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Workshop on the Potential Effects of Fishing Gear on Benthic Habitat

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Workshop on the Potential Effects of Fishing Gear on Benthic Habitat

Edited by

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INTRODUCTION

This report contains abstracts from a workshop on the potential effects of fishing gear on benthic habitat held in September 1996 at the National Marine Fisheries Service (NMFS) Auke Bay Laboratory (ABL) in Juneau, Alaska. The purpose of the workshop was to review the progress and preliminary results of studies begun in 1996 and to discuss approaches and priorities for proposed research in 1997. Attendance was by invitation, and about 30 people participated in the workshop, including scientists from the Resource Assessment and Conservation Engineering (RACE), Resource Ecology and Fishery Management (REFM), and ABL divisions of the NMFS Alaska Fisheries Science Center (AFSC); NMFS Alaska Regional Office (ARO); U.S. Geological Survey (USGS); Alaska Department of Fish and Game (ADF&G); University of Alaska Fairbanks (UAF); University of Washington; and the National Undersea Research Center. The workshop agenda and a list of workshop attendees are in appendices to this report.

Presentations included preliminary observations from a manned submersible of trawled versus untrawled hard-bottom areas in the eastern Gulf of Alaska, an overview of field studies to examine bottom trawl impacts in the Bering Sea, a description of methods for examining benthic community structure and possible effects of trawling based on historical data in the Gulf of Alaska and Aleutian Islands, and video tape showing how different types of trawl gear can impact seafloor habitats. Additional presentations included a review of fishing gear impact studies off the northeastern United States and preliminary evaluations of the feasibility of using laser-line scan systems, sidescan sonar, and hydroacoustic habitat mapping systems as research tools to examine fishing gear impacts. Proposed research for 1997 included continuation of trawling impact studies begun in 1996, an examination of the effects of trawling on gorgonian corals in heavily fished areas in the Aleutian Islands near Seguam Pass, and examination of the effects of scallop dredges on benthic habitat.

Synopsis of 1996 Field Work Related to Trawling Impacts on Hard-Bottom Areas of the Eastern Gulf of Alaska

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In the eastern Gulf of Alaska (EGOA), trawling for rockfish by foreign fishing fleets was extensive in the 1960s and 1970s. Foreign trawlers were replaced by domestic trawlers in the 1980s, targeting mainly depressed rockfish stocks. Pacific ocean perch (*Sebastes alutus*), the primary target species of bottom trawlers, is a demersal rockfish that inhabits the outer continental shelf shoreward, and is trawled for at depths of 165–290 m. Adult Pacific ocean perch concentrate on simple, low-profile habitat.

There is widespread agreement among marine investigators that bottom trawling alters the seafloor, but the effects of this activity on the overall stability and productivity of benthic communities are not well understood. Although numerous studies have focused on the effects of trawling on target species, research regarding the effects of trawling on non-target organisms and seafloor habitat has been limited. Heretofore, no study has been conducted in the EGOA that attempted to quantify the effects of bottom trawling on benthos, although disturbance to both substrate and associated biota was noted during previous manned submersible studies in the EGOA conducted by the NMFS Auke Bay Laboratory. The objective of our 1996 field study was to determine whether a bottom trawl outfitted with tire gear foot rope causes changes to the seafloor and associated epifauna. We used both a commercial trawler and a two-man submersible in this investigation. The trawler was fitted with a Nor'eastern bottom trawl equipped with tire gear. The trawl was also fitted with a transponder. Trawl tracks were plotted by following the trawler with the sub tender and using the tender's integrated navigation system (using DGPS and ultra-short baseline acoustic tracking). Most trawling was on the outer continental shelf in low-profile habitat (pebble/cobble) from depths of 200–220 m. Tows lasted 5–10 min. The trawler completed 14 single-pass tows, 2 triple-pass tows, and 1 seven-pass tow. All organisms collected in the trawl were sorted on deck, identified to species, counted, and weighed. Organisms not identifiable in the field were preserved in 10% buffered formalin for later identification in the laboratory.

After each trawl track was completed, the submersible descended to the seafloor and located the track. Weighted flags were deployed at the beginning and end of each track to facilitate relocation. The submersible was equipped with two Hi8 video cameras. One camera was oriented vertically, and the other at a 55° angle to the substrate. The vertically mounted camera had a laser scaler to facilitate substrate classification. Transects were run within each trawl path for the length of the path; reference transects were run parallel to the trawl path approximately 50 m distant. We also ran 3–5 transects perpendicular to each trawl path where trawl-door, roller, or tire marks were visible. The perpendicular transects ran between door marks, plus an additional 50–100 m beyond each door mark. Video tape shows 10 trawl paths: seven single-tow paths, two triple-tow paths, and one seven-tow path. Videotape data will be analyzed during winter 1996–1997, initially concentrating on habitat classification, sessile and motile epifauna in trawled vs. reference transects, impacts to epifauna, and comparisons of trawl bycatch with organisms *in situ*.

Trawl Impact Studies in the Eastern Bering Sea

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When used to harvest living marine resources, bottom trawls may cause changes in properties of the seafloor and associated biota. Recently, the North Pacific Fishery Management Council (NPFMC) substantially increased the area closed to bottom trawling in the Bering Sea. However, scientific data that directly address potential trawl impacts in the region are lacking. Hence, experimental trawling was conducted in the Bering Sea this past summer (31 July – 6 August 1996) to improve our understanding of the effects of bottom trawls on the soft-bottom benthos. An historical analysis of commercial bottom trawl effort in the Bering Sea identified adjacent pairs of heavily fished and unfished 1 nautical mile^2 areas of the seafloor. A total of 104 samples were collected with a NMFS 83–112 bottom trawl modified to improve retention of epifauna (i.e., tickler chain and 1¼-inch liner along bottom of net were added). In this study, epifauna are considered indicators ("integrators") of seafloor attributes because of their characteristically strong affinities for particular substrates. Multivariate analyses and randomization significance tests will be used to compare population densities and community structure in the two groups of stations. A color video system attached to the experimental trawl provided additional information on habitat features. This research will also provide important spatial information about fine-scale variability in these benthic communities and will serve as the basis for more rigorous manipulative investigations in FY97. Anticipated products of this work include technical advice to the NPFMC, refereed journal articles, and presentations at technical conferences and workshops.

Introduction to Trawl Gear in Contact with the Seafloor

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The impact of trawl gear on seafloor habitats and communities varies considerably depending at least on:

1. The component of the trawl involved: door, sweep, footrope, codend.
2. The construction of that component: weight, diameter, material, and rigging on the trawl.
3. The type of substrate: rocks, mud, sand, etc.
4. The organisms on that substrate.

A collection of videos taken during AFSC research on commercial and survey bottom trawls demonstrated how:

1. The design of all trawl components varies, depending on the target species, the expected substrate, and other factors.
2. Doors are the heaviest component of a bottom trawl, responsible for spreading the trawl and sinking it to the seafloor. The doors contact the smallest area of seafloor.
3. Sweeps and bridles cover the largest area of seafloor and herd fish into the path of the trawl net.
4. The footrope must be designed to compromise between preventing the escape of fish underneath and protecting the trawl netting. Rough seafloor requires larger diameter footropes than conventional gear.
5. Softer substrates are more easily furrowed and suspended by fishing gear.
6. High-profile rocks can be overturned by the passage of a trawl.
7. High-profile organisms are vulnerable to trawl damage.

A Retrospective Analysis of Trawling Effects in the Gulf of Alaska and Aleutian Islands

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This investigation will 1) examine the spatial distribution of trawling activity in the Gulf of Alaska (GOA) and Aleutian Islands (AI) and how it may have changed over time; 2) examine epibenthic macroinvertebrate and demersal fish assemblages for GOA and AI; and 3) determine whether the influences of bottom trawling on the benthic assemblages can be assessed by retrospective analyses. Two primary data bases will be used for the study: the National Marine Fisheries Service (NMFS) domestic groundfish observer data base (NORPAC), and the NMFS triennial surveys from 1987–1996. Trawling activity, catch statistics, and environmental variables from both data bases will be entered by location on a geographical information system (GIS) program such as ARCVIEW to analyze spatial and temporal aspects of trawling activity. Multivariate methods, including classification and ordination techniques, will be used to analyze community structure of the benthic assemblages sampled by the trawls. Areas of high and low trawling activity will be matched to NMFS triennial trawl surveys to assess the influences of trawling on the benthic assemblages. The study is correlational by design, but one may be able to infer trawling effects, e.g., if assemblage composition or structural attributes have changed over time in areas of high trawling intensity compared with areas of low trawling intensity.

Retrospective of Fishing Gear Impacts Studies off the Northeast United States

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In coastal waters off the northeastern United States, historic low population levels of principal groundfish species and a large increase in fishing effort since the early 1980s have created a concern about the impacts of widespread fishing activities on seafloor habitats. Studies conducted in the Gulf of Maine have applied a variety of approaches to understanding the effects of mobile fishing gear (bottom trawls and scallop dredges) on habitat characteristics, community composition, and ecosystem-level processes. Underwater vehicles (ROVs, occupied submersibles) have been used to conduct video transects to quantify the distribution of abiotic (e.g., sedimentary bedforms) and biotic (e.g., epibenthic fauna, biogenic structures) habitat features. Studies have included comparisons of impacted and reference sites as well as temporal comparisons (i.e., pre- and post-impact). Sidescan sonar has been used to assess the distribution of habitats and gear impacts on 10–100 times the area assessed using underwater vehicles alone.

These studies concluded that mobile fishing gear reduced spatial complexity of seafloor habitats by direct removal of epifauna, smoothing sedimentary bedforms, and removal of taxa that create structure. Changes in the structure of fish and invertebrate assemblages have also been attributed to the impacts of gear. The demersal fish assemblage has shifted from a gadid- to an elasmobranch-dominated assemblage, based on research survey trawl samples. This shift has been attributed to direct fishing mortality of target species, but some hypotheses about ecosystem changes impeding a return to historic community composition have been advanced. Photographic sled transects and naturalist-dredge samples have been used to quantify changes in benthic community structure attributed to impacts by scallop-dredge gear. Abundance of taxa associated with gravel habitats that were sensitive to disturbance declined significantly. Benthic primary production, by benthic microalgae, can be a significant fraction of primary production over shallow coastal waters and banks (i.e., approximately 30–40 m depth).

Sampling using benthic respiration chambers and demersal zooplankton re-entry traps has shown that mobile fishing gear removes benthic microalgae on sand bottoms, shifting primary production to phytoplankton and the zooplankton community to holozooplankton. These studies have demonstrated impacts of fishing gear at habitat, community, and ecosystem levels. If these patterns are widespread, current literature suggests that recovery of principal groundfish species may be impeded due to reduced survivorship of early benthic phase stages due to reduced cover from predators and reduced availability of primary prey.

Feasibility Of Using A Laser Line Scan System To Assess Trawl Impacts On Bottom Habitat

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The AFSC's Kodiak Laboratory in cooperation with the Alaska Department of Fish and Game studied the feasibility of using an underwater Laser Line Scanning System (LLSS) to detect trawl-induced physical and biological changes to bottom habitat. Operations consisted of 1) general observations of organisms, bottom features, and targets such as derelict crab pots (20 tows), 2) targeted tows where sonic-tagged pods of king crabs were observed (5 tows), and 3) observation of six separate fresh trawl tracks (8 tows). Images obtained are similar to black-and-white television pictures and available in still-frame and video format. Of 33 tows, the LLSS produced good images for the entire track in 17 cases, produced usable images for part of the track in 14 cases, and failed to obtain images in 2 cases. Web in lost crab pots, numerous organisms (starfish, crabs, flounders, kelp), and bottom features (rocks, shells, lost line, bottles, cans) were routinely and clearly visible. Trawl tracks were imaged well for two tracks, partially observable for two tracks, and not observable for two tracks. Trawl tracks were difficult or impossible to observe in well-sorted sand mixed with shell hash, more easily observed in sand/silt-mud bottom, and clearly observable in soft bottom. The LLSS fills a gap between side-scanning sonar and ROVs, is easily deployed, and is capable of detecting some effects of trawling. The LLSS can be a useful resource-assessment tool for macro-invertebrates such as crabs or scallops.

The Role of Sidescan Sonar in Seafloor Classification, with a Direct Application to Commercial Fisheries Management

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Demersal shelf rockfishes (*Sebastes* spp.) are the target of an important shore-based fishery in the eastern Gulf of Alaska (945 metric ton allowable catch). These fishes are difficult to assess using traditional techniques because they are closely associated with complex rocky habitats. The Alaska Department of Fish and Game (ADF&G) has been using an occupied submersible to conduct line transects for estimating density of demersal shelf rockfish since 1990, concentrating on yelloweye rockfish (*S. ruberrimus*) because it accounts for 90% of the commercial catch of this assemblage. Biomass of adult yelloweye rockfish is derived from the product of estimated density (for all rocky habitats), the estimate of area of suitable habitat within the 200-m depth contour, and average weight of fish from port samples by management area. Currently the estimate of area is based solely on the habitat description from bathymetric charts, with areas described as "rocky" or "hard" included in our analysis. Although not yet used specifically for management, habitat-specific densities are also estimated. These habitats have been defined based on *in situ* characterization. Yelloweye rockfish are significantly more abundant in areas with refuge spaces (e.g., caves, large cracks, overhangs, or boulder fields where both the boulder size and the void-to-clast ratio is large). We currently estimate the density of adult yelloweye rockfish in the Central Southeast Outside management area (CSEO) to be 2,929 fish/km^2.

In 1994, we began a pilot study using sidescan sonar to help delineate available habitat and identify areas of key habitat types in the Edgecumbe offshore lava field, an important fishing ground in the CSEO. In 1996, we expanded this sidescan survey using an AMS-150 sidescan (150 kHz) and collected bathymetry data concurrent with the sidescan. The result is a large mosaic of the seafloor off Kruzof Island, which covers approximately one-fourth of the entire CSEO area. The area is diverse in habitat, including areas of plutonic rock with Sitka Graywacke outcrops, sand and silt, cobble, and an extended area of lava. The lava surface exhibits well-defined and little-eroded aa and pahoehoe lava, lobate lava fronts, collapsed lava tubes, volcanic cones, and fault scarps. These habitat characterizations have been groundtruthed with direct observations from the submersible.

The diversity and distribution of rockfish species appears to be related to habitat and depth; suitably sized refuge spaces are a key to demersal rockfish occurrence. For example, the two large volcanic cones on the southern margin of the lava field appear similar. However, one has significantly more fishes, both in terms of abundance and diversity. The sidescan clearly shows the key difference in habitat: the "19-fathom" pinnacle has a field of immense boulders on its flank, providing refuge habitat that is not available on the adjacent pinnacle.

We plan to use the level of categorization available from the sidescan mosaic to reclassify fish habitats, and then collect fish density data for these habitats. We also plan to continue our sidescan work in conjunction with NOAA NMFS, eventually mapping the entire eastern Gulf of

Alaska. Seafloor classifications over a wide geographic region will allow us to significantly improve our fishery management plan for demersal shelf rockfish by allowing us to use habitat-specific densities. Ultimately, our ocean-mapping efforts will provide a permanent record of the seafloor for use in the management of living resources within the region.

An Evaluation of Hydroacoustic Technology for Seafloor Classification

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Effective management of a commercially exploited fish stock depends on a thorough understanding of the biology of the species as well as its relationship to the physical environment. Detailed environmental information is needed to design effective field studies of the effects of fishing activities on fish habitat. Furthermore, the Magnuson-Stevens Fishery Conservation and Management Act of 1996 has added new mandates concerning the identification and protection of essential fish habitat. Despite steady improvement in the analytical tools available to the fishery scientist, major gaps remain in the data required for these tasks. To address these needs, an acoustic bottom-typing system (*QTC View Series 3*, manufactured by the Quester Tangent Corporation, Sidney, B.C.) was acquired to begin evaluating the efficacy of remote sensing of seafloor properties. This technology does not require dedicated ship time, adapts to a variety of installed echosounders, and continuously collects seabed classifications during routine vessel operations, including fishing. Also being investigated is the feasibility of post-processing previously archived hydroacoustic fishery data to obtain the requisite data on seafloor properties at considerable savings. After a shakedown cruise in Puget Sound (11–12 July 1996), the *QTC View* system was deployed on the R/V *Miller Freeman* (18 July – 7 August 1996) in the eastern Bering Sea for testing in soft-bottom areas. Problems with signal saturation using the Simrad EK-500 scientific echosounder were encountered, and we are currently working with the manufacturers of the equipment to resolve the problem. To this end, engineering cruises are planned for 1997 before redeployment in the Bering Sea. The bottom-typing system was also deployed in the Gulf of Alaska in 1996 (22–29 August) aboard the R/V *John N. Cobb* with a Simrad EQ-50 navigational echosounder, to evaluate the utility and operational limits of this technology in hard-bottom areas. Additional field work is planned. Ultimately, synoptic mapping of benthic habitats may be accomplished with chartered fishery survey vessels and this technology.

Residence Time, Movement, and Habitat of Adult Tanner Crabs in Taku Inlet, Alaska: Potential Impacts from Submarine Tailings Disposal

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The Alaska-Juneau (AJ) gold mine near Juneau, Alaska, is in the permitting process to reopen. Submarine tailings disposal (STD) is one option the mine is considering for tailings disposal. During the life of the mine, an estimated 75 million metric tons of tailings would be deposited into Taku Inlet south of Juneau, an extremely important area for recreational and commercial fisheries. If permitted by federal and state agencies, the AJ mine would be the only mine in the United States and one of only a few mines in the world to use STD.

Smothering of the seafloor is an obvious impact of STD. Tanner crabs (*Chionoecetes bairdi*) are the most important commercial species in Taku Inlet, and they may be directly impacted by STD. Tanner crabs may remain in the impact area or migrate to areas not covered by tailings. If they remain in the impact area, they could incorporate heavy metals into their tissues—Tanner crabs bury in and often ingest sediment while feeding. The objectives of our study were to determine 1) residence time, 2) seasonal movement, and 3) habitat use (e.g., depth, bottom type) of Tanner crab in the proposed STD area. Twenty-six adult Tanner crabs (16 males, 10 females) were captured in Taku Inlet in May 1996, sonic-tagged, and released at their original capture location. Crabs were tracked weekly by surface vessel through August 1996. Position (DGPS), depth, and key habitat parameters (salinity, temperature, dissolved oxygen) were recorded each week for each crab. In addition, the manned submersible *Delta* was used in late August to visually document the condition of tagged crabs, note their spatial relationship to other crabs, and identify important habitat.

After 20 weeks, most (22) tagged crabs were in good condition and at liberty in Taku Inlet—no crab had moved outside the proposed impact area. By late August, the average distance tagged crabs (males and females) had moved from their original capture location was about 5 km (not in a straight line). One male had moved a straight line distance of about 12 km since release. Depths of tagged crabs have ranged from about 35 to 220 m on soft, silty bottoms. With the submersible, we found and videoed eight tagged crabs—some on steep slopes, and most usually near other Tanner crabs. Two derelict tags that had fallen off crabs were also recovered with the manipulator arm of the submersible. We plan to continue tracking crabs through spring 1997. To date, however, it appears that Tanner crabs have small home ranges and are resident to Taku Inlet. Therefore, STD may have a direct and likely long-term impact on Tanner crab. Repeating this study after STD begins will provide information on whether Tanner crabs utilize an altered seafloor.

Appendix A. Agenda

Workshop on the Potential Effects of Fishing Gear on Benthic Habitat
24–25 September
Auke Bay Laboratory

Tuesday 24 September: Review, progress, and discussion of studies initiated in 1996

8:30– 9:00	Opening remarks, introduction, logistics, objectives (Dahlberg and Heifetz)
9:00–10:00	Eastern Gulf of Alaska submersible studies (Freese and Johnson)
10:00–10:30	Break
10:30–11:30	Bering Sea trawl studies (McConnaughey)
11:30–12:00	Gulf of Alaska/Aleutians retrospective study (Shirley)
12:00– 1:30	Lunch (Canton House)
1:30– 2:00	Video tape of bottom trawl (Rose)
2:00– 2:30	Sidescan sonar habitat mapping (O'Connell)
2:30– 3:00	Laser line technology (Nelson and Somerton)
3:00– 3:15	Break
3:15– 4:15	Acoustic habitat typing (McConnaughey and von Szalay)

Wednesday 25 September: Discussions and planning

9:00–10:00	Review of East Coast and other studies in relation to Alaska studies (Auster)
10:00–10:15	Break
10:15–12:00	General discussion What questions do we want answered? Limits of submersible studies Role of habitat-typing technology Other approaches Other gear besides trawls Where should we be working—Bering Sea, Gulf of Alaska, Aleutians?
12:00– 1:30	Lunch (Open)
1:30– 4:00	AFSC 1997 Proposal Continuation of FY96 studies Priorities Funding? Base funds, add-ons, NURP Time frame Cooperators (ARO, USGS, ADF&G, UAF, Fishing industry)
4:00– 4:30	Conclusions

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