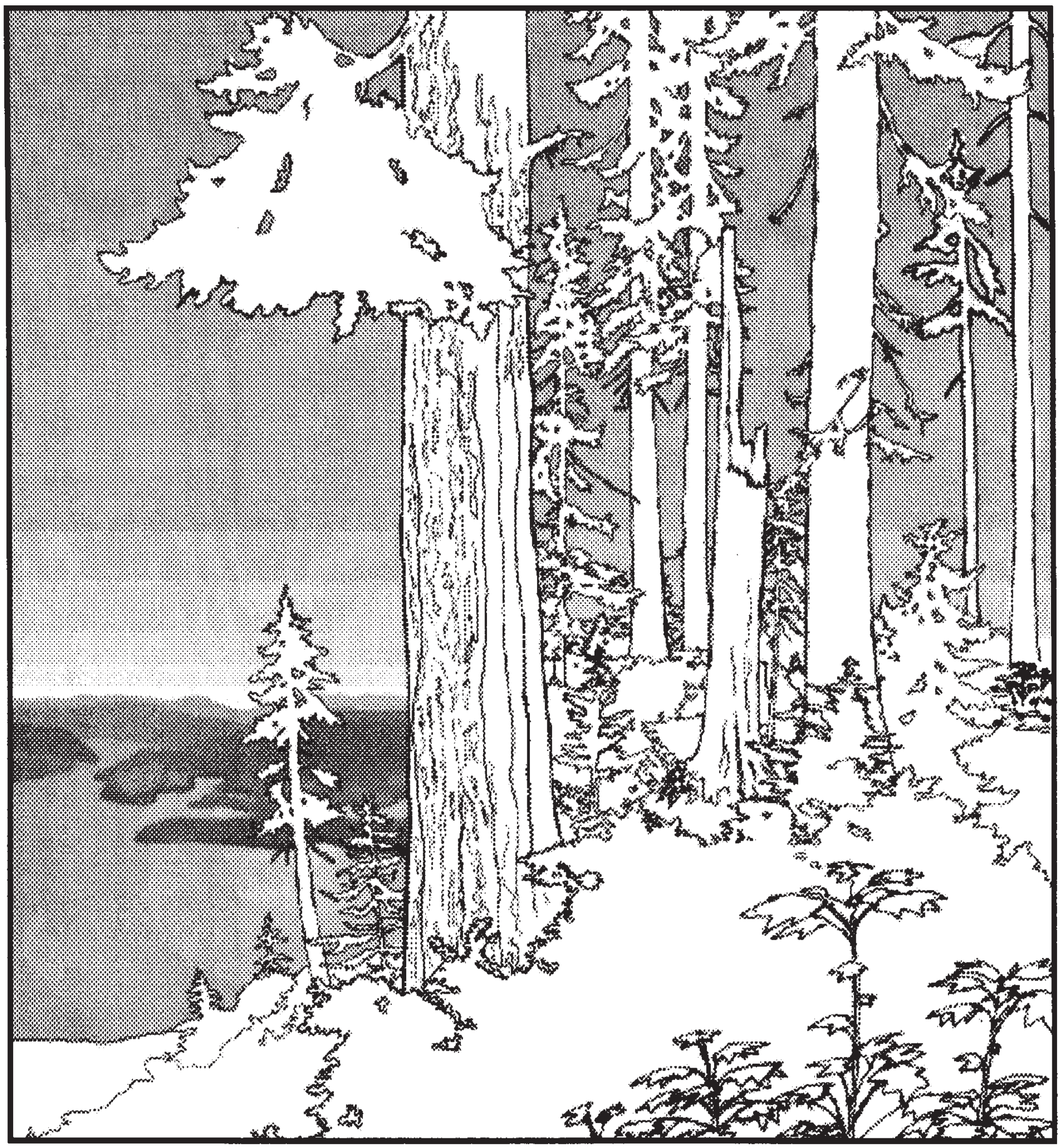
United States
Department of
Agriculture

Forest Service

General Technical
Report
PNW-GTR-415
October 1997

Evaluation of the Use of Scientific Information in Developing the 1997 Forest Plan for the Tongass National Forest

Fred H. Everest, Douglas N. Swanston, Charles G. Shaw III,
Winston P. Smith, Kent R. Julin, and Stewart D. Allen



Authors

FRED H. EVEREST is a research fisheries biologist and research policy coordinator for the Tongass Land Management Planning Team, DOUGLAS N. SWANSTON is a research geologist and coleader of the Tongass Land Management Planning Team, CHARLES G. SHAW III is a research plant pathologist and science manager for the Tongass Land Management Planning Team, WINSTON P. SMITH is a research wildlife biologist, KENT R. JULIN is a research forest ecologist, and STEWART D. ALLEN is a research social scientist for the Tongass Land Management Planning Team, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane, Suite 2A, Juneau, AK 99801-8545.

Conservation and Resource Assessments for the Tongass Land Management Plan Revision

Charles G. Shaw III, Technical Coordinator

Evaluation of the Use of Scientific Information in Developing the 1997 Forest Plan for the Tongass National Forest

Fred H. Everest, Douglas N. Swanston, Charles G. Shaw III,
Winston P. Smith, Kent R. Julin, and Stewart D. Allen

Published by:
U.S. Department of Agriculture
Forest Service
Pacific Northwest Research Station
Portland, Oregon
General Technical Report PNW-GTR-415
October 1997

Abstract

Everest, Fred H.; Swanston, Douglas N.; Shaw, Charles G., III; Smith, Winston P.; Julin, Kent R.; Allen, Stewart D. 1997. Evaluation of the use of scientific information in developing the 1997 Forest plan for the Tongass National Forest. Gen. Tech. Rep. PNW-GTR-415. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 69 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

The Tongass National Forest is the largest remaining relatively unaltered coastal temperate rain forest in the world. The Forest consists of 16.9 million acres of land distributed across more that 22,000 islands and a narrow strip of mainland in southeast Alaska. The Forest contains abundant timber, wildlife, fisheries, mineral, and scenic resources.

The authors participated as scientists on the Tongass Land Management Planning Team from 1995 to 1997. We joined the planning team as full members but maintained separate and distinct roles from National Forest System members. We were asked to assure that credible, value-neutral, scientific information was developed independently without reference to management decisions. We also displayed the likely levels of risk to resources and society associated with various management options.

We examined how scientific information was used in making management decisions and evaluated whether the decisions were consistent with the available information. We developed and used a set of criteria to evaluate the way in which managers used scientific information in formulating decisions. This evaluation began while the final alternative was in the formative stages so that managers could alter their management approach, if they so desired, before the Forest plan was finalized. Many management decisions were altered during this “adaptive decisionmaking process” in which changes were made concurrent with iterations of this paper. Our conclusion was that the final management decisions made in developing the 1997 Forest plan achieved a high degree of consistency with the available scientific information. This paper does not consider any information gathered after the signing of the record of decision on May 23, 1997, or deal with subsequent implementation of the 1997 Tongass Forest plan.

Keywords: Tongass National Forest, forest management, land management planning, science evaluation, science policy.

Preface

Any reasoned decision about the management of natural resources must be based on a sound foundation of scientific information. The complexity of natural systems and their importance to people depending on them demand this.

Though an essential consideration, science information alone does not "make" a decision: Decisionmakers make decisions. They make decisions after they complete what is essentially a value-oriented integration of the good and bad features of the outcomes of alternative management paths.

Because science information does not make decisions, what part should scientists play in validating and evaluating a decision? Scientists should not advocate any particular outcome or decision. They should, however, advocate that the relevant scientific information be considered when a decision is made. They should determine whether the decision is *consistent* with the science information.

The authors of this report charted new ground in the application of scientific information to natural resource decisions. This science consistency check was valuable in three ways. First, early drafts of this check communicated the science information to the land management decisionmakers more effectively than separate science reports would have. Second, the science consistency check helped counteract those who alleged that science in fact did "make" decisions. Third, it helped the scientists better clarify and stay within their science role. In the process, the authors helped us all better craft the proper role of scientific information and of scientists in decisions about the management of the Nation's natural resources.

Thomas J. Mills
Station Director
Pacific Northwest
Research Station

Summary

The authors participated as scientists on the Tongass Land Management Planning (TLMP) Team from 1995 to 1997. We joined the planning team as full members but maintained separate and distinct roles from National Forest System members. We worked in cooperation with other resource experts from the Forest Service, state and other Federal agencies, and universities to assemble the most complete base of information ever developed for Forest planning in the Tongass National Forest. We were asked to assure that credible, value-neutral, scientific information was developed independently without reference to management decisions. Emphasis was placed on acquisition, assessment, and synthesis of available information. We displayed options and the likely levels of risk to resources and society associated with various decisions.

The information, with a scientific interpretation of it, was provided to the managers responsible for deciding the content and direction of the Tongass land management plan revision. Managers considered this information as they developed an array of draft alternatives and, subsequently, a draft of the preferred alternative for management of the Tongass. After further analysis and review of public comment, the managers modified the draft of the preferred alternative into the Forest plan.

One of our final responsibilities as members of the TLMP Team was to examine how the available scientific information was used in making management decisions and to evaluate whether the decisions were consistent with that information. We developed and used a specific set of criteria to evaluate consistency of management decisions with scientific information. The evaluation of how scientific information was used began while the final alternative was still in the formative stages.

Management decisions were evaluated as they were made in an iterative process that resulted in more than 20 drafts of this paper, and a like number of changes in management decisions, before the emerging preferred alternative was finalized. In the final analysis, we consider that this paper, as much as any other aspect of the planning process, helped assure that the Forest plan was scientifically credible, legally defensible, and resource sustainable in the long term.

This evaluation does not consider any information gathered after the signing of the record of decision on May 23, 1997, or deal with subsequent implementation of the 1997 Tongass Forest plan.

A clear understanding of the different roles that science and management play in natural resource decisionmaking is necessary to establish criteria for assessing the consistency of management decisions relative to available scientific information. Scientists provide managers and policymakers with the foundational information for making reasoned decisions, but policy issues, not science, dictate the decisions. Scientists objectively follow rigid scientific protocols in developing new information, integrating and synthesizing existing and new information, assuring that information is interpreted correctly, and assessing the probable consequences associated with various proposed management actions.

Managers and policymakers, on the other hand, use scientific information, legal mandates, societal desires, and other factors to make decisions about, for example, allocation of natural resources on Federal lands. All policy decisions concerning the use of natural resources contain some level of risk to resources as a result of long-term implementation. Potential risks associated with decisions can be numerous and might affect, for example, community stability, wildlife viability, or long-term sustainability of resources. When making decisions, managers strive to balance the array of

risks associated with their decisions with the values of goods and services flowing to society from National Forest lands. Such management decisions almost always include compromises for one or more resources.

The appropriate level of risk to accept in management of the National Forests is a policy decision determined by managers. It is not an issue that can be answered by the scientific method. If scientists attempt to participate in or personally influence such decisions, then their objectivity may be compromised as they bring their personal values regarding levels of acceptable risk to bear on the decision.

To address how scientific information was used by managers making decisions about revision of the Tongass land management plan, we developed the following criteria:

A. A management decision was considered to be *consistent* with available scientific information if the following three conditions were met:

   1. All relevant scientific information made available to managers was considered in the decision.

   2. Scientific information was understood and correctly interpreted.

   3. Resource risks associated with decisions were acknowledged and documented.

   All three criteria had to be met before a decision could receive a summary rating of being *consistent*, in our assessment, with available scientific information.

B. A management decision was considered to be *inconsistent* with available scientific information if *any* of the following circumstances occurred:

   1. Managers misrepresented or reinterpreted information in ways not supported by the original information.

   2. Managers selectively used information such that a different decision was reached than would have been made if all available information had been used.

   3. Decisions were stated and documented in such a way that implementation effects could not be predicted.

   4. Projected consequences of management actions were not consistent with scientific information.

   Failure to meet any of these criteria resulted in a summary rating of being *inconsistent*, in our assessment, with available scientific information.

The following example addressing brown bear habitat illustrates how these criteria were used to assess consistency of decisions with available scientific information.

Example: Radio-telemetry data from a brown bear study indicate that areas along principal salmon spawning streams are key brown bear feeding habitat and that bear-use of these zones extends about 500 feet on either side of the streams. The long-term health of bear populations is tied to maintenance of old-growth forest habitat in these areas, which provides hiding cover from humans and isolates feeding and resting bears from each other. In this example, we consider three possible approaches for management of brown bear feeding areas along salmon spawning streams.

1. Managers develop standards and guidelines for managing brown bear feeding areas along salmon spawning streams that protect about 500-foot widths of forest habitat along each side of the streams. They acknowledge, and risk assessment panels verify, that the risk to bear populations would be low from using this management approach.

   We would consider this decision to be consistent with available scientific information because managers were provided relevant information, it appears that they understood it by developing management directions that fully protected this key bear habitat, and they documented the risk to bear populations.

2. Managers develop no standards and guidelines that specifically protect brown bear feeding areas along salmon spawning streams. Managers, however, document in the final environmental impact statement (FEIS) that research indicates key brown bear feeding areas extend about 500 feet on each side of principal salmon spawning streams. They also state that they considered riparian standards and guidelines prescribed for these streams, which protect an average 300-foot width along each side and provide an acceptable compromise between maintenance of bear habitat and timber production. They acknowledge that the risk to bear populations could be increased by this decision and commit to further studies to assess the extent of risk.

   We also would consider this decision consistent with available scientific information. The managers based their decision on a reasonable interpretation of relevant scientific information, with consideration of public desires for resources and, perhaps, legal mandates. Managers acknowledge and document that some increased risk to brown bear populations will result from their management direction.

3. Managers develop no standards and guidelines specifically to protect brown bear feeding areas along salmon spawning streams. They state in the FEIS that they considered riparian standards and guidelines prescribed for these streams, which protect an average 300-foot width along each side, adequate to protect the principal brown bear feeding areas along salmon spawning streams.

   We would consider this decision to be inconsistent with available scientific information. Even though all relevant scientific information was provided to managers, they failed to acknowledge its existence or to incorporate it into their decision, and they also failed to acknowledge and document the increased risk to brown bear feeding areas associated with the decision.

   Certain types of decisions cannot be subjected to this type of evaluation. Any scientific document containing recommendations for managers may be in this category. Most recommendations are not scientific conclusions but, rather, a combination of scientific information integrated with professional experience and personal values that embody a level of risk that those making the recommendations thought appropriate. Recommendations, even those made by scientists, were not considered in this evaluation of the use of scientific information.

Using the criteria as defined above, many of the major components of the emerging final alternative were evaluated for consistency with the available information base. Results of the evaluation are detailed in table 1 for riparian and fish sustainability, wildlife viability, karst and caves protection, slope stability, timber resources, social and economic effects, and monitoring. Overall, while we remain value-neutral on the Forest plan, our evaluations indicated that the decisions made in developing the plan achieved a high degree of consistency with the available scientific information.

Table 1—Summary of whether information on key issues in the Tongass Forest plan was considered, understood, and risks revealed and documented, and whether decisions are consistent with available scientific information

	Criteria for decision							
	Was all information considered?		Was information understood and interpreted correctly?		Were risks revealed and documented?		Was decision consistent?	
Issue	Yes	No	Yes	No	Yes	No	Yes	No
Aquatic:								
Watershed analysis	X		X		X		X	
Cumulative effects	X		X		X		X	
Hydrologic function	X		X		X		X	
Sediment	X		X		X		X	
Water quality	X		X		X		X	
Riparian vegetation	X		X		X		X	
Stability of complex channels	X		X		X		X	
Woody debris	X		X		X		X	
Slope stability	X		X		X		X	
Fish access	X		X		X		X	
Anadromous fish habitat	X		X		X		X	
Resident fish habitat	X		X		X		X	
Wildlife:								
Viability	X		X		X		X	
Goshawk	X		X		X		X	
Wolf	X		X		X		X	
Deer	X		X		X		X	
Brown bear	X		X		X		X	
Terrestrial mammals	X		X		X		X	
Beach/estuary	X		X		X		X	
Matrix lands	X		X		X		X	
Reserves	X		X		X		X	
Road management	X		X		X		X	

Table 1—Summary of whether information on key issues in the Tongass Forest plan was considered, understood, and risks revealed and documented, and whether decisions are consistent with available scientific information (continued)

	Criteria for decision							
	Was all information considered?		Was information understood and interpreted correctly?		Were risks revealed and documented?		Was decision consistent?	
Issue	Yes	No	Yes	No	Yes	No	Yes	No
Karst and caves	X		X		X		X	
Slope stability	X		X		X		X	
Timber:								
Estimation of old-growth timber volume	X		X		X		X	
Modeling implementation reduction factors (MIRFS)	X		X		X		X	
Estimation of young-growth timber volume	X		X		X		X	
Noninter-changable components (NICs)	X		X		X		X	
Management of forested wetlands	X		X		X		X	
Windthrow	X		X		X		X	
Socioeconomic concerns	X		X		X		X	
Monitoring and adaptive management	X		X		X		X	

Contents

Introduction

The Tongass National Forest is the largest remaining relatively unaltered coastal temperate rain forest in the world. The Forest consists of 16.9 million acres of land distributed across more than 22,000 islands and a narrow strip of mainland, which extends about 540 miles north from the southern end of the Alexander Archipelago (fig. 1 located in inside back cover). Geographic extent and isolation, physiographic variation, and elevational and climatic gradients combine to produce numerous spatially and temporally heterogeneous environments that support a diverse indigenous biota including several endemic plants and animals. There are 21 ecological provinces that stratify the Forest according to various configurations of physical, climatic, and biotic features. About 10 million acres is timberland; the remainder is fen, sphagnum bogs, rock, glaciers, ice fields, and water. Before large-scale industrial logging began (ca. 1954), there were about 5.4 million acres of productive old-growth forest[1] with nearly half in high-volume old-growth forest.[2] During the last half of the 20th century, about 400,000 acres of primarily high-volume old-growth forest were clearcut logged, which further fragmented naturally dissected landscapes and forest habitats.

Of the 5 million plus acres of productive old-growth forest that remain in 1997, 4.2 million acres are withdrawn from timber production, including 1.7 million acres of legislated wilderness areas. The more productive timberlands are in the southern half of the Forest where a world-class karst and cave resource, sensitive to timber harvest activities, is prevalent. The lakes, streams, and surrounding marine waters support one of the most diverse and productive fisheries for wild anadromous salmonids in the world. Although there are expanding recreational and tourist interests that complement a commercial fishery, mining, and timber based economy, subsistence is still a significant component of the lifestyle of many residents.

Balancing the levels of protection and use of natural resources across such a vast and diverse landscape has been an ongoing challenge for USDA Forest Service officials in Alaska. Under the direction of the Alaska Regional Forester and the three Tongass National Forest Supervisors, the Tongass land management plan revision was completed on May 23, 1997. A basic principle of National Forest System planning requires that resources be managed in a sustainable fashion (U.S. Laws, Statutes 1976:sect. 6(e)(1)). Sustained yield is "...the achievement and maintenance in perpetuity of a high-level of annual or periodic output of the various renewable resources... without impairment of the productivity of the land" (USDA Forest Service 1982).

In accordance with the principles of National Forest System planning, the authors participated as scientists and full members of the 1995-97 Tongass Land Management Planning (TLMP) Team but maintained roles distinct from those of the National Forest System members. We independently developed credible, value-neutral, scientific information without reference to management decisions. Emphasis was placed on

---

[1] Productive old-growth forest is operationally defined as a previously unharvested forested area of trees more than 150 years old with greater than 10 percent tree cover, and an accumulated net saw-log volume of more than 8,000 board feet per acre (mbf/acre) (Julin and Caouette 1997).

[2] High-volume old-growth forest in the Tongass averages 34,600 board feet per acre (Julin and Caouette 1997).

acquisition, assessment, and synthesis of available information, including new information generated by ongoing studies. We displayed options and the likely levels of risk to resources and society associated with various decisions. We did not suggest or concur on what level of risk was acceptable because that is a public policy decision to be determined by policymakers, not scientists. We also did not make management decisions.

We collaborated with other resource experts and scientists from the Forest Service, state and other Federal agencies, and universities to assemble the most complete information ever developed for forest planning in the Tongass National Forest. The principle components of the information base included:

- Scientific assessments for Queen Charlotte goshawk (*Accipiter gentilis laingi*) (Iverson and others 1996), Alexander Archipelago wolf (*Canis lupus ligoni*) (Person and others 1996), marbled murrelet (*Brachyrampus marmoratus*) (DeGange 1996), anadromous fish habitat (Anadromous Fish Habitat Assessment [AFHA] Team 1995), karst and cave resources (Baichtal and Swanston 1996), and socioeconomic effects (Allen and others, in press).

- Resource analyses on forested wetlands (Julin and Meade 1997), slope stability (Swanston 1997), old-growth timber volume strata (Julin and Caouette 1997), wind disturbance (Nowacki and Kramer, in prep.), a synthesis of wildlife viability (Iverson and René 1997), and timber demand (Brooks and Haynes 1997).

- Expert panels commissioned to evaluate the risk to resources from implementation of an array of proposed draft alternatives for managing the Tongass National Forest. Panels examined potential effects of proposed alternatives on brown bear (*Ursus arctos*), Queen Charlotte goshawk, American marten (*Martes americana*), marbled murrelet, Alexander Archipelago wolf, Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), other terrestrial mammals, fish and riparian conditions, old-growth ecosystems, subsistence, and socioeconomic issues (Shaw, in prep.; Swanston and others 1996). As the emerging final alternative was nearing completion, a second set of risk assessment panels was conducted to evaluate risk to brown bear, Queen Charlotte goshawk, American marten, Alexander Archipelago wolf, other terrestrial mammals, and fish and riparian conditions (Shaw, in prep.).

- A document that distilled key findings from the information components listed above (Swanston and others 1996).

We provided the information listed above, and a scientific interpretation of it, to the managers responsible for deciding the content and direction of the Tongass land management plan revision. The managers considered this information as they developed and modified a draft of the preferred alternative for management of the Tongass and, after further analysis and review of public comment on this draft, modified it into the Forest plan.

"Forest plan" refers to the selected alternative as presented in the final environmental impact statement (FEIS) (USDA Forest Service 1997b) and documented in the record of decision (ROD) (USDA Forest Service 1997c). "Emerging final alternative" refers to the alternative that was being built by the planning team for several months and was "finalized" into the Forest plan. This term is not to be confused with the "preferred alternative" in the revised supplemental draft environmental impact statement (RSDEIS) (USDA Forest Service 1996b), which contains some different management strategies from the final alternative in the FEIS.

One of our final responsibilities as members of the TLMP Team was to examine how the available scientific information was used in making management decisions and to evaluate whether the decisions were consistent with that information. We developed and used a specific set of criteria to evaluate consistency of management decisions with scientific information. The evaluation of how scientific information was used began while the final alternative was still in the formative stages.

Management decisions were evaluated as they were made in an iterative process that resulted in more than 20 drafts of this paper, and a like number of changes in management decisions, before the emerging preferred alternative was finalized. In the final analysis, we consider that this paper, as much as any other aspect of the planning process, helped produce a Forest plan that was scientifically credible, legally defensible, and resource sustainable in the long term.

Methods

A clear understanding of the different roles that science and management play in natural resource decisionmaking is necessary to establish criteria for assessing the consistency of management decisions relative to available scientific information. Scientists provide managers and policymakers with the foundational information for making reasoned decisions, but policy issues, not science, dictate the decisions. Scientists objectively follow rigid scientific protocols in developing new information, integrating and synthesizing existing and new information, assuring that information is interpreted correctly, and assessing the probable consequences associated with various proposed management actions.

Managers and policymakers, on the other hand, use scientific information, legal mandates, societal desires, and other factors to make decisions on, for example, allocation of natural resources on Federal lands. All policy decisions concerning the use of natural resources contain some level of risk to resources as a result of long-term implementation. Potential risks associated with decisions can be numerous and might affect, for example, community stability, wildlife viability, or long-term sustainability of resources. When making decisions, managers strive to balance the array of risks associated with their decisions with the values of goods and services flowing to society from National Forest lands, while still meeting legal mandates. Such decisionmaking almost always includes compromises for one or more resources.

The appropriate level of risk to accept is a policy decision determined by managers. It is not an issue that can be answered by the scientific method. If scientists attempt to participate in or personally influence such decisions, then their objectivity may be compromised as they bring their personal values regarding levels of acceptable risk to bear on the decision.

To address how scientific information was used by managers making decisions about revision to the Tongass land management plan, we developed the following criteria:

A. A management decision was considered to be *consistent* with available scientific information if the following three conditions were met:

1. All relevant scientific information made available to managers was considered in the decision.
2. Scientific information was understood and correctly interpreted.
3. Resource risks associated with decisions were acknowledged and documented.

All three criteria had to be met before a decision could receive a summary rating of being *consistent*, in our assessment, with available scientific information.

B. A management decision was considered to be *inconsistent* with available scientific information if *any* of the following circumstances occurred:

1. Managers misrepresented or reinterpreted information in ways not supported by the original information.
2. Managers selectively used information such that a different decision was reached than would have been made if all available information had been used.
3. Decisions were stated and documented in such a way that implementation effects could not be predicted.
4. Projected consequences of management actions were not consistent with scientific information.

Failure to meet any of these criteria resulted in a summary rating of being *inconsistent*, in our assessment, with available scientific information.

Two examples, one related to brown bear habitat and another related to slope stability, are used to illustrate how the criteria were applied to management decisions.

Example 1: Radio-telemetry data from a brown bear study indicate that areas along principal salmon spawning streams are key brown bear feeding habitat and that bear-use of these zones extends about 500 feet on either side of the streams. The long-term health of bear populations is tied to maintenance of old-growth forest habitat in these areas, which provides hiding cover from humans and isolates feeding and resting bears from each other. In this example, we consider three possible approaches for management of brown bear feeding areas along salmon spawning streams.

1. Managers develop standards and guidelines for managing brown bear feeding areas along salmon spawning streams that protect about 500-foot widths of forest habitat along each side of the streams. They acknowledge, and risk assessment panels verify, that the risk to bear populations would be low from using this management approach.

> We would consider this decision to be consistent with available scientific information because managers were provided relevant information, it appears that they understood it by developing management directions that fully protected this key bear habitat, and they documented the risk to bear populations.

2. Managers develop no standards and guidelines that specifically protect brown bear feeding areas along salmon spawning streams. Managers, however, document in the final environmental impact statement (FEIS) that research indicates key brown bear feeding areas extend about 500 feet on each side of principal salmon spawning streams. They also state that they considered riparian standards and guidelines prescribed for these streams, which protect an average 300-foot width along each side and provide an acceptable compromise between maintenance of bear habitat and timber production. They acknowledge that the risk to bear populations could be increased by this decision and commit to further studies to assess the extent of risk.

> We also would consider this decision consistent with available scientific information. The managers based their decision on a reasonable interpretation of relevant scientific information, with consideration of public desires for resources and, perhaps, legal mandates. Managers acknowledge and document that some increased risk to brown bear populations will result from their management direction.

3. Managers develop no standards and guidelines specifically to protect brown bear feeding areas along salmon spawning streams. They state in the FEIS that they considered riparian standards and guidelines prescribed for these streams, which protect an average 300-foot width along each side, adequate to protect the principal brown bear feeding areas along salmon spawning streams.

> We would consider this decision to be inconsistent with available scientific information. Even though all relevant scientific information was provided to managers, they failed to acknowledge its existence or to incorporate it into their decision, and they also failed to acknowledge and document the increased risk to brown bear feeding areas associated with the decision.

Example 2: Roads and timber harvest directly influence stability of slopes across the Tongass National Forest through disturbance of the soil mantle and alteration of natural drainages. The resulting landslides remove soil from forest slopes and are major contributors of sediment and large woody debris to streams used by anadromous fish. Managers recognized the significance of this relation and developed a mass failure hazard (landslide) assessment protocol in 1987 based on the information available at the time. This protocol defined a set of variables controlling stability on steep forested slopes and identified the critical slope gradient above which no timber harvesting should occur, because of the high potential for landslides.

Inspection of the 1987 protocol indicated that the data on which the protocol was based were out of date, and there was a lack of consistency in identification, measurement, and interpretation of variables across Administrative Areas (Ketchikan, Stikine, and Chatham) of the Forest. A reanalysis and assessment of slope stability literature and the most current data, including recently developed field information from southeast Alaska, identified the need to redefine and lower the critical slope gradient identifying high-hazard soils from 75 percent to 72 percent and revise and standardize the protocol to provide for consistent measurement and application of variables across Administrative Areas of the Forest.

In this example, we consider three possible management directions for addressing slope stability.

1. Managers acknowledge and document in the FEIS the new information provided in the analyses and assessments, adopt the revised mass failure hazard protocol, lower the critical slope gradient from 75 percent to 72 percent, develop soil and water standards and guidelines for managing potentially unstable terrain that reflect these changes, and acknowledge that the risk of accelerated mass erosion is reduced when these changes are applied to timber sales.

> We would consider this decision to be consistent with available scientific information, because managers considered all available information, understood it, and developed management direction that maximized protection of high-hazard soils and reduced the potential for accelerated delivery of sediment and large woody debris to anadromous fish streams. Managers also acknowledged the risk associated with their decision.

2. Managers do not adopt the revised protocol, do not lower the critical slope gradient from 75 percent to 72 percent, and do not alter existing standards and guidelines. Managers, however, do acknowledge and document in the FEIS the new information provided in the analyses and assessments. They state that even though the new information is valuable and will be incorporated into the Forest plan where practical, they consider that the existing standards and guidelines and current high-hazard soil boundary provide more management flexibility and represent an acceptable compromise between protection of unstable slopes and timber production. They acknowledge that the risk of accelerated landslides could be increased by this decision and commit to a monitoring and assessment program to evaluate the protocol and determine the extent of risk.

> This decision is based on correct interpretation of available scientific information, with consideration of public desires and resources. Managers acknowledge and reveal that some increased risk of landslides as the result of forest management is inherent in the decision. We would consider this decision to be consistent with available scientific information.

3. Managers do not adopt the revised protocol, do not lower the critical slope gradient from 75 percent to 72 percent, and do not alter existing standards and guidelines. They state in the FEIS that they consider that the existing protocol and critical slope gradient of 75 percent are adequate to protect high-hazard soils and reduce the potential for accelerated delivery of sediment and large woody debris to anadromous fish streams.

> This decision does not consider all available scientific information and fails to acknowledge and reveal the increased risk of landslides and accelerated sediment delivery associated with the decision. We would consider this decision to be inconsistent with available scientific information.

Certain types of decisions cannot be subjected to this type of evaluation. Any scientific document containing recommendations for managers may be in this category. Recommendations are not scientific conclusions but, rather, a combination of scientific information integrated with professional experience and personal values that embody a level of risk that those making the recommendations think appropriate. Recommendations, even those made by scientists, were not considered in this science consistency check.

Evaluation of Decisions Related to Specific Resources

Decisions related to some resource areas, for example fish and wildlife issues, better lend themselves to a science consistency check of this type than, for example, socioeconomic and monitoring issues, which may be based on less quantitative science. In resource areas where information is more qualitative, a greater degree of uncertainty surrounds a science consistency evaluation, and it is thus more difficult to conduct.

Aquatic, Riparian, and Fisheries Sustainability

The Tongass National Forest lies in the northern sector of the coastal temperate rain forest along the west coast of North America. The high annual precipitation along this coast and fairly even distribution of precipitation in time and space creates and maintains an extensive variety of stream, river, lake, wetland, and riparian habitats across the Forest. These abundant physical features of the landscape provide essential habitats for a wide variety of fish and wildlife species of special interest to sport, commercial, and subsistence users.

Protection of aquatic and riparian habitats was identified as one of the key issues in the 1995-97 revision of the Tongass land management plan. The focus on aquatic and riparian habitats was related largely to the importance of anadromous salmonids (primarily Pacific salmon and steelhead [*Oncorhynchus mykiss*] produced annually in these habitats, although resident fish and other species also are of interest and concern to managers. The management standard for anadromous fish in the current Forest plan is maintenance of current habitat productivity sufficient to provide for undiminished future harvestable populations.

The stream and lake habitats of the Tongass National Forest are unique in their complexity and productivity. Islands of the Alexander Archipelago and the narrow strip of mainland southeast Alaska contain:

- Numerous small creeks and streams on islands
- Some large streams and rivers on islands
- Some large transboundary mainland rivers
- Numerous small coastal mainland rivers
- Numerous stream and lake complexes in all types of systems

All these aquatic systems are subjected to variable climatic conditions that result in streams dominated by glaciers, interior continental climate, coastal maritime climate, climate of the transition snow zone, and local orographic effects.

The aquatic and fisheries resources of the Tongass are adapted to this diversity of habitats and climatic conditions. Consequently, numerous species and discrete spawning populations of anadromous and resident salmonids exist in the region. Mixed assemblages of wild salmonids occur in nearly all the different habitat types. Most watersheds of the Tongass contain five or more species of salmonids—a common mix includes coho salmon (*O. kisutch*), chum salmon (*O. keta*), and pink salmon (*O. gorbuscha*), steelhead, sea-run cutthroat trout (*O. clarki*), and Dolly Varden char (*Salvelinus malma*). These species may all reside together in the same watershed and share the same stream reaches, but each uses available habitat in a slightly different way. Although all species and age classes in fresh water are vulnerable to habitat disturbances, the most vulnerable are those whose juveniles reside in fresh water the longest before migrating to sea (e.g., steelhead and cutthroat trout; Reeves and others 1993). Any major changes in these habitats can have immediate effects on the productivity and community structure of salmonids (Reeves and others 1995) and other aquatic species.

Anadromous salmonids represent one of the preeminent natural resources in southeast Alaska. The Alexander Archipelago and the mainland of southeast Alaska support one of the most productive and highly valued fisheries for wild salmon in the world. Commercial salmon fisheries yield 160 million pounds (average annual production from the Tongass) worth about $250 million annually and provide more than 5,000 direct jobs (AFHA 1995). The sport fishing industry is smaller in economic and employment effects but is growing at an average of 10 percent per year (AFHA 1995). Sport fishing now provides more than 1,200 direct, full-time job equivalents with over $28 million in earnings and 250,000 angler days. Sport fishers spend more than $90 for each salmon caught. The annual subsistence harvest of salmon is in excess of 1.2 million pounds. Harvesting salmon in traditional areas is important to sustaining the Tlingit, Haida, and Tsimshian cultures. Activities associated with salmon annually support the highest number of natural resource-related jobs in southeast Alaska (Allen and others, in press).

The variety of freshwater habitats where anadromous fish breed and reside for variable periods before entering the marine phase of their life cycles are essential to the long-term sustainability of their populations. The same is true for resident fish and other aquatic species.

Factors influencing aquatic, riparian, and fish habitats—Salmonids have exacting freshwater habitat requirements and are sensitive to habitat disturbances (Everest and others 1985). All salmonids require relatively pristine freshwater habitats during all or part of their life cycles (Meehan 1991). Consequently, salmonids can be used as effective indicators of the health of aquatic systems (Sonstegard and Leatherland 1984). If salmonid populations are healthy in watersheds, then populations of other aquatic species generally are healthy as well.

Salmonids in fresh water are vulnerable to natural and human-caused changes in habitat quality. The quality of habitat for fish or other aquatic species in any stream depends on the condition of the area that it drains. Thus, watersheds are the basic unit of forested landscapes, controlling the quality of aquatic habitats and to a large extent the populations of fish and other aquatic species present, as well as the numbers of fish that can be sustainably harvested (AFHA 1995).

Watersheds in southeast Alaska are disturbed by both natural events and human activities, but the effects of these disturbances on fish habitat are generally different. The primary differences are related to the frequency and extent of disturbances across forested landscapes and the potential for recovery of disturbed landscapes and fish habitats.

Natural disturbances (e.g., floods, landslides, windthrow of trees, insect outbreaks, and earthquakes) that create spatial and temporal variability in aquatic habitats across forested landscapes can negatively affect fish and other aquatic species. These disturbances, however, are infrequent and sporadic in time and space, such that entire watersheds rarely are affected by a single event (Reeves and others 1995). The recurrence interval for large natural disturbances, such as earthquakes and major landslides, is often in the range of centuries to millennia for any given site. Because only a small component of the landscape usually is affected at any one time, and disturbances are infrequent, refugia usually are available to provide for survival of aquatic species until the disturbed area recovers naturally, which might take a century or more. Salmonids and other aquatic species have adaptive strategies for natural disturbances and, consequently, are rarely placed at risk of extinction from natural events.

Human disturbances typically are more frequent and widespread than natural disturbances. The most common forms of human disturbances in forested watersheds are logging, often in relatively large blocks, and the associated construction and maintenance of roads. There is no natural analog to either type of disturbance in southeast Alaska. Aquatic species in the region may not be able to adapt to the intensities of these disturbances before irrevocable population changes occur. Logging affects water quality, hydrologic function, and other characteristics of aquatic habitats in watersheds. Disturbance from logging is relatively frequent in both time and space across watersheds subjected to timber harvest. Roads, even where not associated with timber management, create major watershed disturbances with perennial effects on aquatic resources and watershed function (Furniss and others 1991). Roads interrupt natural hydrologic function in watersheds and generally increase both suspended and bedload sediments in streams. Clearly, widespread and frequent human disturbances, such as logging and road construction, increase the risk to aquatic ecosystems and associated species in southeast Alaska. Management actions can be applied to reduce risk, however (AFHA 1995).

Critical features of aquatic systems for salmonid and other species—Salmonids and other aquatic species have developed within a natural range of habitat variability in watersheds of southeast Alaska. Because of the economic and social importance of salmonids and their role as management indicator species, the critical features that combine to form and maintain productive salmonid habitat also are assumed to provide productive habitat for other aquatic species. Salmonid habitats have been intensively studied for decades, and a large body of information exists on their habitat needs and preferences. Several excellent synthesis papers have been prepared on the subject over the past few years. The following summary of critical features of salmonid habitat was derived primarily from Stouder and others (1997), Meehan (1991), Salo and Cundy (1987), and Everest and others (1985).

If the natural range of variability in critical habitat features can be maintained in the watersheds of southeast Alaska, then aquatic habitats for salmonids and other aquatic species generally will be at lower risk from human disturbance (AFHA 1995). The natural range of these features can be determined from inventory and monitoring of largely undisturbed watersheds.

Key features of aquatic habitats include:

- Hydrologic function (in time, space, and amplitude), including stream flow, ground water, and hyporheic flow (Gregory and Bisson 1997)
- Sediment supply and routing (Everest and others 1987)
- Water quality, including temperature (Beschta and others 1987), dissolved oxygen (Bjornn and Reiser 1991), and nutrients (Murphy and Meehan 1991)
- Riparian vegetation, including intact old-growth forests (Gregory and Bisson 1997)
- Relatively stable, complex stream channels (Sullivan and others 1987)

- Side-channel and off-channel habitats in flood plains (Gregory and Bisson 1997)
- Large woody debris in stream channels (Bisson and others 1987)
- Upstream access (Bjornn and Reiser 1991) and downstream access (Everest and others 1985) for migratory salmonids

Current condition of watersheds in the Tongass National Forest—The general condition of watersheds in the Tongass was assessed in 1992 by National Forest System personnel. Their findings were reported in AFHA (1995:15) as follows:

> Information from the 11 Ranger Districts of the Tongass was summarized by using four general types of land allocation: wilderness, roadless, variety of uses and outputs, and commodity emphasis. Each type was assigned into two categories: watershed condition currently healthy (conditions and functions generally in balance) or watershed condition not healthy. The biologists and hydrologists working on the assessment based their determinations on information about the natural conditions of the watershed, known changes in riparian conditions or stream habitat, and professional observations and experience (J. Christner, data on file at Tongass National Forest, Chatham Area, 204 Siginaka Way, Sitka, AK 99835). Stream class, channel type, management influences (for example, riparian area harvested, minerals activity, or roads), soil hazard rating, and results from a riparian harvest-effects model for coho salmon also influenced their assessments.

For lands within the Tongass National Forest boundary, including all ownerships, 77 percent of the watersheds were considered to have a healthy watershed function and condition and 23 percent had a reduced condition. In the categories "variety of uses and outputs" and "commodity emphasis," 72 percent of these watersheds were classified as healthy, and 28 percent had conditions with reduced condition.

Most watersheds with reduced function and conditions were affected by commercial timber harvest operations during the 1950s to 1970s when Best Management Practices (USDA Forest Service 1993) were not used. Watersheds managed during the 1980s and 1990s were subject to Best Management Practices. In some places, the watersheds have become wilderness or legislated roadless [areas] since the logging or other activity occurred. What are currently considered Best Management Practices were not in use during the earlier periods when activities such as clearcutting to all channel banks, salvage and removal of natural large woody debris from streams, yarding logs across or through stream channels, extensive road construction in flood plains, inadequate road drainage structure designs, and limited erosion control measures were common.

Results of the watershed assessment indicated that most aquatic habitats in the Tongass remain in relatively undisturbed states, with exceptions in some areas heavily logged two to three decades ago. The strategy developed by managers during the 1995-97 TLMP revision was designed to reduce risk of any further degradation of watershed function in the Forest.

An overview of aquatic and riparian components in the Forest plan—The Forest plan (USDA Forest Service 1997a) draws heavily from scientific information in AFHA (1995), and other sources to develop a strategy for maintaining the productivity and integrity of aquatic, riparian, and fish habitats. A number of management actions are included that reduce risk to aquatic resources from human disturbances. Further actions could have been taken and were not, presumably for other resource considerations. Whether the final risk to fish habitats, as estimated by expert opinion (Shaw, in prep.; table 2) is acceptable is a policy question and not a question that can be answered by science. In the Forest plan, key components of the strategy to protect aquatic, riparian, and fish habitat include:

1. The following land use designations (LUDs) that protect old-growth forest habitat and reduce the effects of human disturbance on watersheds, riparian areas, and streams:

- An array of lands totaling about 4.2 million acres that are legislatively withdrawn from timber production (USDA Forest Service 1997b:table 3-77).
- An old-growth forest conservation strategy that includes a network of large, medium, and small old-growth reserves, which in combination with various other LUDS protect an additional 3.5 million acres of old-growth habitat (Iverson 1997).
- The spatial distribution of at least one very large old-growth reserve in each of the 21 biogeographic provinces of the Tongass, and a small reserve in each of 237 large watersheds (USDA Forest Service 1997c).
- A 1,000-foot beach and estuary buffer that provides an additional 140,000 acres of protected old-growth habitat within timber production LUDs (Iverson 1997).

Table 2—Likelihood scores (100 points possible) for fish from 2d set of risk assessment panels, Tongass Forest plan[a]

Species	Scores
Chinook salmon	100
Coho salmon	87
Sockeye salmon	93
Chum salmon	94
Pink salmon	93
Steelhead	88
Cutthroat trout:	
Resident	84
Anadromous	85
Dolly Varden:	
Resident	84
Anadromous	89

[a] Panelists evaluated whether salmonid habitats suitable for maintenance of current levels of fish production would be met throughout most of the Tongass National Forest, and if little or no additional habitat degradation would occur, following 100 years of implementation of the emerging final alternative.

Source: Shaw, in prep.

- Riparian buffers along class I, class II, and most class III streams that protect approximately 224,000 additional acres of productive old-growth habitat within timber production LUDs (Iverson 1997).
- Approximately 500-foot buffers to protect principal brown bear feeding areas along salmon streams and also protect riparian and salmon habitat along those streams.

2. Standards and guidelines and other features of the Forest plan that contribute to protection of aquatic, riparian, and fish habitat:

- Direction to buffer all class I, class II, and most class III streams with appropriate widths of existing vegetation, which in most cases is old-growth forest (USDA Forest Service 1997b:4-53, 4-56 to 4-69).
- Direction to conduct watershed analysis (watershed-scale planning) before changing buffer widths designated by standards and guidelines for class I, II, and III streams (USDA Forest Service 1997b:4-51, app. J).
- Direction to implement Best Management Practices to protect beneficial uses of water (USDA Forest Service 1997b:4-53, app. C).
- Riparian management areas (those areas of particular value to watershed and stream system integrity) must be defined for all class I, II, and III streams before timber harvest begins (USDA Forest Service 1997b:4-51).
- Special protection is given to off-channel fish habitats of flood plain, glacial outwash, and alluvial fan process groups (for description of process groups see Paustian 1992; USDA Forest Service 1997b:4-53, 4-56 to 4-59).
- Special emphasis is given to design of windfirm buffers (USDA Forest Service 1997b:4-58 to 4-68).
- New definitions of class III and IV streams are developed (USDA Forest Service 1997b:4-7 to 4-8).
- Operating rules for mass erosion hazard areas are clarified and revised (USDA Forest Service 1997b:4-82).
- Quantitative objectives for fish habitat management are required (USDA Forest Service 1997b:4-8 to 4-9).
- Specific rules for salvage of timber from riparian areas, (USDA Forest Service 1997b:4-54).
- Specific rules for road design, layout, construction, and maintenance (USDA Forest Service 1997b:4-53, 4-57 to 4-71, 4-107).
- Maintain migratory access for anadromous salmonids (USDA Forest Service 1997b:4-57 to 4-69).

Habitat features absent from the Forest plan—The following additions to actions, prescriptions, and standards and guidelines in the Forest plan would likely provide incremental and cumulative benefits toward maintaining aquatic and riparian habitats and sustainability of fisheries in the Tongass. Absence of these features, however, is not an indication that the Forest plan is deficient, and including these or any other features does not ensure that a Forest plan meets acceptable levels of risk for maintaining sustainability of aquatic, riparian, and fishery resources as indicated previously.

1. Increased width of buffer strips along all class I, II, and III streams. Such action would further reduce the risk of windthrow in the core area of buffer strips and increase the likelihood that old-growth timber would remain standing near streams where it contributes incrementally to further gains in:

- Long-term recruitment of large woody debris to stream channels
- Stable and complex stream banks
- Stable summer and winter microhabitat conditions within buffer strips
- Natural summer and winter water temperature regimes
- Natural water quality and nutrient levels
- Stable habitats for anadromous and resident fish

2. Increased protection of class IV headwater streams. Vegetative buffer strips along class IV stream channels, or other measures such as directional timber felling and yarding used to reduce the risk of major disturbances to these channels, would likely reduce the risk of:

- Loss of habitat for old-growth-associated, riparian amphibians
- Acute and chronic mass erosion from headwater channels
- Long-term cumulative effects of sedimentation on water quality and fish habitat in downstream waters

3. More conservative engineering of road drainage structures (e.g., for 100-year storm events) to reduce the risk of road cut and fill failures during exceptional storm events. Drainage structures designed to accommodate larger storm events would reduce the risk of catastrophic sedimentation of fish habitats.

4. Longer timber rotation age in the matrix lands. This addition, coupled with a correspondingly reduced allowable sale quantity, would reduce watershed disturbance in time and space and reduce the risk of both accelerated stream sedimentation and buffer strip blowdown.

5. More comprehensive and intensive watershed analysis. A more comprehensive and detailed level of watershed analysis likely would reduce management-related risks to all resources in a watershed, including aquatic, riparian, and fishery resources.

Consistency in the use of aquatic- and riparian-related information—Sustainability of aquatic, riparian, and fishery resources was identified as a major focal issue to be addressed during the revision of the Tongass land management plan. Protection of fishery resources in particular has been a long-standing controversial issue for the Tongass as evidenced by the debate over passage of the Tongass Timber Reform Act (U.S. Public Laws, Statutes 1990), and the subsequent debate over AFHA (1995). Consequently, how information on aquatic, riparian, and fishery resources was used in the Forest plan is important. Relevant information in several publications synthesizing literature on salmonid habitats, and the anadromous fish habitat assessment report (AFHA 1995), was used in developing the strategy and standards and guidelines for protecting aquatic habitats in the Forest plan. A summary of how scientific information on key issues related to sustainability of aquatic, riparian, and fishery resources was used in the Forest plan and how risks were acknowledged is provided in table 1 (see "Summary"). The actual risk ratings (likelihood scores), as estimated by expert opinion, for implementation of the emerging final alternative for 100 years, are explained by Shaw (in prep.) and summarized in table 2.

The Forest plan makes consistent use of available scientific information and provides a strong relation between key features of salmonid habitat (see p. 9-10) and Forest plan LUDs and standards and guidelines (see p. 10-12) to produce a strategy with a high likelihood of maintaining sustainable levels of aquatic, riparian, and fish habitats. Overall, the consistency criteria of using all available information, interpreting and considering the information correctly, and acknowledging and documenting risks associated with management decisions were met to a high degree.

A science consistency check on recommendations within the AFHA report (1995) is not appropriate, but a general comparison between AFHA recommendations and the Forest plan is made in appendix 1. The AFHA recommendations are a combination of scientific information, professional experience, and the personal values of those making the recommendations and therefore are not suitable for a science consistency check.

Wildlife Viability

The Tongass represents habitat for numerous indigenous vertebrates: 53 mammals, 231 birds, and 5 amphibians and reptiles (USDA Forest Service 1996a). The Forest encompasses the largest remaining largely unaltered block of coastal temperate rain forest in the world (Lawford and others 1996). It is comprised of the Alexander Archipelago and a narrow strip of North American mainland. Like the more than 22,000 islands of the archipelago, the mainland is largely isolated from other large, contiguous land masses because of mountains, glaciers, and icefields immediately to the east that create a significant barrier to movement by vertebrates. A few east-west river valleys dissect an otherwise snow-, ice-, or rock-covered mountainous landscape, each river valley providing only a constricted corridor for dispersal of wildlife. Because of these features, southeast Alaska supports a rich and varied flora and fauna including many unique organisms. Indeed, mammals alone are represented by 27 recognized endemic taxa (MacDonald and Cook 1996).

There are several uses and values associated with the indigenous fauna of the Forest, including commercial and noncommercial commodity values, subsistence use, maintaining Native cultural traditions, sport hunting, wildlife viewing, recreation and tourism, and ecosystem integrity. Thus, maintaining the diversity and viability of fauna within the Tongass meets many needs.

National Forest Management Act regulations state that "wildlife habitat shall be managed to maintain viable populations of native and desired non-native vertebrate species" (USDA Forest Service 1982:19). Unfortunately, there currently is not a clear definition in the scientific literature of what viability represents among all wildlife species. The National Forest Management Act regulations define a viable population for planning purposes as "one which has the estimated numbers and distribution of reproductive individuals to ensure its continued existence is well distributed in the planning area." Furthermore, "habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that individuals can interact with others in the planning area."

Concerns about long-term viability of wildlife in the Tongass led the leader of the TLMP Team to establish an interagency viable population committee (V-POP) in 1990. The committee's draft report (Suring and others 1993) provides recommendations for old-growth forest retention designed to protect long-term wildlife viability in the Tongass. The committee also made recommendations designed to maintain the viability of individual wildlife species. The committee's report was subsequently subjected to review (here called the peer review), at the request of the Regional Forester, by scientists affiliated with the Pacific Northwest Research Station (Kiester and Eckhardt 1994).

An attempt was made to reconcile differing recommendations made in the original V-POP report and the peer review to provide a consistent set of recommendations for an old-growth retention strategy to provide habitat sufficient to meet viability needs for all wildlife species in the Tongass. Preliminary recommendations for reconciliation were made (Suring and others 1994) but they were never subjected to scientific analysis or further review because the V-POP committee was disbanded by the Regional Forester.These documents articulated the need for a strategy to maintain habitat for old-growth-associated wildlife in the Tongass and made recommendations for ways to achieve that goal. The V-POP documents, and many others pertaining to wildlife viability, were provided to forest managers for consideration in revision of the Tongass land management plan.

The V-POP reports contained detailed recommendations on how, in the opinion of the authors, to achieve wildlife viability in the Tongass National Forest. The recommendations, however, are not science but rather a combination of scientific information integrated with professional experience and personal values embodying a level of risk the authors thought appropriate. Recommendations of this type cannot be subjected to a science consistency evaluation using the criteria defined in this paper. Because of interagency interest in the V-POP documents, however, recommendations in those documents are compared to the Forest plan in appendix 2. This exercise is simply a comparison of one possible strategy with another for managing wildlife habitat in the Tongass.

In general, any major disturbance to the landscape, especially in highly fragmented archipelago systems, poses some increased level of risk of local extripation to the resident biota (Burkey 1995). Generally, the more the disturbance processes deviate from the natural disturbance regime, the greater the likelihood of an increased risk to the viability of the resident biotic communities. When the areal extent, distribution, or frequency of a disturbance becomes great enough, and fragmentation of habitat extensive enough, then the ability of a species to persist across the landscape may be compromised. An estimate of temporal and spatial disturbance to habitat resulting from implementation of the Forest plan therefore is assessed in terms of risk to the viability of wildlife species of the Tongass and the probability of populations remaining well distributed across the planning area.

Factors influencing wildlife viability—Although population viability is difficult to define for many wildlife species, wildlife biologists clearly recognize the primary factors influencing viability (Soulé and Wilcox 1980). Numerous factors contribute to the viability of wildlife populations, not the least of which are the quantity, quality, and distribution of habitat, in both time and space. Habitat provides necessary resources such as shelter, food, and water, and habitat quality significantly influences susceptibility to predation, disease, and severe climate. Ultimately, habitat determines reproductive success, recruitment, and demography, all important parameters influencing viability (Soulé and Wilcox 1980).

In addition to habitat, environmental features such as geologic history and natural processes, which affect regeneration and development of natural communities, establish the ecological and evolutionary context within which organisms must respond and ultimately adapt. More specifically, how the environment influences a species will differ and depends on several factors: trophic position (e.g., primary consumers like herbivores versus top level carnivores); dispersal ability; and any one of numerous life history traits including whether a species is migratory, whether a species is monogamous, generation time, age at first reproduction, number of litters or broods of young produced per year, and ecological affinities or interspecific relations.

Numerous species have very narrow habitat niches (specialists), or they may be involved in obligate relations with other species (e.g., predator-prey relations). For habitat specialists, the range of tolerance to habitat disturbance is narrow; for species dependent on others for food, viability is linked not only to its own habitat requirements but also to those of its prey. Also, whereas species occupying early forest successional seres (or other ephemeral habitats) have evolved dispersal ability and other traits that facilitate colonizing new habitat that becomes available, old-growth-associated species have instead evolved keen competitive abilities (Pianka 1988). The consequence is that old-growth-associated vertebrate species are typically poor dispersers and do not fare well at reoccupying disturbed habitat following extirpation (MacArthur 1972:87; MacArthur and Wilson 1967:81), even though the habitat may recover in 200 to 300 years.

This life history attribute is especially problematic in archipelago systems where habitat is already naturally fragmented and “source” populations are already isolated (Burkey 1995). Management activities that fragment habitats within existing land masses and contiguous forest habitat will further increase the likelihood that populations may not only become locally extirpated but also that fewer source populations may exist, and opportunities for colonizing any suitable second-growth forest habitat may be diminished because habitat connectivity has been interrupted.

For endemic vertebrates with restricted ranges (i.e., one or a few islands), the risk to viability, indeed extinction, is greater than for widely distributed species (Burkey 1995, Soulé and Wilcox 1980). Habitat requirements of many old-growth associates not only include microhabitat and macrohabitat dimensions but also are spatially explicit within a broader landscape context; that is, some endemic species have specific stand-level (and even finer scale) habitat requirements and are also “area-sensitive” (Soulé and Wilcox 1980). Thus, landscape context is as important as overall habitat quantity or quality. Small carnivores like marten, for example, have some of the largest mass-specific home ranges and need fairly large, contiguous, tracts of habitat (Chapman and Feldhamer 1982, Harlow 1994).

Land management planning for the Tongass National Forest occurs at the scale of millions of acres (USDA Forest Service 1996a), which is a broader scale than that used by wildlife populations that rely on habitat distributed at a spatial scale an order or more in magnitude finer than the Forest, or even an Administrative Area. Indeed, many rare and endemic mammals have entire distributional ranges representing only thousands of acres. For example, the entire known geographic range of the Suemez Island ermine (*Mustela erminea seclusa*) is Suemez Island (MacDonald and Cook 1996), which is less than 40,000 acres.

Elements of Forest planning that affect the viability of old-growth-associated wildlife species are (1) total amount of habitat, habitat type representation, and habitat patch size; (2) extent of additional fragmentation of productive old-growth habitat; (3) connectivity of old-growth habitat; (4) extent, frequency, and intensity of disturbance within the matrix (e.g., rotation length, regeneration method, distribution in time and space); and (5) amount, distribution, and duration of roads and road access.

The draft alternatives and the emerging final alternative used different combinations of the above elements to address the issue of wildlife viability. The basic premise of this approach was that similar levels of protection can be achieved through wildlife management strategies employing different combinations of the elements. For example, similar levels of risk for a certain species may be achieved by using either a strategy emphasizing well-connected reserves, or one with no specific reserve strategy that uses a 300-year rotation across all lands scheduled for timber harvest, especially if harvest occurs in small blocks emulating natural disturbances.

An overview of wildlife components in the Forest plan—The Forest plan includes an array of components derived from available scientific information that managers have used to protect wildlife viability across the Tongass. These management actions reduce the risk to wildlife viability; additional actions could have been taken to further reduce risk and were not, presumably to gain other benefits. Whether the risk in the Forest plan is acceptable is a policy question, not one of science. The TLMP scientists evaluated the risk posed to maintaining habitat for well-distributed wildlife populations in the Tongass across the entire array of alternatives so that managers could see how the emerging final alternative compared to the draft alternatives (see appendix 3). The key components of the viability strategy in the Forest plan include:

- An array of lands totaling 4.2 million acres that is legislatively withdrawn from timber production (USDA Forest Service 1997b:table 3-77).
- An old-growth habitat conservation strategy that includes a network of large, medium, and small reserves, which in combination with various other LUDs protect an additional 3.5 million acres of old-growth forest habitat (Iverson 1997).
- Strategic location of reserves across the 21 biogeographic provinces of the Tongass to enhance their connectivity to other reserves or protected habitat; the system includes at least one very large old-growth reserve per ecological province and a small reserve in each of 237 large watersheds (USDA Forest Service 1997c).
- A mechanism for controlling human access to roads across the entire Forest, as necessary, to protect wolves and brown bears.
- A 1,000-foot beach and estuary buffer that provides an additional 140,000 acres of protected productive old-growth habitat within timber production LUDs (Iverson 1997) and connectivity among some reserves.

- Riparian buffers that protect an additional 223,800 acres of productive old-growth habitat within timber production LUDs (Iverson 1997) and provide connectivity among some reserves while providing protection for fish habitat.
- Approximately 500-foot buffers to protect principal brown bear feeding areas along salmon streams and provide connectivity with other old-growth habitats.
- Removal of all forested islands ≤1,000 acres (n=461) from the timber base to protect about 43,000 acres of productive old-growth habitat (Iverson 1997).
- A reevaluation of candidate species to include on the Regional Forester's sensitive species list.
- Strengthening the rigor of procedures and standardizing protocols to conduct biological evaluations for taxa on the Regional Forester's sensitive species list.
- Establishment of a "survey before management" approach for endemic mammals before beginning projects that substantially alter vegetation on islands ≤50,000 acres in size. Similar surveys on larger islands may be conducted if an initial assessment indicates a high likelihood that endemic mammals are present. Survey results will be used as necessary to modify project design to provide for the continued persistence of endemic taxa identified during surveys.
- Accelerated research on endemic mammal taxa in the Forest.
- A timber harvesting plan that schedules <43 percent of the acres of old-growth timber in the lands available for timber harvest between reserves (timber-emphasis LUDs, also called matrix lands) for harvest in a rotation, leaving after 100 years of implementation about 1 million acres (i.e., 57 percent) of the productive old growth in the matrix (Iverson 1997) and 84 percent of the Forest-wide productive old-growth habitat that was present in 1954 (USDA Forest Service 1997c).

After a full rotation of implementation (100 years), the Forest plan leaves about 57 percent of the old-growth forest within the portions of the Tongass National Forest designated for timber emphasis which are either protected by standards and guidelines or will be classified as too isolated or difficult to use for timber production. Scheduled timber harvests, however, contribute to additional fragmentation of forest habitat for old-growth-associated wildlife species.

Management actions that reduce risk to viability—The Forest plan includes several standards and guidelines that reduce risk to the viability of all wildlife species, including a subgroup called other terrestrial mammals.[3] Reduction in risk is measured from that associated with current practices in use on the Tongass; i.e., before the 1995-97 planning effort. These actions include many fundamental elements used in developing the array of Forest plan alternatives. These elements and their likely effect on each wildlife species are summarized in table 3.

[3] The classification "other terrestrial mammals" includes a group designated as "wide ranging" and an endemic group. Several species are contained in each group (Shaw, in prep.).

Table 3—Synthesis derived from the 1st set of risk assessment panels on how various elements of the draft alternatives contribute to maintaining wildlife viability in the Tongass National Forest[a b]

		Alternative features				
Panels	Reserves	Rotation length in years	Harvest method [c]	VCU[d] harvest[e] thresholds	Old-growth retention[f]	Riparian options
Wolf	+	200>100	ul>2>es	+	+	1>2
Bear	+	0/-(differs by situation)	0	-		++1>2
Murrelet	++	200>100	ul>2>es	++	+	0 or -
Northern goshawk	+	200>100	ul>2>es	++	0/+	1>2
American marten	++e.g. Alternative 3	200>100 to clearcut	ul>2>es	+	+	1>2
Other terrestrial mammals	++	200>100 to clearcut	ul>2>es	+	+	1>2
Subsistence deer harvest	+ (community specific)[g]	200>100	ul>2>es	+	++	1>2
Old growth:						
Abundance and diversity	++	200>100	ul>2>es	++	1>2	
Connectivity	++	200>100	ul>2>es	+	1>2	
Process, structure, and function	+	200>100	ul>2>es	+	1>2	
Fisheries and riparian				+		

Table 3—Synthesis derived from the 1st set of risk assessment panels on how various elements of the draft alternatives contribute to maintaining wildlife viability in the Tongass National Forest[a] [b] (continued)

	Alternative features							
	Beach fringe 0-500 feet	Beach fringe 0-1000 feet	Estuary fringe	Deer winter range	Mixed matrix managed lands	Matrix and reserve[h]	Roads	Wild and scenic rivers
Wolf	+	+	+	+			-	
Bear	+	0	++	0	-	++	-	0
Murrelet	+	+	+	+			0	+
Northern goshawk	+	++	++		++	-	0	
American marten	+	++	++	+			0	
Other terrestrial mammals	+	+	+	+	-		-	
Subsistence deer harvest	+	++	++	++	0	0	-	0
Old growth:								
Abundance and diversity			+	+				0
Connectivity		+	+			-		
Process, structure, and function	+	+					-	
Fisheries and riparian							-	+

[a] Panel evaluation symbols:
0 neutral or benign
\+ important positive feature
++ critical positive feature
\- detriment
> better than
= comparable
No mark in a column indicates that panels made no comment.

[b] Swanston and others 1996.

[c] Harvest method: ul = uneven aged-management,rotation (≤200 yr); es = even-aged management, short rotation (100 yr); 2 = 2-aged management.

[d] VCU=value comparison unit, equivalent to an individual watershed.

[e] Refers to threshold to trigger “no further management” when VCU has experienced a predetermined percentage of harvesting (USDA Forest Service 1996a).

[f] Size and distribution of old-growth blocks was initially consistent across alternatives as determined by a 1995 GIS (geographic information system) inventory (USDA Forest Service 1995).

[g] Benefits derived for deer and other subsistence resources differ among communities.

[h] Refers to a management approach that uses a combination of alternatives to clearcutting in the matrix and a configuration of habitat reserves to achieve a desired condition for wildlife and other nontimber values (USDA Forest Service 1996a).

All wildlife species—Standards and guidelines and habitat elements designed to address all wildlife species excluding “other terrestrial mammals” include:

1. The identification and mapping of large, medium, and small old-growth reserves across the Tongass National Forest with consideration for historical distribution of habitat and connectivity among reserves. Reserves contain productive old-growth forest habitat types strategically distributed for wildlife purposes. After 100 years of implementing the Forest plan, about 3.5 million acres of the estimated 5.4 million acres of productive old growth present in 1954 will be retained through this old-growth habitat conservation strategy. There will be at least one large reserve (≥40,000 acres) in each of the 21 biogeographical provinces and one small reserve (≥1,600 acres) present in each of 237 large (>10,000 acres) watersheds. An additional 360,000 acres of productive old-growth habitat within timber production LUDs is protected by beach, estuary, and riparian buffers, and also contributes to landscape connectivity among reserves and other protected habitat (Iverson 1997).

2. A 1,000-foot, largely undisturbed beach fringe buffer, of which 60 percent is productive old-growth forest. Historically, limited partial logging and some clearcut logging occurred in the beach buffer; however, 93 percent of its total acreage and the productive old growth remain largely unaltered. Below are examples of wildlife species benefiting from this component.

a. Queen Charlotte goshawks benefit because the beach fringe is highly utilized and preferred old-growth habitat (Iverson and others 1996).

b. American marten benefit from the additional connectivity across lowland old-growth habitat provided by undisturbed beach fringe buffers as well as an addition of high-quality habitat.

c. Marbled murrelets benefit from an increase in interior-forest nesting habitat across the landscape by adding undisturbed old-growth forest habitat near existing, contiguous old-growth habitat; murrelets also may nest within the beach fringe buffer.

d. Beach fringe represents important winter range habitat for Sitka black-tailed deer, the predominant prey of the Alexander Archipelago wolf. Undisturbed beach fringe increases connectivity across lowland productive old-growth habitat.

e. Breeding density of bald eagles (*Haliaeetus Ieucocephaius*) is reduced when nests are within about 1,000 feet of clearcuts; within the 1,000-foot proximity, some benefit is afforded to eagles that nest further from clearcuts (Gende and others, in press).

3. A 1,000-foot undisturbed estuary buffer benefits all old-growth-associated wildlife species. Below are some examples of wildlife species that would particularly benefit from this action.

a. Queen Charlotte goshawks, because the estuary fringe is highly used and a preferred old-growth habitat (Iverson and others 1996).

b. American marten, from the additional connectivity across lowland old-growth habitat provided by an undisturbed estuary fringe buffer as well as an addition of high-quality habitat.

c. Marbled murrelets, from an increase in interior-forest nesting habitat across the landscape by adding undisturbed old-growth forest habitat near existing, contiguous old-growth habitat; murrelets also may nest within the estuary fringe buffer.

d. Alexander Archipelago wolves because the estuary fringe represents important winter range habitat for Sitka black-tailed deer, the predominant prey of the Alexander Archipelago wolf. Undisturbed estuary fringe increases connectivity across lowland productive old-growth habitat and to upland habitat, which serves as summer or winter range, and lowland winter range.

e. Breeding density of bald eagles in southeast Alaska is reduced when nests are within about 1,000 feet of clearcuts; a 1,000-foot estuary buffer reduces the likelihood of some bald eagles nesting within 1,000 feet of a clearcut (Gende and others, in press).

4. Brown bears benefit from provisions to provide about 500-foot undisturbed buffers as needed along salmon streams, which function as principal feeding areas, and from protected estuary fringes, especially those associated with class I anadromous fish streams, which serve as principal feeding areas. These buffers also are potential corridors for wildlife movement among designated reserves.

5. Brown bears and wolves benefit from the interagency process to determine whether road access markedly contributes to mortality and from implementing an effective road management plan where necessary (USDA Forest Service 1997c).

6. The Forest plan protects 86 percent of the highest quality deer winter range in the Tongass National Forest, which is more than all draft alternatives except alternative 1—the no-additional-management alternative (USDA Forest Service 1997b:table 3-111). Winter range is included within the 1,000-foot beach fringe, riparian buffers, large, medium, and small old-growth habitat reserves, legislated reserves, and other large reserved areas such as south Cleveland Peninsula and South Kuiu Island that result in scheduling a relatively small proportion of old growth for timber harvest (474,000 acres of old-growth forest over the next 100 years).

7. Applying riparian standards and guidelines as consistent with the AFHA report (1995) provides some reduction of risk to wildlife viability. The benefits accrue primarily as corridors for movement because the buffers do not represent "habitat" for most old-growth-associated wildlife species, particularly area-sensitive species (e.g., hairy woodpecker [*Picoides villosus*], marbled murrelet). Species that would perhaps benefit from riparian movement corridors include American marten, brown bear, Sitka black-tailed deer, and the Alexander Archipelago wolf.

8. Several standards and guidelines under Wildlife and Threatened, Endangered, and Sensitive Species (USDA Forest Service 1997a: chapter 4) were added to strengthen the emerging final alternative in response to the 1997 risk assessment panel results and other comments. In general, these additions were made to improve habitat conditions for the northern goshawk and the American marten in programmed harvest units within high-priority habitat areas for each species. Guidelines detail various actions to maintain more old-growth character deemed important to these species in cutting units. Additional measures were included to further evaluate any increases in American marten mortality (e.g., as may occur from hunting and trapping) where such

mortality is identified as posing a serious threat to marten populations. Another addition is intended to provide additional assurance of maintaining connections among habitat blocks throughout the Tongass. Where existing conditions (e.g., riparian and beach buffers) are determined to not provide for adequate connectivity, additional habitat will be allocated to provide for connectivity of old-growth habitats. It is unclear how determinations will be made as to the sufficiency of existing conditions to provide adequate connectivity.

Wildlife habitat elements noted below likely would provide increased incremental and cumulative benefits toward maintaining wildlife viability but are absent from the Forest plan. The benefits afforded each species probably differ and are difficult to quantify. Absence of these elements is not an indication that the Forest plan is deficient, and the inclusion of these or any other elements does not ensure that a Forest plan meets acceptable levels of risk for maintaining wildlife viability. That is a policy decision. Appendix 3 includes an evaluation of the risks to wildlife viability of implementing the emerging final alternative for 100 years. The wildlife habitat elements are as follows:

1. Application of all riparian prescriptions from draft alternative 3, which included increased protection of specific, high-value watersheds identified by the Alaska Department of Fish and Game (option 1), as well as application of AFHA (1995) recommendations (option 2).

2. Riparian buffers and movement corridors that are wide enough (e.g., some biologists suggest corridors of 600 feet or more) to allow unrestricted movement of marten and other far-ranging wildlife species among old-growth forest blocks and provide sufficient forest-interior habitat to support breeding of area-sensitive species (e.g., hairy woodpecker). Buffers for protection of streams and riparian zones, as proposed, are generally too narrow to provide any substantial interior habitat on class I streams. Although additional measures to enhance connectivity for wildlife, particularly small mammals (USDA Forest Service 1997b:app. N, p. 10) and marten (USDA Forest Service 1997b:app. N, p. 14) seek to minimize edge and include interior-forest habitat, these measures lack clarity as to how the connectivity corridors will be designed to contain sufficient interior habitat to support successful reproduction of area-sensitive species. Broader corridors also would likely benefit wolves by increasing Sitka black-tailed deer winter range and by reducing human-caused mortality of wolves through an increase in escape cover along roadway buffers.

3. More productive riparian old-growth forest habitat than proposed in the Forest plan, a highly used, preferred habitat of goshawks. Riparian-associated forests are equally or more productive in supporting bird and mammal populations, which are important prey species for goshawks.

4. Broader riparian buffers than proposed in the Forest plan, along streams associated with estuaries near marine foraging habitat important for marbled murrelets. This would contribute important interior-forest habitat for nesting murrelets, which are vulnerable to increased nest predators associated with forest edge habitat.

5. Retention of all deer winter range in watersheds where deer harvest exceeds 20 percent of deer habitat capability (applying deer standard and guides from draft alternative 3; USDA Forst Service 1996a), and retention of important winter range where deer harvest is between 10 and 20 percent of deer habitat capability. This action would be particularly important in portions of the forest with wolves, where both wolf viability and human subsistence use of deer are focal issues.

6. Protection of more highly preferred lowland productive old-growth habitat than offered in the Forest plan, for American marten and goshawk nesting and foraging.

7. Retention of all deer winter range (e.g., productive old-growth forest) below 800 feet in elevation. Besides benefiting deer, this measure also would contribute to available interior-forest habitat for nesting murrelets and other area-sensitive species, which are vulnerable to increased nest predators associated with forest edge habitat.

8. Applying a greater proportion of longer rotation and uneven-age management within the forest matrix among reserves than that in the Forest plan would be especially beneficial to the old-growth-associated species noted in items a and b, below.

> a. Applying long rotations and additional uneven-age management in all matrix lands rather than only those in certain locations (USDA Forest Service 1997a, 1997b:app. N, p. 15) would more closely approach a dynamic landscape circumstance than current practices and thus likely reduce the viability risk to goshawks (Iverson and others 1996).
>
> b. Applying long rotations and additional uneven-age management in all matrix lands rather than only those in certain locations (USDA Forest Service 1997a,1997b:app. N, p. 15) would increase potential nesting habitat for marbled murrelets because it will allow for the development of a more contiguous, mature forest habitat with stems that are old and large enough to possess the features typical of marbled murrelet nest trees (Ralph and others 1995).

Other terrestrial mammals—There are 27 currently recognized “unique” taxa of mammals that occur in southeast Alaska, all of which are known from the Tongass National Forest (MacDonald and Cook 1996). The taxonomic diversity of terrestrial mammals (and presumably other faunal elements) mainly results from the high degree of naturally fragmented landscapes in the Tongass. Indeed, across the Alexander Archipelago, isolated habitat types historically existed within oceanic islands because of topography, geology, climate, and other environmental features. Because of this situation, both spatial and temporal heterogeneity occur in a manner rarely found elsewhere. A consequence of this environmental context is isolation of vertebrate populations, reduced gene flow, and ultimately through time, separate and distinct breeding populations that are genetically isolated and become recognized as unique taxa.

Many distinct taxa (e.g., Prince of Wales flying squirrel [*Glaucomys sabrinus griseifrons*]) have restricted geographic distributions; including one (Suemez Island ermine) known from only a single island. The smaller a population is, the more likely it will be negatively impacted by habitat disturbance and possibly become extirpated; the fewer the populations, the more likely a taxon will become extinct. Clearly, extinction rates are higher in archipelago systems (Burkey 1995).

Habitat disturbances like timber harvest, particularly clearcutting, can further fragment wildlife populations, which can reduce the size of contiguous populations and the number and distribution of larger populations, increase sensitivity to stochastic perturbations, and increase the likelihood that more isolated and smaller populations may become extirpated (Soulé and Wilcox 1980). What may represent a small proportional reduction in old-growth habitat across the Forest could represent a substantial portion, indeed perhaps the entire known habitat, of an endemic mammal’s range.

Both risk assessment panels for “other terrestrial mammals” (Shaw, in prep.; Swanston and others 1996) recognized the potential negative impacts of forest management on the viability of both “wide ranging” and “endemic” mammals in the Forest. Indeed, recognition by the first panel that some appreciable risk to viability already existed because of past management is reflected in the relatively high likelihood (67 percent) of at least one taxon “not being well distributed” in the alternative with essentially no further management (alternative 1). For that reason, the panel provided options for reducing risk to taxa already impacted by past management (e.g., Prince of Wales flying squirrel) and suggestions for reducing the risk to viability from future management actions in the Forest.

The habitat elements noted above under “All Wildlife Species” also benefit “Other Terrestrial Mammals” as a group, including endemic terrestrial mammals. Additional measures specific to endemic mammals were provided by the panel and an analysis of available science information. The following three items are included in the Forest plan.

1. Protection of all islands ≤1,000 acres (USDA Forest Service 1997c) will reduce risks to viability of some small endemic mammals (see Lidicker 1994) such as voles (*Clethrionomys* and *Microtus*), mice (*Peromyscus*), and shrews (*Sorex*). But a conservation strategy for maintaining these species should not rely just on protection of these small islands (Burkey 1995).

2. Evaluation and designation of rare and endemic vertebrates as sensitive species where appropriate. To reduce risk, designated sensitive species require a biological evaluation (USDA Forest Service 1997c) as part of the National Environmental Protection Act (NEPA) process before any project implementation. Such biological evaluations (USDA Forest Service 1997c) will include an on-the-ground survey conducted according to acceptable protocols. Additional taxa could be included as Alaska Region sensitive species.

3. Commitment to further research on the distribution, abundance, detectability and genotypic variability of small endemic mammals in the Tongass (see USDA Forest Service 1997c).

Results of the 1997 risk assessment panels indicated concern for small, endemic, and widely distributed mammals (Shaw, in prep.). The following additional conservation measures that reduce viability risk to small, endemic, and widely distributed mammals were added to the emerging final alternative to form the Forest plan:

a. Surveys for endemic mammals are to be completed before projects are begun that would substantially alter vegetation on islands of ≤50,000 acres. Surveys will be conducted on larger islands if initial assessment indicates high likelihood that endemic mammals occur there.

b. Where endemic taxa are detected by surveys, projects will be designed to provide for continued persistence of these taxa.

c. Ongoing research of endemic taxa within the Tongass will be accelerated.

d. Endemic and widely distributed small mammals benefit from conservation measures to maintain connectivity of large and small reserves and other nondevelopment LUDs.

e. Endemic and widely distributed small mammals benefit from guidelines to increase old-growth character for marten and goshawk habitat.

The following habitat elements likely would provide incremental and cumulative benefits toward maintaining viability of other terrestrial mammals but are absent from the Forest plan. These elements were identified in the viability panel assessments and by analysis of available science information. The benefits afforded each species in this group probably differ and are difficult to quantify. The absence of these elements is not an indication that the Forest plan is deficient, or does including these or other elements ensure that a Forest plan meets acceptable levels of risk for maintaining wildlife viability. That is a policy decision. Appendix 3 includes an evaluation of the risks to wildlife viability of implementing the emerging final alternative for 100 years. These elements include:

1. For endemic and rare taxa with restricted ranges, application of an old-growth-retention prescription across the entire range, rather than a survey and manage approach on islands ≤50,000 acres, until additional study concludes that the geographic distributions or habitat requirements do not warrant this degree of protection.

2. Restoration of habitat further fragmented because of management actions within the existing range of certain endemics (e.g., the Prince of Wales Island flying squirrel on northern Prince of Wales Island).

Restoration could include delaying, preventing, or possibly improving habitat through subsequent entries into clearcuts. Or it could limit future harvest to small group selections so that older (i.e., ≥250 years) forest habitat would be preferentially retained in landscapes where it currently coexists in a highly fragmented matrix of recent clearcuts, seedlings, young growth, or young sawtimber stands. This action would reduce the risk to maintaining well-distributed populations by increasing connectivity as well as by increasing the total amount of mature forest habitat (i.e., well beyond the understory reinitiation phase; Lawford and others 1996) within the range of the species.

Consistency in use of wildlife-related information—Wildlife viability was identified as a major focal issue to be addressed during revision of the Tongass land management plan. Consequently, the manner in which wildlife information was used in developing the emerging final alternative is critically important. New assessments completed for anadromous fish (AFHA 1995), marbled murrelet (DeGange 1996), Queen Charlotte goshawk (Iverson and others 1996), and Alexander Archipelago wolf (Person and others 1996), the existing V-POP documents (Kiester and Eckhardt 1994; Suring and others 1993, 1994) , and other documents (Iverson and René 1997) were used in developing the wildlife viability strategy in the Forest plan. A summary of how scientific information on key wildlife viability issues was used in the Forest plan and how risks were acknowledged and documented is provided in table 1 (see "Summary").

Overall, the consistency criteria were met. The Forest plan makes consistent use of available scientific information and provides a strategy that reduces the risk of not maintaining well-distributed wildlife populations across the planning area to a level lower than any of the original draft alternatives, except draft alternatives 1 or 5, depending on the species.

A science consistency check of recommendations within V-POP documents (Kiester and Eckhardt 1994; Suring and others 1993, 1994) is not appropriate, but a general comparison between V-POP recommendations and the Forest plan is made in appendix 1. Recommendations from the V-POP reports were designed to produce a wildlife viability strategy with a reasonable probability of maintaining well-distributed, viable populations of all wildlife species across the planning area. These recommendations, as previously noted, are not science but a combination of scientific information, professional experience, and the personal values of those making the recommendations and therefore are not suitable for a science consistency check.

The Forest plan, which seeks to maintain wildlife viability through a somewhat different strategy than that recommended by the V-POP report (Suring and others 1993) and the peer review (Kiester and Eckhardt 1994), differs in many respects from the detailed species-specific recommendations of these V-POP documents (see appendix 1). The levels of risk to maintaining habitat for well-distributed populations of wildlife across the planning area, therefore, might be different. But whether the level of risk embodied in the Forest plan is acceptable is not an issue for science. It is a public policy decision, the making of which should benefit from available scientific information.

Karst and Cave Protection

Introduction—The Tongass National Forest contains the largest concentration of dissolution caves known in Alaska. The Forest also contains unique karst landform features, particularly epikarst (surface karst), concentrated primarily in the alpine and subalpine zones. The caves and the karst landform features are intimately related and a direct manifestation of chemical weathering of limestone and marble bedrock underlying approximately 437,400 acres of the Tongass in a northwest trending band extending across the Forest. These karst and cave resources are a newly discovered and recognized attribute of the Tongass National Forest. They are of national and international significance for many reasons, including their intensity and diversity of development; biological, mineralogical, cultural, and paleontological components; and recreational values (Aley and others 1993, Baichtal and Swanston 1996).

Karst landforms—The basic principles of karst development and cave formation are known internationally and are well documented (Ford and Williams 1994, White 1988, White and White 1989). The interactions of the variables controlling the rate and extent of karst landscape and cave development, however, are not fully understood, particularly as they relate to development of these features under the cool, moist, heavily forested conditions along the north Pacific coast. In southeast Alaska, karst landforms comprise a geologic terrain developed atop and within carbonate bedrock in which unique caverns, tunnels, and surface features have developed as the result of differential solution by acid surface waters and ground waters (Baichtal and Swanston 1996). The surface of the terrain is characterized by distinct erosional features such as deep shafts, crevasslike dissolved fissures, erosion or dissolution rills, and spikes and spires of nearly pure limestone and marble. Surface drainage in such terrain is infrequent, with surface water moving rapidly underground and into complex subsurface drainage networks associated with extensive cave and underground tunnel systems. Once the water and any associated sediment enters the underground drainage system, the breadth of distribution and points of discharge are unpredictable and may extend far beyond surface watershed boundaries.

Significant features—Field observations indicate a definite direct association between presence of karst terrain and the productivity of the western hemlock-Sitka spruce (*Tsuga heterophylla* (Raf.) Sarg.-*Picea stichensis* (Bong.) Carr.) forests found in the Tongass (Baichtal and Swanston 1996). The controlling variables seem to be the nutrient richness of soils on the valley floors and along slopes below 400 feet in elevaton, well-developed subsurface drainage, and dissected bedrock surfaces that allow tree roots to hold fast and become windfirm. Exceptionally dense stands of very large-diameter western hemlock and Sitka spruce are characteristic of these low-elevation sites, and the old-growth forest cover provides a well-structured, multi-layered canopy important as winter habitat for Sitka black-tailed deer and other mammals.

Streams draining these karst areas support extremely productive aquatic communities. The geochemistry associated with karst development contributes to productivity of aquatic environments through its carbonate buffering capacity and carbon input dissolved from the limestone bedrock (Wissmar and others 1997). This action has significant downstream effects on the aquatic food chain and biotic community. Preliminary studies suggest that aquatic habitats associated with karst landscapes may be 8 to 10 times more productive than adjacent, nonkarst-dominated aquatic habitats (Bryant and others, in prep.). The karst-dominated aquatic habitats also appear to support a higher biodiversity than the noncarbonate-based systems, have higher growth rates for salmon smolts and resident fish, reflect less variable water temperatures and flow regimes, and contain unique habitats affecting species distribution, abundance, and adaptations.

Many wildlife species find the epikarst features, the stable environment, and the shelter provided within associated caves to be suitable habitat. Caves have been used as natal denning sites by northern river otter (*Lutra canadensis*) and as resting and denning sites for Sitka black-tailed deer, bear, wolf, and small furbearers (Baichtal 1993b, Baichtal and Swanston 1996). Sitka black-tailed deer are known to rest around cave entrances in summer, when the air coming from the caves is cooler, and in winter, when the cave entrance environment is warmer than surrounding terrain. Cave systems are known to provide critical roosting and hibernating habitat for bats (Baichtal 1993b, Baichtal and Swanston 1996, Parker 1996). Several birds such as the water ouzel (*Cinclus mexicanus*), thrush (Turdidae), and swallow (Hirundinidae) use cave entrances for nesting and feeding. Rookeries for sea birds, including cormorants (Phalacrocoracidae) and pigeon guillemots (*Cepphus coluba*), occur in some littoral caves (Baichtal 1993a, 1993b; Baichtal and Swanston 1996).

The potential cultural and paleontological significance of the karst landscapes also is high. The Pleistocene paleontology and late Pleistocene and Holocene history of the area associated with carbonate terrain in southeast Alaska is primarily known from cave and rock shelter deposits, which often are intimately related to significant archeological sites. The cool, stable, basic environmental conditions in the caves result in exceptionally good preservation of bone and organic materials (Aley and others 1993). Recent work on Prince of Wales and surrounding islands on the extensive karst resources, combined with botanical surveys of alpine areas and genetic studies on chum salmon populations (Kondzela and others 1994), strengthen the argument for a well-developed coastal refugium along the west coast of the southern end of southeast Alaska. The evidence sheds new light on our understanding of glacial chronology, climatic change, biogeography, and archeology along the western margin of North America (Autrey and Baichtal 1992, Dixon and others 1992, Heaton and Grady 1992).

The functions and biological and cultural significance of karst landscapes are only just beginning to be understood. Preliminary investigations suggest an increased productivity for plant, animal, and aquatic communities that develop on top of or otherwise benefit from karst landscapes. Developing paleontological and archeological information, derived from bones, cultural artifacts, and sediment layers in caves and rock shelters, is providing growing evidence of a coastal refugium through which Pleistocene mammals and humans may have migrated south from the Bering Sea landbridge. Based on these preliminary findings alone, the significance of the karst and cave resources in the Tongass, and the importance of careful forest management on this fragile ecosystem, is apparent.

Quantitative information on the effects of forest harvest on karst ecosystems in southeast Alaska is limited. Recent sediment deposits and waterline marks in caves and underground systems suggest that timber harvesting has increased sediment and debris transport and flooding of underground passages that had not been flooded for centuries. Many cave entrances are filled or blocked by logging slash, sediment, and debris. Field observations and aerial-photo interpretation also show strong evidence of greatly increased surface runoff on karst landforms and adjacent surfaces after harvest, which increases sediment, nutrient, and debris transport capability of associated drainage networks. The vulnerability of a particular karst system to harvest activity is related to the openness of the system. The many solution-widened fissures, sinkholes, and cave entrances become deposition areas for slash, sediment, and debris and injection points into the complex subsurface drainage system. These fissures rapidly move water, sediment, and debris vertically downward into the underground lateral systems. Material transported from roads and disturbed lands may emerge unexpectedly at one or more distant springs or resurgence channels, altering the chemical, nutrient, and sediment loads of the receiving streams.

We and other Tongass land management planning team members analyzed and assessed the available literature and the most up-to-date technical information on karst development and solution cave formation, as well as current thinking on karst management. An independent assessment of karst and cave resource significance for the Ketchikan Area (Aley and others 1993) provided additional quantitative information on processes and controlling variables operating in the area of maximum karst development in the Tongass. Information from active research and monitoring programs designed to measure and analyze biological and cultural interactions with karst terrain and ongoing Alaska Region inventories of karst landscapes provided information used for defining important karst terrain characteristics and significant areas of management concern Forest-wide.

Results of these analyses and assessments and the emerging field information were used by managers to develop a detailed karst and cave management strategy for the Tongass that incorporates methodologies to identify sensitive terrain and assess risk from forest harvest activities. The methodology also provides standards and guidelines for overall management of karst landscapes.

Managers gave full consideration to the scientific information in developing the Forest plan. The entire management strategy developed by the team, with input from the PNW scientists, has been incorporated into the final plan (USDA Forest Service 1997a:4-17 to 4-19 and app. I; 1997b: 3-82 to 3-86). Incorporation of this strategy into the plan and subsequent discussions with managers and field personnel on application have demonstrated that the information is understood and correctly interpreted. Resource risks are acknowledged and accounted for in the application of the strategy. Overall, the three consistency criteria were met (table 1).

Slope Stability

The Tongass National Forest is characterized by steep slopes, shallow, permeable soils, and exceptionally high rainfall—factors contributing significantly to unstable conditions in this mountainous terrain. Because of high soil permeabilities, slope drainage is primarily by subsurface flow with little or no surface flow outside established channels. When surface flow does occur, the thick mat of forest humus and plant cover is adequate to protect the mineral soil from surface erosion. During major storms, high soil moisture levels, local areas of saturation, and temporary water table development are produced on the slope, greatly increasing the unstable character of the soils. This combination of events can cause mass erosion events (landslides) to occur.

Landslides, involving the downslope movement of soil, primarily under the force of gravity, are the principal processes of hillslope erosion and sediment transport to channel systems, and constitute a major management concern for the Tongass National Forest. A critical balance exists between slope stability and slope failure on these unstable lands. The anchoring effect of root growth through the thin soil and into joints and fractures in the bedrock probably increases the stability of these soils somewhat, as does the cohesion provided by organic colloids. The effectiveness of these stabilizing factors, however, may be reduced during periods of high rainfall by development of seepage and pore-water pressures associated with rising soil-water levels. Under these conditions, the soils are in their least stable condition, and only a small triggering force is required to cause total failure and rapid downslope movement of the soil mass. Such a force can be produced by sharp increases in soil-water content, rapid increase in soil mass, and direct destruction of stabilizing root masses.

Landslides are a natural disturbance process in southeast Alaska, but human activities can affect the rate, size, and location of landslide events. Roads and timber management directly influence stability of slopes across the Tongass National Forest through disturbance of the soil mantle. The result is an increase in soil mass movement or landslides, which remove productive soil layers on slopes and transport large quantities of sediment and large woody debris into anadromous fish streams.

Forest managers recognized the significance of this relation and developed a mass failure hazard indexing methodology in 1987 (Alexander 1987). The methodology was developed at two scales. At the larger scale, the index is used to assess risks related to the amount and methods of timber harvest and extent of road construction at the Area and project levels. At this scale, the methodology is primarily field oriented and is based on physical characteristics of soil units and on measured or estimated slope, drainage, and landform characteristics that control the stability of soils. At the smaller scale, the landscape or Forest planning level, index values based on geographic information system (GIS) soil mapping units and slope gradient values developed from digital elevation models (DEM) were used to identify lands with a potentially high hazard for landslide development. These lands were then removed from the “tentatively suitable” timber base.

Initial inspection of the 1987 methodology indicated that although the methodology is sound, the database from which the indexing values were derived was out of date and there was a lack of consistency in identification, measurement, and interpretation of variables across Administrative Areas of the Forest. A careful reanalysis and assessment of slope stability literature and the most current data, as well as recently developed field information from southeast Alaska, have resulted in a revision of the methodology to provide a current and standardized base for Forest-wide stability hazard evaluation (Swanston 1997). The approach directly addresses a concern and recommendation of AFHA (1995). The analyses also have provided a reliable and defensible slope gradient boundary for defining highly unstable terrain.

Managers and resource specialists in the field have been closely involved with development of this revised methodology. The critical field gradient for soil stability has been redefined at 72 percent, based on these analyses. Slopes greater than this gradient are not suitable for timber harvest because of the high potential for landslides after harvest.

Digital elevation models analyzed with GIS can markedly underestimate actual slope steepness. At the Forest planning level, lands above this gradient (as defined by the DEM) therefore are removed from the tentatively suitable timber base with the caveat that withdrawal of these lands should be verified at the Area and project level by suitable field analysis. This criterion is in close agreement with the recommendations of AFHA (1995). Managers have used this information in developing the Forest plan. The redefinition of the high-hazard boundary as a 72-percent slope has been incorporated into the latest GIS analyses and has resulted in improved accuracy for delineation of tentatively suitable forest lands in the Tongass. The new information and revised methodology is understood and has been correctly interpreted in final plan development (USDA Forest Service 1997a:4-81 to 4-84; 1997b:3-197 to 3-201). The revised methodology clearly defines resource risk. Overall, the three consistency criteria were met (table 1).

Timber Resources

For purposes of the Forest plan, productive old growth within the Tongass National Forest is defined as a previously unharvested forested area of trees more than 150 years old with greater than 10 percent tree cover, and an accumulated net saw-log volume of more than 8,000 board feet per acre (bf/acre; Julin and Caouette 1997). The term "productive" refers to the utility of this forested area to provide wood products, although timber volume has been used in Forest planning as a surrogate for wildlife habitat capability. Many of the stands designated as productive old growth in the Tongass GIS database may be relatively young (i.e., 150 to 200 years old) as a result of natural windthrow cycles that prevent development of recognized old-growth attributes (Nowacki and Kramer, in prep.).

Within the boundaries of the 16.9-million-acre Tongass National Forest, there are about 10 million acres of forest land (>10 percent tree cover) and about 6.9 million acres of ice, rock, water, alpine meadow, fen, and sphagnum bog (USDA Forest Service 1997b). Forest conditions range from fens with scattered trees, to heavily timbered stands with volumes that sometimes exceed 70,000 bf/acre. An estimated 5 million acres of this forest is coniferous old-growth forest supporting accumulated levels of wood volume considered to be economical for harvest. About 580,000 acres of the National Forest supports young-growth stands regenerated after logging (69 percent) and natural disturbance (31 percent) (USDA Forest Service 1997b).

The species composition and spatial distribution of forested lands varies in a complex mosaic over the fragmented Alexander Archipelago landscape with changes in elevation, aspect, soil drainage, and patterns of disturbance. Western hemlock, Sitka spruce, Alaska-cedar (*Chamaecyparis nootkatensis* (D.Don) Spach), western redcedar

(*Thuja plicata* Donn ex D.Don), and mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.) are harvested for a variety of traditional (Native and non-Native) and commercial uses. Western hemlock and Sitka spruce are the most abundant tree species, comprising 64 percent and 28 percent of the total growing stock, respectively (Harris and Farr 1974). Alaska-cedar is the most economically valuable, however, particularly in the export market.

Tlingit and Haida people have long used this timber for building houses, canoes, totem poles, and creating ceremonial, household, and personal objects. Non-Native timber use began with Russian colonization in the 1790s and was continued by the United States on a limited scale until the mid-1950s. Development of the Ketchikan Pulp Mill (1954), the Sitka Pulp Mill (1959), and their affiliated saw mills significantly increased timber harvest levels. From 1954 through 1995, we estimate that 17.2 billion board feet were harvested from the Tongass—an average of about 41.5 thousand board feet per acre (mbf/acre). The closure of the Sitka Pulp Mill and Wrangell saw mill in 1993 and the closure of the Ketchikan Pulp Mill in 1997 have markedly reduced capacity to locally process Tongass timber. Currently there are several saw mills and individuals operating in southeast Alaska producing dimension lumber, cedar shingles, specialty products (e.g., guitar faces and piano sounding boards), and cants for export to Pacific Rim markets.

The Forest plan schedules 676,000 acres of old- and young-growth timber for harvest over the next 100 years (USDA Forest Service 1997a). Young-growth stands are not programmed for harvest for another 50 to 60 years—coincident with the projected 95-percent culmination of maximum annual average stand growth rate. This schedule is a key factor controlling the rate at which remaining old growth is harvested. Under this management regime, the future commercial forest, if harvested as planned, may consist of relatively small-diameter trees more suited by current standards for fiber (e.g., pulp, fiber board) or laminated products than for dimension lumber.

A basic principle of National Forest System planning is that resources are to be managed in a sustainable fashion (U.S. Public Laws, Statutes 1960). Sustained yield is “the achievement and maintenance in perpetuity of a high-level of annual or periodic output of the various renewable resources...without impairment of the productivity of the land” (USDA Forest Service 1982). At its most general level, timber sustainability is determined by the availability of commercial timber and the rate of its use through time. Commercial timberland in the Tongass is first defined in terms of suitability for timber production. Once the extent of the timber base is defined, and the amount of available timber in young and old growth is estimated, harvest rate is defined in terms of allowable sale quantity, which must be below the long-term sustainability of the Forest. The actual rate of harvest is determined by numerous factors including but not limited to economics (timber value and operability), appropriated funds, and litigation.

The managers made many decisions concerning the availability, growth, and use of the timber resource in the Forest Plan. Below we discuss six important decisions concerning timber resources. These decisions include how (1) old-growth timber volume was estimated, (2) young-growth timber volume was estimated, (3) uncertainty in the size of the suitable land base was recognized, (4) allowable sale quantity was partitioned to promote economic sustainability (5) certain forested wetlands will be managed, and (6) effects of windthrow will be mitigated.

Decisions regarding the application of each feature of the linear programming model (FORPLAN; Johnson 1986) used in estimating Forest outputs are not fully explored here. Two reviews conducted at the Rocky Mountain Forest and Range Experiment Station raised various questions about the application of FORPLAN in the estimation of Forest plan outputs.[4] Some of these questions were addressed in appendix B of the FEIS (USDA Forest Service 1997b); other questions may warrant further attention. The managers recognized the uncertainty associated with FORPLAN estimates by prescribing a monitoring activity to review modeling assumptions used in FORPLAN every 5 years or whenever major changes in the assumptions occur.

Estimation of old-growth timber volume—The managers used a three-strata approach (low, medium, and high volume) to estimate the abundance of productive old-growth timber in the Forest (USDA Forest Service 1997b). In addition, they assumed that net growth over time in the old-growth component is equal to zero.

Brickell (1989) evaluated the spatial accuracy of the Tongass interpreted timber type data layer (TIMTYP map). This data layer contains mapped information about volume levels within the forested landscape. Using forest inventory data for validation, Brickell found no statistical basis for maintaining separate strata for the higher volume classes (volume classes 5, 6, and 7) on the TIMTYP map.

Julin and Caouette (1997) describe five options for estimating net saw-log old-growth volume in the Tongass. These options define mean timber volume strata by using the volume class item (volume classes 4-7) from the TIMTYP map alone and in combination with the forest type item from the TIMTYP map, and several items from the common land unit database (slope, hydric and nonhydric soils, and site index). Managers modified the low-, medium-, and high-volume strata developed by Julin and Caouette (1997) from a 16-foot net saw-log basis to a 32-foot net saw-log plus utility basis by applying their estimates for breakage, standing merchantable dead volume, and Tongass cut and sold reports (see footnote 4).

The managers seem to have correctly interpreted the available scientific information. The managers abandoned the use of the four original volume classes based on work by Brickell (1989) as confirmed by Julin and Caouette (1997). Instead, they used an approach providing differences among volume strata (low, medium, and high) that are statistically significant for each Administrative Area. The assumption regarding net growth equaling zero cannot be substantiated but seems to be reasonable.

Modeling implementation reduction factors (MIRFs)—Managers recognized limitations in their ability to accurately estimate timber output levels based on existing inventories and unforeseen circumstances encountered during project implementation. “Fall down” occurs when the number of acres actually harvested is less than the number of acres planned for harvest. Unmapped stream buffers, new eagle nests, and misclassified karst vulnerability lands, for example, result in fall down. To anticipate fall down, managers applied MIRFs to reduce the area of land suitable for timber production.

The methodologies used to define MIRFs are documented in appendix B of the FEIS (USDA Forest Service 1997b) and in the planning record (see footnote 4). These factors are based on professional judgment and some limited project experience. Discrepancies between the coefficients in the MIRF documentation and those in FORPLAN

[4] Planning record. On file with: Tongass Land Management Planning Office, 8465 Old Dairy Road, Juneau, AK 99801.

are noted in the planning record. These discrepancies are generally 1 to 2 percent, and planning team analysts predict that such differences will not noticeably alter model results. The application of these factors can markedly affect calculated levels of sustainable timber production. An estimated 731,000 acres are designated as suitable for timber harvest in the Forest plan.

Managers acknowledge the risk of overestimating the available timber resource by applying MIRFs. The accuracy of these estimates will be determined through monitoring and evaluation during project implementation.

Estimation of young-growth timber volume—Young-forest volume is estimated in the Forest plan from the SEAPROG model (Dixon and others 1992), which is the best model available for estimating tree growth in the Tongass. It was constructed from more than 11,000 tree records[5] from (1) the Tongass timber inventory (1982-84), (2) the PNW and Alaska Region stand density study, (3) Administrative Area stand data (stand exams, young-growth surveys, growing stock studies), (4) Makah Indian Reservation inventory data, and (5) Queen Charlotte Island forest inventory data. Tongass land management plan analysts assessed the relation of young-forest yield projections generated by using the SEAPROG model to yields from three normal yield tables for stand ages 30 to 150 years (Barnes 1962, Meyer 1937, Taylor 1934). A test for differences among regression coefficients (slope) revealed no significant differences between the yield table estimates and the SEAPROG projection. The data used to construct the SEAPROG model may not represent the range of stand conditions now subject to timber harvest—namely higher elevation and other poor quality sites (e.g., forested wetlands). An overestimation of the availability of the timber resource (where timber harvest levels may not be sustainable) could result from using a model derived generally from higher quality sites. With information lacking, sensitivity analyses could be beneficially used to examine this issue.

Noninterchangable components (NICs)—The managers partitioned the annual allowable sale quantity of 267 million board feet into two components to promote economic sustainability of the timber resource. This approach distinguishes portions of the timber supply at lower risk of attainment from those portions at higher risk of attainment owing to marginal economic conditions and possible changes in future demand. Volumes associated with each component are to be identified separately in annual harvest plans for the Forest and are not to be substituted (i.e., noninterchangeable) for volume from the other component to determine the allowable sale quantity.

The managers used logging operability maps to identify three logging feasibility categories: (1) normal operability—areas that are expected to be logged economically by using standard logging systems (e.g., tractor, standard cable, and short-distance helicopter); (2) difficult operability—areas that could be logged, but at significantly higher costs, by using long-span cable systems and medium-distance helicopter yarding; and (3) isolated operability—areas that would be extremely costly to log with long-distance helicopter yarding. These categories were developed in the late 1980s by logging engineers and timber planners at each Administrative Area and were based on existing and proposed roads, types of terrain, and professional judgment.

---

[5] Data on file with: USDA Forest Service WO-TM Service Center, 3825 E. Mulberry St., Fort Collins, CO 80524.

The managers assigned low-volume stands of difficult operability and low- and medium-volume stands of isolated operability to a nonharvest prescription. The managers then created two noninterchangeable components based on operability: land of normal operability was designated NIC I (220 million board feet per year); all other land was designated as NIC II (47 million board feet per year).

Although this approach is intended to discourage harvest that is not economically sustainable, there is some uncertainty about the proportions of the allowable sale quantity that fall within each component. One analysis of the operability layer, that was considered by managers, indicated that the NIC I component may be overestimated by about 12 percent (USDA Forest Service 1997d). The operability layer was not modified on the basis of this analysis. Instead, managers acknowledged uncertainty of this data layer through their plans to “review the accuracy of the planning information used to allocate ASQ between the two NICs during the first year of Plan implementation” (USDA Forest Service 1997c). Using our criteria, the decision is thus consistent with the available information.

Forested wetlands—Managers decided to minimize timber harvest on certain forested wetlands (Kaikli, Kitkun, Karheen, and Maybeso Series) until more information related to the effects of timber harvesting in such locations is developed (USDA Forest Service 1997c).

Brock and Kissinger (1995) questioned the suitability of these forested wetlands for timber production, about 40,000 acres of which are designated as suitable for timber production in the Forest Plan. Brock and Kissinger’s concern for harvesting timber on these soils is based on the following: (1) the few records available to categorize timber productivity following harvest—the four, 50-year site index records they cited ranged from 38 to 48 feet (Babik 1983, Farr 1984, Stephens and others 1968a); (2) Kissinger and others (1979) observed stunted, chlorotic forested wetlands on south Kupreanof Island; (3) the British Columbia Ministry of Forests recognizes forested wetland sites as “marginally merchantable” owing to drainage and aeration problems (Banner and others 1993); (4) Weetman and others (1989) report stunted forested wetland plantations in British Columbia; and (5) Moore (1982) reports that some forested wetlands in Europe have been converted to bogs following timber harvest, fire, and grazing.

Zaborske (1995) polled Alaska Region soil scientists and silviculturists about their concerns over harvesting timber from forested wetlands. Based on their work experience, most of these professionals (9 of 11) were not concerned about the effects of harvesting trees from these forested wetlands in terms of regeneration and growth response. The levels of experience with these particular forested wetlands (i.e., harvested acreage, field observations following harvest) are not documented.

Julin and Meade (1997) reviewed relevant background information—literature, plot records, and professional experience—concerning these forested wetlands. They found no information concerning damage resulting from timber harvest on these forested wetlands in southeast Alaska or coastal British Columbia; they found seven, 50-year site index records for these forested wetlands that project a range of heights from 38 to 65 feet (Babik 1983; Farr 1984; Stephens and others 1968a, 1968b). This overall lack of information can be attributed to our limited experience harvesting and studying growth and yield in low-volume stands.

It appears that the managers correctly interpreted the available scientific information on the forested wetlands in question. For example, when modeling growth and yield, they used 50-year site indexes ranging from 40 to 50 feet. These values are within the range known for forested wetlands in the Tongass.

The managers acknowledged the risk to forested wetlands by providing direction in the record of decision (USDA Forest Service, 1997c) to "...avoid harvesting on these four forested wetland soils." They also recognized that small inclusions (less than 2 acres) of these forested wetlands would be incidentally harvested owing to practical considerations. About 2,500 acres of these forested wetlands are scheduled for harvest in the next 60 years. They also commissioned a study to further clarify the status of young-growth stands on these soil types (Julin and McClellan 1996). Thus, using our criteria, the forested wetlands decision is consistent with the available information (table 1).

Windthrow—Managers applied standards and guidelines to reduce the risk of windthrow associated with timber harvest activities. This decision is based on the recognition that windthrow is a common form of disturbance in southeast Alaska (Harris 1989, Harris and Farr 1974) that can be exacerbated by timber harvest activities. Although catastrophic windstorms may be viewed as devastating to the timber resource, wind is considered an important ecological driver in that it creates tree canopy gaps that promote understory development (Alaback and Tappeiner 1991; Nowacki and Kramer, in prep.), and maintains soil productivity by uprooting trees that mix soil layers (Bormann and others 1995).

Harris (1989) describes physiographic circumstances where windthrow commonly occurs and provides guidelines for reducing windthrow damage. Nowacki and Kramer (in prep.) summarize several unpublished studies on wind disturbance at both small and large scales. They also present a model developed for Kuiu Island that predicts the probability of windthrow at a landscape level.

The managers seem to have correctly interpreted the available scientific literature and acknowledged risks by incorporating the following directions in to the Forest plan (USDA Forest Service 1997a):

- Riparian standards and guidelines: "Manage an appropriate distance beyond the no-harvest zone to provide a reasonable assurance of windfirmness of the Riparian Management Area."
- Timber standards and guidelines: "Where the chance of windthrow in adjacent stands is increased by timber harvest, measures should be taken to contain the windthrow within Land Use Designations where timber harvest is allowed."
- Modified landscape and timber production management prescriptions: "Seek to provide for a reasonable assurance of windfirm boundaries. To design for windfirmness, consider conditions such as soils, local wind patterns, tree height and size, and other site factors."

The managers also committed to using guidelines for reducing windthrow damage developed by Harris (1989) and other appropriate information to anticipate and mitigate windthrow damage described in the record of decision (USDA Forest Service 1997c). Timber harvest prescribed in the Forest plan will vary temporally and spatially over the landscape, and associated windthrow will be dispersed in time and space; it also will mimic (at a higher intensity) natural windthrow, which is considered an important disturbance agent in the Forest.

Summary of information related to timber issues—The use of information in the decisions considered here and whether risks were documented in development of the Forest plan are summarized in table 1. Overall, the timber-related decisions were consistent with the available information.

Social and Economic Effects

The Tongass National Forest, which comprises 85 percent of the land base of southeast Alaska, has profound effects on the quality of life for the nearly 75,000 residents. Management of the Tongass has provided or contributed to many types of employment in southeast Alaska. The Tongass historically has contributed nearly half of the timber harvested annually in southeast Alaska and, thus provided a substantial portion of the approximately 2,000 direct jobs in the industry. The industry, however, has experienced a decline of over 1,500 jobs since 1990. The Tongass provides habitat that supports the fishing and seafood processing industries, which together formed the region's largest private industry with an estimated 3,500 employees in 1994. The Forest also directly or indirectly contributes to the tourism and recreation industry, the fastest growing of the resource-dependent sectors, providing nearly 3,000 direct jobs in the region.

In addition to these employment opportunities and the related benefits that flow to local communities, the Forest provides habitat for many fish and wildlife species used for subsistence, a critical component of the lifestyles of Native and non-Native residents. Subsistence activities perpetuate cultural customs and traditions, supplement personal income, provide a major source of unprocessed food, and serve many other social, cultural, spiritual, and economic needs. In 1987, 85 percent of rural southeast Alaska households harvested subsistence food, and half of those reported harvesting more than 80 pounds of edible product per person. The Alaska Department of Fish and Game currently is updating subsistence-use information for southeast Alaska, which will result in a better understanding of current harvest levels.

The Tongass also provides opportunities for recreation for both residents and nonresidents. The unique wildlife-related opportunities and vast amount of scenic resources that are increasingly in demand are reflected in a steady increase in visits to the Tongass, which have more than doubled in the last 10 years.

The communities of southeast Alaska are affected in diverse ways by management of the Tongass. Many types of effects cannot be generalized from community to community, because the communities are unique in population size, access, economic structure and diversity, visions of the future, and local uses of the Tongass. Trends present at the regional or borough level manifest themselves in different ways in the communities, so data cannot be extrapolated to broader geographic areas or political boundaries. Analyses at multiple scales are necessary to understand social and economic conditions and trends in southeast Alaska.

The Tongass also has value to the entire Nation. As the largest National Forest in the United States and a key component of the largest remaining relatively unaltered coastal temperate rain forest on Earth, it has unique biodiversity values of concern to an increasing number of Americans. The tremendous increase in cruise ship visits also reflects the national and global interest in viewing and experiencing southeast Alaska's unique environment and culture. Alaska is typically used as an example of a place having high values apart from direct use, often referred to as "existence" or "preservation" values: people value just knowing it is there. These national values are reflected by the number of comments about the Tongass Forest plan that came from outside Alaska—nearly two-thirds of the 21,000 responses received. Although the dollar value of nonmarket resources and opportunities in the Tongass was not estimated, there is little question that the amount is significant.

A substantial body of social and economic information is available to help decisionmakers identify effects of the Forest plan on residents of southeast Alaska and others who have an interest in management of the Tongass. An assessment of socioeconomic conditions and trends will be published soon (Allen and others, in press). Most of the data are regularly collected and compiled by the Alaska Department of Labor, the Alaska Department of Community Affairs, the Alaska Department of Fish and Game, and other agencies. These data include recreational opportunities and uses, subsistence use of wildlife and plants, structure and diversity of local, subregional, and regional economies, areas used by local residents, Federal revenue sharing payments, and socioeconomic panel ratings of the original RSDEIS alternatives (Swanston and others 1996).

Given the available information,[6] the following four questions can be used to gauge the consistency of decisions leading to the Forest plan:

1. Does the decision consider effects on the quality of life of southeast Alaska residents?

> The socioeconomic panel addressed potential effects on quality of life as one of nine indicators in its evaluation of the nine RSDEIS (USDA Forest Service 1996b) draft alternatives. Further analysis of panel ratings suggest that draft alternative 5 would provide overall the most beneficial effects on quality of life; panelists estimated that 15 communities would be beneficially affected, 4 negatively affected, and 9 unaffected (they disagreed on effects in 4 communities). Of lesser, but still positive benefit were draft alternatives 1, 4, and 6. Of these three alternatives, however, draft alternative 1 was predicted to have negative effects in twice as many communities as 4 and 6. Draft alternative 1 was anticipated to be either positive or negative for all but 4 communities, and draft alternative 4 was expected to have little effect in 16 communities. In contrast, draft alternative 7 was expected to have negative effects on quality of life in 24 communities, compared to positive effects in 3, and few effects either way in just 2 communities. The panel did not evaluate the emerging final alternative, which required the decisionmakers to extrapolate from the original judgments.
>
> Based on language contained in the ROD (USDA Forest Service 1997c), it seems that decisionmakers considered effects of the Forest plan on quality of life, including such components as opportunities for employment in Tongass-related industries, the availability of and access to resources used for subsistence, recreational opportunities, environmental quality, payments to local governments, and related aspects of quality of life that are directly affected by management of the Tongass.

---

[6] For purposes of our analysis, we assumed that socioeconomic information and analyses contained in the FEIS (USDA Forest Service 1997b) were incorporated into the decision.

2. Does the decision consider the diversity of southeast Alaska communities in terms of their economic diversity and structure, population size, subsistence use, community use areas, and other social and economic characteristics that could be affected by changes in management of the Tongass?

The FEIS (USDA Forest Service 1997b) contains detailed information on 32 southeast Alaska communities. Based on language in the ROD (USDA Forest Service 1997c), it seems that decisionmakers considered the differential effects of the Forest plan on southeast Alaska communities. Documentation could be improved, however, by including more of their reasoning in the ROD, along with discussion of differential risk carried by the final plan.

The decision did not appear to misrepresent or incorrectly interpret the scientific information available. At the broad scale, the apparent focus of the decision on timber industry employment seems to be consistent with the data available. The alternatives were projected to differ little in their short-term effects on employment in other resource-dependent industries, such as recreation and tourism, mining, and seafood processing, leaving timber industry employment as the key employment variable. Consistent with the science information available in the FEIS (USDA Forest Service 1997b), the ROD (USDA Forest Service 1997c) acknowledges uncertainty regarding long-term effects on employment in the fishing and seafood processing industries and the possible long-term risk to recreation and tourism employment. The ROD also explicitly acknowledges anticipated declines in employment in the timber industry, while still providing sustainable levels of annual timber harvest.

3. Does the decision consider effects on others who have a stake or concern in management of the Tongass?

Based on language in the ROD (USDA Forest Service 1997c), it seems that decisionmakers considered broader social and economic concerns extending beyond southeast Alaska communities, including the 65 percent of the 21,000 RSDEIS (USDA Forest Service 1996b) comments that came from nonresidents. Such concerns, apart from those discussed above, include ecosystem conditions and functioning, roadless areas, wild and scenic rivers, and the preservation of values providing benefits aside from actual use of Tongass resources. The discussion in the ROD incorporates both market and nonmarket benefits. The ROD also considers consistency of the Forest plan with national policy, such as the Forest Service long-term, national strategic plan, the Forest and Rangeland Renewable Resources Protection Act (RPA) (U.S. Public Laws, Statutes 1974), and the National Forest Management Act (U.S. Public Laws, Statutes 1976).

4. Does the decision contain a mechanism for addressing ongoing concerns about effects of Tongass management on the communities of southeast Alaska?

Whether impacts associated with risks actually occur depends on many variables—some within Forest Service control, such as where and how timber harvest and other activities occur, and some outside Forest Service control, such as what companies bid for contracts, where wood processing occurs, and what happens to timber prices. Such uncertainties are one reason why it is difficult to predict the effects of a programmatic plan on individual communities.

In this situation, monitoring, mitigation, and an effective means for involving local residents in ongoing Forest Service activities becomes critical. Monitoring that includes tracking social and economic indicators at the community group scale would strengthen the plan. The spotted owl (*Strix occidentails*) decision in the Pacific Northwest, for example, lists a number of items to be monitored to assess the effects of the plan on rural economics and communities: demographics, employment in relevant sectors, government revenues, facilities and infrastructure, social service burden, Federal assistance programs, business trends, and taxes. Including quality of life and community resiliency information (how well communities are equipped to deal with change) as part of the monitoring plan would help to mitigate lack of quantitative prediction of socioeconomic impacts.

The ROD (USDA Forest Service 1997c) acknowledges the room for improvement in the plan's monitoring provisions, which could include emphasis on social and economic variables. Mitigation, which includes working with communities likely to be negatively affected (or simply with all communities), would help to identify ways of addressing impacts. The Forest plan contains an objective calling for such efforts, which presumably includes efforts such as the collaborative stewardship strategy currently being planned. Forest-wide standards and guidelines in the Forest plan call for consideration of local community needs in project plans, and for working with communities to jointly identify and develop natural resource opportunities. Finally, the "Information Needs" section of the Forest plan identifies social and economic research as a high priority, with the results inserted into the adaptive management feedback loop of the plan. This should help to ensure that additional scientific information on social and economic conditions will be collected and applied.

Table 1 summarizes how information on social and economic issues was used and how risks were documented in developing the Forest plan.

Monitoring

The Tongass land management plan identifies management direction for the Forest in terms of goals, objectives, and standards and guidelines. Within a logical planning framework, these elements are linked hierarchically and have specific roles. Goals describe desired conditions to be achieved some time in the future and are normally expressed in broad general terms. Objectives form the basis for further planning to define the precise steps to be taken and resources used in achieving identified goals (USDA Forest Service 1982). Objectives are concise, time-specific statements of measurable planned results that respond to goals. A standard is a limitation on management activities and a guideline is a description of a preferred or advisable course of action—both of which respond to objectives.

The Forest plan fits well within the planning framework outlined above. As a result, the monitoring plan will be effective as an adaptive management tool. Several of the key elements follow:

- Forest plan objectives are representative of Forest plan goals. For each of the 18 resource goals there is a corresponding objective (table 4).

Table 4—Status of objectives and monitoring plan items for each resource goal in the Tongass Forest Plan

Goals	Stated objectives	Measurable objectives	Monitoring plan items
Air	1	1	1
Biodiversity	2	2	4
Fish	2	2	3
Heritage resources	1	0	2
Karst and caves	2	2	2
Local and regional economies	2	2	2
Minerals and geology	1	0	1
Recreation and tourism	3	2	2
Research	1	1	1
Scenery	4	4	1
Soil and water	4	4	4
Subsistence	1	1	1
Timber	4	4	6
Transportation	3	3	1
Wetlands	2	2	2
Wild and scenic rivers	3	3	2
Wilderness	1	1	2
Wildlife	2	2	1
Total	39	36	38

- Most of the objectives are measurable. Of the 39 resource objectives identified, 36 are measurable (i.e., clear and quantifiable). Application of standards and guidelines was not considered to be a measurable objective.
- Monitoring items are representative of goals. All the resource goals have at least one monitoring item.

The Regional Forester recognized some limitations of the current monitoring plan and included language in the ROD (USDA Forest Service 1997c) to facilitate its improvement. The statement in the ROD is (p. 52):

> The monitoring plan does not specify the protocols to be used in gathering monitoring information. I would like to see these protocols developed, and monitoring accomplished, through a cooperative effort with our federal partners (i.e., the Environmental Protection Agency [EPA], Fish and Wildlife Service [FWS], and National Marine Fisheries Service [NMFS]) and the State of Alaska. Accordingly, I am directing the Forest Supervisors to convene an interagency group within 60 days to develop recommended monitoring protocols for the monitoring questions specified in chapter 6 of the Forest plan [USDA Forest Service 1997a]. I have requested the participation of the Pacific Northwest Research Station to assist in these efforts. I would also like private organizations, recognized tribes, and interested individuals to have an opportunity to participate in monitoring activities.

Table 1 summarizes how information on monitoring issues was used and how risks were documented in developing the Forest Plan.

Review of Overall Consistency

While we remain value-neutral on the Tongass Forest plan, our evalutions indicated that the plan achieved a high degree of overall consistency with the available scientific information. The major decisions related to management of riparian habitat, beach fringe habitat, and estuarine areas are consistent with the information base. Decisions on management of steep slopes and karst and cave resources also are consistent with available information. Decisions on development of an old-growth forest reserve strategy to provide habitat for well-distributed wildlife populations across the Tongass are consistent with available information. Treatment of timber resources and socioeconomic issues is consistent with available information, although decisions on these issues, especially socioeconomics, are subject to more uncertainty than the foregoing issues. And finally, the process now in place to monitor various issues, and accelerate research in high priority areas, helps assure that any remaining areas of uncertainty are subjected to ongoing reevaluation.

Metric Equivalents

When you know:	Multiply by:	To find:
feet	0.31	meters
miles	1.61	kilometers
acres	0.40	hectares
board feet per acre	0.017	cubic meters per hectare

References

Alaback, P.B.; Tappeiner, J.C. 1991. Response of western hemlock (*Tsuga heterophylla*) and early huckleberry (*Vaccinium ovalifolium*) seedlings to forest windthrow. Canadian Journal of Forest Research. 21: 534-539.

Alexander, E.B. 1987. Mass failure hazard rating, Tongass National Forest. Document dated June 23, 1987. 5 p. On file with: USDA, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane, Suite 2A, AK 99801-8545.

Aley, T.; Aley, C; Elliot, W.; Huntoon, P. 1993. Karst and cave resource significance assessment. Draft report. 76 p. On file with: USDA, Forest Service, Ketchikan Area, Ketchikan, AK 99901.

Allen, S.D.; Robertson, G.; Schaefers, J. [In press]. Economics in transition: an assessment of trends relevant to management of the Tongass National Forest. Gen. Tech. Rep. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Anadromous Fish Habitat Assessment Team [AFHA]. 1995. Report to Congress: anadromous fish habitat assessment. R10-MB-279. Juneau, AK: U. S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; Alaska Region. [Irregular pagination].

Autrey, J.T.; Baichtal, J.F. 1992. Evidence suggesting coastal refugia in southern southeast Alaska during the height of the late Wisconsin glaciation [Abstract]. In: Proceedings, Alaska Anthropological Association: 19th annual meeting; 1992 March 27-29; Fairbanks, AK. [Place of publication unknown]: Alaska Anthropological Association.

Babik, N. 1983. Soil-woodland correlation field data sheet, small island south of Brownson Island. On file with: Alaska Region, Box 21628, Juneau AK 99802-1628.

Baichtal, J.F. 1993a. An update on the exploration and resource evaluation of the cave resources on the Ketchikan Area of the Tongass National Forest, southern southeast Alaska [Abstract]. In: Proceedings of the 20th annual meeting of the Alaska Anthropological Association; 1993 April 8-10; Anchorage, AK. [Place of publication unknown]: Alaska Anthropological Association.

Baichtal, J.F. 1993b. Karst and cave resources. In: Central Prince of Wales Island final environmental impact statement. R10-NM-229A. Juneau, AK: U.S. Department of Agriculture, Forest Service, Tongass National Forest: 179-200.

Baichtal, J.F.; Swanston, D.N. 1996. Karst landscapes and associated resources: a resource assessment. Gen. Tech. Rep. PNW-GTR-383. Portland, OR: U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station. 13 p. (Shaw, Charles G., III; Julin, Kent R., tech. coords.; Conservation and resource assessments for the Tongass land management plan revision).

Banner, A.; MacKenzie, W.; Haeussler, S.[and others]. 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region. Part 2: Ministry of Forests research program. Prince Rupert, BC: [Publisher unknown].

Barnes, G.H. 1962. Yield of even-aged stands of western hemlock. Tech. Bull. 1273. Washington, DC: U.S. Department of Agriculture, Forest Service. 52 p.

Beschta, R.L.; Bilby, R.E.; Brown, G.W. [and others]. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. In: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contrib. 57. [Seattle, WA]: College of Forest Resources, University of Washington: 191-232.

Bisson, P.A.; Bilby, R.E.; Bryant, M.D. [and others]. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. In: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contrib. 57. [Seattle, WA]: College of Forest Resources, University of Washington: 143-190.

Bjornn, T.C.; Reiser, D.W. 1991. Habitat requirements of salmonids in streams. In: Meehan, W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Publ. 19. Bethesda, MD: American Fisheries Society: 83-138.

Bormann, B.T.; Spaltenstein, H.; McClellan, M.H. [and others]. 1995. Rapid soil development after windthrow disturbance in pristine forests. Journal of Ecology. 83: 747-757.

Brickell, J.E. 1989. Review of forest inventory methodology and results. Tongass National Forest Unpublished report. 28 p. On file with: USDA Forest Service, Alaska Region, 709 W. 9th Street, Juneau, AK 99801.

Brock, T.; Kissinger, E. 1995. Questioning the suitability of volume class 4 forests that occur on organic soils. Posit. pap. On file with: USDA Forest Service, Tongass Land Management Planing Office, 8465 Old Dairy Road, Juneau, AK 99801.

Brooks, D.J; Haynes, R.W. 1997. Timber products output and timber harvests in Alaska: projections for 1997-2010. Gen. Tech. Rep. PNW-GTR-409. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 17 p. (Shaw, Charles G., III, tech. Coord.; Conservation and resource assessments for the Tongass land management plan revision).

Bryant, M.D.; Swanston, D.N.; Wissmar, R.C.; Wright, B.E. [In prep.]. Salmonid populations in the karst landscape of north Prince of Wales Island, southeast Alaska.

Burkey, T.V. 1995. Extinction rates in archipelagos: implications for populations in fragmented habitats. Conservation Biology. 9: 527-541.

Chapman, J.A.; Feldhamer, G.A., eds. 1982. Wild mammals of North America. Baltimore, MD: The Johns Hopkins University Press. 1147 p.

DeGange, A.R. 1996. A conservation assessment of the marbled murrelet in southeast Alaska. Gen. Tech. Rep. PNW-GTR-388. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 72 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Dixon, E.J.; Mann, D.H.; Edwards, M. [and others]. 1992. Prehistory and paleoecology of southeastern Alaska karst: a prospectus for interdisciplinary research submitted to the National Science Foundation. 23 p. On file with: USDA, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane, Suite 2A, Juneau, AK 99801-8545.

Everest, F.H.; Armantrout, N.B.; Keller, S.M. [and others]. 1985. Chapter 10, salmonids. In: Brown, E.R., tech ed. 1985. Management of wildlife and fish habitats in the forests of western Oregon and Washington. Part 1: Chapter narratives. R6-F&WL-192-1985. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region: 199-230.

Everest, F.H.; Beschta, R.L.; Schrivener, J.C. [and others]. 1987. Fine sediment and salmonid production: a paradox. In: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contrib. 57. [Seattle, WA]: College of Forest Resources, University of Washington: 191-232.

Farr, W.A. 1984. Site index and height curves for unmanaged even-aged stands of western hemlock and Sitka spruce in southeast Alaska. Res. Pap. PNW-326. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 26 p.

Ford, D.C.; Williams, P.W. 1994. Karst geomorphology and hydrology. London: Chapman and Hall. 601 p.

Forest Ecosystem Management Assessment Team [FEMAT]. 1993. Forest ecosystem management: an ecological, social, and economic assessment. Portland, OR: U.S. Department of Agriculture; U.S. Department of the Interior [and others]. [Irregular pagination].

Furniss, M.J; Roelofs, T.D.; Yee, C.S. 1991. Road construction and maintenance. In: Meehan, W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Publ. 19. Bethesda, MD: American Fisheries Society: 297-324.

Gende, S.M.; Willson, M.F.; Marston, B.H. [and others]. [In press]. Bald eagle nesting in relation to clearcut logging in southeast Alaska. Biological Conservation.

Gregory, S.V.; Bisson, P.A. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. In: Stouder, D.J.; Bisson, P.A.; Naiman, R.J., eds. Pacific salmon and their ecosystems, status and future options. New York: Chapman and Hall: 277-314.

Gregory, S.V.; Swanson, F.J.; McKee, W.A.; Cummins, K.W. 1991. An ecosystem perspective of riparian zones: focus on links between land and water. BioScience. 41(8): 540-551.

Harlow, H.J. 1994. Trade-offs associated with the size and shape of martens. In: Baskirk, S.W.; Harestad, A.S.; Raphael, M.G.; Powell, R.A., eds. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press: 391-403.

Harris, A.S. 1989. Wind in the forests of southeast Alaska and guides for reducing damage. Gen. Tech. Rep. PNW-GTR-244. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 63 p.

Harris, A.S.; W.A. Farr. 1974. The forest ecosystem of southeast Alaska. 7: Forest eocolgy and timber management. Gen. Tech. Rep. PNW-GTR-25. Portland, OR: U.S. Department of Agriculture Forest Service, Pacific Northwest Forest and Range Experiment Station. 109 p.

Hartman, G.F.; Brown, T.G. 1987. Use of small, temporary, floodplain tributaries by juvenile salmonids in a west coast rain forest drainage basin, Carnation Creek, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences. 44: 262-270.

Heaton, T.H.; Grady, F. 1992. Preliminary report on the fossil bears of El Capitan Cave, Prince of Wales Island, Alaska. Current Research in the Pleistocene. 9: 97-99.

Hicks, B.J.; Hall, J.D.; Bisson, P.A.; Sedell, J.R. 1991. Responses of salmonids to habitat changes. In: Meehan, W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Publ. 19. Bethesda, MD: American Fisheries Society: 483-518.

Iverson, G.C. 1997. Old-growth forest habitat conservation strategy: Alexander Archipelago wolf and Queen Charlotte goshawk. In: Tongass land management planning record. On file with: USDA Forest Service, Tongass Land Management Office, 8465 Old Dairy Road, Juneau, AK 99801. 30 p. [plus appendices].

Iverson, G.C.; Hayward, G.D.; Titus, K. [and others]. 1996. Conservation assessment for the northern goshawk in southeast Alaska. Gen. Tech. Rep. PNW-GTR-387. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 101 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Iverson, G.C.; Renè, B. 1997. Conceptual approaches for maintaining well-distributed, viable wildlife populations: a resource assessment. In: Julin, K.R., comp. Assessments of wildlife viability, old-growth timber volume estimates, forested wetlands, and slope stability. Gen. Tech. Rep. PNW-GTR-392. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station:1-23. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Janik, P. 1994. Personal communication, Dec. 29, 1994. Regional Forester, Alaska Region, Box 21628, Juneau, AK 99802-1628.

Janik, P. 1995. Instructions to field units. Letter dated Aug. 25, 1995, from the Regional Forester, Alaska Region. On file with: USDA Forest Service, Alaska Region, Box 21628, Juneau, AK 99802-1628.

Johnson, N.K. 1986. FORPLAN version 1: structures and options guide. Washington DC: U.S. Department of Agriculture, Forest Service.

Julin, K.R.; Caouette, J.P. 1997. Options for defining old-growth timber volume strata: a resource assessment. In: Julin, K.R., comp. Assessments of wildlife viability, old-growth timber volume estimates, forested wetlands, and slope stability. Gen. Tech. Rep. PNW-GTR-392. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 24-37. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Julin, K.R.; McClellan, M.H. 1996. Forest growth of wetland soils in southeast Alaska. Unpublished study plan. 55 p. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane, Suite 2a, Juneau, AK 99801.

Julin, K.R.; Meade, C.T. 1997. Tentative suitability of forested wetlands for timber production: a resource assessment. In: Julin, K.R., comp. Assessments of wildlife viability, old-growth timber volume estimates, forested wetlands, and slope stability. Gen. Tech. Rep. PNW-GTR-392. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 38-43. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Kiester, A.R.; Eckhardt, C., eds. 1994. Review of wildlife management and conservation biology on the Tongass National Forest: a synthesis with recommendations. Corvallis, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 282 p.

Kissinger, E.; Kaija, K.; Skrine, G. 1979. Preliminary report, investigation of stunted second growth stands, south Kupreanof area. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 11 p.

Kondzela, C.M.; Guthrie, C.M.; Hawkins, S.L. [and others]. 1994. Genetic relationships among chum salmon populations in southeast Alaska and northern British Columbia. Canadian Journal of Fisheries and Aquatic Sciences. 51(1): 50-64.

Lawford, R.; Alaback, P.B.; Fuentes, E.R., eds. 1996. High latitude rainforests of the west coast of the Americas: climate, hydrology, ecology, and conservation. New York: Springer-Verlag.

Lidicker, W.Z., Jr. 1994. Tongass land management plan scientific review. In: Kiester, A.R.; Eckhardt, C., eds. Review of wildlife management and conservation biology on the Tongass National Forest: a synthesis with recommendations. Corvallis, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 84-93.

Linstone, H.A.; Turoff, M., ed. 1975. The Delphi method: techniques and applications. Reading, MA: Addison-Wesley. 620 p.

MacArthur, R.H. 1972. Geographical ecology. New York: Harper and Row.

MacArthur, R.H.; Wilson, E.O. 1967. The theory of island biogeography. Monographs in Population Biology 1. Princeton, NJ: Princeton University Press.

MacDonald, S.O.; Cook, J.A. 1996. The mammals of southeast Alaska: a distribution and taxonomic update. Fairbanks, AK: The University of Alaska Museum.

Meehan, W.R., ed. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Publ. 19. Bethesda, MD: American Fisheries Society. 751 p.

Meyer, W.H. 1937. Yield of even-aged stands of Sitka spruce and western hemlock. Tech. Bull. 544. Washington DC: U.S. Department of Agriculture, Forest Service. 86 p.

Moore, P.D. 1982. Beneath the blanket bogs of Britian. Natural History. November: 49-54.

Murphy, M.L.; Meehan, W.R. 1991. Stream ecosystems. In: Meehan, W.R., ed. Influences of forest and rangeland management on salmonid fishes and their habitats. Spec. Publ. 19. Bethesda, MD: American Fisheries Society: 417-46.

Nowacki, G.J.; Kramer, M.G. [In prep.]. The natural disturbance regime with emphasis on wind disturbance. In: Shaw, Charles G., III, tech. coord. Conservation and resource assessments for the Tongass land management plan revision.

Parker, D.I. 1996. Forest ecology and distribution of bats in Alaska. Fairbanks: University of Alaska Fairbanks. 72 p. M.S. thesis.

Paustian, S.J., ed. 1992. A channel type users guide for the Tongass National Forest, southeast Alaska. R10-TP-26. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 179 p.

Person, D.K.; Kirchoff, M.; Van Ballenberghe, V. [and others]. 1996. The Alexander Archipelago wolf: a conservation assessment. Gen. Tech. Rep. PNW-GTR-384. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 42 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Pianka, E.R. 1988. Evolutionary ecology. 4th ed. New York: Harper and Row.

Ralph, C.J.; Hunt, G.L.; Raphael, M.G.; Piatt, J.F. 1995. Ecology and conservation of marbled murrelets in North America: an overview. In: Ralph, C.J.; Hunt, G.L.; Raphael, M.G.; Piatt, J.F., eds. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 3-22.

Reeves, G.H.; Benda, L.E.; Burnette, K.M. [and others]. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. In: Proceedings of a symposium on evolution and the aquatic ecosystem: defining unique units in population conservation; 1994 [day and month unknown]; Monterey, CA. Symp. 17. Bethesda, MD: American Fisheries Society: 334-349.

Reeves, G.H.; Everest, F.H.; Sedell, J.R. 1993. Diversity of juvenile salmonid communities in basins in coastal Oregon, U.S.A., with different levels of timber harvest activity. Transactions of the American Fisheries Society. 122(3): 309-317.

Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contrib. 57. [Seattle, WA]: College of Forest Resources, University of Washington. 471 p.

Shaw, C.G., III. [In prep.]. Use of risk assessment panels during revision of the Tongass land management plan. In: Shaw, Charles G., III, tech. coord. Conservation and resource assessments for the Tongass land management plan revision.

Sonstegard, R.A.; Leatherland, J.F. 1984. Great Lakes coho salmon as an indicator organism for ecosystem health. Marine Environment Research. 14: 480.

Soulé, M.E.; Wilcox, B.A. 1980. Conservation biology. Sunderland, MA: Sinauer Associates, Inc.

Stephens, F.R.; Gass, C.R.; Billings, R.F.F. 1968a. Provisional site index curves based on tallest Sitka spruce and bh age. Rep. 1, R-10 Soil-Site Index Administrative Study. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 11 p.

Stephens, F.R.; Gass, C.R.; Billings, R.F.F. 1968b. Soils and site index curves based on tallest Sitka spruce and bh age. Rep. 2, R-10 Soil-Site Index Administrative Study. Juneau, Ak: U.S. Department of Agriculture, Forest Service, Alaska Region. 17 p.

Stouder, D.J., Bisson, P.A.; Naiman, R.J., eds. 1997. Pacific salmon and their ecosystems, status and future options. New York: Chapman and Hall. 685 p.

Sullivan, K.; Lisle, T.E.; Dolloff, C.S. [and others]. 1987. Stream channels: the link between forests and fishes. In: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contrib. 57. [Seattle, WA]: College of Forest Resources, University of Washington: 39-97.

Suring, L.H.; Crocker-Bedford, D.C.; Flynn, R.W. [and others]. 1993. A proposed strategy for maintaining well-distributed, viable populations of wildlife associated with old-growth forests in southeast Alaska. U.S. Department of Agriculture, Forest Service, Alaska Region; report of the interagency committee, Tongass Land Management Planning Team. 278 p. On file with: U.S. Department of Agriculture, Forest Service, Tongass Land Management Planning Office, 8465 Old Dairy Road, Juneau, AK 99801.

Suring, L.H.; Crocker-Bedford, D.C.; Flynn, R.W. [and others]. 1994. Response to the peer review of: a proposed strategy for maintaining well-distributed, viable populations of wildlife associated with old-growth forests in southeast Alaska. U.S. Department of Agriculture, Forest Service, Alaska Region; response of the interagency committee, Tongass Land Management Planning Team. 11 p. [plus appendices]. On file with: U.S. Department of Agriculture, Forest Service, Tongass Land Management Planning Office, 8465 Old Dairy Road, Juneau, AK 99801.

Swanston, D.N. 1997. Controlling stability characteristics of steep terrain with discussion of needed standardization for mass movement hazard indexing: a resource assessment. In: Julin, K.R., comp. Assessments of wildlife viability, old-growth timber volume estimates, forested wetlands, and slope stability. Gen. Tech. Rep. PNW-GTR-392. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 44-58 (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Swanston, D.N.; Shaw, C.G., III; Smith, W.P. [and others]. 1996. Scientific information and the Tongass land management plan: key findings derived from the scientific literature, species assessments, resources analyses, workshops, and risk assessment panels. Gen. Tech. Rep. PNW-GTR-386. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 30 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

Taylor, R.F. 1934. Yield of second-growth western hemlock-Sitka spruce stands in southeastern Alaska. Tech. Bull. 412. Washington DC: U.S. Department of Agriculture, Forest Service.

U.S. Department of Agriculture, Forest Service. 1979. Tongass land and resource management plan. Juneau, AK: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1982. 36 CFR Part 219, National Forest System Land and Resource Planning. Federal Register, 47(190): 43026-43052

U.S. Department of Agriculture, Forest Service. 1993. FSH 2509.22, Soil and water conservation handbook. Juneau, AK: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1994. A Federal agency guide for pilot watershed analysis, Version 1.2. Portland, OR. 202 p.

U.S. Department of Agriculture, Forest Service. 1995. GIS inventory of remaining old-growth blocks on the Tongass National Forest. On file with: USDA Forest Service, Tongass Land Management Planning Office, 8465 Old Dairy Road, Juneau, AK 99801.

U.S. Department of Agriculture, Forest Service. 1996a. Tongass National Forest land and resource management plan revision. Juneau, AK: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1996b. Tongass land management plan revision: revised supplement to the draft environmental impact statement (RSDEIS)— Chapter 3. Environment and effects. R10-MB-314A. Juneau, AK: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1997a. Land and resource management plan: Tongass National Forest. R10-MB-338dd [Juneau, AK]: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1997b. Tongass land management plan revision: final environmental impact statement [FEIS].Part 1: Summary, chapters 1 and 2 and chapter 3 (physical and biological environment). R10-MB-338b. Juneau, AK]: Alaska Region.

U.S. Department of Agriculture, Forest Service 1997c. Tongass land management plan revision: record of decision [ROD]. R10-MB-338a. [Juneau, AK]: Alaska Region.

U.S. Department of Agriculture, Forest Service. 1997d. Tongass National Forest land and resources planning record. On file with: USDA Forest Service, Tongass Land Management Planning Office, 8465 Old Dairy Road, Juneau, AK 99801.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Draft environmental assessment for implementation of interim strategies for managing anadromous fish-producing watersheds in eastern Oregon, Washington, Idaho, and portions of California. Washington, DC. 68 p.

U.S. Public Laws, Statutes, etc. 1960. Public Law 74-215. Multiple-use Sustained Yield Act of 1960. 16 U.S.C. 528-531.

U.S. Public Laws, Statutes, etc. 1974. Public Law 93-378. Forest and Rangeland Renewable Resources Planning Act of 1974. 16 U.S.C. 1601(1974).

U.S. Public Laws, Statutes, etc. 1976. Public Law 94-588. National Forest Management Act of 1976. 16 U.S.C. 1604, section 6 (e)(1).

U.S. Public Laws, Statutes, etc. 1990. Public Law 101-626. Tongass Timber Reform Act of 1990. 16 U.S.C. 539d(1990).

U.S. Public Laws, Statutes, etc. 1994. FY 1994 Appropriations Act for Interior and related agencies.

Weetman, G.F.; Fournier, R.; Baker, J. [and others]. 1989. Foliar analysis and response of fertilized chlorotic Sitka spruce plantations on salal-dominated cedar-hemlock cutovers on Vancouver Island. Canadian Journal of Forest Research. 19: 1501-1511.

White, W.B. 1988. Geomorphology and hydrology of karst terrains. New York: Oxford University Press. 464 p.

White, W.B.; White, E.L., eds. 1989. Karst hydrology: concepts from the Mammoth Cave area. New York: Van Nostrand and Reinhold. 346 p.

Wissmar, R.C.; Swanston, D.N.; Bryant, M.D.; McGee, K. 1997. Factors influencing stream chemistry in catchments on Prince of Wales Island, Alaska. Freshwater Biology. 38: 101-114.Alaska.

Zaborske, R. 1995. Personal communication. Regional silviculturist, Alaska Region, Box 21628, Juneau, AK 99802-1628.

Appendix 1

This appendix is a comparison of the recommendations in AFHA (1995) with standards and guidelines, elements, and features in the Forest plan for protection of anadromous fish habitats in the Tongass National Forest.

Authors of the AFHA report (1995), in response to congressional directives, made numerous recommendations for management of aquatic and riparian habitats. These recommendations were a combination of scientific information and the professional experience and personal values of those making the recommendations. Correspondence from Regional Forester, Phil Janik, clearly states that he believed the AFHA recommendations, and their associated risk levels, were well founded and warranted careful consideration in the TLMP revision (Janik 1994). He suggested that AFHA (1995) should be the benchmark against which aquatic and riparian management decisions in the final TLMP alternative are compared and evaluated. We followed this suggestion and make that comparison here.

The AFHA is currently the definitive assessment for anadromous fish in the Tongass. The document was prepared in response to directives in the 1994 Congressional Appropriations Act Conference Committee Report (U.S. Public Laws, Statutes, 1994). The Alaska Region of the Forest Service was directed to:

- Proceed with stream analyses and studies and review procedures related to the PACFISH strategy in 1994 in order to study the effectiveness of current procedures (for protecting the habitat of anadromous salmonids).
- Determine if any additional protection (for anadromous fish habitat) is needed.

The AFHA report concluded that current procedures (those used in timber harvest activities after passage of the Tongass Timber Reform Act of 1990) were not fully effective in protecting anadromous fish habitat in the long term and made recommendations for improved protection.

Some of the AFHA recommendations could be accomplished by strengthening current direction for management of fish habitat and riparian zones on the Forest. The Regional Forester (Janik 1995) subsequently issued instructions to field units to accomplish the things necessary to comply with those specific recommendations from the AFHA report.

A second set of AFHA recommendations required new management direction, or changes in Forest policy, for implementation. Those recommendations were referred to TLMP by the Regional Forester for study and consideration in the current revision of the Tongass land management plan. The planning team addressed each of the recommendations, and the results were incorporated in the plan RSDEIS (USDA Forest Service 1996b), subsequently modified, and then included in the FEIS for the Forest Plan (USDA Forest Service 1997b).

The AFHA recommendations examined in the TLMP process were:

- To increase protection of headwater areas: steep slopes, high-hazard soils, and class III and IV streams.
- To modify streamside buffers on flood plains, alluvial fans, and confined alluvial channels.

- To clarify the current Tongass plan direction to “...preserve the biological productivity of all fish streams on the Tongass.”
- To establish quantitative objectives for fish habitat capability.

Many AFHA recommendations on these issues were general. For example, recommendations in the fish habitat assessment team report from the expert field review (AFHA 1995:24) state:

> Stream Buffers: Buffer design should consider fish habitat, and water and sediment routing, rather than just the presence or absence of fish species. Buffers should also match the site topography, and those associated with flood plains managed to at least the borders of the active flood plain. Buffers should be designed to remain windfirm. Generally 100-foot buffers are not sufficient on larger, unconfined class I and II streams to meet these needs. Numerous suggestions were made on how to size the width of buffers to retain the buffer function, considering the amount of windthrow in southeast Alaska. Recommendations ranged from maintaining an additional 25% width of the needed “functional” buffer size, to incorporating entire flood plains plus 100 additional feet. Recommendations were also made that no harvest occur in areas of extreme windthrow hazard. Salvage of windthrow timber in buffers should not be allowed because the windthrown trees function to break-up the force of wind as it approaches the remaining standing timber and provide nurse logs for tree regeneration.

Other summary AFHA recommendations (AFHA 1995:38-43) were more specific:

> Additional protection of fish habitat requires two parallel efforts: the first is an ecosystem approach for evaluating and protecting watershed processes and functions at the landscape scale, and the second is the full implementation of Best Management Practices in planning and implementing activities that could affect aquatic ecosystems [p. 38].
>
> We recommend implementing watershed analysis using concepts presented in A Federal Agency Guide for Pilot Watershed Analysis (USDA Forest Service 1994) as a precursor to timber sales and other management activities that could significantly influence fish habitat [p. 39].
>
> We recommend as part of watershed analysis, that Riparian Management Areas be defined and the area within them managed to fully protect fish habitat in the long-term [p. 39].
>
> Because watershed analysis on all Tongass watersheds will not be implemented immediately, we propose the following interim recommendations:
>
> We recommend that riparian zones adjacent to unconfined alluvial flood plain channels, alluvial fan channels, and glacial outwash channels (Paustian 1992) should not be subject to timber harvest unless they are fully evaluated. The entire flood plain should be considered as the interim Riparian Management Area. In these channel types, riparian zones may extend beyond the minimum width specified under current procedures because the

stream is often dissected into a main low-flow channel with several side channels. These side channels are important fish habitat (Hartman and Brown 1987). Ecosystem-scale analysis should consider the whole riparian area, as defined by riparian soils and vegetation. Site specific harvest is only allowable when these riparian areas are fully evaluated and the purpose is consistent with the goal of full riparian protection [p. 39].

We recommend using a distance equivalent to the height of a site-potential tree to determine the Riparian Management Area width (assuming it is greater than 100 feet) for confined alluvial channel types of class I and II streams. In no case would Riparian Management Areas be less than 100 feet wide. Again, proposed harvest in these areas should fully protect riparian values. We had similar concerns about confined alluvial channel types that are class I and II streams. In these channels, debris recruitment may come from beyond a fixed distance, depending on bank slope, topography, and tree height of the dominant debris-producing trees [p. 39].

We recommend minimum 100-foot buffers on each side of class III streams until individual needs are identified during watershed analysis. Class III streams have important water quality values. These streams also are sources for woody debris recruitment and litter, and they deliver nutrient and sediment inputs into larger streams (FEMAT 1993:app. C.2; Gregory and others 1991; Hicks and others 1991). These streams are typically high-gradient streams often associated with steep, unstable terrain. Timber management opportunities within the buffers are evaluated case by case, considering mass movement hazards as debris, litter, nutrient, and sediment input [p. 39-43].

We recommend defining a new category, class IV streams for the intermittent or ephemeral colluvial channels and small, perennial spring-fed rill channels that are not dominant sediment transport channels. Streams that are currently unclassified and class III streams that are misclassified cause some confusion. They should be managed primarily to protect water quality. These streams are typically very small, high-gradient streams draining mountain slopes. They rarely need buffer strips, but often require special provisions for felling, yarding, and determining where to place landings and roads [p. 40].

We recommend that consistent Forest-wide definitions, inventory standards, and interpretations of mass-movement-hazard areas be developed, and that a full inventory and analysis of high-and very high-hazard soils be conducted [p. 40].

We recommend adopting the following additional management measures where steep slopes, high-hazard soil conditions, or both threaten fish habitat:

High-hazard soils should not be clearcut or roaded before their mass-movement potential is assessed on site.

No slopes greater than 84% should be clearcut.

No coluvial hollows or highly dissected mountain slopes greater than 70% should be clearcut [p. 40].

The AFHA (1995:45) also states the following in regard to riparian management objectives:

> We recommend fish habitat objectives for large woody debris, width/depth ratio, and pool frequency based on currently undisturbed conditions. We also recommend further analysis and inventory to establish additional fish habitat objectives.

In regard to upslope stability:

> Areas of very high mass-movement hazard are removed from the timber base.

In regard to watershed analysis:

> Watershed analysis is recommended before timber harvest and other major land-disturbing activities. This recommendation is similar to the PACFISH (USDA Forest Service and USDI Bureau of Land Management 1994) strategy.

The foregoing recommendations indicate that the intent of AFHA (1995) is to increase protection of class I and II flood-plain systems, alluvial fan channels, and confined alluvial channels, provide buffer protection to class III streams, reduce the risk to fish habitat from mass erosion, and develop quantitative management objectives for aquatic systems. It is recommended that watershed analyses be conducted to ascertain the site-specific prescriptions needed to protect riparian and fish habitats before major human disturbances are conducted. The AFHA (1995:16) also states that without first conducting watershed and project analyses, the default buffer along class I and II flood-plain channels, alluvial fan channels, and glacial outwash channels is the entire flood plain; along class I and II confined alluvial channels, the buffer is the height of one site-potential tree; and along class III streams, the buffer is 100 feet of limited harvest.

These recommendations were forwarded to the TLMP team for further study, analysis, and modification as necessary to clarify and meet the intent of the AFHA (1995) report, and finally, incorporation into the TLMP revision process. In accordance with the AFHA recommendations, management of aquatic and riparian habitat in the Tongass has two goals: (1) the stated goal in the Tongass land management plan RSDEIS (USDA Forest Service 1996b) is to "maintain and restore the natural range and frequency of aquatic habitat conditions Forest-wide to sustain the diversity and production of fish and other freshwater organisms"; and, (2) it is the policy of the Alaska Region of the Forest Service to manage the Forest to avoid listing of fish stocks under the Endangered Species Act. These goals are clearly aimed at maintaining the biological productivity of the Forest's fisheries and preventing any management that might lead eventually to the nonviability of fish stocks.

An interdisciplinary and interagency group of specialists took the AFHA (1995) recommendations and crafted a set of standards and guidelines (riparian option 2) to meet the intent of AFHA (USDA Forest Service 1996a:sec. 2.9). At the same time, two other sets of standards and guides were crafted. Riparian option 1, more restrictive than AFHA, is similar to the PACFISH (USDA Forest Service and USDI Bureau of Land Management 1994) strategy of the Pacific Northwest. Riparian option 3 is similar to procedures currently used in the Tongass to manage fish and riparian habitats. The standards and guides for these three riparian management options were differentially applied to the array of alternatives described in the Tongass RSDEIS (USDA Forest Service 1996b).

The riparian standards and guides in the Forest plan are not identical to riparian standards and guides in any of the draft alternatives described in the RSDEIS, although they contain elements from several of the draft alternatives. The Forest-wide riparian standards and guides for the final TLMP alternative are subdivided into general standards and guides, and those for each stream process group. In general, the standards and guides are written as direction for management of riparian habitat in the Tongass. The direction can be changed after watershed analysis, if the objectives established for each process group can be met. The guidelines provide well-defined defaults that will be used for riparian buffers and other management practices in the absence of watershed analysis. The riparian standards and guides developed for the Forest plan in the TLMP FEIS (USDA Forest Service 1997a) and key recommendations from the AFHA (1995) report are compared for consistency in table 5. With minor exceptions noted in the table, the riparian standards and guides of the Forest plan are consistent with the recommendations and intent of the AFHA (1995) report.

Table 5—Comparison of some key AFHA[a] recommendations with standards and guidelines in the Tongass Forest plan for management of riparian areas.

AFHA recommendation	Are final TLMP standards and guides consistent with AFHA?		
	Yes	No	Unknown
Use ecosystem approach for protecting watershed processes and functions	X		
Implement existing best management practices	X		
Implement watershed analysis	X[b]		
Define riparian management areas and manage to fully protect fish habitat in the long term	X		
No timber harvest in flood plains of glacial outwash, alluvial fan[c], and flood-plain process groups before watershed analysis	X		
Any timber harvest in flood plains of glacial outwash, alluvial fan, and flood-plain process (postwatershed analysis) must meet riparian protection goals	X		
Use distance equal to height of 1 site-potential tree to define riparian management areas along confined alluvial channels of class I and II streams	X		
Use minimum 100-foot buffers on each side of class III streams until individual needs are determined during watershed analysis	X		
Design buffers to remain windfirm	X		
Develop a new stream class (IV)	X		
Manage class IV streams to protect water quality	X		
Control timber harvest of steep and unstable slopes	X		
Develop consistent definitions, inventory standards, and interpretations of mass-movement hazard areas	X		
Develop objectives for fish habitat management	X		
No timber salvage in riparian areas unless approved by line officer in consultation with fisheries biologist or other resource experts	X		

[a] Anadromous Fish Habitat Assessment (1995).

[b] There are minor differences in use of watershed analysis but overall level of protection meets AFHA.

[c] Some unprogrammed timber harvest could be allowed in the alluvial fan process group before watershed analysis if objectives of the process group are met.

Appendix 2

This appendix is a comparison of the viable population committee reports and the final TLMP alternative.

Concerns about long-term viability of wildlife on the Tongass caused the leader of the Tongass land management planning team to establish an interagency viable population committee (V-POP) in 1990. The committee's report (Suring and others 1993) provided recommendations for an old-growth forest retention strategy designed to protect long-term wildlife viability in the Tongass. The committee also made recommendations designed to maintain the viability of individual wildlife species. The committee's report was subsequently subjected to peer review (referred to here as the "peer review") by a team of scientists commissioned by PNW (Kiester and Eckhardt 1994). An attempt was made to reconcile differing recommendations made in the original V-POP report and the peer review to provide a consistent set of recommendations for an old-growth-retention strategy to provide habitat sufficient to meet viability needs for all wildlife species in the Tongass. Preliminary recommendations for reconciliation were made in a report (Suring and others 1994) but were never subjected to scientific analysis or review. These documents articulate the need for a strategy to maintain habitat for old-growth-associated wildlife in the Tongass and make recommendations for one or more ways to achieve that goal.

The V-POP report and the peer review contain detailed recommendations on how to achieve wildlife viability on the Tongass National Forest. The recommendations, however, are not science but rather a combination of scientific information and interpretation, integrated with professional experience and personal values embodying a level of risk the authors thought appropriate. Recommendations of this type cannot be subjected to a science consistency check by using the criteria defined in this paper. Because of the interagency interest in the V-POP report and peer review, the recommendations are compared to the Forest plan in tables 6, 7, and 8. Remember, when reviewing the tables, that they do not represent a science consistency check but a comparison of one possible strategy for managing wildlife habitat in the Tongass with another.

Tables 6, 7, and 8 summarize, respectively, the degree of consistency between the Forest plan and the recommendations of the V-POP committee, the peer review, and the attempted reconciliation between the latter two.

Table 6—Comparison of V-POP[a] committee recommendations for wildlife viability and standards and guidelines for implementing the Tongass Forest plan

	Forest plan		
V-POP recommendations	Meets or exceeds V-POP	Addresses needs with another strategy[b]	Fails to address species needs
Old-growth habitat: Size, quality and distribution of large, medium, and small habitat conservation areas	X		
Matrix: Management of forested lands subject to timber harvest between reserves		X	
Great blue heron (*Ardea herodias*): Within 2 yr after nesting, no development within 1/8 mile of nest, or flights within 660 feet elevation (1/4 mile) of active nest, March 1-July 31.		X	
Goshawk: Inventory timber sales for active nests; estimate breeding pair home range and male core area; no disturbance in core, < 5% in home range		X	
Wolf and roads: Maintain open road density ≤1 mi/mi^2 including shorelines) in any 3 contiguous Alaska Department of Fish and Game wildlife analysis areas (WAAs) where wolves occur and roads are accessible to communities ≥1,000 people (≤1.25 mi/mi^2 in WAAs next to roadless or wilderness areas)		X	
Wolf and prey: Maintain habitat for ≥5 deer/mi^2 where deer are primary prey	X		
Brown bear: Locate human facilities ≥1 mile from seasonal brown bear concentrations; protect habitat and reduce human-bear conflicts; close roads in habitat conservation areas (HCAs) except during resource extraction; maintain 300-foot buffer along salmon streams that are important bear feeding areas; no roads within 300 feet of these streams	X		
River otter: 500-foot old-growth buffers along marine coastline and 1,000-foot buffers along estuaries	X		
Goats: Maintain 100% of potential winter habitat capability for populations of ≤50 goats as determined by models; protect kidding areas May 1-Aug. 1; keep development ≥1 mile from winter habitat and kidding areas; reduce human-goat conflicts via seasonal restrictions	X		

Table 6—Comparison of V-POP[a] committee recommendations for wildlife viability and standards and guidelines for implementing the Tongass Forest plan (continued)

	Forest plan		
V-POP recommendations	Meets or exceeds V-POP	Addresses needs with another strategy[b]	Fails to address species needs
Boreal owl (*Aegolius funereus*): Provide HCAs ≥5,000 acres ≤10 miles apart; protect nests outside HCAs with 0.5-mile buffer	X		
Flying squirrel: Maintain ≥1 patch of 1,000 acres of productive old growth (POG) per watershed; maintain corridors of POG between POG patches; corridor interruptions ≤65 feet; other details, see Suring and others (1993:255)	X		
Marten: Large, medium, and small HCAs recommended; consider connectivity among HCAs; minimize roads, HCAs, and corridors; employ effective road management techniques	X		

[a] Suring and others (1993).

[b] Level of risk likely differs from that embodied (but undefined) within V-POP recommendation.

Table 7—Comparison of peer review[a] recommendations for wildlife viability and standards and guidelines for implementing the Tongass Forest plan

Peer review recommendations	Forest plan: Meets or exceeds V-POP[b] peer	Forest plan: Addresses needs with another strategy[c]	Forest plan: Fails to address species needs
Vancouver Canada goose (*Branta canadensis*): Broaden the array of habitat features to evaluate habitat capability; include as a management indicator species	X		
Bald eagle: Standards and guidelines should be based on field information as well as habitat capability estimates	X		
Hairy woodpecker: Maintain specific micro-habitat features or mitigate for continued persistence across the forest, especially patches of recently dead trees; include as management indicator species	X		
Red-breasted sapsucker (*Sphyrapicus varis*): Develop habitat standards, especially for winter; include as management indicator species	X		
Brown creeper (*Certhia familiaris*): Use existing habitat capability index model to evaluate habitat; include as management indicator species	X		
Wolf: Needs more protected habitat than available in the Tongass National Forest, cooperate with other agencies and Canada to maintain habitat; provide effective road management	X		
Black bear (*Ursus americanus*): Require suitable matrix management with small clearcuts and alternative methods of harvesting; distribution and quality of habitat conservation areas (HCAs) reflect naturally fragmented nature of Tongass National Forest; emphasize HCAs and connectivity where needed most	X		
Brown bear: Preferred standards and guides meet V-POP and peer recommendations	X		
Marten: Need HCA strategy with different spacing than proposed by V-POP; matrix management better solution than in preferred alternative (P)	X		
River otter: No specific management recom-mendations beyond V-POP	X		
Deer: No additional specific guidelines related to management of this species	X		

Table 7—Comparison of peer review[a] recommendations for wildlife viability and standards and guidelines for implementing the Tongass Forest plan (continued)

Peer review recommendations	Forest plan: Meets or exceeds V-POP peer[b]	Forest plan: Addresses needs with another strategy[c]	Forest plan: Fails to address species needs
Mountain goat (*Oreamnos americanus*): Do not focus just on habitat for ≤50 animals; evaluate existing and additional fragmentation for this species		X	
Red squirrel (*Tamiasciurus hudsonicus*): Not included in V-POP species list; ensure availability of spruce cones and other habitat features at a spatial scale to maintain breeding populations and interactions among populations		X	
Great blue heron: Recommendations similar to those in V-POP report		X	
Goshawk: proposed under V-POP likely not adequate; matrix management likely critical to maintaining habitat capability		X[d]	
Boreal owl: Management of second growth next to HCAs critical in maintaining populations of this species		X	
Northern flying squirrel: No new management considerations; maintain corridors to facilitate movement		X	
Blue grouse (*Dendragapus obscurus*): No evidence that this species should be considered as a management indicator species	X		

[a] Keister and Eckhardt (1994).

[b] Suring and others (1993).

[c] Level of risk likely differs from that embodied (but undefined) within V-POP and peer review recommendations.

[d] See Iverson and others (1996).

Table 8—Comparison of reconciliation between V-POP[a] and peer review[b] recommendations for wildlife viability and standards and guidelines for implementing the Tongass Forest plan

V-POP and peer review reconciliation	Forest plan: Meets or exceeds V-POP reconciliation	Forest plan: Addresses needs with another strategy[c]	Forest plan: Fails to address species needs
Restrict logging and road building to areas other than volume classes 6 and 7 old-growth forest below 800 feet elevation		X	
Restrict logging, road building, and salvage sales to areas other than large and medium habitat conservation areas (HCAs)	X		
Restrict logging and road building to areas outside 3 largest old-growth forest patches within each ecological province		X	
Establish a 0.5- to 1-mile buffer around all large and medium HCAs as a special management zone in which road building and clearcutting are prohibited		X[d]	
Connect large and medium HCAs with corridors where logging is not allowed (1,600+feet wide between large HCAs; 1,000+feet wide between medium HCAs): keep corridors below 800 feet elevation. Place a 3,300-foot-wide "special management zone" along the coastline		X[d]	
Maintain old-growth forests that have been identified as important wildlife habitat through local knowledge or field experience (e.g., wildlife habitat retention areas mapped in the current plan[e])		X	

[a] Suring and others (1993).

[b] Keister and Eckhardt (1994).

[c] Level of risk likely differs from that embodied (but undefined) within V-POP and peer review recommendations.

[d] See Iverson and others 1996.

[e] USDA Forest Service 1979.

Appendix 3

Evaluation of Wildlife Viability in the Forest Plan Through Risk Assessment Panels

Scientists on the TLMP team used panels of subject matter experts, somewhat similar to the "Delphi method" (Linstone and Turoff 1975), to independently evaluate each of the original nine draft Forest plan alternatives for likely effects on wildlife populations (Shaw, in prep.; Swanston and others 1996). A second set of risk assessment panels was held early in 1997 to similarly evaluate the emerging final alternative (Shaw in prep.; USDA Forest Service 1997b:app. N). Members of each panel independently evaluated a selected species (or group) for the likelihood of obtaining specific outcomes regarding its status and distribution following implementation for 100 years of each draft Forest plan alternative. Each wildlife species (or group) was selected according to specific life history characteristics and habitat needs. Our intent was to select an array of old-growth associates whose individual life histories were dissimilar; yet, collectively their ecologies incorporated the breadth of forest habitat features and other environmental variation represented across the Tongass National Forest.

Six wildlife panels were conducted in the first set of panels: brown bear, marbled murrelet, Queen Charlotte goshawk, Alexander Archipelago wolf, American marten, and "other terrestrial mammals," which comprised a group of more wide ranging mammals and a group of endemic small mammals, some with known distributions in southeast Alaska that are restricted to a few islands or isolated portions of the mainland (MacDonald and Cook 1996). Except for marbled murrelet, the second set of panels considered the same species.

Each panel was comprised of subject matter experts who independently evaluated each draft Forest plan alternative (Shaw, in prep.; Swanston and others 1996). Each evaluator served on only one panel in each set, but most evaluators served on that species' panel in both sets. With one exception, none of the evaluators had previous involvement with the TLMP process. During the panel, each evaluator independently assigned 100 "likelihood" points across five outcomes for each alternative. Likelihood points assigned to each outcome were not probabilities in the empirical sense of frequencies; rather, they reflected extent of conviction, or uncertainty, according to available information and sound professional judgment in expected outcomes and were expressed through a probability-like scale. Individual ratings remained anonymous. A scribe recorded scores, computed a mean score for each alternative, and provided all results to each panel member for further discussion.

The "other terrestrial mammals" panel followed this general procedure with one notable exception: evaluators examined 14 species, most of them old-growth associates, but selected what they considered to be the most sensitive species or group of species to evaluate the effect of each alternative on the guild. For some alternatives, this group was comprised of a few or even one species. This, in part, reflected differences in geographic distribution of many island endemics and the variation in human-caused disturbance represented among alternatives. In many circumstances, however, several species were viewed as responding similarly to a selected alternative. Regardless, this guild was treated similarly to the single species in that 100 points were assigned for each alternative (Shaw, in prep.; Swanston and others 1996).

Outcomes reflected the expected population distribution and abundance of wildlife species relative to current condition of habitat in the Tongass, and to the projected condition of habitat following implementation of each draft alternative for 100 years (Shaw, in prep.; Swanston and others 1996).

The five outcomes were:

I Habitat is of sufficient quality, distribution, and abundance to allow the species to maintain well-distributed breeding populations across the Tongass National Forest. The concept of well distributed must be based on knowledge of the distributional range of the species and its life history.

II Habitat is of sufficient quality, distribution, and abundance to allow the species to maintain breeding populations across the Tongass National Forest. Some local populations, however, are more ephemeral because of reduced population levels and increased susceptibility to environmental extremes and stochastic events associated with reduced habitat abundance and distribution. Vacated habitats may become recolonized in the future.

III Habitat is of sufficient quality, distribution, and abundance to allow the species to maintain some breeding populations, but with significant gaps in the historic distribution on the Forest. These gaps likely are permanent and will result in some limitation of interaction among local populations. Significance of gaps must be judged relative to the distributional range of the species and its life history.

IV Habitat allows continued species existence only in refugia, with substantial limitations on interactions among local populations. Significance of extirpations across islands or regional landscapes must be evaluated relative to the distributional range of the species and its life history.

V Habitat conditions result in species extirpation from Federal land.

Limited discussions by the evaluators in the first set of panels (along with our appraisal of the notes from these sessions) related to outcomes meeting the condition of maintaining well-distributed populations across the planning area led us to derive two new outcomes from the original five: (1) populations likely will be well distributed—thus, mean likelihood scores from outcomes that likely will maintain well distributed populations (i.e., outcomes I and II in the previous list) for each species (or group) were summed to represent outcome I; and (2) populations likely will not be well distributed relative to their historic range—mean likelihood scores from the remaining outcomes (i.e., outcomes III, IV, and V) were summed to represent outcome II (Shaw, in prep.; Swanston and others 1996).

Each of the second set of panels had considerable, indepth discussion on this issue and on the differences, if any, between "viable" and "well-distributed" populations. Results of these discussions indicated that the panelists' concepts of habitat conditions sufficient to support viable and well-distributed populations differed but, generally, fell within outcome III with well distributed being the more stringent criterion to meet.[1] Because of the indepth discussion of these topics in the second set of panels, we place more emphasis on their evaluation of where within the five habitat outcomes the concepts of habitat sufficient to support viable and well-distributed populations are described. As such, the boundaries of the two new outcomes changed such that only outcomes IV and V clearly represent (except for brown bear viability, which may be only outcome V; Shaw, in prep.) habitat conditions where populations likely will not be well distributed relative to their historic range.

---

[1] Evaluators indicated that well distributed equaled the sum of outcomes I and II for endemic mammals.

Mean likelihood scores among the five initial outcomes for the wildlife species common to both sets of panels appear in appendix N of the FEIS (USDA Forest Service 1997b). The means are presented with an understanding that there is a variance, often large, around these values (Swanston and others 1996). These tables also present the scores as summed for outcomes I and II combined, and outcomes I, II, and III combined to help evaluate the concept of habitat sufficient to support viable and well-distributed populations. Results of the first set of panels, including those for marbled murrelet, also appear in the wildlife section of chapter 3 of the FEIS (USDA Forest Service 1997b:351-430).

Evaluation of Wildlife Viability in the Forest Plan

Assessment—Before the second set of risk assessment panels occurred, the emerging final alternative had not been subjected to risk assessment panels. Because of the high interest in the likely risk to wildlife viability posed by the then-emerging final alternative, we reviewed the issue by examining substantive changes from draft alternative 3, the base from which the emerging final alternative was developed, and evaluated the direction (i.e., increase or decrease) of changes in risk to wildlife species. Particular emphasis on risk to Alexander Archipelago wolf and Queen Charlotte goshawk was evaluated because those species were being considered for listing under the Endangered Species Act.

To evaluate risk associated with the emerging final alternative, we examined the likelihood scores from the first set of panels for draft alternative 3, the draft alternative on which the final was based, and assessed effects of the departure of each design element from draft alternative 3.

The substantive departures from alternative 3 in the RSDEIS (USDA Forest Service 1996b) included:

1. Departures that decrease risk:

- A reduction in projected cut of old-growth acreage from about 571,000 to 474,000 acres over a 100-year timber rotation, with an associated reduction in building of roads.
- A mechanism for controlling road access when necessary to protect wolves and brown bears.
- An increase in spatially explicit reserves and the connectivity among reserves.
- More old-growth retention in timber LUDs.
- An increase in protected beach fringe from 500 to 1,000 feet.
- The removal of islands ≤1,000 acres from the timber base to increase protection of small endemic mammals.
- A survey and manage standard that requires biological evaluations for “sensitive” small mammals before timber harvest on islands ≤ 50,000 acres.
- An increase in protection of principal brown bear feeding areas along salmon streams.
- An increase in the number of wild and scenic rivers.
- Increased “firmness” in the language of standards and guidelines.

2. Departures that increase risk:

- A reduction in protection of riparian systems (i.e., from riparian options 1 and 2 applied to Forest Habitat Integrity Program[1] 1 and 2 watersheds, respectively, to a revised and improved option 2 Forest-wide).
- A reduction in the amount of timber harvested with prescriptions other then clear-cutting from matrix lands between reserves (i.e., from 100 percent to an unknown percentage in areas designated in green, yellow, and brown on the Forest plan map; fig. 1, inside back cover).
- A decrease in protection levels for specific deer winter ranges.

The risk to wildlife viability from implementing draft alternative 3 was represented by the sum of likelihood scores assigned to outcomes III, IV, and V combined in the first set of panels (Swanston and others 1996). Conceptually, this sum represented the view of the first set of panels that "not meeting well distributed" described populations across the Forest of each of the six species or groups evaluated. Expected effects on wildlife viability of implementing draft alternative 3 for 100 years differed among wild-life species but can be characterized through three discernible groups, based on the first set of risk assessment panel likelihood scores: the marbled murrelet and the Alexander Archipelago wolf, which each had >80-percent likelihood of maintaining well-distributed populations across the planning area; the brown bear, American marten, and northern goshawk, which had roughly a 50-50 distribution of mean likeli-hood scores; and endemic mammals, where at least one species had less than a 25-percent likelihood of maintaining well-distributed populations across the Tongass National Forest (Swanston and others 1996).

Each of the significant changes (made to draft alternative 3 to develop the emerging final alternative) independently affected risk to wildlife viability. How much each design element influences wildlife viability, or more importantly, the cumulative effect of these changes, is difficult to quantify.

Each projected departure in alternative elements differs in the manner and the extent of its influence on the risk to viability of individual species. Each projected departure also differs in its effect among different species. The change in riparian protection, for example, primarily reduces the number of headwater buffers for class III streams; nar-row strips of riparian timber associated with this change are of limited value to old-growth-associated wildlife species. The change from two-age timber management in the matrix lands between reserves to primarily clearcutting may have some negative affect on overall biodiversity, but the isolated clumps of old growth left by two-age management likely would provide limited habitat features for some old-growth-associated species in the original alternative 3.

Although the TLMP scientists cannot ascribe numerical changes in risk (i.e., specific likelihood scores) to wildlife viability associated with each change, the direction of these changes in the emerging final alternative appeared to present an increase from draft alternative 3 in the likelihood of wildlife populations meeting criteria for being well-distributed. The reduction in total acres of old-growth forest scheduled to be cut in the next 100 years and the associated reduction in new roads, increased old-growth forest area dedicated to reserves, increased protection of brown bear feeding

---

[1] Forest Habitat Integrity Program (FHIP) defines highest quality watersheds for sport and commercial fish.

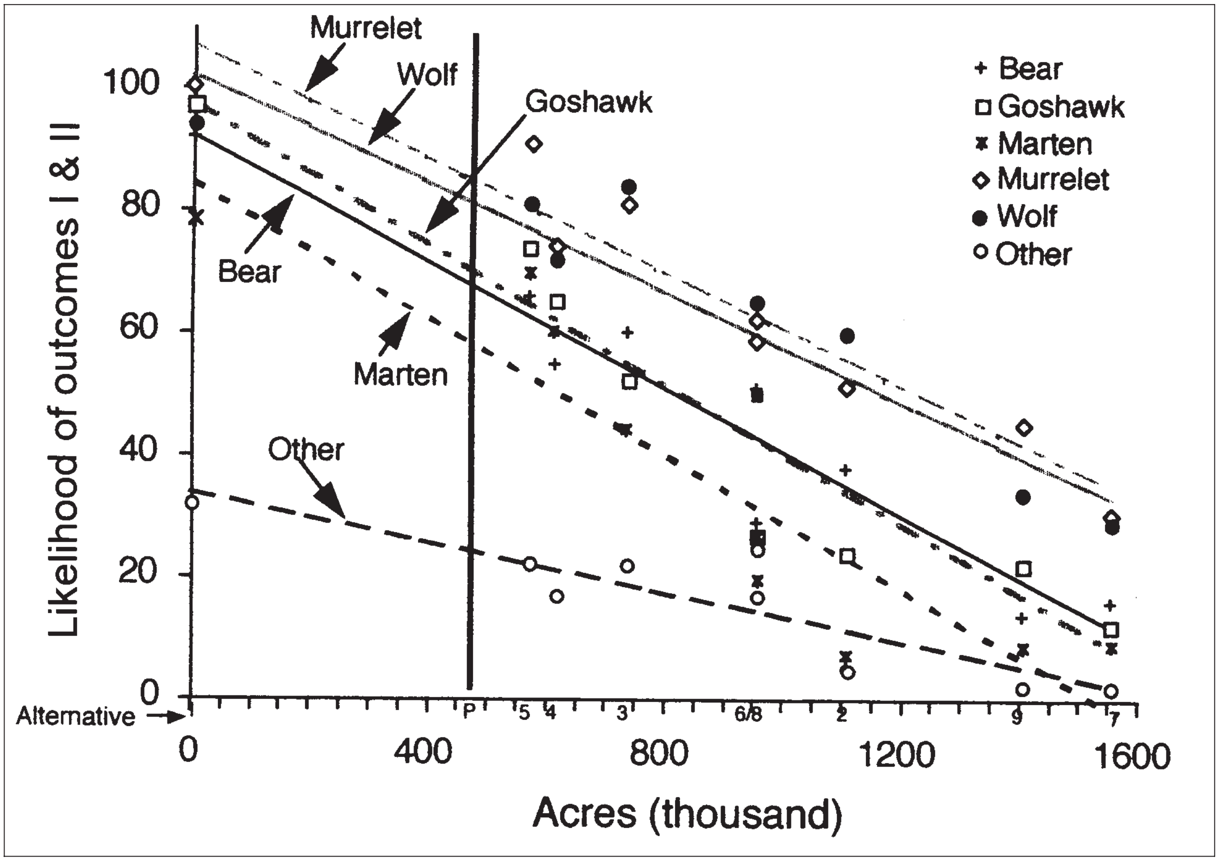


Figure 2—Analysis of mean scores from the first set of risk assessment panels indicated a negative correlation between acres of old-growth forest scheduled for harvest over the next 100 years in each draft alternative and the correspondingly assigned likelihood scores for maintaining habitat sufficient to support well-distributed populations of selected wildlife species across the Tongass. Partially from this relation, we estimated that the emerging final alternative, with 474,000 acres of productive old-growth scheduled for harvest over the next 100 years, would fall between draft alternatives 1 and 5 in its likeilhood of maintaining habitat sufficient to support well-distributed populations of various wildlife species.

areas, increased protection for small endemic mammals, and firmer standards and guidelines are important factors that decrease risk to wildlife viability. For example, reduction in total acres of productive old-growth scheduled to be harvested appeared to correspond with increases in assigned likelihood scores of maintaining well-distributed populations among the species reviewed by the first set of panels (fig. 2), probably because panelists used acres harvested as a surrogate for habitat loss during the evaluation process.

The lines in figure 2 are a regression plot of mean, first-set panel scores for each draft alternative. Without subjecting figure 2 to more analysis than is appropriate, and assuming that panelists would have applied the same criteria in evaluating the emerging final alternative as they did in evaluating draft alternatives, it is reasonable to assume that had panelists rated the emerging final alternative, their mean scores would have fallen between those assigned to draft alternatives 1 and 5. Following this logic, combined mean scores for outcomes I and II (i.e., meeting the concept of well-distributed as distilled from the first set of panels) likely would fall between 81 and 94 for the Alexander Archipelago wolf, and between 74 and 98 for the Queen Charlotte goshawk. Accordingly, we estimated that the emerging final alternative would have a lower risk to wildlife viability than all draft alternatives except draft alternative 1; i.e., risk would fall between alternatives 1 and 5.

The original nine draft alternatives were consistently discernible as three groups relative to their likelihood of "meeting well-distributed" criteria for each wildlife species or group (USDA Forest Service 1996b). Draft alternatives 1, 4, and 5 represented a group that generally had the greatest likelihood of meeting criteria for well distributed, whereas draft alternatives 2, 7, and 9 had the least likelihood of meeting these criteria. Draft alternative 3 was among a group, including alternatives 6 and 8, intermediate in their likelihood of meeting for criteria well distributed (USDA Forest Service 1996b). The emerging final alternative appears to fall within the first group that generally had the greatest likelihood of meeting well-distributed criteria.

Corroboration—Conducting the second set of risk assessment panels provided us with an unexpected opportunity to examine further our evaluation of the risk level associated with the emerging final alternative. Considering that the second set of panels further clarified their concepts of where within the outcomes habitat sufficient to support well-distributed populations is represented (generally within outcome III), our estimated range of scores within which the emerging final alternative would fall was similar to the results from the second set of risk assessment panels—the comparable panel scores for well-distributed populations would be between 83 and 97 for the Alexander Archipelago wolf and between 71 and 97 for the Queen Charlotte goshawk.

Our evaluation that the risk posed by the emerging final alternative to wildlife viability would be lower than all draft alternatives except alternative 1 was only partially corroborated by results from the second set of panels. This evaluation was consistent with panel scores for most species of fish, wolf, and endemic mammals—but not the other species paneled. Rather, the panel results more closely paralleled our third generalization; namely that the emerging final alternative fell within a group with original draft alternatives 1, 4, and 5—a group that had the greatest likelihood of meeting criteria for well distributed.

Additional measures were added to the Forest plan after the second set of panel evaluations. These measures were designed to further reduce the risk posed by the Forest plan to wildlife viability, most specifically for the northern (Queen Charlotte) goshawk and the American marten. Actions designed to improve connectivity among blocks of old-growth forest, where needed, also were included. These measures are discussed in the wildlife section in the body of this document, in the wildlife standards and guidelines for the Forest plan (USDA Forest Service 1997a), and in appendix N of the FEIS (USDA Forest Service 1997b).

Everest, Fred H.; Swanston, Douglas N.; Shaw, Charles G., III; Smith, Winston P.; Julin, Kent R.; Allen, Stewart D. 1997. Evaluation of the use of scientific information in developing the 1997 Forest plan for the Tongass National Forest. Gen. Tech. Rep. PNW-GTR-415. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 69 p. (Shaw, Charles G., III, tech. coord.; Conservation and resource assessments for the Tongass land management plan revision).

How scientific information was used in making management decisions relative to the Tongass land management plan was examined and evaluated on whether the decisions were consistent with the available information. The final conclusion was that the management decisions made in developing the final alternative achieved a relatively high degree of consistency with the available scientific information.

Keywords: Tongass National Forest, forest management, land management planning, science evaluation, science policy

Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, Oregon 97208-3890

This page has been left blank intentionally.
Document continues on next page.

U.S. Department of Agriculture
Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, OR 97208