capita income, 1997	$20,185	$16,392	$18,258	$11,090	$15,014	$21,998	$18,180
Civilian labor force 1999	1,083,912 (49% of population)	2,698 (57% of population)	2,695 (45% of population)	4,920 (34% of population)	1,419 (56% of population)	2,363,705 (46% of population)	59,098 (51% of population)
Employed by government	17.2%	19.2%	22.5%	32.9%	20.9%	14.2%	23.5%
Unemployment	3.7%	8.3%	4.0%	7.9%	5.9%	4.4%	6.8%
Retail sales per capita, 1997	$9,666	$4,021	$5,760	$2,491	$4,124	$9,657	$9,507
Land area, square miles	82,144	5,174	3,992	7,820	2,460	113,635	18,617
Persons per square mile	27.2	0.9	1.5	1.8	1.0	45.2	6.2

a. Source: U.S. Census Bureau's FedStats site (http://www.fedstats.gov).

The Arizona portion of Glen Canyon National Recreation Area is in Coconino County. Coconino County encompasses 18,617 square miles, and is the largest county in Arizona and the second largest county in the United States. The county seat is in Flagstaff, about 135 miles south of the Glen Canyon Dam area.

> The year 2000 population of Coconino County was 116,320 people. This was a 20% increase from the year 1990 number. The population of the county grew at about half the rate of the state of Arizona, which saw a population increase of 40% over the decade.
>
> About 63% of the county's citizens identified themselves as white. American Indians constituted 28.5% of the population. The remaining 9.5% of the population identified other ethnic backgrounds. About 11% of residents identified themselves as also having Latino or Hispanic heritage.
>
> Per capita income in 1997 was $18,180. This was 17% below the state average of $22,000. However, retail sales per capita were similar to the statewide value.
>
> The civilian labor force in 1999 was about 59,100 people, and represented 51% of the county's population. Almost 25% of these people worked for local, state, or federal government agencies. Unemployment in 1999 was about 6.8%, which was higher than the state rate of 4.4%.
>
> Population density was quite low, at 6.2 people per square mile. The Arizona average is more than 45 people per square mile.

The city of Page was founded to provide housing for workers during construction of the dam, and has evolved into the gateway community for Glen Canyon National Recreation Area facilities near the dam.

In 1990, the population of Page was 6,598 people. The year 2000 census showed that Page grew 3.2% over the decade, to a population of 6,809. Tourism and power generation are the largest sources of revenue in Page. The largest employers are Lake Powell Resorts and Marinas, the Navajo Generating Station, and the Page Unified School District.

The four Utah counties include Garfield, Kane, San Juan, and Wayne. All four counties are very sparsely populated (all have fewer than 2 people per square mile) and are largely agricultural, with some tourism that is generated primarily from their proximity to Glen Canyon National Recreation Area and other NPS units.

> The combined populations of the four counties in 2000 was just under 24,000 people. All four counties grew between 14% and 19% in the preceding decade, well below the Utah average of 29.6%.
>
> Within San Juan County, which includes part of the Navajo Indian Reservation, more than 55% of the residents identified themselves as Native American and about 40% identified themselves as white. In the other three counties, 95% or more of the residents identified themselves as white. The percentage of residents identifying themselves as also having Latino or Hispanic heritage ranged from 2.0% to 3.7%.
>
> Per capita income in 1997 ranged from $18,258 in Kane County to $11,090 in San Juan County. In all four counties, per capita income was lower than the Utah average of $20,185. Retail sales

per capita also were low compared to the statewide average of $9,666, ranging from $2,491 in San Juan County to $5,760 in Kane County.

The percentage of the population in the labor force ranged from 34% for San Juan County to 57% in Garfield County. Throughout the state, the labor force represents about 49% of the population. The portion of the labor force that worked for local, state, or federal government agencies was about 33% in San Juan County and around 20% in the other counties. Statewide, the value was 17.2%. Unemployment in the four counties ranged from 4.0% in Kane County to 8.3% in Garfield County.

There are no large population centers in any of these counties. Some of the closer communities to Glen Canyon National Recreation Area with populations between 100 and 1,000 include Big Water, Blanding, Boulder, Escalante, Hanksviille, Kanab, Mexican Hat, Monticello, and Ticaboo.

RECREATION AREA MANAGEMENT AND OPERATIONS

Management of personal watercraft in the recreation area requires the participation of seven recreation area divisions. They include the superintendent's office, administration, visitor protection, interpretation, maintenance, concessions, and resource management. The superintendent's office and the administration division do not expend resources directly to manage personal watercraft. Instead, they provide support for the other divisions in their management of personal watercraft use and other activities in the recreation area.

Other agencies also provide management services within the recreation area that may be affected by changes in personal watercraft management. These agencies at both the federal and state level coordinate closely with the National Park Service.

The following is a description of the federal and state operations that are involved in the management of personal watercraft at Glen Canyon National Recreation Area.

VISITOR PROTECTION

Personal watercraft users in the recreation area must comply with Coast Guard boating requirements, and with the regulations, laws, and rules set forth by Arizona and Utah while operating on the waters within these states. These regulations, laws, and rules are enforced by several agencies, including the National Park Service, U.S. Coast Guard, Arizona State Parks and Recreation, Arizona Game and Fish Department, Utah State Parks and Recreation, and Utah Department of Natural Resources.

Federal officers, including NPS rangers and U.S. Coast Guard employees, enforce both federal and state regulations, laws, and rules. For areas such as personal watercraft use where there are no federal requirements, the federal officers enforce the applicable state regulations (NPS 2002s). State requirements for personal watercraft are presented in appendix B and summarized in table 4. Utah's standards generally are more strict than those of Arizona and include age, education, and insurance requirements as well as prohibitions on personal watercraft use between sunset and sunrise.

The states also provide officers, such as state park rangers or conservation officers, to enforce state boating laws. Currently, four full-time boat patrol officers from Utah State Parks and Recreation and two full-time boat patrol officers from Arizona Game and Fish Department are assigned to enforce state boating laws in the recreation area.

Glen Canyon National Recreation Area normally employs between 25 and 30 permanent rangers who patrol and enforce boating laws, including personal watercraft regulations. During high-visitor-use periods, the recreation area typically hires about 10 seasonal employees to support existing enforcement staff.

Patrol staff are divided into two districts, uplake and downlake. The districts are divided into seven subdistricts on the lake, five of which are actively involved with enforcing personal watercraft regulations.

The distribution of enforcement staff is based on levels of visitor use and the frequency of problems. Table 30 shows the distribution of law enforcement rangers in the summer (NPS, Mayer, pers. com., April 2002k) compared to watercraft use (from table 20). As shown in table 30, almost half of the law enforcement staff is assigned to the Wahweap subdistrict, which accounts for about a quarter of the use both by personal watercraft and other watercraft. The Hite area has the lowest number of rangers relative to use levels.

TABLE 30: SUMMER DISTRIBUTION OF NATIONAL PARK SERVICE LAW ENFORCEMENT RANGERS COMPARED TO LAKE USE LEVELS

Subdistrict	Number of Rangers	Watercraft Use (percent)
Wahweap	17	26
Bullfrog	9	12 (combined with Halls Crossing)
Halls Crossing	4	12 (combined with Bullfrog)
Dangling Rope	3	10
Hite	2	11

NPS rangers are responsible for ensuring the safety of visitors and for protecting recreation area resources on both land and water. This presents a challenge because most visitor activity is water-based while about 85% of the recreation area is dry land. Land-based areas of concentrated visitor activity, such as the boat launches and campgrounds, require disproportionate commitments of NPS enforcement staff. During high-visitor-use periods, the major land-based developed areas at both the uplake and downlake districts require approximately 80% of the patrol staff's time (NPS, Hibbs, pers. com., April 2002i; NPS, Mayer, pers. com., April 2002k).

During the high-use period, only 20% of recreation area visitor protection staff time can focus on water-based activities. As a result, visitor protection on the lake tends to be reactive, with rangers responding to accidents or incidents when they occur. As shown in table 26, 14% of accidents on the lake involve personal watercraft and 86% involve other vessels.

INTERPRETATION

Development and dissemination of materials related to recreation area resources, visitor activities, and visitor safety and conflict is provided by the interpretive division. During the high-use season, the recreation area employs about 25 interpretive staffers, including 7 full-time and 18 season workers, to interact with the public. This interaction occurs at the visitor centers at Wahweap and Bullfrog, at presentations such as those regularly scheduled at the Wahweap Amphitheatre, and during personal contacts with interpretive rangers throughout the recreation area. Information pertaining to recreation area resources and visitor activities also is available through non-personal media such as the recreation area newspaper and brochure. These are available to visitors at all entry points and at other developed sites throughout the recreation area.

It is the responsibility of the visitor to know all applicable boating rules and regulations. The recreation area provides information regarding boating regulations and general boating safety at numerous locations and in various forms. Some of these include:

> Printed information detailing safe use of watercraft, which is included in the recreation area brochure and newspaper. These are distributed at entry gates and are available at visitor centers, marinas, and recreation area headquarters.
>
> Displays at locations throughout the recreation area that illustrate proper and improper behavior while using a motorized vessel.
>
> Federal and state boating regulations, laws, and rules, which are available at ranger stations and on the recreation area's website.

MAINTENANCE

There are about 50 permanent and 20 seasonal maintenance employees in the recreation area. In conjunction with their other duties, they perform a variety of services related to personal watercraft use. These include, but are not limited to, facilities upkeep, sign construction and repair, dock repair, maintenance and placement of navigational devices such as buoys according to changes in lake level, and sanitation services.

CONCESSIONS

The concessions division manages the concessions program, including concessions contracts, in the recreation area. Its staff includes one seasonal and 11 permanent positions. The primary concessioner in the recreation area is ARAMARK Leisure Services, Inc., which operates under three contracts. These include separate contracts for uplake and downlake services and a contract for raft trips downstream from the dam. This concessioner provides many services for personal watercraft users, including as fueling stations and personal watercraft rental and repair.

In 2001, personal watercraft constituted approximately 8% of the concessioner's total rental fleet (NPS 2001d). These vessels were available for rent at the Bullfrog, Hall Crossing, and Wahweap marinas.

Incidental business permits are issued to authorize and document commercial activities occurring within Glen Canyon National Recreation Area. Currently, the recreation area has issued 160 incidental business permits to companies that provide a wide variety of services (NPS, Schreier, pers. com., June 2002o). Some of these that relate to personal watercraft include launch and retrieval services for private vessels and repair services.

RESOURCE MANAGEMENT

The resource management division protects and monitors natural and cultural resources. Its staff of 10 full-time and up to 10 seasonal employees includes terrestrial and aquatic biologists, archeologists, and geographic information system specialists.

Among other responsibilities, this staff provides monitoring to ensure that the recreation area meets state and federal water quality standards. This includes monitoring lake water for *Escherichia coli* (*E. coli*) under the direction of the Technical Advisory Committee. The current level of effort involves two resource management division staff members collecting samples twice a year.

ENFORCEMENT CASES

Table 31 shows law enforcement cases involving watercraft at Glen Canyon National Recreation Area for the three-year period, 1999 through 2001. Definitions for terms used in this table included the following.

> Cases included incidents plus accidents. All cases required that action to be taken by federal or state visitor protection personnel.

TABLE 31: SUMMARY OF WATERCRAFT ENFORCEMENT CASES FOR GLEN CANYON NATIONAL RECREATION AREA, 1999 THROUGH 2001

	1999		2000		2001		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All cases	1,316	100	1,814	100	1,057	100	4,187	100
Personal watercraft	212	16	304	17	118	11	634	15
Other vessels	1,104	84	1,510	83	939	89	3,553	85
Incidents	1,044	79	1,530	84	802	76	3,376	81
Personal watercraft	180	14	253	14	86	8	519	12
Other vessels	864	66	1,277	70	716	68	2,857	68
Accidents	272	21	284	16	255	24	811	19
Personal watercraft	32	2	51	3	32	3	115	3
Other vessels	240	18	233	13	223	21	696	17
All incidents	1,044	100	1,530	100	802	100	3,376	100
Personal watercraft without death, injury or property damage	180	17	253	17	86	11	519	15
Other vessels without death, injury or property damage	784	75	1198	78	613	76	2,595	77
Personal watercraft property damage	0	0	0	0	0	0	0	0
Other vessels property damage	4	<1	4	<1	4	<1	12	<1
Personal injury incident (vessel type not specified)	69	7	70	5	93	12	232	7
Personal watercraft fatal	0	0	0	0	0	0	0	0
Other vessels fatal	7	1	5	<1	6	1	18	1
All accidents	272	100	284	100	255	100	811	100
Personal watercraft property damage	6	2	7	2	4	2	17	2
Other vessels property damage	118	43	129	45	100	39	347	43
Personal watercraft injury	26	10	35	12	28	11	89	11
Other vessels injury	121	44	112	40	122	48	355	44
Personal watercraft fatal	0	0	1	<1	0	0	1	<1
Other vessels fatal	1	<1	0		1	<1	2	<1

Source: NPS 2001c. U.S. Coast Guard Boating Statistics 2001.

Incidents were events on the water that were not related to a vessel in motion. Within this category, there were fatal incidents that resulted in death but were not caused by a vessel in motion (for example, a drowning of a person swimming from an anchored boat), property damage only incidents, and personal injury incidents.

Accidents were events on the water that were a result of a vessel in motion. Fatal accidents resulted in a death that involved a vessel in motion in some way. There also were property damage only accidents, and personal injury accidents.

The percentages in table 31 can be compared to personal watercraft use, which in 2001 represented 26% of all boat days and 18% of all operating hours on Lake Powell. Key features of the accident data were provided previously in table 26. The following focuses primarily on the case and incident data.

There were 4,187 reported boating cases in Glen Canyon National Recreation Area over the three-year period, for an average of 1,396 per year. This is an average of 7.75 boating cases each day over the six-month high-use period from May through October that accounts for 9% of all boat-use days on Lake Powell.

Personal watercraft averaged 15% of all cases, 15% of all incidents, and 14% of all accidents. All of these values are slightly under the proportion of watercraft operating hours attributed to personal watercraft (18% of all watercraft operating hours).

Among all enforcement cases, 81% were incidents and 19% were accidents. These values closely matched the personal watercraft data, where 82% of cases were incidents and 18% were accidents.

Personal watercraft did not account for any property damage or any fatal incidents over the three-year period.

Environmental Consequences

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Table 5 provides a summary of the environmental effects of each of the personal watercraft management alternatives on each impact topic. Detailed descriptions of the effects evaluation are provided in this section.

SUMMARY OF LAWS AND POLICIES

Three overarching environmental protection laws and policies guide the National Park Service - the *National Environmental Policy Act of 1969*, and its implementing regulations; the *National Parks Omnibus Management Act of 1998*; and the *National Park Service Organic Act*.

The *National Environmental Policy Act* is implemented through regulations of the Council on Environmental Quality (40 CFR 1500–1508). The National Park Service has in turn adopted procedures to comply with *National Environmental Policy Act* and the CEQ regulations, as found in *Director's Order 12* and *Handbook: Conservation Planning, Environmental Impact Analysis, and Decision Making* (2001b), and its accompanying handbook.

The *National Parks Omnibus Management Act of 1998* (Title 16 U.S.C. 5901 *et seq*.) underscores the *National Environmental Policy Act* in that both are fundamental to NPS management decisions. Both acts provide direction for articulating and connecting the ultimate resource management decision to the analysis of impacts, using appropriate technical and scientific information. Both also recognize that such data may not be readily available, and they provide options for resource impact analysis should this be the case.

The *Omnibus Act* directs the National Park Service to obtain scientific and technical information for analysis. The NPS handbook for *Director's Order 12* (NPS 2001b) states that if "such information cannot be obtained due to excessive cost or technical impossibility, the proposed alternative for decision will be modified to eliminate the action causing the unknown or uncertain impact or other alternatives will be selected" (section 4.4). Section 4.5 of the *Director's Order 12* handbook adds to this guidance by stating "when it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impacts, and such information is essential to making a well-reasoned decision, the National Park Service will follow the provisions of the regulations of Council on Environmental Quality (40 CFR 1502.22)." In summary, the National Park Service must state in an environmental assessment or impact statement:

> Whether such information is incomplete or unavailable;
>
> The relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;
>
> A summary of existing credible scientific adverse impacts which is relevant to evaluating the reasonably foreseeable significant adverse impacts; and
>
> An evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community.

The 1916 *National Park Service Organic Act* (Title 16 U.S.C. 1) commits the National Park Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS

GENERAL ANALYSIS METHOD

While much has been observed and documented about the overall effects of personal watercraft on the environment, as well as public safety concerns, the site-specific impacts, or impacts on any particular resource, under all conditions and scenarios are more difficult to measure and affirm with absolute confidence. Even with monitoring, data collected and interpreted since personal watercraft were introduced in parks, and their effects on recreation area resources relative to other uses and influences, are difficult to define and quantitatively measure.

Recognizing this dilemma, the interdisciplinary planning team created a process for impact assessment, based upon the directives of the *Director's Order 12* handbook (section 4.5(g)).

For each impact topic, applicable regulations were identified and the techniques used to perform the analysis were defined. Each impact topic analysis then involved the following steps.

Define issues of concern, based on public scoping.

Identify the geographic area that could be affected.

Define the resource within the area that could be affected. This information was included in the "Affected Environment" chapter.

Compare the resources to the area of potential effect.

Identify the effects caused by the alternative, in comparison to the baseline represented by the continuation of management practices outlined in the *Superintendent's Compendium* (NPS 2002c), to determine the relative change in resource conditions. Characterize the effects based on the following factors:

> Whether the effect would be beneficial or adverse.
>
> The area affected by the alternative's effects, such as local or regional.
>
> Duration of the effect, either short term or long term. Unless an impact-topic-specific definition of these terms is provided, the following were used.
>
> > A short-term impact would last only a few days or weeks.
> >
> > A long-term impact would last several years or more, or would recur periodically over several years.

Whether the effect would be a direct result of the action or would occur indirectly because of a change to another impact topic. An example of an indirect impact would be increased mortality of an aquatic species that would occur because an alternative would increase soil erosion, which would reduce water quality.

The intensity of the effect, either negligible, minor, moderate, or major. Impact-topic-specific thresholds for each of these classifications are provided in each impact topic methodology section. Threshold values were developed based on federal and state standards, consultation with regulators from applicable agencies, and discussions with subject matter experts.

Determine whether impairment would occur to resources and values that are considered necessary and appropriate to fulfill the purposes of Glen Canyon National Recreation Area.

Determine cumulative effects by evaluating the effect in conjunction with the past, current, or foreseeable future actions for Glen Canyon National Recreation Area and the region.

If appropriate, *identify mitigation measures* that may be employed to offset potential adverse impacts.

ASSUMPTIONS

Several assumptions were used in evaluating the effects of personal watercraft management on Glen Canyon National Recreation Area. These assumptions were applied to all of the impact topics unless otherwise noted.

Analysis Period

The analysis period is 10 years (2002 to 2012). This management action would not produce any new changes after that length of time. Changes after that period would be the result of market and regulatory factors beyond the influence of this management action.

Analysis Area

Unless otherwise specified, the impact analysis area includes the entire recreation area upstream of Glen Canyon Dam, with detailed attention being focused on the area within 500 horizontal feet of the maximum pool elevation of 3,700 feet above sea level. The area downstream of the Glen Canyon Dam was not included in the analysis area because it is already closed to personal watercraft use.

Level of Use and Distribution by Watercraft Type

For all alternatives, it was assumed that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. A boat day equals one watercraft on the lake during a 24-hour period and watercraft operating hours are the average number of hours a vessel is underway during a 24-hour period. The proportion of use by watercraft on the lake was not expected to change over the analysis period. Therefore, for these alternatives, 26% of boat days and 18% of the operating hours would be personal watercraft, 72% of boat days and 82% of the operating hours would be other motorized watercraft, and 2% of the total boat days would be non-motorized craft.

It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake

Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

Engine Emissions

An EPA 1996 regulation requiring cleaner marine (boat) engines (EPA 1996a) is currently reducing the water and air emissions from both newly purchased vessels and the aggregate fleet of watercraft. By the 2006 model year, the fleet of marine engines, including those for personal watercraft, produced by each manufacturer must be 75% cleaner than the average for the fleet produced by that manufacturer in 1996. The improved engines will produce lower levels of hydrocarbon emissions, visible smoke, fumes that can be detected by smell, and noise.

The analyses of water and air emissions used the predictions for emission reductions from the Environmental Protection Agency. Table 32 provides a chronology of the estimated hydrocarbon reductions.

Key dates in this chronology begin with 1999, when the Environmental Protection Agency began to require production line testing for 75% HC reduction in new outboard motors, and 2000, when testing for 75% HC reduction in personal watercraft was started. By 2006 all new personal watercraft and outboards manufactured in the United States must have a 75% reduction in HC emissions. In 2005 and 2012 overall reductions in HC emissions are estimated to be 25% and 50%, respectively, in personal watercraft and outboard motors. These estimates are based on interpolations of the emissions reduction percentages and associated years reported by the Environmental Protection Agency (1996a), but with a one-year delay in the implementation of production line testing (EPA 1997a).

The average operating life of a personal watercraft is 5 to 10 years, depending upon the source. The formula for determining the operating life of personal watercraft was published in the *Federal Register* on October 4, 1996 (EPA 1996a). Based on this formula, the National Park Service expects that by 2012, most boat owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes the typical operating life of a personal watercraft rental is three years and approximately five to seven years for a privately owned vessel (PWIA correspondence to NPS, May 28, 2002a: comment on *Lake Mead National Recreation Area Lake Management Plan and Draft Environmental Impact Statement*).

TABLE 32: ESTIMATED EPA REDUCTIONS IN WATERCRAFT EMISSIONS

Date	Action
1999	EPA requires production line testing for 75% HC reduction in new outboards and begins to see reductions as newer models are introduced (EPA 1997a).
2000	EPA requires production line testing for 75% HC reduction in new personal watercraft and begins to see reductions as newer models are introduced (EPA 1997a).
2005	Estimated 25% reduction in HC emissions overall as a result of newer models being gradually used (EPA 1996a; date modified in EPA 1997a).
2006	EPA fully implements 75% HC reduction in new outboards and personal watercraft (EPA 1996a).
2012	Estimated 50% reduction in HC emissions overall (EPA 1996a; date modified in EPA 1997a).

IMPAIRMENT ANALYSIS METHOD

Management Policies 2001 (NPS 2000d) require analysis of potential effect to determine whether or not actions would impair recreation area resources or values.

The fundamental purpose of the national park system, established by the *Organic Act* and reaffirmed by the *General Authorities Act*, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, actions that would adversely affect park resources and values.

These laws give the National Park Service the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement (enforceable by the federal courts) that the National Park Service must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise.

The impairment that is prohibited by the *Organic Act* and the *General Authorities Act* is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Impairment may result from NPS activities in managing Glen Canyon National Recreation Area, from visitor activities, or from activities undertaken by concessioners, contractors, and others operating in Glen Canyon National Recreation Area.

An impact on any park resource or value may constitute impairment. However, an impact would be most likely to constitute impairment if it affects a resource or value whose conservation is:

> Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of Glen Canyon National Recreation Area;
>
> Key to the natural or cultural integrity of Glen Canyon National Recreation Area or to opportunities for enjoyment of Glen Canyon National Recreation Area; or
>
> Identified as a goal in Glen Canyon National Recreation Area's general management plan or other relevant NPS planning documents.

A determination on impairment is included in the impact analysis section for all impact topics relating to Glen Canyon National Recreation Area resources and values. It is based on the impact-topic-specific definition of impairment that is provided in the methodology section for each impact topic that addresses recreation area resources or values.

CUMULATIVE EFFECTS ANALYSIS METHOD

The Council on Environmental Quality (1978) regulations for implementing the *National Environmental Policy Act* require assessment of cumulative effects in the decision-making process for federal actions. Cumulative effects are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative effects are considered for both the no-action alternative and the two action alternatives.

Cumulative effects were determined by combining the effects of the alternative with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other past, ongoing, or reasonably foreseeable future actions within Glen Canyon National Recreation Area and in the surrounding region. Future actions that have the potential to have a cumulative effect in conjunction with this personal watercraft management action include:

> The future expansion of the Wahweap Campground to increase overnight visitor capacity and hookup by 48 units. This expansion could contribute to incremental increases in visitor numbers renting and using personal watercraft.
>
> The concessioner housing master plan (residential accommodations), which would decrease accommodations by approximately 41 people. This could cause a small incremental decrease in personal watercraft use on Lake Powell.
>
> The Antelope Point Marina Resort and Development project, which would be located on Lake Powell about 3.5 miles southeast of the Wahweap Marina. It would include a floating marina village and boat docks, dry storage for boats, campground and recreational vehicle park, resort hotel and cultural center, optional employee housing, and supporting infrastructure.

One future NPS project within the recreation area would not affect personal watercraft launches or facilities. The Hite Marina upgrade would be located near the confluence of the Colorado and Dirty Devil Rivers in the northeast section of the recreation area. This project would upgrade existing facilities and provide additional parking, but would not expand present launch facilities.

WATER QUALITY

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Water quality issues related to personal watercraft that were identified during scoping included the following.

The emission of hydrocarbons into lake waters from both burned and unburned fuel.

The possible toxicity of hydrocarbon emissions to aquatic life.

Potential contamination of drinking water supplies by hydrocarbon from personal watercraft.

Management Objectives

Maintaining and improving water quality has long been recognized as an important management objective in all NPS units. *Management Policies 2001* (NPS 2000d) emphasizes the need to work cooperatively with other agencies and governing bodies to obtain the highest possible standards available under the *Clean Water Act* for the protection of park waters, and to maintain or restore the quality of waters within parks. The importance of water quality is also reflected in the goal in the Glen Canyon National Recreation Area general management plan to encourage the maintenance of high water quality in all bodies and sources of water.

As identified in table 3, three water quality objectives were identified for personal watercraft management. They include:

Manage personal watercraft emissions that enter the water in accordance with water quality protection policies and goals.

Protect aquatic organisms from personal watercraft effects, including those related to emissions and sediment.

Manage human wastes associated with personal watercraft use in accordance with water quality protection policies and goals.

GUIDING REGULATIONS AND POLICIES

The Environmental Protection Agency has developed national recommended ambient water quality criteria for approximately 120 priority pollutants for the protection of both aquatic life and human health (through ingestion of fish, shellfish, or water) (EPA 2001d). These criteria have been adopted as enforceable standards by most states.

There are no EPA water quality criteria for the protection of aquatic life for the five contaminants of concern from personal watercraft that were identified in the "Affected Environment" chapter. For human health, the Environmental Protection Agency has established the criteria for benzene and some

polycyclic aromatic hydrocarbon compounds that are shown in table 9 in the "Affected Environment" chapter.

State water quality standards for Arizona and Utah also were provided in table 9 in the "Affected Environment" chapter. The National Park Service must meet the most stringent water quality standards from either state throughout Lake Powell.

As described in the preceding section on management objectives, *Management Policies 2001* (NPS 2000d) contains general goals for water quality. In accordance with these goals, the National Park Service works cooperatively with the states of Utah and Arizona, plus watershed management agencies throughout the Colorado River watershed upstream from the recreation area to protect and enhance the quality of water in the tributary rivers.

Water quality antidegradation policies for Utah and Arizona were described in the "Affected Environment" chapter. As described in that section, both states have policies to maintain water bodies in a condition suitable to serve their intended purposes, and to maintain water quality at existing levels, even if it is already better than the minimum standard necessary to protect designated uses.

The designated uses for the waters of Glen Canyon National Recreation Area are described in the "Affected Environment" chapter. The reservoir is designated for multiple purposes, including recreation, fishery support, irrigation, and a drinking water source. The *Safe Drinking Water Act* (42 U.S.C. 300 (f)-(j)) requires that (park) waters used for municipal drinking water comply with all federal, state, and local primary drinking water regulations. Standards for either the protection of aquatic life or drinking water have been set by the Environmental Protection Agency for acidity and for many substances.

METHODOLOGY AND ASSUMPTIONS

Emissions of gasoline and exhaust associated with each of the personal watercraft management alternatives were compared to existing water quality conditions and to state water quality standards to determine their effects. Where standards were not available for the target compounds, ecotoxicological and human health toxicity benchmarks were acquired from the scientific literature.

Summary of Water Quality Evaluation Procedure for Personal Watercraft

The steps that were used to determine the effects of personal watercraft emissions on water quality included the following.

> Emissions of the pollutants of concern to the water during personal watercraft operational hour were estimated, based on literature values. The values that were used, and the sources of this information are included in appendix G.
>
> The total loading of the pollutants to the water was calculated, based on the estimated hours of personal watercraft use.
>
> Using the technique described in appendix G, the volume of water required to dilute the calculated emission loading to the level of the water quality standard or benchmark, referred to as the "threshold volume of water," was calculated.

The threshold volume of water was compared to the volume of water available in the most limited mixing zone (top 40 feet) that occurs in Lake Powell.

Mechanisms that would result in the loss of a pollutant from the water were qualitatively considered.

The effect of personal watercraft use in conjunction with the use of other motorized watercraft on the lake was calculated (cumulative effect).

The result of this analysis was a conclusion as to whether the standards or benchmarks would be exceeded, even on a short-term basis, by personal watercraft use alone, or by personal watercraft use in combination with other boating use of Lake Powell.

Estimation of Personal Watercraft Use and Other Boating Use

Glen Canyon National Recreation Area does not have boating use records that include distribution of two-stroke and four-stroke engines or engine size. However, during 2001 data were gathered on the number of boats using Lake Powell, expressed as boat days. Separate counts were made for personal watercraft and other vessels. (A boat day equals one watercraft on the lake during a 24-hour period.) These values were combined with data collected from Lake Mead, including vessel ratios and daily running times for each type of vessel, to estimate use by engine type on Lake Powell. Data from Lake Mead were obtained during an extensive boat use study in 1999 (Hagler Bailly 1999). The Lake Mead data are appropriate to apply to Lake Powell because the two lakes have very similar volumes, natural and socioeconomic environments, visitor uses, and types of activities.

Table 33 shows the distribution of engine types and daily running hours that were used in this analysis. It is assumed that this distribution will remain constant throughout the analysis period for alternatives A and B. Based on Lake Mead data, it was estimated that 75% of the motorized vessels on Lake Powell have four-stroke or direct-injection two-stroke engines. Because these engines have emission rates that are 75% to 90% lower than those of carbureted two-stroke engines, vessels with carbureted two-stroke engines were accounted for separately in the analysis of pollutant loadings.

The evaluation analyzed boat use in June and July. These two months were selected to correspond to the water quality data obtained at Lake Powell on June 29 through July 2, 2001. Data for these months, which represent a high-use period, indicate worst-case levels of hydrocarbon pollution.

For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

TABLE 33: ESTIMATED DISTRIBUTION OF USE BY ENGINE TYPE ON LAKE POWELL IN JUNE AND JULY 2001

Engine Type	Boat Days (total for two-month period)	Running Hours per Boat Day	Total Engine Hours (total for two-month period)	Total Hours on Lake (percent)
Outboard engine				
Carbureted two-stroke	21,192	2.90	61,457	5
Direct injection two-stroke	8,077	2.93	23,666	2
Electronic fuel injection two-stroke	8,077	2.93	23,666	2
Four-stroke	16,154	2.93	47,331	4
Inboard/stern drive				
Four-stroke	181,693	4.74	861,225	65
Two-stroke carbureted, jet drive	10,422	3.99	41,584	3
Diesel, auxiliary sail	5,916	3.61	21,357	2
Personal watercraft				
Carbureted two-stroke	84,431	2.44	206,012	15
Direct injection two-stroke	6,308	2.67	16,842	1
Four-stroke	6,308	2.67	16,842	1
Total	**348,578**	**—**	**1,319,982**	**100**

Calculation of Lake Loading by Carbureted Two-Stroke Personal Watercraft

The impacts on water quality were determined by estimating whether the use of personal watercraft over a particular time (such as a typical busy weekend day) would result in exceedences of water quality standards or toxicity benchmarks. The analysis used the concentrations of components in gasoline, the rate of discharge of a two-stroke engine, and the running time of two-stroke engines on Lake Powell to calculate potential pollutant loading to the lake. A brief description of the approach is provided below, with more detailed information in appendix G.

The objective of the lake-loading analysis was to determine if Lake Powell would receive concentrations of selected compounds from gasoline or its combustion products that would result in an unacceptable risk to human health or the environment. Daily pollutant loadings from two-stroke personal watercraft were determined, and the quantity of water needed to dilute the loading was calculated. This threshold volume was then compared to the amount of water available in the mixing zone of Lake Powell to determine if water quality standards or other benchmarks would be exceeded.

The analysis used data on the composition of gasoline (Gustafson et al. 1997) and estimates for fuel discharges from personal watercraft (CARB 1998a). These values were then applied to Lake Powell boat-use data and the volume of the lake's mixing zone.

This method has been reviewed and accepted by water quality experts at the Water Resources Division of the National Park Service. It has been used previously to assess effects of personal watercraft at Big Thicket National Preserve in Texas and Assateague Island National Seashore in Virginia and Maryland.

An advantage of this approach is that it provides a mechanism to determine pollution levels, even in the absence of baseline water quality data. A limitation is that the calculations yield a total daily load

that would be instantaneously delivered to the lake, and is assumed to disappear by the start of the next boating day. In reality, the pollutant load is added in conjunction with boating activities throughout the day, and a small residual concentration of some compounds may carry over from one day to the next.

The calculation identified the loading of each contaminant in Lake Powell on a daily basis if all of the material that was introduced to the water was retained for the entire day. However, as described in the "Affected Environment" chapter, these compounds evaporate from the water to the atmosphere, and also are subject to chemical breakdown by light, bacterial action, or other processes. Therefore, this analysis qualitatively considered mechanisms that result in loss of the pollutant from the water.

Factors that were evaluated because of their effect on these mechanisms included water temperature, mixing, and each compound's solubility, vapor pressure, and weight compared to water. When the half-life of a compound in water was available, it was included in determining lake loadings from personal watercraft. Example calculations are included in appendix G.

In 1994, the Environmental Protection Agency released a public memorandum entitled "The Effects of Marine Engine Exhaust on Water Quality: Summary of Findings of Various Research Studies." This document summarized 11 research papers and present volatilization rates and dilution ratios for observable effects such as taste, odor and generation of oil film.

At temperatures commonly found in Lake Powell during the summer boating season (77°F to 86°F), 78% to 84% of typical two-stroke gasoline/oil mixture (50:1) would be evaporated from the water in 1.2 hours (EPA 1994). This EPA review also cites a 1974 study by the Boating Industrial Association describing the two-stroke gas/oil mixture as having an 11 day half-life in a quiescent water (laboratory tank) and a half-life of less than one day in open aerated water (such as a lake).

As described in the "Affected Environment" chapter, some hydrocarbons have the potential to adsorb on suspended soil particles. As the particles settle out, the hydrocarbons are removed from the water column and accumulate in the sediment. However, most sedimentation in Lake Powell occurs within 25 miles of each river's mouth, and there is very little suspended sediment in the body of the lake. Therefore, pollutant adsorption to sediment was not considered as an attenuating mechanism in this analysis.

Estimation of Personal Watercraft Emissions Changes in Response to Regulatory Requirements

The "Discharge of Gasoline, Oil, and Other Chemicals by Personal Watercraft Engines" section in the "Affected Environment" chapter describes federal and state requirements that currently are reducing the amounts of emissions produced by personal watercraft and other watercraft engines. As a result of these regulations, low-emissions personal watercraft represented 12% of the personal watercraft use on Lake Powell in 2001, up from an estimated 4% previously.

This analysis used the following projections to estimate future emissions by personal watercraft at Glen Canyon National Recreation Area.

> In 2005, the emissions from the fleet of watercraft using Lake Powell would be reduced by 25% compared to emissions in 1996; and
>
> In 2012, the emissions from the fleet of watercraft using Lake Powell would be reduced by 50% compared to emissions in 1996.

These projections are slightly more conservative (would indicate greater lake loadings) than those included in the EPA rule (1996a) and presented in the "Affected Environment" chapter. They are intended to represent the worst conditions of engine emissions that occur from personal watercraft and other watercraft at Lake Powell.

Calculation of Lake Loading by Low-Emissions Personal Watercraft

A typical conventional (i.e., carbureted) two-stroke personal watercraft engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999c; CARB 1999a). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999c). According to data from the California Air Resources Board, two-stroke personal watercraft engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). (As described in appendix G, an estimated discharge rate of 3 gallons per hour is used in the water quality impact calculations.)

As discussed in the "Affected Environment" chapter, the California Air Resources Board is requiring personal watercraft and other vessels from model year 2008 and later that are sold in that state to be 90% cleaner than they were in 1998. Based on this requirement, this analysis assumed that new vessels after 2008 at Lake Powell that use two-stroke engines also will emit pollutants at a rate that is one-tenth of that produced by carbureted, two-stroke engines.

The calculation of lake loading by low-emissions personal watercraft included the following.

> The lake-loading values per unit time of use by carbureted, two-stroke personal watercraft were multiplied by 10% to determine lake-loading values per unit time of use by low-emissions personal watercraft.

The resulting value was multiplied by the estimated running time of low-emissions personal watercraft in that year, based on their proportion of the total number of personal watercraft using the lake. This produced an estimate of the volumes of pollutants discharged to the lake that year by low-emissions personal watercraft.

The volumes of pollutants discharged to the lake by low-emissions personal watercraft were added to the volumes of pollutants discharged to the lake by carbureted, two-stroke personal watercraft to get total lake loading levels by all personal watercraft.

Although overall hydrocarbon emissions will be reduced as a result of implementation of EPA 2006 marine engine standards, the emission of PAH compounds to the water varies by engine type. A recent study by the Tahoe Regional Planning Agency (2003) compared the concentrations of PAH compounds released into the water and found that the two-stroke carbureted outboard engine emitted lower PAH levels into the water than did the two-stroke direct-injected engine. The four-stroke carbureted outboard engine emitted the lowest PAH levels, as well as other gasoline-related contaminants into the water (TRPA 2003; CARB 2001). However, the two-stroke carbureted outboard engine emitted higher levels of benzene than the two-stroke direct-injected engine model (CARB 2001). Personal watercraft engines follow the same patterns of emission rates as outboard engines (CARB 2001). The TRPA (2003) study confirms other findings regarding emissions into the water and does not substantially change NPS conclusions regarding water quality impacts.

Comparison to State Standards or Toxicity Benchmarks

For compounds of concern in gasoline and its emissions that have Arizona or Utah water quality standards, the values in table 9 in the "Affected Environment" chapter were used in the analysis. These compounds included benzo(a)pyrene, naphthalene, and benzene. For 1-methyl naphthalene and methyl tertiary-butyl ether, which do not have state standards, ecotoxicological and/or human health toxicity benchmarks were acquired from the scientific literature and are provided in table 10.

The threshold volume of water is the volume of water required to dilute the calculated emission loading to the concentration required to meet the water quality standard or benchmark. For example, the results might show that for a target compound, 50 acre-feet of water would be needed to dilute the expected emissions to the most stringent state standard. (One acre-foot equals 1 acre of water 1 foot deep.) If the receiving body of water is a 100-acre reservoir with an average depth of 20 feet (total volume of 2,000 acre-feet) and is well-mixed, there would be little chance that the water quality standard would be exceeded. The potential for exceeding the standard would be further reduced when mechanisms that reduce the amount of the compound in the water are considered.

Analysis of Cumulative Effects – Calculation of Lake Loading by All Watercraft

The analysis of cumulative effects used the same procedures described above for personal watercraft. However, contaminant loadings to the lake were calculated based on total boat hours from all watercraft, not just personal watercraft. Each boat/engine type has specified hours of use per day, as shown in table 33. The different running times were incorporated into the model described in appendix G to determine their pollutant loadings. This analysis did not consider the differing horsepower ratings or fuel consumption rates of the various vessels.

For alternative A, it was assumed that in the year 2012, most of the personal watercraft and about 60% of the other vessels would have low-emission engines. The average operating life of a personal watercraft is 5 to 10 years, depending upon the source (see "Affected Environment" chapter). As a result, as noted previously, the 2012 emissions from the fleet of watercraft using Lake Powell would be reduced by 50% compared to emissions in 1996.

Under alternative B, all personal watercraft allowed on Lake Powell would be compliant with the EPA requirements beginning in 2012. Benefits of implementation of the EPA requirements would be realized in 2013 and beyond. Therefore, carbureted two-stroke personal watercraft would be restricted from using the lake at that time. The analysis assumed the same vessel and daily hour use distribution as presented for alternative A, with clean technology personal watercraft replacing the carbureted two-stroke engines. In addition, the potential for increased or decreased use of the lake for recreational boating is captured as a range, through the project period, ending in 2012. An annual increase and decrease of 2% was used to estimate the possible future use rates of the lake.

It was assumed for alternative A and alternative B that the percentages of total hours shown in table 33 for vessels with outboard engines, vessels with inboard/stern drive engines, and personal watercraft would continue throughout the 10-year analysis period.

The alternative C analysis assumed these same percentages for vessels with outboard engines and vessels with inboard/stern drive engines. In addition, the alternative C analysis assumed that personal watercraft use does not resume on Lake Powell. Changes in overall recreational boat use are based on an assumed change in visitor use of + or – 2% annually over the next 10 years.

Impact Threshold Definitions

The following impact thresholds were established to describe the relative changes in water quality under the three personal watercraft management alternatives.

Negligible — Chemical or physical changes to water quality would not be detectable, would be well below water quality standards or criteria, and would be within historical or desired water quality conditions.

Minor — Chemical or physical changes to water quality would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions.

Moderate — Chemical or physical changes to water quality would be detectable but would be at or below water quality standards or criteria. Water quality would be altered on a short-term basis compared to historical baseline or desired water quality conditions.

Major — Chemical or physical changes to water quality would be detectable and would be frequently altered from the historical baseline or desired water quality conditions; and/or chemical, physical, or biological water quality standards or criteria would be locally slightly and singularly exceeded on a short-term and temporary basis.

Impairment — Chemical or physical changes to water quality would be detectable and would be substantially and frequently altered from the historical baseline or desired water quality conditions and/or water quality standards. The impacts would involve deterioration of the recreation area's water quality and aquatic resources over the long term, to the point that the recreation area's purpose could not be fulfilled, or resources could not be experienced and enjoyed by future generations.

Geographic Area Evaluated for Impacts

The geographic area evaluated for water quality impacts included all waters of Glen Canyon National Recreation Area upstream from Glen Canyon Dam that provide sufficient depth and flow to support personal watercraft use, even on an occasional basis. This includes Lake Powell and the San Juan, Dirty Devil, Escalante, and Colorado Rivers.

The municipal water intake serving Page, Arizona, located at Glen Canyon Dam, is not under the jurisdiction of the National Park Service. Potential effects to source drinking water quality are discussed in this assessment, but the National Park Service would not have the authority to test water quality at this intake.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Under alternative A, current management conditions would remain in place. The use of personal watercraft and other vessels on Lake Powell would not change during the next 10 years. However, because manufacturers of personal watercraft and other vessels must meet EPA emissions standards, emissions from the fleet of personal watercraft using Lake Powell will decline by at least 25% by the

year 2005 and 50% by 2012. Table 34 shows estimated daily hydrocarbon pollutant loadings to Lake Powell by carbureted, two-stroke engines in 2001 and loadings that will occur in 2005 and 2012 with continued implementation of the EPA goals.

The year 2001 values are used in this analysis because they represent the worst-case condition that would occur during the analysis period. Loadings in all subsequent years will be lower, and as shown in the table, the emissions from the collective fleet of watercraft using Lake Powell would be reduced by 50% in 2012.

The calculations in table 34 used data from boat counts on Lake Powell in 2001. These showed that 88% of personal watercraft during the count period used carbureted, two-stroke engines and 12% used low-emissions four-stroke or direct-injection two-stroke engines.

Table 35 shows that the overall two-stroke loadings to Lake Powell decrease with implementation of the EPA emission reduction program. Because the distribution of vessel types is assumed to remain constant, personal watercraft would contribute twice the pollutant load of other two-stroke vessels, as is the case for the 2001 analysis.

TABLE 34: ESTIMATED DAILY LOADINGS TO LAKE POWELL BY CARBURETED, TWO-STROKE ENGINES DURING A HIGH-USE PERIOD IN 2001, UNDER ALTERNATIVE A

Parameter	2001 Loadings to Lake Powell[a]			2005 Loading (25% reduction)	2012 Loading (50% reduction)
	From Personal Watercraft	Other two-stroke Watercraft	Total		
Benzo(a)pyrene (kilograms)[b]	0.081	0.040	0.12	0.091	0.061
Naphthalene (metric tons)	0.14	0.07	0.21	0.16	0.11
1-methyl naphthalene (metric tons)	0.22	0.11	0.33	0.25	0.17
Benzene (metric tons)	0.71	0.35	1.06	0.80	0.53
Methyl tertiary-butyl ether (metric tons)	4.22	2.11	6.33	4.75	3.16

a. All loadings are based on 40-hour watercraft use units.

b. 1 kilogram = 2.205 pounds; 1 metric ton = 1,000 kilograms or 2,205 pounds.

TABLE 35: ESTIMATED DAILY LOADINGS TO LAKE POWELL BY CARBURETED, TWO-STROKE ENGINES DURING A HIGH-USE PERIOD IN 2005 AND 2012, UNDER ALTERNATIVE A

Parameter	2005 Loadings to Lake Powell[a] (includes 25% EPA emission reduction)		2012 Loadings to Lake Powell (includes 50% EPA emission reduction)	
	From Personal Watercraft	Other Two-Stroke Watercraft	From Personal Watercraft	Other Two-Stroke Watercraft
Benzo(a)pyrene (kilograms)[b]	0.06–0.07	0.028–0.032	0.031–0.05	0.015–0.025
Naphthalene (metric tons)	0.1–0.14	0.053–0.057	0.053–0.087	0.026–0.044
1-methyl naphthalene (metric tons)	0.15–0.18	0.08–0.09	0.083–0.14	0.042–0.068
Benzene (metric tons)	0.49–0.58	0.24–0.28	0.27–0.44	0.13–0.22
Methyl tertiary-butyl ether (metric tons)	2.9–3.43	1.5–1.7	1.57–2.62	0.8–1.31

a. All loadings are based on 40-hour watercraft use units.

b. 1 kilogram = 2.205 pounds; 1 metric ton = 1,000 kilograms or 2,205 pounds

As described above in the "Methodology and Assumptions" section the calculation assumed that a low-emission engine had one-tenth of the emissions produced by a carbureted two-stroke engine. As a result, low-emissions personal watercraft were calculated to contribute less than 2% of the lake loading by personal watercraft in 2001, even though they represent 12% of this class of vessels.

The state standards and toxicity benchmarks from tables 9 and 10, were used with the evaluation technique described in appendix G to calculate the volumes of water required to meet toxicological thresholds. As shown in table 36:

> The compound that would require the greatest volume of water to meet the ecotoxicological criteria was 1-methyl naphthalene. About 5,500 acre-feet of water would be needed to dilute the pollutant loading from the personal watercraft that used Lake Powell during the 2001 heavy-use period.
>
> Benzene was the compound that would require the greatest volume of water to meet the state standards or human health criteria. Approximately 500,000 acre-feet of water would be needed to dilute the pollutant loading from the personal watercraft that used Lake Powell during the 2001 heavy-use period (table 36).

As described at the beginning of the "Affected Environment" chapter, the surface of Lake Powell varies in size from 52,000 acres to 163,000 acres and usually is about 160,000 acres. At minimum pool, the mixing zone of Lake Powell would have to be about 10 feet deep to provide the threshold quantity of water needed to prevent human health effects. At the usual pool, a mixing zone of 3.2 feet would satisfy this criterion. For ecotoxicological effects, a mixing zone less than 2 inches deep when the lake is at minimum pool would provide the threshold quantity of water.

As noted in the description of the Lake Powell hydrology in the "Affected Environment" chapter, the thermocline occurs at a depth varying from 40 to 150 feet below the lake surface. The thermocline represents the bottom of the mixing zone. Above this layer, the entire column of lake water has a similar temperature and can mix freely in response to inflow of river water, wind action at the surface, and boat traffic.

TABLE 36: ACRE-FEET OF WATER NEEDED TO MEET STATE STANDARDS OR TOXICOLOGICAL CRITERIA

	Threshold quantity of water below which ecotoxicological effects might occur (in acre-feet)		Threshold quantity of water below which human health effects might occur (in acre-feet)	
Parameter	Personal Watercraft Only	Other Two-Stroke Engines	Personal Watercraft Only	Other Two-Stroke Engines
Benzo(a)pyrene (fuel and exhaust)	4,651	2,322	14,883	7,432
Naphthalene	1,860	929	No standard	No standard
1-methyl naphthalene	5,243	2,617	No standard	No standard
Benzene	8,117	4,054	479,470	239,417
Methyl tertiary-butyl ether (chronic)	186	93	No standard	No standard
Methyl tertiary-butyl ether (acute)	64	32	262,144	130,898

It is recognized that this evaluation technique provides a very simplified model of a complex lake system. However, it demonstrates that under the most extreme adverse conditions, the size of the mixing zone is four times bigger than the threshold quantity of water below which toxicological effects might occur. These extreme adverse conditions include:

The lowest possible pool size for Lake Powell of just 52,000 acres;

The most shallow thermocline depth (40 feet) the lake experiences;

A mix of personal watercraft that includes a greater proportion (88%) of high-polluting carbureted two-stroke engines than will occur again on Lake Powell;

Use levels that are found during the heaviest-use period on a 160,000-acre lake;

The compound (benzene) that would require the greatest volume of water to meet the most stringent criterion (human health); and

A loading scenario where the entire daily pollutant load is introduced simultaneously, without any action by attenuating factors such as evaporation or photodegradation.

Based on the impact threshold definitions, personal watercraft use under alternative A would cause negligible to minor, direct, adverse effect on the water quality of Lake Powell. Effects would be long term because they would recur during each summer heavy-use season. Under the worst-case conditions described above, the chemical changes to water quality sometimes would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions. Most of the time, as demonstrated by the summer 2001 sampling, the chemical changes to water quality would not be detectable with current analytical techniques.

Cumulative Effects. Based on the data in table 33, personal watercraft in 2001 represented only 17% of the boating hours on Lake Powell during the two-month count period (18% of total annual operating hours). Therefore, pollutant loading from all watercraft must be considered to determine the cumulative effects of alternative A.

As shown in table 33, 15% of the boating hours on Lake Powell during the count period were personal watercraft with carbureted, two-stroke engines and 8% were other watercraft with carbureted, two-stroke engines. The remaining 77% of boating hours on the lake involved four-stroke engines or direct-injection two-stroke engines, both of which emit pollutants at about one tenth the rate of carbureted, two-stroke engines.

The cumulative effects analysis used the same method that was used to evaluate personal watercraft effects. It determined pollutant loadings for all of the vessels operating on Lake Powell during a heavy-use day. The results are shown in table 37.

TABLE 37: POLLUTION CONTRIBUTION RELATIVE TO ENGINE TYPE UNDER ALTERNATIVE A

Engine Type	2001 Contribution (percent total)	2005 Contribution (25% emission reduction)	2012 Contribution (50% emission reduction)
Carbureted two-stroke	77	58	39
Personal watercraft	50	38	25
Other	27	20	14
All others	23	23	23
Total (relative to year 2001)	**100**	**81**	**62**

The analysis showed that in the year 2001, 50% of the pollutant loading to the lake was from personal watercraft. Another 27% was from carbureted, two-stroke engines on other types of watercraft. Other engines, including four-stroke and direct-injection engines, collectively contributed less than a quarter of the lake's pollutant load, even though these engines outnumbered carbureted, two-stroke engines by a ratio of more than three to one.

In the year 2005, two-stroke engines on personal watercraft would account for only 58% of the lake loading by hydrocarbon pollutants. The other 42% would be from four-stroke and direct-injection engines. However, the total daily hydrocarbon loading to the lake would be reduced to 81% of the year 2001 loadings, and 75% of the lake loadings in 1996, prior to the EPA rule that requires cleaner engines. As shown in table 37, the reductions would continue in the year 2012. The total pollution contribution by engine type does not amount to 100% because the emissions from two-stroke engines are reduced based on EPA mandated standards, and the contribution of pollutants from other engine types was assumed to remain constant.

The worst-case condition, represented by the year 2001 pollutant loadings for all vessels using Lake Powell, was generated using the extreme adverse lake loading conditions that were listed previously in the personal watercraft analysis. Under these conditions, the size of the mixing zone would be twice as large as the threshold quantity of water needed to prevent toxicological effects.

Although a small portion of the gas/oil mixture may accumulate in the water column, water quality testing at Lake Powell did not reveal detectable levels of most PAH components. The low level of occurrence (less than 10 parts per trillion) results from all hydrocarbon inputs, including all boat usage and runoff from nearby parking lots. Because levels of most PAH contaminants were below detection levels at most locations, the effect of accumulation of these pollutants on water quality was assumed to be negligible.

Based on the impact threshold definitions, the cumulative effect from the use of all vessels under alternative A would cause negligible to minor, direct, adverse effect on the water quality of Lake Powell. Under the worst-case conditions described above, the chemical changes to water quality would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions. However, most of the time, as demonstrated by the summer 2001 sampling, the chemical changes to water quality would not be detectable with current analytical techniques.

Benzene concentrations in two samples collected during a 2001 high boat-use period at Lake Powell exceeded the Utah standard for a drinking water intake of 1.2 µg/L (see table 9). Benzene concentrations of 1.4 and 3.43 µg/L were measured at Moqui Canyon and the Bullfrog Marina, respectively. However, none of the samples exceeded the EPA benzene standard of 5 µg/L for treated drinking water. Testing performed in Knowles Canyon, an area closed to all motorcraft use, did not indicate the presence of any hydrocarbons at the limits of detection.

The Moqui Canyon and the Bullfrog Marina areas are heavily used by all classes of vessels that use Lake Powell, including personal watercraft. In addition, the Bullfrog Marina contains a fueling station. Under alternative A, concentrations of hydrocarbon pollutants probably would continue to approach or slightly exceed water quality standards or benchmarks for at least some of the constituents of concern in these and other high-use areas on high-use days. Such elevated concentrations would be short-lived.

It is highly unlikely that detectable benzene levels would occur near the drinking water intake serving Hite since the intake is located upstream from high motorcraft use or fueling stations. The Utah

Department of Environmental Quality, Water Quality Division, was contacted regarding the benzene findings relative to the status of Lake Powell as a drinking water source. The state does not anticipate that the elevated benzene concentrations found in Moqui Canyon and Bullfrog Marina areas would result in degradation of the lake's water quality that would result in impairment of the lake as a drinking water source (Utah Department of Environmental Quality, Water Quality Division, Moellmer, pers. com. 2002b).

The water quality sampling performed at Lake Powell in the summer of 2001 did not indicate that Arizona state water quality criteria were exceeded. As shown in table 9 of the "Affected Environment" chapter, Arizona criteria are less stringent that those of Utah for all analyzed gasoline components, except naphthalene and benzene (warm water fishery designation). The 3.43 µg/L benzene concentration found at Bullfrog Marina is below the Arizona drinking water source criteria of 5 µg/L. Under alternative A, no degradation or impairment of Lake Powell for its Arizona designated uses would be anticipated.

The National Park Service established the project area for this analysis to coincide with the areas of personal watercraft use at Glen Canyon National Recreation Area. Analysis of downstream impacts is outside the scope and mandate of this assessment. However, because uses of Lake Powell do affect the quality of water downstream, activities that impair or degrade the lake's water quality could affect downstream water uses.

The water quality analysis reveals that negligible to minor adverse effects occur due to personal watercraft use on Glen Canyon National Recreation Area. Measured water quality showed that no established water quality criteria were exceeded, with the exception of benzene. As discussed in the water quality analysis, only half of the PAH and other gasoline components found in lake waters would be emitted from personal watercraft use, which is the sole subject of this assessment. Given the volatile nature and brief half-life of benzene (5 hours) and the method of water release through Glen Canyon Dam (from the bottom), it is unlikely that fuel components found in lake waters contributed by personal watercraft use on the lake would have detectable effects below the dam.

Conclusion. Under alternative A, personal watercraft have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Effects would be long term because they would recur during each summer heavy-use season. Cumulatively, the lake loadings from all vessels also would have negligible to minor, direct, adverse effects on the water quality of Lake Powell. Alternative A would not result in the impairment of the water quality of Lake Powell or any other waters.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

The management actions included under alternative B would include elimination of carbureted two-stroke personal watercraft at the end of 2012. Until the implementation of the restriction in 2012, the type and distribution of watercraft on the lake is assumed to change in accord with the EPA forecast. This would result in a 25% emission reduction for 2005 and a 50% reduction for 2012. For this analysis, the range of anticipated boating use of the lake is expressed as a 2% increase and decrease annually over the project period (see the "Visitor Use and Experience" section).

To meet NPS mandates and to ensure that the waters of Lake Powell continue to serve the multiple purposes designated by Utah and Arizona, a lake-wide water quality monitoring program would be

implemented under alternative B. The program, to be developed by the Lake Powell Technical Advisory Committee, would incorporate existing data and new information to help guide the National Park Service in making management decisions that may affect water quality at Glen Canyon National Recreation Area.

Prior to implementation of clean technology restrictions on personal watercraft, the effects of alternative B would be the same as those described in alternative A. Overall two-stroke loadings to the lake would decrease with implementation of the Environmental Protection Agency emission reduction program (see Table 35). About 5,500 acre-feet of water would be needed to dilute 1-methyl naphthalene pollutant loading from personal watercraft. Benzene would require the greatest volume of water (500,000 acre-feet) to meet the state standards or human health criteria (see Table 36). Under the worst case conditions described earlier, the chemical changes to water quality would be detectable sometimes, but would be well below the water quality standards or criteria and within historical or desired water quality conditions. Personal watercraft use prior to 2012 would cause negligible to minor, direct, adverse effects on the water quality of Lake Powell. After implementation of personal watercraft compliance standards, there would likely be reduced concentrations of gasoline components in the water of Lake Powell. However, these pollutants would still occur in measurable quantities. Therefore, the effects of alternative B would be adverse, long-term, and negligible to minor.

Gross pollutant loadings from personal watercraft under alternative B after implementation of the 2012 restriction on carbureted two-stroke personal watercraft engines are expressed in table 38. The current (2001) loadings, as well as the loadings expected in 2005 and 2012 with the 25% and 50% emission reductions anticipated by the Environmental Protection Agency, and without implementation of non-compliant personal watercraft restriction, can be seen in tables 34 and 35, above. The calculations include the range of anticipated future use.

By comparing the findings in table 38 with those in tables 34 and 35, a decline in two-stroke pollutant loadings can be seen after 2012 restrictions are in place. Implementation of the ban on carbureted two-stroke personal watercraft would decrease the pollution contribution of personal watercraft to less than that of other two-stroke engines remaining on the lake. This could yield a beneficial effect to water quality. However, given the low concentrations of gasoline components measured at Lake Powell in 2001, any decrease in pollutant concentrations may be difficult to quantify.

The remainder of this discussion focuses on the effects of alternative B on the San Juan, Colorado, Dirty Devil, and Escalante Rivers. Compared to current management, alternative B would prohibit personal watercraft use in 123 miles of these rivers (see table 4).

TABLE 38: ESTIMATED DAILY LOADINGS TO LAKE POWELL WITH EPA 2006 COMPLIANT TECHNOLOGY RESTRICTIONS DURING A HIGH USE PERIOD

Clean Technology Personal Watercraft Loadings to Lake Powell in 2012[a]	
Parameter	**Compliant Personal Watercraft**
Benzo(a)pyrene (kilograms)[b]	0.006–0.011
Naphthalene (metric tons)	0.011–0.017
1-methyl naphthalene (metric tons)	0.017–0.027
Benzene (metric tons)	0.054–0.088
Methyl tertiary-butyl ether (metric tons)	0.32–0.53

a. All loadings are based on 40-hour watercraft use units.

b. 1 kilogram = 2.205 pounds; 1 metric ton = 1,000 kilograms or 2,205 pounds

All four rivers have low rates of personal watercraft use. The Colorado and San Juan Rivers are visited by fewer than one vessel of any type per day, including personal watercraft. Each day during high-use season, the Escalante and Dirty Devil Rivers receive between 2 and 10 visits from personal watercraft, and from 2 to 10 visits from other vessels.

Alternative B would eliminate personal watercraft use in the inflow of the Dirty Devil River for a distance of 19 miles and from the Escalante River inflow for a distance of 41 miles. Both of these rivers have relative low flow volumes during summer months (see the "Affected Environment" chapter). Elimination of personal watercraft use in these tributary arms would potentially provide long-term benefits to water quality. The beneficial effects could be important locally, but because of the large size of Lake Powell, the effect would be negligible downstream as the tributary flow entered the lake.

Similar analyses were performed for the Colorado River (average July flow of 9,114 cubic feet per second) and San Juan River (average July flow of 2,541 cubic feet per second). On both of these rivers, the daily flows would be sufficient to dilute the loadings caused by the extremely low levels of personal watercraft use (less than one vessel per day), even without considering the attenuating factors listed above. Therefore, the water quality effects from removing personal watercraft use in the Colorado and San Juan Rivers would be beneficial but negligible.

Cumulative Effects. Through 2005, the cumulative effects of alternative B would be similar to those described for alternative A. However, once clean technology restrictions are implemented, the pollutant contribution of personal watercraft would decrease. Using the assumption that clean technology would produce 90% less loading to water, lake-wide pollutant loading from personal watercraft would fall from the current rate of 50% to 5%. Therefore, the total pollutant load from all vessels relative to current loadings would fall to 42%. This represents a decrease from total loads under alternative A of 47%.

This alternative would contribute to water quality benefits resulting from the Lake Powell Pure Program and Wahweap wastewater treatment plant improvements. The contribution of this alternative to these efforts would be long-term and beneficial, and of negligible intensity.

Conclusion. Localized, long-term benefits to water quality would occur in the four tributaries where personal watercraft use would be restricted. However, because these areas have low rates of use, the intensity would likely be negligible.

Prior to the end of 2012, effects to water quality would be the same as those described for alternative A. This is anticipated because boat usage and engine type distribution are assumed to be the same as in alternative A. After implementation of clean technology personal watercraft restrictions, pollutant loadings from personal watercraft would decrease. However, changes in water quality may be difficult to quantify. The continued contribution of personal watercraft to pollutant loading in Lake Powell would result in long-term, adverse effects to water quality of negligible to minor intensity.

Cumulative effects from all watercraft would be similar to alternative A until 2005. A decrease in pollutant loading with implementation of personal watercraft engine type restrictions at the end of 2012 and other water quality improvement projects would result in long-term negligible benefits.

Alternative B would not result in the impairment of the water quality of Lake Powell or any other waters.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Alternative C would permanently prohibit personal watercraft use at Glen Canyon National Recreation Area. This would eliminate all personal watercraft hydrocarbon pollution in the lake. As shown in table 39, personal watercraft contribute approximately 50% of the total emissions to Lake Powell during the initial period of the ban. Therefore, implementation of the no-action alternative would reduce by half the daily hydrocarbon loadings of Lake Powell, over the short-term. This beneficial effect would be negligible to minor in intensity, because personal watercraft currently have only negligible to minor adverse effects on the water quality of the lake.

As the use of motorized craft returns to the levels predicted for 2012 and beyond, the majority of pollutant loading would be generated by 2006 compliant engines. A small component of carbureted two-stroke engines would also likely be present. This mix of technology is anticipated to result in reduced pollutant loadings compared to alternative A, and increased loadings compared to alternative B.

Alternative C would not reduce benzene concentrations from those measured at Bullfrog Marina (3.43 µg/L) to levels below the Utah drinking water intake standard (1.2 µg/L). As with alternative A, concentrations of hydrocarbon pollutants probably would continue to approach or slightly exceed water quality standards for at least some of the constituents of concern in high-use areas on high-use days.

Within the San Juan, Colorado, Dirty Devil, and Escalante Rivers, alternative C would produce direct, long-term, beneficial effects on water quality. Because these areas have little personal watercraft use, the lake-wide prohibition of personal watercraft would likely make changes in water quality in these reaches difficult. This low level of change in contaminant concentration would result in negligible, long-term benefits.

The effect on lake loadings of eliminating personal watercraft use would be short term, because former personal watercraft users would return over the next several years using other watercraft. Water quality effects from the return of these visitors with other watercraft are included in the discussion of cumulative effects for alternative C, below.

Cumulative Effects. For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B.

TABLE 39: POLLUTION CONTRIBUTION RELATIVE TO ENGINE TYPE UNDER ALTERNATIVE C

Engine Type	2001 Contribution (percent total)	Personal Watercraft Ban	2005 Contribution (25% emission reduction)	2012 Contribution (50% emission reduction)
Personal watercraft	50	0	0	0
Other two-stroke	27	27	25	17
All four-stroke	23	23	30	30
Total (relative to current 100%)	**100**	**50**	**55**	**47**

This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

Current and projected daily pollutant loading to Lake Powell from carbureted, two-stroke engines under alternative C are represented in two tables from alternative A. The pollution contributions made by the remaining two-stroke engines using Lake Powell correspond to the "Other Two-Stroke Watercraft" column in the tables. Pollutant loading occurring in 2001, with a full range of engine use on the lake, is shown in table 34. Loadings for 2005 and 2012 can be found in table 35.

For all three years, hydrocarbon loadings from this class of engine would be only about a third of those that would occur under alternative A. This would occur because alternative C would remove a large number of high-emission vessels from the lake compared to the numbers that would occur in the three analyzed years under alternative A. Although pollutant loadings from carbureted, two-stroke outboard engines would be reduced over time, they would continue to be a source of pollutant loadings in Lake Powell.

Table 39 shows the estimated short- and long-term reduction in pollutant loading under this alternative. This alternative would produce short-term reduction in pollutant loadings of 50%, and long-term reductions of 47%.

A direct, beneficial, long-term effect on water quality would occur under alternative C from the combined action of immediately removing all high-emissions personal watercraft engines from the lake in combination with the gradual replacement of high-emission engines on other types of motorcraft. This change in water quality sometimes would be measurable. However, as demonstrated by the year 2001 water quality sampling program, many of the compounds of concern currently occur at concentrations below the detection levels of analytical equipment. Water quality would continue to be within the range of historical norms, and would continue to be well below water quality standards or criteria. As a result, the cumulative beneficial effect of alternative C would be only negligible or minor.

Conclusion. Alternative C would eliminate personal watercraft pollutant loadings in Lake Powell compared to alternatives A and B, both in the short-term and long-term. This would produce a negligible to minor, direct, beneficial, long-term effect on the water quality of the lake. The four tributary inlets would also experience localized, long-term benefits, but due to their low personal watercraft use rates, these would be negligible. Alternative C would not result in the impairment of the water quality of Lake Powell.

AIR QUALITY

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Personal watercraft emit various compounds that pollute the air. For example, most personal watercraft are powered by two-stroke carbureted engines. In these engines:

> The lubricating oil is used once and is expelled as part of the exhaust; and
>
> The combustion process results in emissions of air pollutants such as volatile organic compounds, nitrogen oxides, particulate matter, and carbon monoxide (EPA 1996a). Volatile organic compounds are a broad class of pollutants encompassing hundreds of specific toxic compounds, including polycyclic aromatic hydrocarbons such as benzo(a)pyrene, naphthalene, and 1-methyl naphthalene.

Even though personal watercraft engine exhaust is usually expelled below the waterline, a portion of the exhaust gases end up in the air. Many organic pollutants that are initially dissolved in the water volatilize to the atmosphere, especially if they have high vapor pressures, are lighter than water, and mixing occurs at the air/water interface. However, it is difficult to assess the specific evaporation rates of exhaust pollutants from personal watercraft because the rates will differ according to the ratio of gas to oil used, by fuel brand, by engine, and operating conditions such as temperature. Fuel components volatilize (evaporate) more quickly at warmer temperatures. At temperatures commonly found in Lake Powell during the summer boating season (77°F to 86°F), 78% to 84% of typical two-stroke gasoline/oil mixture (50:1) would be evaporated from the water to the air in 1.2 hours (EPA 1994).

Personal watercraft also emit fuel components such as benzene and fuel additives that are known to cause adverse health effects. Air pollutants from personal watercraft exhaust may adversely impact recreation area visitor and employee health, as well as sensitive recreation area resources. Visibility effects may also occur from discharge of exhaust smoke into the air and photochemical transformations of the engine emissions that contribute to the formation of smog.

For example:

> Hydrocarbons and nitrogen oxide emissions, in the presence of sunlight, form ozone which can cause or contribute to respiratory illness (EPA 1996a).
>
> Ozone also is toxic to vegetation. It causes visible injury to foliage, decreases plant growth, and increases plant susceptibility to insects and diseases.
>
> Carbon monoxide can affect humans. It interferes with the oxygen-carrying capacity of blood, resulting in lack of oxygen to tissues.
>
> Nitrogen oxide and particulate matter emissions associated with personal watercraft use also can degrade visibility.

Management Objectives

As identified in table 3, the recreation area objective is to manage personal watercraft activity so that exhaust emissions do not appreciably degrade ambient air quality.

GUIDING REGULATIONS AND POLICIES

Clean Air Act. The *Clean Air Act* establishes national ambient air quality standards to protect the public health and welfare from air pollution. The act also establishes a program for the prevention of significant deterioration of air quality.

The prevention of significant deterioration program was designed to protect clean air resources. The program was developed out of a May 30, 1972 decision by the U.S. District Court for the District of Columbia, in a lawsuit brought by the Sierra Club, interpreting the *Clean Air Act* as requiring the prevention of significant deterioration of air quality in all clean air areas of the country. The Supreme Court affirmed that decision on June 11, 1973. Prevention of significant deterioration thresholds are established in the *Clean Air Act* (40 CFR, section 51.166).

One purpose of this program is to preserve, protect, and enhance air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value (42 U.S.C. 7401 *et seq*.). The program also includes the following classification approach for controlling air pollution.

> Class I areas, which typically are national parks and wilderness areas, are afforded the greatest degree of air quality protection. Very little deterioration of air quality is allowed in these areas, and the unit manager has an affirmative responsibility to protect visibility and all other class I area air-quality-related values from the adverse effects of air pollution.
>
> Class II areas include all national park system areas not designated as class I. The *Clean Air Act* allows only moderate air quality deterioration in these areas. In no case, however, may pollution concentrations violate any of the national ambient air quality standards. Glen Canyon National Recreation Area is designated a class II area.

Conformity Requirements. National park system areas that do not meet the national ambient air quality standards or whose resources are already being adversely affected by current ambient levels require a greater degree of consideration and scrutiny by NPS managers. Areas that do not meet national air quality standards for any pollutant are designated as nonattainment areas. Section 176 of the *Clean Air Act* states:

> No department, agency, or instrumentality of the federal government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to [a State] implementation plan. . . [T]he assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency or instrumentality.

Essentially, federal agencies must ensure that any action taken does not interfere with a state's plan to attain and maintain the national ambient air quality standards in designated nonattainment and maintenance areas. Because the Arizona and Utah counties that Glen Canyon National Recreation Area occupies are designated as in attainment for all six of the criteria pollutants (shown in table 11)

(EPA 2002a), there are no state implementation plans that apply to the project area. Therefore, personal watercraft management actions would not be subject to particular federal conformity determination or requirement.

Emission Standards for Gasoline-Powered Marine Engines. The Environmental Protection Agency issued a spark-ignition gasoline marine engine final rule in August 1996. The rule, which took effect in 1998, affects manufacturers of new outboard engines and the type of inboard engines used in personal watercraft. In the rule, the agency required reductions in air emissions from marine engines using a phased approach.

By the year 2006, personal watercraft manufacturers must meet a corporate average emissions standard that is equivalent to a 75% reduction from their 1998 hydrocarbon emissions. The corporate average standard allows manufacturers to build some engines to emission levels lower than the standard and some engines to emission levels higher than the standard, and to employ a mix of technology types, as long as the overall corporate average is at or below the standard. In making the rule, the Environmental Protection Agency recognized that some increase in nitrogen oxides would be "technologically inevitable" if hydrocarbon reductions of 75% or more are to be achieved. In 1996, the Environmental Protection Agency estimated that an overall 52% reduction in hydrocarbon plus nitrogen oxides emissions from marine engines will be achieved by 2010 and a 75% reduction by 2030. The actual reduction in emissions is dependent on the sale of lower emitting marine engines. The 1997 rule delayed implementation by one year (EPA 1996a, 1997a).

Low-emission engines, including both four-stroke engines and direct-injection two-stroke engines, generate reduced amounts of most air pollutants, including carbon monoxide, particulate matter, hydrocarbons, and volatile organic compounds. However, the low-emission engines produce more nitrogen oxides than do carbureted two-stroke engines (EPA 1996a) and the two-stroke direct injected engine has been shown to generate more airborne-particulate PAH emissions, a class of volatile organic compounds, than the two-stroke carbureted engines (Kado et al. 2000). The Environmental Protection Agency estimates that conversion to four-stroke engines and two-stroke direct injection will both result in an increase in the level of nitrogen oxides produced by personal watercraft engines. In order to meet stringent hydrocarbon emission reduction contained in the EPA final rule, the Environmental Protection Agency estimates that manufacturers will need to recalibrate their engines to run at leaner air-fuel ratios, resulting in higher combustion temperatures, more complete combustion, and some increase in nitrogen oxide formation. In addition, conversion to two-stroke direct inject and four-stroke technology have little internal exhaust gas recirculation (EGR) which could reduce emission rates of nitrogen oxides (EPA 1996a).

Organic Act and Management Policies 2001. The *National Park Service Organic Act* (16 U.S.C. 1, *et seq*.) and *Management Policies 2001* (NPS 2001d) guide the protection of park and wilderness areas. The mandates of the *Organic Act* state that the National Park Service will

> promote and regulate the use of . . . national parks . . . by such means and measures as conform to the fundamental purpose of the said parks, . . . which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Under its *Management Policies 2001* the National Park Service will "seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas."

Management Policies 2001 further state that the National Park Service will assume an aggressive role in promoting and pursuing measures to protect air-quality-related values from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the National Park Service "will err on the side of protecting air quality and related values for future generations."

The *Organic Act* and *Management Policies 2001* apply equally to all areas of the national park system, regardless of *Clean Air Act* designation. Therefore, the National Park Service will protect resources at both class I and class II units. Furthermore, the *Organic Act* and *Management Policies 2001* provide protection beyond that afforded by the *Clean Air Act's* national ambient air quality standards, because the National Park Service has documented that specific park air-quality-related values can be adversely affected at levels below the national standards or by pollutants for which no standards exist.

METHODOLOGY AND ASSUMPTIONS

The Environmental Protection Agency has promulgated national ambient air quality standards and regulations for the protection of public health and welfare and the environment in compliance with the *Clean Air Act* and its amendments. Those standards, shown in table 11 in the "Affected Environment" chapter, were the basis for this air quality analysis.

The analysis of impacts of the personal watercraft management alternatives on air quality separately assessed the effects of personal watercraft and other sources of pollution emissions on human health and the environment. The following methods and assumptions were used:

Air quality designations for the recreation area and surrounding area were determined. This information is included in the "Affected Environment" chapter. As described there, Glen Canyon National Recreation Area and the nearby areas are in attainment for all criteria pollutants.

Local ambient air quality data from the Salt River Project monitoring site near Wahweap were reviewed. The level and frequency of pollutant concentrations were ascertained.

Short-term sampling within the recreation area at Halls Crossing and Wahweap was conducted during the Labor Day weekend 2001 to assess current air quality conditions. Wahweap represented a high-use area and Halls Crossing reflected air quality conditions at a moderate use area. For each pollutant, the maximum concentration, shown in table 12, was compared with the national ambient air quality standards.

Boat days and watercraft operating hours were used as basic units of measurement of the intensity and impact of watercraft use. A boat day equals one watercraft on the lake during a 24-hour period. Watercraft operating hours are the average number of hours a vessel is underway during a 24-hour period.

The annual boat days and operating hours for all motorized watercraft at the recreation area were determined from visitation records, launching permits, and seasonal observations by recreation area personnel.

Numbers of watercraft of each type, type of engine per watercraft, and hours per trip were estimated from information published by Hagler Bailly (1999). Personal watercraft use in Glen Canyon National Recreation Area in 2001 was estimated to be 26% of the total annual boat days of all motorized

watercraft and 18% of the total watercraft operating hours. For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

The ratio of the number of each type of watercraft to total number of watercraft was not changed under alternative A. Changes in the proportion of personal watercraft numbers were based on the Environmental Protection Agency mandated reduction of emissions from gasoline marine engines. Based on EPA data, it was assumed that 21.6% of the carbureted two-stroke engines in use in 1998 would have been replaced by 2004, and that 58.4% would have been replaced by 2012.

For alternative B, assumptions regarding the replacement of carbureted two-stroke personal watercraft by 2004 are the same as for alternative A. Under the modified alternative B, carbureted two-stroke personal watercraft engines would be phased out over the next 10 years. The carbureted two-stroke personal watercraft engines would be replaced proportionally with other cleaner types of personal watercraft engines by the end of 2012. By 2013, all personal watercraft in the recreation area would be required to be 100% compliant with EPA emission standards. The air quality emissions associated with alternative B with implementation of the 2012 restriction would be realized beginning in 2013.

For alternative C, the ratio of other motorized vessels was adjusted to compensate for the removal of personal watercraft.

Data were collected on Lake Powell in 2001 to estimate the emissions of pollutants from personal watercraft and other motorized vessels. The average rated horsepower and emission factors for each watercraft type were taken or developed from the EPA NONROAD model. This model is used to calculate emissions of criteria pollutants from operation of non-road spark-ignition engines, including personal watercraft. Model elements included the following.

> The average rated horsepower of each type of watercraft for the State of Utah presented in the NONROAD model was assumed to apply to Glen Canyon National Recreation Area. This assumption is valid because the average rated horsepower of each type of watercraft for Arizona, Colorado, and Utah varies by less than 1%.
>
> Volatile organic compound emissions comprise approximately 100% of the total hydrocarbon for two-stroke engines and 93% of the total hydrocarbon for four-stroke engines (EPA 1997b). Volatile organic compound emissions are higher than total hydrocarbon emissions because the presence of alcohol and aldehydes, which are not detected by the source test method.
>
> All particulate emissions were assumed to be less than 10 microns in diameter (PM_{10}). Among these, 92% of the PM_{10} emissions were assumed to be less than 2.5 microns in diameter (EPA 1999b).

The emission factor for two-stroke, direct injection engines was incorrectly set equal to the emission factor for two-stroke, carbureted engines in the EPA NONROAD model. This was corrected by assuming that the emission factor for two-stroke, direct injection engines on personal watercraft would be the same as the emission factor for two-stroke, direct injection outboard engines of equal horsepower.

The NONROAD model does not include emission factors for two-stroke inboard/sterndrive engines. Therefore, emission factors for two-stroke inboard/sterndrive engines were estimated from emission factors for two-stroke outboard engines of equivalent horsepower.

The average engine load for all watercraft was assumed to be 21%.

No engine degradation or nonexhaust total hydrocarbon/volatile organic compound emissions were considered in the emission estimates. Non-exhaust hydrocarbon emissions from watercraft are less than exhaust emissions but are not negligible. For watercraft, the principal sources of non-exhaust emissions are evaporative emissions from fuel tanks when the engine is not in use and refueling emissions. The quantities of these emissions are related to the number of pieces of equipment, number of trips, and watercraft fuel tank volume. The elements of the three alternatives that relate to watercraft type would change engine types, with variations in exhaust emissions. Fuel tank volumes would not be anticipated to change substantially. The number of trips per year would vary by 2%, at most, under all alternatives. Therefore, non-exhaust emissions would not change the impact analysis. In July 2002, the Environmental Protection Agency proposed new evaporative emissions standards for gasoline-fueled boats and personal watercraft. These proposed standards would require most new boats produced in 2008 or later to be equipped with low-emission fuel tanks or other evaporative emission controls.

Any reductions in emissions resulting from implementing control strategies were taken into account, as were changes in emissions resulting from increased or decreased usage.

Established threshold levels of total emission loadings that would characterize the significance criteria for mobile sources are not available. Therefore, estimates of total annual emissions from personal watercraft under each alternative were compared to prevention of significant deterioration thresholds established in the *Clean Air Act* (40 CFR, section 51.166 (b)(1)(i)(b)) for stationary sources. Under prevention of significant deterioration, a major stationary source is:

Any source in a fixed location that emits at least 250 tons per year of any pollutant regulated under the *Clean Air Act*; or

Any source of 28 EPA-specified source categories that emit at least 100 tons per year of any regulated criteria pollutant.

These prevention of significant deterioration stationary thresholds were applied to this analysis as significance criteria for nonroad mobile sources.

Ozone injury on sensitive plants found in the recreation area was assessed from regional biomonitoring data provided by the U.S. Forest Service, Forest Health Biomonitoring Program (Forest Service 1999; 2002).

A calculation referred to as SUM06 (parts per million per hour) was used for evaluating the implications of ozone. The highest three-month, five-year average commonly used for the area was

determined by comparing ambient air quality data (available from the National Park Service, Air Resources Division) to the Environmental Protection Agency proposed SUM06 level of 25 parts per million per hour that is associated with injury effects on vegetation.

Visibility impacts were determined by assessing particulate matter levels from local monitoring data, or from qualitative evidence such as personal observations and photographs.

Cumulative impacts were analyzed qualitatively, considering only the effects of air emissions from personal watercraft and other motorized watercraft. Although the recreation area also has air emissions from fueling stations, from land-based vehicles such as cars, trucks, and recreational vehicles, and from campfires, emissions from these sources were not assessed. The cumulative impact analysis also did not consider emissions from point sources, such as the Navajo Generating Plant near Page and Nuclear Fuel Service near the Bullfrog area. A discussion of the emissions from these and other point sources in the region is included in the draft air quality report for Glen Canyon National Recreation Area (NPS 2002u).

Impact Threshold Definitions

Personal watercraft impact thresholds for air quality depend on the type of pollutants produced, the background air quality, and the resources in the environment that may be affected by airborne pollutants (air quality related values). Air quality related values include "visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality" (43 FR 15016).

Impact thresholds may be qualitative, such as photos of degraded visibility. They also can be quantitative, based on impacts on air quality related values or federal air quality standards, or emissions based on emission factor models. The type of thresholds used in an analysis depend on what type of information is appropriate or available.

Because the Environmental Protection Agency has established standards that are regulated by states to protect human health and the environment, two categories of potential airborne pollution impacts from personal watercraft are analyzed. They include: (1) impacts on human health; and (2) impacts on air quality-related values in the recreation area. Impact intensity thresholds for each impact category are discussed below.

Human Health Effects from Airborne Pollutants. Based on the national standards and the methods described above, the following impact thresholds for human health effects from airborne pollutants related to personal watercraft use were defined. To assess a level of impact on human health from airborne pollutants, both the emissions of each pollutant related to motorized watercraft activity and the background air quality were evaluated and then considered according to the thresholds defined below.

	Activity Analyzed		Current Air Quality
Negligible:	Emission levels would be less than 50 tons per year for each pollutant	**and**	The first highest three-year maximum for each pollutant is below (less than 60%) the national ambient air quality standards.
Minor:	Emission levels would be less than 100 tons per year for each pollutant	**and**	The first highest three-year maximum for each pollutant is below (less than 80%) the national ambient air quality standards.

Moderate:	Emission levels would be greater than or equal to 100 tons per year for any pollutant	**or**	The first highest three-year maximum for each pollutant is greater than 80% of the national ambient air quality standards.
Major:	Emission levels would be greater than or equal to 250 tons per year for any pollutant	**and**	The first highest three-year maximum for each pollutant is greater than 80% of the national ambient air quality standards.

NOTE: The annual carbon monoxide emission levels presented in the following analysis should not be correlated to recent carbon monoxide-related fatalities that occurred in the recreation area. Carbon monoxide-related fatalities occurred because of exposure to extremely high levels of carbon monoxide in confined, poorly ventilated spaces such as under a boat swimming platform, or near exhaust ports. The estimated annual emission levels presented in this analysis represent carbon monoxide levels over the entire recreation area, dispersed in a large volume of air, and are based on year-long boating activity.

Air Quality Related Values. Impacts on environmental resources and values include visibility and biological resources (specifically ozone effects on plants) that may be affected by airborne pollutants emitted from personal watercraft and other sources. These pollutants include ozone, nitrogen oxides, total hydrocarbons, and particulate matter. Particulate matter and nitrogen oxide emissions are evaluated for visibility impairment. Volatile organic compounds and nitrogen oxides are precursors to the formation of ozone and are evaluated in lieu of ozone emissions, which is formed as a secondary pollutant.

To assess the impact of ozone on plants, the five-year ozone index value was calculated and is represented as SUM06. The Air Resources Division of the National Park Service, based on local monitoring site data, developed SUM06 values used in this analysis.

To assess a level of impact on air quality related values from airborne pollutants, both the emissions of each pollutant related to motorized watercraft activity and the background air quality must be evaluated and then considered according to the thresholds defined below.

	Activity Analyzed		**Current Air Quality**
Negligible:	Emission levels would be less than 50 tons per year for each pollutant	**and**	There are no perceptible visibility impacts (photos or anecdotal evidence); <u>and</u> There is no observed ozone injury to plants; <u>and</u> SUM06 ozone is less than 12 parts per million per hour.
Minor:	Emission levels would be less than 100 tons per year for each pollutant	**and**	SUM06 ozone is less than 15 parts per million per hour.

Moderate:	Emission levels would be greater than 100 tons per year for any pollutant or Visibility impacts from cumulative personal watercraft emissions would be likely (based on past visual observations).	**or**	Ozone injury symptoms are identifiable on plants; and SUM06 ozone are less than 25 parts per million per hour.
Major:	Emission levels would be equal to or greater than 250 tons per year for any pollutant or Visibility impacts from cumulative personal watercraft emissions would be likely (based on modeling or monitoring).	**and**	Ozone injury symptoms are identifiable on plants; or SUM06 ozone is greater than 25 parts per million per hour.

Impairment is defined as impacts that:

Have a major adverse effect on recreation area resources and values;

Contribute to deterioration of the recreation area's air quality to the extent the recreation area's purpose could not be fulfilled as established in its enabling legislation;

Affect resources key to the recreation area's natural or cultural integrity or opportunities for enjoyment; or

Affect the resource whose conservation is identified as a goal in the recreation area's general management plan or other recreation area planning documents.

Geographic Area Evaluated for Impacts

The analysis area includes the immediate locations of personal watercraft use and the surrounding near-shore environment where air pollutants may accumulate. For this analysis, the analysis area is Lake Powell within Glen Canyon National Recreation Area.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Personal watercraft use in Glen Canyon National Recreation Area in 2001 was estimated to be 26% of the total annual boat days of all motorized watercraft. Under alternative A, a 2% increase or decrease annually in visitation to the recreation area is assumed over the next 10 years, however no change in the percent of annual number of personal watercraft boat days or operating hours in the recreation area would be expected through 2012. However, with full implementation of EPA regulations for reduced

emissions from marine engines in 2006, a change in the type of personal watercraft engine used in the recreation area would be expected to occur.

Human Health Impacts from Airborne Pollutants

The ambient air quality levels in the analysis area meet the national ambient air quality standards (see the "Affected Environment" chapter) and would continue to be in attainment under alternative A. No change in class II airshed status would result from this alternative, as personal watercraft activity has not resulted in a violation of any national air quality standard. Ambient air quality would likely improve slightly by 2012 as carbureted two-stroke emissions personal watercraft were gradually replaced with personal watercraft that complied with the regulations reduced emissions from marine engines.

Table 40 presents the range of annual estimated personal watercraft emission loads based on visitation growth of between –2% and +2% annually and ambient air quality data for 2004 and 2012. Key points include the following.

Volatile organic compounds and hydrocarbons are precursors to the formation of ozone. Based on air quality data collected during the 2001 air quality study conducted in the recreation area and available from the Salt River Project monitoring site, ozone levels in 2001 did not exceed the national standard. In fact, ozone levels in the region are less than 80% of the national ambient air quality standards. Using the assumptions noted in the "Methodology and Assumptions" section, emissions levels of hydrocarbons and volatile organic compounds would be above 100 tons per year (see table 40).

No long-term data are available concerning carbon monoxide levels in the recreation area. However, carbon monoxide emissions were measured during the busy Labor Day weekend in 2001 and were found to be only 14% of the national air quality standards.

TABLE 40: ALTERNATIVE A PERSONAL WATERCRAFT EMISSIONS AND AMBIENT AIR QUALITY LEVELS

	Annual Emissions (tons per year)	
Pollutant	**2004[a]**	**2012[a]**
Carbon monoxide	2,867–3,168	2,523–3.334
Nitrogen oxide	19–22	33–43
Particulate matter 10 microns or less	62–69	50–67
Particulate matter 2.5 microns or less	57–63	46–61
Hydrocarbons	1,141–1,261	674–891
Volatile organic compounds	1,177–1,301	693–915
Hydrocarbon + nitrogen oxide	1,160–1,283	707–934
	Ambient Air Quality	
National standards	Below 80% of the standard	Below 80% of the standard
SUM06	11.3 parts per million/hour	11.3 parts per million/hour

a. Emissions are presented based on a range of visitation growth of –2% or +2%.

Implementation of EPA-mandated emission standards would result in a beneficial effect on air quality within the recreation area by reducing the emission of volatile organic compounds, hydrocarbons, and carbon monoxide over time. However, over the life of the analysis, emission levels of these pollutants would exceed 100 tons per year.

In 2012, an increase in nitrogen oxide emissions would occur under alternative A, because nitrogen oxide emissions from clean engine technology are greater than those of carbureted two-stroke engines. As described in the "Methodology" section, the sum of hydrocarbons plus nitrogen oxide emissions is the standard of the EPA rule. Hydrocarbons and nitrogen oxide are also the principle constituents of ozone. Under alternative A, hydrocarbon plus nitrogen oxide emissions would be reduced by 349 tons per year by 2012 considering an annual 2% visitor increase over time which would potentially benefit regional ozone levels.

The estimated level of long-term adverse impact on human health from alternative A would be moderate. This conclusion was based on the modeling results and the current air quality measurements, which are well below the national standard.

Levels of particulate matter from personal watercraft in 2004 were estimated to be below 100 tons per year, indicating a minor adverse impact on human health. Ambient levels of particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$) measured during the 2001 study and from the Salt River Project monitoring site ranged from 3 to 16% of the national ambient air quality standards. By 2012, particulate matter emissions from personal watercraft use would be reduced from 2004 levels and range between 46 to 61 tons per year because of the increased use of low-emissions engines. The long-term adverse impacts on human health from particulate matter emission would be negligible to minor.

Air Quality Related Value Impacts from Airborne Pollutants

Ozone effects were determined by comparing ozone measurements recorded by the Salt River Project monitoring station over a three-year period with the Environmental Protection Agency proposed SUM06 level of 25 parts per million per hour. This SUM06 level is associated with significant effects on vegetation such as crop yield and biomass loss.

The SUM06 ozone measurement for the recreation area was 11.3 parts per million per hour. As described in the human health impact analysis, alternative A would result in a potential reduction of regional ozone formation. This would lead to a potential reduction in the SUM06 index.

The U.S. Forest Service, Forest Health Biomonitoring Program has numerous biomonitoring stations in southwestern Utah and within the intermountain region west, including Arizona, New Mexico, Nevada, Utah, Colorado, Wyoming, Montana, and Idaho. Based on this monitoring, ozone-induced injury to plants has not been detected within this region (Forest Service, Boyer, pers. com., June 2002).

As described in the human health impact analysis, the emissions of volatile organic compounds and hydrocarbons currently exceed 100 tons per year. By the year 2012, the increased proportion of low-emissions on personal watercraft would substantially reduce the emissions of these pollutants, but they would still exceed 100 tons per year. As a result, the estimated level of long-term adverse impact on air quality related values from alternative A would be moderate.

Particulate matter and nitrogen oxide emissions can degrade visibility. In the presence of sunlight, nitrogen oxide is a constituent in the formation of smog. With implementation of alternative A, particulate matter emissions would decrease to levels ranging between 46 to 67 tons per year by 2012. However, nitrogen oxide emissions would increase from 19–22 tons per year in 2004 to 33–43 tons per year in 2012. This would occur because the low-emission engines produce more nitrogen oxide emissions than do carbureted two-stroke engines. The emissions of these pollutants from personal watercraft activity in high-use areas could cause localized degradation of visibility during peak-use periods. The long-term adverse effects of these pollutants produced by personal watercraft on air quality and visibility would be negligible to minor.

Cumulative Effects. Other motorized craft, mostly powerboats and houseboats, represent 72% of the total boat days and 82% of the total operating hours on Lake Powell. It was estimated that the inboard and sterndrive carbureted or electric direct-injection engines with power ratings of 170 horsepower made up 52% of the total boat days and 65% of the total operating hours on the lake.

Based on the assumption listed above in the "Methodology" section, the cumulative emissions of all motorized craft is represented as a range assuming a 2% increase or decrease in visitor use annually to the recreation area. It is expected that implementation of Environmental Protection agency emission standards for marine engines would maintain ambient air quality levels below 80% of the national standards and SUM06 ozone levels would remain below 15 parts per million per hour. The cumulative emissions resulting from all motorized boating activities under alternative A are presented in table 41. Effects on human health, visibility, and plants due to airborne pollutants were considered.

As a result of implementation of EPA emission standards, emission levels for carbon monoxide, particulate matter, hydrocarbons, and volatile organic compounds would decline, while nitrogen oxide emissions would increase by about 5%. However, the emission for all of these compounds would exceed 100 tons per year. As a result, the long-term cumulative adverse effects on air quality related values and human health from all motorized vessel use would be moderate.

TABLE 41: ALTERNATIVE A CUMULATIVE EMISSIONS FROM PERSONAL WATERCRAFT AND OTHER MOTORIZED BOAT USE AND AMBIENT AIR QUALITY LEVELS

	Annual Emissions (tons/year)	
Pollutant	**2004[a]**	**2012[a]**
Carbon monoxide	14,219–15,711	13,679–18,071
Nitrogen oxide	479–529	486–641
Particulate matter 10 microns or less	94–104	80–105
Particulate matter 2.5 microns or less	87–96	73–97
Hydrocarbons	1,855–2,050	1,318–1,741
Volatile organic compounds	1,874–2,070	1,316–1,738
Hydrocarbon + nitrogen oxide	2,334–2,581	1,804–2,382
	Ambient Air Quality	
National standards	Below 80% of the standard	Below 80% of the standard
SUM06	11.3 parts per million/hour	11.3 parts per million/hour

a. Emissions are presented based on a range of visitation growth of –2% to +2%.

With an increase in visitation of 2% annually over the next 10 years and the conversion to lower emission engines, the particulate matter emission levels would increase slightly to levels slightly above 100 tons per year by 2012. Localized visual impacts from motorized boating exhaust would continue to be detectable in the year 2012 during peak use periods in high-use areas. The long-term cumulative effects on air quality related values and human health from particulate matter emissions would be adverse and minor to moderate.

Conclusion. Personal watercraft management under alternative A would have the following effects on air quality.

> Emission levels of carbon monoxide, hydrocarbons, and volatile organic compounds would decrease between 2004 and 2012. Hydrocarbon plus nitrogen oxide emissions, which are the principal constituents of ozone, would also decrease by 2012. All of this change would be attributable to increased proportions of low-emission engines on the lake. However, these pollutants would continue to be emitted by personal watercraft at volumes exceeding 100 tons per year. As a result, alternative A would have moderate, long-term, direct, adverse impacts on human health and air quality related values.
>
> Particulate matter emissions from personal watercraft would decrease by 2012 to between 46 to 67 tons per year. These levels of particulate matter would continue to cause locally degraded visibility from personal watercraft exhaust during peak use periods in high-use areas. This would be a direct, long-term, negligible to minor, adverse effect on human health and air quality related values.
>
> Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect).
>
> SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect).
>
> No change in class II airshed status would result from this alternative (negligible effect).

The cumulative effect on air quality related values and human health from all motorized vessel would be direct, long-term, adverse, and minor to moderate. This alternative would not result in an impairment of the air quality resource or related values.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Alternative B would eliminate personal watercraft use in sections of the San Juan, Colorado, Dirty Devil, and Escalante Rivers. This action would eliminate personal watercraft exhaust emissions in these areas.

The total quantity of exhaust emissions from personal watercraft engines is related to speed. A new flat-wake zone on 7 miles of the Escalante River would result in localized decreases in pollutant emissions.

Restrictions associated with alternative B would result in localized improvement to air quality in the tributary areas.

Under this alternative, use of personal watercraft with carbureted two-stroke engines would be prohibited in the recreation area at the end of 2012 and in subsequent years. Carbureted two-stroke personal watercraft would be proportionally replaced with cleaner engines. There would be no restrictions on the type of engine permitted for use prior to 2012. As under alternative A, a range of emissions is given representing a change in total boat days and watercraft operating hours of between –2% or +2% annually over the next 10 years.

Human Health Impacts from Airborne Pollutants

Under alternative B, the ambient air quality levels in the analysis area would be expected to meet the national ambient air quality standards through 2012, and the area would continue to be in attainment. No change in class II airshed status would result from implementation of alternative B, as personal watercraft activity has not resulted in a violation of any national air quality standard. Table 42 presents the range of annual estimated personal watercraft emission loads and ambient air quality data for 2004 and 2012.

Emissions from personal watercraft under alternative B in 2004 would be similar to those shown in table 40 for alternative A. Volatile organic compounds, total hydrocarbons, and carbon monoxide levels would be higher than 100 tons per year throughout the assessment period. In conjunction with ambient air quality measurements that are well below the national standard, the estimated long-term level of adverse effect on human health would be moderate.

TABLE 42: MODIFIED PREFERRED ALTERNATIVE B PERSONAL WATERCRAFT EMISSIONS AND AMBIENT AIR QUALITY LEVELS

	Annual Emissions (tons per year)	
Pollutant	**2004[a]**	**2012[a]**
Carbon monoxide	2,867–3,168	2,237–2,955
Nitrogen oxide	19–22	46–61
Particulate matter 10 microns or less	62–69	40–53
Particulate matter 2.5 microns or less	57–63	37–49
Hydrocarbons	1,141–1,261	230–304
Volatile organic compounds	1,177–1,301	232–306
Hydrocarbon + nitrogen oxide	1,160–1,283	276–365
	Ambient Air Quality	
National standards	Below 80% of the standard	Below 80% of the standard
SUM06	11.3 parts per million/hour	11.3 parts per million/hour

a. Emissions are presented based on a range of visitation growth of –2% or +2%.

Under alternative B, hydrocarbon emissions would be reduced by 957 tons per year and volatile organic compounds by 995 tons per year by 2012, assuming an increase in visitor use of 2% annually. Hydrocarbon plus nitrogen oxide emissions would be reduced by up to 918 tons per year under this alternative and a potential beneficial effect on regional ozone levels. The reductions in these constituents would occur because carbureted two-stroke engines would be replaced with cleaner engines after 2012. However, over the life of the analysis, emission levels of these pollutants would exceed 100 tons per year resulting in a long-term adverse impact on human health that would be moderate.

Conversion of carbureted two-stroke engines by 2012 would result in carbon monoxide emissions being reduced by 213 tons per year under a positive growth scenario or by 630 tons per year assuming a negative growth scenario. The impact to human health from carbon monoxide emissions would be moderate.

Particulate matter emission levels associated with personal watercraft use would be reduced by 14 to 22 tons per year from 2004 to 2012 with a range of between 37 and 53 tons per year by 2012. This would indicate a long-term, negligible to minor, adverse effect on human health.

Air Quality Related Value Impacts from Airborne Pollutants

The SUM06 ozone measurement for the recreation area was 11.3 parts per million per hour. With no change in personal watercraft use expected over the next 10 years, SUM06 levels would not be expected to decrease over time with the conversion of two-stroke carbureted personal watercraft to low-emission engines.

As described in the human health impact analysis, alternative B would result in a potential reduction of regional ozone formation. Hydrocarbon plus nitrogen oxide emission would be reduced by over 900 tons per year from 1,283 tons per year in 2004 to 365 tons per year in 2012 with the replacement of carbureted two-stroke personal watercraft engines in 2012. Total hydrocarbon and volatile organic compound emissions however would remain above 100 tons per year over time. The SUM06 ozone measurement would be below the national standard. Long-term, adverse impacts on air quality related values, including potential ozone injury to plants, would be moderate.

Emissions of particulate matter and nitrogen oxide from personal watercraft can degrade visibility. In the presence of sunlight, nitrogen oxides can contribute directly to the formation of haze. Under alternative B, particulate matter of 2.5 microns would be reduced between 14 to 20 tons per year to below 50 tons per year by 2012. Particulate matter of 10 microns would be reduced from a potential high of 69 tons per year to 53 tons per year. Nitrogen oxide emissions would increase from 21 to 61 tons per year by 2012. The reduction in particulate emissions would tend to improve visibility, and the increase in nitrogen oxide emissions from personal watercraft activity in high-use areas would cause localized degradation of visibility that may be detectable by visitors. This would be a long-term, negligible to minor, adverse impact on air quality and visibility.

Cumulative Effects. Cumulative impacts associated with alternative B would be similar to those described for alternative A in 2004. With the replacement of two-stroke carbureted personal watercraft by the end of 2012, the emissions associated with all motorized vessels including personal watercraft would be reduced compared to alternative A.

It is expected that even with a 2% annual increase in visitation, implementation of EPA emission standards to phase-out all two-stroke carbureted marine engines would maintain ambient air quality levels below 80% of the national standards and SUM06 ozone levels would remain below 15 parts per million per hour. The cumulative emissions resulting from all motorized boating activities under alternative B are presented in table 43.

Emission levels for hydrocarbons and volatile organic compounds would decline substantially by 2012 with replacement of two-stroke carbureted personal watercraft engines with cleaner engines. Nitrogen oxide emissions would increase by 20 to 130 tons per year depending upon the growth scenario. With a negative growth scenario, carbon monoxide emissions would decline over time by nearly 830 tons per year. However under a positive growth scenario these emissions would increase by 1,981 tons per year. Emissions for all of these compounds would exceed 100 tons per year. As a result, the long-term cumulative adverse effects on air quality related values and human health from all motorized vessel use would be moderate.

By the end of 2012 particulate matter of 10 microns would be reduced from 104 tons per year under a positive growth scenario to 92 tons per year by 2012. Particulate matter of 2.5 microns would also be reduced to between 64 to 85 tons per year by 2012. Localized visual impacts from motorized boating exhaust would continue to be detectable in the year 2012 during peak use periods in high use areas. The long-term cumulative effects on air quality related values and human health from particulate matter emissions would be reduced from minor to moderate adverse levels in 2004 to minor levels by 2012.

TABLE 43: ALTERNATIVE B CUMULATIVE EMISSIONS FROM PERSONAL WATERCRAFT AND OTHER MOTORIZED BOAT USE AND AMBIENT AIR QUALITY LEVELS

	Annual Emissions (tons/year)	
Pollutant	**2004[a]**	**2012[a]**
Carbon monoxide	14,219 – 15,711	13,392 – 17,692
Nitrogen oxide	479 –529	499 – 659
Particulate matter 10 microns or less	94 – 104	70 – 92
Particulate matter 2.5 microns or less	87 – 96	64 – 85
Hydrocarbons	1,855 – 2,050	874 – 1,154
Volatile organic compounds	1,874 – 2,070	855 – 1,129
Hydrocarbon + nitrogen oxide	2,334 – 2,579	1,158 – 1,1813
	Ambient Air Quality	
National standards	Below 80% of the standard	Below 80% of the standard
SUM06	11.3 parts per million/hour	11.3 parts per million/hour

a. Emissions are presented based on a range of visitation growth of –2% or +2%.

Conclusion. Effects of alternative B would be similar to those of alternative A in 2004. Conversion of carbureted two-stroke personal watercraft to cleaner engines under the modified alternative would have the following effects on air quality.

> There would be sizeable reductions in volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide emissions. There would also be reduction in particulates (PM_{10} and $PM_{2.5}$) and carbon monoxide emissions.
>
> Human health effects would be adverse and moderate for volatile organic compounds, carbon monoxide, hydrocarbons, and hydrocarbons plus nitrogen oxides. Some beneficial effects would occur after 2012 from the elimination of carbureted two-stroke personal watercraft engine emissions as hydrocarbon, carbon monoxide, volatile organic hydrocarbons, and particulate matter emissions are reduced.
>
> Adverse impacts to air quality-related values would be reduced from minor levels in 2004 to negligible to minor in 2012. Particulate matter reductions would contribute to an improvement in visibility, and the reduced ozone production would contribute to a reduced potential for plant damage.
>
> Air quality in the recreation area would continue to be below national ambient air quality standards (negligible effect).
>
> SUM06 ozone measurements in the recreation area would remain between 8 and 15 parts per million per hour (negligible effect).
>
> No change in class II airshed status would result from this alternative (negligible effect).

The cumulative effect on air quality related values and human health from all motorized vessels would be direct, long-term, adverse, and minor to moderate.

This alternative would not result in an impairment of the air quality resource or related values.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Human Health Impacts from Airborne Pollutants

Alternative C would eliminate all emissions from personal watercraft. The resulting beneficial impacts on human health would range from negligible to moderate.

Air Quality Related Value Impacts from Airborne Pollutants

Alternative C would eliminate all emissions from personal watercraft. The benefit to air quality, plant health, and visibility could range up to moderate.

Cumulative Impacts. There would be no incremental contribution to cumulative impacts from personal watercraft activity because personal watercraft use would no longer be permitted in the recreation area. However, emissions from other motorized vessels would continue.

The ban on personal watercraft would be expected to decrease visitor use of the recreation area in the years immediately following the action. As a result, there would be a decrease in all emissions in the first few years following the ban that reflected the decline in overall visitor use. The cumulative emissions associated with this short-term decline in visitor use are summarized in table 44 for 2004.

By 2012, the total number of boat days and operating hours spent on the lake by all vessels would be the same levels as those expected for alternatives A and B. Most of these vessels would have low-emission engines. The cumulative air quality impacts from all motorized vessels under the no-action alternative in 2012 are summarized in table 44. As under alternatives A and B, a range of emissions is given reflecting a change in total annual boat days and watercraft operating hours of between –2% or +2% annually over the next 10 years.

Under alternative C, the current ambient air quality levels would be expected to remain below 80% of the national standard with implementation of EPA emission standards that would apply to all two-stroke carbureted marine engines. In addition, SUM06 ozone levels would remain below 15 parts per million per hour.

Alternative C would result in a reduction of cumulative emissions in 2004 (table 44) compared to alternative A (table 41). In 2004, particulate matter emissions would be reduced to negligible levels. There would be little difference in nitrogen oxide emission levels between these two alternatives. Hydrocarbons, volatile organic compounds, and hydrocarbons plus nitrogen oxide emissions would be reduced by more than 1,000 tons per year in 2004 when compared to alternative A. In 2004, cumulative emissions of carbon monoxide would be reduced by approximately 3,000 tons per year under alternative C. However, the emission levels of these compounds would still exceed 100 tons per year. As a result, the short-term cumulative adverse effects on human health and air quality related values from all motorized vessel use would be moderate.

TABLE 44: NO ACTION CUMULATIVE EMISSIONS FROM PERSONAL WATERCRAFT AND OTHER MOTORIZED BOAT USE AND AMBIENT AIR QUALITY LEVELS

	Annual Emissions (tons/year)	
Pollutant	**2004[a]**	**2012[a]**
Carbon monoxide	11,352–12,543	15,416–20,366
Nitrogen oxide	459–508	627–828
Particulate matter 10 microns or less	32–36	40–53
Particulate matter 2.5 microns or less	30–33	37–49
Hydrocarbons	715–789	877–1,158
Volatile organic compounds	696–769	848–1,121
Hydrocarbon + nitrogen oxide	1,174–1,297	1,504–1,986
	Current Air Quality	
National standards	Below 80% of the standard	Below 80% of the standard
SUM06	11.3 parts per million/hour	11.3 parts per million/hour

a. Emissions are presented based on a range of visitation growth of –2% or +2%.

A comparison of the year 2012 cumulative effects for alternative A (table 41) and alternative C (table 44) shows that there would be little difference in the air emissions between these two alternatives. Alternative C would have higher emissions of carbon monoxide and nitrogen oxide, but lower emissions of particulate matter, hydrocarbons, and volatile organic compounds compared to alternative A. These differences would occur because of the differences in engine sizes and different emissions rates between the engines used in personal watercraft and the engines used on the other motorized vessels that use Lake Powell. Considering that ambient air quality standards would continue to be met, the cumulative, long-term, adverse effects on air quality related values and human health would be similar to alternative A.

Particulate matter emissions related to other vessel usage would be reduced to 53 tons per year assuming a positive growth scenario. Localized visual impacts from motorized boating exhaust would be detectable during peak-use periods, particularly in high-use areas. The cumulative effects on human health and visibility from particulate matter emissions would be long-term, adverse, and negligible to minor.

Conclusion. Under the no-action alternative, the air quality condition in the recreation area would continue to be below national ambient air quality standards. SUM06 ozone measurements in the recreation area would remain below 15 parts per million per hour. No change in class II airshed status would be expected because historical motorized boating activity has not resulted in a violation of any national air quality standard.

The no-action alternative would have long-term, negligible to moderate, beneficial impacts on air quality related values and human health. These would result from the elimination of personal watercraft emissions of hydrocarbons, volatile organic compounds, carbon monoxide, nitrogen oxide, and particulate matter in the recreation area.

In the short-term, total vessel operating hours would be reduced as personal watercraft would be prohibited from the park. In 2004, there would be sizeable reductions in the cumulative emissions of carbon monoxide, volatile organic compounds, hydrocarbon, and hydrocarbon plus nitrogen oxide when compared with alternative A. Particulates (PM_{10} and $PM_{2.5}$) would be reduced from minor to moderate levels under alternative A to negligible under the alternative C, the no-action alternative.

In the long-term visitors would replace personal watercraft with a different variety of motorized vessel and other vessels usage would continue. This would offset the benefits to air quality from elimination of personal watercraft. Considering that ambient air quality standards would continue to be met, moderate, long-term, adverse impacts on human health and air quality related values would occur from carbon monoxide, nitrogen oxide, hydrocarbon, and volatile organic compound emissions associated with all motorized boating activity. The long-term, adverse impacts on human health and visibility associated with particulate matter emissions would be negligible to minor.

Implementation of this alternative would not result in an impairment of the air quality resource.

NATURAL SOUNDSCAPES

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Soundscape issues related to personal watercraft that were identified during scoping included the following.

Effects of personal watercraft on natural soundscapes. Noise can directly affect natural soundscapes by masking, modifying, or intruding on natural sounds that are an intrinsic part of the environment. This can be especially true in quiet places, such as in secluded coves and river corridors, and when sounds from the noise source occur in the same sound frequency as sounds in the natural soundscape.

Effects of noise on recreation area visitor experiences. Visitor experience is a resource-based opportunity appropriate to a given area within the recreation area. The following issues regarding noise effects on the visitor experience in the recreation area were identified.

> The sensitivity of listeners to personal watercraft noise. Typically, a visitor seeking solitude would be more affected by personal watercraft noise than would another personal watercraft operator.
>
> The rapid changes in the level and frequency distribution of sound produced by personal watercraft. As described in the "Affected Environment" chapter, these changes result from personal watercraft operator behaviors such as rapid acceleration and deceleration, frequent changes in direction, and jumping into the air.
>
> Noise effects in areas where personal watercraft operators "play." Some personal watercraft operators use their vessels within a relatively small area for extended periods of time, for such activities as turning in circles or repeatedly cruising up and down a stretch of shoreline. This behavior contrasts with that of most other vessels, which usually travel from place to place.
>
> Factors that increase noise or amplify the perception of noise, such as use in confined areas, use close to beach areas, and travel of personal watercraft users in groups.
>
> Noise from personal watercraft during sensitive times of day or season. These can include nighttime (in Arizona, a personal watercraft can be operated at night if the vessel has lights) and early morning, or any time from October through March when there are few other sources of engine noise on the lake.

Effects on wildlife resources. There was concern that species that make sound in the same frequency bands as personal watercraft may especially be adversely affected by interference from personal watercraft noise. Effects of noise on wildlife are included in the "Wildlife and Wildlife Habitat" section.

General Effects of Noise on the Natural Soundscape

The natural soundscape in a park is defined as its mix of ambient acoustic conditions without the intrusion of human-caused sound. The soundscape is a resource to be associated with the natural settings and conditions that may be found within a park. A healthy natural soundscape is critical to the enjoyment of a park by visitors, and to some natural biological processes that are part of a park's ecosystem, as expressed in some of the issues presented above.

Noise can adversely affect park resources or values, including but not limited to natural soundscapes, cultural resources, wildlife, and visitor experience. It can directly impact them by modifying or intruding upon the natural soundscape, masking the natural sounds that are an intrinsic part of the environment. This can be especially true in quiet places, such as in secluded coves and when sounds from the noise source occur in the same sound frequency bands as sounds in the natural soundscape. It is important to distinguish between the intrinsic value of the soundscape as a natural resource, or as something to be experienced by people, or as part of wildlife habitat, or as part of a cultural (historic, religious) resource. This distinction is not a radical concept, as the *Organic Act* talks both to conserving resources and providing for their enjoyment. Air, water, wildlife, cultural resources, and sound all are valued for their existence in parks, as well as for their potential to be enjoyed in that state by visitors.

Noise can adversely impact wildlife resources by interfering with sounds important for animal communication, including territory establishment, courtship, nurturing, predation, avoiding predators, migration, and foraging functions. Certain types and levels of sound can, especially in non-habituated populations, cause animals to use avoidance mechanisms. Avoidance, initiated as it may be by annoyance or stress, can cause individual animals to alter normal behavior, move to less preferred habitats, and unduly use energy during critical times of the year. In some cases, animals may become habituated, or accustomed, to some level of human-caused noise without negative impacts, unless habituation itself is a negative impact. However, in cases where animals do not habituate or where noise levels are such that normal behavior is altered, a whole suite of negative consequences may result. Effects of watercraft use on wildlife, which includes the noise emitted by them, are presented in the "Wildlife and Wildlife Habitat" section.

Noise can adversely impact park visitor experiences. Managing parks for "visitor experience" means providing the opportunity for visitors to enjoy a park's resources and values in a manner appropriate to the park's purpose and significance. Visitors usually have expectations about the experience being offered in units of the National Park System. The impacts of noise on visitor experience can be especially evident when visitor expectations include solitude, serenity, tranquility, or contemplation, (as in the natural zone of Glen Canyon National Recreation Area). Many visitors have great expectations for national park units in this regard, since daily life for many people consists of high and constant levels of noise in urban/suburban settings. Effects of watercraft use on visitor experience, which includes the noise emitted by them, are presented in the "Visitor Use and Experience" section.

Management objectives, or desired conditions, for protection of natural soundscapes, cultural resources, wildlife, and visitor experience are derived through well-established public planning processes. They are based in law, policy, regulations, and management direction applicable to the entire national park system and to each specific park unit, as provided in the next two sections.

Management Objectives

When the Glen Canyon National Recreation Area general management plan (NPS 1979a) was being prepared in the late 1970s, the importance of natural soundscape was not as well recognized as it is today. Therefore, the recreation area's general management plan does not include management objectives for soundscapes.

The emerging recognition of the natural soundscape as an important park resource is demonstrated by the recent publication of *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000b). This resource also is addressed in *Management Policies 2001* (NPS 2000d).

The soundscape management objective in table 3 is to manage the effects of personal watercraft on soundscapes in a manner consistent with recreation area management zones. This objective recognizes that the sound-related goals for personal watercraft will vary, depending on the management zone. The goals described below conform to the general goals for developed and natural areas that are described in *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000b).

> In the Recreation and Resource Utilization Zone and Development Zone, the management objective for sound from personal watercraft is to reduce noise to the level consistent with the best technology available. This would mitigate noise impacts without adversely affecting the use of personal watercraft.
>
> The Natural Zone is managed to maintain natural processes and existing conditions, and to preserve the land, water, and other natural resources. The Cultural Zone is managed to preserve, interpret, and restore (where deemed appropriate by professional analysis) the historic and archeological resources of the recreation area. In these zones, the goal is to return the soundscape to as near natural conditions as possible over time, while allowing visitors to access and enjoy the recreation area in a manner consistent with recreation area management goals.

GUIDING REGULATIONS AND POLICIES

The fundamental mission of the national park system, established in law (16 U.S.C. 1 *et seq*.), is to conserve park natural and historic resources, and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in section 1.4.6 of *Management Policies 2001* (NPS 2000d), natural soundscapes are recognized and valued as a park resource in keeping with the NPS mission.

The natural soundscape, sometimes called natural quiet, is the aggregate of all of the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Management goals for soundscapes are included in section 4.9 of *Management Policies 2001* (NPS 2000d) and in *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000b). The NPS management objectives for managing sound in Glen Canyon National Recreation Area, which are presented in the preceding section, reflect the management goals of these two documents.

Management Policies 2001 (NPS 2000d) requires restoration of degraded soundscapes to the natural condition whenever possible, and protection of natural soundscapes from degradation. In section 4.9, the National Park Service is directed to "take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or

values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored."

Visitor uses of parks will only be allowed if they are appropriate to the purpose for which a park was established, and can be sustained without causing unacceptable impacts on park resources or values (sections 8.1 and 8.2 of *Management Policies 2001*). Unless mandated by statute, the National Park Service does not allow visitors to conduct activities that, among other things, unreasonably interfere with "the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within Glen Canyon National Recreation Area."

Director's Order 47: Soundscape Preservation and Noise Management (NPS 2000b) requires, "to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources." It also states that "the fundamental principle underlying the establishment of soundscape preservation objectives is the obligation to protect or restore the natural soundscape to the level consistent with park purposes, taking into account other applicable laws." Noise is generally considered appropriate if it is generated from activities consistent with park purposes and at levels consistent with those purposes.

Director's Order 47 provides the following policy direction: "Where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape." Where legislation provides for specific noise-making activities in parks, the soundscape management goal would be to reduce the noise to the level consistent with the best technology available, which would mitigate the noise impact but not adversely affect the authorized activity. Where a noise-generating activity is consistent with park purposes, "soundscape management goals are to reduce noise to minimum levels consistent with the appropriate service or activity."

A key concept for noise management in both *Management Policies, 2001* and *Director's Order 47* is the purpose for which a park was established. The establishing legislation for Glen Canyon National Recreation Area (86 Stat 1311) states that the recreation area was established "to provide for public outdoor recreation use and enjoyment of Lake Powell and the lands adjacent thereto." Based on this statement, noise generated by watercraft, including personal watercraft, is consistent with the recreation area's purposes, but noise levels must be within the standards established by NPS regulations.

NPS regulations pertaining to noise abatement for boating and other water use activities in parks nationwide are included in 36 CFR 3.7. These regulations prohibit operating a vessel on inland waters "so as to exceed a noise level of 82 decibels measured at a distance of 82 feet (25 meters) from the vessel" and specify testing procedures to determine such noise levels. Watercraft that exceed these levels are subject to fine and removal from the recreation area.

It is important to note that this NPS regulation and the testing procedure were developed for enforcement purposes, not impact assessment purposes. Nonetheless, it is reasonable to assume for this analysis that 82 decibels at 82 feet is the maximum that would be emitted by any legal watercraft at full acceleration (normally the loudest portion of its operation). This regulation sets a limit for the maximum allowable noise, but does not imply that there are no noise impacts from vessels operating below that noise level.

The states of Arizona and Utah also regulate noise from personal watercraft and other watercraft. Arizona regulations prohibit a vessel from being operated in a manner that causes it to emit a sound level in excess of 86 decibels when measured from a distance of 50 feet or more. Utah laws and rules prohibit a vessel from being operated in a manner that will cause it to emit more than 75 decibels of noise at the shoreline.

METHODOLOGY AND ASSUMPTIONS

The technique used to assess noise impacts from personal watercraft in this document is consistent with methods being developed for *NPS Reference Manual 47, Soundscape Preservation and Noise Management* (NPS in preparation), in accordance with *Management Policies 2001* (NPS 2000d) and *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000b). The evaluation method considered noise context, sound characteristics including audibility, and time factors, such as duration, frequency of occurrence, and sensitive time periods. These all interact to determine the degree of impact for an activity.

Context

Glen Canyon National Recreation Area resources most likely to be affected by personal watercraft noise include the recreation area's natural soundscape, sites used by Native Americans for traditional religious activities, and noise-sensitive wildlife. Sound levels generated by personal watercraft using the lake affect recreational users differently, depending on each visitor's activities and expectations. Typically, personal watercraft noise of a specified duration and amplitude would have a greater impact on visitor experience in a highly sensitive context. Visitor experiences that are most likely to be adversely affected by personal watercraft noise are the opportunities to experience solitude and the recreation area's natural soundscape. Visitors who recreate using motorized means on the lake surface are generally less impacted by sound generated in this pursuit, by themselves or others. The Natural Zone and Cultural Zone are considered areas of high sensitivity to noise, while the Recreation and Resource Utilization Zone and Developed Zone are considered areas of low sensitivity. Impacts on visitor experience are presented in the "Visitor Use and Experience" section. Potential impacts of personal watercraft use, including noise, on cultural resources and wildlife are presented in those sections of this document. Analysis in this section is intended to disclose impacts on the natural soundscape specifically, recognizing that sound is an intrinsic part of other resources and values in Glen Canyon National Recreation Area.

Sound Characteristics Used in the Analysis

The L_{90} is the sound level descriptor specified in *Director's Order 47* to use in estimating the natural ambient sound level when only a single descriptor is used. It represents the sound level exceeded 90% of the measuring time. The daytime median L_{90} measured at the low-use Last Chance Canyon site by the Harris Miller Miller & Hanson, Inc. (2002) study was 13.4 decibels. This value was used in this evaluation as the average daytime natural soundscape that could be affected by the personal watercraft alternatives.

A noise prediction model was employed to evaluate alternatives using a real-time simulation of a limited time period at one high-use site. The noise propagation equations in the model were based on the Federal Highway Administration's Traffic Noise Model (Menge et al. 1998) and the U.S. Army

Construction Engineering Research Laboratory's SoundProp Model (White 1994). Model features included the following.

> The ground was assumed to be gradually rising away from shore, like many of the beach areas at Glen Canyon National Recreation Area.
>
> A real-time simulation of the various watercraft moving about the lake was created and mated with the propagation model to develop a simulated time-history of the sound levels at various distances from the shore. This process used a documented 10-minute period of activity at the high-use site at Crosby Canyon. The hourly equivalent level (L_{eq}) was computed from these time history records.
>
> For audibility calculations, sound levels in 1/3-octave bands were compared with the background sound level and the human threshold of hearing to determine moment-to-moment audibility of watercraft.

The noise prediction model provided qualitative comparisons of the alternatives related to amplitude (loudness), time factors, and audibility. This included calculation of the predicted rate at which the maximum pass-by sound level of various watercraft would decrease with distance from the shoreline, and the predicted distance that the different watercraft could be heard. Predicted distances from the sources of sound allows computation of the natural soundscape area affected in each alternative. These calculations were done for both single and multiple watercraft.

Time Factors

The time of day or time of year influences the impact a given noise will have. This analysis assumed that during the summer, the periods of greatest sensitivity to noise include sunset, sunrise, and at night. On an annual basis, it was assumed that there is greater sensitivity to noise from personal watercraft during the winter when there is very little noise from other human-related sources and, potentially, a greater expectation for solitude from recreation area visitors.

Duration and frequency of occurrence of a noise affect the impact the noise will produce. For example, in popular use areas where personal watercraft use is almost constant from dawn to dusk, noises from personal watercraft blend with the general noise produced by other watercraft and other sources such as generators, automobile engines, and radios. In lightly used areas adjoining the Natural Zone, the intermittent sound from a single personal watercraft passing by would have a greater effect than the same action in a popular use area. These factors were addressed qualitatively in the impact analysis.

Other Methods and Assumptions

The soundscapes analysis assumed for alternative A and alternative B that throughout the analysis period, 26% of boat days and 18% of operating hours were personal watercraft, 72% of boat days were other motorized watercraft, and 2% were nonmotorized watercraft. (A boat day equals one watercraft on the lake during a 24-hour period.) For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of

motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

Data collected during the August 2001 sound study were reviewed by noise specialists from the National Park Service and from Harris Miller Miller & Hanson, Inc. (2002). Based on their previous experience and comparisons with published literature, they determined that the data collected at Glen Canyon National Recreation Area were consistent with information from other sites and represented the best available data on which to base the impacts analysis.

Impact Threshold Definitions

Director's Order 47 (NPS 2000b) states that the natural ambient sound level of a park is the basis for determining the affected environment in environmental impact statements and other documents prepared for compliance with the *National Environmental Policy Act*. Therefore, impact thresholds for the soundscape were written as comparisons to the daytime median L_{90} of 13.4 decibels that was measured at the low-use Last Chance Canyon site by Harris Miller Miller & Hanson, Inc. (2002). Each threshold integrates sound characteristics, audibility and time factors to indicate the magnitude of impact for each of the personal watercraft management alternatives.

The Recreation and Resource Utilization and Developed Zones in the Glen Canyon Recreation Area are established for use by motorized watercraft. These zones are consistent with the purposes for which the recreation area was established. During high-use seasons, heavy personal watercraft use generates high noise levels within this zone, which the park has determined is consistent with its purpose. Therefore, even though the soundscape is heavily impacted in this area, it is not considered to be unacceptably impacted as defined by the recreation area's *General Management Plan*. Consequently, all noise impacts within this area are basically considered to be negligible or minor, providing the watercraft are used within the state's laws, rules, and regulations (speed, behavior, operating times, area restrictions) and that these enforceable measures are effectively administered by recreation area management and enforcement personnel of Utah and Arizona.

Noise that is generated within the use and development zone is efficiently carried across the water surface and beyond the surrounding shoreline areas. Much of the water surface perimeter and use zone immediately abuts the Natural and Cultural Zones. The extent of the impact on these zones depends on the sound characteristics of the source; the amount and duration of generated sound; and the distance that the sound is propagated into, and audible within, the adjoining zone. The following definitions describe the varying levels of impact on the Natural and Cultural Zones.

> *Negligible*: Natural sounds predominate. Noise impacts are not audible in most of the zone. Where noise is audible, it is for short duration with significantly lengthy periods of time that are noise-free. Noise is not audible between sunset and sunrise.
>
> *Minor*: Natural sounds usually predominate. Noise impacts are not audible in most of the zone. Where noise is audible, impacts occur for short durations frequently during the day, and is occasionally audible between sunset and sunrise.

Moderate: Natural sounds compete with human-caused sounds. Noise impacts are commonly audible in some areas for up to half the daylight hours. In locations where noise is commonly audible, it occurs occasionally between sunset and sunrise. Noise is audible at times and places up to two miles from the shoreline.

Major: Natural sounds are dominated by human-caused sounds. In some areas, natural sounds are commonly impacted by noise during extended periods of time and frequently between sunset and sunrise. Noise is audible at times and places more than two miles from the shoreline.

Impairment: In the Natural and Cultural Zones, the natural soundscape would be impaired at the major level of adverse impact. The sound-related management objectives that were provided at the beginning of this analysis could not be fulfilled in significantly large areas of the zone.

Geographic Area Evaluated for Impacts

Personal watercraft use (and its associated noise) occurs on virtually the entire lake surface. Concentrated personal watercraft use occurs close to marinas and other developed areas. However, locations long distances from marinas or launch ramps routinely are accessed by personal watercraft that are used in conjunction with houseboats. Therefore, the entire lake surface, including all coves and tributaries that are accessible when the lake surface is at an elevation of 3,700 feet above sea level, were included in the geographic area evaluated for noise impacts.

Most of the time, the tributary rivers to Lake Powell do not have sufficient flow for personal watercraft use. However, under certain flow conditions, there is enough water for personal watercraft use, and these vessels currently are allowed on the rivers in a downstream direction of travel. Therefore, the tributary rivers also were included in the geographic area evaluated for noise impacts.

Noise modeling by Harris Miller Miller & Hanson, Inc. (2002) indicated that within the Natural Zone, noise from individual personal watercraft and from boats other than those powered by V-8 engines could be distinguished from the natural soundscape up to a mile from the shoreline. The noise from multiple watercraft was greater than that of individual vessels, but modeling showed that it would not carry for 2 miles. The land area evaluated for noise impacts extended 2 miles inland from the shoreline, and it is therefore assumed from modeled results that there would be no impacts from the activity beyond that distance.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Alternative A would manage personal watercraft consistent with the *Superintendent's Compendium* (NPS 2002c). All of the effects on the soundscape were determined to be direct. Indirect effects on wildlife are included in the "Wildlife and Wildlife Habitat" section. Other indirect effects were evaluated in the "Visitor Use and Experience" and "Cultural Resources" sections.

In the Natural and Cultural Zones, where noise from motorized use is inconsistent with the management zoning, only the areas within 2 miles of the lake would be affected by noise from personal watercraft. The areas most affected would be where the Natural Zone is adjacent to high use "play" areas in the Recreation and Resource Utilization Zone, and where the terrain is relatively open without features such as cliffs that act as sound barriers.

Modeling was performed to determine sound effects in the Natural Zone for three conditions. Tables 45 and 46 summarize the results. The alternative A condition included use of the area, primarily for pass-bys, of 53 personal watercraft and 31 boats in 1 hour. This level of use would be considered a heavy use condition for an Recreation and Resource Utilization Zone area near the Natural Zone.

In much of the Recreation and Resource Utilization Zone adjacent to the Natural Zone, the typical use, even during the summer, would be more like the other modeled conditions of 31 motorized vessels in 1 hour and 3 motorized vessels in 1 hour. (As demonstrated by the noise study performed by Harris Miller Miller & Hanson, Inc. [2002], similar levels of noise were produced by personal watercraft and other motorized watercraft [except boats with V-8 engines, which typically were louder]. As a result, the number of watercraft is a more important factor in determining the amount of noise than the type of watercraft.)

The modeling results displayed in tables 45 and 46 indicated that Natural Zone areas up to about 2 miles from the lakeshore would be likely to experience adverse noise impacts from the high use activity of personal watercraft and other vessels. At or near the shoreline, sound is audible 100% of the time at an average sound pressure level of 53 decibels. The sound continues to be audible 100% of the time out to a distance of 3,240 feet, but diminishes in loudness arithmetically to 30 decibels over the distance. Because the average natural soundscape (L_{90}) assumed in this analysis is at 13.4 decibels, the created sound level over this range is substantially louder than natural sounds, and on the average, would dominate natural sounds. Occasional peaks of sound at higher decibel levels would intrude, and human-caused sound would recede at times. At 3,240 feet (about 0.6 miles), the percent of the time personal watercraft are audible begins to diminish, along with its sound pressure level. At 10,240 feet from the source (or about 2 miles measured from the shoreline), the sound reaches its limit of audibility (is audible 0% of the time) with a sound pressure level of 14 decibels. Up to this modeled limit of audibility, the sound of personal watercraft would be distinguishable from the natural sound of the environment by virtue of the frequencies and the sound pressure levels at which the sounds were generated. Non-natural sounds generated in these frequencies are audible at decibel levels below those of the natural soundscape.[4] They would also be distinguishable from, and perhaps more audible than, other watercraft by virtue of greater fluctuation in noise emissions (see "Affected Environment" chapter).

However, at 0.6 miles from the shoreline, the noise level from 84 watercraft per hour would be only 30 decibels, which is the noise level typically found in suburbs at night. At 2 miles, the noise level produced by the 84 watercraft would differ from the modeled low-use condition by only 1 decibel.

The effect of this alternative is that the presence and high use of personal watercraft increases the audibility of watercraft noise by 24% to a distance of over 3,240 feet from the shoreline, and that it elevates the sound level over this distance by 4 to 5 decibels. This would be a noticeable difference for most visitors in the affected area. At present use levels and distribution, this impact would occur

4. The sounds of helicopters, snowmobiles, other two-stroke combustion engines, and virtually all human-caused sounds are distinguishable from the natural ambient soundscape even at 10 decibels below the natural ambient sound pressure level. Audibility is associated not only with loudness, but also the frequency at which the sound is generated. Considering only the decibel level does not fully characterize the impact. "Masking" only occurs when the frequencies of natural sounds coincide with frequencies of non-natural sounds. At the same frequency and the same decibel level, one sound could be said to mask the other - or make them indistinguishable (HMMH 2002; NPS 2003).

TABLE 45: COMPUTED WATERCRAFT PLUS BACKGROUND NOISE AT VARIOUS DISTANCES FROM THE SHORELINE

Condition	L_{eq} (decibels) at Distance from Shoreline (feet)					
	240	540	990	1290	3240	10,240
Existing condition (alternative A) (53 personal watercraft and 31 boats in 1 hour)	53	50	45	41	30	14
No personal watercraft condition (alternative C) (31 boats in 1 hour)	48	45	40	37	26	14
Low-use condition (2 personal watercraft and 1 boat in 1 hour)	40	36	31	28	18	13

TABLE 46: WATERCRAFT NOISE PERCENT TIME AUDIBLE AT VARIOUS DISTANCES FROM THE SHORELINE

Condition	Percent Time Audible at Distance from Shoreline (feet)					
	240	540	990	1290	3240	10,240
High-use condition – alternative A or B (53 personal watercraft and 31 boats in 1 hour)	100	100	100	100	100	0
High-use condition with no personal watercraft – alternative C (31 boats in 1 hour)	76	76	76	76	76	0
Low-use condition – alternative A or B (2 personal watercraft and 1 boat in 1 hour)	17	17	17	17	17	0

during four months of the year from June through September. Impacts during most of the remaining months would be associated with the low-use scenario shown in the above tables. Personal watercraft and boats in the low-use scenario would be audible 17% of the time to a distance of 3,240 feet from the shoreline, at sound pressure levels 12 to 14 decibels less than at high use.

Adverse impacts of personal watercraft on the natural soundscape vary with the amount of use, assuming even spatial use distribution in the Recreation and Resource Utilization Zone. During high-use seasons, personal watercraft use impacts areas of the Natural and Cultural Zones for extended periods up to 0.6 mile from shoreline. The impact of personal watercraft added to boats is 24% greater than the impact of boats alone, and the fluctuating sound quality is such that it is distinguishable from boats and marginally more audible than boats. From 0.6 mile to 2 miles, the impact declines to zero. This level of effect is defined as moderate, and most of the zone area would not be affected.

Noise impacts from personal watercraft during lower use times (about seven to eight months of the year) would be substantially less frequent, or nonexistent, at lower sound levels and decreasing distances to audibility. This corresponds with a negligible to minor level of adverse impact, as defined. During these times, most of the human-caused noise impacts in the near-shore areas of the Natural and Cultural Zones would be from other types of watercraft.

The above presentation of impacts is based on a general model that assumed a gradual incline in elevation from the shoreline. With this assumption, the distance to a limit of audibility is about 2 miles. This does not account for variation in topography around the shoreline, such as cliff faces that would represent effective barriers to propagation of sound over a distance. It also does not account for reflection of sound within the canyon confines (in the Recreation and Resource Utilization Zone) that would intensify sound and carry it further along the course of the shoreline and up the side channels. Relative to impacts on the Natural or Cultural Zones, barriers to sound do exist at the shoreline. Recreation Area staff have mapped areas along the shoreline where 50 vertical feet of rock face are

assumed to represent an effective barrier to sound propagation. This area is calculated to be about 16,000 acres, or 2.3% of the 668,670 acre Natural Zone.

Cumulative Effects. As described in the "Affected Environment" chapter, numerous aircraft operate year-round in the vicinity of Glen Canyon National Recreation Area. In many remote parts of the Natural Zone, aircraft are assumed to produce the only mechanical noise impacting the natural soundscape, given the modeled distance of audibility at 2 miles from shoreline. In the Recreation and Resource Utilization and Developed Zones, aircraft noise mixes with the other human-caused noise as described below. In much of these zones, watercraft rather than aircraft often are the dominant noise source. However, in secluded coves or times of low watercraft use, aircraft can represent an important noise source.

The Harris Miller Miller & Hanson 2002 study included a practice called "observer source identification logging."[5] This practice enables the scientist to establish real-time links between recorded sounds and sound pressure levels with identified sound sources. Observers note all sounds heard during the sampling period, and log human caused sounds such as aircraft, watercraft, wheeled vehicles, radios, and voices. They also log natural sounds of birds, vegetation in the wind, waves, insects, mammals and other. Logging was accomplished at the sites where all sound data was collected, and at the Rainbow Bridge site, during the heavy use part of the year (August).

Data from this part of the study allows a characterization of all human-caused sound sources that are ambient in the park soundscape. This data is equivalent to sound cumulative effects at the sites in question during the sampling period.

Considering all sites together, the sound of personal watercraft was dominant about 5% to 40% of the time, while the sound of boats was dominant about 10 to 45% of the time. The sound of personal watercraft and boats together were logged separately from the sounds of boats alone and personal watercraft alone. When heard together, they accounted for less than 5% of the time. All aircraft types together were dominant about 0 to 13% of the time. The sounds of voices and radios were not evident at all sites, nor were personal watercraft or aircraft, but all contribute to the total cumulative impact of human-caused sound. The percent time audible for all sources logged by HMMH is displayed, by site, in figure 19 of the draft HMMH report. NPS logging at site 3 captured personal watercraft audibility nearly 60% of the time, small boats just over 30% of the time, and propeller aircraft, large boats, houseboats, people, and other human-related noise less than 5% of the time each.

In the near shore areas of the Natural or Cultural Zones, within 1 or 2 miles, it is expected that the total cumulative impact on the natural soundscape would be dominated by watercraft. The extent to which personal watercraft contribute to the total would vary by location around the perimeter of the water surface. Beyond two miles, it is assumed (based on the modeled analysis), that aircraft would represent the dominant human-caused sound. Aircraft noise would be a mix of commercial aircraft at high and lower elevations, military aircraft, and air tour operators. Personal watercraft would not contribute to the total cumulative effect in most of the natural zone areas.

Reasonably foreseeable sources of noise that should be considered, and added qualitatively to this analysis, include: the potential for increased numbers and types of overflights, the potential for increased numbers of air tours and air tour operators using different types of aircraft, and the potential

5. Draft Technical Report on Noise, pages 27-31.

for an increasing use of watercraft of all types when assuming a positive growth scenario of 2% annually. These do not necessarily represent new types of impact sources, but they would serve to increase the average ambient human-caused noise (L_{eq}) relative to the ambient natural soundscape (L_{90}) within the recreation area. In areas where noise is presently audible the frequency, duration, and loudness of human-caused sound would increase.

Collectively, all of these noise sources would have a minor to moderate effect within the Recreation and Resource Utilization Zone and Developed Zone. In the Natural Zone and Cultural Zone, most of the adverse noise effects from these sources would be minor with occasional moderate effects. Boats with V-8 engines and aircraft both could produce moderate effects within the Natural Zone.

Conclusion. During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. Given this level of impact, and the amount of use that occurs during peak seasons, mitigation takes the form of education and enforcement of the existing regulations and compendium. Noise-producing behaviors are regulated to the greatest possible extent, and use of newer technologies that reduce noise are encouraged. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in Natural and Cultural Zones.

In the Natural and Cultural Zones, alternative A would produce negligible to moderate adverse effects on the soundscape within a mile of the lakeshore, depending on the level of boating use in nearby waters at various times of the year. During high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. These areas consist of about 16,000 acres covering 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected.

All of these effects would be adverse, both short and long term, and direct. Alternative A would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

As with alternative A, all of the noise effects of alternative B would be both short- and long-term and direct. Several provisions of alternative B would mitigate noise effects from personal watercraft compared to current conditions. These include:

> New use restrictions on personal watercraft on the rivers that drain into Lake Powell, including the Dirty Devil, Escalante, San Juan, and Colorado Rivers.
>
> One additional area where flat-wake speeds would be required.
>
> Improved education, which would provide information on areas of the lake where visitors can experience natural quiet and solitude.

The mitigation does not reduce the overall impact of personal watercraft sound in terms of loudness, distance of audibility, or percent time audible within the Natural and Cultural Zones (see tables 45 and 46). Therefore, all the impacts shown for alternative A apply to alternative B as well.

Cumulative Effects. Because the mitigation measures defined for alternative B would not reduce the overall noise impacts of personal watercraft within the natural and cultural zones, cumulative effects of this alternative would be the same as those described for alternative A.

Conclusion. Alternative B would have overall noise impacts similar to those described under alternative A. During summer days in the Recreation and Resource Utilization and Developed Zones, the existing level and character of noise generated by personal watercraft are acceptable within the expressed purpose of the park to provide the motorized watercraft form of recreation. During other times of the year, the overall impact of noise within this area decreases. Noise generated in this zone, year-round, affects adjacent areas in Natural and Cultural Zones.

In the Natural and Cultural Zones, under alternative B during high-use periods, areas in which noise is audible would be affected at minor to moderate levels. During low-use periods, areas in which noise is audible would be affected at negligible to minor levels. The area affected would be 2.3% of the natural and cultural zones. The remainder of the zone area is expected to be unaffected.

All of these effects would be adverse, both short and long term, and direct. Alternative B would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area since a major level of impact is not demonstrated.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Under the no-action alternative, personal watercraft would be permanently eliminated from operating within the recreation area. As described in the "Methodology and Assumptions" section, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

Recreation and Resource Utilization and Developed Zones. In the Recreation and Resource Utilization and Developed Zones, 72% of boat days currently involve use of motorized watercraft other than personal watercraft. Although the elimination of personal watercraft would somewhat reduce noise (a beneficial effect), the noise levels in the high-use locations at high-use times would continue to be minor to moderate.

In the long term, former personal watercraft users would return to Lake Powell using other types of motorized watercraft. As shown in table 14 in the "Affected Environment" chapter, the noise levels produced by personal watercraft and motorboats other than those with V-8 engines are similar.

Therefore, the noise levels in the Recreation and Resource Utilization and Developed Zones that would occur at the end of the planning period (long-term effect) would be similar to those described for alternative A.

Tables 45 and 46 show the modeled effects on noise in the Natural and Cultural Zones. Removing all personal watercraft use from a high-use area of the Recreation and Resource Utilization Zone would, during the high use season, reduce average noise levels by 4 to 5 decibels at all modeled distances up to 3,240 feet from the shoreline. This could be a noticeable change for visitors in that portion of the Natural or Cultural Zone. Up to and beyond that distance, during high use periods, watercraft noise could be audible 24% less of the time without personal watercraft use. The distinctive audible signature of personal watercraft use, that of fluctuating sound levels, and the occasional spikes of sound above the average, would be eliminated.

Modeled results are not presented for alternative C during low use periods. However, it can be stated that during periods without personal watercraft use, the impacts would be reduced to the equivalent of the passage of one boat per hour. Compared to alternatives A or B, at low use times, this reduction would be equivalent to the magnitude of the passage of two personal watercraft per hour. The result is that watercraft would be audible substantially less than 17% of the time, and at lower decibel levels than would be indicated for two personal watercraft plus one boat per hour (table 45). The distance to the limit of audibility would also be reduced and greater noise free intervals of time would be expected.

Cumulative Effects. Please see the general cumulative effects discussion for alternatives A and B, which summarizes the data sources used for this type of analysis. The same data is used for assessing the cumulative impacts in alternative C.

For alternatives A and B, considering all sites together, the sound of personal watercraft was dominant about 5 to 40% of the time, while the sounds of boats were dominant about 10% to 45% of the time. When heard together, the sounds of boats and personal watercraft accounted for less than 5% of the time. All aircraft types together were dominant about 0 to 13% of the time. The sounds of voices and radios were not evident at all sites, nor were personal watercraft or aircraft, but both contribute to the total cumulative impact of human-caused sound. NPS logging captured personal watercraft audibility nearly 60% of the time, small boats just over 30% of the time, and propeller aircraft, large boats, houseboats, people, and other human-related noise less than 5% of the time each. Alternative C, in eliminating personal watercraft would significantly reduce the total cumulative impact on the natural soundscape in the environments represented by the sample sites. Considering the times personal watercraft or boats and personal watercraft were dominant in the soundscape, the reduction would be on the order of about 10% to 45% of the time. Other sources of sound might become more audible at times and in some places due to the elimination of personal watercraft as a sound source.

In the near shore areas of the Natural or Cultural Zones, within 1 or 2 miles, it is expected that the total cumulative impact on the natural soundscape would be substantially reduced by elimination of personal watercraft. The extent of the reduction would vary by location around the perimeter of the water surface. Beyond two miles, it is assumed (based on the modeled analysis), that aircraft would remain the dominant human-caused sound. Aircraft noise would be a mix of commercial aircraft at high and lower elevations, military aircraft, and air tour operators. Personal watercraft would not contribute to the total cumulative effect in most of the natural zone areas.

Reasonably foreseeable sources of noise that should be considered, and added qualitatively to this analysis, include: the potential for increased numbers and types of overflights, the potential for

increased numbers of air tours and air tour operators using different types of aircraft and the potential for an increasing use of watercraft of all types when assuming a positive growth scenario of 2% annually. These do not necessarily represent new types of impact sources, but they would serve to increase the average ambient human-caused noise (L_{eq}) relative to the ambient natural soundscape (L_{90}) everywhere in the recreation area. Areas and times in which noise is presently audible, would experience an increase in the frequency, duration and loudness of human-caused sound.

Collectively, all of these noise sources would have a minor to moderate effect within the Recreation and Resource Utilization Zone and Developed Zone. In the Natural Zone and Cultural Zone, most of the noise effects from these sources would be minor with occasional moderate effects. Boats with V-8 engines and aircraft both could produce moderate effects within the Natural Zone.

Conclusion. Due to the elimination of personal watercraft noise in alternative C, impacts on the natural soundscape would be reduced compared to noise levels produced in alternatives A or B. This represents a beneficial impact on the natural soundscape – eliminating an adverse impact judged as minor to moderate at high use times of the year. Compared to low use times of the year, the level of beneficial impact would not be considered as great in magnitude by eliminating a negligible to minor adverse impact. Alternative C would not result in impairment of the natural soundscape of Glen Canyon National Recreation Area.

WILDLIFE AND WILDLIFE HABITAT

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Some research suggests that personal watercraft uses may affect fish and wildlife by interrupting normal activities, causing alarm or flight, causing animals to avoid habitat near an area of disturbance and displacing animals from habitats, causing habitat damage, and affecting reproductive success. Such effects may be caused by a combination of personal watercraft speed, noise, human presence and ability to access shallow-water and other wildlife habitats where other kinds of watercraft are rarely found. Some literature reports and personal testimony suggest that personal watercraft can access shoreline areas that are inaccessible to other watercraft and that are important to wildlife species that may be typically associated with shoreline areas.

Literature reports have suggested that personal watercraft and their users may have a relatively greater impact on waterfowl and nesting birds associated with beach or shoreline areas because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. These factors may force nesting birds to either abandon nests and eggs during the incubation stage; may flush birds from feeding, refuge, or security areas; or may create additional stresses and associated behavioral changes. Literature reports of personal watercraft collisions with birds and other wildlife causing animal injury and mortality suggest another mode of potential wildlife impact.

Management Objectives

Objectives in taking action include protecting fish and wildlife (including threatened and endangered species) and their habitats from:

> Personal watercraft disturbances that result in injury, changes in distribution (both individuals and populations), changes in essential habitat features, and/or changes in population demographics; and
>
> Adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.

GUIDING REGULATIONS AND POLICIES

The *Organic Act*, which directs parks to conserve wildlife unimpaired for future generations, is interpreted by the agency to mean that native animal life should be protected and perpetuated as part of Glen Canyon National Recreation Area's natural ecosystem. Natural processes are relied on to control populations of native species to the greatest extent possible; otherwise they are protected from harvest, harassment, or harm by human activities.

The National Park Service *Management Policies 2001* (NPS 2000d) state that the National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals (Section 4.4.1). The National Park Service will achieve this through (Section 4.4.1):

> Preserving and restoring the natural abundance, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and communities and ecosystems in which they occur.
>
> Restoring native plant and animal populations in parks when they have been extirpated by past human-caused actions.
>
> Minimizing human impacts on native plants, animal populations, communities, and ecosystems, and the processes that sustain them.

The mission of Glen Canyon National Recreation Area includes the provision to:

> "…preserve and protect the scenic, scientific, and historic features therein while providing a significant understanding to visitors of the scientific and cultural importance of objects, sites, populations, beliefs, and habitats of the past and future."

One of the recreation area's significance statements, indicates (NPS 2000g):

> The climate and physical features of Glen Canyon National Recreation Area have created local environmental conditions favorable to the preservation of scientifically important objects, sites, populations, habitats or communities that are significant in and of themselves or provide opportunities to add to our understanding of past or ongoing events.

Mission goal Ia for preserving recreation area resources states (NPS 2000g):

> Natural and cultural resources and associated values of Glen Canyon National Recreation Area and Rainbow Bridge NM are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context.

Collectively, these mission statements, significance statements, and mission goals establish long-term goals to protect, manage, maintain, and restore wildlife populations and their supporting habitats. Additional federal, state, and local regulations and/or policies for wildlife and wildlife habitats at Glen Canyon National Recreation Area are shown in table 47. Threatened and endangered species and their designated critical habitats are addressed as the next impact topic.

TABLE 47: LAWS AND NATIONAL PARK SERVICE POLICIES RELATING TO WILDLIFE AND WILDLIFE HABITAT

Laws or Policies	Management Direction
General – National Park Service	
National Park Service Organic Act	The National Park Service will "conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."
Management Policies 2001 (NPS 2000d)	"National Park Service Obligation to Conserve and Provide for Enjoyment of Park Resources and Values: Congress, recognizing that the enjoyment by future generations of the national parks can be assured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant." NPS management policies acknowledge that providing opportunities for public enjoyment are a fundamental part of the NPS mission. But they emphasize that recreational and other activities, including NPS management activities, may be allowed

Laws or Policies	Management Direction
	only when they will not cause impairment or derogation of a park's resources, values, or purposes. The sole exception is when an activity that would cause impairment or derogation is specifically mandated by Congress.
Public Law 92-593	On October 27, 1972 Congress established Glen Canyon National Recreation Area to "… provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto in the States of Arizona and Utah and to preserve the scenic, scientific, and historic features contributing to public enjoyment of the area . . ."
Public Law 95-625; 16 U.S.C. 1a-7(b)(4)	NPS management plans must include measures for protecting Glen Canyon National Recreation Areas' resources and "indications of potential modifications to the external boundaries of the unit and the reasons therefore."
General Wildlife and Natural Resources	
Management Policies 2001 (NPS 2000d) *Natural Resources Management Guideline* (*Director's Order* 77)	These guidelines direct the National Park Service to "encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man and to enrich the understanding of the ecological systems and natural resources important to the Nation . . . " Policies and guidelines for natural resources direct that Glen Canyon National Recreation Area must (1) identify and complete the inventories of natural resources for baseline information; (2) minimize impacts of human activities, developments, and uses on marine and terrestrial resources; (3) continue to close areas to protect nests; and (4) manage endangered, threatened, and candidate species.
Fish and Wildlife Coordination Act of 1934, as amended	This act requires consultation with the U.S. Fish and Wildlife Service and the fish and wildlife agencies of states where "the waters of any stream or other body of water are proposed or authorized, permitted, or licensed to be impounded, diverted … or otherwise controlled or modified" by any agency under a federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources."
The *Bald and Golden Eagle Protection Act of 1940*, as amended	This law, originally passed in 1940, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.
Migratory Bird Treaty Act of 1918, as amended	The Migratory Bird Treaty Act prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a valid permit (50 *CFR* 21.11). Additionally, the act authorizes and directs the Secretary of the Interior to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take (for example, hunting seasons for ducks and geese). "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.
Title 36 CFR 1.5, 1.6, 1.10, 2.1, 2.2, 2.3, 2.4, 2.5	Title 36 *CFR* provides authorization for closing areas and limiting public use to protect resources; providing public notice of closures or use limits; prohibiting the destruction, defacing, or disturbing of resources; and protecting fish and wildlife and permit research.
Executive Order 11990, "Protection of Wetlands"	This order requires federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction of modification of wetlands.
Executive Order 11988, "Floodplain Management"	This order requires federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modifications of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Source: Adapted from *Management Policies 2001* (NPS 2000d).

METHODOLOGY AND ASSUMPTIONS

The focus of wildlife and wildlife habitat information gathering and impact analysis was on wildlife groups, species, and habitats that were considered most likely to be exposed to potential effects of personal and other types watercraft uses in the analysis area. Using technical reports from the published literature that described the most susceptible aspects of species life cycle and/or habitat needs as a guide, quantitative and qualitative information was gathered regarding the presence and status of these features within the recreation area. Knowledgeable scientists and ecologists on the recreation area staff, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, and Utah Division of Wildlife Resources were contacted for unpublished information and professional judgments regarding the status of species, wildlife groups, habitats, special habitat features, and likely personal watercraft and other watercraft effects on these wildlife groups and habitat features.

Wildlife groups considered to be particularly high interest and strong candidates for reflecting reactions to personal and other watercraft uses included nesting and feeding shore- and wading birds, waterfowl, nesting raptors (which includes hawks, owls, eagles, and falcons), desert bighorn sheep, and Glen Canyon chuckwalla. Special-interest habitat features that were evaluated for potential effects included wading and shorebird nesting rookeries, active raptor nest sites, gull and/or tern beach or shoreline nesting areas, shallow-water fish spawning areas, high-density wildlife concentration areas (typically associated with wetlands or submerged aquatic vegetation beds), and colonial roost sites. The presence of these features were determined by interviewing knowledgeable scientists and ecologists and by reviewing existing geographic information systems resource maps of the recreation area. Resource specialists were also interviewed about reports or documentation of past conflicts between watercraft users and wildlife and habitat. If such conflicts were documented, information regarding the locations, frequency, and causes of the conflicts was acquired and evaluated.

Threatened and endangered species, which include species that are members of these general groups are addressed separately in the "Threatened, Endangered, and Special-Concern Species" section.

Aquatic species and especially susceptible habitat features are included in this section.

The area of analysis is the area where personal watercraft are permitted to operate and the adjoining shoreline, extending up to 500 feet inland from the maximum pool of 3,700 feet above sea level. Beyond this point, personal watercraft noise would be considerably reduced, and effects from personal watercraft users would decline substantially.

Technical wildlife and fisheries literature findings were used to assess potential effects of watercraft operations, noise, user behaviors, minimum flushing distances, recommended protective buffer zone distances on each target wildlife group and species. The susceptibility of habitat features and vegetation communities to adverse effects caused by watercraft and their users was derived from literature reports addressing plant community and wildlife species tolerances to human disturbances and recovery capabilities. Reported literature findings were supplemented and adjusted to account for existing environmental conditions and visitor and watercraft use characteristics currently present in the analysis area.

It was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of

watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B.

Impact Threshold Definitions. The following thresholds were used to determine the intensity or magnitude of effects on wildlife and wildlife habitats:

Negligible — There would be no observable or measurable impacts on native fish and wildlife species, their habitats, or the natural processes sustaining them. Impacts would be of short duration and well within the range of natural fluctuations.

Minor — Impacts would be detectable, but they would not be expected to be outside the natural range of variability and would not be expected to have any long-term effects on native species, their habitats, or the natural processes sustaining them. Population numbers, population structure, genetic variability, and other demographic factors for species may have small, short-term changes, but long-term characteristics remain stable and viable. Occasional responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, or other factors affecting population levels. Key ecosystem processes may have short-term disruptions that would be within natural variation. Sufficient habitat would remain functional to maintain viability of all species. Impacts would be outside of critical reproduction periods for sensitive species.

Moderate — Breeding animals of concern are present; animals are present during particularly vulnerable life-stages, such as migration or juvenile stages; mortality or interference with activities necessary for survival can be expected on an occasional basis, but is not expected to threaten the continued existence of the species in the recreation area. Impacts on native fish and wildlife species, their habitats, or the natural processes sustaining them would be detectable, and they could be outside the natural range of variability for short periods of time. Population numbers, population structure, genetic variability, and other demographic factors for species may have short-term changes, but would be expected to rebound to pre-impact numbers and to remain stable and viable in the long term. Frequent responses to disturbance by some individuals could be expected, with some adverse impacts on feeding, reproduction, or other factors affecting short-term population levels. Key ecosystem processes might have short-term disruptions that would be outside natural variation (but would soon return to natural conditions). Sufficient habitat would remain functional to maintain viability of all native fish and wildlife species. Some impacts might occur during critical periods of reproduction or in key habitat for sensitive native species.

Major — Impacts on native fish and wildlife species, their habitats, or the natural processes sustaining them would be detectable, and they would be expected to be outside the natural range of variability for long periods of time or to be permanent. Population numbers, population structure, genetic variability, and other demographic factors for species might have large, short-term declines with long-term population numbers significantly depressed. Frequent responses to disturbance by some individuals would be expected, with adverse impacts on feeding, reproduction, or other factors resulting in a long-term decrease in population levels. Breeding colonies of native species might relocate to other portions of the recreation area. Key ecosystem processes might be disrupted in the long term or permanently. Loss of habitat may affect the viability of at least some native species.

Impairment — Impairment of recreation area's wildlife resources would occur if an impact resulted in the elimination of a native species, significant population declines in a native species, or the inability of the recreation area to meet recovery objectives for listed species.

Geographic Area Evaluated for Impacts. The area being analyzed for possible impacts on wildlife and wildlife habitats consists of Lake Powell and its associated tributaries including, but not limited to, the San Juan, Colorado, Dirty Devil, and Escalante Rivers within the boundaries of Glen Canyon National Recreation Area. The area of analysis includes a terrestrial zone encompassing these water bodies from the water-land interface up to either 500 horizontal feet beyond the 3,700-foot water surface elevation or the canyon wall apex, depending on the topography of the area being considered.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Under alternative A, except for natural changes in visitor growth rate that would occur over the next 10 years, personal watercraft use on Lake Powell would not be substantially different from levels that existed when personal watercraft were used in accordance with the *Superintendent's Compendium* (NPS 2002c). Noise, human disturbance, access into shallow-water, and possible alterations of vegetated areas of potential value to wildlife as habitats from personal watercraft use would occur at or close to the existing conditions discussed in the "Affected Environment" chapter.

Several potential impacts on wildlife and wildlife habitats have been associated with personal watercraft use. These include habitat disturbance; noise; and the ingestion, absorption and/or bioaccumulation of petroleum hydrocarbon additives and derivatives. These potential impacts are described briefly below.

Personal watercraft have the ability to navigate shallow waters using their method of "jet" propulsion. This ability gives them access to areas not accessible by other motorized watercraft. These may include shallow areas that provide wildlife habitat. As shown in figure 14, the topographic features of the recreation area create many conditions that allow other types of motorized watercraft to approach very close to the shore. Extensive areas of shallow-water flats that might attract wildlife use and exclude all motorized watercraft except shallow-draft personal watercraft are rare conditions in the recreation area (see figure 15).

FIGURE 14: TYPICAL STEEP SHORELINE

FIGURE 15: SHORELINE ACCESS BY MOTORIZED VESSELS

Habitat disturbance from personal watercraft would include impacts due to watercraft wakes, traveling through near-shore and shallow-water areas at high speed, and impacts of personal watercraft users accessing/trampling shoreline vegetation. Nonmotorized watercraft such as canoes, kayaks, and rafts would also be able to access similar shallow-water areas, although the general abundance and radius of mobility of these types would not be as extensive as motorized personal watercraft (unless these craft are associated with and brought to an area with a houseboat).

Noise emissions from personal and other motorized watercraft are associated with motorcraft operations. Total noise intensities, durations, and frequencies change dramatically throughout the recreation area as a function of several variables, including number of engines, engine mixes, distance between the wildlife receptor and the noise sources, topographic features that may shield potential receptors from noise sources, and the level of noise habituation possessed by the wildlife receptor. Current motorized boating and other recreational activities expose wildlife receptors to a wide range of noise conditions. Noise levels are generally directly proportional to the levels of visitor use. Noise intensity and durations tend to be higher and most persistent near the marina, launch, and fueling facilities and most noticeable during the peak use months.

The vast majority of personal watercraft in use today are powered by conventional two-stroke, carbureted engines, which discharge as much as 30% of their fuel directly into the water (NPS 1999c; CARB 1999a).This discharge releases contaminants into the water. The possibility exists for some aquatic and water-associated wildlife species to inadvertently ingest or absorb some of these contaminants, primarily polycyclic aromatic hydrocarbons and the benzene, toluene, ethylbenzene, and xylenes complex, during feeding or other activities.

Mammals. Noise would produce negligible, short-term, adverse impacts on larger mammals (i.e., bighorn sheep, mule deer, and coyote) within the area of analysis. The highly mobile large mammals found within the Lake Powell area spend relatively limited time near the shoreline where expose to noise and human activity would be most intense. These areas are generally avoided because of unsuitable habitat conditions. In addition it is likely these animals have already habituated to anthropogenic sources of noise, such as noise generated by watercraft engines. Future changes would not be expected with this alternative.

Wagner (1994) and Rodgers and Schwikert (2002) measured noise production from personal watercraft compared to other two-stroke outboard motors. They reported that personal watercraft noise levels are either lower than or not much different from most other types of watercraft. Noise loudness decreased with distance from the watercraft, such that the sound level was within background levels at distances of 300 feet or more (Wagner 1994). These findings suggest potential noise impacts from personal watercraft would be limited in areal effect, temporary, and similar to the effects of other types of two-stroke outboard engine watercraft present in the recreation area (classified as negligible, direct, adverse, short-term impacts).

During their study of the effects of simulated, low-flying aircraft noise (92 to 112 decibels) on mule deer and desert bighorn sheep, Krausman et al. (1996) concluded that “the animals in the study habituated rapidly [to noise] and probably did not view the stimuli as a threat. The frequency and noise level were not detrimental to their well-being, and the noise did not inhibit their reproductive mechanisms.” Noise levels produced by personal watercraft are substantially lower than those of the aircraft in the study, ranging from 65–78 decibels at 50 feet (decreasing with increasing distance), and would be expected to have similar negligible impacts on individuals or herds in the vicinity. Primary contact activities, feeding near and/or drinking from Lake Powell and its tributaries would occur from

dusk until dawn when very few (1%) personal watercraft users are active and noise levels are at a minimum.

Impacts on rodents due to habitat disturbance would include trampling of burrows, and in very rare instances trampling of individuals, by personal watercraft users. These potentially adverse impacts would be short-term and negligible, due to the limited amount of suitable habitat found within the area of analysis, and the rarity of such occurrences.

Potential impacts on mammals from possibly ingesting fuel-contaminated surface waters would be a negligible, short-term adverse impact because contaminant concentrations would be very low (after fuel discharges became diluted by surface waters), the exposure frequency would be very low, and the acute and chronic toxicity thresholds for the contaminants are typically very high for mammals (generally on the order of thousands or tens of thousands of parts per million) required to produce detectable toxic effects.

The recreation area's law enforcement and environmental staffs were interviewed as another method of determining whether personal watercraft or other types of motorized watercraft uses were responsible for adverse impacts on high-interest wildlife resources and wildlife habitats. There were no reported or documented cases of problems (NPS, Spence, pers. com., May 2002n).

Birds. Impacts on water-associated birds, particularly waterfowl, wading, and shore-line nesting species, would be a negligible, short-term adverse effect. Several reasons support this conclusion. First, concentrations or large numbers of birds that might develop for nesting, breeding, or staging purposes do not occur to any significant degree during the months when personal watercraft uses are most common. This condition precludes many potential impacts associated with watercraft, including flushing birds; creating wakes and disturbances that might disrupt nesting activities; altering habitat so that it becomes unsuitable for bird feeding, loafing, or security uses; and injuring birds through physical contact. An occasional flushing response may be elicited as watercraft move through areas occupied by water or shorebirds. However, these reactions are common with all motorized watercraft, not just personal watercraft. Such disturbances are usually temporary events that are restricted to limited areas and affect a small number of individuals.

High-density bird concentration areas, such as nesting or roosting rookeries, feeding areas, and shoreline gull or tern nesting colonies are not present at the recreation area (NPS, Spence, pers. com., May 2002n). Therefore, there would be no adverse effect on these special-interest bird groups or shoreline areas that might provide habitat for such uses.

Potential boating and personal watercraft disturbance effect on water-associated bird groups were recently reported on by Rodgers and Schwikert (2002). The objectives of the investigations were to:

> Determine whether there were differences in minimum flushing distances among different bird species when they were exposed to moving personal watercraft and outboard-powered boats (14-foot, 30 horsepower boat); and
>
> Estimate minimum buffer zone distances that would protect the species from either personal watercraft or outboard motor disturbances in *critical wildlife foraging and loafing areas*.

Twenty-three species of birds were tested, with 16 species producing comparable data for the two types of watercraft. For 11 of the 16 species (about 69% of the species tested), there was no significant difference in the minimum flushing distances between the two types of watercraft. For four of the five

remaining species (80%) where there were significant differences in the minimum flushing distance between watercraft types, the outboard-motor powered boat more often elicited a significantly greater flush distance than the personal watercraft. A notable finding of the testing revealed highly variable results among bird species and among individual birds within the same species in response to vessels of both types.

Recommended buffer distances for exposure to high-speed vessels varied by bird taxonomic group and by type of vessel, ranging from about 594 feet for wading birds to about 330 feet for plovers and sandpipers. The authors indicated buffer distances could be shortened in flat-wake zones where there are low levels of human activity and limited intrusion but provided no specific distances. Burger (1998) suggested a buffer zone distance of about 330 feet to protect nesting colonies of common terns from disturbance effects of personal watercraft.

Rodgers and Schwikert (2002) measured the noise levels of the two types of watercraft at fixed distances, although the analysis of noise-induced effects were not a focus of the investigation. These measurements indicated the outboard-powered boat generated 2 to 5 decibels more noise at each 33-foot measurement increment than the personal watercraft. Decibel measurements for the outboard-powered boat ranged from 87 decibels at 33 feet to 66 decibels at 165 feet. Decibel measurements for the personal watercraft ranged from 83 decibels at 33 feet to 64 decibels at 165 feet. The authors concluded flushing distances were primarily determined by the speed and the approach angle of the approaching vessel (Rodgers and Schwikert 2002).

Based on such findings and the existing bird uses of the recreation area shorelines and main lake areas, disturbance effects from personal watercraft would be a negligible adverse, short-term impact because effect on populations and habitats would be well within the range of natural variability and no detectable changes in habitats would result from such activities.

Water birds, such as herons, gulls, and ducks, feed on aquatic and benthic invertebrates and ingest sediments in the process. This may cause concerns about the effects of polycyclic aromatic hydrocarbons in sediments and bioaccumulation. However, birds generally tolerate ingestion of petroleum hydrocarbons easily. Studies have noted no signs of toxicity, reduction in feeding, loss of body weight, or grossly visible pathological abnormalities in mallards fed up to 100,000 parts per million of weathered Exxon Valdez crude oil (Neff and Stubblefield, 1995). This concentration would not be encountered under normal circumstances within the Lake Powell area, suggesting only short-term, negligible to minor, adverse impacts would be expected from birds ingesting petroleum hydrocarbon additives and derivatives associated with personal watercraft or other types of motorized watercraft. Other fuel constituents, such as ethylbenzene, xylene, and toluene are very volatile and evaporate or are degraded to non-toxic constituents within hours or days by physical, chemical, and microbiological processes. Therefore, at concentrations typically associated with recreational boating, these contaminants would be unavailable for bird or other wildlife ingestion.

Reptiles and Amphibians. There is a general absence of reptile and amphibian populations within the reservoir and the river tributary shoreline zones because of environmental constraints. Therefore, adverse impacts from personal watercraft or their uses would be negligible and long-term. No changes from present conditions would be expected with this alternative.

The Glen Canyon chuckwalla occurs throughout the terrestrial portion of the area of analysis, most commonly in rocky or cliff habitats near the lake shore. As a result, this chuckwalla subspecies would be susceptible to capture or disturbances by personal watercraft users. Alternative A would have a

negligible, long-term, adverse impact on this species, with effects probably resulting from occasional opportunistic collecting by personal watercraft users.

Fish. Few studies have documented direct impacts of boat activity on individual fish behavior or mortality (Asplund 2000). No studies were located that documented such effects from personal watercraft operations. Asplund (2000) concluded available studies have demonstrated that boating activity can temporarily disturb fish from shallow-water nesting areas, but that overall breeding success is likely not adversely affected. Toxic effects on fish have generally not been observed, except in extreme situations, such as near boat testing facilities.

A few laboratory studies conducted on the impacts of noise on the auditory threshold of fish concluded that some species (like the fathead minnow and other cyprinid fishes) may experience an elevated auditory threshold as a result of exposure to high intensity (142 dB), close range (3 feet), noises (Scholik and Yan 2002a). However, the circumstances of this study would rarely, if ever, be duplicated in the Lake Powell setting. Under normal conditions effect on fish from noise would include occasional flushing when motorized watercraft ran directly over individuals or schools. The direct adverse impact on the fish would be short-term and negligible because the effects would disappear as soon as the watercraft moved out of the area and effects would be restricted to the immediate areas of the watercraft. Such effects could also occur with other motorized watercraft that beach or launch in shallow-water areas typically used by minnows and other shallow-water species.

Impacts on fish from the physical intrusion of personal watercraft would primarily be associated with direct or indirect disturbance of their habitat, including spawning habitat. While approaching more remote landing areas around the lake, personal watercraft activity may temporarily increase subsurface turbidity and scour subgrades. However, personal watercraft operator's tendency to concentrate near central marinas on the lake where there are deeper waters would make the effect on shallow aquatic habitats infrequent occurrences. Consequently, direct effects from such activities would be short-term and negligible, primarily because of the limited number of instances when such conditions could occur.

Potential direct adverse toxic effects on fish from pollutants in personal watercraft exhaust would be short-term and negligible. Average toluene concentrations observed within the limited Lake Powell water sample results were less than 3 parts per billion, while levels known to have an effect on fish occur at around 6,000 parts per billion (Devlin et al. 1982). Benzene concentrations found within the lake also fall well below ecotoxicological levels, as do concentrations of naphthalene, 1-methyl naphthalene, and methyl tertiary-butyl ether (see "Water Quality" in the "Environmental Consequences" chapter). There have been no reported or documented fish kills or chronic aquatic life pollution problems reported for the recreation area that have been linked to personal or other watercraft (NPS, Spence, pers. com., May 2002n).

The U.S. Fish and Wildlife Service conducted a study between 1991 and 1994 in which fish bile was tested for concentrations of polycyclic aromatic hydrocarbons (PAH). PAH can be taken up from the environment through ingestion and/or absorption and are linked to adverse health effects such as liver and skin lesions and tumors. The fish were collected from the main channel, marinas, and San Juan arm of the recreation area. PAH were detected in the bile of fish at concentrations consistent with values indicating exposure to sediments that are considered to be low to moderately contaminated. However, no indication of adverse health effects, lesions or tumors, were found in any of the fish collected (U.S. Fish and Wildlife Service 2002b).

Aquatic Invertebrates. Most aquatic invertebrates (mussels, clams, insects, zooplankton) are found in and on bottom substrates, such that direct impacts from noise and habitat disturbance would not occur. This is particularly true on Lake Powell where shallow-water shoreline areas constitute very little of the total area. Although some negligible, short-term, adverse direct impacts might occur within a localized shallow-water area under certain conditions (e.g., the area supported populations of aquatic invertebrates and the area was used frequently and for prolonged periods by personal watercraft), the adverse effects would be within the range of natural aquatic system variability. Adverse physical conditions would typically involve isolated events, resulting from short-term increases in turbidity and scouring of the bottom.

Reported direct toxic effects of benzene, toluene, ethylbenzene, and xylenes compounds to aquatic invertebrates include increases in oxygen consumption, decreased hemoglobin concentration, increased appendage movement, reduced ingestion rates, immobilization and mortality. Among the polycyclic aromatic hydrocarbons, toxicity is reported to increase with the number of rings, and with molecular weight (Foster Wheeler Environmental Corporation 1997). Limited measurements of benzene, toluene, ethyl benzene, and xylenes and polycyclic aromatic hydrocarbons concentrations within Lake Powell during high-use personal watercraft periods (see "Water Quality" in the "Environmental Consequences" chapter) were lower than reported toxic (i.e., immobilization and death) concentrations. Indirect impacts from bioaccumulation of benzene, toluene, ethylbenzene, and xylenes and polycyclic aromatic hydrocarbons would be short-term, negligible to minor, and adverse.

Cumulative Effects. The incremental effects resulting from operating personal watercraft as proposed by alternative A would be negligible contributors to the cumulative condition of wildlife and fish resources in the recreation area. Even when personal watercraft effects were combined with the incremental effects resulting from other motorized watercraft operating on the lake, the cumulative impacts would be negligible to minor, short-term, and adverse.

As was described in the preceding sections, the effects would be noticeable but would be temporary and localized. Adverse effects on vegetation from personal watercraft users that could provide wildlife habitat would be masked by the effects of water level changes associated with reservoir management. Fish populations, including their habitats, would be affected substantially more by reservoir operations than by the limited effects that personal watercraft equipment and users might have on local populations and habitat conditions within the lake.

The incremental changes in fish and wildlife resources possibly resulting from personal watercraft users who would be associated with future projects would also be negligible to minor adverse direct impacts because of the low numbers involved. For example, the proposed Wahweap campground improvements would accommodate additional campers during peak season by providing 48 additional hookup sites. If every additional user were a personal watercraft operator, the total number would represent a very small contribution to the current annual visitor population. The Antelope Point marina project would facilitate personal watercraft launch and retrieval operations, but would probably not result in substantially greater numbers of watercraft on the reservoir. No cumulative impacts on wildlife or wildlife habitats due to this small increase in recreation area visitation would be expected.

Conclusion. Personal and other watercraft uses with alternative A would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Population numbers, population structure, genetic

variability, and other demographic factors for species may experience small, short-term changes, but long-term characteristics of wildlife and wildlife habitat within the area of analysis would remain stable and viable.

Operations of personal watercraft would not adversely impact special-interest wildlife concentration or high-quality wildlife habitat areas because such resources are not present in the recreation area. Special-interested wildlife features (such as active peregrine falcon nest sites) are present in the recreation area and many occur in areas visited by personal watercraft and other types of motorized watercraft.

Alternative A would not contribute to deterioration of the recreation area's fish or wildlife resources to the extent that the recreation area's purpose could not be fulfilled as established in its enabling legislation. It would not affect resources key to the recreation area's natural integrity or opportunities for enjoyment or affect the wildlife or wildlife habitat resource, whose conservation is identified as a goal in the recreation area's general management plan. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Personal watercraft use under alternative B would be the same as alternative A except that additional geographic restrictions on personal watercraft use would be implemented and carbureted two-stroke personal watercraft would be prohibited at the end of 2012. About 25 miles of the Colorado River upstream of Sheep Canyon and upper portions of the San Juan (38 miles), Escalante (41 miles), and Dirty Devil (19 miles) Rivers would be closed to all personal watercraft. Flat-wake speed restrictions would also be prescribed for upper portions of the Escalante River.

Current use of these proposed restricted areas is very light, even during the high use season, with an average of 2 to 10 personal watercraft and about the same number of other watercraft types observed at any time within the restricted areas on the Escalante and Dirty Devil Rivers. Less than one personal watercraft and other type of watercraft might be present at any given time on either the Colorado or San Juan Rivers.

Prohibiting the use of carbureted two-stroke personal watercraft under alternative B at the end of 2012 would provide an indirect beneficial impact to wildlife and wildlife habitat as a result of a decrease in emissions to air and water quality.

Cumulative Impacts. Incremental effect on cumulative impacts from personal watercraft and other watercraft associated with either the Wahweap campground improvement project or the Antelope Point marina project would be similar to those described for alternative A.

Conclusion. Impacts on wildlife and wildlife habitats due to alternative B would result in negligible to minor short-term adverse impacts. Under some conditions impacts, from noise, high-speed personal watercraft operations, shoreline habitat disturbances, and the ingestion or absorption of fuel constituents, petroleum hydrocarbon additives and derivatives, could be observable and/or measurable. However, changes resulting from such conditions would not be expected to be outside the range of natural environmental and biological variability. Prohibiting carbureted two-stroke personal watercraft engines at the end of 2012 would indirectly benefit wildlife and wildlife habitat.

Alternative B would not contribute to deterioration of the recreation area's wildlife resource to the extent that the recreation area's purpose could not be fulfilled as established in its enabling legislation. Implementing this alternative would not result in an impairment of wildlife, fish, or supporting habitat resources.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

With alternative C, personal watercraft use would be prohibited. Noise and disturbance effect on fish and wildlife species and their supporting habitats from existing personal watercraft use on the lake would be incrementally reduced by the number of personal watercraft currently present. These effects would be short-term, negligible, direct and indirect, beneficial impacts. The beneficial effects of the personal watercraft ban would be negligible and temporary because motorized watercraft of several types and their users would still use the lake, creating noise emissions and human disturbances. In the longer-term when visitor numbers recovered, effects would be similar to those described for alternative A.

Cumulative Effects. Closure of Lake Powell to personal watercraft use would reduce the total number of watercraft on the lake by approximately 26%. Other motorized watercraft use would continue. Possible short-term and long-term benefits derived from eliminating personal watercraft use would not be noticeable or distinguishable from background variations in wildlife population numbers or conditions.

The Wahweap campground improvement project and the Antelope Point marina project would slightly increase the use of the lake for water-based recreation. Under alternative C, all of these visitors would use watercraft other than personal watercraft. Although this use would be additive with current use of the lake, it would differ little from the effects that would occur from personal watercraft under alternatives A or B and would have a negligible effect on wildlife and wildlife habitat.

Conclusion. Alternative C would have a negligible, short-term, beneficial impact on wildlife and wildlife habitat from a reduction in boat-days that initially would result from eliminating personal watercraft use on the lake. By the end of the analysis period in 2012, the number of boat-days would have returned to levels within the range predicted for alternatives A and B. Because the effects on wildlife and wildlife habitats from personal watercraft and other types of motorcraft are similar, the long-term effect of alternative C on wildlife and wildlife habitats would be negligible. Alternative C would not result in impairment of fish and wildlife species or their supporting habitats.

THREATENED AND ENDANGERED SPECIES

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

The same personal watercraft management issues described for wildlife and wildlife habitats and for shoreline vegetation pertain to the species designated as either endangered or threatened. These species have the same kinds of environmental needs as species without this designation. Key differences are that endangered or threatened species generally are much less abundant, have more limited range distributions, and many have less tolerance to habitat alterations.

Issues for endangered or threatened species relate to noise, human disturbance, toxicity from compounds in fuel, and habitat loss or degradation. In addition, endangered or threatened species require consideration in accordance with the requirements of the *Endangered Species Act*. The National Park Service must ensure that the effects of personal watercraft management would not jeopardize the continued existence of designated species or their designated critical habitats.

Management Objectives

Glen Canyon National Recreation Area has several management objectives that provide for the management of endangered fish habitat. The *Natural Resources Management Plan and Environmental Assessment for Glen Canyon National Recreation Area* (NPS 1986) established protection of all known populations of endangered fish species from impacts of human activities in the recreation area. The *Fish Management Plan*, *Glen Canyon National Recreation Area* (Utah Division of Wildlife Resources 1996) includes provisions for inflow and endangered native species habitat protection. This management document acknowledges river inflow areas as a critical habitat and stated that surplus endangered fish species provided from the native fish-stocking program occasionally are released in the critical habitat reaches at inflows to Lake Powell.

Three objectives that apply to endangered native species habitat management were included in the *Fish Management Plan, Glen Canyon National Recreation Area* (Utah Division of Wildlife Resources 1996). They include:

> Maintaining or enhancing forage conditions to allow adequate nutrition of all fish in Lake Powell;
>
> Providing adequate habitats with ample vegetative cover to improve nursery habitat; and
>
> Understanding and minimizing the impacts of dam operation on native and sport fish populations.

GUIDING REGULATIONS AND POLICIES

The *Endangered Species Act* (16 U.S.C. 1531 *et seq*.) defines the terms and conditions of the Federal status of species in the recreation area and requires an examination of impacts on all federally listed,

species proposed for listing, and designated critical habitats for threatened or endangered species. *Management Policies 2001* (NPS 2000d) further states that the National Park Service will consider potential effects of agency actions on state or locally listed species. The National Park Service is required to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend.

Neither Arizona nor Utah has a threatened or endangered fish and wildlife statute, but both have statutes that protect endangered and threatened plant species. The Utah State Lands Endangered and Threatened Plant Species statute (Title 65A-2-3) defines the terms and conditions of the state status of endangered or threatened plant species. The State Lands Division may make determinations concerning the management, protection, and conservation of plant species officially designated as endangered or threatened under the federal *Endangered Species Act of 1973*, as amended, on state lands. Under the schools and state trust lands statute (Title 53C), this is also true for state trust lands.

Arizona statute Title 3 Chapter 7 (Article 1, section 3-903) authorizes the director to establish and maintain a list of state-protected native plants. The statute includes protective coverage of native plants that are present on state, public, or privately owned land. Categories of protected native plants include species that are:

> In danger of extinction throughout all or a significant portion of their ranges;
>
> Likely within the foreseeable future to become jeopardized or in danger of extinction throughout all or a significant portion of their ranges; or
>
> Resident to Arizona and listed as endangered, threatened, or category 1 in the federal *Endangered Species Act of 1973* (PL 93-205; 87 Stat. 884; 16 U.S.C., sections 1531 *et seq*.), as amended, and any regulations adopted under that act.

Title 3 chapter 7 article 1, section 3-910 defines the terms and conditions for investigations of native plants and authorizes the state to determine whether or not protected species exist on the land.

METHODOLOGY AND ASSUMPTIONS

Identification of state and federally listed species and designated critical habitats was accomplished through discussions with recreation area staff, informal consultation with U.S. Fish and Wildlife Service personnel, and reviews of databases maintained by the Arizona Game and Fish Department and Utah Division of Wildlife Resources. A letter requesting a current list of federal threatened, endangered, and special-concern species was sent to the U.S. Fish and Wildlife Service. The response from the U.S. Fish and Wildlife Service to this request is included in appendix H.1. As part of the consultation process, the Draft Environmental Impact Statement was submitted to the U.S. Fish and Wildlife Service for their review in October 2002. The U.S. Fish and Wildlife Service provided response to the *Draft Environmental Impact Statement* and concurred that the three alternatives presented are "not likely to adversely affect" threatened or endangered species or their critical habitat. Their response to the *Draft Environmental Impact Statement* can be found in volume II of this *Final Environmental Impact Statement*. The Arizona Game and Fish Department and Utah Division of Wildlife Resources were also contacted to identify state threatened, endangered and special-concern species. Responses are included in appendix H.2 and appendix H.3.

An analysis of the potential impacts on listed species and designated critical habitats occurring in the recreation area is included in this section. Species analyzed include the humpback chub, bonytail, Colorado pikeminnow, razorback sucker, southwestern willow flycatcher, yellow-billed cuckoo, and bald eagle. An impact analysis was not conducted for Federally listed or candidate species that do not occur within the analysis area (see table 15).

Management Policies 2001 (NPS 2000d) states that potential effects of agency actions will also be considered on state- or locally listed species. An analysis of the potential impacts on the American peregrine falcon, which is classified as an Arizona special-status species and a Utah endangered species, is included in this section. The humpback chub, bonytail, Colorado pikeminnow, razorback sucker, Mexican spotted owl, and the southwestern willow flycatcher are also listed as endangered or threatened by the Utah Division of Wildlife Resources.

Data used from the recreation area include staff interviews, general management, natural resource management, fish management and water resources management plans.

Steps used in assessing impacts of personal watercraft management alternatives on listed species included:

Establishing current presence, habitat availability, and uses of areas by listed species;

Identifying species associated with areas most likely to be affected by personal watercraft use under each alternative;

Determining habitat loss or alternation caused by the alternatives; and

Determining displacement and disturbance potential of the actions and the species' potential to be affected by personal and other watercraft activities.

The information contained in this analysis was obtained through best professional judgment of recreation area staff and experts in the field (as cited in the text), and literature review. Assumptions made regarding how personal watercraft and other watercraft operate relative to threatened, endangered, and special-concern species included the following.

The analysis area includes Lake Powell up to the 3,700-foot water surface elevation shoreline, and near-shore uplands within 500 horizontal feet of Lake Powell's 3,700-foot water surface elevation. Personal and other watercraft use could involve activities along the shore and on the near-shore uplands to approximately 500 feet from the 3,700-foot lake water surface elevation. This 500-foot area is assumed to cover the range of personal and other watercraft uses of adjacent upland near-shore areas such as travel to and from the shoreline, short-term excursions to explore uplands adjacent to the shoreline, and temporary watercraft landing and storage.

The entire lake is within one management zone, the Recreation and Resource Utilization Zone. Near-shore uplands adjacent to the lakeshore include Natural and Development Zones, and the coverage of these zones fluctuates in relation to the lake-surface elevation.

Primary personal watercraft and other watercraft use occurs from Memorial Day to Labor Day. The secondary periods of recreation area visitation are May 1 to Memorial Day and Labor Day until October 15.

Personal watercraft and boat users accessing the shoreline from the recreation area tend to use existing boat ramp facilities to launch their watercraft.

When accessing the shoreline from the lake, most personal watercraft and other boat users stay within visual sight of their watercraft.

Personal watercraft within 60 feet of other watercraft or facilities with other watercraft present travel at a speed of 5 miles per hour or less to minimize wake production.

Impact Threshold Definitions

The *Endangered Species Act* effect categories used to define impacts on listed species are as follows:

No effect/no adverse modification: This conclusion is reached if the proposed action and its interrelated and interdependent actions would not directly or indirectly affect listed species or adversely modify designated critical habitat.

May affect/not likely to adversely affect/adversely modify critical habitat: Effects on special-status species or designated critical habitat are discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or completely beneficial.

May affect/likely to adversely affect species/adversely modify critical habitat: When an adverse effect to a listed species or designated critical habitat may occur as a direct or indirect result of proposed actions and the effect is either not discountable or completely beneficial.

Is likely to jeopardize proposed species/adversely modify proposed critical habitat: The appropriate conclusion when the National Park Service or the U.S. Fish and Wildlife Service identify situations in which personal watercraft use could jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within or outside recreation area boundaries.

The following impact thresholds were used to determine the intensity effects on listed species and critical habitat:

Negligible — No listed species of concern is present; no impacts or impacts with only temporary effects are expected.

Minor — Nonbreeding animals of concern are present but only in low numbers. Habitat is not critical for survival; other habitat is available nearby. Occasional flight responses by animals are expected, but without interference with feeding, reproduction or other activities necessary for survival.

Moderate — Breeding listed species are present; listed species are present during particularly vulnerable life-stages such as migration or juvenile stages; mortality or interference with activities necessary for survival expected on an occasional basis, but not expected to threaten the continued existence of the listed species in the recreation area.

Major — Breeding listed species are present in relatively high numbers, and/or listed species are present during particularly vulnerable life stages. Habitat targeted by personal watercraft use or

other actions has a history of use by listed species during critical periods and is somewhat limited. Mortality or other effects are expected on a regular basis and could threaten continued survival of the species in the recreation area. A taking under section 7 of the *Endangered Species Act* could occur.

Impairment — Personal watercraft use would contribute substantially to the deterioration of natural resources to the extent that the recreation area's listed species and critical habitat would no longer function as a natural system. Listed species and its habitat would be affected over the long term to the point that the recreation area's purpose (Enabling Legislation, *General Management Plan*, *Strategic Plan*) could not be fulfilled and resource could not be experienced and enjoyed by future generations.

Geographic Area Evaluated for Impacts

The area being analyzed for possible impacts on threatened and endangered fish species and designated critical habitats for this assessment (area of analysis) consists of Lake Powell above the Glen Canyon Dam, and its associated tributaries including, but not limited to the San Juan, Colorado, Dirty Devil, and Escalante Rivers within the boundaries of Glen Canyon National Recreation Area. For all other species the analysis area includes the 500-foot shoreline zone around the 3,700-foot elevation within the entire recreation area.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

With alternative A, personal watercraft and other watercraft would have access to and operate throughout Lake Powell and in river inlets where critical habitat for the endangered humpback chub, bonytail, Colorado pikeminnow and razorback sucker has been designated. Personal watercraft activity may occasionally coincide with peregrine falcon foraging and roosting, and with foraging activities of yellow-billed cuckoos or southwestern willow flycatchers along river or tributary riparian habitats.

Humpback Chub, Bonytail, Colorado Pikeminnow, and Razorback Sucker. Implementation of alternative A would have negligible, adverse, direct and indirect, short-term effects on endangered or threatened fishes. Under section 7 of the *Endangered Species Act*, these effects would be unlikely to adversely affect federally listed endangered or threatened fish species or their designated critical habitats in the recreation area. The magnitude and reasons for the effects are described in the following sections.

Access to the Colorado River and San Juan River inlets would remain open to use where critical habitat has been designated. Use of personal watercraft upstream of areas with measurable current would not be permitted on the Dirty Devil River thereby reducing the likelihood of any potential effect on critical habitat of endangered fish present in this river inlet. Effects of personal watercraft use on designated critical habitat of endangered fish species are not well known and no studies in the recreation area have been conducted on the subject (NPS, Spence, pers. com., May 2002n). The few razorback suckers and Colorado pikeminnows observed in the river inlets suggest there may be short periods of time that young-of-the-year and adult fish use Lake Powell's river inlets. There are no reported cases in which personal watercraft use in these areas were responsible for adverse impacts on these species.

Personal watercraft activity may generate audible surface and subsurface noise within or adjacent to critical habitat that may influence normal distribution and behavior of endangered fish. This could temporarily change normal use of backwaters and eddy currents, reducing the period of time fingerlings have to adjust to the river habitat (Radle n.d.). However, this would not likely adversely affect the razorback sucker because current personal watercraft use in river inlets during peak season is typically less frequent (less than 5%) and use does not occur over extended periods of time, nor is the watercraft activity as intense as it is nearer to the marinas (James et al. 2001a).

A majority of the more intense day-users typically use deeper, open waters of Lake Powell near Wahweap, Bullfrog, Halls Crossing, and Hite where no endangered fish or critical habitat are present. Because of the limited use of river inlets by endangered fish species, noise from personal watercraft would cause direct, short-term, negligible, adverse impacts. These changes may affect but would not likely adversely affect endangered fish or their critical habitats. There would be no impacts on these species in main reservoir areas because suitable habitat is absent.

Razorback suckers often use habitats comprised of flooded shorelines of saltcedar in the San Juan River inflow and frequent reaches near Neskahi Bay, Nokai Canyon and Paiute Farms to Clayhills Crossing (Mueller and Karp 2002). While approaching more remote landing areas around the lake personal watercraft may temporarily increase subsurface turbidity and scour subgrades in critical habitat. The watercraft launch and takeout area located at Clay Hills Crossing and Paiute Farms on the San Juan River provides very limited habitat conducive to razorback sucker use because only a few sparse stands of young saltcedar exist along these shorelines (NPS, Peterson, 1979a). However, few watercraft use river inlets because fluctuation of the lake water surface limits access to these shallow waters. Personal watercraft operators tend to avoid flooded areas containing shrubs, trees and emergent vegetation attractive to endangered fish. Minor disturbance to shallow sand or gravel bars and cobble substrate in shoreline coves may create or improve microhabitat for endangered fish. Such localized disturbance of critical habitat would be a direct, adverse, short-term, negligible impact. Under section 7 of the *Endangered Species Act*, these effects would not be considered likely to adversely affect endangered fish.

When traveling river inlets personal and other watercraft operators may periodically exceed the normal watercraft operating speed, intensity and duration. Exhaust from carbureted two-stroke engines during such conditions could generate hydrocarbon pollutants that accumulate on water surfaces and in sediment. Such exhaust emissions would temporarily change water quality conditions in a small area. Under flowing river conditions, concentrations would be diluted rapidly, and the more volatile constituents would evaporate and disperse quickly from surface waters.

Bioaccumulation of fuel pollutants generated by personal watercraft exhaust emissions would not be a concern because these constituents would either evaporate or be degraded by microbes within hours or days. Fuel discharge concentrations from the low number of personal watercraft that access river areas thought to be used by the endangered fish species would be low. Consequently, it is anticipated the direct and indirect adverse effects from personal watercraft pollutants would be short-term and negligible impacts. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect endangered fish.

Effects from personal watercraft use on designated critical habitat areas would be negligible, short-term, adverse, and direct because temporary channel, bottom, or vegetation changes caused by personal watercraft would be indistinguishable from the natural variability of these areas. River channel areas have constantly changing bottom configurations because of flow variations and

changing sediment loads. Physical changes resulting from personal watercraft use would quickly be masked by normal bottom and bank changes.

Bald Eagle. This species winters in the recreation area when limited personal watercraft activity occurs. As a result, personal watercraft use under alternative A would have little effect on wintering bald eagles or their winter habitat. The occasional disturbance of individual eagles by personal watercraft or other motorized watercraft passing nearby during the winter season would be a negligible, short-term, direct, adverse effect. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect the bald eagle.

American Peregrine Falcon. Direct interaction between personal watercraft and peregrine falcons would be unlikely. Indirect adverse effects may result from varying personal and other watercraft speed that generate noise levels that reverberate against steep canyon walls frequented by peregrine falcon. Depending on the speed, intensity and duration of the engine noise and the distance between the motorized personal watercraft, and the physical barriers that may exist between the source and a peregrine falcon, temporary exposure to high noise levels may temporarily change or influence peregrine falcon behavior.

The use of personal watercraft may indirectly affect peregrine falcons that forage in the vicinity of Lake Powell (NPS, Spence, pers. com., May 2002n). Motorized watercraft, including personal watercraft, currently use the upper reaches of the Escalante, Dirty Devil, and Colorado Rivers (James et al. 2001a) and the peregrine falcon continues to nest and breed successfully in these areas. The noise may cause localized avoidance of these locations by falcons during peak periods of watercraft operation, which would be a short-term, adverse, negligible effect on this species. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect this species.

Southwestern Willow Flycatcher. Alternative A would have negligible adverse effects on the southwestern willow flycatcher. This conclusion in based on the:

Low numbers of birds present throughout its occupied range;

Infrequent occurrence of this species in the analysis area;

Limited availability of suitable habitat in the recreation area; and

Very low likelihood that personal watercraft and their operators would use the shoreline areas with suitable habitat that are frequented by this species.

Designated critical habitat is not present in the recreation area. Therefore, there would be no adverse effects on this aspect of the southwestern willow flycatcher's environment. If interactions between personal watercraft operators and this species occurred, the direct adverse effects would be short-term and negligible, and probably would be limited to flushing a bird from a perch. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect the species at the population level.

Western Yellow-Billed Cuckoo. It is unlikely that personal watercraft operators would interact with this species. This conclusion in based on the limited availability of suitable cottonwood-willow riparian habitat and the limited and infrequent presence of this species along the river corridors. Few personal watercraft operators would access riparian shorelines with cottonwood-willow habitat used

by this species. On occasions when personal watercraft operators entered an area occupied by this species, there may be circumstances when the birds may be flushed from perch sites. This would be a short-term, direct, negligible, adverse effect. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect this species.

Cumulative Effects. Cumulative effects are not likely to adversely affect federally listed threatened or endangered species or their critical habitats. Lake Powell is located in the Recreation and Resource Utilization Zone, which permits the use of watercraft, including personal watercraft, and allows the development of facilities for these uses. Watercraft activity, support services, and other recreation activities allowed in the past would continue throughout the lake, including in river inlets and remote side canyons of the lake that contain critical habitat. Other recreational and shoreline access activities such as camping, picnicking, hiking, and nonmotorized boating would continue in remote tributaries and at more heavily used marinas. Effects of these activities would be negligible to minor for the reasons described above.

Annual and seasonal flooding and draw-down of the reservoir would affect the habitat use, habitat availability, and spawning success of endangered fish far more than the negligible potential effects on water quality, audible noise, or subsurface turbidity and bottom scouring that would be caused by watercraft activities. Shoreline flat-wake speeds applied to all watercraft would reduce engine emissions into the surface waters, resulting in minor improvement to water quality and reductions of ambient noise. Additional low-pollution engines would incrementally improve water quality over the long term.

Personal and other watercraft use in more remote river inlets such as the San Juan River would be less intense than near the marinas. The short-term use of watercraft in these tributaries would be considered normal recreational use. Under normal recreational use, engine emissions would have little direct effect on water quality (Warrington 1999), and indirectly to the fish species associated with this area.

The proposed Wahweap campground improvements would bring additional campers with motorcraft, including personal watercraft. The effects of these vessels would be additive with the effects of vessels already using the lake, but probably would not cause any additional adverse impacts on critical habitats or endangered fish. Reductions in employee housing in the Wahweap area also would not affect these species. The proposed new facilities at Antelope Point also would not change conditions for critical habitat or endangered fish.

Visitor access to remote areas within the river inlets where critical habitat for endangered fish could be located would continue at current levels. Visitors would include personal watercraft users, other boaters, hikers, and land-based users utilizing accessible shorelines.

Technological improvements in personal and other watercraft engines would reduce noise emissions. This could produce a negligible beneficial effect by reducing disturbances of sensitive individual or species. The improved engines also would have lower air and water emissions, which would have negligible benefits to critical habitat of endangered fish and bird species within river inlets of Lake Powell.

Beneficial effects on special-concern aquatic species would continue from ongoing implementation of the Glen Canyon natural resource management plan (NPS 1986) and the recreation area fish management plan (Utah Division of Wildlife Resources 1996). Benefits also would occur from current reintroduction of native endangered fish species. However, these species would continue to experience

adverse cumulative effects from predation, particularly by non-native species, and by the reduction in available habitat that was caused by damming the Colorado River and its tributaries.

Conclusion. Alternative A would not adversely affect any ecological, biological, or physical processes associated with endangered fish critical habitats. Continuing the location restriction on upstream portions in the Colorado, San Juan, Dirty Devil, and Escalante Rivers would provide some protection of critical habitat for endangered fish. Compared to current conditions, alternative A would have negligible effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo or their critical habitats within Lake Powell and its tributaries in the recreation area. Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area.

No impairment to threatened or endangered species or their designated critical habitats would occur from the implementation of alternative A.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

With alternative B, personal watercraft could operate throughout the upper portions of Lake Powell in river inlets where critical habitats for the endangered humpback chub, bonytail, Colorado pikeminnow, and razorback sucker have been designated in accordance with the restrictions described previously. Personal watercraft activity may occasionally coincide with peregrine falcon foraging and roosting, and with foraging activities of yellow-billed cuckoos or southwestern willow flycatchers along river or tributary riparian habitats.

Humpback Chub, Bonytail, Colorado Pikeminnow, and Razorback Sucker. Personal watercraft use would not be permitted in some portions of the Colorado, Escalante, Dirty Devil, and San Juan Rivers. This potentially would improve the protection of critical habitat available for endangered fish species. Increased protection of critical habitat located upstream of Sheep's Canyon in the Colorado River and Clay Hills Crossing in the San Juan River where adult razorback suckers occur would benefit potential fish uses of the inflow areas of Lake Powell (Mueller et al. 2002; Mueller and Karp 2002; USGS n.d.). Therefore, there would be a negligible, long-term, direct, localized beneficial impact on endangered fish in these areas. Use would be allowed on some portions of the Escalante River, but only at flat-wake speeds. The flat-wake restriction potentially would reduce audible subsurface noise and the emission of chemical contaminants into surface waters.

Personal watercraft use within river inlets would not be limited by season. Although peak watercraft operations run from late May to early September, a one-month transition season in the spring coincides with spawning periods of these species. Personal watercraft could temporarily increase the scour of shallow aquatic habitat while approaching or landing on river shorelines. However, personal watercraft use in river inlets would be lowest in the spring. Personal watercraft operators would typically avoid dense stands of inundated saltcedar where endangered fish larvae would be concentrated during the spring season. Thus, potential adverse direct effects on endangered fish spawning habitat and production potential would be short-term and negligible because the anticipated number and timing of personal watercraft presence would be very low or infrequent at the time fish use such areas. Fish use of such areas would be infrequent as well.

There would be an indirect beneficial impact on endangered fish under alternative B as a result of prohibiting carbureted two-stroke personal watercraft engines at the end of 2012 which would reduce the amount of petroleum related pollution being emitted into the water.

Effect on federally listed endangered fish related to personal watercraft use in other areas under alternative B would be similar those discussed for alternative A. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect any of the four endangered fish species or their designated critical habitats.

Bald Eagle. Bald eagles are transient users that seasonally winter in Glen Canyon National Recreation Area. Because of their transient nature and their presence primarily during the winter (in contrast to personal watercraft use, which occurs primarily during the summer), there would be negligible, direct, beneficial, effects from limiting personal watercraft use along the rivers. Under section 7 of the *Endangered Species Act*, the effects of alternative B may affect, but would be considered unlikely to adversely affect the bald eagle.

American Peregrine Falcon. This alternative would slightly decrease human disturbances and noise in some areas of the recreation area used by peregrine falcons. Negligible, long-term benefits could be associated with the reduced human access in some areas and reduced personal watercraft speeds in other areas. Otherwise, there would be little difference in effects compared to alternative A. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect this species.

Southwestern Willow Flycatcher. There would be no adverse or beneficial effects of this alternative for the same reasons that were described for alternative A. Designated critical habitat is not present in the recreation area, therefore, there would be no adverse effects on this aspect of the species' environment. If interactions between personal watercraft operators and this species occurred, the direct beneficial effects would be short-term and negligible, probably consisting of only one to two fewer cases of not flushing or displacing a bird. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect this species.

Western Yellow-Billed Cuckoo. Limited availability of suitable habitat and the infrequent presence of this species throughout the analysis area would make it unlikely that personal watercraft and their operators would interact with this species. As under alternative A, few personal watercraft operators would access riparian shorelines with cottonwood-willow habitat used by this species. On occasions when personal watercraft operators entered an area occupied by this species, there may be circumstances when the birds would be flushed from perch sites. This would be a short-term, direct, negligible, adverse effect. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect this species.

Cumulative Effects. Cumulative impacts are not likely to adversely affect federally listed endangered or threatened species or their designated critical habitats in the recreation area. Restriction of personal watercraft would further reduce the current number of personal watercraft that travel reaches of river inlets where critical habitats for the endangered fish species are located. However, because other types of motorized watercraft that produce effects similar to those of personal watercraft, the beneficial impacts from restricting personal watercraft would be negligible.

Annual and seasonal flooding and draw-down of the reservoir affect the habitat use, habitat availability, and spawning success of endangered fish far more than the negligible potential effects on water quality, audible noise, or subsurface turbidity and bottom scouring caused by watercraft

activities. Shoreline flat-wake speeds applied to all watercraft would reduce engine emissions into the surface waters, resulting in minor improvement to water quality and reductions of ambient noise. Additional low-pollution engines would incrementally improve water quality over the long term.

Conclusion. Restrictions on access and designation of flat-wake speeds along sections of river shorelines would produce short-term, direct, negligible benefits to habitats of endangered fishes in the inflow areas. These would occur because fewer personal watercraft would use these areas, and the remaining vessels would operate at lower speeds, producing less site disturbance. These effects would not change ecological function or structure of critical habitat and would probably be indistinguishable from the range of environmental variation that occurs under natural conditions. The availability, use, and location of suitable endangered fish habitat would be more extensively affected by reservoir operations and annual river runoff patterns than by operation of personal watercraft. Therefore, the impacts on endangered fish species and their designated critical habitat with alternative B would be similar to alternative A. Endangered fish would benefit indirectly with the prohibition of carbureted two-strike personal watercraft engines at the end of 2012 which would reduce the amount of fuel discharge into the water in subsequent years. There would be no distinguishable adverse effects on the bald eagle, American peregrine falcon, southwestern willow flycatcher, or yellow-billed cuckoo. As a result, this alternative would be unlikely to adversely affect these species in the recreation area.

Cumulative impacts are not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area.

No impairment would be expected to endangered, threatened, or special-concern species or their designated critical habitats with this alternative.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

With alternative C, personal watercraft would be eliminated. However, former personal watercraft users eventually would return to the lake with other types of motorcraft so that by the end of the 10-year analysis period, lake-wide use levels would be within the range predicted under alternatives A and B. This alternative would be unlikely to adversely affect federally listed endangered or threatened species or their designated critical habitats. Effects on these species and critical habitats under alternative C would be similar to those discussed for alternative A and alternative B.

Humpback Chub, Bonytail, Colorado Pikeminnow, and Razorback Sucker. Alternative C would provide negligible short-term improvements to critical fish habitat by reducing the number of motorcraft using the lake, including the river inlets, for two or three years. Reducing the currently small number of vessels that pass through shallow-water sand and gravel bars to reach near-shore uplands and sand beaches would reduce the potential of inadvertent disruption of some fish habitat. The magnitude of this effect on the species would be negligible and would be difficult to distinguish from the effects of natural river processes. The overall effect on the endangered fishes and their habitat would be direct, short-term, and negligible. Under section 7 of the *Endangered Species Act*, these effects would be considered unlikely to adversely affect any of these four species.

Bald Eagle. Effects on the bald eagle would be similar to those described for alternative B.

American Peregrine Falcon. The effects on the American peregrine falcon would be similar to those described for alternative B.

Southwestern Willow Flycatcher. The effects on the southwestern willow flycatcher would be similar to those described for Alterative B.

Western Yellow-Billed Cuckoo. The effect on the western yellow-billed cuckoo would be the similar to those described for Alterative B.

Cumulative Effects. As stated in the "General Methodology" section of this chapter, it was assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics. Removing personal watercraft from the lake would cause a short-term reduction in visitation, which would reduce the potential for the disturbance of some endangered or threatened species or their habitats. In the long term, total motorized watercraft numbers would return to previous levels. Benefits derived from removing personal watercraft would be restricted to the canyon areas where conditions would be similar to alternative B.

Visitor activity such as river rafting and other watercraft use within river inlets would continue along with camping, picnicking, and fishing. Shoreline flat-wake speeds would continue to apply to other watercraft. Engine emissions, which directly affect water quality and have an indirect effect on endangered or threatened species, would have minor improvements as the percentage of low-emissions engines on the lake increased. Combined with these other past, present, and foreseeable future activities, alternative C would result in negligible cumulative effects that are not likely to adversely affect endangered species or their designated critical habitat.

Annual and seasonal flooding and draw-down of the reservoir would affect the habitat use, habitat availability, and spawning success of endangered fish far more than the negligible potential effects on water quality, audible noise, or subsurface turbidity and bottom scouring that would be caused by watercraft activities. Shoreline flat-wake speeds applied to all watercraft would reduce engine emissions into the surface waters, resulting in minor improvement to water quality and reductions of ambient noise. Additional low-pollution engines would incrementally improve water quality over the long term.

Conclusion. Negligible improvements to endangered fish habitat would be expected, resulting in short-term, direct beneficial impacts on endangered fish and their designated critical habitats in the inflow areas. The bald eagle, American peregrine falcon, southwester willow flycatcher, and yellow-billed cuckoo might experience some negligible short-term beneficial direct impacts from reduced disturbance incidents during the two to three years when the total number of boat days are expected to decline. Alternative C would be unlikely to adversely affect endangered fish or birds or their critical habitat, special-concern species or state-sensitive species known to use critical habitats or frequent near-shore uplands and riparian habitats within the recreation area.

Cumulative impacts are negligible and not likely to adversely affect endangered, threatened, or special-concern species or their designated critical habitats in the recreation area.

No impairment would be expected to endangered, threatened, or special-concern species or their designated critical habitats from this alternative.

SHORELINE VEGETATION

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Previously identified concerns regarding personal watercraft activities that may disturb, injure or eliminate riparian, wetlands and submerged aquatic vegetation are addressed by the following analysis. Lake Powell is located within the Recreation and Resource Utilization Management Zone of Glen Canyon National Recreation Area. The recreation area's general management plan (NPS 1979a) guidelines encourage the maintenance of natural processes within this zone while allowing the use of watercraft and other recreational activities. In general, certain recreational activity such as beaching or landing of personal watercraft to access the shoreline could expose shoreline vegetation to trampling and compaction in some areas. Once on the shoreline, personal watercraft and other watercraft operators may disembark to explore or conduct other recreational activities. Shoreline and near-shore upland vegetation could be trampled while accessing trails or other portions of the shoreline.

Management Objectives

The management objective for shoreline vegetation for personal watercraft uses is listed in table 3. The objective is to manage personal watercraft use to protect native vegetation at or near the shoreline from personal watercraft user activity and access. Shoreline vegetation management objectives are not addressed by either the general management plan or the strategic plan for the recreation area.

GUIDING REGULATIONS AND POLICIES

According to *Management Policies 2001* (NPS 2000d), natural shoreline processes such as erosion, deposition, dune formation, overwash, inlet formation and shoreline migration should continue without interference within a park unit. Where the nature or rate of natural shoreline processes has been altered, the National Park Service is directed to identify alternatives for mitigating the effects of such activities or structures and for restoring natural conditions. The National Park Service must also comply with Executive Order 11990, Protection of Wetlands, which requires federal agencies to avoid the short-term and long-term adverse impacts associated with the destruction or modification of wetlands whenever possible.

The state of Arizona limits personal watercraft operations within 60 feet of another vessel unless both vessels are flat-wake. The state of Utah prohibits wake-producing speeds within 150 feet of another vessel; recreating individuals such as a swimmer, waterskier, or shore fisherman; or facilities such as a launching ramp, dock, or swimming area. Maintaining flat-wake speeds helps to reduce surface water displacement and compounded waves that may erode shorelines and shoreline substrate where vegetation may be present.

METHODOLOGIES AND ASSUMPTIONS

The analysis addressed several types of shoreline vegetation communities, which included riparian zones, wetlands, and submerged aquatic communities. All of these community types are associated with either the immediate shoreline or shallow standing water areas. Primary steps in assessing impacts on shoreline and submerged aquatic vegetation include:

Determine the presence, distribution, existing characteristics, and quality of submerged aquatic vegetation, riparian areas, wetlands, and shoreline vegetation in the recreation area in general and in areas routinely used by personal watercraft users in particular.

Evaluate potential changes in submerged aquatic and shoreline vegetation conditions by comparing potential personal watercraft user effects on vegetation location, type, and susceptibility to disturbances with each alternative.

Differentiate intensity of personal watercraft use as compared with other watercraft use and effect on the shoreline environment.

Account for the effects of existing reservoir management and operations in regulating shoreline and submerged aquatic vegetation.

Impact Threshold Definitions

The following impact thresholds were established to describe the relative changes in shoreline and submerged vegetation under the alternatives being considered:

Negligible — Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

Minor — Impacts would be measurable or perceptible but would be localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate — Impacts would cause a change in the plant community (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized.

Major — Impacts on the plant community would be substantial, highly noticeable, and permanent.

Impairment — Personal watercraft use would contribute substantially to the deterioration of the shoreline or shallow water environment to the extent that the recreation area's shoreline or submerged vegetation would no longer function as a natural system. These resources would be affected over the long term to the point that the recreation area's purpose could not be fulfilled and the resource could not be experienced and enjoyed by future generations.

Assumptions used for the impact analysis include:

Shoreline vegetation occurs within 50 feet of the existing water-shoreline interface. This location changes with fluctuations in water surface elevations.

Personal watercraft and other watercraft users generally stay within direct or reasonable view of their motorcraft.

Personal watercraft users would travel no more than 500 feet inland from the high-water surface elevation (3,700 feet).

Future impacts related to personal watercraft operator use would be similar to those currently occurring. Personal watercraft use over the analysis period, taking into account natural changes in visitor growth rate, is not expected to be substantially different from levels that existed when personal watercraft were used in accordance with the *Superintendent's Compendium* (NPS 2002c).Natural processes related to fluctuation of the reservoir level influence the presence, absence, and distribution of shoreline riparian, wetland, and submerged aquatic vegetation.

For analysis of alternatives A and B, the number of personal watercraft and other motorized watercraft would be proportionately the same as that which is currently occurring.

Geographic Area Evaluated for Impacts

The area analyzed for possible impacts on shoreline vegetation consists of Lake Powell and its associated tributaries including, but not limited to, the San Juan, Colorado, Dirty Devil, and Escalante Rivers within the boundaries of Glen Canyon National Recreation Area. The area of analysis includes a terrestrial zone extending from the water-land interface inland to either 500 horizontal feet beyond the 3,700-foot water surface elevation or the canyon wall apex. For submerged aquatic vegetation, the analysis area extended into the water to the edge of the vegetated zone.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Riparian Vegetation. Personal watercraft use would occur as managed under the *Superintendent's Compendium* (NPS 2002c). Most personal watercraft day-use activity would be concentrated in deeper water in close proximity to the four marinas Wahweap, Bullfrog, Halls, and Hite (James et al. 2001a; Utah Division of Wildlife Resources, Gustaveson, pers. com., April 2002b). Less than 5% of personal watercraft users would access river drainages and side canyons located on the San Juan River and along upper elevations of the Colorado River (James et al. 2001a). Houseboats or other motorboats accessing these more remote sites tend to stay on the lake for three to four days or longer and use the personal watercraft they bring along for short periods of time (Utah Division of Wildlife Resources, Gustaveson, pers. com., April 2002b).

Topography prevents watercraft from landing along many portions of the lake where rock and cliffs rise vertically from the water surface. These same conditions prevent development of shoreline or submerged vegetation. None of the deep-water areas of the lake, many shoreline areas with accessible banks, or areas located near boat ramps at the marinas have existing shoreline or submerged vegetation that could be affected by personal and other watercraft operations. Therefore, there would either be no effect on vegetation or operating and landing personal watercraft in areas occupied by some vegetation would produce direct short-term adverse and negligible impacts from the shoreline activities of personal watercraft operators. These effects would occur to both native and non-native plant species. In many locations, non-native saltcedar would be the primary species affected.

To access riparian shorelines personal watercraft operators may occasionally use shallow waters to land on sand beaches and rock shores where nonmotorized watercraft, canoes and river rafts also land. During landing, some riparian and sand beach vegetation may be temporarily exposed to trampling and soil compaction. Based on the low vegetation density and sparse ground cover, these effects would be localized and restricted to a limited number of individual plants.

Under alternative A, personal watercraft would be prohibited from upstream travel into more remote coves and canyons of the Escalante, San Juan, Colorado and Dirty Devil Rivers but downstream use and access by other watercraft would be allowed. Dense saltcedar stands dominate most riparian areas along many of these canyons, which personal watercraft and other watercraft operators avoid to prevent damaging their watercraft (Waring 1992). Saltcedar is also resilient to many types of disturbance and would not be injured from light trampling. Therefore, there would be a short-term, direct, negligible, adverse impact on riparian vegetation dominated by saltcedar stands from trampling by personal and other watercraft operators.

Wetlands. Wetlands are intermittently distributed along protected coves and canyons adjacent to river tributaries and inlets. Not only do fewer watercraft access these areas; but natural barriers such as sand berms and dense saltcedar stands along the tributaries further limit watercraft access. There are no substantial wetland areas located at or near any of the launch areas or any of the popular personal watercraft use areas. Therefore, negligible adverse impacts on wetlands would be expected. Its location in isolated areas would contribute to infrequent use and the probability for negligible adverse impacts. Personal watercraft use would not increase use of wetlands or provide improved access to these areas. Therefore, it would not create any direct perceptible loss or changes of wetland communities. Effect on wetlands would be short-term, direct, negligible, and adverse.

Submerged Aquatic Vegetation. The rocky shoreline, cliffs, and canyon walls along the shoreline combined with the fluctuating water surface preclude development and restrict growth of submerged aquatic vegetation. Scattered populations of pondweed and the exotic, spiny naiad would be more affected by lake fluctuation levels than by personal watercraft use. Therefore, personal watercraft use would cause short-term, direct, negligible, adverse effects where such use occurred in one of the areas occupied by this community.

Cumulative Effects. Shoreline vegetation has been historically subjected to many sources of disturbance since the recreation area was created. The most important has been repeated inundation and desiccation as the reservoir level rises and falls. Other sources that have affected, and would continue to affect, shoreline vegetation included personal watercraft operators, other watercraft operators and passengers, general recreation area visitors, and livestock in some areas. Activity areas with the most noticeable effects on shoreline vegetation include boat launches, marinas, and campgrounds (both developed and primitive).

The incremental effect from personal watercraft users on shoreline vegetation conditions would be indistinguishable from other visitor-induced effects. Foot traffic from all visitor activities would occur on shorelines and lake beaches in accessible shoreline areas. Some of the more remote watercraft landing areas at key destination sites located on the Escalante, Dirty Devil, San Juan and Colorado Rivers that provide shoreline access also provide multi-use facilities such as camping and trails. Limited grazing, which is permitted in some areas of the Recreation and Resource Utilization Zone, affects the density of some riparian and other shoreline vegetation. Because personal watercraft use is less frequent in these remote areas there would be short-term, direct, negligible effects on shoreline vegetation from this activity.

The proposed Wahweap campground improvements would attract additional campers and personal watercraft users. It is unlikely that the small proportion of campers with personal watercraft would adversely impact shoreline vegetation.

Conclusion. Personal watercraft use would have negligible, adverse, direct and indirect impacts, for both short and long terms. This would occur because there would be no perceptible changes to shoreline, riparian, aquatic, or wetland community size, integrity, or continuity. Alternative A would not result in any substantial or noticeable physical change of submerged, riparian, or wetland shoreline vegetation.

Past, current, and future use of personal watercraft and other motorized watercraft also would not produce any noticeable effect on shoreline vegetation. Therefore, cumulative effects would also be short-term, direct, and negligible. Alternative A would not result in impairment of shoreline vegetation at Glen Canyon National Recreation Area.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Personal watercraft numbers under alternative B would be similar to alternative A except that additional geographic restrictions on personal watercraft use would be implemented.

About 25 miles of the Colorado River upstream of Sheep Canyon and upper portions of the Escalante (41 miles), Dirty Devil (19 miles), and San Juan (38 miles) Rivers would be closed to all personal watercraft, possibly benefiting riparian vegetation on a localized and very limited basis. Use levels by personal watercraft operators within these areas are very low under current conditions. Although this alternative would involve the closure of a long reach of the Colorado River, currently less than 1% of this area is used by personal watercraft. Also there are no developed shoreline access points that would encourage concentrated and prolonged visitor uses, that might adversely affect shoreline vegetation.

More personal watercraft use occurs in the Escalante River (10% to 14%) (James et al. 2001a) where personal watercraft use would only be allowed to operate at flat-wake speeds along a portion of river. Shoreline launching occurs in the central and southern portions of the Dirty Devil and the Escalante Rivers along with camping and fishing. The sparse, mixed-shrub dune communities and scattered pockets of riparian vegetation along these shorelines are comprised primarily of saltcedar. This non-native, aggressive shrub species is very tolerant of human disturbance activities and would experience little, if any permanent adverse effects from personal watercraft landing and shoreline use activities by personal watercraft operators. The results would be negligible, short-term, direct adverse degradation of existing stands of vegetation.

Effects on shoreline riparian, wetland, and submerged aquatic vegetation from personal watercraft use in areas remaining open under alternative B would be similar to those discussed under alternative A. Effects would be essentially the same for the same reasons that were described before. Shorelines are rocky and watercraft access would be difficult in these areas, wetland and submerged aquatic communities are essentially absent, shoreline vegetation development would be precluded by reservoir fluctuations, and where present, shoreline riparian vegetation would be dominated by the resilient non-resident saltcedar.

Cumulative Effects. Cumulative impacts related to shoreline riparian, wetland, and submerged aquatic vegetation would be similar to those described under alternative A. Closure of river reaches would further reduce the current low level of personal watercraft use. Some negligible benefits to developing riparian shoreline vegetation might be realized over time by eliminating even the occasional trampling that might otherwise occur. Because other watercraft operators and visitors use the same river inlets where personal watercraft would be restricted, it is unlikely the potential negligible benefits of personal watercraft restrictions would be noticeable or measurable. Compared to the substantial influences that existing reservoir fluctuations and shoreline conditions exert on present shoreline vegetation conditions, it is very unlikely that personal and other watercraft users would have a noticeable cumulative impact on shoreline vegetation (including submerged aquatic, riparian, and wetland vegetation).

Conclusion. Restricting access to upper portions of the Colorado, Escalante, Dirty Devil, and San Juan Rivers would provide negligible beneficial protection of riparian shoreline vegetation. Impacts on shoreline vegetation in the vicinity of the four main marinas would be similar to those described for alternative A and would result primarily from minor short-term foot traffic associated with users of personal watercraft and other watercraft when landing on lake shorelines. Limiting personal watercraft operations to flat-wake speeds on a portion of the Escalante River would reduce wave production but because of the lack of existing shoreline vegetation no benefits to shoreline vegetation would be expected. Past, current, and future personal watercraft use would not produce any noticeable effect on submerged aquatic, riparian and wetland vegetation. Therefore, cumulative effects would remain similar to alternative A and would be short-term, direct, and negligible.

Alternative B would not result in impairment of shoreline vegetative resources.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Alternative C would make permanent the ban on personal watercraft use on Lake Powell that was implemented in November 2002. Permanent elimination of personal watercraft use would reduce a portion of the trampling to shoreline vegetation located in the vicinity of existing marinas and more remote landing areas along the lakeshore. These changes would not produce measurable changes in plant community size or distribution because present visitor and personal watercraft uses have had only a negligible adverse effects.

There would be no discernable beneficial or adverse impacts on riparian or wetland vegetation a result of discontinued personal watercraft use because other watercraft would continue to launch and land watercraft at existing marinas and landing facilities. There would be no discernable improvements to shoreline riparian, wetland, or submerged aquatic vegetation from discontinued personal watercraft use. Impacts on shoreline riparian, wetland, and submerged aquatic vegetation would either have no noticeable adverse effects or they might be direct, negligible, and locally beneficial over the short term.

Cumulative Effects. Closure of Lake Powell marinas and landing areas to personal watercraft use might reduce the number of people using near-shore uplands and sand beaches for landing. If current personal watercraft users switch to another type of motorized watercraft and continue to visit the same locations, there would be no net change in effect on shoreline vegetation compared to current conditions. Other watercraft users and visitors would continue to use marina facilities and other recreation services located near the lake shoreline and remote landing areas. Ongoing visitor use and

minor increased use associated with the Wahweap campground improvements along accessible shorelines would continue to have negligible adverse impacts on shoreline vegetation. Any benefits derived from discontinuing personal watercraft use would not be noticeable.

Conclusion. Alternative C would not result in any substantial or noticeable adverse physical change of riparian, submerged aquatic, or wetland vegetation. The lakeshore does not support extensive areas of submerged aquatic vegetation. Short-term and localized negligible improvements to shoreline vegetation would be expected as a result of implementing this alternative. Past, current, and future motorcraft use would not produce any noticeable effect on submerged aquatic, riparian, and wetland vegetation. Therefore, cumulative effects would be similar to alternative A and would be short-term, direct, and negligible.

Alternative C would not result in impairment of shoreline vegetative resources.

VISITOR USE AND EXPERIENCE

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Personal watercraft characteristics such as noise, odors, operator behavior, and use in proximity to other lake users may affect the experience of some other recreation area visitors. For other recreation area visitors, the use of personal watercraft is a primary trip purpose and an important part of the recreational experience.

GUIDING REGULATIONS AND POLICIES

Management Policies 2001 (NPS 2000d section 8.2) states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all park units and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy Glen Canyon National Recreation Area units. Because many forms of recreation can take place outside of a national park setting, the National Park Service therefore seeks to:

> Provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular park unit.
>
> Defer to others to meet the broader spectrum of recreational needs and demands that are not dependent on a national park setting. Those others can include local, state, and other federal agencies; private industry; and non-governmental organizations.

Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that:

> Would impair park resources or values;
>
> Create an unsafe or unhealthful environment for other visitors or employees;
>
> Are contrary to the purposes for which Glen Canyon National Recreation Area was established; or
>
> Unreasonably interfere with the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within Glen Canyon National Recreation Area; NPS interpretive, visitor service, administrative, or other activities; NPS concessioner or contractor operations or services; or other existing, appropriate park uses.

Part of the purpose of Glen Canyon National Recreation Area is to provide for public outdoor recreation use and enjoyment of Lake Powell and adjacent lands. Part of its significance lies in its diversity of both water-based and land-based recreational opportunities. Lake Powell is the second largest man-made lake in North America and both provides a unique opportunity for recreation in a natural environment and serves as a transportation corridor to remote backcountry areas of the recreation area.

Goals for visitor experience were provided in the recreation area's five-year *Strategic Plan* for 2000 through 2005 (NPS 2000g). They include:

Mission Goal IIa — Visitors safely enjoy and are satisfied with the availability, accessibility, diversity, and quality of recreation area facilities, services, and appropriate recreational opportunities at Glen Canyon National Recreation Area.

Long-term Goal IIa1 — 95% of Glen Canyon National Recreation Area visitors are satisfied with appropriate recreation area facilities, services, and recreational opportunities.

METHODOLOGIES AND ASSUMPTIONS

The purposes of this impact analysis were to determine if the use of personal watercraft under each management alternative at Glen Canyon would be compatible with:

Desired visitor experience goals; and

The purpose of the recreation area as identified in the enabling legislation and in other laws and policies affecting visitor use.

Staff observations and a 2000 Minnesota visitor survey report (James et al. 2001a) were evaluated to determine visitor attitudes and satisfaction in areas where personal watercraft are encountered. The potential for changes in visitor experience as a result of each management alternative was evaluated by identifying projected increases or decreases in both personal watercraft and other visitor uses, and determining whether these projected changes would affect desired visitor experiences and produce additional user conflicts. Alternatives were assessed based on their compatibility with the purpose established in the recreation area's enabling legislation. Impacts were evaluated qualitatively, based on best professional judgment.

For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

Impact Threshold Definitions

The following threshold definitions were applied to determine personal watercraft effects on visitor use and experience.

Negligible — Visitors would not likely be aware of the effects associated with changes proposed for visitor use and enjoyment of recreation area resources.

Minor — Visitors would likely be aware of the effects associated with changes proposed for visitor use and enjoyment of recreation area resources. However, the changes in visitor use and experience would be slight and likely short-term. Other areas in the recreation area would

remain available for similar visitor experience and use without effects on recreation area resources and values.

Moderate — Visitors would be aware of the effects associated with changes in visitor use and enjoyment of recreation area resources. Changes in visitor use and experience would be readily apparent and likely long-term. Other areas in the recreation area would remain available for visitor experience and use without effects on resources and values, but visitor satisfaction may be measurably affected. Some visitors who want to continue using personal watercraft would have to pursue their choice in other available regional areas.

Major — Visitors would be highly aware of the effects associated with changes proposed for visitor use and enjoyment of recreation area resources. Changes in visitor use and experience would be readily apparent and long-term. The change in visitor use and experience would preclude some visitors' enjoyment of recreation area resources and values for future generations. Visitors who want to continue using personal watercraft would have to pursue their choice in other available regional areas.

Geographic Area Evaluated for Impacts

The geographic area that was evaluated for visitor use and experience included:

The entire surface of Lake Powell.

The tributary rivers in all areas where there is sufficient flow, even occasionally, to support personal watercraft use.

All other locations within the recreation area where effects of personal watercraft use, such as noise or the smell of fumes, could be discerned. This area would not extend more than 2 miles inland from the shoreline.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Alternative A would not have any effects on visitor use and experience relating to personal watercraft compared to current conditions. With no change in the amount, character, or distribution of use expected over the next 10 years, visitors would notice little change from current conditions and impacts of the alternative would be negligible.

As described previously, several areas of the lake currently have restrictions on the use of personal watercraft, such as flat-wake speed requirements or closures to upstream travel in tributary arms. The visitor experience in all of these areas would to be similar to the condition defined by the *Superintendent's Compendium* (NPS 2002c).

A large portion of personal watercraft use would continue to be associated with other watercraft use. Groups that used powerboats and houseboats as their primary vessel would continue to tow or transport personal watercraft to destinations throughout the lake to be used in conjunction with their visit. With multiple watercraft types in one group, visitors would continue to have flexibility to enjoy

the diverse range of opportunities available on the lake. There would be little detectable change over time and impacts would be negligible when compared to current conditions.

Baseline visitor survey data at Glen Canyon National Recreation Area indicate that most visitors are satisfied with their current experience (James et al. 2001a). Under alternative A, high levels of satisfaction with the lake experience would occur for the overall boating population and for personal watercraft users.

Both personal watercraft and other watercraft users would find opportunities to meet their trip goals and achieve expected outcomes from their visit to the recreation area. This would include passive outcomes such as enjoying the scenery of Lake Powell, experiencing nature, experiencing natural quiet, and experiencing solitude. It would also include more active and social outcomes such as doing something with family and members of a group, and participating in recreational activities.

There would be a small portion of watercraft users, including those in nonmotorized craft, who could not achieve one or more objectives of their visit because of the behavior of personal watercraft users, such as speed, unsafe or inconsiderate maneuvers, or drunkenness, or because they believed there were too many personal watercraft. There would also be a segment of the general recreating public who would choose not to visit the recreation area because of the presence of personal watercraft and the expected adverse effect that personal watercraft would have on their experience. For these visitors, impacts would be negligible in the long term as there would be little detectable difference from current conditions.

Noise from personal watercraft would be perceived as a problem by some watercraft users, although the overall boating population would identify little or no problem associated with personal watercraft noise. Most watercraft users would feel that their desire to experience natural quiet was somewhat to fully attained. A small portion would report that their desires for experiencing natural quiet were not met. Some visitors would perceive the noise of personal watercraft to be distinctively different from other watercraft and therefore annoying.

Visitors in the undeveloped Natural Zone up to 2 miles from the lake would be able to detect personal watercraft noise, which would detract from the experience of those for whom solitude and natural sounds were important. Noise from other types of motorized watercraft would mask or exceed noise levels associated with personal watercraft. This would result in negligible adverse effects from the implementation of alternative A. In remote and quiet areas of the recreation area where the effect of a small number of personal watercraft would be more pronounced, there could be localized adverse effects on the visitor experience related to noise, but the change from current conditions would be negligible.

A very small number of personal watercraft users would be able to access the recreation area from upstream on the San Juan River. This would be a negligible beneficial effect of alternative A.

Cumulative Effects. The location and number of other watercraft and the behavior of other watercraft users would continue to affect the experience of visitors. Motorized boats would continue to be present on the lake in patterns and numbers similar to the present. Undesirable activities and behavior of some other watercraft users, such as speed, drunkenness, or operating too close to others, would continue. There would be negligible cumulative effects related to personal watercraft and other watercraft on visitor experience since there would be little detectable change from current conditions. Most visitors would continue to be satisfied with their visit to Glen Canyon National Recreation Area.

Conclusions. Alternative A would have negligible effects on visitor use and experience because the number of personal watercraft using Lake Powell and their management would not change. The effect on the visitor experience for personal watercraft users would continue to be beneficial, while experiences for visitors seeking quiet and solitude would continue to be adversely affected. Cumulative effects would be either adverse or beneficial, depending on the visitor's goals. However, in either case impacts would be negligible.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Under alternative B, personal watercraft use would occur at the same levels and general distributions as under alternative A. Their proportions relative to other watercraft (26% of all watercraft boat days) would remain the same, and personal watercraft use by groups in association with powerboats and houseboats would continue. Therefore, impacts would be similar to those described for alternative A, with the following exceptions.

As described in the "Alternatives" chapter, alternative B would close several areas within the tributary arms of the lake to personal watercraft use. Currently, these areas can be used by personal watercraft traveling in a downstream (but not upstream) direction. It also would implement and additional flat-wake restriction on a portion of the Escalante River. Despite these actions, both personal watercraft and other watercraft users would find opportunities within the recreation area to meet most of their trip goals and achieve expected outcomes from their visit. Although these management actions would have a long-term, direct, adverse effect on the experience of personal watercraft users, the intensity would be only negligible to minor. The modified preferred alternative would prohibit personal watercraft use along 19 miles of the Dirty Devil River from U.S. Highway 95 Bridge to the recreation area boundary. Personal watercraft use would also be prohibited on 41 miles of the Escalante River upstream of the confluence with Coyote Creek. These restrictions would reduce conflict with river rafters, fishermen, and backcountry hikers; promote visitor enjoyment; and ensure visitor safety. There would be a negligible to minor, long-term, direct, beneficial effect on the experience of other recreation area visitors who use these areas, particularly nonmotorized users.

Alternative B would prohibit travel by personal watercraft above Sheep Canyon on the Colorado River. This would eliminate the opportunity to recreate in these portions of the recreation area with a personal watercraft. It also would reduce the flexibility and range of opportunities on the Colorado River for powerboat and houseboat users that have personal watercraft in their party. However, as shown in table 21, few motorized watercraft parties travel to this section of the lake. Closure of this area to personal watercraft would be a negligible to minor, direct, adverse, long-term effect. Some individuals who were denied the opportunity to use personal watercraft in this area might perceive the adverse effect as minor to moderate.

Elimination of personal watercraft use on the Colorado River above Sheep Canyon and on the Dirty Devil River would reduce intrusions by personal watercraft on the experience of other visitors. These would include visitors on river float trips that originate in Canyonlands National Park and end at Hite Marina. Currently, visitors on river trips encounter 10 or fewer personal watercraft per day. There would be minor, beneficial, direct, long-term effects on the experiences of these visitors.

The improved visitor education component of alternative B would provide information that might change the behavior of some personal watercraft users who would otherwise, under alternative A, act

in a manner that would detract from the experience of others. This would result in negligible to minor, indirect, long-term, beneficial effects.

Noise from personal watercraft would be eliminated or reduced in areas where personal watercraft use was prohibited or where flat-wake speeds were implemented. This would be perceived as a direct, long-term, beneficial effect by other visitors. However, because these are relatively small areas with low levels of personal watercraft use, the effect would be negligible to minor.

Cumulative Effects. The location and number of other watercraft and the behavior of other watercraft users would continue to affect the experience of visitors. The cumulative effect would be similar to that described for alternative A. Most visitors would continue to be satisfied with their visit to Glen Canyon National Recreation Area.

Conclusion. Most effects of alternative B would be similar to those described for alternative A. Most effects would be long-term and negligible to minor because of the presence of other motorcraft. An additional flat-wake zone and closed areas would produce negligible to minor, long-term, direct effects. Perceptions of individual visitors would determine if the effects were adverse or beneficial. Improvements in visitor education would result in negligible to minor, indirect, long-term, beneficial effects.

Cumulative effects on visitor experience would be long-term, indirect, and moderate because there would be detectable change on certain portions of the lake. Perceptions of individual visitors would determine if effects were adverse or beneficial.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

With alternative C, personal watercraft use would no longer be allowed in the recreation area. Initially, this would affect 26% of all visitor boating days and 18% of all boat operating hours, and as many as 32% of boating days (22% of the boating hours) during the peak summer months. For visitors who use personal watercraft as a primary vessel or who consider personal watercraft to be of central importance to their visit, this would produce direct, adverse, major, short- and long-term effects on their experience in Glen Canyon National Recreation Area.

Personal watercraft serve multiple recreational functions, as indicated by survey data showing that personal watercraft are associated with 44% of all houseboat groups and 25% of all powerboat groups. Popular personal watercraft–related activities include camping, fishing, hiking in side canyons, and visiting archeological sites.

Visitors could have other options to pursue many of the activities now associated with personal watercraft. For example, many houseboat parties have personal watercraft to allow greater travel and recreation flexibility, such as exploring side canyons. Houseboat users would be able to tow a small motorized boat and gain equal access to resources and equal flexibility to pursue multiple recreation opportunities. For these visitors, eliminating personal watercraft use would cause a direct, short-term, minor to moderate, adverse effect. In the long term, the effect on these visitors would be negligible.

Seven percent of all watercraft users travel to Glen Canyon National Recreation Area solely to use personal watercraft. For an undefined number of other visitors, the use of personal watercraft is of

central importance to their visit. For these visitors, the elimination of personal watercraft would result in major adverse short- and long-term effects.

In the short term, eliminating personal watercraft would eliminate conflicts between other watercraft users and personal watercraft users. This would improve the experience for visitors who report that the number of personal watercraft on the lake is a moderate to very serious problem (13% of respondents) or that conflicts with personal watercraft operators are a moderate to very serious problem (11%). This would be a beneficial, minor to moderate, direct effect. In the long term, some lake visitors with other vessels may prefer to operate those vessels in a manner similar to personal watercraft, such as performing stunts or focusing activities in a small area. Visitors who previously chose not to visit Lake Powell because of the presence of personal watercraft may choose to visit when personal watercraft are absent. Therefore, compared to alternative A, the long-term effect of this alternative on visitor experience would be minor to moderate beneficial.

In the short term, shoreline users and visitors in the Natural Zone would have greater periods of natural quiet. Elimination of personal watercraft noise on the experience of these visitors would result in a minor to moderate, indirect, beneficial effect. In the long term, the effect would be negligible, because the volume of watercraft would return to pre-ban levels, and other types of boats make approximately the same amount of noise as personal watercraft.

Cumulative Effects. The experience of visitors would continue to be affected by the presence, density, and behavior of all other watercraft. Noises from other watercraft would continue to be heard the Natural Zone. In the short term, there would be a negligible to minor beneficial impact compared to alternative A, but it would decrease to negligible levels over the long term as former personal watercraft users returned to the lake with other watercraft. Most visitors would continue to be satisfied with their visit to Glen Canyon National Recreation Area.

Conclusion. In the short term, visitors who use personal watercraft as a primary vessel or who consider personal watercraft to be of central importance to their visit would experience direct, major, adverse short- and long-term effects from alternative C. Other users of personal watercraft, such as those who use them in conjunction with houseboats, would experience short-term, minor to moderate, adverse effects that would decrease to negligible in the long term.

Visitors who did not use personal watercraft would generally perceive minor to moderate, short-term benefits from reduced conflicts and reduced noise. These benefits would decline to negligible in the long term.

VISITOR CONFLICTS AND VISITOR SAFETY

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Visitor conflicts and visitor safety were two of the areas specified for analysis in the settlement agreement between the National Park Service and the Bluewater Network. Issues at Glen Canyon National Recreation Area include:

> Potentially unsafe behavior by personal watercraft users, such as underage operation, unsafe speeds, unsafe proximity to other vessels, and lack of personal flotation devices.
>
> The potential for accidents and injuries to occur from the use of personal watercraft at rates that are higher than those from other watercraft.
>
> Conflicts associated with the use of personal watercraft in areas that are popular for nonmotorized recreation, including the tributary rivers.

Management Objectives

As shown in table 3, the objectives of managing personal watercraft use in Glen Canyon National Recreation Area relating to visitor conflicts and visitor safety include the following.

> Manage personal watercraft use to enhance the quality of the visitor experience.
>
> Reduce potential conflicts associated with personal watercraft use and other uses of Glen Canyon National Recreation Area.
>
> Reduce the potential for personal watercraft user accidents.

GUIDING REGULATIONS AND POLICIES

Some of the guiding regulations and policies discussed for "Visitor Use and Experience," also are applicable to visitor conflict and visitor safety. In addition, *Director's Order 9* (NPS 2000a), in conjunction with *Reference Manual 9* (NPS 2000f), establishes and defines standards and procedures for the National Park Service Law Enforcement Program. Commissioned employees perform resource stewardship, education, and visitor use management activities, including law enforcement. They provide for safe, tranquil, sustainable use and enjoyment of recreation area resources while protecting resources from all forms of degradation.

Section 8.3.1 of *Management Policies 2001* (NPS 2000d) states that "The Service will make reasonable efforts to provide for the protection, safety, and security of park visitors, employees, concessioners, and public and private property, and to protect the natural and cultural resources entrusted to its care." Further, in section 8.2.5.1, the National Park Service "strives to protect human

life and provide for injury-free visits. . . . The Service will seek to provide a safe and healthful environmental for visitors and employees."

Arizona and Utah personal watercraft regulations are enforced within Glen Canyon National Recreation Area. These regulations are summarized in table 4, with the full text provided in appendix B. Some of the visitor conflict and visitor safety aspects they regulate include the type of personal watercraft activities near the shore, the distance that should be maintained between personal watercraft and the shoreline and other boats, the timing of personal watercraft use, and the age and educational requirements of personal watercraft operators.

METHODOLOGY AND ASSUMPTIONS

The method used to evaluate effects of the alternatives to visitor conflicts and visitor safety is similar to that used for the visitor experience evaluation.

Impact Threshold Definitions

The definitions for impact intensities applied to visitor conflict and visitor safety follow.

Negligible — The impacts on visitor conflict and safety would not be measurable or perceptible.

Minor — The impacts on visitor conflict and visitor safety would be measurable or perceptible, but it would be limited to a relatively small number of visitors at localized areas. Impacts on visitor safety might be realized through a minor increase in the potential for visitor conflicts in current accident areas.

Moderate — The impact on visitor conflict and visitor safety would be sufficient to cause a change in accident rates or to change the potential for visitor conflicts throughout large areas of the lake.

Major — The impact on visitor safety would be substantial. Accident rates in areas usually limited to low accident potential would substantially increase.

In situations where adverse impacts on visitor conflicts and visitor safety became moderate or greater, it is assumed that current visitor satisfaction and safety levels would begin to decline and some of the recreation area's long-term visitor goals would not be achieved.

Geographic Area Evaluated for Impacts

The geographic area that was evaluated for visitor conflicts and visitor safety included:

The entire surface of Lake Powell.

The tributary rivers in all areas where there is sufficient flow, even occasionally, to support personal watercraft use.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Under alternative A, personal watercraft use would occur approximately at year 2001 levels in the areas where it is currently permitted. There would be about 40 accidents involving personal watercraft each year, of which about 30 would result in personal injury. Operators of other watercraft would view personal watercraft as representing a slight safety hazard. These effects of alternative A would represent a negligible impact in both the short and long term.

Downstream use of personal watercraft in tributaries would be allowed under alternative A. This would result in conflicts with users of nonmotorized craft such as rafts and kayaks in these areas, which often have a narrow navigable channel. There would be a negligible impact with the implementation of alternative A.

Alternative A would enforce Arizona or Utah watercraft regulations, laws, and rules in each state's portion of the lake. As a result, personal watercraft users in Utah, which includes about 95% of the lake, would have to meet more strict safety requirements with regard to registration, insurance, education, and equipment. While the differences in state regulations, laws, and rules may generate some confusion for personal watercraft users, this regulatory approach would have negligible effects.

Law enforcement levels currently are inadequate to patrol visitor activities on the land and water during the peak season. Alternative A would seek additional funding to increase enforcement capability and enhance visitor contact. This would have a long-term, direct and indirect, minor, beneficial effect on visitor conflicts and safety. The recreation area staff would improve response time, and the increased law enforcement presence would reduce illegal personal watercraft activities that can lead to personal injury accidents. This action would provide only a minor benefit because only about 30 injury accidents involving personal watercraft currently occur each year.

The current system for educating visitors and distributing safety information to recreation area users, including personal watercraft operators, would continue. This would result in a negligible effect on visitor conflict and visitor safety compared to current conditions.

Cumulative Effects. Accidents would occur among all watercraft at approximately the levels shown in table 26. In addition, safety risks would continue to be associated with other recreation area activities such as swimming, diving from cliffs, and hiking in side canyons. Risks of all of these activities would be greater if participants have been consuming alcohol. These activities would continue to account for most watercraft- and recreation-related accidents in the recreation area. In response, recreation area managers would continue to take precautions to prevent accidents and injuries and provide with visitors with information about safe boating and recreation behavior. The effects would be negligible.

The lake management plan that would be prepared under alternative A would include improved safety and reduced visitor conflicts among its primary goals.

Conclusion. Alternative A would have negligible impacts on visitor conflicts and visitor safety. Improvements in visitor protection staffing would result in long-term minor beneficial effects on visitor conflicts and safety. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Alternative B would close the tributary rivers to personal watercraft use. Compared to alternative A, this action would have a direct, long-term, minor, beneficial effect on visitor conflicts in the following areas:

Colorado River upstream from Sheep Canyon (about 25 river miles).

Dirty Devil River upstream of Highway 95 Bridge.

Escalante River upstream from the confluence with Coyote Creek (about 41 river miles).

San Juan River upstream from the Clay Hills pullout (about 38 river miles).

Alternative B also would reduce visitor conflicts by requiring new flat-wake zones on the Escalante River (about 7 river miles).

Effects of the new closures and flat-wake zones on visitor safety compared to alternative A would be long-term, direct, and beneficial. The intensity would be negligible to minor because these areas are lightly used by personal watercraft and few accidents involving personal watercraft currently occur in these areas.

With alternative B, the National Park Service would work cooperatively with Arizona and Utah in an attempt to develop unified laws for personal watercraft operations throughout the recreation area. This would have an indirect, long-term, negligible effect on visitor conflict and visitor safety compared to alternative A. If the unified laws matched or exceeded the strict Utah laws, which currently apply to 95% of the lake, the effect on safety could be slightly beneficial. The effect on safety could be slightly adverse if the unified laws were more lenient than those of Utah. There would be a negligible effect on visitor safety because of better understanding of which laws apply, since there are no data to indicate that the current condition, while sometimes confusing, adversely affects visitor safety.

Alternative B would seek additional funding to increase enforcement capability and enhance visitor contact which would have a long-term, direct and indirect, minor, beneficial effect on visitor conflicts and safety. The recreation area staff would improve response time, and the increased law enforcement presence would reduce illegal personal watercraft activities that can lead to personal injury accidents. This action would provide only a minor benefit because only about 30 injury accidents involving personal watercraft currently occur each year.

Alternative B would include education enhancements to provide more information to visitors regarding personal watercraft use and safety. This action would have an indirect, long-term, minor, beneficial effect on visitor conflict and visitor safety by reducing the potential for personal watercraft users to engage in inconsiderate or unsafe practices.

Alternative B would provide materials that highlight areas of the lake where visitors can experience natural quiet and solitude without conflicts with noisier visitors. This action may produce indirect, long-term benefits by reducing visitor conflicts compared to alternative A. The magnitude would be negligible because many visitors already know of areas where they can go to experience natural quiet

and solitude, and because the identified areas may become more busy and conflict-prone as they became the destinations for increased numbers of visitors.

Cumulative Effects. The enhanced visitor education would reduce visitor conflicts and improve visitor safety compared to alternative A. Otherwise, the cumulative effects of alternative B and alternative A would be similar.

The lake management plan that would be prepared under alternative B would include improved safety and reduced visitor conflicts among its primary goals.

Under alternative B, enhanced information would be provided to visitors regarding safe boating, safe use of personal watercraft, the prevention of accidents and injuries, and appropriate, courteous behavior that should be applied by all boaters in Glen Canyon National Recreation Area. Cumulative visitor conflict and visitor safety impacts related to improved education of visitors would be indirect, long-term, beneficial, and negligible to minor in intensity.

Conclusion. Compared to alternative A, alternative B would have direct and indirect, long-term, minor, beneficial impacts on both visitor conflicts and visitor safety. Cumulatively, the improved education components of this alternative would have indirect, long-term, beneficial, negligible to minor effects on visitor conflicts and visitor safety.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

With alternative C, personal watercraft use would no longer be allowed in the recreation area. Initially, this could reduce the number of accidents occurring annually by about 14% and the number of injury accidents by about 20%. This would produce a direct, beneficial, short-term, moderate effect on visitor safety.

For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

The data in table 26 indicate that other vessels have a slightly higher accident rate in Glen Canyon National Recreation Area than personal watercraft. Therefore, the number of accidents occurring annually would be at least as high as the alternative A levels and could increase slightly per year. However, because people in other vessels are less prone to injury than personal watercraft users, the change in the long-term injury rate may not be measurable compared to alternative A.

Alternative C would eliminate personal watercraft use of the tributary rivers. This would have a direct, long-term, minor, beneficial effect on visitor conflict in the tributary rivers and a direct, long-term, negligible to minor, beneficial effect on visitor safety in these areas.

The state boating laws in Arizona and Utah for vessels other than personal watercraft are based on Coast Guard requirements and are quite similar. Therefore, alternative C may reduce confusion among operators about which regulations, laws, and rules apply in various areas of the lake. This would have a negligible effect, since there are no data to indicate that the current condition adversely affects visitor safety.

Law enforcement levels currently are inadequate to patrol visitor activities on the land and water during the peak season. Similar to alternative A, the National Park Service would seek additional funding to increase enforcement capability and enhance visitor contact which would have a long-term, direct and indirect, minor, beneficial effect on visitor conflicts and safety.

The current system for educating visitors and distributing safety information to recreation area users would continue. However, with the absence of personal watercraft, more attention could be focused on conflict and safety issues relating to boats. The long-term effect would be beneficial, but the intensity would be negligible.

Cumulative Effects. Under alternative C, personal watercraft could not use Lake Powell. Therefore, cumulative effects would not differ from those described above for alternative A.

Conclusion. In the short term, alternative C would have a direct, beneficial, moderate effect on visitor safety. However, as visitors returned in other watercraft, which have higher accident rates on Lake Powell than personal watercraft, the long-term effect on safety would be adverse and negligible to minor. Visitor conflicts would be reduced in the long term and improvements in visitor protection staffing would produce both direct and indirect, minor, beneficial effects. Cumulative effects of watercraft use and other visitor activities on visitor conflicts and safety combined with NPS management activities to prevent accidents would be negligible.

CULTURAL RESOURCES

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

With their shallow draft design, personal watercraft can come close to shore and facilitate the use of areas generally inaccessible by other types of watercraft or motor vehicles. Cultural sites in isolated areas such as canyons that can be reached using personal watercraft can be vulnerable to trampling, looting, and vandalism.

Personal watercraft can facilitate visitor access to isolated areas containing ethnographic sites or areas where traditional cultural practices occur. The noise from personal watercraft and the presence of visitors in these areas can interrupt religious activities or disturb sites valued by tribes.

Management Objectives

Management objectives for cultural resources were included in table 3. On a recreation area-wide basis, management objectives include interpreting historical and archeological resources and the culture of traditional societies while centering interpretive themes around outdoor recreation.

Management objectives associated with personal watercraft involve managing personal watercraft use and access to enhance protection of cultural resources.

GUIDING REGULATIONS AND POLICIES

Numerous legislative acts, regulations, and NPS policies provide direction for the protection, preservation, and management of cultural resources on public lands. These laws and policies establish what must be considered both in planning, such as in general management plans and implementation plans, and in administrative actions, such as rule-makings. They also define how cultural resources must be managed in future undertakings resulting from approved plans and rules, regardless of the final alternative chosen.

Applicable NPS policies relevant to cultural resources are included in *Management Policies 2001* (NPS 2000d) and *Director's Order 28: Cultural Resource Management* (NPS 1996d). Applicable laws and regulations include the:

Antiquities Act of 1906 (PL. 59-209);

Organic Act of 1916 (PL 64-235);

National Historic Preservation Act of 1966 (PL 89-665);

National Environmental Policy Act of 1969 (PL 91-190);

Archaeological Resources Protection Act of 1979 (PL 96-95); and

Native American Graves Protection and Repatriation Act of 1990 (PL 101-601).

The *Antiquities Act* authorized the president to establish historic landmarks and structures as monuments owned or controlled by the United States government. It also instituted a fine for unauthorized collection of artifacts.

The *Organic Act* established the National Park Service to manage parks and monuments. Its purposes specifically include conserving historic objects within these lands and providing for their enjoyment.

The *National Historic Preservation Act*, as amended, required in section 106 that federal agencies with direct or indirect jurisdiction over undertakings take into account the effect of those undertakings on properties that are listed on, or eligible for listing on, the National Register of Historic Places. The act further requires federal land managers to establish programs in consultation with the state historic preservation office to identify, evaluate, and nominate properties to the national register. This act applies to all federal undertakings or projects requiring federal funds. The act also provides for confidentiality provisions where the release of sensitive site location information could endanger the resource.

The *National Environmental Policy Act* declared a federal policy to preserve important historic, cultural, and natural aspects of our national heritage. It required federal agencies to employ a systematic, interdisciplinary approach to ensure the integrated use of the natural and social sciences in planning and in decision-making activities that may affect the human environment.

The *Archaeological Resources Protection Act* further strengthened the federal government's efforts to protect and preserve archeological resources on public lands. It increased criminal penalties and instituting civil penalties for the unauthorized collection of artifacts. Additionally, it established a permit system for the excavation and removal of artifacts from public lands, including their final disposition.

The *Native American Graves Protection and Repatriation Act* set forth procedures for determining the final disposition of any human remains, funerary objects, or objects of cultural patrimony that are discovered on public lands or during the course of a federal undertaking.

METHODOLOGY AND ASSUMPTIONS

General Analysis Method

Cultural resources typically include buildings, archeological sites, structures, districts, and objects as defined in the *National Historic Preservation Act*. This act and its implementing regulations provide guidance for deciding whether cultural resources are of sufficient importance to be determined eligible for listing on the National Register of Historic Places.

The effects of personal watercraft management actions were described in terms of whether they were beneficial or adverse, the area they would affect (such as site-specific, local, or regional), their intensity, their duration, and whether they were direct or indirect. They also were evaluated to determine if they would impair the recreation area's cultural resources.

Cumulative impacts on cultural resources were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions.

The most important past action that affected cultural resources in the region was the construction of Glen Canyon Dam and filling of Lake Powell. Construction of the dam and appurtenant facilities, including the City of Page, disturbed or destroyed some surface artifacts. Filling of the lake submerged numerous prehistoric and historic sites in the river bottoms and along the canyon walls of the Colorado River and its tributaries. Because of the desert setting, these were the areas where most human activity in the region previously had occurred.

Other important actions that occurred in the past and will continue into the future are the vandalism of and unauthorized collection from archeological and historical sites. Cultural resources are non-renewable, so over time, small incidents of vandalism or unauthorized collecting within and outside of the recreation area cumulatively diminish the regional resource base. These losses reduce the number and variety of cultural sites available for visitor appreciation and scientific study.

Future development in the area will occur, such as development of the Antelope Point Marina and growth of the City of Page. These actions probably would cause some disturbance of cultural resources, particularly archeological sites. If the sites are on federal land, they would have to be mitigated in accordance with the *National Historic Preservation Act*. If they are on private land, they could be permanently lost.

Impacts on Cultural Resources, and Section 106 of the National Historic Preservation Act

This impact analysis is intended to comply with the requirements of section 106 of the *National Historic Preservation Act* (36 CFR Part 800, Protection of Historic Properties) as well as the *National Environmental Policy Act*. In accordance with the Advisory Council on Historic Preservation's regulations implementing section 106, impacts on cultural resources were identified and evaluated by:

Determining the area of potential effects;

Identifying cultural resources present in the area of potential effects that were either listed in or eligible to be listed in the National Register of Historic Places;

Applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed in the National Register; and

Considering ways to avoid, minimize or mitigate adverse effects.

Under the Advisory Council's regulations, a determination of either adverse effect or no adverse effect must be made for affected, National Register eligible cultural resources.

An adverse effect occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register. Examples could include diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects that would occur later in time, be farther removed in distance, or be cumulative (36 CFR Part 800.5, Assessment of Adverse Effects).

> A determination of no adverse effect means there may be an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the National Register.

The Council on Environmental Quality (1978) regulations and *Director's Order 12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision Making* (NPS 2001b) call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact (e.g., reducing the intensity of an impact from major to moderate or minor). Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation under the *National Environmental Policy Act* only. It does not suggest that the level of effect as defined by section 106 is similarly reduced. Although adverse effects under section 106 may be mitigated, the effect remains adverse.

A section 106 summary is included in the impact analysis sections for archeological resources, historic structures and buildings, cultural landscapes, and ethnographic resources. The recreation area's collections would not be affected by any of the proposed actions for managing personal watercraft, and are not included in the analysis.

The section 106 summary is intended to meet the requirements of section 106 of the *National Historic Preservation Act*. It also is intended to provide an assessment of the effect of the undertaking (implementation of the alternative) on cultural resources, based upon the criteria found in the Advisory Council's regulations.

Impact Threshold Definitions

Archeological Resources. Many important questions about human history can only be answered by the physical material of archeological resources. An archeological site can be eligible to be listed in the National Register of Historic Places if the site has yielded, or may be likely to yield, information important in prehistory or history. An archeological site can be nominated to the National Register in one of three historic contexts or levels of significance: local, state, or national (see National Register Bulletin #15, *How to Apply the National Register Criteria for Evaluation*, NPS n.d.*)*. Impact intensity thresholds are based on the potential of the site to yield important information, and the probable historic context of the affected site. Table 48 lists the definitions of intensity levels for cultural resources, including archeological resources.

Historic Structures/Buildings. To be listed in the National Register of Historic Places, a structure or building must meet the following criteria.

Be associated with an important historic context. That is, it must possess significance such that a meaning or value is ascribed to the structure or building.

Have integrity of those features necessary to convey its significance. Typically, these would include location, design, setting, workmanship, materials, feeling, and national association.

Complete information on criteria for listing is included in National Register Bulletin #15, *How to Apply the National Register Criteria for Evaluation*. Impact thresholds for historic structures and buildings are defined in table 48.

TABLE 48: DEFINITIONS OF INTENSITY LEVELS FOR CULTURAL RESOURCES

Archeological Resources	
Negligible	Impact is at the lowest levels of detection – barely measurable with no perceptible consequences, either adverse or beneficial, to archeological resources. For purposes of section 106, the determination of effect would be *no adverse effect*.
Minor	Adverse impact – disturbance of a site is confined to a small area with little, if any, loss of important information potential. For purposes of section 106, the determination of effect would be *no adverse effect*. Beneficial impact – preservation of a site in its natural state. For purposes of section 106, the determination of effect would be *no adverse effect*.
Moderate	Adverse impact – disturbance of the site does not result in a substantial loss of important information. For purposes of section 106, the determination of effect would be *adverse effect*. Beneficial impact – stabilization of the site occurs. For purposes of section 106, the determination of effect would be *no adverse effect*.
Major	Adverse impact – disturbance of the site is substantial and results in the loss of most or all of the site and its potential to yield important information. For purposes of section 106, the determination of effect would be *adverse effect*. Beneficial impact – active intervention occurs to preserve the site. For purposes of section 106, the determination of effect would be *no adverse effect*.
Impairment	A major, adverse impact occurs to an archeological resource whose conservation is necessary to fulfill specific purposes identified in the establishing legislation of Glen Canyon National Recreation Area; key to the natural or cultural integrity of the recreation area; or identified as a goal in the recreation area's general management plan or other relevant NPS planning documents.
Historic Resources	
Negligible	Impact is at the lowest levels of detection – barely measurable with no perceptible consequences, either adverse or beneficial, to historic resources. For purposes of section 106, the determination of effect would be *no adverse effect*.
Minor	Adverse impact – impact does not affect the character-defining features of a National Register of Historic Places-eligible or -listed structure or building. For purposes of section 106, the determination of effect would be *no adverse effect*. Beneficial impact – stabilization/preservation of character-defining features occurs in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (NPS 1995b) to maintain existing integrity of a structure or building. For purposes of section 106, the determination of effect would be *no adverse effect*.
Moderate	Adverse impact – impact alters a character-defining feature of the structure or building but does not diminish the integrity of the resource to the extent that its National Register eligibility is jeopardized. For purposes of section 106, the determination of effect would be *no adverse effect.* Beneficial impact – rehabilitation of a structure or building occurs in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (NPS 1995b) to make possible a compatible use of the property while preserving its character-defining features. For purposes of section 106, the determination of effect would be *no adverse effect.*
Major	Adverse impact – impact alters a character-defining feature of the structure or building, diminishing the integrity of the resource to the extent that it is no longer eligible to be listed in the National Register. For purposes of section 106, the determination of effect would be adverse effect. Beneficial impact – restoration occurs in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties (NPS 1995b) to accurately depict the form, features, and character of a structure or building as it appeared during its period of significance. The section 106 determination of effect would be no adverse effect.
Impairment	A major, adverse impact occurs to a historic resource whose conservation is necessary to fulfill specific purposes identified in the establishing legislation of Glen Canyon National Recreation Area; key to the natural or cultural integrity of the recreation area; or identified as a goal in the recreation area's general management plan or other relevant NPS planning documents.

Cultural Landscapes	
Negligible	Impact is at the lowest levels of detection - barely measurable with no perceptible consequences, either adverse or beneficial, to cultural landscapes. For purposes of section 106, the determination of effect would be no adverse effect.
Minor	Adverse impact – impact does not affect the character defining features of a National Register of Historic Places-eligible or -listed cultural landscape. For purposes of section 106, the determination of effect would be no adverse effect. Beneficial impact – preservation of character-defining features occurs in accordance with the Secretary of the Interior's standards to maintain existing integrity of the cultural landscape. For purposes of section 106, the determination of effect would be no adverse effect.
Moderate	Adverse impact – impact alters a character-defining feature of the cultural landscape but would not diminish the integrity of the landscape to the extent that its National Register eligibility is jeopardized. For purposes of section 106, the determination of effect would be no adverse effect. Beneficial impact – rehabilitation of a landscape or its features occurs in accordance with the Secretary of the Interior's standards, to make possible a compatible use of the landscape while preserving its character-defining features. For purposes of section 106, the determination of effect would be no adverse effect.
Major	Adverse impact – impact alters a character-defining feature of the cultural landscape, diminishing the integrity of the resource to the extent that it is no longer eligible to be listed in the National Register. For purposes of section 106, the determination of effect would be adverse effect. Beneficial impact – restoration occurs in accordance with the Secretary of the Interior's standards, to accurately depict the features and character of a landscape as it appeared during its period of significance. For purposes of section 106, the determination of effect would be no adverse effect.
Impairment	A major, adverse impact occurs to a cultural landscape whose conservation is necessary to fulfill specific purposes identified in the establishing legislation of Glen Canyon National Recreation Area; key to the natural or cultural integrity of the recreation area; or identified as a goal in the recreation area's general management plan or other relevant NPS planning documents.
Ethnographic Resources	
Negligible	Impact is barely perceptible and would alter neither resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group's body of beliefs and practices. There would be no change to a group's body of beliefs and practices. For purposes of section 106, the determination of effect on ethnographic resources would be no adverse effect.
Minor	Adverse impact – impact is slight but noticeable. It does not appreciably alter resource conditions, such as traditional access or site preservation, or the relationship between the resource and the affiliated group's body of beliefs and practices. For purposes of section 106, the determination of effect on ethnographic resources would be no adverse effect. Beneficial impact – impact enhances traditional access and/or accommodates a group's traditional practices or beliefs. For purposes of section 106, the determination of effect on ethnographic resources would be no adverse effect.
Moderate	Adverse impact – impact is apparent and alters resource conditions. Interference occurs with traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices, even though the group's beliefs and practices would survive. For purposes of section 106, the determination of effect on ethnographic resources would be adverse effect. Beneficial impact – a group's beliefs and practices are facilitated. For purposes of section 106, the determination of effect on ethnographic resources would be no adverse effect.
Major	Adverse impact – impact alters resource conditions. Traditional access, site preservation, or the relationship between the resource and the affiliated group's body of beliefs and practices are blocked or greatly affected, to the extent that the survival of a group's beliefs and/or practices would be jeopardized. For purposes of section 106, the determination of effect on ethnographic resources would be adverse effect. Beneficial impact – a group's beliefs or practices are encouraged. For purposes of section 106, the determination of effect on ethnographic resources would be no adverse effect.
Impairment	A major, adverse impact occurs to an ethnographic resource or value whose conservation is necessary to fulfill specific purposes identified in the establishing legislation of Glen Canyon National Recreation Area; key to the natural or cultural integrity of the recreation area; or identified as a goal in the recreation area's general management plan or other relevant NPS planning documents.

Cultural Landscapes. Cultural landscapes are the result of the interaction between people and the land, and reflect the influence of human beliefs and actions over time on the natural landscape. Cultural landscapes are shaped through time by historical land-use and management practices, politics, property laws, levels of technology, and economic conditions. Cultural landscapes are a living record of an area's past, providing a visual chronicle of its history.

The dynamic nature of human life contributes to the continual reshaping of cultural landscapes. This makes them a good source of information about specific times and places, but renders their long-term preservation a challenge.

For a cultural landscape to be listed in the National Register, it must possess significance (the meaning or value ascribed to the landscape) *and* have integrity of those features necessary to convey its significance. The character-defining features of a cultural landscape include spatial organization and land patterns; topography; vegetation; circulation patterns; water features; and structures or buildings, site furnishings, and objects. These character-defining features are detailed in *The Secretary of the Interior's Standards for the Treatment of Historic Properties With Guidelines for the Treatment of Cultural Landscapes* (NPS 1995b). Impact intensity thresholds for cultural landscapes are defined in table 48.

Ethnographic Resources. Ethnographic resources relate to cultural content and context of cultural resources. They involve the identity and heritage of contemporary peoples or groups. As defined by the National Park Service, an ethnographic resource is a site, structure, object, landscape, or natural resource feature that has been assigned a traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it. Some specific places of traditional cultural use may be eligible for inclusion in the National Register of Historic Places if they meet national register criteria for traditional cultural properties. Impact intensity thresholds for ethnographic resource are defined in table 48.

Durations of Impacts on Cultural Resources. Impacts on virtually all cultural features other than vegetation components would be long-term effects because most cultural resources are non-renewable. These would include any effects on archeological, historic, or ethnographic resources, and on non-vegetation elements of a cultural landscape.

Short-term impacts would involve such things as treatment effects on the natural elements of a cultural landscape that would extend for no more than about five years. Examples would include the restoration of historic plantings or the regrowth of vegetation.

Geographic Area Evaluated for Impacts

The geographical area that was evaluated for impacts on cultural resources extends 0.5 miles (horizontally) from the full-pool line at 3,700 feet above sea level.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Archeological Resources. Under alternative A, most personal watercraft use would occur in open lake areas. Although personal watercraft would not be allowed to travel upstream into the canyons of the

San Juan, Escalante, Dirty Devil, and Colorado Rivers, downstream travel in the rivers would be allowed.

The most noticeable effects on archeological sites that are potentially eligible for listing in the National Register of Historic Places would result from personal watercraft users who land in areas such as narrow, steep-walled canyons that are inaccessible to most other visitors. Damage to these sites, including submerged sites, from personal watercraft users could result from inadvertent actions, such as the landing of craft or trampling of sites, or from deliberate actions such as illegally collecting artifacts or vandalizing resources. Canyon areas where archeological sites reflect the most damage include Moqui, Slick Rock, Lake, and Iceberg.

Access to the canyons varies with water levels. In addition, the distance traveled from shoreline by personal watercraft users in some areas can be limited by a lack of suitable footwear and clothing. (This constraint is less common with users of other watercraft, who can more readily carry extra clothing and shoes.) This constraint helps reduce disturbances by personal watercraft users at sites away from the shoreline.

In areas other than narrow canyons, archeological sites are equally accessible to users of all vessels. They often also can be accessed by hikers and people using automobiles. In these areas, the frequency of trampling, vandalism, and illegal collecting by personal watercraft users under alternative A would occur at the same rate as that from other recreation area users. However, the damage caused by personal watercraft users may be less than that of other visitors because of the inconvenience of carrying tools such as shovels on a personal watercraft. While the effect from personal watercraft users would be additive, it would be indistinguishable from damage to archeological sites caused by visitors using other means of access.

The presence of other visitors can sometimes be a deterrent to vandalism. Therefore, isolated sites in the upper canyons that are accessible primarily by personal watercraft could be more vulnerable to vandalism and looting than sites in more visible areas.

Most personal watercraft users, like other recreation area visitors, are conscientious about protecting the recreation area's archeological resources and do not engage in the deliberate disturbance of sites. In addition, alternative A's prohibition of upstream travel by personal watercraft limits the number of personal watercraft users who can easily access the archeological resources in the canyon areas. Therefore, while direct effects on archeological resources from personal watercraft use under alternative A would be adverse and long-term, the intensity would be negligible to minor, depending on-site vulnerability and accessibility.

Wave action over time tends to erode soils around archeological sites and wear away petroglyphs and pictographs. Under alternative A, wakes created by watercraft would have a negligible to minor adverse effect on vulnerable archeological sites. The impact would be limited to the small number of sites directly on the lake shore, and to submerged sites that are exposed as lake levels fall. While personal watercraft contribute to this indirect adverse effect, their contribution would be negligible because of their relatively small size and water displacement.

Historic Resources. Most of the recreation area's historic resources, including the Hole-in-the-Rock area and the Hole-in-the-Rock Trail, can be accessed by automobile (sometimes limited to 4-wheel-drive vehicles), by boat, or on foot. Direct and indirect adverse impacts on historic sites from unauthorized collecting or vandalism would be likely to continue at negligible to moderate levels, based on records of past resource disturbance. In these areas under alternative A, adverse effects from

personal watercraft users would occur at the same rate as those from other recreation area users. While the effect from personal watercraft users would be additive, it would be indistinguishable from disturbance to historic resources caused by visitors using other means of access.

Cultural Landscapes. No cultural landscapes have been formally defined within Glen Canyon National Recreation Area. However, areas like the Hole-in-the-Rock comprise an important historic scene enjoyed by visitors. Impacts on this and other historic landscapes would be similar to those described above for historic resources.

Areas valued by tribes for traditional activities comprise an ethnographic landscape. Impacts on these areas would be similar to those described for ethnographic resources, below.

Ethnographic Resources. The recreation area's ethnographic sites have not been formally evaluated as traditional cultural properties. However, traditional uses are known to occur along river corridors, cliffs, beaches, and shorelines (NPS 1988a). To protect their integrity and values, the locations of sites that are sacred and highly valued by tribes are not disclosed.

The shallow draft of personal watercraft allows them to maneuver close to shore, and to reach areas of Glen Canyon National Recreation Area that are difficult to access by other types of vessels. The presence of personal watercraft users in these areas could be intrusive when tribes are conducting site-specific traditional activities. Even though these intrusions often would be unknowing and short-term, they still could be disruptive. The presence of personal watercraft, their users, and trash also could constitute a visual intrusion on traditional activities.

The variable noise from personal watercraft associated with their rapid direction changes and frequent acceleration and deceleration may be especially disruptive to tribal religious activities. The disturbance caused by this noise could be sufficient to discourage tribal use of some areas for activities that require quiet. This could occur either in the short term until the personal watercraft users leave the area, or on a long-term basis, particularly at sites that are close to popular personal watercraft use areas.

Some ceremonial activities or collecting of special resources require that practitioners have solitude and privacy. Activities also may be time sensitive and must be completed during a particular time period. These activities could be adversely affected by the presence of any nearby recreational users. However, practitioners probably would find visitors on personal watercraft "playing" in a nearby cove more disruptive than the same number of people on a houseboat anchored in the cove over the same period.

Alternative A would prohibit upstream use of personal watercraft in the San Juan, Colorado, Escalante, and Dirty Devil Rivers. This would help limit the number of visitors who might inadvertently intrude on traditional practitioners in these areas. However, direct and indirect adverse effects on ethnographic resources from downstream personal watercraft use would occur.

Impacts of personal watercraft use on ethnographic resources would be adverse and both direct and indirect, and would vary from negligible to moderate. Duration would be both short-term and long-term. The intensity would depend on the location, importance of the area to tribes, time of year, type of ethnographic activity, number of personal watercraft, and how the personal watercraft was being used (for example, travel from point to point versus "playing" in a cove).

Cumulative Effects. Throughout the recreation area, direct, adverse effects on cultural resources from trampling, unauthorized collecting, and vandalism by unscrupulous visitors would be likely to

continue. The impact intensity would vary from negligible to moderate, depending on site vulnerability and accessibility, with an overall impact intensity of minor. Negligible to minor, adverse, indirect effects on cultural sites that are near the shore or are sometimes submerged would continue from the wave action caused both by boats and wind.

Under alternative A, most visitors would value the recreation area's cultural resources and would continue to be conscientious about protecting them. They would not engage in the deliberate disturbance of sites and sometimes would serve as *ad hoc* sentries, reporting suspicious activities to authorities and discouraging illegal collecting and vandalism simply by their presence.

The recreation area would continue measures to protect cultural resources. These would include monitoring site conditions and educating visitors about the importance of and the need to protect the recreation area's cultural resources. Eroding or damaged sites would be recorded and stabilized. Some sites could be hardened, fenced, or placed off-limits to visitation. Interpretive programs, signing, and ranger patrols would help prevent site disturbance. In special cases, data recovery might be initiated where sites are in imminent danger.

The Navajo Nation also has an interest in protecting the area's cultural resources. The tribe would continue its current work with the National Park Service and other federal agencies to identify threatened sites on the reservation, and to develop mitigating measures.

Cultural resources outside of the recreation area would continue to be disturbed or destroyed by vandals or those who would profit from artifact sales. Because cultural resources are non-renewable, incidents of vandalism or unauthorized collecting within and outside the recreation area would cumulatively diminish the region's cultural resource. These losses would reduce the number and variety of cultural sites available for public appreciation and scientific study.

Cultural resources also would continue to be lost to development of the area. The loss of sites near the Colorado River and its tributaries would be especially detrimental to the cultural record because so many of these types of sites were lost during the filling of Lake Powell. In areas of new development, major resources that are listed in the National Register of Historic Places or potentially would be eligible for listing would be mitigated in accordance with the *National Historic Preservation Act*. Less significant sites would be lost. While the loss of individual sites may not appear important, the collective loss of many sites would diminish the ability to appreciate and draw accurate conclusions about the record of people, both prehistoric and historic, in the region.

Cumulatively, the recreation area's cultural resources would continue to derive a substantial measure of protection from their location within Glen Canyon National Recreation Area. Outside of the recreation area, most effects on cultural resources would continue to be adverse. Impact intensities would vary by resource type and accessibility, and would range in intensity at individual sites from negligible to major. Regionally, the cumulative effect on cultural resources would be adverse, moderate, and long-term.

Conclusion. Effects on cultural resources from the implementation of alternative A would be adverse and mostly long-term. While most personal watercraft users would be conscientious about protecting the recreation area's cultural resources, a few would engage in destructive actions such as illegal collecting of artifacts or vandalism. The effects of this behavior would be most noticeable in the narrow, steep-walled canyon areas that are inaccessible by most other types of motorcraft, but that can be traveled in a downstream direction by personal watercraft under alternative A. In these areas, impact intensities mostly would be negligible to minor. Impact intensities from personal watercraft

users would be of similar magnitude in other areas, but would be indistinguishable from the adverse effects caused by the relatively few destructive visitors who used other transport methods to access the sites.

Cumulatively, direct, adverse, long-term effects on the cultural resources in the recreation area would vary in intensity from negligible to moderate, depending on individual site vulnerability and accessibility. Negligible to minor, adverse, indirect effects on near-shore cultural sites would continue from the wave action caused both by boats and wind. The contribution of personal watercraft under alternative A to wave-caused effects would be negligible. Overall, the direct effect within the recreation area would be adverse and minor. Regionally, the effect from activities that occur outside of the recreation area would continue to be adverse and moderate. The contribution of alternative A to the regional effects would be negligible.

Alternative A would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

As shown in table 4 and figures 6 through 8, alternative B would close the upper canyons of the Dirty Devil, Escalante, San Juan, and Colorado Rivers to all use by personal watercraft. This action would make archeological sites, ethnographic sites, and ethnographic landscapes along these approximately 123 miles of river less accessible and less vulnerable to vandalism and illegal collection of artifacts. Compared to alternative A, this would produce direct, long-term, negligible to minor, beneficial effects on the archeological and ethnographic resources of these areas. The effects of these closures on historic resources would be negligible because few resources of these types occur in the steep canyon areas.

Rafters and other users of nonmotorized vessels could still access the canyon areas. However, the tendency of these visitors to travel in fairly large groups and to observe each other's activities would limit the potential for individuals to collect artifacts or vandalize sites. The absence of engines on these watercraft would reduce noise intrusions on traditional activities in the canyons compared to alternative A, which would be a direct, beneficial, negligible to moderate effect.

Alternative B would include a new flat-wake zone along a total of about 7 miles of the Escalante River (see table 2). The resulting reductions in wave action from personal watercraft might slow the erosion process and subsequent loss of vulnerable archeological resources along the shoreline and at submerged sites. This effect would be negligible compared to alternative A because personal watercraft wakes currently are causing only negligible adverse effects on these resources, and because these areas would continue to be subject to the sometimes-violent action of wind-caused waves.

Alternative B would include an improved education program for personal watercraft users. This program could include information on such subjects as the need to protect cultural resources, ways to avoid damaging cultural resources when beaching a craft, and procedures for contacting recreation area staff when a visitor observed a site being vandalized. The beneficial effects of improved education could be negligible to moderate for individual sites, but on a recreation area-wide basis would be negligible to minor.

Other effects of alternative B on cultural resources would be similar to those described under alternative A. However, physical intrusions and noise reductions associated with this alternative would produce modest reductions in disturbances to traditional sites and activities.

Cumulative Effects. Cumulative effects of alternative B would be similar to those described for alternative A.

Conclusion. Compared to alternative A, alternative B would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic sites along the river canyons. Effects on traditional practices would be beneficial and negligible to moderate in intensity. In other areas, the effects of alternative B may be beneficial compared to alternative A, but the intensity would be negligible. Cumulative effects would be similar to alternative A. Alternative B would not result in impairment of the cultural resources of the recreation area.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Alternative C would make permanent the ban personal watercraft use on Lake Powell. This would eliminate the use of personal watercraft in the canyons areas. The effects in these areas would be similar to those described for alternative B.

In the remainder of the lake, visitor use may decline by as much as 25% immediately following the ban. Visitor disturbances to cultural resources would be decrease by an equivalent amount. However, the intensity of this short-term, beneficial effect on cultural resources would be negligible, because visitors usually do little harm to the recreation area's cultural resources on an annual basis. Except for rare cases of major damage by vandals or artifact collectors, adverse effects on most cultural sites would accumulate slowly over extended periods of time.

As stated in the "General Methodology" section of this chapter, it was assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. By the year 2012, visitor use in the recreation area may return to prior levels or slightly higher and personal watercraft use may be replaced on Lake Powell with other types of watercraft. While these vessels would produce approximately the same noise as personal watercraft, they are not as noticeable because they tend to travel from point to point rather than concentrating their use in a small area, usually operate farther away from shore, and would not typically make rapid turns and changes in speeds. As a result, the change in type of watercraft would have a long-term, beneficial, negligible to minor effect on traditional practices that are conducted within a mile of the lake shore throughout the recreation area.

Cumulative Effects. The cumulative effects of alternative C would be similar to those of alternative A.

Conclusion. Compared to alternative A, alternative C would have direct, long-term, negligible to minor, beneficial effects on archeological and ethnographic resources, and negligible to moderate,

beneficial effects on traditional practices in the river canyons in the recreation area. It also would have direct, long-term, negligible to minor, beneficial effects on traditional practices that are conducted within a mile of the lake shore.

In the short term, the reduced visitation that would follow implementation of alternative C would result in a negligible, short-term reduction in disturbances to cultural sites. This condition would end by 2012 if visitor use of the recreation area increases due to natural growth in visitation, to visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Other cumulative effects would be similar to alternative A. Alternative C would not result in impairment of the cultural resources of Glen Canyon National Recreation Area.

SECTION 106 SUMMARY

This draft environmental impact statement provides detailed descriptions of three alternatives (including a no-action alternative) and analyzes the potential impacts associated with possible implementation of each alternative. The analysis of potential impacts of personal watercraft at Glen Canyon National Recreation Area also considered access by other types of watercraft.

Visitors access areas of the recreation area by many transport modes, including motor vehicles and airplanes, in boats of all types, by hiking, and by personal watercraft. Because of this diversity of modes of access, the impacts on archeological and historic cultural resources directly attributable solely to personal watercraft users are difficult to define. Effects can best be defined in the upper canyons where access is limited by area topography to shallow-draft watercraft like personal watercraft and nonmotorized vessels such as canoes or kayaks. Under alternative B, in these upper canyon areas, negligible to minor benefits to archeological resources could result from reductions in the number of personal watercraft accessing the area. This would constitute a "*no adverse effect*" on archeological resources.

Reduced wake zones under alternative B would slow damage to a few vulnerable archeological resources that are partially submerged, or that are located along the beaches and canyon walls. However, because of their small size and amount of water displacement, wakes from personal watercraft would make up an extremely small part of the lake wave action. Thus, beneficial impacts of reduced wake zones outlined under alternative B would be negligible, resulting in *no adverse effects* from this source under this alternative.

Continuation of traditional religious activities is crucial to preservation of tribal cultural values and identity. Visitors using personal watercraft, as well as other means of transport, can deliberately or unknowingly intrude on ceremonial activities or disturb resources and archeological sites valued by tribes. Under alternative B, personal watercraft use would be eliminated in the upper canyons. Most of this use would transfer to more developed areas containing fewer ethnographic resources. Closure of the area above the Clay Hills pullout on the San Juan River to personal watercraft would help reduce noise and other intrusions on ethnographic sites and resources valued by tribes, resulting in minor benefits (*no adverse effects*) on ethnographic resources. Other types of watercraft such as rafts and canoes could still access these areas and intrude on traditional practices, resulting in negligible to minor adverse impacts (*no adverse effects)*.

Under alternative B, fewer personal watercraft users would be present in some areas, resulting in minor benefits (*no adverse effect)* on ethnographic landscapes. Impacts on historic resources and cultural landscapes would be likely to continue at negligible to moderate levels (*no adverse effect*).

To help reduce impacts on cultural resources, resources would continue to be monitored on a regular basis. Vulnerable resources listed on or potentially eligible for the National Register would have priority for protective measures, and the recreation area staff would continue to actively work with tribes to protect ethnographic resources and privacy for traditional activities. During periods of draw-down and potential exposure of vulnerable submerged archeological resources, appropriate management actions would be implemented. These could include such actions as monitoring, site stabilization, and visitor management actions such as signing, ranger patrols, or interpretive messages.

In cases where it was determined there was a potential for *adverse* impacts (as defined in 36 CFR 800) to cultural resources listed on or eligible for listing on the National Register of Historic Places, the National Park Service would coordinate with the state historic preservation officers of Utah and Arizona to determine the level of effect on the property, and to determine what mitigation measures would be needed.

Glen Canyon National Recreation Area staff would continue to educate visitors regarding archeological and ethnographic site etiquette to provide long-term protection for surface artifacts, architectural features, and traditional activities. If necessary, additional mitigation measures would be developed in consultation with the state historic preservation officers and concerned Native American tribes.

Concerned Native American tribes will receive copies of this draft environmental impact statement for review and comment. This draft environmental impact statement also will be sent to the Arizona and Utah state historic preservation officers, and to the Advisory Council on Historic Preservation for review and comment as part of the section 106 compliance process.

Pursuant to 36 CFR Part 800.5, implementing regulations of the *National Historic Preservation Act* (revised regulations effective January 2001), addressing the criteria of effect and adverse effect, the National Park Service finds that the implementation of the plan in Glen Canyon National Recreation Area, with identified mitigation measures, would be beneficial, and would not result in any new adverse effects *(no adverse effect)* to archeological, historic, ethnographic, or cultural landscape resources currently identified as eligible for or listed on the National Register of Historic Places.

SOCIOECONOMIC ENVIRONMENT

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Changes in personal watercraft management at Glen Canyon National Recreation Area could affect the local economy in several ways, including changes in recreation area visitation, sales and profits of local businesses, local employment, and local and state sales tax revenue.

GUIDING REGULATIONS AND POLICIES

The *National Environmental Policy Act* requires analysis of social and economic impacts resulting from proposed major federal actions in an environmental impact statement. From this requirement, the National Park Service has identified conditions that it wants to achieve in association with its management of national parks. These conditions are described in *Management Policies 2001* (NPS 2000d) and for Glen Canyon National Recreation Area. They include the following:

> Public participation in planning and decision-making ensures that the National Park Service fully understands and considers the public's interests in Glen Canyon National Recreation Area, which is part of their national heritage, cultural traditions, and community surroundings. The service actively seeks out and consults with existing and potential visitors, neighbors, people with traditional cultural ties to recreation area lands, scientists and scholars, concessioners, cooperating associations, gateway communities, other partners, and government agencies.
>
> The service works cooperatively with others to improve the condition of Glen Canyon National Recreation Area; to enhance public service; and to integrate the recreation area into sustainable ecological, cultural, and socioeconomic systems.
>
> In the spirit of partnership, the service seeks opportunities for cooperative management agreements with state or local agencies that would allow for more effective and efficient management of Glen Canyon National Recreation Area.
>
> Possible conflicts between alternatives and land use plans, policies, or controls for the area concerned (including those of local and state governments and Indian tribes) and the extent to which the recreation area would reconcile the conflict are identified in environmental documents.

METHODOLOGY AND ASSUMPTIONS

This section summarizes the socioeconomic impacts associated with the proposed regulatory alternatives for personal watercraft use in Glen Canyon National Recreation Area. A detailed description of these impacts and a complete list of references are provided in *Economic Analysis of Personal Watercraft Regulations in Glen Canyon National Recreation Area* (Law Engineering and Environmental Sciences, Inc. 2003).

Impact Threshold Definitions

Impacts on socioeconomics were evaluated using the process described in the "General Methodology for Establishing Impact Thresholds and Measuring Effects" section. Impact threshold definitions for socioeconomic conditions were defined as follows.

> *Negligible* — Economic and socioeconomic conditions would not be affected, or effects would not be measurable.
>
> *Minor* — The effect on economic and socioeconomic conditions would be small but measurable, and would affect a small portion of the population. Few effects could be discerned outside of the Page area.
>
> *Moderate* — The effect on economic and socioeconomic conditions would be readily apparent and widespread in the vicinity of Page, with effects being evident at the five-county level.
>
> *Major* — The effect on economic and socioeconomic conditions would be readily apparent and would substantially change the economy or social services within the five-county area.

Short-term impacts would be effects that would end within three to five years after the implementation of the management action. Long-term effects would occur beyond the 10-year analysis period of this study.

Geographic Area Evaluated for Impacts

The socioeconomic impact analysis focused primarily on the city of Page, Arizona, with secondary consideration of the five-county area surrounding the lake. There are businesses outside of this area, such as Salt Lake City, Utah or Grand Junction, Colorado that rent or sell personal watercraft to Glen Canyon visitors. While these businesses could be affected by personal watercraft management decisions at the recreation area the value of this business contributes little to the local economy compared to other activities. Effects of the alternatives on these businesses and economies are considered qualitatively.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Alternative A would allow personal watercraft use at Glen Canyon National Recreation Area consistent with the *Superintendent's Compendium* (NPS 2002c). While some manufacturers have reported a drop in personal watercraft sales nationally, there is no indication that this trend is substantially affecting sales of personal watercraft intended for use at Glen Canyon National Recreation Area. Therefore, it is assumed that personal watercraft use would either change in a manner similar to overall recreation area use or would continue to occur at recent levels through the next 10 years.

Rentals, sales, and visitor expenditures related to personal watercraft use at the recreation area would contribute to the regional economy at generally the same levels as recent years. As a result, personal watercraft use and its contributions to income and sales, both in Page and regionally, would not

change from recent conditions. The effects of alternative A on socioeconomic conditions would be negligible.

Cumulative Effects. Alternative A would not change overall recreation or visitation at Glen Canyon National Recreation Area. Therefore, the cumulative effects of alternative A would be negligible.

Conclusion. Alternative A would have a negligible socioeconomic effect by itself and cumulatively with other actions.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

As discussed in the "Visitor Use and Experience" section, the management actions included under alternative B would not change the levels of personal watercraft use. However, the distribution of use would change in response to changes in access to river sections. High levels of satisfaction with the lake experience would occur, similar to alternative A. As a result, rentals, sales, and visitor expenditures related to personal watercraft use at Glen Canyon National Recreation Area would contribute to the economy of Page and the regional at generally the same levels as alternative A (Law Engineering and Environmental Science, Inc. 2003). The effect on socioeconomic conditions would be negligible.

A ban on carbureted two-cycle personal watercraft at the end of 2012 would have little effect on the local and regional economy. It is assumed, based on recent trends and based on the commercial availability of newer technology that suppliers of personal watercraft sales and services would have converted to newer technology by 2012. Some visitors may still have old technology and would no longer visit the recreation area. This would result in a direct reduction in local service and repair business and would result in a negligible adverse economic effect.

Cumulative Effects. Alternative B would not change overall recreation or visitation at Glen Canyon National Recreation Area. Therefore, the cumulative effects of alternative B would be negligible.

Conclusion. Alternative B would have a negligible socioeconomic effect by itself and cumulatively with other actions.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

For this analysis, it was assumed for all alternatives that there would be a change in total boat days and watercraft operating hours of between –2% and +2% annually over the next 10 years. It was also assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. This was the same assumption that was used for the other impact topics.

This analysis considered the socioeconomic effects of both of these conditions.

The report *Economic Analyses of Personal Watercraft Regulations in Glen Canyon National Recreation Area* (Law Engineering and Environmental Services, Inc. 2003) identified the following short-term effects on the economy of Page with the implementation of alternative C.

> Annual visitation to Glen Canyon National Recreation Area would decline by 238,000 to 425,000 people. This represents approximately 10% to 20% of the more than 2 million visitors to Glen Canyon National Recreation Area each year.
>
> If personal watercraft users stay in hotels outside of the recreation area at the same rate as all recreation area visitors (10%), hotel stays in Page would decrease by 23,800 to 42,500 visitors per year.
>
> Restaurants and retail sales in Page would experience declines in business proportional to the decreases in visitor numbers.
>
> Personal watercraft rentals and sales in Page would probably be eliminated. This would occur because there are no other locations within the five-county region that can support use by large numbers of personal watercraft.
>
> Companies that service personal watercraft would see a decline in business.
>
> The annual loss of revenues to the business sector in Page would be between $25 million and $42 million. This could cause some retailers and service providers to go out of business.

Based on these effects, alternative C would cause a major, adverse, long-term effect on the economy of Page (Law Engineering and Environmental Sciences, Inc. 2003). Other communities in the counties surrounding the recreation area also would experience adverse effects. However, they would be less severe because the economies of these communities are less dependent on visitation at Glen Canyon National Recreation Area.

The adverse effects would be both direct and indirect. Direct effects would be experienced by companies that provide for the sales, storage, service, and/or rental of personal watercraft. Indirect effects would include, but would not be limited to such things as lower retail sales at stores and restaurants, fewer hotel nights, reduced sales tax revenues, and less spending by Page residents who experienced income reductions or lost their jobs.

Over time, visitor numbers would return to the levels that occurred before alternative C was implemented. As a result, some sectors of the Page economy would return to their previous levels. These sectors would include restaurants, hotels, and retail stores for products other than personal watercraft. Businesses providing servicing and storage of watercraft also would experience a recovery.

Businesses in Page that sold personal watercraft would probably lose most or all of their business on a permanent basis (Law Engineering and Environmental Sciences, Inc. 2003). Because boats can be very expensive, visitors are less likely to buy boats in Page than personal watercraft. Boat sales might rise in cities such as Phoenix and Salt Lake City, but compared to the much larger and more diverse economies of these areas, such increases would have a negligible beneficial effect on the economy. Reduced sales in watercraft in Page would produce a moderate, long-term, direct, adverse effect in this city.

Cumulative Effects. While personal watercraft-related visitation, rentals, and sales are substantial contributors to the overall economy of Page, people who only use personal watercraft constitute just 7% of all visitors. These are the visitors who would be most likely to stop visiting Glen Canyon National Recreation Area when personal watercraft use was prohibited. The remaining 90% to 95% of current visitors would continue to come to the area and would support the area's revenues, employment, personal income, taxes, sales and other economic measures. While personal watercraft use is an important contributor to the local economy, Page and other communities in the area do not solely depend on personal watercraft use at Glen Canyon National Recreation Area. While businesses that depend on this form of recreational vessel would experience major impacts, the overall effect, in consideration with other economic factors influencing the regional economy, would be moderate.

Conclusion. Alternative C would cause a major, adverse, long-term effect on the economy of Page. Other communities in the counties surrounding the recreation area would experience less intense adverse effects. The effects would be both direct and indirect as reduced demand for sales and service related to personal watercraft-based recreation rippled through the economy. Cumulative effect on the regional economy would be moderate. In the long term, the economy would recover to previous levels, except for businesses that had focused on personal watercraft sales and rentals. Therefore, the long-term effect on the local economy would be moderate to major.

RECREATION AREA MANAGEMENT AND OPERATIONS

ISSUES AND MANAGEMENT OBJECTIVES RELATED TO PERSONAL WATERCRAFT USE

Issues

Personal watercraft management issues that have been associated with management and operations of Glen Canyon National Recreation Area include the following.

> Management of personal watercraft in the recreation area involves seven NPS divisions plus boating enforcement agencies from Arizona and Utah. Any changes in management of personal watercraft may affect the operations of these entities.
>
> Staffing levels in the recreation area may not be adequate to manage personal watercraft issues or changes in personal watercraft management.
>
> Boating regulations for Arizona and Utah are enforced on their respective waters. These states have differences in their personal watercraft requirements. While the differences in the state regulations do not affect the ability to enforce the regulations, they cause confusion for some personal watercraft operators that makes compliance difficult.

Management Objectives

As shown in table 3, two objectives for recreation area management and operations were identified for personal watercraft management. They included:

> Maintain cooperation with state entities that regulate personal watercraft use and protect quality of air and water.
>
> Provide sufficient staffing levels as funding allows to adequately manage personal watercraft use and to resolve personal watercraft user-related conflicts.

These objectives tier from the recreation area management and operations objectives that were included in the general management plan and strategic plan. The more general objectives from these plans that are relevant to personal watercraft management include:

> Maximizing the efficiency and effectiveness of the management of the recreation area and adjacent lands.
>
> Cooperating with the Bureau of Reclamation in their management of the reservoir.
>
> Cooperating with the Navajo Tribe in managing and developing the southern shoreline of Lake Powell for recreational use.

GUIDING REGULATIONS AND POLICIES

In Glen Canyon National Recreation Area, boating regulations from the U.S. Coast Guard and from the states of Arizona and Utah apply. Based on *Management Policies 2001* (NPS 2000d), "the Service will seek to acquire concurrent legislative jurisdiction for all units of the national park system, as required by the 1976 amendment to the *General Authorities Act*. Concurrent jurisdiction allows the National Park Service to enforce federal criminal statutes and also to assimilate state law under 18 U.S.C. 13, when no applicable federal law or regulation exists." Personal watercraft operation falls under this statement because there are no federal requirements for this type of vessel. Concurrent jurisdiction allows for the more efficient conduct of both state and federal law enforcement functions within the parks.

Management Policies 2001 (NPS 2000d) guide maintenance activities in park units. Section 9.1.4.1 states that

> the Service will conduct a program of preventive and rehabilitative maintenance and preservation to (1) provide a safe, sanitary, environmentally protective, and esthetically pleasing environment for park visitors and employees; (2) protect the physical integrity of facilities; and (3) preserve or maintain facilities in their optimum sustainable condition to the greatest extent possible. Preventive and rehabilitative maintenance programs will incorporate sustainable design elements and practices to ensure that water and energy efficiency, pollution prevention, and waste prevention and reduction are standard practice.

The Concession Division manages three concession contracts with ARAMARK Leisure Services, Inc. Alternatives to manage personal watercraft in the recreation area may result in the modification of the concessions contracts. According to section 10.2.3.2 of *Management Policies 2001* (NPS 2000d), "Concession contracts may be modified only by written amendment. Amendments developed after the issuance of a concession contract must be consistent with current NPS policies and orders."

Guidelines for interpretation and educational programs are provided in Chapter 7 of *Management Policies 2001* (NPS 2000d). These guidelines direct the National Park Service to disseminate to the public the history and significance, the resources, and the mission goals of Glen Canyon National Recreation Area. In instances when park managers must make difficult resource decisions that may be highly controversial, the interpretive and educational programs can build public understanding of, and support for, such decisions and initiatives, and for the NPS mission in general. Section 7.5.3 directs that "parks should, in balanced and appropriate ways, thoroughly integrate resource issues and initiatives of local and Servicewide importance into their interpretive and educational programs. . . . Resource issue interpretation should be integrated into both on and off site programs, as well as into printed and electronic media whenever appropriate."

METHODOLOGY AND ASSUMPTIONS

Impact Threshold Definitions. The following thresholds were used to determine the magnitude of effects on recreation area management and operations.

> *Negligible* — Recreation area management and operations would not be affected or the effect would be at or below the lower levels of detection.

Minor — The effect would be detectable, but would be of a magnitude that would not have an appreciable effect on recreation area management and operations. If mitigation were needed to offset adverse effects, it would be relatively simple and successful.

Moderate — The effects would be readily apparent and would result in a substantial change in recreation area management or operations in a manner noticeable to staff and the public. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful.

Major — The effects would be readily apparent and would result in a substantial change in recreation area management or operations in a manner noticeable to staff and the public. Mitigation measures to offset adverse effects would be needed, could be expensive, and their success could not be guaranteed.

Geographic Area Evaluated for Impacts. Most recreation area management and operations activities directly relating to personal watercraft would occur on Lake Powell. However, staffing constraints often mean that committing additional resources to one area requires a reduction in services in another area. For example, additional water-based law enforcement needs could reduce ranger availability to patrol campgrounds. Therefore, the entire recreation area was included in the geographic area evaluated for impacts on recreation area management and operations.

ALTERNATIVE A: CONTINUE PERSONAL WATERCRAFT USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

Because Glen Canyon National Recreation Area is a proprietary jurisdiction, the states of Arizona and Utah have primary law enforcement jurisdiction on waters within their boundaries. Therefore, no conflicts between recreation area regulations and other personal watercraft regulations exist. NPS rangers would continue to enforce both Arizona and Utah personal watercraft regulations, laws, and rules, plus the personal watercraft and other boating requirements in the superintendent's compendium.

Current differences in state regulations, laws, and rules between Arizona and Utah (see table 4 and appendix B) do not have an adverse effect on NPS rangers' ability to enforce regulations. With alternative A, there would continue to be a lack of understanding of the applicable state regulations among some personal watercraft users. This would lead to a frequency of accidents and incidents similar to those presented in table 31. Compared to current conditions, this would produce a negligible, long-term effect on enforcement operations.

Current recreation area staffing levels would be maintained, interpretation, maintenance, resource management, and concessions. Recreation area visitor protection personnel would continue to commit about 20% of their time to responding to water-based recreational situations. Arizona and Utah law enforcement staff would continue their full-time assignments of patrolling the lake and enforcing their respective state's boating regulations laws, and rules.

Other divisions within the recreation area currently commit few resources directly to the management of personal watercraft. The short- and long-term adverse effects of alternative A on these divisions would be negligible.

Alternative A would increase funding for visitor protection staff. This would allow for proactive boat patrols and would give recreation area staff an opportunity to interact with personal watercraft operators in situations other than incidents and accidents. Rangers could provide visitors with a clearer understanding of applicable state regulations, laws, and rules, potential consequences of unsafe or inconsiderate actions, and the need to protect the recreation area's resources. This would have a beneficial, long-term, minor effect on visitor protection services.

Cumulative Effects. No conflicts with state or other regulations or policies would be anticipated with the continuation of current boating practices under alternative A. Each year there would be about 1,400 watercraft-based incidents and accidents that would result in 5 to 10 deaths. About 85% of these would involve vessels other than personal watercraft and about 80% would not involve a vessel in motion.

The improvements visitor protection staff and proactive boat patrols would improve the understanding of boating regulations and safe practices on the water among all boaters, not just personal watercraft operators. This potentially would decrease the number of incidents and accidents that occur on the lake. As a result, rangers could focus on the protection of resources and the safety of visitors, and reduce time spent responding to emergencies. This would be a beneficial, long-term, negligible to minor effect.

Recreation area commitments of staff resources to provide visitor services, education, and the upkeep and maintenance of facilities that relate to all activities in the recreation area would not change. Recreation area operation needs for all other user groups would be similar to existing conditions, because the number of visitors and boats would not be altered by this alternative. Cumulative impacts on management and operations from all recreational use would continue to place demands on recreation area personnel and resources and the effects of alternative A would be considered negligible.

Conclusion. Use of personal watercraft in the recreation area under alternative A would have negligible, short- and long-term effects on operations. Increased funding for visitor protection staff would offset some of the long-term impacts to visitor protection services. The cumulative effects on management and operations of personal watercraft use in conjunction with other activities at existing levels also would be negligible.

ALTERNATIVE B (MODIFIED PREFERRED ALTERNATIVE): PROMULGATE A SPECIAL REGULATION TO CONTINUE PERSONAL WATERCRAFT USE WITH ADDITIONAL MANAGEMENT RESTRICTIONS

Under alternative B, new restrictions on personal watercraft use would be implemented by prohibiting personal watercraft use in the upper areas of the tributaries and zoning other areas of the tributaries as flat-wake. These restrictions would not conflict with state personal watercraft regulations or jurisdiction. There would be no impacts related to conflicts with state or local requirements or policies.

The new closed areas and wake restriction areas would be marked by navigation devices. Increased maintenance staff time and funding would be required to construct and install new buoys and signs in these areas. Once the markers were installed, periodic repair and replacement would be required. Initially, these activities would result in a short-term, minor, adverse effect on management and operations. Long-term effects would be adverse and negligible to minor.

It is anticipated that the newly closed or flat-wake areas would be self-regulating after the signs and markers were installed. Little additional staff time would be needed to enforce the restrictions, and staff demands to respond to accidents or incidents in the tributaries might be reduced. The long-term effect on enforcement from these restrictions would be negligible.

Prohibiting the use of carbureted two-strike personal watercraft after 2012 would result in short-term negligible adverse effects on recreation area operations including rangers and visitor services staff. The average operating life of a personal watercraft is 5 to 10 years, depending upon the source (see "General Methodology" section of the "Environmental Consequences" chapter). By 2012, the National Park Service expects most personal watercraft owners will already be in compliance with the 2006 EPA standard. In addition, over the next 10 years educational materials produced by recreation area staff would inform visitors of the new restriction. It is expected that by 2012, little staff time would be required to enforce the restriction.

Under alternative B, the recreation area would work with Arizona and Utah jurisdictions to unify boating regulations. This would produce a negligible effect on law enforcement because there is no evidence or information indicating that the current condition, while sometimes confusing, would increase the number of incidents or accidents.

Alternative B would increase funding for visitor protection staff. This would allow for proactive boat patrols and would give recreation area staff an opportunity to interact with personal watercraft operators in situations other than incidents and accidents. This would have a beneficial, long-term, minor effect on visitor protection services similar to alternative A.

Alternative B would increase funding for visitor protection staff. This would allow for proactive boat patrols and would give recreation area staff an opportunity to interact with personal watercraft operators in situations other than incidents and accidents. Rangers could provide visitors with a clearer understanding of applicable state regulations, laws, and rules, potential consequences of unsafe or inconsiderate actions, and the need to protect the recreation area's resources. This would have a beneficial, long-term, minor effect on visitor protection services compared to alternative A.

Alternative B also would provide additional funds for enhanced educational materials. This could include the use of such media as brochures, newsletters, wayside exhibits, interpretive programs, and the recreation area's website to teach safe boating and highlight activities and behaviors that result in violations, citations, and accidents. The improved education program would potentially reduce the number of incidents and accidents involving personal watercraft operators that require ranger response. Beneficial, long-term, negligible to minor effects on visitor protection operations would occur from the improved educational program.

Additional staff time initially would be needed to develop the educational materials for distribution to personal watercraft users. This activity would include participation by the concession division, because the occasional renter would be less likely to be familiar with area restrictions and safe operating procedures than a personal watercraft owner. The education materials would highlight the new area restrictions as prescribed under this alternative. As the public became more familiar with the new restrictions, the time devoted to educating the public would decrease to levels similar to those under alternative A. Adverse impacts on interpretation and concessions operations would be negligible to minor in the short term and would decrease to negligible over the long term.

Under alternative B, resource management staff would continue to monitor water quality in the recreation area for *Escherichia coli* (*E. coli*). The resource management staff also would develop and

implement new monitoring programs to establish baseline conditions and assess the effects of personal watercraft emissions and noise on the water quality, air quality, and soundscapes of the recreation area. This increased monitoring would require additional staff and time to collect, compile, interpret, and report the data. Monitoring would occur throughout the life of the plan. Without any increase in current staffing levels, it would result in a long-term, negligible to minor, adverse effect on operations of the resource management division.

Cumulative Effects. No conflicts with regulations or policies at the state or local levels would be anticipated from implementing additional restrictions under alternative B. The restrictions would apply to the recreation area only, and would not affect other regulations.

The improvements in educational materials, visitor protection staff, and proactive boat patrols would improve the understanding of boating regulations and safe practices on the water among all boaters, not just personal watercraft operators. This potentially would decrease the number of incidents and accidents that occur on the lake. As a result, rangers could focus on the protection of resources and the safety of visitors, and reduce time spent responding to emergencies. This would be a beneficial, long-term, negligible to minor effect.

NPS staff would continue to provide visitor services, upkeep and maintenance of facilities, and resource management associated with all other recreational uses of the recreation area. Changes in these services, aside from those mentioned previously for personal watercraft-related management, would be negligible.

Conclusion. Alternative B primarily would affect the enforcement, interpretation, and facilities maintenance components of recreation area operations. Short-term impacts would be minor, as staff resources were committed to marking newly restricted areas and developing and implementing new educational programs. In the long term, most of these effects would decrease to negligible levels. Increased funding for visitor protection staff would lead to long-term, minor benefits to visitor protection services. Effects on recreation area staff from restrictions on carbureted two-stroke personal watercraft at the end of 2012 would be negligible as most watercraft would already be compliant with EPA emission standards and distribution of education materials would inform users well in advance of the restriction. Without additional funding, staff requirements for additional monitoring could have long-term, negligible to minor, adverse effects on operations of the resource management division.

Cumulatively, all recreation area visitors would benefit from the improved education and visitor protection services that would be implemented with alternative B. These could reduce the need to respond to emergencies and improve the ability to focus recreation area services on the protection of resources and the safety of visitors. These would be beneficial, negligible to minor, direct and indirect, long-term effects on recreation area operations.

ALTERNATIVE C: NO-ACTION (PERSONAL WATERCRAFT USE WOULD BE ELIMINATED)

Alternative C would permanently eliminate personal watercraft use in the recreation area. Because recreation area managers have the right to regulate the types of activities that take place, and because there are no provisions in state personal watercraft regulations forbidding additional controls or bans, there would be no conflicts. Impacts related to conflicts with other regulations or policies would be non-existent or negligible.

A primary point of information regarding the ban on personal watercraft could occur at the recreation area entrance gates, where visitors trailering personal watercraft could be informed that the vessels could not be launched or used on Lake Powell. Visitors seeking explanations could cause delays at the entry points. If substantial numbers of visitors requested additional information, noticeable lines could form at entry points and additional staff would have to be assigned to these stations. In the short term, this would cause direct, minor, adverse effects on recreation area operations. The effect would decrease to negligible levels as visitors became familiar with the situation and the number of staff assigned to entry stations returned to normal.

Some visitors enter the recreation area during evening, night, or early morning periods when the gates are not staffed by the National Park Service. Therefore, additional information would be needed at key locations such as launch ramps. There would be a minor, short-term commitment of staff to create educational materials and install signs, but the effect would rapidly decrease to negligible levels.

Much of the ban would be self-enforcing, as informed visitors at sites such as launch ramps notified people intending to launch personal watercraft that the vessels were no longer allowed on the lake. However, law enforcement staff occasionally would be needed. Therefore, there would be negligible to minor requirements for law enforcement services to monitor compliance.

As described in the "Affected Environment" chapter, personal watercraft currently account for 15% of water-based law enforcement cases, including 15% of all incidents and 14% of all accidents. Banning these vessels would eliminate personal watercraft-related incidents and accidents, which in the short term would produce a 15% decrease in water-based law enforcement cases.

As stated in the "General Methodology" section of this chapter, it was assumed that the removal of personal watercraft in alternative C would result in an initial decrease in annual boat days in the short-term. However, by the end of the 10-year analysis period, the total number of watercraft operating hours and the total number of motorized watercraft using Lake Powell under alternative C would be within the range predicted for alternatives A and B. This would be due to either natural growth in visitation, to visitors finding other watercraft to fulfill functions previously served by personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft and now choose to visit in their absence. By the year 2012, visitor use in the recreation area may return to prior use levels or slightly higher and personal watercraft use may be replaced on Lake Powell with other vessels. The data in table 31 indicate that other vessels have a higher law enforcement case rate in Glen Canyon National Recreation Area than personal watercraft. Therefore, in the long term, the number of incidents and accidents requiring law enforcement action would be similar to or slightly higher than the alternative A levels, resulting in a negligible to minor adverse effect. The beneficial effects of improvements to visitor protection staff similar to those described under alternative A would offset some of the long-term adverse impacts to visitor protection services.

Minor, short-term, adverse effects would occur on other recreation area management and operations with implementation of a personal watercraft use ban. In particular, concession contracts and incidental business permits would need to be modified to reflect the prohibition of personal watercraft use in the recreation area. In the long term, these effects would be negligible.

Cumulative Effects. There would not be any differences between the effects described above for alternative C and the cumulative effects from this alternative on management and operations of the recreation area.

Conclusion. Alternative C would cause short-term, direct, minor, adverse effects on recreation area operations, primarily because of time commitments needed to inform visitors about the ban on personal watercraft. In the long term, these effects would decline to negligible levels. Law enforcement requirements on the lake initially would be reduced, as the number of visitors decreased in association with the ban. However, the long-term effect on law enforcement activities would be negligible if visitor use of the recreation area increases due to natural growth in visitation, to visitors finding other watercraft to replace personal watercraft, or to increases in visitation by individuals who previously avoided the recreation area due to personal watercraft use. Increased funding for visitor protection staff would offset some of the long-term impacts on visitor protection services. There would not be any additional cumulative effect from alternative C.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are those environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action is taken. Therefore, they would remain throughout the duration of the action.

There would be unavoidable adverse impacts on the experience of some visitors under alternatives A and B, who find personal watercraft annoying or disruptive. Under the no-action alternative (alternative C), there would be unavoidable adverse impacts on personal watercraft users who could no longer participate in this activity in the recreation area and have to pursue this activity elsewhere.

Alternatives A and B would continue unavoidable adverse impacts on the natural soundscape. Both alternatives A and B would continue personal watercraft emissions of air and water pollutants, although total emissions would decrease with gradual conversion of personal watercraft engines to less-polluting models.

With alternative A, ethnographic resource experiences in some upper canyons would continue to be adversely affected by inadvertent intrusions associated with the use of personal watercraft.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The intent of this determination is to identify whether the proposed action would trade-off the immediate use of the land or resources for any long-term management possibilities, adversely affecting the productivity of recreation area resources. This determination also discloses whether the proposed action or alternatives would be a sustainable action that could continue over the long term without environmental problems (NPS 2001b).

None of the alternatives suggest substantial loss or impairment of natural resources or ecosystems in the recreation area as a consequence of their implementation. There would be some trade-offs from a local or short-term perspective as is described below.

> Alternative A would continue personal watercraft use at the recreation area over the long term. This alternative does not propose any additional management actions to minimize adverse impacts. Trade-offs would include continued emissions into water and air resources and the natural soundscape for recreation by those who want to experience the recreational area by personal watercraft. Personal watercraft impacts on these resources would range from negligible to moderate.
>
> Alternative B would close about 123 miles of river and reduced personal watercraft speed in about 7 miles of river and would prohibit the use of carbureted two-stroke personal watercraft at the end of 2012. This alternative would reduce, in these areas, long-term incremental contributions of personal watercraft noise, water, and air pollutants which would benefit these resources.

Alternative C would trade removal of personal watercraft from the recreation area with concurrent, long-term improvements in water, noise, and air quality (due to reduced emissions from personal watercraft) and improvements in the desired recreational experiences for some visitors.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The intent of this determination is to identify whether the proposed action or alternative would result in effects or impacts that could not be changed over the long term or would be permanent. An effect on a resource would be irreversible if the resource could not be reclaimed, restored, or otherwise returned to conditions that existed before the disturbance. An irretrievable commitment of resources involves the effects on resources that, once gone, cannot be replaced or recovered (NPS 2001b).

All three alternatives would involve the irretrievable commitment of energy resources (gasoline, fuel oil, electrical power) for the operations of personal watercraft and other motorcraft that use Lake Powell. None of the alternatives would be expected to result in the irreversible or irretrievable commitment of recreation area resources.

Consultation and Coordination

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HISTORY OF PUBLIC INVOLVEMENT

SCOPING PROCESS AND PUBLIC PARTICIPATION

The scoping process for managing personal watercraft in Glen Canyon National Recreation Area began in May 2001 with a meeting of the National Park Service planning team. The team discussed the recreation area's objectives for management of personal watercraft, identified issues related to personal watercraft management, and developed a range of preliminary alternatives.

In August 2001, the recreation area notified the public of the intent to prepare an environmental impact statement for managing personal watercraft in an announcement in the *Federal Register* (NPS 2001i). The notice requested the public to comment on the scope of the environmental impact statement, issues and alternatives related to personal watercraft management, and other personal watercraft resource concerns. The notice also announced the recreation area's intent to hold public scoping workshops to further facilitate public participation in the process.

Public meetings were held in Salt Lake City, Utah and in Page and Phoenix, Arizona in August 2001 to solicit early input into the scope and range of issues to be analyzed related to the management of personal watercraft within Glen Canyon National Recreation Area. Scoping comments continued to be accepted and considered within the planning process. During this comment period, the National Park Service facilitated several hundred discussions and briefings to recreation area staff, congressional delegations, elected officials, tribal representatives, public service organizations, educational institutions, and other interested members of the public.

More than 3,500 letters and e-mail messages concerning personal watercraft use on Lake Powell were received. A mailing list of interested parties was compiled from attendees at the meetings and from any written comments received at the recreation area. During this first comment period, Glen Canyon National Recreation Area received:

503 individual written letters of concern;

270 petition form letters originating from the American Watercraft Association requesting that personal watercraft be regulated just as any other type of watercraft and access should not be denied;

325 petition postcards originating from the American Watercraft Association requesting that Glen Canyon National Recreation Area adopt reasonable regulations to support continued access by all boaters versus implementing discriminatory regulations; and

523 e-mail letters.

Glen Canyon National Recreation Area also received more than 1,100 electronic form letters. These included:

152 titled 'No Jet Skis at Glen Canyon!' supporting the elimination of personal watercraft;

926 titled 'End Jet Ski Pollution at Glen Canyon' supporting the elimination of personal watercraft on Lake Powell; and

109 titled 'Free Glen Canyon National Recreation Area of Jet Skis' also supporting personal watercraft elimination.

Lake Powell Magazine obtained 533 signatures from boating shows supporting continued rights for personal watercraft use on Lake Powell.

During the public workshops, 146 written comments regarding issues, concerns, and alternatives for management were received. These comments ranged from the support of the continued use of personal watercraft throughout the recreation area (over 80%), to a total ban on personal watercraft use, to restrictions in selected areas of the recreation area.

Issues generated during the comment period included:

Visitor safety concerns related to illegal and reckless operation of personal watercraft;

Conflicts among different user groups;

Educational requirements for all boaters;

Potential resource impacts; and

The impacts of personal watercraft use related to other motorized vessels.

The planning team used the public comments and agency input to revise the preliminary alternative concepts into the three personal watercraft management alternatives for Glen Canyon National Recreation that were evaluated in this environmental impact statement. Public input also was used to define the issues that were evaluated within each impact topic.

The *Draft Environmental Impact Statement: Personal Watercraft Rule-Making, Glen Canyon National Recreation Area* was made available for public review in September 2002. The document was available in hard copy, on computer disk, and on the recreation area's website at www.nps.gov/glca/plan.htm.

The draft environmental impact statement was on public review for 60 days after the Environmental Protection Agency had accepted the document and published a notice of availability in the *Federal Register* (67 FR 178). The 60-day review and public comment period ended on November 27, 2002.

Public meetings were held from October 7 through October 10 following the release of the draft environmental impact statement. Public meetings were held in Salt Lake City, Utah; Grand Junction, Colorado; and Phoenix and Page, Arizona. The National Park Service provided notification of public meetings on the Glen Canyon National Recreation Area website and through press releases to newspapers and television and radio stations in the region including each of the cities where meetings were held.

Members of the NPS interdisciplinary planning team were available at the public meetings to answer questions concerning the environmental impact statement. Comment sheets were provided for people to submit written comments, and a stenographer was available to record verbal comments. The public was also encouraged to comment via the Internet.

During the public comment period, over 30,000 comments were received on the draft environmental impact statement. The National Park Service and its contractor analyzed all comments that were received during the public comment period in order to identify and respond to substantive issues. The introduction to Volume 2, "Comments and Responses to the Draft Environmental Impact Statement," contains a description of the purpose and methodology used in reviewing and responding to public comments, provides a brief summary of comments received, and describes the organization of that volume.

ENDANGERED OR THREATENED SPECIES CONSULTATIONS

In accordance with section 7 of the *Endangered Species Act* (16 U.S.C. 1531 *et seq*.), the National Park Service conducted informal consultation with the U.S. Fish and Wildlife Service. A letter from the U.S. Fish and Wildlife Service dated May 9, 2002 and included in appendix H.3 identified seven species for Coconino County, Arizona and eight species for Kane and San Juan Counties, Utah that may occur within or adjacent to the personal watercraft analysis area. Of the 15 species identified, 13 are listed, 1 is proposed, and 1 is a candidate species. Lake Powell also provides critical habitat for four endangered fish species.

The analysis of actions that "may affect" listed or proposed species, or designated critical habitat is provided in this environmental impact statement. The evaluation determined that the proposed action is not likely to jeopardize the continued existence of any species listed as endangered or threatened (listed species). The proposed action also would not result in the loss or adverse modification of habitat designated as critical.

The *Draft Environmental Impact Statement* was submitted to the U.S. Fish and Wildlife Service in October 2002 for their review as part of the consultation process. Their response can be found in volume II of this *Final Environmental Impact Statement*.

CULTURAL RESOURCES CONSULTATIONS

On April 26, 2002 Glen Canyon National Recreation Area sent letters to the Utah and Arizona state historic preservation officers (appendix H.1) and the Advisory Council on Historic Preservation (appendix H.2). The letters invited them to participate in the planning process and informed them that the National Park Service plans to use this environmental impact statement to fulfill the requirements of section 106 of the National Historic Preservation Act as well as to comply with provisions of the *National Environmental Policy Act*. A reply dated May 7, 2002 was received from the Utah State Historic Preservation Officer acknowledging that the recreation area will be using the environmental impact statement process to accomplish section 106 compliance. A copy of this correspondence is included in appendix H.1. The *Draft Environmental Impact Statement* was submitted to the Arizona and Utah state historic preservation officers in September 2002.

Glen Canyon National Recreation Area also sent letters to the Navajo Tribal Historic Preservation Officer on April 26, 2002. The Navajo Nation Historic Preservation Department, Traditional Cultural Program responded on May 14, 2002, noting that the Navajo Nation does not have any concerns with the proposed project at this time, but requested that they be notified should Navajo resources be identified. A copy of this correspondence is provided in appendix H.6.

Traditionally associated tribes were contacted by letter in May 2000 and August 2002 to begin government-to-government consultation regarding this project. Copies of this correspondence are provided in appendix H.6. As of August 12, 2002, a reply had been received only from the Navajo Nation. A copy of this letter is included in appendix H.6. Recreation area staff will make follow-up calls to ensure that the tribes are kept informed about the project.

List of Native American Tribes

Hopi Tribe
Kaibab Paiute Tribe
Kanosh Band of the Paiute Indian Tribe of Utah
Koosharem Band of the Paiute Indian Tribe of Utah
Navajo Nation
San Juan Southern Paiute Tribe
Ute Mountain Indian Tribe

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The following agencies, tribes, groups, and organizations have been identified as having an interest in this issue and NEPA decision-making process. Each listed entity, as well as numerous interested individuals, has been sent a copy of this draft environmental impact statement.

FEDERAL AGENCIES

Advisory Council on Historic Preservation
Bureau of Land Management, Utah and Arizona
Bureau of Reclamation
House Interior Appropriations Subcommittee
House Parks Subcommittee
National Park Service, Office of the Director
National Park Service, Intermountain Regional Office
Natural Resources Conservation Service
Senate Interior Appropriations Subcommittee
Senate Parks Subcommittee
U.S. Department of the Interior, Office of the Solicitor
U.S. Coast Guard
U.S. Environmental Protection Agency, Region 8, Region 9, and EIS Filing Section, Washington
U.S. Fish and Wildlife Service
U.S. Forest Service, North Kaibab District
U.S. Geological Survey, Grand Canyon Monitoring Research Center

NATIVE AMERICAN TRIBES

Hopi Tribe
Kaibab Paiute Tribe
Kanosh Band of the Paiute Indian Tribe of Utah
Koosharem Band of the Paiute Indian Tribe of Utah
Navajo Nation, Parks and Recreation
San Juan Southern Paiute Tribe
Ute Mountain Indian Tribe
White Mesa Ute Council

STATE OF ARIZONA

Arizona Boating Coordinator
Arizona Department of Environmental Quality
Arizona Department of Natural Resources
Arizona Game and Fish Department
Arizona NPS State Coordinator
Arizona Office of Tourism
Arizona State Historic Preservation Office
City of Page
City of Page Chamber of Commerce
Coconino County Board of Supervisors
Congressman Bob Stump
Congressman Ed Pastor
Congressman J.D. Hayworth
Congressman Jeff Flake
Congressman Jim Kolbe
Congressman John Shadegg
Governor Jane D. Hull
Governor's Northern Arizona Office
Senator John Kyl
Senator John McCain

STATE OF NEW MEXICO

San Juan County Commission

STATE OF UTAH

Bigwater Town Council
Blanding Chamber of Commerce
City of Kanab
Congressman Chris Cannon
Congressman James Hansen
Congressman Jim Matheson
Garfield County Commission
Garfield County Sheriff
Governor
Kane County Commission
Kane County Travel Council
Moab Area Travel Council
San Juan County Commission
San Juan County Sheriff
Senator Orrin G. Hatch
Senator Robert F. Bennett
Utah Boating Coordinator

Utah Department of Environmental Quality, Division of Water Quality
Utah Department of Natural Resources
Utah Division of Parks and Recreation
Utah Division of State History
Utah Division of Wildlife Resources
Utah NPS State Coordinator
Utah State Historical Society
Utah Travel Council
Wayne County Commission

STATE OF IDAHO

Idaho Department of Parks and Recreation

LIBRARIES

Burton Barr Central Library, Phoenix, Arizona
Denver Public Library, Colorado
Flagstaff City – Coconino County Public Library, Arizona
Mesa County Public Library District, Grand Junction, Colorado
Page Public Library, Arizona
Salt Lake City Public Library, Utah

PARKS, MONUMENTS AND RECREATION AREAS

Arches National Park
Bryce National Park
Canyonlands National Park
Capitol Reef National Park
Grand Canyon National Park
Grand Canyon Parashant National Monument
Grand Staircase Escalante National Monument
Lake Mead National Recreation Area
Natural Bridges National Monument
Navajo National Monument
Vermilion Cliffs National Monument
Zion National Park

BUSINESSES AND ORGANIZATIONS

All American Boat & RV Storage
Alpine PowerSports
American Canoe Association
American Watercraft Association
Anchors Away Rental & Storage
ARAMARK Lake Powell Resorts and Marinas
B. B. Financial Benefits Group, Inc.
B & T Marine
Beautiful Lady House Boat, Inc.
Big Water Boat Storage
Blanding Chamber of Commerce
Blue Ribbon Coalition
Bluewater Network
Bullfrog Clinic
Bullhead 4 Wheelers, Inc.
Charles Gustafson, P. C., Attorney at Law
Chiropractic Associates, Inc.
Dee's Launch and Retrieval
Deep Creek Recreation
Desert Phantom, Inc.
Desert Service Inc.
DJ Rentals/Offshore Marina
Donn's Boat Ship, Inc
Doo Powell Inc.
Escalante Wilderness Project
Friends of Lake Powell
Frontier Biomedical
Glacier Guides, Inc.
Glen Canyon Action Network
Glen Canyon Institute
Glen Canyon Natural History Association
Grand Canyon Trust
H_20 Zone PWC Rentals & Repairs
Hidden Canyon Kayak LLC
High Desert Adventures
Jerry's Marine Service
John Wesley Powell Memorial Museum
Lake Powell Chronicle
Lake Powell Communications
Lake Powell Kayak Adventures
Lake Powell Magazine
Lake Powell Marine
Lake Powell Suites
Lake Powell Waterworld
Lake Powell Yacht Club
Living Rivers
Maverick Boat Services, Inc.
MHF Enterprises
Moab Area Travel Council
Multiple Access Conservation Coalition
National Marine Manufacturers Association
National Park Foundation
National Parks Conservation Association

North American Wild Sheep – Utah Chapter
Old West Marine Service
Outdoor Sports
Page Chamber of Commerce
Page Honda
Paradise Valley Community College
Personal Watercraft Industry Association
Precision Die & Stamping Inc.
River Runners for Wilderness
Saco Management, Inc.
Salt River Project, Navajo Generating Station
San Juan Expeditions
Sierra Club
Sierra Club – Grand Canyon Chapter
Sierra Club - Recreation Issues Committee
Sierra Club – Utah Chapter
Skylite Boat Rentals
Steadman's Recreation, Inc.
Sundance Marine
TAB Associates, Inc.
Tracy Duepner Services
Utah Shared Access Alliance
Utah Travel Council
Wet Desert WaterSports
Wilderness Society, The

Appendixes

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APPENDIX A
PARTS OF THE SUPERINTENDENT'S COMPENDIUM, 2002
APPLICABLE TO PERSONAL WATERCRAFT

Lees Ferry

Personal Watercraft Use Below Glen Canyon Dam: The use of personal watercraft is prohibited on the waters of the Colorado River between Glen Canyon Dam and the downstream river boundary of Glen Canyon National Recreation Area where it adjoins Grand Canyon National Park.

Determination: This closure will provide for the protection of environmental values and the avoidance of conflict among traditional visitor use activities.

River Travel Upstream of Lees Ferry: River travel is prohibited upstream of the three closure buoys, approximately 1/4 mile downstream of Glen Canyon dam without a permit. A sign is posted on the shoreline on both sides of the river designating this closure.

Determination: The area above the closure signs is closed due to safety and security reasons: The proximity to water releases from Glen Canyon dam, and the possibility of items being dropped from the bridge. Authorized concession, administrative and scientific work is permitted in the closure. Additionally this area is closed by 33 *Code of Federal Regulations* (CFR) Part 165, National Security Closure.

36 CFR SECTION 3.3 – BOATING AND WATER USE ACTIVITIES, PERMITS

Vessels are prohibited from remaining within the lands and/or waters of Glen Canyon National Recreation Area for more than 30 consecutive days without a valid Boat Storage Agreement for a slip or buoy with an authorized concessioner. There must be a minimum break of 24 hours from the time the vessel leaves the recreation area until it re-enters.

Private vessels over 75 feet in total length and 22 feet total beam are prohibited. For purposes of this section, total length and beam include all temporary and permanent appurtenances. Manually operated gangplanks designed for passenger boarding that retract flush with the hull when the vessel is underway will be exempted from the appurtenance clause. Total length will be determined by a straight line measurement from the foremost part of the vessel to the aftmost part of the vessel, measured end-to-end over the deck excluding sheet, and measured parallel to the centerline, with all appurtenances, (excluding gangplanks) in a fully extended position. Total beam will be determined by a straight-line measurement from the outermost sides of the vessel at its widest point with all appurtenances in a fully extended position.

Determination: The 75 foot total length and 22 foot total beam are dictated by natural and/or design limitations of marinas, fairways, docks, slips, buoy fields, boat ramps, fueling and pumpout facilities. Vessels exceeding that length and/or beam pose potential safety hazards when operated in and around these areas. Specifically, those hazards include but are not limited to collision with a fixed object, collision with a floating object, and collision with another vessel or vessels. The hazards increase when these areas and facilities are congested with other vessel traffic and/or when weather conditions are less than favorable. Vessels equipped with auxiliary equipment such as bow/stern thrusters and camera systems can increase a vessel's maneuverability, but do not necessarily mitigate the hazards.

The term total length used in this section is not to be confused with the term length overall. Length overall does not include appurtenances such as bowsprits, rudders, outboard motor brackets, davits, booms, platforms, slides, handles, fittings, attachments, and extensions. Inclusion of moveable appurtenances in their fully extended, deployed, or operating configuration as part of the total measurement of the vessel will place a limit on the length of vessels that may be operated with such equipment deployed. Deployment of appurtenances may be

intentional, particularly if the equipment was designed to be deployed while underway, or may be accidental, particularly if the equipment was not secured properly. Recent trends in recreational boat construction have led to some innovative additions to basic hull configurations and these additions can result in a vessel that is significantly longer than a vessel measurement that does not include appurtenances. The terms total length and total beam used in this section are derived from definitions found in Title 36 CFR section 183.3

36 CFR SECTION 3.6 – PROHIBITED OPERATIONS

All motorized vessels are prohibited from further upstream travel at the following areas:

Escalante River at the confluence of Coyote Creek

Determination: Allowing motorized watercraft to be operated up the Escalante Arm of Lake Powell to Coyote Creek will enable motorized visitors reasonable access to view Stevens Arch, a popular geological landmark and sightseeing attraction, as well as to hike nearby canyons — including Coyote Gulch. Areas upstream will subsequently maintain an atmosphere of quiet and solitude, qualities that backpackers and other backcountry hikers desire while visiting the area. Similarly, fragile riparian areas upstream will be protected from exceeding physical and social carrying capacities due to easy access by motorized watercraft. Also, river water quality will be protected from fuel spills or other discharges and additional human waste accumulations.

Coyote Gulch is the most popular destination of backcountry hikers in the Escalante Canyons and most visitors to the canyon hike all the way to the Escalante River confluence. Allowing motorized watercraft traffic upstream to the Coyote confluence presents a reasonable accommodation of both categories of visitors to the vicinity.

San Juan River at the Clay Hills pullout

Colorado River at the base of Imperial Rapid

Dirty Devil River at that point where measurable downstream current is encountered

Except in instances of emergency circumstances directly affecting the health and safety of visitors, upstream motorized travel by all motorized vessels will be prohibited upstream from Clay Hills pullout on the San Juan River and Imperial Rapid on the Colorado River. Upstream-motorized vessel travel will be permitted on the Dirty Devil River along the entire length of the Dirty Devil Arm of the Lake to that point where measurable downstream current is encountered.

Any motorized vessels on those open portions of the rivers will be subject to all other restrictions applicable to other river parties including, but not limited to, camping permit requirements, human waste sanitation, and campfires.

Determination: The state of Utah has established the "last active rapid" on The Colorado River as the location where rafting parties are no longer required to wear Personal Flotation Devices at all times (Utah R651-215-12). Upstream-motorized running of rapids is an advanced boating skill that most visitors to the recreation area do not possess. Restricting motorized boating parties to areas below these rapids prevents visitors from endangering themselves to the unrecognized dangers inherent in running up rapids, and in doing so violating State PFD regulations should they not be wearing their life jackets. Boaters attempting to run upstream in these rapids pose a high risk to themselves and to downstream traffic.

In the recent past the rapids have been the last active rapids on the Colorado River. Extreme fluctuation of the lake levels of Lake Powell could result in other "rapids" being present. For the sake of consistency this rapid will be considered the "last active rapid."

Imperial Rapid has also been used by the commercial rafting companies as a location where they meet river trips with motorized vessels launched at Hite to tow the rafts across the flatwater sections to Hite. Restricting motorized travel below this point would alter this traditional use.

Clay Hills is the traditional termination and pullout retrieval point for rafting parties on the San Juan River. Designating this point for prohibited upstream traffic will preclude recreational use conflicts.

Operating a vessel in excess of 5 mph or creating a wake in the following areas is prohibited:

- Within harbors as defined above, mooring areas, and wakeless areas
- Within any other "No Wake" buoyed area
- Rainbow Bridge National Monument

Launching and retrieval of vessels is permitted at the following locations:

- All public launch ramps
- Vessels up to 25 feet at Lone Rock Beach may be launched at the designated area as signed in accordance with section 1.7.
- The beach areas legally accessible by motor vehicles at the primitive camping area of Stanton Creek, Upper Bullfrog North, and Upper Bullfrog South
- The San Juan River take-out at Clay Hills Crossing
- The Red Canyon area
- The Paiute Farms area
- At Hite, from 300 feet upstream of the public launch ramp to 300 feet upstream of the marina houseboat loading dock
- The Farley Canyon area
- The White Canyon area

Bullfrog and Halls Crossing Ferry Ramp or areas adjacent to the marina may be used only when authorized by the Superintendent or his/her designee.

Determination: The above areas are public launch ramps specifically developed for vessel launching and retrieval or areas accessible by road which are beaches or other areas which are suitable for launching and retrieving boats and which do not suffer undue degradation of natural or cultural values as a result.

Lone Rock Beach, an undeveloped launch area, has an angle of underwater slope that precludes the launching of vessels exceeding 25 feet in length.

The use of ferry launch ramps or areas adjacent to marinas as additional launch and retrieval areas is intended to reduce occasional congestion or overcrowding at regular launch ramps.

APPENDIX B
ARIZONA AND UTAH WATERCRAFT REGULATIONS
APPLICABLE TO PERSONAL WATERCRAFT

UTAH PERSONAL WATERCRAFT REGULATIONS

73-18-13.5. Personal watercraft accidents — Investigation and report of operator security — Agency action if no security — Surrender of registration materials.

(1) Upon request of a peace officer investigating an accident involving a personal watercraft, the operator of the personal watercraft shall provide evidence of the owner's or operator's security required under section 73-18c-301.

(2) The peace officer shall record on a form approved by the division:

(a) the information provided by the operator;

(b) whether the operator provided insufficient or no information; and

(c) whether the peace officer finds reasonable cause to believe that any information given is not correct.

(3) The peace officer shall deposit all completed forms with the peace officer's agency, which shall forward the forms to the division no later than ten days after receipt.

(4) (a) The division shall revoke the registration of a personal watercraft involved in an accident unless the owner or operator can demonstrate to the division compliance with the owner's or operator's security requirement of section 73-18c-301 at the time of the accident.

(b) Any registration revoked may not be renewed for a period of one year following the date of revocation.

(5) A person may appeal a revocation issued under subsection (4) in accordance with procedures established by the board by rule that are consistent with Title 63, Chapter 46b, *Administrative Procedures Act*.

(6) (a) Any person whose registration is revoked under subsection (4) shall return the registration card and decals for the personal watercraft to the division.

(b) If the person fails to return the registration materials as required, they shall be confiscated under section 73-18-13.6.

(7) The board may make rules for the enforcement of this section.

(8) In this section, “evidence of owner's or operator's security” includes any one of the following:

(a) the operator's:

(i) insurance policy;

(ii) binder notice;

(iii) renewal notice; or

(iv) card issued by an insurance company as evidence of insurance;

(b) a copy of a surety bond, certified by the surety, which conforms to section 73-18c-102;

(c) a certificate of the state treasurer issued under section 73-18c-305; or

(d) a certificate of self-funded coverage issued under section 73-18c-306.

Enacted by Chapter 348, 1997 General Session

73-18-15.2. Minimum age of operators — Boating safety course for youth to operate personal watercraft.

(1) (a) Except as provided in subsection (2), a person under 16 years of age may operate a motorboat on the waters of this state, if he is accompanied by a person who is at least 18 years of age.

(b) A person under 16 years of age may operate a sailboat, if he is under the direct supervision of a person who is at least 18 years of age.

(2) A person under 16 years of age and 12 years of age or older may operate a personal watercraft provided he:

(a) is under the direct supervision of a person who is at least 18 years of age;

(b) completes a boating safety course approved by the division; and

(c) has in his possession a boating safety certificate issued by the boating safety course provider.

(3) A person under 18 years of age and 16 years of age or older may operate a personal watercraft, if he:

(a) completes a boating safety course approved by the division; and

(b) has in his possession a boating safety certificate issued by the boating safety course provider.

(4) A person required to attend a boating safety course under subsection (3)(a) need not be accompanied by a parent or legal guardian while completing a boating safety course.

(5) No person may give permission to another person to operate a vessel in violation of this section.

(6) As used in this section, “direct supervision” means oversight at a distance within which visual contact is maintained.

(7) (a) The division may collect a fee not to exceed $12 from each person who takes the division's boating safety course to help defray the cost of the boating safety course.

(b) Money collected from the fee collected under subsection (7)(a) shall be deposited in the Boating Account.

Amended by Chapter 205, 1998 General Session

73-18-15.3. Personal watercraft — Prohibition on operation between sunset and sunrise.

A person may not operate a personal watercraft on the waters of this state between sunset and sunrise.

Enacted by Chapter 205, 1998 General Session

73-18-11. Regulation of muffling devices — The board shall adopt rules for the regulating of muffling devices on all vessels.

Amended by Chapter 197, 1986 General Session

ARIZONA PERSONAL WATERCRAFT REGULATIONS

5-350. Personal watercraft; requirements for operation; definition

A. A person shall not operate a personal watercraft unless each person aboard is wearing a wearable personal flotation device that is approved by the United States coast guard.

B. A person who operates a personal watercraft that is equipped by the manufacturer with a lanyard type engine cutoff switch shall attach the lanyard to his body, clothing or personal flotation device as appropriate for the specific watercraft.

C. A person shall not operate or knowingly allow another person to operate a personal watercraft under his ownership or control in a reckless or negligent manner endangering the life or property of another person. Prima facie evidence of reckless operation exists if the person commits two or more of the following acts simultaneously:

1. Operates the personal watercraft within a zone of proximity to another watercraft closer than sixty feet unless both are leaving a flat wake or are traveling at a speed of five nautical miles per hour or less.

2. Operates the personal watercraft within the vicinity of a motorboat in a manner that obstructs the visibility of either operator.

3. Heads into the wake of a motorboat that is within a zone of proximity closer than sixty feet and causes one-half or more of the length of the personal watercraft to leave the water.

4. Within a zone of proximity to another watercraft closer than sixty feet, maneuvers quickly, turns sharply or swerves, unless the maneuver is necessary to avoid a collision.

D. If equipped by the manufacturer, a person shall not operate a personal watercraft without a functioning spring-loaded throttle mechanism that immediately returns the engine to an idle speed on release of the operator's hand from the control or without any other engine cutoff feature that is installed by the manufacturer.

E. A personal watercraft shall not be loaded and operated with passengers or cargo beyond its safe carrying capacity or the manufacturer's recommended limits.

F. A person who owns, leases or hires a personal watercraft or who has charge or control over a personal watercraft shall not authorize or knowingly permit the personal watercraft to be operated in violation of this section.

G. This section does not apply to a performer who engages in a professional exhibition or to a person who participates in an officially sanctioned regatta, race, marine parade, tournament or exhibition.

H. For purposes of this section, “personal watercraft” means a watercraft that is less than sixteen feet long, propelled by machinery powering a water jet pump and designed to be operated by a person who sits, stands or kneels on rather than sitting or standing inside the watercraft.

5-336. Muffling devices

A. Every motor driven watercraft shall at all times be equipped with effective equipment, in good working order and in constant operation, to prevent excessive or unusual noise except as provided in subsection C.

APPENDIX C
PROPOSED PILOT STUDY TO RESEARCH SOCIAL CONDITIONS IN SUPPORT OF A LAKE MANAGEMENT PLAN

Glen Canyon National Recreation Area proposed to conduct a three-year pilot study that would evaluate the effects of visitor conflicts between boat users in the several areas with the associated management actions outlined below. The purpose of the pilot study would be to test whether certain management actions would mitigate visitor conflict issues such as complaints about noise, reckless driving (speed and proximity), and erratic use around campsite areas at unusual hours. Canyon and bay area sites where the pilot study would be conducted would be selected using five criteria:

Close proximity to a launch ramp and/or marina. Law enforcement cannot expend resources responding long distances away from duty stations unless it is for emergency response Therefore, closer locations would be selected for better enforceability. The sites also would be chosen to facilitate visitor access.

Shoreline camping opportunities. Locations would be selected that exhibited both large numbers of shoreline access and limited shoreline access for camping.

High visitation sites. Perceived high visitation sites are likely to have greater potential for visitor conflicts. The more visitors that will use these study areas, the more data that may be collected and the greater potential for conflict.

Safety. Although safety is not a major problem at Glen Canyon National Recreation Area, it would not hurt to designate areas wakeless that are already geographically challenging to maneuver through due to their narrowness and high use.

Geography and Closure Points. Closure points would need to be placed in areas that geographically facilitate the posting of wakeless or non-motorized zones. Locations would be selected where a fairly clear distinction could be made from where the zones started and sign posting could be accomplished effectively.

A geographic information systems or UTM coordinates would be provided to show approximate location of wakeless and non-motorized areas. These exact locations would be determined on a seasonal basis by the recreation area, while taking into account present and fluctuating lake levels. A large education campaign to advertise or publish these areas would be proposed. The education and outreach program would include, but would not be limited to:

Flyers at all entry gates and visitor centers

Webpage flyer

Bulletin boards at marina launch sites

Article in annual recreation area newspaper

Press releases

Weekly local radio spots

Interpretative talk at Wahweap/Bullfrog campgrounds explaining pilot study

Education and interaction with visitors at the launch ramps

The actions proposed in the pilot study would be included in the personal watercraft rule-making environmental impact statement, but not the special rule. If necessary, the special rule would address the pilot study in theory, but would not address specific locations on Lake Powell.

In the absence of a comprehensive lake management plan with several years of baseline data, it is very difficult to select specific areas of Lake Powell to apply certain management actions without further analysis. Glen Canyon National Recreation Area has collected baseline data for air, water and noise analyses and plans to continue to collect data to solidify its understanding of baseline resource conditions in these areas. However, very little information exists on visitor use, experience and conflict in regards to specific areas on Lake Powell.

A visitor use and experience survey was conducted in fiscal year 2000 to collect data on WHAT some of the visitor conflicts are in relation to personal watercraft use on the Lake, WHO (type of user) are experiencing the conflicts and WHY the conflicts exist. However, little information was collected on WHEN and WHERE they are occurring or HOW to resolve the conflicts. A pilot study that tests specific management actions in certain locations for specific scientific purposes to carefully analyze hypotheses and reactions of the visitors to these actions would provide significant information and insight to better management practices at effective location areas.

The results of the pilot study would provide essential social data and visitor use and experience information to include in a lake management plan and to apply adaptive management principles to areas on Lake Powell to enhance and maximize a positive experience for all recreational users. During the three-year study period, areas or locations, as well as different types of management action may be applied as required to effectively collect social condition data and maximize visitor experience.

At the end of the three-year pilot study, it would be anticipated that recreation area managers would have enough information to make informed decisions regarding permanent management actions that may be applied to areas on Lake Powell.

The following provides a sample of the criteria and logic that would be used initially to determine the pilot study locations and proposed management actions. It is only a preliminary outline that will be developed over time after additional interviews are conducted and further analysis of how current lake elevations have affected the shoreline conditions that visitors relay on for beach recreation and camping. The sites referenced are only used to outline how the criteria will be applied to later select the study locations.

The purpose of the following text is to provide a sample of the logic that would be used to select specific areas on Lake Powell for the pilot study. These sites may or may not be selected, based on the data and information that is on hand at the time of the selection process. Glen Canyon National Recreation Area anticipates conducting additional interviews with staff and other agencies with a presence on the lake to gain further insight for determining the best study locations.

Last Chance Bay: The far reaches of this canyon would be designated wakeless to all vessel traffic. All vessels would be authorized use, but only while wakeless, in the back quarter of this very large canyon. This canyon is located in close proximity to the Wahweap and Antelope Point launch ramps and provides some of the best hiking, back canyon sight-seeing and shoreline camping opportunities. The mouth of this canyon area is heavily used by all vessels, particularly for water sports such as skiing, however, the back end of the canyon usually does not receive quite as much visitation. The concept of allowing a wakeless use area for all vessels would test whether all users can recreate without the conflicts associated with some personal watercraft use, i.e. the thrill-seeker types of personal watercraft users. Wakeless zones would eliminate the speed, maneuverability and noise issues associated with the primary complaints non-users have. The visitor survey indicated that those that do not like personal watercraft, generally state it is because of noise, feeling unsafe, their maneuverability (unpredictability) and their use after what is considered regular use hours. This action would test the hypothesis that if a personal watercraft is wakeless, all the characteristics associated with personal watercraft use would no longer exist.

Rock Creek Bay: Same theory would be tested in this canyon, only less shoreline access and fewer camping sites exist. The far reaches of this canyon are more narrow. This location would provide another option for users from the Wahweap/Antelope Point access areas to coexist. A wakeless area would be designated for the back third of the canyon.

North Gulch and Moqui Canyon: North Gulch and Moqui are extremely popular canyons for uplake visitors, usually originating from either Bullfrog or Halls Crossing. Again, the same theory would be applied to these areas as at Last Chance, wakeless only for all vessels. These areas have ruins and petroglyphs in the back of their canyons, which make them very popular hiking and day use targets. These canyons are also popular for camping and water sports such as skiing.

Knowles Canyon: Knowles Canyon has been closed to all motorized traffic for over a year for purposes of conducting scientific studies (control canyon). This canyon is also in the Bullfrog/Halls Crossing region. The entire Knowles Canyon would be designated non-motorized, restricting access to all motorized vessels. Only non-motorized vessels would be allowed in this canyon. This action would test the feasibility and public acceptability of canyons with non-motorized vessel access only. It would also continue to serve as a control canyon for resource monitoring activities in support of water quality and other similar studies.

Hite Area: Actions may not be proposed in the Hite area due to previous management actions identified for Cataract Canyon and the Dirty Devil River, both in close proximity to the Hite Area. Also, the Hite area has very little personal watercraft use relative to the rest of the lake.

APPENDIX D
RESULTS OF SAMPLING AND SURVEYS

D.1: Water Quality 2001 Sample Results

The National Park Service conducted water quality testing at Glen Canyon National Recreation Area to determine the concentrations of hydrocarbons in Lake Powell. Samples were taken over a 4-day period from June 29, 2001 through July 2, 2001. This period was selected because it represents a high-use period by motorcraft, including personal watercraft.

Sample areas were chosen to capture different levels of motorboat use. They included:

An open-water area in Wahweap Bay.

An area closed to all motor vessel access (control area) at Knowles Canyon.

A busy marina with fueling station at Bullfrog.

A high-boat-use area at Moqui (sometimes spelled Moki) Canyon.

Three locations were sampled at each test site, and samples were acquired from two depths. A total of 27 samples were obtained. At each site:

A 0.5-meter-deep (about 20 inches) sample was collected to represent the near-surface conditions where lighter-weight contaminants, such as benzene, would presumably concentrate.

A 3-meter-deep (about 10 feet) sample was collected based on research at Lake Tahoe that found complete mixing of polycyclic aromatic hydrocarbon contaminants at this level (NPS, Vanmouwerik, pers. com., May 2002).

Analyses were performed by the State of Utah, The Woods Hole Group, Inc., and the U.S. Geologic Survey research laboratories.

Table D.1.1 presents results from the State of Utah and U.S. Geologic Survey

Table D.1.2 presents results from the Woods Hole Group, Inc.

Table D.1.3 presents results from the State of Utah and U.S. Geologic Survey

Table D.1.4 presents results from The Woods Hole Group, Inc.

The summer 2001 water quality sampling does not provide a complete characterization of hydrocarbon contamination of Lake Powell. The results are only a "snapshot" of hydrocarbon levels in the lake's waters on the days of testing. However, in the absence of more complete data, they are useful for indicating current conditions.

TABLE D.1.1: BTEX AND ANALYTICAL RESULTS FOR LAKE POWELL WATER SAMPLES (ALL UNITS IN µG/L, OR PARTS PER BILLION). RESULTS EXCEEDING CRITERIA ARE IN BOLD FONT

			Area sampled	Wahweap Bay								Knowles Canyon								Bullfrog Marina				
			date, time	6/29/01, 4 - 6:15 pm						7/2/01, 9am >|		6/30/01, 12 - 5:50pm								7/1/01, 9 - 11:45				
Parameter	**Reporting Limit**	**State of Utah numeric criteria for use designation 1C**		equipment blank, day 1	W1-.5m	W1-3m	W2-.5m	W2-.5m dup	W2-3m	W3-.5m	W3-3m	equipment blank, day 2	K1-.5m	K1-3m	K2-.5m	K2-3m	K3-.5m	K3-.5m dup	K3-3m	equipment blank, day 3	BM1-.5m	BM1-3m	BM2-.5m	BM2-3m
		water and organsms	**organisms only**																					
		(µg/L)	(µg/L)																					
temperature (deg. F)	--	--	--	--	78.9	75.3	76.9	--	75.9	78.2	78.0	--	--	79	81.8	79.5	81.6	--	78.8	--	79.8	79.0	79.2	78.3
(St. of UT lab results)																								
benzene	0.5 µg/L	1.2	71	U	NA	0.8	0.8	f	1.1	0.7	J 0.8	U	NA	U	U	U	U	g	U	NA	NA	**1.6**	**1.4**	0.8
toluene	0.5 µg/L	6,800	200,000	U	NA	2.6	2.8	f	2.6	2.4	2.9	U	NA	U	U	U	U	g	U	NA	NA	3.9	3.2	1.4
ethylbenzene	0.5 µg/L	3,100	29,000	U	NA	J 0.3	J 0.3	f	J 0.3	J 0.3	J 0.4	U	NA	U	U	U	U	g	U	NA	NA	J 0.4	J 0.3	U
xylenes	0.5 µg/L	na	na	U	NA	2.2	2.2	f	2.5	2.1	2.4	U	NA	U	U	U	U	g	U	NA	NA	2.8	2.2	1.0
naphthalene	1.0 µg/L	na	na	U	NA	U	U	f	U	U	U	U	NA	U	U	U	U	g	U	NA	NA	U	U	U
MTBE [a]	1.0 µg/L	na	na	U	NA	J 0.8	1.3	f	1.5	J 0.5	J 0.6	J 0.3	NA	U	U	U	U	g	U	NA	NA	J 0.5	J 0.4	J 0.3
1,3,5 trimethylbenzene	0.5 µg/L			U	U	U	U	f	U	U	U	U	NA	U	U	U	U	g	U	NA	NA	J 0.3	U	U
1,2,4 trimethylbenzene	0.5 µg/L			U	U	1.1	1.4	f	0.6	0.5	0.6	U	NA	U	U	U	U	g	U	NA	NA	0.5	0.5	U
(USGS-NJ lab results)																								
Benzene	0.035 µg/L	1.2	71	NA	0.954	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	**3.43**	NA	NA	NA
Toluene	0.05 µg/L	6,800	200,000	NA	3.56	NA	NA	NA	NA	NA	NA	NA	0.102	NA	NA	NA	NA	NA	NA	J 0.08	10.25	NA	NA	NA
Ethylbenzene	0.030 µg/L	3,100	29,000	NA	0.677	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	1.72	NA	NA	NA
m- and p-Xylene	0.06 µg/L	na	na	NA	2.85	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	8.16	NA	NA	NA
o-Xylene	0.038 µg/L	na	na	NA	1.06	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	3.11	NA	NA	NA
MTBE [a]	0.17 µg/L	na	na	NA	0.620	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	1.42	NA	NA	NA
ETBE [b]	0.054 µg/L	na	na	NA	U	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	U	NA	NA	NA
TAME [c]	0.11 µg/L	na	na	NA	U	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	U	NA	NA	NA
DIPE [d]	0.10 µg/L	na	na	NA	U	NA	NA	NA	NA	NA	NA	NA	U	NA	NA	NA	NA	NA	NA	U	U	NA	NA	NA
TBA [e]	1.0 µg/L	na	na		#		#			#			U		#		#				#		#	

Footnotes:

a - Methyl tert-butyl ether

b - Ethyl tert-butyl ether

c - tert-amyl methyl ether

d - Diisopropyl ether

e - tert-butyl alcohol

f - duplicate sample never received by lab; either not collected or lost.

g - bottles broken in transit.

h - trace levels detected.

na - criterium not available (does not exist).

NA - "not applicable" because this sample not collected for this lab to analyze.

J - Estimated value, below the reporting limit.

U - this analyte was analyzed for but not detected at the reporting limit concentration.

TABLE D.1.2: PAH ANALYTICAL RESULTS FOR LAKE POWELL WATER SAMPLES
ALL UNITS IN NG/L, OR PARTS PER TRILLION)

			Area sampled	Wahweap Bay								Knowles Canyon								Bullfrog Marina				
			date, time	6/29/01, 4 - 6:15 pm						7/2/01, 9am		6/30/01, 12 - 5:50pm								7/1/01, 9 - 11:45				
Parameter	**Reporting Limit**	State of Utah numeric criteria for use designation 1C		equipment blank, day 1	W1-.5m	W1-3m	W2-.5m	W2-.5m dup	W2-3m a	W3-.5m	W3-3m	equipment blank, day 2	K1-.5m	K1-3m	K2-.5m	K2-3m	K3-.5m	K3-.5m dup	K3-3m	equipment blank, day 3	BM1-.5m	BM1-3m	BM2-.5m	BM2-3m
		water and organisms	organisms only																					
		(ng/L)	(ng/L)																					
temperature (degrees F)	--	--	--	--	78.9	75.3	76.9	--	75.9	78.2	78.0	--	--	79.3	81.8	79.5	81.6	--	78.8	--	79.8	79.0	79.2	78.3
(Woods Hole lab results)																								
naphthalene	10 or 11ng/L	na	na	U	170	140	120	130	100	150	180	J 9.0	J 7.4	J 7.2	U	J 6.9	J 5.4	J 7.7	J 5.9	13	400	51	120	14
2-methylnaphthalene	10 or 11ng/L	na	na	U	120	93	78	92	65	100	120	U	U	U	U	U	U	U	U	U	240	21	56	U
1-methylnaphthalene	10 or 11ng/L	na	na	U	59	50	39	48	35	52	59	U	U	U	U	U	U	U	U	U	140	14	33	U
biphenyl	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	J 9.5	U	U	U
2,6-dimethylnaphthalene	10 or 11ng/L	na	na	U	12	J 9.3	J 9.7	11	J 8.4	12	12	U	U	U	U	U	U	U	U	U	34	U	J 8.0	U
acenaphthylene	10 or 11ng/L	na	na	U	J 7.1	J 8.1	J 6.6	J 6.6	J 5.9	J 7.8	J 7.7	U	U	U	U	U	U	U	U	U	24	U	J 9.2	U
acenaphthene	10 or 11ng/L	1,200,000	2,700,000	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
flourene	10 or 11ng/L	1,300,000	14,000,000	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	11	U	U	U
2,3,5-trimethylnaphthalene	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	15	U	U	U
phenanthrene	10 or 11ng/L	na	na	U	J 11	J 8.8	J 8.3	J 7.5	J 8.9	J 8.9	J 8.0	U	U	U	U	U	U	U	U	U	19	J 5.9	J 6.4	U
anthracene	10 or 11ng/L	9,600,000	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
1-methylphenanthrene	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
fluoranthene	10 or 11ng/L	300,000	370,000	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	J 9.7	U	U	U
pyrene	10 or 11ng/L	960,000	11,000,000	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	J 9.2	U	U	U
benz[a]anthracene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
chrysene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
benzo[b]fluoranthene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
benzo[k]fluoranthene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
benzo[e]pyrene	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
benzo[a]pyrene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
perylene	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
indeno[1,2,3-cd]pyrene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
dibenz[a,h]anthracene	10 or 11ng/L	2.8	31	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
benzo[g,h,i]perylene	10 or 11ng/L	na	na	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

Footnotes:
a - the reporting limit for this sample was 12 ng/L.
b - bottle broken in transit
na - criterium not available (does not exist)
J - Estimated value, below the reporting limit.
U - this analyte was analyzed for but not detected at the reporting limit concentration.

TABLE D.1.3. BTEX AND ANALYTICAL RESULTS FOR LAKE POWELL, RESULTS EXCEEDING CRITERIA ARE IN BOLD FONT

		State of Utah Lab Results								USGS - N.			
Water Depth	**temperature (deg. F)**	**benzene (ug/L)**	**toluene (ug/L)**	**ethylbenzene (ug/L)**	**xylenes (ug/L)**	**naphthalene (ug/L)**	**MTBE a (ug/L)**	**1,3,5 trimethylbenzene (ug/L)**	**1,2,4 trimethylbenzene (ug/L)**	**Benzene (ug/L)**	**Toluene (ug/L)**	**Ethylbenzene (ug/L)**	**m- and p Xylene (ug/L)**
State of Utah numeric criteria for use designation 1C - Water and organisms (ug/L)		1.2	6,800	3,100	na	na	na			1.2	6,800	3,100	na
State of Utah numeric criteria for use designation 1C - Organisms only (ug/L)		71	200,000	29,000	na	na	na			71	200,000	29,000	na
Reporting Limit		0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.035	0.05	0.030	0.06
Wahweap Bay													
equipment blank, day 1	--	U	U	U	U	U	U	U	U	NA	NA	NA	NA
W1-.5m	78.9	NA	NA	NA	NA	NA	NA	U	U	1.0	3.6	0.7	2.8
W1-3m	75.3	0.8	2.6	J 0.3	2.2	U	J 0.8	U	1.1	NA	NA	NA	NA
W2-.5m	76.9	0.8	2.8	J 0.3	2.2	U	1.3	U	1.4	NA	NA	NA	NA
W2-.5m dup	--	f	f	f	f	f	f	f	f	NA	NA	NA	NA
W2-3m	75.9	1.1	2.6	J 0.3	2.5	U	1.5	U	0.6	NA	NA	NA	NA
Knowles Canyon													
equipment blank, day 2	--	U	U	U	U	U	J 0.3	U	U	NA	NA	NA	NA
W1-.5m	--	NA	NA	NA	NA	NA	NA	NA	NA	U	0.102	U	U
W1-3m	79.3	U	U	U	U	U	U	U	U	NA	NA	NA	NA
W2-.5m	81.8	U	U	U	U	U	U	U	U	NA	NA	NA	NA
W2-3m	79.5	U	U	U	U	U	U	U	U	NA	NA	NA	NA
W2-.5m	81.6	U	U	U	U	U	U	U	U	NA	NA	NA	NA
W2-.5m dup	--	g	g	g	g	g	g	g	g	NA	NA	NA	NA
W2-3m	78.8	U	U	U	U	U	U	U	U	NA	NA	NA	NA
Bullfrog Marina													
equipment blank, day 3	--	NA	NA	NA	NA	NA	NA	NA	NA	U	J 0.08	U	U
BM1-.5m	79.8	NA	NA	NA	NA	NA	NA	NA	NA	**3.43**	10.25	1.72	8.16
BM1-3m	79.0	**1.6**	3.9	J 0.4	2.8	U	J 0.5	J 0.3	0.5	NA	NA	NA	NA
BM2-.5m	79.2	**1.4**	3.2	J 0.3	2.2	U	J 0.4	U	0.5	NA	NA	NA	NA
BM2-3m	78.3	0.8	1.4	U	1.0	U	J 0.3	U	U	NA	NA	NA	NA
BM3-.5m	79.3	**2.3**	6.1	0.7	4.7	U	J 0.8	0.5	1.2	NA	NA	NA	NA
BM3-.5m dup	--	**2.3**	6.1	0.7	4.6	U	J 0.8	J 0.4	1.2	NA	NA	NA	NA
BM3-3m	--	1.1	2.4	U	1.6	U	J 0.3	U	J 0.3	NA	NA	NA	NA
Moki Canyon													
M1-.5m	--	NA	NA	NA	NA	NA	NA	NA	NA	0.755	1.68	0.248	1.56
M1-3m	77.5	J 0.3	J 0.4	U	J 0.3	U	J 0.9	U	U	NA	NA	NA	NA
M2-.5m	74.6	**1.9**	2.6	J 0.3	3.3	U	J 0.9	J 0.4	1.0	NA	NA	NA	NA
M2-3m	77.8	**1.6**	1.8	U	2.3	U	J 0.8	U	J 0.3	NA	NA	NA	NA
M3-.5m	79.9	**2.0**	4.1	J 0.5	3.2	U	1.2	J 0.3	J 0.6	NA	NA	NA	NA
M3-3m	77.4	**1.4**	1.9	J 0.3	1.6	U	1	U	U	NA	NA	NA	NA

Footnotes:

a - Methyl tert-butyl ether

b - Ethyl tert-butyl ether

c - tert-amyl methyl ether

d - Diisopropyl ether

e - tert-butyl alcohol

f - duplicate sample never received by lab; either not collected or lost

g - bottles broken in transit.

h - trace levels detected.

na - criterium not available (does not exist).

NA - "not applicable" because this sample not collected for this lab to analyze.

J - Estimated value, below the reporting limit.

U - this analyte was analyzed for but not detected at the reporting limit concentration.

TABLE D.1.4. PAH ANALYTICAL RESULTS FOR LAKE POWELL WOODS HOLE LAB RESULTS

Water Depth	temperature (degrees F)	naphthalene (ug/L)	2-methyl-naphthalene (ug/L)	1-methyl-naphthalene (ug/L)	biphenyl (ug/L)	2,6-dimethyl-naphthalene (ug/L)	acenaphthylene (ug/L)	acenaphthene (ug/L)	flourene (ug/L)
State of Utah numeric criteria for use designation 1C - Water and organisms (ug/L)		na	na	na	na	na	na	1,200,000	1,300,000
State of Utah numeric criteria for use designation 1C - Organisms only (ug/L)		na	na	na	na	na	na	2,700,000	14,000,000
Reporting Limit		10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000
Wahweap Bay									
equipment blank, day 1	--	U	U	U	U	U	U	U	U
W1-.5m	78.9	170000	120000	59000	U	12000	J 7000.1	U	U
W1-3m	75.3	140000	93000	50000	U	J 9000.3	J 8000.1	U	U
W2-.5m	76.9	120000	78000	39000	U	J 9000.7	J 6000.6	U	U
W2-.5m dup	--	130000	92000	48000	U	11000	J 6000.6	U	U
W2-3m a	75.9	100000	65000	35000	U	J 8000.4	J 5000.9	U	U
W3-.5m	78.2	150000	100000	52000	U	12000	J 7000.8	U	U
W3-3m	78.0	180000	120000	59000	U	12000	J 7000.7	U	U
Knowles Canyon									
equipment blank, day 2	--	J 9000.0	U	U	U	U	U	U	U
K1-.5m	--	J 7000.4	U	U	U	U	U	U	U
K1-3m	79.3	J 7000.2	U	U	U	U	U	U	U
K2-.5m	81.8	U	U	U	U	U	U	U	U
K2-3m	79.5	J 6000.9	U	U	U	U	U	U	U
K3-.5m	81.6	J 5000.4	U	U	U	U	U	U	U
K3-.5m dup	--	J 7000.7	U	U	U	U	U	U	U
K3-3m	78.8	J 5000.9	U	U	U	U	U	U	U
Bullfrog Marina									
equipment blank, day 3	--	13000	U	U	U	U	U	U	U
BM1-.5m	79.8	400000	240000	140000	J 9000.5	34000	24000	U	11
BM1-3m	79.0	51000	21000	14000	U	U	U	U	U
BM2-.5m	79.2	120000	56000	33000	U	J 8000.0	J 9000.2	U	U
BM2-3m	78.3	14000	U	U	U	U	U	U	U
BM3-.5m	79.3	250000	130000	73000	J 6000.1	19000	22000	U	J 7000.8
BM3-.5m dup	--	210000	100000	60000	J 5000.1	15000	16000	U	J 6000.1
BM3-3m	--	27000	J 6000.7	U	U	U	U	U	U
Moki Canyon									
M1-.5m	--	J 8000.0	U	U	U	U	U	U	U
M1-3m	77.5	J 8000.1	U	U	U	U	U	U	U
M2-.5m	74.6	b	b	b	b	b	b	b	b
M2-3m	77.8	70000	27000	18000	J 5000.4	J 7000.2	U	U	U
M3-.5m	79.9	130000	68000	39000	U	13000	J 6000.5	U	U
M3-3m	77.4	47000	18000	11000	U	U	U	U	U

D.1.4: (CONTINUED)

Water Depth	2,3,5-trimethyl-naphthalene (ug/L)	phenanthrene (ug/L)	anthracene (ug/L)	1-methyl-phenanthrene (ug/L)	fluoranthene (ug/L)	pyrene (ug/L)	benz[a] anthracene (ug/L)	chrysene (ug/L)	benzo[b] fluoranthene (ug/L)
State of Utah numeric criteria for use designation 1C - Organisms only (ug/L)	na	na	9,600,000	na	300,000	960,000	2.8	2.8	2.8
State of Utah numeric criteria for use designation 1C - Organisms only (ug/L)	na	na	na	na	370,000	11,000,000	31	31	31
Reporting Limit	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000	10000 or 11000
Wahweap Bay									
equipment blank, day 1	U	U	U	U	U	U	U	U	U
W1-.5m	U	J 11000	U	U	U	U	U	U	U
W1-3m	U	J 8000.8	U	U	U	U	U	U	U
W2-.5m	U	J 8000.3	U	U	U	U	U	U	U
W2-.5m dup	U	J 7000.5	U	U	U	U	U	U	U
W2-3m a	U	J 8000.9	U	U	U	U	U	U	U
W3-.5m	U	J 8000.9	U	U	U	U	U	U	U
W3-3m	U	J 8000.0	U	U	U	U	U	U	U
Knowles Canyon									
equipment blank, day 2	U	U	U	U	U	U	U	U	U
K1-.5m	U	U	U	U	U	U	U	U	U
K1-3m	U	U	U	U	U	U	U	U	U
K2-.5m	U	U	U	U	U	U	U	U	U
K2-3m	U	U	U	U	U	U	U	U	U
K3-.5m	U	U	U	U	U	U	U	U	U
K3-.5m dup	U	U	U	U	U	U	U	U	U
K3-3m	U	U	U	U	U	U	U	U	U
Bullfrog Marina									
equipment blank, day 3	U	U	U	U	U	U	U	U	U
BM1-.5m	15	19000	U	U	J 9000.7	J 9000.2	U	U	U
BM1-3m	U	J 5000.9	U	U	U	U	U	U	U
BM2-.5m	U	J 6000.4	U	U	U	U	U	U	U
BM2-3m	U	U	U	U	U	U	U	U	U
BM3-.5m	J 7000.3	12000	U	U	J 6000.5	J 5000.7	U	U	U
BM3-.5m dup	J 5000.7	J 9000.0	U	U	J 5000.8	J 5000.1	U	U	U
BM3-3m	U	U	U	U	U	U	U	U	U
Moki Canyon									
M1-.5m	U	U	U	U	J 7000.1	U	U	U	U
M1-3m	U	U	U	U	J 7000.0	U	U	U	U
M2-.5m	b	b	b	b	b	b	b	b	b
M2-3m	J 5000.5	J 6000.8	U	U	J 6000.6	U	U	U	U
M3-.5m	U	J 7000.9	U	U	J 6000.5	U	U	U	U
M3-3m	U	U	U	U	U	U	U	U	U

Footnotes:

a - the reporting limit for this sample was 12000 ug/L.

b - bottle broken in transit

na - criterium not available (does not exist)

J - Estimated value, below the reporting limit.

U - this analyte was analyzed for but not detected at the reporting limit concentration.

D.2: RESPONSES TO VISITOR USE SURVEY

In 2000, the National Park Service contracted with the University of Minnesota to conduct visitor surveys on Lake Powell. Questionnaires were distributed to watercraft users that asked about travel patterns, length of trip, group characteristics, types of watercraft used, attitudes towards the quality of their trip, conditions encountered on the lake, and potential management actions. The results were published in the *Final Report: Visitor Use at Glen Canyon National Recreation Area, Comparison of personal watercraft Users and Nonusers, Summer 2000 Data Collection* (James et al. 2001a).

The information from the questionnaires and report was used in the "Visitor Use and Experience" sections in the "Affected Environment" and "Environmental Consequences" chapters. Responses to four of the questions that are most relevant to the management of personal watercraft are provided in the tables in this appendix.

TABLE D.2.1: RESPONSE TO "INDICATE HOW IMPORTANT EACH EXPERIENCE WAS TO YOU ON YOUR MOST RECENT VISIT TO THE AREA"

			Percent of All Respondents by Response Category[a]					Personal Watercraft Operators		Non-Personal Watercraft Operators	
Experience[b]	**N**	**Mean**	**1**	**2**	**3**	**4**	**5**	**N**	**Mean**	**N**	**Mean**
To enjoy the scenery of Lake Powell	184	4.5	4	0	3	23	70	93	4.5	90	4.6
To do something with my family[c]	179	4.4	6	2	7	14	71	88	4.7	90	4.2
To get away from the usual demands of life	178	4.4	2	2	6	32	59	91	4.5	86	4.4
To be with members of my group	171	4.2	4	5	13	28	52	87	4.3	83	4.1
To be with people who enjoy same things I do	177	4.2	4	3	13	33	47	90	4.3	86	4.0
To experience nature	176	4.1	3	5	11	40	42	87	4.2	88	4.1
To experience natural quiet	178	4.0	3	5	17	43	33	88	4.0	89	3.9
To participate in recreational activities	175	4.0	4	8	11	37	40	88	4.0	86	4.0
To relax physically	181	4.0	3	4	14	43	36	91	4.1	89	4.0
To be close to nature	173	3.9	3	5	18	45	30	88	4.0	84	3.9
To use my own equipment	177	3.8	8	8	14	37	34	88	4.0	88	3.7
To have thrills and excitement	177	3.8	6	3	27	35	31	90	3.9	86	3.7
To stargaze	178	3.7	5	10	23	42	22	89	3.8	88	3.6
To be away from other people	173	3.7	5	11	22	36	25	87	3.7	85	3.7
To feel healthier	175	3.7	4	3	32	37	24	89	3.9	85	3.6
To experience solitude	172	3.6	5	8	31	36	22	86	3.5	85	3.7
To experience an undeveloped lake	168	3.5	7	14	29	29	22	83	3.5	84	3.4
To experience new and different things	174	3.5	5	12	25	41	17	89	3.5	84	3.5
To think about my personal values	175	3.5	5	11	36	30	18	87	3.4	87	3.5
To get exercise	179	3.5	6	10	30	38	17	90	3.5	88	3.5
To learn about the cultural history of the area	175	3.4	5	11	31	40	10	87	3.3	87	3.4
To be on my own	177	3.3	9	20	26	30	11	88	3.3	87	3.2
To test my skills and abilities	176	3.2	6	18	36	31	17	89	3.1	86	3.3
To share my skill and knowledge with others	176	3.2	8	12	47	22	9	87	3.2	86	3.1
To challenge myself	174	3.1	8	18	40	23	11	87	3.1	84	3.1
To be creative by doing something such as sketching, painting, taking photographs	169	2.8	18	21	34	18	8	85	2.7	83	2.8

Experience[b]	N	Mean	Percent of All Respondents by Response Category[a] 1	2	3	4	5	Personal Watercraft Operators N	Mean	Non-Personal Watercraft Operators N	Mean
To meet new people	175	2.6	21	26	35	13	6	88	2.6	86	2.5
To participate in ranger-led activities	174	2.1	35	30	31	3	1	88	2.0	85	2.1

Source: Mail-back survey, Question 2.

a. Rank ordered by mean importance scores for total sample respondents.

b. Responses based on a 5-point scale:
1 = very unimportant
2 = unimportant
3 = neither unimportant or important
4 = important
5 = very important.

c. Bold font = differences between groups are statistically significant at the $p<0.05$ level.

TABLE D.2.2: RESPONSE TO "FOR EACH EXPERIENCE FOR WHICH YOU CIRCLED EITHER A 4 OR 5, PLEASE INDICATE HOW MUCH YOU WERE ABLE TO ATTAIN EACH OF THOSE EXPERIENCES"

			Percent of All Respondents by Response Category[a]				Personal Watercraft Operators		Non-Personal Watercraft Operators	
Experience[b]	N	Mean	1	2	3	4	N	Mean	N	Mean
To be with members of my group	117	3.9	0	0	14	86	63	3.8	53	3.9
To do something with my family	133	3.8	1	3	14	83	71	3.8	62	3.7
To be with people who enjoy same things I do	126	3.8	0	4	17	79	63	3.8	62	3.7
To enjoy the scenery of Lake Powell	150	3.8	0	3	15	83	73	3.8	76	3.8
To use my own equipment	112	3.7	0	7	17	76	56	3.7	56	3.6
To stargaze	95	3.7	1	4	22	73	50	3.7	45	3.6
To participate in recreational activities	123	3.6	0	7	29	64	62	3.6	60	3.5
To be close to nature	112	3.5	0	5	45	50	57	3.5	54	3.4
To get away from the usual demands of life	141	3.5	1	6	31	61	73	3.6	67	3.5
To have thrills and excitement	100	3.5	0	6	38	56	55	3.5	44	3.5
To experience nature	123	3.4	1	12	37	50	59	3.4	63	3.3
To test my skills and abilities	57	3.4	0	7	51	42	24	3.3	33	3.4
To think about my personal values	70	3.4	1	4	47	47	32	3.4	38	3.4
To get exercise	86	3.4	1	9	42	48	44	3.3	42	3.4
To share my skill and knowledge with others	46	3.4	0	4	52	44	20	3.4	26	3.4
To feel healthier	90	3.4	0	13	37	50	45	3.4	45	3.4
To be creative by doing something such as sketching, painting, taking photographs	38	3.3	0	13	42	45	17	3.2	21	3.4
To relax physically	122	3.3	2	7	46	45	62	3.4	59	3.3
To experience an undeveloped lake	78	3.2	3	21	33	44	37	3.1	41	3.2
To experience new and different things	83	3.2	2	16	43	39	42	3.1	40	3.2
To challenge myself	52	3.2	0	14	56	31	26	3.2	26	3.1
To experience natural quiet	117	3.1	5	23	33	33	61	3.1	56	3.0
To be on my own	69	2.9	4	23	42	42	32	3.1	37	2.9
To learn about the cultural history of the area	72	2.9	6	25	44	44	28	3.1	44	2.8
To learn about the natural history of the area	83	2.9	4	24	51	51	35	3.0	47	2.8
To participate in ranger-led activities	7	2.9	29	0	29	29	1	4.0	6	2.7
To be away from other people	94	2.9	10	20	39	39	48	3.0	46	2.8

			Percent of All Respondents by Response Category[a]				Personal Watercraft Operators		Non-Personal Watercraft Operators	
Experience[b]	**N**	**Mean**	**1**	**2**	**3**	**4**	**N**	**Mean**	**N**	**Mean**
To experience solitude	87	2.9	10	24	30	30	39	3.1	48	2.8
To meet new people	104	2.7	13	26	42	42	50	2.7	51	2.7

Source: Mail-back survey, Question 2.

a. Responses based on a 4 point scale:
1 = did not attain
2 = somewhat attained
3 = moderately attained
4 = totally attained.

b. Rank ordered by mean attainment scores of total sample.

TABLE D.2.3: SITUATIONS RESPONDENTS MAY HAVE EXPERIENCED WHILE VISITING GLEN CANYON NATIONAL RECREATION AREA

			Percent of All Respondents by Response Category[a]					Personal Watercraft Operators		Non-Personal Watercraft Operators	
Experience	**N**	**Mean[b]**	**No Problem**	**Slight Problem**	**Moderate Problem**	**Serious Problem**	**Very Serious Problem**	**N**	**Mean**	**N**	**Mean**
Finding beach campsite	166	2.1	42	22	23	9	4	89	2.1	72	2.2
Finding an unoccupied campsite	165	2.0	50	22	18	6	5	83	2.0	76	2.0
Litter on beaches and shoreline	180	2.0	43	27	21	3	6	91	2.0	83	2.1
People being inconsiderate	180	2.0	46	26	17	5	7	89	**1.8**	86	**2.3**
Unsafe operation of personal watercraft	181	2.0	51	19	17	6	8	91	**1.7**	84	**2.4**
Too many personal watercraft on the lake	180	1.9	57	18	13	3	8	92	**1.5**	82	**2.3**
Boats closer to my boat than I like	179	1.9	54	20	15	7	5	91	**1.7**	82	**2.1**
Poor water quality	168	1.7	60	19	16	4	3	85	1.8	78	1.7
Unsafe operation of motorized boats	181	1.7	59	24	12	2	3	91	1.6	84	1.8
Too much noise on the lake	185	1.7	59	27	6	5	3	91	1.6	88	1.8
Conflicts with personal watercraft operators on lake	179	1.7	67	15	9	5	5	92	1.4	81	2.0
Evidence of pets and their droppings	181	1.7	59	24	6	6	5	91	1.7	58	1.9
Adequate floating toilet facilities on lake	157	1.7	66	13	12	5	4	77	1.7	75	1.7
Too many motorized boats on the lake	181	1.6	61	23	11	2	3	92	1.6	83	1.7
Human waste on shore or in water	171	1.6	71	16	6	1	6	86	1.5	80	1.7
Sufficient navigational aids on Lake Powell	171	1.5	71	19	6	2	3	88	1.5	77	1.4
Conflicts with others for beach space	177	1.5	69	15	10	4	2	89	1.4	82	1.7
Adequate toilet facilities at landings	179	1.5	72	16	7	4	3	88	1.5	85	1.5
Confusion about rules and regulations	176	1.5	70	18	7	3	2	91	1.5	79	1.6
Lack of National Park Service presence on the lake	172	1.5	75	10	9	4	2	87	1.4	79	1.6
Too many commercial tour boats	180	1.4	81	8	7	3	2	89	1.3	84	1.4
Evidence of livestock	174	1.3	84	8	5	1	3	88	1.2	80	1.5
Too much light on lake at night	179	1.2	91	6	1	2	1	91	1.1	82	1.2
Noise from airplanes	180	1.2	90	6	3	1	1	90	1.1	84	1.3
Too much light at the marinas at night	171	1.1	92	5	2	0	1	87	1.1	78	1.1
Evidence of mining operations	170	1.1	95	3	1	1	1	86	1.1	78	1.1

			Percent of All Respondents by Response Category[a]					Personal Watercraft Operators		Non-Personal Watercraft Operators	
Experience	**N**	**Mean[b]**	**No Problem**	**Slight Problem**	**Moderate Problem**	**Serious Problem**	**Very Serious Problem**	**N**	**Mean**	**N**	**Mean**
Enough ranger-led activities	127	1.1	94	2	3	1	1	64	1.2	60	1.1

Source: Mail-back survey, Question 7.

a. Responses based on a 5-point scale:
1 = no problem
2 = slight problem
3 = moderate problem
4 = serious problem
5 = very serious problem.

b. Rank ordered by mean scores of total sample.

c. Bold font = differences between groups are statistically significant at the $p<0.05$ level.

TABLE D.2.4: RESPONSE TO: "GIVEN THE CONDITIONS IN THE GLEN CANYON NATIONAL RECREATION AREA, TO WHAT EXTENT DO YOU OPPOSE EACH POSSIBLE MANAGEMENT ACTION"

			Percent of All Respondents by Response Category[a]					Personal Watercraft Operators		Non-Personal Watercraft Operators	
Management Action[b]	N	Mean	Strongly Oppose	Oppose	Neither Support nor Oppose	Support	Strongly Support	N	Mean	N	Mean
Provide more information to visitors about appropriate behavior	186	4.0	3	3	19	43	33	91	3.9	90	4.1
Aggressively enforce safety rules and regulations on lake	185	3.7	5	7	22	41	24	90	3.7	90	3.8
Provide visitors with natural history information about the area	184	3.7	2	3	34	46	16	91	3.7	88	3.7
Use management controls to prevent damage to the environment by visitors	184	3.7	7	5	22	42	24	91	3.7	88	3.8
Provide more toilet facilities at landings	183	3.7	2	3	32	44	19	91	3.8	87	3.7
Provide more park rangers on the lake to educate visitors about appropriate behavior	185	3.6	5	7	30	40	18	90	3.5	90	3.7
Improve public access to the lake	184	3.3	11	18	24	27	21	90	3.3	89	3.3
Expand the number of marina slips	185	3.3	7	12	38	29	15	91	3.4	89	3.2
Use management controls to prevent conflicts between lake users	181	3.3	6	12	39	35	9	91	3.2	85	3.5
Establish "off-limit" zones to protect sensitive resources	184	3.2	17	11	19	37	16	90	3.3	99	3.3
Require visitors to learn about appropriate behavior on the lake (e.g., watch a short video presentation)	181	3.0	13	20	32	22	13	90	2.9	87	3.2
Prohibit drinking alcoholic beverages on the lake	185	2.8	31	17	14	15	23	91	2.7	89	3.0
Restrict personal watercraft use to designated areas only	183	2.7	31	20	12	19	19	89	2.2	89	3.3
Restrict further facility development and expansion	184	2.7	19	24	33	17	7	90	2.6	89	2.7
Close area to pets	186	2.7	24	18	32	15	11	91	2.6	90	2.9
Zone the waters to provide specific uses at specific places	184	2.7	31	20	19	21	10	90	2.4	89	2.8
Limit number of personal watercraft allowed	186	2.6	34	19	18	17	11	91	2.1	90	2.9

			Percent of All Respondents by Response Category[a]					Personal Watercraft Operators		Non-Personal Watercraft Operators	
Management Action[b]	**N**	**Mean**	**Strongly Oppose**	**Oppose**	**Neither Support nor Oppose**	**Support**	**Strongly Support**	**N**	**Mean**	**N**	**Mean**
on lake at any one time											
Limit number of boats allowed on lake	181	2.4	31	27	21	16	6	88	2.3	88	2.4
Limit number of houseboats allowed on lake at any one time	184	2.4	33	23	24	14	6	91	2.2	88	2.5
Limit number of motorized watercraft allowed on lake at any one time	184	2.4	35	25	22	14	4	91	2.1	88	2.4
Limit number of non-motorized watercraft allowed on lake at any one time	185	2.3	41	28	25	5	2	91	2.0	89	2
Restrict number of people using lake at any one time	185	2.0	40	30	20	10	1	91	2.0	89	2
Limit number of people *per group* allowed on lake	185	2.0	42	30	17	9	3	91	1.9	89	2
Prohibit personal watercraft on the lake	185	1.9	52	24	14	4	5	91	1.5	89	2.3
Prohibit non-motorized watercraft on the lake	184	1.7	52	32	11	3	2	90	1.7	89	1.7
Prohibit motorized watercraft on the lake	184	1.4	70	21	9	1	0	91	1.4	89	1.5

Source: Mail-back survey, Question 11.

a. Rank ordered by mean scores of total sample.

b. Responses based on a 5-point scale:
1 = strongly oppose
2 = oppose
3 = neither support nor oppose
4 = support
5 = strongly support.

APPENDIX E
METHOD USED TO CALCULATE BOAT USE DAYS

ASSUMPTIONS

The purpose of the following is estimate the amount of boat use specifically personal watercraft use on Lake Powell during calendar year 2001. This use was broken down into two broad categories:

All boats except personal watercraft, and

Personal watercraft

The following definitions apply through this analysis:

Data – Rental, and slip and buoy data used in this analysis was obtained from ARAMARK, a concessioner for Glen Canyon National Recreation Area. Entry data was obtained from monthly use data, principally entry gate counts or trailer counts.

Boat days – All figures used in the analysis were reduced to boat days. A boat day equals one watercraft on the lake for a 24-hour period. For example, a single boat that enters Glen Canyon National Recreation Area and stays for 14 days would equate to 14 boat days.

Monthly summaries – All use approximations were developed on a monthly basis to give a reasonable approximation of the seasonal nature of use. In addition, both ARAMARK and the National Park Service provide data on a monthly basis.

Entry – Entry was assumed to mostly occur through established entry gates at Wahweap, Lone Rock, Antelope Point, Bullfrog, Halls Crossing, and Hite.

Miscellaneous access – Two sources of lake access were considered sufficiently significant to estimate for the analysis. These sources were after-hour access at the Bullfrog and Halls Crossing developed areas, as well as Bullfrog north and south undeveloped areas.

ENTRY DETERMINATIONS

Entry numbers were based on actual entry gate counts when the gates were open. Trailer counts were used to estimate entry numbers when gate counts were not available.

Entry gate and trailer counts were used at the following locations and times for analysis:

Entry Location	Gate Counts	Trailer Counts
Wahweap	April – November	December – March
Lone Rock	April – October	November – March
Bullfrog	April – October	November – March
Halls Crossing	May – October	November – April
Hite	No entry gate	January – December

Entry gate numbers – Entry gate numbers were converted to boat days with the following formula:

AB = Entry gate monthly AB total time the average length of stay (ALS) for all boats

personal watercraft = Entry gate monthly personal watercraft total time the average length of stay for personal watercraft

where the ALS is the following:

Time Period	ALS for personal watercraft[1]	ALS for AB[1]
Winter (January – March)	5.1[2]	6.5[2]
Spring (April – June)	7.6	9.0
Summer (July – September)	5.0	4.1
Fall (October – December)	5.1	6.5

1. ALS determined by James et al. 2001
2. No data for winter ALS assumed to be same as fall ALS

Trailer count numbers – Trailer count numbers were converted to AB and personal watercraft boat days using the following formula:

AB = Trailer count – personal watercraft

personal watercraft = Trailer count multiplied by a seasonal adjuster[1]

where the seasonal adjuster[1] is the following:

Time Period	Adjuster[1]
October through April	0.035
May	0.25
June through August	0.47
September	0.21

1. Adjuster determined by AB/personal watercraft ratio from gate figures

Miscellaneous access – Access after hours at Bullfrog and accessing the lake at Bullfrog north and south beaches was assumed to account for additional numbers given the following formula:

Bullfrog entry numbers times 20

Where 20 is the estimated amount of after hour and ungated access

RENTALS

Rental numbers were derived directly from the figures (days out) provided by ARAMARK.

SLIPS AND BUOYS

Total slip and buoy numbers (estimated days out on the lake) were provided to the National Park Service by ARAMARK. Percent personal watercraft and AB were calculated using the following two formulas:

AB (on Lake Powell) = Total monthly slip and buoy number (days out) reported by ARAMARK times a Seasonal Adjuster[2]

where seasonal adjuster[2] accounts for boats taken out of a slip or buoy but not on Lake Powell (provided by Dan Cordesen of ARAMARK) and is the following:

Time period	Adjuster[2]
December through February	0
March	.25
April	.50
May through September	1
October	.50
November	.25

personal watercraft = AB times 0.44 or 0.10 (the average # of personal watercraft/boat in a slip or buoy) times seasonal adjuster[3]

where the average number of personal watercraft per slip or buoy is

0.44 at Wahweap, Bullfrog, and Halls Crossing (359/809) and

0.10 at Hite (5/50)

and seasonal adjuster[3] (accounting for decreased use of personal watercraft during the cold period) was assumed as the following:

Month	Adjuster[3]
December through March	0.2
April and November	0.4
May	0.6
October	0.8
June through September	1.0

DRY STORAGE

It was assumed that ARAMARK dry storage would not be counted by the entrance gate or the trailer counts.

Dry storage numbers were derived using the monthly summary numbers (days out) provided to the National Park Service by ARAMARK.

Percent AB and personal watercraft for a particular month were calculated using the following formula:

AB = Total monthly dry storage days out number from ARAMARK minus personal watercraft days out number

personal watercraft = Total monthly dry storage days out number from ARAMARK times 0.075 where 0.075 is the average number of personal watercraft in ARAMARK dry storage

APPENDIX F
TEN-YEAR VISITATION CHANGE (1991–2001)
53 SELECTED NATIONAL PARKS INCLUDING
PERSONAL WATERCRAFT RULEMAKING PARKS

Parks were generally selected based on one or more of the following characteristics:

- Personal Watercraft Rule
- Water-based, National Recreation Area reservoirs, National Seashores
- Large National Parks - for general comparison
- Western parks

Park	Average Annual Growth – 1991–2001	Average Annual Growth in Personal Watercraft Use in Parks
Amistad National Recreation Area	-0.3%	-0.3%
Apostle Islands National Landmark	3.8%	
Arches National Park	0.9%	
Assateague Island National Seashore	-0.8%	-0.8%
Badlands National Park	-4.0%	
Bandelier National Monument	0.1%	
Big Bend National Park	1.8%	
Big South Fork National River and Recreation Area	0.8%	
Big Thicket National Preserve	7.7%	7.7%
Bighorn Canyon National Recreation Area	-4.8%	-4.8%
Black Canyon of the Gunnison National Park	-4.7%	
Blue Ridge Parkway	1.9%	
Buffalo National River	-0.8%	
Canaveral National Seashore	2.0%	
Cape Cod National Seashore	-2.0%	-2.0%
Cape Hatteras National Seashore	2.2%	
Cape Lookout National Seashore	9.2%	9.2%
Capitol Reef National Park	-0.8%	
Chaco Culture National Historic Park	1.0%	
Chattahoochee River National Recreation Area	6.3%	
Chickasaw National Recreation Area	1.2%	1.2%
Crater Lake National Park	0.1%	
Curecanti National Recreation Area	-2.0%	-2.0%
Death Valley National Park	3.5%	
Delaware Water Gap National Recreation Area	1.2%	1.2%
Dinosaur National Monument	-3.2%	
Everglades National Park	-1.5%	
Fire Island National Seashore	1.9%	1.9%
Gateway National Recreation Area	4.7%	4.7%
Glacier National Park	-1.1%	

Ten-Year Visitation Change (1991–2001) 53 Selected National Parks Including Personal Watercraft Rulemaking Parks

Park	Average Annual Growth – 1991–2001	Average Annual Growth in Personal Watercraft Use in Parks
Glen Canyon NRA	-2.6%	-2.6%
Golden Gate NRA	-0.8%	
Great Smoky Mountains National Park	1.3%	
Guadalupe Mountains National Park	1.4%	
Gulf Islands National Seashore	2.5%	2.5%
Indiana Dunes National Landmark	-1.7%	-1.7%
Lake Chelan National Recreation Area	-1.5%	
Lake Mead National Recreation Area	0.1%	0.1%
Lake Meredith National Recreation Area	0.3%	0.3%
Lake Roosevelt National Recreation Area	-1.3%	-1.3%
Mount Rainier National Park	-1.2%	
New River Gorge National River	5.0%	
Ozark National Scenic Riverways	-3.7%	
Padre Island National Seashore	-2.8%	-2.8%
Pictured Rocks National Landmark	-4.5%	-4.5%
Point Reyes National Seashore	-0.6%	
Rainbow Bridge National Monument	-0.3%	
Ross Lake National Recreation Area	2.2%	
Saint Croix National Scenic River	-4.3%	
Sleeping Bear Dunes National Landmark	-0.8%	
Voyageurs National Park	0.4%	
Whiskeytown-Shasta-Trinity National Recreation Area	-0.9%	-0.9%
Yellowstone National Park	2.5%	
Overall Average Annual Change	**0.251%**	**0.261%**

APPENDIX G
APPROACH TO EVALUATING SURFACE WATER QUALITY IMPACTS FROM THE USE OF PERSONAL WATERCRAFT

OBJECTIVE

Using simplifying assumptions, estimate the minimum (threshold) volume of water in a reservoir or lake below which concentrations of gasoline constituents from personal watercraft or outboards would be potentially toxic to aquatic organisms or humans. Using the estimated threshold volumes, and applying knowledge about the characteristics of the receiving waterbody and the chemical in question, estimate if any areas within the waterbody of interest may present unacceptable risks to human health or the environment.

OVERALL APPROACH

Following are the basic steps in evaluating the degree of impact a waterbody (or portion of a water body) would experience based on an exceedence of water quality standards / toxicity benchmarks for personal watercraft and outboard engine -related contaminants.

> Determine concentrations of polycyclic aromatic hydrocarbons, benzene, and methyl tertiary-butyl ether in gasoline (convert from weight percent to mg/L, as needed) and polycyclic aromatic hydrocarbons in exhaust. The half-life of benzene in water is 5 hours at 25°C (Verschueren 1983; EPA 2001).
>
> Estimate loading of polycyclic aromatic hydrocarbons, benzene, and methyl tertiary-butyl ether for various appropriate personal watercraft-hour levels of use for one day (mg/day)
>
> Find/estimate ecological and human health toxicity benchmarks (risk-based concentrations [RBCs]) (µg/L) for polycyclic aromatic hydrocarbons, benzene, and methyl tertiary-butyl ether.
>
> Divide the estimated loading for each constituent (µg) by a toxicity benchmark (µg/L) to determine the waterbody threshold volume (L) below which toxic effects may occur (convert liters to acre-feet).

Estimated hydrocarbon emissions from personal watercraft and outboards will be significantly reduced in the near future, based on regulations issued by the Environmental Protection Agency and California Air Resources Board (CARB).

ASSUMPTIONS AND CONSTANTS

Several assumptions must be made to estimate waterbody threshold volumes for each hydrocarbon evaluated. Each park unit should have specific information that can be used to modify these assumptions or to qualitatively assess impacts in light of park unit-specific conditions such as mixing and stratification, and the characteristics of the chemicals themselves. The assumptions are as follows:

> Benzene, toluene, ethyl benzene, and xylenes (benzene, toluene, ethyl benzene, and xylene) are volatile and do not stay in the water column for long periods of time. Because benzene is a recognized human carcinogen, it is retained for the example calculations below and should be considered in each environmental assessment or environmental impact statement (Verschueren 1983; EPA 2001c).
>
> Methyl tertiary-butyl ether volatilizes slightly and is soluble in water. Methyl tertiary-butyl ether may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.

Polycyclic aromatic hydrocarbons volatilize slightly (depending on structure and molecule size) and may adhere to sediment and settle out of the water column or float to the surface and be photo-oxidized. They may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.

The toxicity of several polycyclic aromatic hydrocarbons increases (by several orders of magnitude) when polycyclic aromatic hydrocarbons are exposed to sunlight. This was not incorporated because site-specific water transparency is not known, and should be discussed qualitatively.

The threshold volume of water will mix vertically and aerially with contiguous waters to some extent, but the amount of this mixing will vary with location in the lake, reservoir, or river. Therefore, although the threshold volume calculation assumes no mixing with waters outside the "boundary" of the threshold volume of water, this should be discussed in the assessment after the threshold volume is calculated. The presence or absence of a thermocline should also be addressed.

Volume of the waterbody, or portion thereof, is estimated by the area multiplied times the average depth.

In addition to these assumptions, several constants required to make the calculations were compiled from literature and agency announcements. Gasoline concentrations are provided for benzene, methyl tertiary-butyl ether and those polycyclic aromatic hydrocarbons for which concentrations were available in the literature. Constants used are:

Gasoline emission rate for two-stroke personal watercraft: 3 gallons per hour at full throttle (CARB 1998a)

Gasoline emission rate for two-stroke outboards: estimated at approximately the same as for personal watercraft for same or higher horsepower outboards (80–150 hp); approximately twice that of personal watercraft for small (e.g., 15 hp) outboards. (Note: Assume total hours of use for the various size boats/motors, and that smaller 15 hp motors that exhaust relatively more unburned fuel would probably be in use for a much smaller amount of time than the recreational speedboats and personal watercraft). This estimate is based on data from Allen et al. 1998 (Fig. 5). It is noted that other studies may show different results, e.g. about the same emissions regardless of horsepower, or larger horsepower engines having more emissions than smaller engines (e.g., CARB 2001a); the approach selected represents only one reasonable estimate.

1 gallon = 3.78 liters

Specific gravity of gasoline: 739 g/L

1 acre-foot = 1.234×10^6 liters

Concentration of benzo(a)pyrene (B[a]P) in gasoline: 2.8 mg/kg (or 2.07 mg/L) (Gustafson et al. 1997)

Concentration of naphthalene in gasoline: 0.5% or 0.5 g/100 g (or 3,695 mg/L) (Gustafson et al. 1997)

Concentration of 1-methyl naphthalene in gasoline: 0.78% or 0.78 g/100 g (or approx. 5,760 mg/L) (estimated from Gustafson et al. 1997)

Concentration of benzene in gasoline: 2.5% or 2.5 g/100 g (or 1.85×10^4 mg/L) (Hamilton 1996)

Concentration of methyl tertiary-butyl ether in gasoline: 15% or 15 g/100 g (or approx. 1.10×10^5 mg/L) (Hamilton 1996). (Note: methyl tertiary-butyl ether concentrations in gasoline vary from state to state. Many states do not add methyl tertiary-butyl ether.)

Estimated emission of B(a)P in exhaust: 1080 μg/hr (from White and Carroll 1998), using weighted average B(a)P emissions from two-cylinder, carbureted two-stroke liquid cooled snow mobile engine using gasoline and oil injected Arctic Extreme injection oil, 24-38:1 fuel:oil ratio. Weighted average based on percentage of time engine was in five modes of operation, from full throttle to idle.

Estimated amount of B(a)P exhaust emissions retained in water phase = approximately 40% (based on value for B(a)P from Hare and Springier 1973).

TOXICITY BENCHMARKS

A key part of the estimations is the water quality criterion, standard, or toxicological benchmark for each contaminant evaluated. There are no Environmental Protection Agency water quality criteria for the protection of aquatic life for the personal watercraft-related contaminants (EPA 1999a). There are, however, a limited number of Environmental Protection Agency criteria for the protection of human health (via ingestion of water and aquatic organisms). Chronic ecotoxicological and human health benchmarks for contaminants were acquired from various sources.

Ecological benchmarks for benzo(a)pyrene, naphthalene, and benzene are from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision* (Suter and Tsao 1996) and from the Arizona Administrative Code (for benzene concentration in a warm water fishery). The ecological benchmarks for benzo(a)pyrene (0.014 μg/L) and benzene (71 μg/L) are Tier II Secondary Chronic Values in table 1 of Suter and Tsao (1996), which were calculated using methods in the Great Lakes Water Quality Initiative (EPA 1993). The ecological benchmark for naphthalene (62 μg/L) is the Environmental Protection Agency Region 4 chronic screening value (table 3 of Suter and Tsao 1996). This screening value was chosen for use as a conservative mid-range value considering the wide range of chronic values for naphthalene (12–620 μg/L) shown in Suter and Tsao (1996) The ecological benchmarks for 1-methyl naphthalene (19 and 34 μg/L) are based on LC_{50} values of 1,900 and 3,400 μg/L for the marine invertebrate, Dungeness crab (*Cancer magister*), and the fresh water/estuarine fish, sheepshead minnow (*Cyprinodon variegatus*) (U.S. Fish and Wildlife Service 2000). The methyl tertiary-butyl ether benchmark 51,000 μg/L is for fresh water and is based on the preliminary chronic water quality criteria presented in Mancini et al. (2001).

TABLE G.1: TOXICITY BENCHMARKS FOR SELECTED CONSTITUENTS OF GASOLINE

Chemical	Ecological Benchmark (µg/L)	Source	Human Health Benchmark[a] (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044[a] 0.049[b]	EPA 1999a
Naphthalene	62	Suter and Tsao 1996	—	—
1-methyl naphthalene	19–34[c]	U.S. Fish and Wildlife Service 2000	—	
Benzene	71	Arizona Administrative Code 1996	1.2[a] 71[b]	EPA 1999a[a]
methyl tertiary-butyl ether[d]	18,000 51,000	Mancini et al. 2002	13[e]	—

a. Based on the consumption of water and aquatic organisms.

b. Based on the consumption of aquatic organisms only.

c. Based on LC_{50s} of 1,900 µg/L and 3,400 µg/L for Dungeness crab and sheepshead minnow, respectively (34 µg/L used for freshwater calculations; 19 µg/L used for marine and estuarine calculations).

d. Ecological benchmarks considered preliminary chronic water quality criteria for marine and freshwater, respectively. Human health toxicological information for methyl tertiary-butyl ether is currently under review. There is no Environmental Protection Agency human health benchmark.

e. California primary drinking water standard (shown for informational purposes).

EXAMPLE CALCULATIONS

Calculations of an example set of waterbody volume thresholds are provided below for the chemicals listed above together with their concentrations in gasoline and available toxicity benchmarks.

Loading to Water

Loadings of the five contaminants listed above are calculated for one day assuming 10 personal watercraft operate for four hours (40 personal watercraft-hours), each discharging 11.34 L gasoline per hour and having concentrations in fuel or exhaust as listed.

Benzo(a)pyrene (from the fuel): 40 personal watercraft-hrs × 11.34 L gas/hr × 2.07 mg/L = 939 mg

Benzo(a)pyrene (from the gas exhaust): 40 personal watercraft-hrs × 1080 µg/hr × 1/1000 mg/µg × 0.40 = 17 mg

Total B(a)P = 956 mg

Naphthalene: 40 personal watercraft-hrs × 11.34 L gas/hr × 3695 mg/L = 1.68×10^6 mg

1-methyl naphthalene: 40 personal watercraft-hrs × 11.34 L gas/hr × 5764 mg/L = 2.62×10^6 mg

Benzene: 40 personal watercraft-hrs × 11.34 L gas/hr × 1.85×10^4 mg/L = 8.39×10^6 mg

methyl tertiary-butyl ether: 40 personal watercraft-hrs × 11.34 L gas/hr × 1.10×10^5 mg/L = 4.99×10^7 mg

Loadings of contaminants from two-stroke outboards should be estimated based on the estimated loading based on the horsepower of the outboards involved (see "Assumptions and Constants" above) and the estimated hours of use, based on the types of boats and the pattern of use observed.

Threshold Volumes

Threshold volumes of water (volume at which a personal watercraft or outboard engine-related contaminant would equal the thresholds listed above) are calculated by dividing the estimated loadings (mg of contaminant) for the number of operational hours (e.g., 40 personal watercraft-hours) by the listed toxicity benchmark concentrations (μg/L), correcting for units (1 mg = 10^3 μg), and converting from liters to acre-feet (1 acre-foot = 1.234×10^6 L):

Protection of Aquatic Organisms

Benzo(a)pyrene: 956 mg B(a)P × 10^3 μg/mg / 0.014 μg/L = 6.8×10^7 L or 55 acre-feet

Naphthalene: 1.68×10^6 mg naphthalene × 10^3 μg/mg / 62 μg/L = 2.71×10^7 L or 22 acre-feet

1-methyl naphthalene: 2.62×10^6 mg 1-methyl naphthalene. × 10^3 μg/mg / 34 μg/L = 7.69×10^7 L or 62 acre-feet

Benzene: 8.39×10^6 mg benzene × 10^3 μg/mg / 71 μg/L = 6.45×10^7 L or 96 acre-feet

methyl tertiary-butyl ether (acute): 4.99×10^7 mg methyl tertiary-butyl ether × 10^3 μg/mg / 51,000 μg/L = 9.42×10^5 L or 0.79 acre-feet

Based on these estimates and assumptions, 1-methyl naphthalene appears to be the contaminant (of those analyzed) that would be the first to accumulate to concentrations potentially toxic to aquatic organisms (i.e., it requires more water [62 acre-feet] to dilute the contaminant loading to a concentration below the toxicity benchmark); however, the threshold volumes are very similar for 1-methyl naphthalene, benzo(a)pyrene, and benzene.

Protection of Human Health

Benzo(a)pyrene: 956 mg B(a)P × 10^3 μg/mg / 0.0044 μg/L = 2.17×10^8 L or 176 acre-feet

Benzene: 8.39×10^6 mg benzene × 10^3 μg/mg / 1.2 μg/L = 6.99×10^9 L or 5,670 acre-feet

Using the numbers provided above, benzene would be the first personal watercraft-related contaminant in these example calculations that would reach unacceptable levels in surface water; however, volatilization of benzene from water to air was not included in the calculation. If human health water quality criteria for ingestion of aquatic organisms only were used for benzo(a)pyrene and benzene (0.049 μg/L and 71 μg/L, respectively), the corresponding threshold volumes would be 15.8 acre-feet and 95.8 acre-feet, respectively.

As a result of the estimated reductions in hydrocarbon emissions (from the unburned fuel) in response to Environmental Protection Agency regulations (listed above), additional personal watercraft and/or outboards may be used in the parks without additional impacts on water quality. For example, based on the expected overall reductions from the Environmental Protection Agency (1996, 1997), up to 75% additional personal watercraft/ outboards may be used in a given area in 2025 without additional impacts on water quality over

current levels. Effects on noise levels, physical disturbance, or hydrocarbon emissions that are products of combustion (e.g., B(a)P) may not be similarly reduced by the reduced emission regulations.

APPLICATION OF APPROACH

Use of the approach described above for evaluating possible exceedence of standards or other benchmarks must be adapted to the unique scenarios presented by each park unit, personal watercraft use, and waterbody being evaluated.

Factors that would affect the concentration of the contaminants in water must be discussed in light of the specific site conditions. These factors include varying formulations of gasoline (especially for methyl tertiary-butyl ether); dilution due to mixing (e.g., influence of the thermocline), wind, currents, and flushing; plus loss of the chemical due to volatilization to the atmosphere (Henry's Law constants can help to predict volatilization to air; see Yaws et al. 1993); adsorption to sediments and organic particles in the water column (e.g., polycyclic aromatic hydrocarbons), oxidation, and biodegradation (breakdown by bacteria). Toxicity of phototoxic polycyclic aromatic hydrocarbons may be of concern in more clear waters, but not in very turbid waters.

The chemical composition of gasoline will vary by source of crude oil, refinery, and distillation batch. No two gasolines will have the exact same chemical composition. For example, B(a)P concentrations may range from 0.19 to 2.8 mg/kg, and benzene concentrations may range from 0% to 7% (2% to 3% is typical). Methyl tertiary-butyl ether concentrations will vary from state to state and season to season, with concentrations ranging from 0% to 15%. The composition of gasoline exhaust is dependent on the chemical composition of the gasoline and engine operating conditions such as temperature, revolutions per minute, and oxygen intake. If site-specific information is available on gasoline and exhaust constituents, they should be considered in the site-specific evaluation. If additional information on the toxicity of gasoline constituents (e.g., methyl tertiary-butyl ether) become available, they should be considered in the site-specific evaluation.

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APPENDIX H
CONSULTATION LETTERS

H.1: State Historic Preservation Officers

H.2: Advisory Council on Historic Preservation

H.3: U.S. Fish and Wildlife Service Section 7 Consultation

H.4: Arizona Game and Fish Department

H.5: Utah Division of Wildlife Resources

H.6: Tribal Consultation

United States Department of the Interior

NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
P.O. Box 1507
Page, Arizona 86040

IN REPLY REFER TO:

APR 26 2002

H4217 GLCA-C

Max J. Evans, Director
Utah State Historical Society
300 Rio Grande
Salt Lake City, Utah 84101-1182

Reference: Glen Canyon National Recreation Area (NRA), Environmental Impact Statement (EIS) to Evaluate Impacts of Personal Watercraft (PWC) Use

Subject: Section 106 Compliance

Dear Dr. Evans:

The National Park Service (NPS) is beginning development of an EIS to make reasoned decisions about whether to continue PWC use at Glen Canyon NRA. The NPS will make the determination based on the park's enabling legislation, mission, management objectives, resources, values, and other uses, as well as PWCs' impacts on the park. The NPS will comply with the National Environmental Policy Act by preparing an EIS.

Although information gathering for this project is just beginning, we believe that its eventual implementation may/could affect properties included, or that may be eligible for inclusion, in the National Register of Historic Places. Therefore, we would like to invite your office to participate in the development of this planning effort in accordance with 36 CFR 800 and with the *1995* Servicewide Programmatic Agreement among your office, the Advisory Council on Historic Preservation, and the NPS.

This letter also is to notify your office that we plan to use the EIS process to accomplish compliance for both Section 106, in accordance with the National Historic Preservation Act, as amended, and the National Environmental Policy Act (as described in 36 CFR 800.8 [a-c]) to analyze potential effects from PWC use.

A scoping brochure is enclosed for your information. We would appreciate your careful consideration of this material. In addition, as soon as they are completed, the draft alternatives and EIS will be forwarded to your office for your review and comment.

H.1: State Historic Preservation Officers

We look forward to your participation in the planning process. We believe that it will result in better planning for cultural resources management, and will help ensure that cultural resources are adequately considered during the preparation of the plan and accompanying EIS.

Should you have any questions or desire additional information, please contact Glen Canyon NRA Archeologist Chris Goetze at 928-608-6277.

Sincerely,

KITTY L. ROBERTS

Kitty L. Roberts
Superintendent

Enclosure

cc:
Chief, Resource Management, GLCA
Archeologist, GLCA
Environmental Specialist, GLCA
Research Coordinator, GLCA
D. Rhodes, Parsons Engineering Science, Inc.

H.1: State Historic Preservation Officers (continued)

State of Utah
Department of Community and Economic Development
Division of State History
Utah State Historical Society

Michael O. Leavitt
Governor
Max J. Evans
Director

300 Rio Grande
Salt Lake City, Utah 84101-1182
(801) 533-3500 FAX: 533-3503 TDD: 533-3502
usha@history.state.ut.us http://history.utah.org

May 7, 2002

Kitty L. Roberts
Superintendent
Glen Canyon National Recreation Area
P. O. Box 1507
Page AZ 86040

RE: Glen Canyon Natural Recreation Area EIS to Evaluate Impacts of Personal Watercraft Use

In Reply Please Refer to Case No. 02-0582

Dear Ms. Roberts:

The Utah State Historic Preservation Office received the referenced information. After consideration of the consultation request in behalf of the National Park Service, the Utah Preservation Office provides the following comments per §36CFR800.

Thank you for the notification that the Park with be using NEPA to accomplish compliance with Section 106, NHPA. Our office will comment as appropriate, or when requested.

This information is provided to assist with Section 106 responsibilities as per §36CFR800. My email address is: jdykman@history.state.ut.us

As ever,

James L. Dykmann
Compliance Archaeologist

JLD:02-0582 NPS/EA

Preserving and Sharing Utah's Past for the Present and Future

H.1: State Historic Preservation Officers (continued)

United States Department of the Interior

NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
P.O. Box 1507
Page, Arizona 86040

IN REPLY REFER TO:

H4217 GLCA-C

APR 26 2002

James Garrison
Arizona State Parks
1300 West Washington Street
Phoenix, Arizona 85007

Reference: Glen Canyon National Recreation Area (NRA), Environmental Impact Statement (EIS) to Evaluate Impacts of Personal Watercraft (PWC) Use

Subject: Section 106 Compliance

Dear Mr. Garrison:

The National Park Service (NPS) is beginning development of an EIS to make reasoned decisions about whether to continue PWC use at Glen Canyon NRA. The NPS will make the determination based on the park's enabling legislation, mission, management objectives, resources, values, and other uses, as well as PWCs' impacts on the park. The NPS will comply with the National Environmental Policy Act by preparing an EIS.

Although information gathering for this project is just beginning, we believe that its eventual implementation may/could affect properties included, or that may be eligible for inclusion, in the National Register of Historic Places. Therefore, we would like to invite your office to participate in the development of this planning effort in accordance with 36 CFR 800 and with the 1995 Servicewide Programmatic Agreement among your office, the Advisory Council on Historic Preservation, and the NPS.

This letter also is to notify your office that we plan to use the EIS process to accomplish compliance for both Section 106, in accordance with the National Historic Preservation Act, as amended, and the National Environmental Policy Act (as described in 36 CFR 800.8 [a-c]) to analyze potential effects from PWC use.

A scoping brochure is enclosed for your information. We would appreciate your careful consideration of this material. In addition, as soon as they are completed, the draft alternatives and EIS will be forwarded to your office for your review and comment.

We look forward to your participation in the planning process. We believe that it will result in better planning for cultural resources management, and will help ensure that cultural resources are adequately considered during the preparation of the plan and accompanying EIS.

Should you have any questions or desire additional information, please contact Glen Canyon NRA Archeologist Chris Goetze at 928-608-6277.

Sincerely,

KITTY L. ROBERTS

Kitty L. Roberts
Superintendent

Enclosure

cc:
Chief, Resource Management, GLCA
Archeologist, GLCA
Environmental Specialist, GLCA
Research Coordinator, GLCA
D. Rhodes, Parsons Engineering Science, Inc.

H.1: State Historic Preservation Officers (continued)

United States Department of the Interior

NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
P.O. Box 1507
Page, Arizona 86040

IN REPLY REFER TO:

H4217 GLCA-C

APR 26 2002

Mr. Don Klima
Advisory Council on Historic Preservation
12136 West Bayaud Avenue, Suite 330
Lakewood, Colorado 80228

Reference: Glen Canyon National Recreation Area (NRA), Environmental Impact Statement (EIS) to Evaluate Impacts of Personal Watercraft (PWC) Use

Subject: Section 106 Compliance

Dear Mr. Klima:

The National Park Service (NPS) is beginning development of an EIS to make reasoned decisions about whether to continue PWC use at Glen Canyon NRA. The NPS will make the determination based on the park's enabling legislation, mission, management objectives, resources, values, and other uses, as well as PWCs' impacts on the park. The NPS will comply with the National Environmental Policy Act by preparing an EIS.

Although information gathering for this project is just beginning, we believe that its eventual implementation may/could affect properties included, or that may be eligible for inclusion, in the National Register of Historic Places. Therefore, we would like to invite your office to participate in the development of this planning effort in accordance with 36 CFR 800 and with the 1995 Servicewide Programmatic Agreement among your office, the National Conference of State Historic Preservation Officers, and the NPS.

This letter also is to notify your office that we plan to use the EIS process to accomplish compliance for both Section 106, in accordance with the National Historic Preservation Act, as amended, and the National Environmental Policy Act (as described in 36 CFR 800.8 [a-c]) to analyze potential effects from PWC use.

A scoping brochure is enclosed for your information. We would appreciate your careful consideration of this material. In addition, as soon as they are completed, the draft alternatives and EIS will be forwarded to your office for your review and comment.

H.2: Advisory Council on Historic Preservation

We look forward to your participation in the planning process. We believe that it will result in better planning for cultural resources management, and will help ensure that cultural resources are adequately considered during the preparation of the plan and accompanying EIS.

Should you have any questions or desire additional information, please contact Glen Canyon NRA Archeologist Chris Goetze at 928-608-6277.

Sincerely,

KITTY L. ROBERTS

Kitty L. Roberts
Superintendent

Enclosure

cc:
Chief, Resource Management, GLCA
Archeologist, GLCA
Environmental Specialist, GLCA
Research Coordinator, GLCA
D. Rhodes, Parsons Engineering Science, Inc.

H.2: Advisory Council on Historic Preservation (continued)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

In Reply Refer To
FWS/R6
ES/UT

May 9, 2002

To: Superintendent, (Attn.: Norm Henderson), Glen Canyon National Recreation Area, P.O. Box 1507, Page, Arizona, 86040-1507

From: Utah Field Supervisor, Fish and Wildlife Service, Ecological Services, West Valley City, Utah

RE: Updated Species List for Environmental Impact Statement on Personal Watercraft Use on Lake Powell

Dear Mr. Henderson:

In response to your phone call on April 8, 2002, below is a list of endangered (E), threatened (T), and candidate (C) species that may occur in the area of influence of your proposed action.

In Utah, Kane and San Juan Counties:

Common Name	Scientific Name	Status
Navajo Sedge	*Carex specuicola*	T
Colorado Pikeminnow[4,10]	*Ptychocheilus lucius*	E
Razorback Sucker[4,10]	*Xyrauchen texanus*	E
Bald Eagle[3]	*Haliaeetus leucocephalus*	T
California Condor[7]	*Gymnogyps californianus*	E
Mexican Spotted Owl[1,4]	*Strix occidentalis lucida*	T
Southwestern Willow Flycatcher[9]	*Empidonax traillii extimus*	E
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	C

In Arizona, Coconino County:

Common Name	Scientific Name	Status
Navajo Sedge	*Carex specuicola*	T
Bald Eagle	*Haliaeetus leucocephalus*	T
Brown Pelican	*Pelecanus occidentalis californicus*	E
California Condor	*Gymnogyps californianus*	E
Mexican Spotted Owl	*Strix occidentalis lucida*	T
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E
Chiricahua Leopard Frog	*Rana chiricahuensis*	P

H.3: U.S. Fish and Wildlife Service Section 7 Consultation

[1] Nests in this county of Utah.
[3] Wintering populations (only four known nesting pairs in Utah)
[4] Critical habitat designated in this county.
[6] Historical range
[7] Experimental nonessential population.
[10] Water depletions from *any* portion of the occupied drainage basin are considered to adversely affect or adversely modify the critical habitat of the endangered fish species, and must be evaluated with regard to the criteria described in the pertinent fish recovery programs.

The proposed action should be reviewed and a determination made if the action will affect any listed species or their critical habitat. If it is determined by the Federal agency, with the written concurrence of the Service, that the action is not likely to adversely affect listed species or critical habitat, the consultation process is complete, and no further action is necessary.

Formal consultation (50 CFR 402.14) is required if the Federal agency determines that an action is "likely to adversely affect" a listed species or will result in jeopardy or adverse modification of critical habitat (50 CFR 402.02). Federal agencies should also confer with the Service on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR 402.10). A written request for formal consultation or conference should be submitted to the Service with a completed biological assessment and any other relevant information (50 CFR 402.12).

Candidate species have no legal protection under the Endangered Species Act (ESA). Candidate species are those species for which we have on file sufficient information to support issuance of a proposed rule to list under the ESA. Identification of candidate species can assist environmental planning efforts by providing advance notice of potential listings, allowing resource managers to alleviate threats and, thereby, possibly remove the need to list species as endangered or threatened. Even if we subsequently list this candidate species, the early notice provided here could result in fewer restrictions on activities by prompting candidate conservation measures to alleviate threats to this species.

Only a Federal agency can enter into formal Endangered Species Act (ESA) section 7 consultation with the Service. A Federal agency may designate a non-Federal representative to conduct informal consultation or prepare a biological assessment by giving written notice to the Service of such a designation. The ultimate responsibility for compliance with ESA section 7, however, remains with the Federal agency.

Please note that the peregrine falcon which occurs in all counties of Utah was removed from the federal list of endangered and threatened species per Final Rule of August 25, 1999 (64 FR 46542). Protection is still provided for this species under authority of the Migratory Bird Treaty Act (16 U.S.C. 703-712) which makes it unlawful to take, kill, or possess migratory birds, their parts, nests, or eggs.

We recommend use of the *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* which were developed in part to provide consistent application of raptor protection measures statewide and provide full compliance with environmental laws regarding raptor protection. Raptor surveys and mitigation measures are provided in the Raptor Guidelines

H.3: U.S. Fish and Wildlife Service Section 7 Consultation (continued)

as recommendations to ensure that proposed projects will avoid adverse impacts to raptors, including the peregrine falcon.

If we can be of further assistance or if you have any questions, please feel free to contact Yvette Converse of our office at (801)975-3330 extension 135.

cc: Steve Spangle, Fish and Wildlife Service, Northern Arizona Field Office, 320 North Beaver Street, Flagstaff, Arizona 86001

H.3: U.S. Fish and Wildlife Service Section 7 Consultation (continued)

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 WEST GREENWAY ROAD, PHOENIX, AZ 85023-4399
(602) 942-3000 • WWW.AZGFD.COM

GOVERNOR
JANE DEE HULL
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MICHAEL M. GOUGHNOUR, FLAGSTAFF
JOE CARTER, SAFFORD
SUSAN E. CHILTON, ANIVIDA
W. HAYS GILSTRAP, PHOENIX
DIRECTOR
DUANE L. SHROUFE
DEPUTY DIRECTOR
STEVE K. FERRELL

January 31, 2002

Mr. Norm Henderson
National Park Service
Glen Canyon National Recreation Area
PO Box 1507
Page, AZ 86040

Re: Special Status Species Information for **Lake Powell with Glen Canyon National Recreation Area; Environmental Impact Statement for the Use of Personal Watercraft.**

Dear Mr. Henderson:

The Arizona Game and Fish Department (Department) has reviewed your request, dated January 15, 2002, regarding special status species information associated with the above-referenced project area. The Department's Heritage Data Management System (HDMS) has been accessed and current records show that the special status species listed on the attachment have been documented as occurring in the project area. In addition, this project does not occur in the vicinity of any proposed or designated Critical Habitats.

The Department's HDMS data are not intended to include potential distribution of special status species. Arizona is large and diverse with plants, animals, and environmental conditions that are ever changing. Consequently, many areas may contain species that biologists do not know about or species previously noted in a particular area may no longer occur there. Not all of Arizona has been surveyed for special status species, and surveys that have been conducted have varied greatly in scope and intensity.

Making available this information does not substitute for the Department's review of project proposals, and should not decrease our opportunities to review and evaluate new project proposals and sites. The Department is also concerned about other resource values, such as other wildlife, including game species, and wildlife-related recreation. The Department would appreciate the opportunity to provide an evaluation of impacts to wildlife or wildlife habitats associated with project activities occurring in the subject area, when specific details become available.

AN EQUAL OPPORTUNITY REASONABLE ACCOMMODATIONS AGENCY

H.4: Arizona Game and Fish Department

Mr. Norm Henderson
January 31, 2002
2

If you have any questions regarding the attached species list, please contact me at (602) 789-3618. General status information and county distribution lists for special status species are also available on our web site at:
http://www.azgfd.com/frames/fishwild/hdms_site/Home.htm

Sincerely,

Sabra S. Schwartz
Heritage Data Management System, Coordinator

SSS:ss

Attachment

cc: Bob Broscheid, Project Evaluation Program Supervisor
Rick Miller, Habitat Program Manager, Region II

AGFD #1-15-02(14)

H.4: Arizona Game and Fish Department (continued)

Special Status Species within 0.5 Mile of Lake Powell within Glen Canyon NRA

Arizona Game and Fish Department, Heritage Data Management System
January 31, 2002

Scientific Name	Common Name	ESA	USFS	BLM	WSCA	NPL
FALCO PEREGRINUS ANATUM	AMERICAN PEREGRINE FALCON	SC	S		WC	

No Critical Habitats in project area AGFD# 1-15-02(14), Environmental Impact Statement regarding the use of personal watercraft

H.4: Arizona Game and Fish Department (continued)

-----Original Message-----
From: Anne Axel
Sent: Monday, April 15, 2002 4:05 PM
To: Chitwood, Connie
Subject: Lake Powell data request

Hi Connie,

At long last, here's your data! I'm attaching a spreadsheet (parsons.xls) with a list of occurrences that showed up within 500 ft of the Lake. I'm also attaching the buffered Lake shapefile (lakebuff.shp) to which I clipped our dataset. In addition, I'm attaching a metadata (metadata.doc) document with information about the projection of the shapefile and a description of what is found in each of the fields in the spreadsheet. I zipped all the files together into parsons.zip. Please let me know if you have any questions or need additional information.

Apologies for the delay--thanks so much for your patience.

Best,
Anne Axel

Anne C. Axel
Information Manager
Utah Natural Heritage Program
Division of Wildlife Resources
1594 West North Temple
Salt Lake City, UT 84114-6301
ph. 801-538-4759
fax 801-538-4745
aaxel@state.ut.us

H.5: Utah Division of Wildlife Resources

United States Department of the Interior

NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
P.O. Box 1507
Page, Arizona 86040

IN REPLY REFER TO:

H4217 GLCA-C

APR 26 2002

Alan Downer, Ph.D
Historic Preservation Department
Navajo Nation
P.O. Box 4950
Window Rock, Arizona 86515

Reference: Glen Canyon National Recreation Area (NRA), Environmental Impact Statement (EIS) to Evaluate Impacts of Personal Watercraft (PWC) Use

Subject: Section 106 Compliance

Dear Dr. Downer:

The National Park Service (NPS) is beginning development of an EIS to evaluate alternatives and potential impacts of proposed regulatory changes to PWC use at Glen Canyon NRA.

Although information gathering for this project is just beginning, we believe that its eventual implementation may have the potential to affect properties located on the Navajo Reservation that are included, or that may be eligible for inclusion, in the National Register of Historic Places. In addition, we want to be sure that the project will not affect ethnographic resources valued by your tribe. Therefore, we are initiating consultation with your office in accordance with 36 CFR 800 and Section 101(d)(6)(B) of the National Historic Preservation Act of 1966.

This letter also is to notify your office that we plan to use the EIS process to accomplish compliance for both Section 106, in accordance with the National Historic Preservation Act, as amended, and the National Environmental Policy Act (as described in 36 CFR 800.8 [a-c]) to analyze potential effects from PWC use.

A scoping brochure is enclosed for your information. We would appreciate your careful consideration of this material. In addition, as soon as they are completed, the draft alternatives and EIS will be forwarded to your office for your review and comment. We look forward to your participation in the planning process. We believe that it will result in better planning for cultural resources management, and will help ensure that cultural resources are adequately considered during the preparation of the plan and accompanying EIS.

Should you have any questions or desire additional information, please contact Glen Canyon NRA Archeologist Chris Goetze at 928-608-6277.

Sincerely,

KITTY L. ROBERTS

Kitty L. Roberts
Superintendent

Enclosure

cc:
Chief, Resource Management, GLCA
Archeologist, GLCA
Environmental Specialist, GLCA
Research Coordinator, GLCA
D. Rhodes, Parsons Engineering Science, Inc.

H.6: Tribal Consultation (continued)

THE NAVAJO NATION

KELSEY A. BEGAYE
PRESIDENT

TAYLOR McKENZIE, M.D.
VICE PRESIDENT

May 14, 2002

Kitty L. Roberts, Superintendent
Glen Canyon National Recreation Area
P.O. Box 1507
Page, Arizona 860240

Subject: Section 106 Compliance

The Nation Historic Preservation Department (HPD) Traditional Culture Program (TCP) is in receipt of your letter H4217 GLCA-C. The letter discuss the potential impacts of proposed regulatory changes to PWC use at Glen Canyon NRA.

Upon review and cross-referencing the HPD-TCP Sacred Database, the Navajo Nation does not have any concerns at this time with the proposed project. However, the Navajo Nation does respectfully request that if resource that is identified resembling anything Navajo, it be notified.

In conclusion, the HPD-TCP appreciates the efforts of the Glen Canyon National Recreation Area for consulting the Navajo Nation in accordance with existing legislation. Should you have questions or require further discussion, please do not hesitate to me at (520) 871-7750 or FAX: (520) 871-7886.

Sincerely,

THE NAVAJO NATION HISTORIC PRESERVATION DEPARTMENT

Robert M. Begay
Anthropologist
Traditional Culture Program
Post Office Box 4950
Window Rock, Arizona 86515

TCP 2002-038

xc: Chrono. Files

H.6: Tribal Consultation (continued)

MAY 13 2002

D18 (GLCA-1445)
Personal Watercraft

Wayne Taylor, Chairman
The Hopi Tribe
P.O. Box 123
Kykotsmovi, Arizona 86039

Dear Chairman Taylor:

On April 20, 2000, the National Park Service (NPS) implemented a service-wide final rule (*36 CFR 3.24*) that prohibits personal watercraft (PWC) use in national park areas unless the NPS determines that this type of water-based recreational activity is appropriate for a specific park. This determination will be based on the legislation establishing that area, the park's resources and values, other visitor uses of the area, and overall management objectives. The rule also recognizes that PWC use may be appropriate in some park areas and established a 2-year grace period following final rule publication to provide the 21 park areas identified in the rule time to consider whether PWC use should continue, then develop and finalize special regulations as appropriate.

PWC are small vessels, usually less than 16 feet, which use an inboard motor powering a water jet pump as its primary source of power. They are operated by persons sitting, standing, or kneeling on the vessel. PWC are commonly referred to as wet bikes or by their trade names, JetSki, Wave Runner, and SeaDoo.

Glen Canyon National Recreation Area (NRA) is proceeding with special regulations as required by the final rule, which includes conducting an environmental impact statement (EIS) under the requirements of the National Environmental Policy Act (NEPA), preparing an economic analysis, and seeking public comment throughout the entire process. This economic analysis requires us to evaluate PWC use within Glen Canyon NRA based on an analysis of the unit's enabling legislation, resources, values, other visitor uses, and overall management objectives. The current schedule for release of the draft EIS for public review and comment is expected to be in July.

Glen Canyon NRA is evaluating various alternatives regarding the use of personal watercraft on Lake Powell. The issues of concern are contained in the enclosed scoping brochure. We are consulting with you on a government-to-government basis regarding any concerns the tribe might

have with this undertaking and its potential impacts on any trust assets, traditional cultural properties, sacred sites, or other issues or resources of tribal concern.

We would like to ensure that the Hopi Tribe has an opportunity to identify its concerns about the proposed rulemaking and to have those concerns addressed in agency planning and compliance under the NEPA and National Historic Preservation Act. In particular, we would greatly appreciate your views on what further actions the NPS should take to identify and evaluate historic properties, especially those of traditional religious or cultural importance that may be near the shoreline of Lake Powell. We would also appreciate your views on the potential effects of the undertaking on such properties and invite you to suggest ways to avoid, minimize, or mitigate any potential adverse effects, if any.

If you need additional information on the proposed project or wish to arrange a consultation meeting regarding the identification, evaluation or mitigation of natural or cultural resources or trust issues, please contact our American Indian Liaison Pauline Wilson at 928-608-6276 within 30 days of the receipt of this letter. If we do not hear from you, we are asking Ms. Wilson to call you to answer any questions or to understand any concerns you may have.

Sincerely,

KITTY L. ROBERTS

Kitty L. Roberts
Superintendent

Enclosure

cc:
Leigh Kuwanswisiwma
Historic Preservation Office

bcc:
Director, Intermountain Region
Utah SHPO
Arizona SHPO
J. Fowler, Council on Historic Preservation
Environmental Specialist, GLCA
Research Coordinator, GLCA

Identical letter sent to President/Chairperson of the five tribes with a cc to each tribe's Historic Preservation office and appropriate chapters (see attached mailing list).

P.Wilson:jmh:5/10/02:q:\ResMgmt\wilson\PWC letter to tribes

H.6: Tribal Consultation (continued)

Mailing List for PWC Consultation
May 10, 2002

Mary Jane Yazzie, Chairman
White Mesa Ute Council
P.O. Box 340
Blanding, Utah 84511

Johnny Lehi, Tribal President
The San Juan Southern Paiute Tribe
P.O. Box 2656
Tuba City, Arizona 86045

Carmen Bradley, Chairwomen
Kaibab Paiute Tribe
HC 65, Box 2
Fredonia, Arizona 86022

Wayne Taylor, Jr., Chairman
The Hopi Tribe
P.O. Box 123
Kykotsmovi, Arizona 86039

Leigh Kuwanwisiwma, Cultural Preservation
The Hopi Tribe
P.O. Box 123
Kykotsmovi, Arizona 86039

Brenda Drye,
HC 65. Box 2
Fredonia, Arizona 86022

Kelsey A. Begaye, President
The Navajo Nation
P.O. Box 9000
Window Rock, Arizona 86515

Alan Downer, Historic Preservation Officer
The Navajo Nation
P.O. Box 4950
Window Rock, Arizona 86515

Richard Begay, Deputy Director
Division of Natural Resources
P.O. Box 9000
Window Rock, Arizona 86515

Timothy Begay,
Navajo Traditional Cultural Program
P.O. Box 4950
Window Rock, Arizona 86515

Navajo Mountain Chapter
P.O. Box 10070
Tonalea, Arizona 86044

Shonto Chapter
P.O. Box 7537
Shonto, Arizona 86054

Inscription House Chapter
HCR 70, Box 3
Tonalea, Arizona 86044

Oljato Chapter
P.O. Box 360455
Monument Valley, Utah 84536

James Garrison
AZ SHPO
1300 West Washington St.
Phoenix, AZ 85007

Max Evans, Director
Utah SHPO
300 Rio Grande
Salt Lake City, Utah 84101-1182

Johnny Fowler, Executive Director
Council on Historic Preservation
12136 West Bayaud
Lakewood, Colorado 80401

Karen Wade, Regional Director
Intermountain Region, National Park Service
Denver, Colorado

H.6: Tribal Consultation (continued)

References and Index

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