

Cruise Report

NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2

(June 1-12, 2004)

**“A Pilot Survey of Deepwater Coral/Sponge Assemblages and their
Susceptibility to Fishing/Harvest Impacts at the Olympic Coast National
Marine Sanctuary (OCNMS)”**

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SUMMARY

The offshore shelf and canyon habitats of the OCNMS (Fig. 1) are areas of high primary productivity and biodiversity that support extensive groundfish fisheries. Recent acoustic surveys conducted in these waters have indicated the presence of hard-bottom substrates believed to harbor unique deep-sea coral and sponge assemblages. Such fauna are often associated with shallow tropical waters, however an increasing number of studies around the world have recorded them in deeper, cold-water habitats in both northern and southern latitudes. These habitats are of tremendous value as sites of recruitment for commercially important fishes. Yet, ironically, studies have shown how the gear used in offshore demersal fishing, as well as other commercial operations on the seafloor, can cause severe physical disturbances to resident benthic fauna. Due to their exposed structure, slow growth and recruitment rates, and long life spans, deep-sea corals and sponges may be especially vulnerable to such disturbances, requiring very long periods to recover. Potential effects of fishing and other commercial operations in such critical habitats, and the need to define appropriate strategies for the protection of these resources, have been identified as a high-priority management issue for the sanctuary.

To begin addressing this issue, an initial pilot survey was conducted June 1-12, 2004 at six sites in offshore waters of the OCNMS (Fig. 2, average depths of 147-265 m) to explore for the presence of deep-sea coral/sponge assemblages and to look for evidence of potential anthropogenic impacts in these critical habitats. The survey was conducted on the NOAA Ship McARTHUR-II using the Navy's Phantom DHD2+2 remotely operated vehicle (ROV), which was equipped with a video camera, lasers, and a manipulator arm for the collection of voucher specimens. At each site, a 0.1-m² grab sampler also was used to collect samples of sediments for the analysis of macroinfauna (> 1.0 mm), total organic carbon (TOC), grain size, and chemical contaminants. Vertical profiles of salinity, dissolved oxygen (DO), temperature, and pressure were recorded at each site with a small SeaCat conductivity-temperature-depth (CTD) profiler. Niskin bottles attached to the CTD also obtained near-bottom water samples in support of a companion study of microbial indicators of coral health and general ecological condition across these sites. All samples except the sediment-contaminant samples are being analyzed with present project funds.

Original cruise plans included a total of 12 candidate stations to investigate (Fig. 3). However, inclement weather and equipment failures restricted the sampling to half of these sites. In spite of the limited sampling, the work completed was sufficient to address key project objectives and included several significant scientific observations. Foremost, the cruise was successful in demonstrating the presence of target deepwater coral species in these waters. Patches of the rare stony coral *Lophelia pertusa*, more characteristic of deepwater coral/sponge assemblages in the North Atlantic, were observed for the first time in OCNMS at a site in 271 meters of water. A large proportion of these corals consisted of dead and broken skeletal remains, and a broken gorgonian (soft coral) also was observed nearby. The source of these disturbances is not known. However, observations from several sites included evidence of bottom trawl marks in the sediment and derelict fishing gear (long lines). Preliminary results also support the view that these areas are important reservoirs of marine biodiversity and of value as habitat for demersal fishes. For example, onboard examination of 18 bottom sediment grabs revealed benthic infaunal species representative of 14 different invertebrate phyla. Twenty-eight species of fishes

from 11 families, including 11 (possibly 12) species of commercially important rockfishes, also were identified from ROV video footage.

These initial discoveries have sparked considerable interests in follow-up studies to learn more about the spatial extent of these assemblages and magnitude of potential impacts from commercial-fishing and other anthropogenic activities in the area. Based on the results thus far, the Pacific Fishery Management Council already has submitted recommendations to the NMFS for a resolution (preliminary DEIS/EFH for groundfish, December 2004) to place a temporary ban on non-tribal commercial-trawling operations in the northern half of the sanctuary, where hard-bottom habitat suitable for the growth of corals is highly concentrated. It is essential to expand our knowledge of these deep-sea communities and their vulnerability to potential environmental risks in order to determine the most appropriate management strategies.

The survey was conducted under a partnership between NOAA's National Centers for Coastal Ocean Science (NCCOS) and National Marine Sanctuary Program (NMSP) and included scientists from NCCOS, OCNMS, and several other west-coast State, academic, private, and tribal research institutions (see Section 4 for a complete listing of participating scientists).

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1.0 Introduction

The offshore shelf and canyon habitats of the OCNMS (Fig. 1) are areas of high primary productivity and biodiversity that support extensive groundfish fisheries. In addition, recent acoustic and bottom-profile surveys conducted in these areas suggest the presence of hard-bottom substrates believed to harbor unique deep-water coral and sponge assemblages. Such fauna are often associated with shallow tropical waters, however an increasing number of studies around the world have recorded them in deeper, cold-water habitats in both northern and southern latitudes. These habitats are of tremendous value as sites of recruitment for commercially important fishes. A growing management concern is that extensive bottom-trawling and other anthropogenic activities within sanctuary waters may be having significant harmful effects on these unique and valuable resources. Prior studies have shown how the gear used in offshore demersal fishing, as well as other commercial operations on the seafloor (such as cable trenching), can cause severe physical disturbances to resident benthic fauna (e.g., NRC 2002, NOAA/USGS/AFS/ESA 2002). Moreover, due to their exposed structure, slow growth and recruitment rates, and long life spans, deep-sea corals and sponges may be especially vulnerable to such disturbances, requiring very long periods to recover. OCNMS has a critical need to explore and document these resources in order to provide enhanced protection to such critical and sensitive habitats. Accordingly, the present survey set out to document the presence of deep-sea coral/sponge assemblages within sanctuary waters and to look for evidence of their potential risk to fishing and other anthropogenic impacts, and thus possible need of more protective zoning.

This study was supported by FY04 funds under a partnership established in 1999 between NCCOS and NMSP to promote research aimed at addressing critical sanctuary management needs. Zoning, fishing/harvest effects, and characterization of living marine resources have been identified as three of the highest-priority management issues for the OCNMS, based on a recent evaluation of information needs for the NMS program (Gittings et al. 2002) and have been ranked as major concerns in recent national forums (NRC 2002, NOAA/USGS/AFS/ESA 2002). The present study was designed to address all three of these management needs. Zoning and fishing/harvest effects, in particular, have been noted as warranting the greatest increase in research activity (Table OC-2, from Gittings et al. 2002). In addition, condition of critical habitat, and comparisons of impacts in areas of high and low fishing intensity, were identified as high-priority endpoints for four of five west-coast sanctuaries. Thus, the present study is addressing sanctuary-wide management needs common to the broader region.

2.0 Objectives

Specific objectives of the study are:

- To help address resource management questions of the OCNMS by conducting a study to document the presence of critical hard-bottom benthic habitats believed to exist in deepwater areas of the sanctuary (based on acoustic habitat surveys and bottom profiles). These habitats are thought to contain diverse and unique assemblages of corals, sponges, and other associated fauna that may be particularly vulnerable to human disturbances;
- To groundtruth the previous acoustic survey records by confirming the presence of these habitats;

- To characterize the diversity, abundances, and health of living marine resources associated with both hard-bottom and soft-bottom substrates in these areas;
- To evaluate fishing/harvest pressures on these critical habitats and their associated fauna in areas of low and high fishing intensity;
- To generate GIS-compatible data on critical habitat, associated species of concern, and basic habitat types in these areas to support future biogeographic mapping efforts; and
- To provide support to sanctuary-wide interests on the west coast to address such topics as condition of critical habitats, and fishing/harvest impacts in these areas, which have been identified as unique regional needs for the majority of west-coast sanctuaries.

3.0 Methods

To begin addressing the above objectives, an initial pilot survey was conducted on June 1-12, 2004 at six offshore sites within the OCNMS (average station depths of 147-265 m) in areas believed to contain critical hard-bottom substrate inhabited by the targeted coral and sponge species (Fig. 2, Table 1). Stations in Table 1 include areas of both high and low fishing intensity to support the evaluation of fishing impacts on these critical habitats and associated fauna. Information used to select these stations came from commercial-fishing records and results of previous acoustic and bottom-profile surveys conducted by the OCNMS and other agencies. Original cruise plans included a total of 12 candidate stations to investigate (Fig. 3, Table 2). However, inclement weather and equipment failures limited the sampling to the six stations listed in Table 1.

The survey was conducted on NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2. The ship (Fig. 4) is 224-feet long with cruising speed of 11 knots, an endurance of 8000 nm and 45 days at sea, and accommodations for a scientific party of up to 15. The ship supported all sampling activities including the use of a Remotely Operated Vehicle (ROV), bottom grabs, and CTD profiles.

Sampling of hard-bottom epifaunal assemblages (inclusive of targeted coral and sponge species) was conducted with underwater photography using the Navy's Phantom DHD2+2 ROV (Fig. 5) equipped with a video camera, lasers, and a manipulator arm for the collection of voucher specimens. At each site, the ROV was deployed along a random transect, with the video camera being used both to fly the vehicle and to obtain photographic footage of bottom substrates and associated fauna. Using the tilt mechanism, footage was obtained of vertical surfaces along high-relief structures as well as flatter low-relief areas. Especially interesting organisms and other objects were recorded and time-coded. Any visual evidence of fishing impacts (e.g., trawl scars, broken coral or sponge parts, derelict gear) in the video images were noted as well. Also, random still photo-frames will be obtained subsequently from the footage and used to help provide quantified estimates of various benthic attributes on an areal basis (e.g., % cover, density/m², # species/m²). The original plan was to supplement this latter effort with random photo-quadrat samples using digital-still photographs; however, design constraints of the small-sized Phantom ROV precluded the simultaneous use of a video camera, manipulator arm, and separate still camera. Initial processing of photographic samples began onboard the ship (i.e., preliminary species identifications where possible). The ROV's manipulator arm was used

where possible to obtain epifaunal voucher specimens and to collect samples of corals in support of a companion study of coral health (see below).

In addition to the ROV operations, a 0.1-m² grab sampler also was used to collect samples of sediments for the analysis of macroinfauna (> 1.0 mm), total organic carbon (TOC), grain size, and chemical contaminants. At each of the six stations, three replicate grabs were collected for macroinfaunal analysis and one additional grab was collected and sub-sampled for the remaining abiotic environmental parameters. As part of the QA/QC procedures, samples that had undergone significant slumping or loss of material through the jaws of the grab (e.g., samples with a sediment layer < 5cm) were rejected. Acceptable macroinfaunal samples were live-sieved onboard through a 1.0-mm screen, placed in adequate/securable plastic containers with lids, and preserved in 10% buffered formalin. Samples for the analysis of sediment grain size and TOC were sub-sampled from composited surface sediment (upper 3-5 cm) collected from the additional grab at each station. The surface layer of sediment was removed from the grab with a scoop, placed in a bowl, and mixed. A TOC sub-sample was then removed from the homogenized sample and placed in a 125-mL plastic jar with lid and stored frozen (-20°C). An additional sub-sample for grain-size analysis was removed from the homogenate and placed in a 500-mL plastic jar with lid and stored frozen (-20°C). All samples were appropriately labeled with pertinent information on the project, station/replicate ID, and sample type. All samples except the sediment contaminant samples are being analyzed with present project funds. The contaminant samples will be archived and analyzed subsequently pending availability of funds.

Vertical profiles of salinity, dissolved oxygen (DO), temperature, and pressure were recorded at each site with a small SeaCat CTD (conductivity, temperature, density). Niskin bottles attached to the CTD rosette also obtained near-bottom water samples in support of the companion study of microbial indicators of coral health and general ecological condition across these sites.

As mentioned above, samples of corals were collected where possible with the manipulator arm of the ROV to provide material in support of a companion coral-health study at the NCCOS/CCEHBR lab in Charleston, SC (led by Dr. Cheryl Woodley and her assistant Sarah Polson). Ongoing studies have led to the development of a variety of novel biomolecular and microbial approaches to assessing the health of corals. In efforts to bring this expertise to bear in the present study, samples for analysis of corals and associated microbial indicators were collected where possible at our sampling sites and provided to Dr. Woodley's laboratory for subsequent analysis. The material included samples of the stony coral *Lophelia pertusa* from one station (Station 3 at 271 m) and samples of sediment and near-bottom water from all six stations. Baseline information on the health of corals associated with these critical habitats would be a valuable contribution to the objectives of this study and goals of the sanctuary.

Data from the present study also will be made available to support other future research efforts at the sanctuary, such as GIS-based biogeographic habitat mapping to be conducted in future years through another NCCOS/OCNMS collaboration. Information on critical habitat, associated living marine resources, and potential fishing impacts in these areas should serve as valuable input data for this subsequent mapping effort.

4.0 Sampling Logistics and Scientific Party

The survey was conducted on NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2, June 1-12, 2004. Mobilization of sampling equipment, including the Navy's Phantom DHD2+2 ROV, occurred in Port Angeles, WA on June 1-2. The ship departed Port Angeles the evening of June 2 and arrived at the first station (11) in the southern end of the study area mid-morning June 3. At-sea operations were conducted June 3-10, during which sampling was completed at the six stations listed in Table 1. Field operations were conducted on an 18-hr/day basis. As feasible, daytime operations (0800 – 2000) were devoted primarily to the ROV work, while nighttime operations (2000 – 0200) were devoted to CTD profiling and sediment grab sampling. The ship returned to Port Angeles the evening of June 10, at which time de-mobilization of all non-ROV scientific crew and equipment occurred. The ship then departed Port Angeles that same evening for Seattle and arrived at the MOC-Pacific home port in Seattle during early morning June 11. Final de-mobilization of the ROV systems occurred on June 12. Further details of these activities are summarized in the Activity Log (Table 3).

This survey was conducted under a partnership between NOAA's National Centers for Coastal Ocean Science (NCCOS) and the Office of National Marine Sanctuaries (ONMS) and included scientists from NCCOS, OCNMS, and several other west-coast state, academic, private, and tribal research institutions. A listing of scientific party members and their affiliations is given in Table 4.

5.0 Preliminary Results

Original cruise plans included a total of 12 candidate stations to investigate (Fig. 3, Table 2). However, inclement weather and equipment failures restricted the sampling to half of these sites (Fig. 2, Table 1). In spite of the limited sampling, the work completed was sufficient to address key project objectives and included several significant scientific observations. Foremost, the cruise was successful in demonstrating the presence of target deepwater coral/sponge assemblages in these waters. Patches of the stony coral *Lophelia pertusa* (Fig. 6) were observed on a rocky ledge at one site (Station 3) in 271 meters of water. Near-bottom water temperature and salinity at this site were 6.5 °C and 33.94 psu, respectively (Table 5). Samples of the coral were collected with the ROV manipulator arm and brought back to use as taxonomic voucher specimens and in support of the companion coral-health study. Initial identification of the coral as *Lophelia* was made in the field by Dr. Alan Kohn, one of the onboard taxonomy specialists, and later confirmed by Dr. Stephen Cairns of the Smithsonian Institution. A related observation also of importance was that a large proportion of these corals consisted of dead and broken skeletal remains. A broken gorgonian (soft coral) also was observed on the seafloor nearby (Fig. 7). The exact source of these disturbances is not known. However, observations from several of the sites (Stations 1, 3, and 11) included accounts of bottom trawl marks in the sediment and derelict fishing gear (long lines; Fig. 8).

Preliminary results of the survey also support the view that these areas are important reservoirs of marine biodiversity. For example, initial onboard visual examination of just 18 bottom sediment grabs (0.1 m² each) revealed benthic infaunal species representative of 14 different invertebrate phyla. These included foraminiferan Protozoa, Porifera, Cnidaria (hydrozoans and anthozoans), Nemertea, Annelida (polychaetes), Mollusca (gastropods, bivalves, scaphopods,

chitons), Arthropoda (crustaceans), Sipunculida (peanut worms), Echiura, Ectoprocta (bryozoans), Brachiopoda (lamp shells), Echinodermata (ophiuroids, holothuroids, echinoids), Hemichordata (acorn worm *Saccoglossus*), and Chordata (Urochordata tunicates). One rock (15 cm by 15 cm), caught accidentally in the jaws of a grab, had species from nine different phyla living on it. Many species of epifaunal invertebrates also were observed from the ROV video footage of rock outcrop and adjacent seafloor throughout the study area. These included hydrozoans, sponges, anemones, gorgonians, sea pens, tubicolous polychaetes, nudibranchs, decapod crustaceans, bryozoans, brachiopods, crinoids (*Flourometra*), sea urchins, starfish, and ophiuroids.

Rocky reefs such as the ones surveyed here can be of tremendous value as habitat for demersal fishes that congregate in these areas for food and shelter. Numerous species of fishes (28) were observed in the present ROV video footage, including 11 (possibly 12) species of the commercially important rockfish guild, family Scorpaenidae (Table 6). Rosethorn rockfish (*Sebastes helvomaculatus*), sharpchin rockfish (*S. zacentrus*) and thornyheads (*Sebastolobus altivelis* and possibly *S. alascanus*) were the most abundant of the rockfishes. Other families identified thus far include Pleuronectidae (flatfish), Bothidae (sanddabs), Zoarcidae (eelpouts), Agonidae (poachers), Bathymasteridae (ronquils), Stichaeidae (pricklebacks), Rajidae (skates), Hexagrammidae (lingcod), Myxinidae (hagfish), and Chimaeridae (ratfish).

The survey also produced at least one species of marine invertebrates new to science. A previously undescribed species of nudibranch (sea slug) was collected in a grab sample from Station 4. The slug (Fig. 9) was 22 mm long and found sitting on its egg mass. Dr. Jeff Goddard, one of the onboard taxonomic specialists, is credited for recognizing it as being a potentially new species of dorid nudibranch. Dr. Sandra Millen of the University of British Columbia later confirmed it to be a new species of the dorid genus *Baptodoris*.

General oceanographic conditions among the various stations, based on results of the CTD profiles and visual inspection of bottom grabs, are summarized in Table 5. Station depths, averaged across replicate grab locations at each station, ranged from 147 m (Station 4) to 265 m (Station 3). Bottom sediments typically consisted of gray muds with varying degrees of gravel, rock, and shell hash. Near-bottom salinity, temperature, and dissolved oxygen (DO) ranged from 33.84–33.97 psu, 6.5–7.1 °C, and 2.46–3.31 mg/L, respectively.

The above preliminary observations will be supplemented with results from follow-up analyses of the video footage (for epifaunal variables) and the grab samples (for infaunal and abiotic sediment variables). As mentioned above, in spite of the downtime caused by poor weather and equipment failures, the survey was highly successful in gathering sufficient information and samples to begin addressing program objectives focused on critical sanctuary management needs. Still, additional future studies will be required to further document the spatial extent of these critical habitats and their potential susceptibility to human activities.

6.0 Acknowledgements

Financial support for this study is provided by FY04 funds through the NCCOS-ONMS Partnership Agreement (NCCOS Proposal 04-2). All members of the scientific crew (Table 4)

are to be commended for their high level of technical expertise, teamwork and dedication to getting the required sampling completed. Special appreciation also is extended to the officers and crew of the NOAA Ship McARTHUR II for their superb job performed on Cruise AR-04-04: Leg 2.

7.0 References

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- National Research Council (NRC). 2002. Effects of trawling and dredging on seafloor habitat. National Academy Press, Washington. 126 pp.
- National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), American Fisheries Society (AFS), and Ecological Society of America (ESA). 2002. "Symposium on Effects of Fishing Activities on Benthic Habitats: Linking Geology, Biology, Socioeconomics, and Management." November 12 – 14, 2002, Tampa, FL.

Table 1. Locations of sampling stations for NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2. Stations are classified by low vs. high categories of anticipated fishing activity based on commercial-fishing records. Water depths are averages of values recorded for replicate grab locations at each station.

| Station | Expected Level of Fishing Intensity | Latitude | Longitude | Average Depth (m) |
|----------------|--|-----------------|------------------|--------------------------|
| OC04001 | High | 48°14.970' | -125°0.793' | 214 |
| OC04003 | High | 48°9.415' | -124°59.979' | 265 |
| OC04004 | Low | 48°7.635' | -125°3.767' | 147 |
| OC04005 | Low | 48°6.732' | -125°8.626' | 209 |
| OC04011 | High | 47°17.564' | -124°47.524' | 241 |
| OC04013 | Low | 48°6.552' | -125°3.878' | 161 |

Table 2. Locations of original 12 candidate sampling sites. Stations are classified by low vs. high categories of anticipated fishing activity. Other rationale for the selection of these sites is included in the comment column.

| Station | Expected Level of Fishing Intensity | Latitude | Longitude | Comments* |
|---------|-------------------------------------|------------|--------------|-----------|
| OC04001 | High | 48°14.970' | -125°0.793' | GT |
| OC04002 | Low | 48°0.714' | -125°19.321' | ND |
| OC04003 | High | 48°9.415' | -124°59.979' | ND/SSS |
| OC04004 | Low | 48°7.635' | -125°3.767' | GT |
| OC04005 | Low | 48°6.732' | -125°8.626' | ND/SSS |
| OC04006 | High | 48°15.901' | -125°0.809' | GT |
| OC04007 | High | 48°9.077' | -125°4.997' | GT |
| OC04008 | Low | 48°22.283' | -124°59.673' | ND/SSS |
| OC04009 | Low | 48°14.536' | -125°9.080' | GT |
| OC04010 | Low | 48°19.982' | -125°2.624' | GT |
| OC04011 | High | 47°17.564' | -124°47.524' | ND/SSS |
| OC04012 | High | 47°46.126' | -125°4.191' | ND |

Comments*

GT = Groundtruth. In addition to being a good candidate coral/sponge site based on evidence of hard-bottom substrate from previous acoustic and bottom-profile surveys, the site also fulfilled the need to groundtruth results of these latter habitat mapping surveys.

ND = No prior acoustic-survey data. Other information, however, suggested these would be potential sites.

ND/SSS = No prior historical data, but new side-scan-sonar data were to be provided for these sites from surveys conducted on the companion Leg 1 of Cruise AR-04-04.

Table 3. Activity log for NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2.

| Date | Time | Activity |
|-------------|---------------------|--|
| 6/01/04 | All day | Begin mobilization of ROV and related equipment in Port Angeles (PA), WA |
| 6/02/04 | 0800-1930 | Continue mobilization of ROV in addition to other non-ROV scientific equipment, supplies & staff. Depart PA 1930 for Station 11 at southern end of study area. |
| 6/03/04 | 1000 | Arrive Station 11. |
| | 1000-1200 | Prepare ROV for launch. |
| | 1200-1500 | Attempted ROV Dive 1 at Station 11; ops aborted due to equipment failure. |
| | 1530-1900 | Bottom grabs & CTD at Station 11. |
| 6/04/04 | 0850-1105 | ROV Dive 2 at Station 11; dive aborted at 1105 due to equipment failure |
| | 1300-1635 | Additional bottom grabs & CTD taken at "Station 11A" near Dive 2 rock outcrop observed at Station 11. Steam to Station 5. |
| | 2242-0041 (6/05/04) | Bottom grabs & CTD at Station 5. |
| 6/05/04 | 0800-1151 | ROV Dive 3 at Station 5. |
| | 1230-1300 | Bathymetric/fathometer survey of Station 5 (to search for relief change). Transit to Station 3. |
| | 1420-2000 | ROV Dive 4 at Station 3. |
| 6/06/04 | 0915-1840 | ROV Dive 5 at Station 1 |
| | 1950-2415 | Bottom grabs & CTD at Station 3 |
| 6/08/04 | 0800-1730 | Standby for safe weather window for ROV ops. Attempt to repair ROV compass. |
| | 1748-2242 | ROV Dive 7 at Station 11 |
| 6/09/04 | 0830-1145 | ROV Dive 8 @ Station 13 |
| | 1245-1540 | Bottom grabs & CTD at |

| | | |
|---------|------------|---|
| | | Station 13. Steam to Station 9A (close to original candidate Station 9) and standby for rest of night. |
| 6/10/04 | 0800-1045 | Continue standby for safe weather window for ROV ops. Abort wait due to continued poor weather. Steam to new optional Station 14 in Straits of Juan de Fuca (off Cape Flattery) & evaluate conditions. Attempt to sample here aborted as well due to weather. Steam to PA & arrive ~1700. |
| | ~1700-2000 | Demobilize all non-ROV scientific equipment, supplies, & staff in PA. Depart for Seattle. |
| 6/11/04 | Early a.m. | Ship arrive MOC-Pacific facility in Seattle. |
| 6/12/04 | Morning | Demobilize ROV equipment & staff. |

Table 4. List of scientific crew members and affiliations for NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2. Scientists Hyland and Bowlby (flagged with asterisks) served as Co-Chief Scientists and can be contacted for further details of the cruise.

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Table 5. General oceanographic conditions among sampling stations based on results of CTD profiles and visual inspection of bottom grabs. Temperature, salinity, and dissolved oxygen (DO) are values for near-bottom water from the CTD. Water depths for each station include two sets of values: (1) values recorded directly from the CTD at the site of the CTD profile, and (2) average of values recorded for replicate grab locations at each station (as in Table 1).

| Station | Depth (m)¹ | Depth (m)² | Salinity (psu) | Temperature (°C) | DO (mg/L) | Sediment Type |
|----------------|----------------------------------|----------------------------------|---------------------------|-----------------------------|----------------------|------------------------------------|
| OC04001 | 194.7 | 214 | 33.9286 | 6.5 | 2.63155 | Gray mud with gravel & shell |
| OC04003 | 256.7 | 265 | 33.9432 | 6.5 | 2.46381 | Gray mud with rock |
| OC04004* | - | 147 | - | - | - | Gray mud with gravel & shell |
| OC04005 | 187.0 | 209 | 33.8924 | 6.7 | 2.9062 | Gray sticky mud |
| OC04011 | 217.7 | 241 | 33.9677 | 6.8 | 2.7343 | Gray mud |
| OC04013 | 189.7 | 161 | 33.8449 | 7.1 | 3.3070 | Gray mud with gravel & shell |

*Note: Near-bottom data from the CTD at Station OC04004 were not available for inclusion in this report due to a problem with the record for that particular depth interval. However, data recorded at a depth of 32 m below the surface at that station included salinity of 32.4 psu, temperature of 9.2 °C, and DO of 8.3 mg/L.

Table 6. Demersal fish species identified from ROV video footage on NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2.

| Family | Scientific Name | Common Name |
|-----------------|-----------------------------------|-----------------------|
| Scorpaenidae | <i>Sebastes helvomaculatus</i> | Rosethorn rockfish |
| | <i>Sebastes zacentrus</i> | Sharpchin rockfish |
| | <i>Sebastes elongatus</i> | Greenstripe rockfish |
| | <i>Sebastes flavidus</i> | Yellowtail rockfish |
| | <i>Sebastes aurora</i> | Aurora rockfish |
| | <i>Sebastes ruberrimus</i> | Yelloweye rockfish |
| | <i>Sebastes babcocki</i> | Redbanded rockfish |
| | <i>Sebastes aleutianus</i> | Rougheye rockfish |
| | <i>Sebastes nigrocinctus</i> | Tiger rockfish |
| | <i>Sebastes borealis</i> | Shortraker rockfish |
| | <i>Sebastolobus altivelis</i> | Longspine thornyhead |
| | <i>Sebastolobus alascanus</i> (?) | Shortspine thornyhead |
| Pleuronectidae | <i>Microstomus pacificus</i> | Dover sole |
| | <i>Eopsetta jordani</i> | Petrable sole |
| | <i>Hippoglossoides elassodon</i> | Flathead sole |
| | <i>Hippoglossus stenolepis</i> | Pacific halibut |
| | <i>Atheresthes stomias</i> | Arrowtooth flounder |
| Bothidae | <i>Citharichthys sordidus</i> | Pacific sanddab |
| Zoarcidae | Spp | Eelpouts |
| Agonidae | Spp | Poachers |
| Bathymasteridae | Spp | Ronquils |
| Stichaeidae | Spp | Pricklebacks |
| Rajidae | <i>Raja binoculata</i> | Big skate |
| | <i>Raja rhina</i> | Longnose skate |
| | <i>Bathyraja kincaidii</i> | Sandpaper skate |
| Hexagrammidae | <i>Ophiodon elongatus</i> | Lingcod |
| Myxinidae | <i>Eptatretus stoutii</i> | Pacific hagfish |
| Chimaeridae | <i>Hydrolagus coliei</i> | Spotted ratfish |



Figure 1. Map of Olympic Coast National Marine Sanctuary (OCNMS).

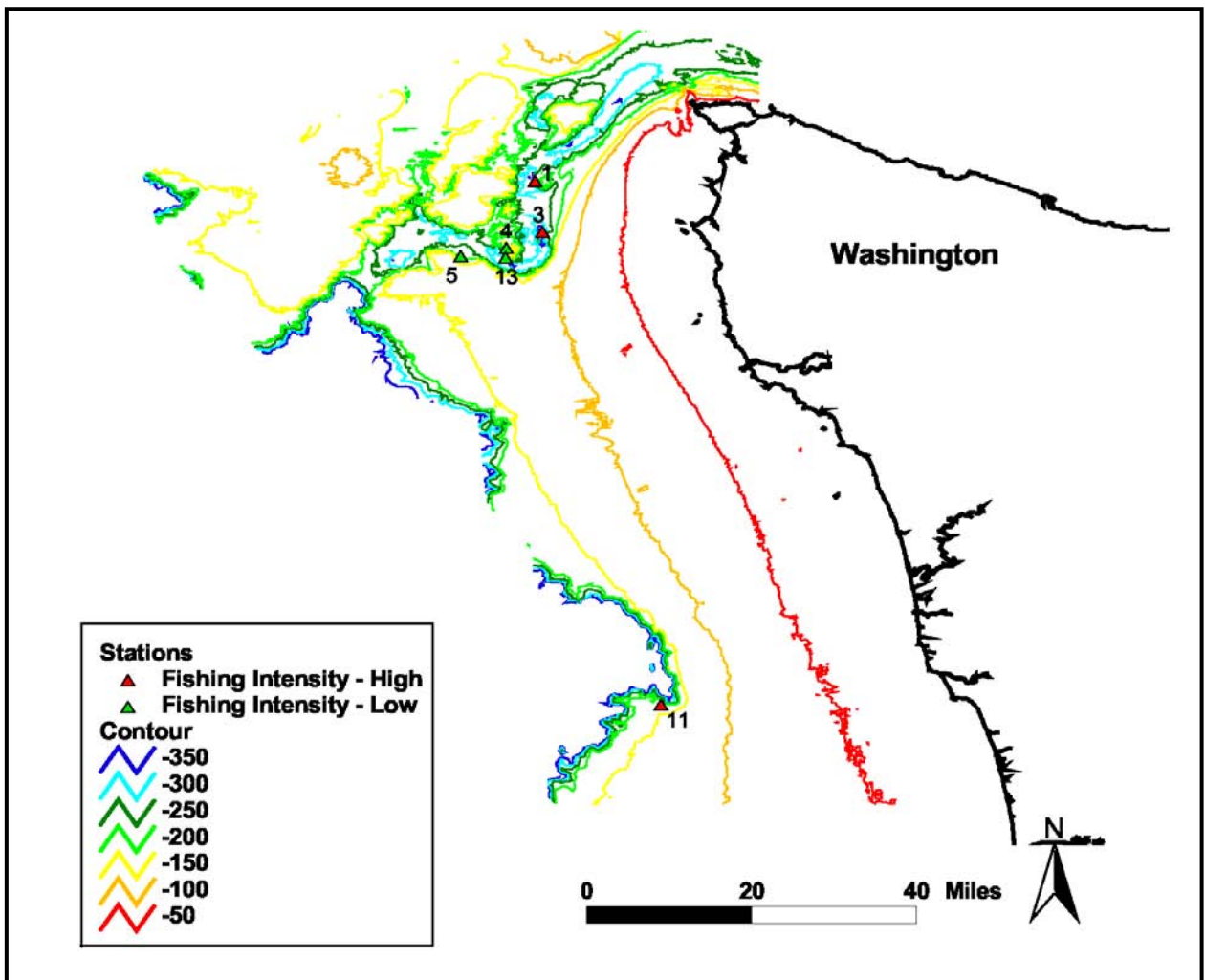


Figure 2. Study area in offshore waters of the OCNMS, showing location of sampling stations for NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2. Red triangles = Stations in areas of high fishing intensity; Green triangles = Stations in areas of low fishing intensity.



Potential ROV Dive Sites and Locations of Side Scan Operations

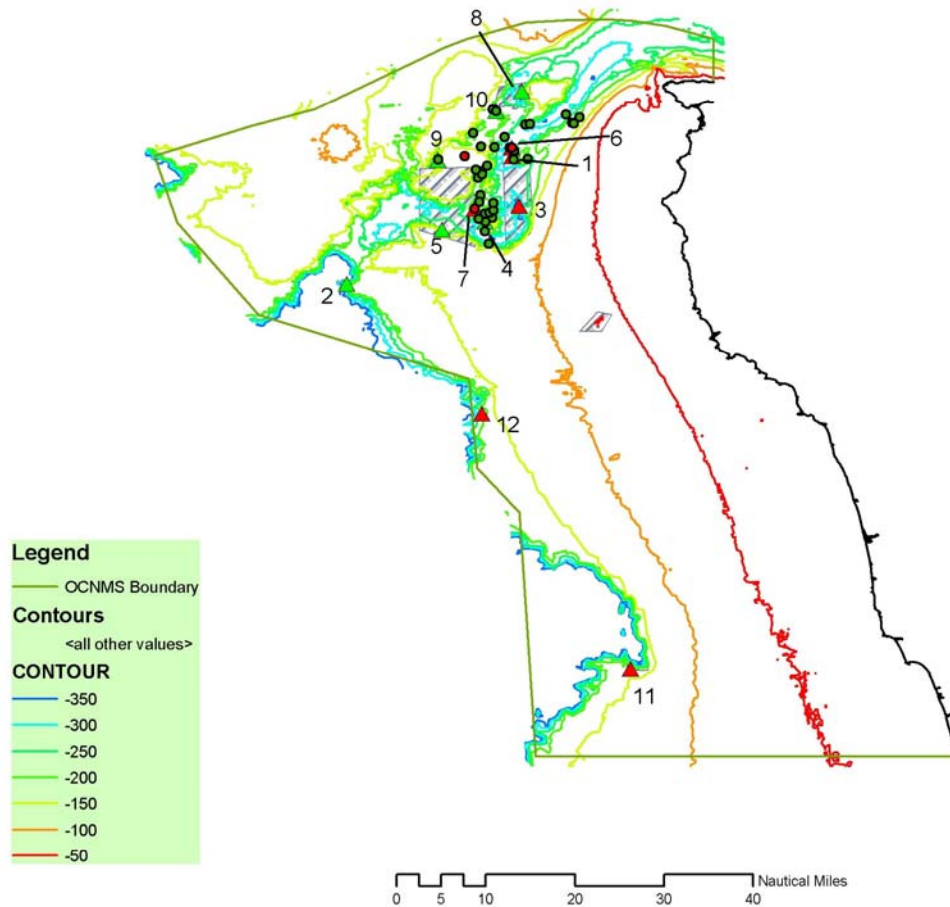


Figure 3. Study area showing location of all 12 original candidate sampling stations. Red triangles = Primary stations in areas of high fishing intensity; Green triangles = primary stations in areas of low fishing intensity; Circles = alternative stations; Diagonals = Side Scan Sonar areas surveyed during the companion Leg 1 cruise to help confirm suitable hard-bottom sites.



Figure 4. Photograph of NOAA Ship McARTHUR II used on Cruise AR-04-04: Leg 2.

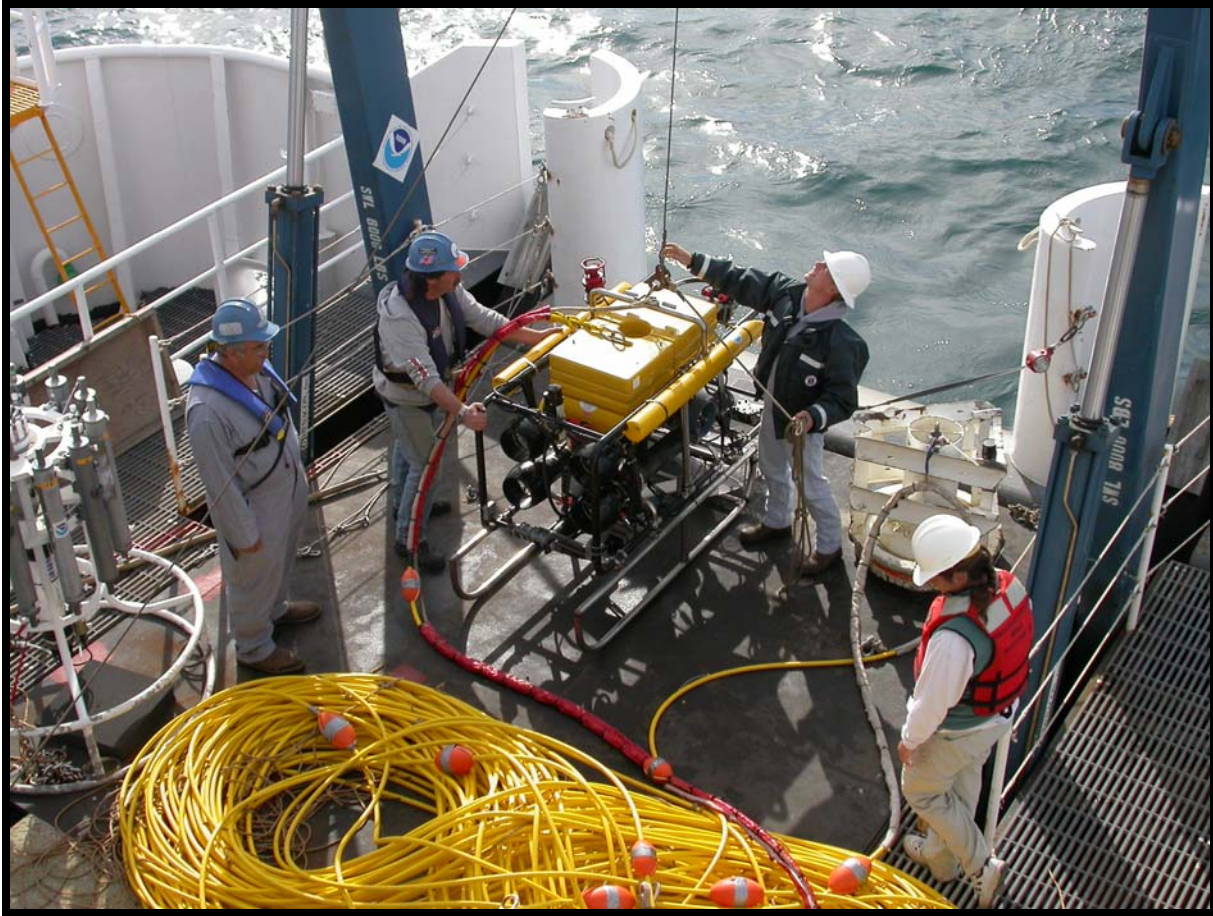


Figure 5. Onboard view of the Navy's Phantom DHD2+2 Remotely Operated Vehicle (ROV). The ROV is equipped with video camera, lasers, and a manipulator arm.



Figure 6. A dense field of the stony coral *Lophelia pertusa*, characteristic of deepwater coral assemblages in the North Atlantic, was observed at OCNMS for the first time during this survey at a site in 271 meters of water (left photo). Right photo: Close up of specimen collected with ROV manipulator arm.



Figure 7. Left Photo: Live gorgonian (soft coral) with attached crinoids observed at OCNMS at 276 m, June 2004. Right Photo: Broken specimen found at 268 m, with rosethorn rockfish (*Sebastes helvomaculatus*) in foreground.



Figure 8. Long-line fishing gear with lure on seafloor at OCNMS. Laser points near rockfish at top of view are 10 cm apart.



Figure 9. A new species of *Baptodoris* (Gastropoda, Nudibranchia) collected in a grab sample from Station 4. The slug was 22 mm long and found sitting on its egg mass (visible at left side of animal). Photo by Dr. Jeff Goddard.