Fishing Gear/Sea Floor Impacts Workshop
AFSC, January 27-28, 1999

Presentation Titles and Speakers

Day 1:

? **Effects of trawling on hard-bottom substrate and associated invertebrate taxa in the EGOA**
(Linc Freese; NMFS, Auke Bay Lab)

? **Trawl impact on red-tree coral, Primnoa spp**
(Ken Krieger; NMFS, Auke Bay Lab)

? **Chronic effects of trawl gear on soft bottom in the Gulf of Alaska**
(Robert Stone; NMFS, Auke Bay Lab)

? **Chronic trawling effects on soft bottom benthos and infauna of the eastern Bering Sea**
(Robert McConnaughey; NMFS, RACE)

? **Acoustic positioning of bottom trawls**
(Robert McConnaughey; NMFS, RACE)

? **A TACOS tour of the eastern Aleutian continental shelf**
(Skip Zenger; NMFS, RACE)

? **Acoustic seabed classification in the eastern Bering Sea**
(Robert McConnaughey; NMFS, RACE)

? **Acoustic habitat classification in the Gulf of Alaska**
(Paul G. von Szalay; NMFS, RACE)

? **Planned project (summer 1999) Dissertation work**
(Michael Martin in collaboration with Paul G. von Szalay)

? **Feasibility of using underwater laser line scanner systems to visualize the sea floor**
(Brad Stevens; NMFS/RACE/Kodiak)

Day 2:

? **Analysis of video data from a net-mounted camera**
(Craig Rose; AFSC/RACE)

? **The use of a sled-mounted video camera to estimate Tanner crab abundance and to observe their behavior**
(Brad Stevens; NMFS/RACE/Kodiak)

? **Net-mounted video camera to estimate the rate of escapement under the footrope**

(Peter Munro; AFSC/RACE)

? **Net-mounted video camera to estimate the rate of escapement of flatfish through the gaps between roller gear of a Poly Nor'eastern trawl**
(Ken Weinberg; AFSC/RACE)

? **The use of video to observe fish behavior under different light and temperature conditions**
(Rich Titgen; Newport, Oregon Fish Behavior Lab)

? **The use of video footage from a bottom-towed sled to quantitatively estimate fish density**
(Bob Lauth; AFSC/RACE)

? **Video footage from the TACOS**
(Skip Zenger; AFSC/RACE)

? **Limitations of video as an assessment tool**
(Robert McConnaughey; AFSC/RACE)

? **Video used in submersible work**
(Ken Krieger; NMFS/ABL)

? **Quantifying trawl-damaged mega epifauna from a submersible**
(Linc Freese; NMFS/ABL)

? **The use of video mounted on a submersible to count flatfish**
(Robert Stone; NMFS/ABL)

List of Attendance

<u>Name & Organization</u>
Bowley, Ed Olympic Coast NMS
Brancato, Mary Sue Olympic Coast NMS
Freese, Linc NMFS/ABL
Heifetz, Jon NMFS/ABL
Ito, Dan AFSC/REFM
Krieger, Ken NMFS/ABL
Lauth, Bob AFSC/RACE
McConnaughey, Robert AFSC/RACE
Munro, Peter AFSC/RACE
Nelson, Russ AFSC/RACE
Rigby, Phil NMFS/ABL
Rose, Craig AFSC/RACE
Stevens, Brad Kodiak/RACE
Stone, Robert MMFS/ABL
Titgen, Rich AFSC/RACE
von Szalay, Paul AFSC/RACE
Weinberg, Ken AFSC/RACE
Zenger, Harold "Skip" AFSC/RACE
Zimmermann, Mark AFSC/RACE

Fishing Gear/Sea Floor Impacts Workshop –1999

Day-1 Presentations (1/27/99)

Speaker: Linc Freese (NMFS, Auke Bay Lab)

Title: Effects of trawling on hard-bottom substrate and associated invertebrate taxa in the EGOA

The objectives of this study were to determine:

? Immediate effects of single trawl overpass on abundance of, incidence of damage to, sessile and motile epifaunal invertebrates.

? Incidence of rolling and/or dragging of boulders caused by a single trawl pass.

? Incidence of invertebrate bycatch in the trawl.

? If delayed mortality due to trawl damage resulted in reduced invertebrate abundances (1 year post-trawl).

A series of 5-7 minute trawl (Nor'eastern) hauls were conducted along isobaths at depths between 206 and 274 meters just shoreward of the continental break near Kruzof Island. The submersibe Delta was used to locate and run transects along the trawl tracks, which ranged between 0.29 and 0.56 km in length. Untrawled reference transects were also run parallel to and 50-70 m away from the trawl transects. Video data were collected with two Hi8 video cameras one of which was mounted with the imaging plane parallel to and the other at a 25-degree angle to the seafloor.

Organisms were classified as damaged if they had broken bases, were knocked over, crushed, lacked body parts, or were torn apart and boulders were classified as either undisturbed or moved. The video was sub-sampled at 15-second intervals in order to classify the substrate as pebble (<6.5 cm), cobble (6.5-25 cm), or boulder (>25 cm). Eight pairwise density comparisons of different taxonomic groups were made (Wilcoxon's signed-ranks test) between the trawled and reference tracks at the time of the trawl experiment and a year later.

Results:

? There was no significant difference in substrate type between the trawled and reference transects, both of which were dominated by pebble (92%).

? Trawl tracks were easily identifiable by semi-continuous furrows (approx. 18 cm deep) and displaced boulders.

? 21 % of boulders in the trawl path were displaced.

? 29 invertebrate taxa were identified from the videotape. The most common were vase, morel, and finger sponges, two species of starfish, one brittlestar, two species of sea cucumbers, two species of urchins, and two species of anthozoans including an anemone and a sea whip.

- ? The density of three out of four groups of sessile epifauna (vase and morel sponges, and anthozoans) was significantly reduced in the trawled tracks. Finger sponges were not significantly reduced in abundance as a result of trawling.

- ? Vase sponges, which accounted for most of the invertebrate biomass, were damaged at a rate of 67%. Morel sponges were also heavily damaged but no quantitative estimate could be generated. Finger sponges were damaged when the cobbles or pebbles to which they were attached were rolled by the trawl (14% lay on the substrate).

- ? 55% of sea whips were either pulled out of the substrate or broken by the trawl. No obvious damage to anemones was noted.

- ? None of the five groups (asteroids and ophiuroids, holothurians, arthropods, molluscs, and echinoids) of motile invertebrates showed a significant reduction in density.

- ? The only motile species susceptible to significant (23%) trawl damage was the brittlestar. Apparent damage to other motile species was less than 1%.

- ? Five of the analyzed invertebrate groups were present in the trawl as bycatch. Large amounts of broken sponge were caught.

- ? Bycatch was greatest for spot prawn (46% caught). The four non-swimming groups were caught much less often.

- ? No significant differences in density were detected for any of the sessile groups one year post-trawl.

- ? Damaged vase sponges were still present in the trawl paths one year post-trawl and showed no signs of delayed mortality or regrowth. Knocked over sponges and pieces of sponge lying on the seafloor still appeared viable. 57% of vase sponges and 6% of finger sponges were damaged.

- ? Trawl paths still appeared fresh and were easy to locate after one year. Furrows caused by the tire gear were not backfilled, and no significant degree of siltation was noticeable.

Conclusions:

- ? Large erect sponges and boulders with which they are associated provide most of the structural habitat features along the shelf break in the eastern GOA.

- ? A single pass of a trawl fitted with tire gear can displace large boulders and reduce numbers of sponges present in the trawl path.

- ? Most remaining sponges are damaged by the trawl and regrowth is very slow.

- ? Densities of motile species appeared to be unaffected by the trawl but this may be due to the time delays in video sampling after trawling, leading to movement of these species into the trawl paths because of scavenging response.

- ? Trawl catch rates of free-swimming invertebrates such as pandalid shrimp were much greater than for non-swimming organisms such as starfish, sea cucumbers, urchins, and molluscs.

? Reversal of trawl disturbance of physical habitat features appears to occur very slowly.

Speaker: Ken Krieger (NMFS, Auke Bay Lab)

Title: Trawl impact on red-tree coral, Primnoa spp.

Megafana associated with the red-tree coral, Primnoa spp. were observed from a manned submersible in the Gulf of Alaska in July of 1997. Six sites were surveyed at depths between 238 and 365 meters and seven megafauna groups were associated with Primnoa spp.: 1) rockfish, Sebastes spp., 2) Starfish, Pteraster spp., 3) nudibranchs, Tritonia exulsans, 4) crinoids, Florometra spp., 5) basket stars, Gorgonocephalus eucnemis, 6) crabs, Lithodes aquaspina, and 7) caridean shrimp. Three species of rockfish totalling 162 fish were observed and 134 of these were associated with Primnoa spp. Of the 81 observed starfish, 76 were associated with Primnoa spp. Starfish were feeding on Primnoa spp. polyps and consumed 45% and 34% of the polyps at the two sites. Most of the crinoids and basket stars were attached to branches where polyps had been consumed. All 21 nudibranchs observed were associated with Primnoa spp., probably to feed on polyps. Small shrimp (2-3 cm long) were abundant among some of the coral colonies and a single pair of brown king crabs were hand-holding beneath a coral colony. Primnoa spp. are main components of the offshore ecosystem and removing these slow-growing corals could cause long-term changes in the megafauna that associate with Primnoa spp.

Observed trawl path: 1990 trawl path in Dixon entrance at 365 m depth.

The substrate was primarily pebble/cobble with scattered boulders.

Nor'eastern trawl used during the GOA bottom trawl survey. Approximately 1 ton of Primnoa spp. caught in the net.

Results:

? 32 corals were observed in the trawl path. Thirteen of these were associated with large (7x4x3 m) colonies and nineteen with small (< 1 m3) colonies.

? 8 of the large colonies, but only 2 of the small colonies were damaged (coral removal).

? 35% of the coral had been damaged or removed from the trawl path.

? There were very few pieces of broken pieces of coral on the seafloor.

? No regrowth of coral was observed after 7 years (between 1990 and 1997).

? No damage to corals was found in the bridle area of the trawl path. Damage was exclusively confined to the path of the tire gear.

? Lots of damage due to starfish predation on polyps.

Speaker: Robert Stone (NMFS, Auke Bay Lab)

Title: Chronic effects of trawl gear on soft bottom in the Gulf of Alaska

This study was carried out in May 1998. A submersible was used to run a series of regularly spaced 3-km long transects that were bisected by the boundaries of two areas that had been closed to trawling since 1986. One site was located in Chiniak Bay in the NE part of Kodiak Island and the other site was located in the southern end of the island. The study sites had to satisfy the following criteria: 1) the bottom had to be uniformly soft, 2) the depth had to be uniform throughout the length of the transects, and 3) the area immediately outside the closed areas had to have been exposed to moderate trawling activity in the last five years. Annual trawling activity immediately outside the closure areas was estimated at 50 trawl hauls per nautical mile squared. It is also known that fishermen have tended to fish very close to the boundaries, providing good contrast between areas inside and outside the closure areas. Depths at the study sites varied between 110 and 150 meters.
Video footage was collected with two cameras, one of which was pointed straight down and the other obliquely downward. Sediment samples were collected with a Shipek grab sampler at the beginning, end, and in the middle of each transect, and were analyzed for infauna, organic carbon, and grain size distribution. The objective was to look for potential differences between trawled and closed areas with respect to these variables.

Results:

Organic carbon concentration (ppm)		
Sample area:	Chiniak Bay	Two-Head
Open area:	4331	8025
Mid point of transect:	4118	7112
Closed area:	3827	6693

Median grain size (microns)		
Sample area:	Chiniak Bay	Two-Head
Open area:	141	77
Mid point of transect:	137	86
Closed area:	152	97

Conclusions:
The organic carbon concentration was significantly higher in areas open to trawling than in closed areas. A possible explanation is that certain parts of the trawl gear digs into the substrate and resuspends carbon-containing matter which then ends up on the seabed surface where it is more accessible to a grab sampler.

The median particle size was significantly bigger in the closed areas than in the areas open to trawling. This finding is contrary to conventional wisdom. One would expect the finer particles in the trawled areas to be resuspended in the water column and potentially carried away with a current, leaving the coarser material behind. There's no obvious mechanism for why the reverse is true.

Speaker: Robert McConnaughey (NMFS, RACE)

Title: Chronic trawling effects on soft bottom benthos and infauna of the eastern Bering Sea

Questions raised:

- ? Are bottom trawl closures necessary?
  - ✍ Are the effects of trawling measurable?
  - ✍ Are the effects of trawling significant?

- ? Are closures effective?
  - ✍ Does a trawled area recover to its original state or a new state?
  - ✍ What is the time span for recovery?

- ? Should closures be permanent or rotating?

Field-based studies were broken down into separate studies of chronic and acute impacts.

Objectives:

- ✍ Historical review of trawl effort.

- ✍ Compare megafauna in highly fished and unfished areas in terms of population parameters (i.e. biomass and numbers) and community structure (biodiversity).

In order to improve the catchability and retention of benthic organisms, a modified bottom trawl net with a tickler chain and liner on the bottom and codend was used on two separate vessels (F/V Arcturus, F/V Aldebaran). A total of 42 pairs (each pair consisted of a sample each from a heavily fished and an unfished area) of samples were collected in an area spanning 176 hectares. 12.5 tons of megafauna was processed and divided up into 92 taxonomic groups which were reduced to 48 for analysis. The effect on the population parameters were analyzed using both multivariate (Nested MANOVA, overall response) and univariate (taxon-specific responses) statistics as well as simple comparisons of means. The data from the two vessels were analyzed separately.

Results:
There was a significant difference in the overall (i.e. lumping all species together) population parameters between the heavily fished and unfished areas according to the data generated from the two vessels ($P=0.0001$ and $P=0.024$). Responses of specific taxa were analyzed with paired t-tests, both with and without Bonferroni corrections. With the Bonferroni correction, significant differences ($a=0.10$) in the density was detected in four taxa (anemones, Neptuea, snail eggs, and Porifera), and in each case the density was greater in the unfished area. When the Bonferroni correction was relaxed (necessary because of very low power to detect differences) in order to reduce the chances of committing a type II error, significant differences were also detected for Asterias, empty G-shells, Gersemia, and bryozoans. With the exception of Asterias, the density was greater in the unfished areas for all of these taxa as well. When mean densities were simply compared, it was found that some differences were very species specific for several taxa.

For example, some crustaceans (Crangon, Oregonia, misc. pagurids) were more prevalent in the unfished areas whereas others (e.g. Hyas) were more abundant in the heavily fished areas.

The effects of trawling on community structure were measured by Shannon's diversity index, H. The diversity index was significantly higher in the unfished than in the heavily fished areas. There was strong evidence for single species dominance, as evidenced by an almost perfect negative correlation (r=-0.98) between Asterias density and H. Niche breadth was measured by the spatial form of H using paired t-tests with Bonferroni correction. For sedentary species the niche breadth was significantly greater (i.e. less patchy) in the unfished areas. No pattern was noted for motile species and bivalves.

Conclusions:
Highly fished areas are less diverse and are characterized by reduced structural complexity (less emergent epifauna and biogenic substrate, more patchy distribution) compared to unfished areas.

Speaker: Robert McConnaughey (NMFS, RACE)

Title: Acoustic positioning of bottom trawls

Motivation:
Acute trawl impact studies require real-time positioning of bottom trawls. Experimental fishing is carried out with sampling both before and after the trawl tow during the impact phase of the study. Since it is crucial that the sampling after the tow is done in the same area as the initial sampling, an accurate positioning system is needed.

Acoustic positioning with USBL systems is usually done with towfish. Applying this technology to trawl nets, however, is difficult because of interference from vessel noise and acoustic multipaths in shallow water. Sea trials are therefore warranted to determine the positioning accuracy and to evaluate the overall performance/utility of the technology. Initial trials were carried out at the US Navy Dabob range in Puget Sound, Washington where fixed SBL underwater tracking with an absolute accuracy of +/- 3 m accuracy was available. Tracking was done simultaneously with USBL and SBL systems, and the performance of the USBL systems was compared with the inherently more accurate SBL system. Three USBL systems were tested: ATS II (Nautronix), ITI Trawl Monitoring and Positioning system (Simrad), and Trackpoint II Plus (ORE).

Results:
Mean positioning errors (absolute distance from SBL fix) were greater along the track than across the track for the ATS II and Trackpoint II Plus systems and ranged from 1.4 meters cross-track for the ATS II to 6.6 meters along-track for the Trackpoint II Plus. The ITI system could not be fully evaluated due to data output limitations.

Conclusions:
The ATS II and Trackpoint II Plus systems are both suitable for real-time trawl positioning while the ITI system could not be fully evaluated due to data output limitations. USBL errors are small relative to potential head misalignment, GPS, gyro, and sound velocity errors.

Speaker: Skip Zenger (NMFS, RACE)

Title: A TACOS tour of the eastern Aleutian continental shelf

A Towed Automatically Compensating Observation System (TACOS), designed to acquire video data in hard bottom habitat and high current areas that are inaccessible to submersibles, was tested in 1998 at field stations around Unalaska and Unimak islands. The TACOS consists of a large aluminum frame with a video camera, lights, laser (laser dots are used to scale objects in the video footage) and buoys mounted on it. The ultimate objective is to use the TACOS in the study of fishing gear impact on habitat in rough and high current areas along the Aleutian Islands. During the 1998 field trials, the TACOS was deployed off the stern ramp of F/V Arcturus, a stern trawler which was able to maintain the required steady speed of 1.5 to 2 knots for the system to work properly. Damage to sponges, corals and other sessile invertebrates along trawl tracks was observed in the 2 m wide viewable footprint. Field trials begun in 1998 will be completed in 1999.

Conclusions:
It is questionable whether the TACOS can be used quantitatively in extreme current conditions, but running regular transects under normal conditions is not likely to present any problems. The F/V Arcturus had difficulty maintaining headway at the slow speeds required for the TACOS. Approximately 2 hours of video data can be acquired per day, and at a typical towing speed of 1.5 knots, 3 nautical miles can be covered daily. Operational depth is primarily limited by cable length. So far, TACOS has been successfully deployed in depths up to 180 meters.

Speaker: Robert McConnaughey (NMFS, RACE)

Title: Acoustic seabed classification in the eastern Bering Sea

The overall objective of this ongoing study is to characterize groundfish habitat in the eastern Bering Sea shelf:

- ? Assemble historical sediment data
- ? Investigate groundfish responses
- ? Evaluate synoptic data collection tools

There is strong evidence for specific sediment preference by such species yellowfin sole, which are found almost exclusively in areas of sand or sandy mud.

The specific QTC View research objectives are:

? Adapt the QTC View to Simrad EK-500 echosounder on board R/V Miller Freeman.

? Investigate the operational limits (e.g. speed, slope, depth) of the system (see Paul von Szalay's talk below).

? Evaluate the utility for essential fish habitat applications:
  - Is the system robust and user friendly?
  - Is it a cost-effective approach to obtain the habitat data?
  - Do fish respond to the properties (e.g. acoustic signatures of the seabed) that are measured with acoustic technology?

ISAH-S Field deployments:
The ISAH-S stores the original echo return in a digital format which can be post-processed using the QTC View algorithms. The main advantage of this unsupervised classification approach to bottom typing is that initial calibration of hardware is not required. Thus, it is not necessary to collect calibration data from all acoustically distinct bottom types in the survey area (e.g. the entire Eastern Bering Sea) prior to data collection. With the supervised classification approach, however (carried out during the 1996 field season), this was a major problem.

The objectives during the 1997-98 field seasons were to 1) Collect echo returns using 38 kHz and 120 kHz frequencies, and 2) Evaluate the quality of the data. A total of 7.6 million echoes were collected.

The results of this study were as follows:
? 38 kHz: Data were flawed due to saturated signals, an undetermined source of external interference, and calibration problems.

? 120 kHz: Excellent quality data.

Plans for the 1999 field season are to re-collect 38 kHz and 120 kHz data and ultimately to generate habitat maps. Post-processing will be carried out in order to:

? Optimize catalogs for both frequencies.

? Optimize algorithms.

? Identify preferred calibration sites.

Results:
Early results from a study in Puget Sound were very promising. There was a realistic correlation between bottom type, as classified by the QTC View, and bathymetry.

Speaker: Paul G. von Szalay (NMFS, RACE)

Title: Acoustic habitat classification in the Gulf of Alaska

Motivation:
The Rockfish Working Group at NMFS (AFSC and ABL) has for several years expressed an interest in stratifying bottom trawl surveys in the Gulf of Alaska by habitat type in order to improve the precision in abundance estimates. Several methods for acquiring bottom type data exist, ranging from such low-tech options as extensive grab sampling to the high-cost alternatives of side-scan and multibeam sonar. Most of these methods are plagued by either very high cost, inefficiency, or may not be suitable for the conditions (e.g. depth, slope, high substrate variability over small scales) presented by the continental slope where rockfish species such as rougheye (Sebastes aleutianus) and shortraker (S. borealis) rockfishes are found. The emerging technology of single beam seabed classification systems appears to be a relatively inexpensive and efficient approach to habitat typing.
One of these systems, the QTC View by the Quester Tangent Corporation, was tested to determine the feasibility of its application in identifying and quantifying rockfish habitat in the Gulf of Alaska.

The objectives of this study were:

? Determine the operational parameters under which accurate classifications are made.
  - speed (3-12 knots)
  - slope
  - depth

? Devise a survey design to quantify habitat.
  - line-intercept method (Seber, 1980)
  - determine the functional relationship between transect spacing and precision in the estimate of the proportion of the survey area that is made up of a particular habitat type

The classification performance with respect to speed was measured in terms of repeatability and was evaluated by a contingency table analysis. The null hypothesis stated that the relative frequency at which various bottom types are classified when traversing the same transect at different speeds is independent of speed.

Results of operational parameters analysis

? Speed: Classification performance was not significantly affected by ship speed for speeds between 3 and 12 knots.

? Depth: The QTC View classifies accurately at depths down to at least 230 meters.

? Slope: The accuracy of classification performance breaks down at slopes somewhere between 5 and 8 degrees.

Line-intercept method to quantify habitat

? The line-intercept method is based on running a series of parallel transects spaced according to.
  - Desired level of precision in the estimate of the quantity of habitat

- ✍ The variability of the substrate (high patch size variability and diversity of bottom types implies closer transect spacing for a given level of precision)

? Estimates of quantity of habitat can be generated from intercepted patch lengths.

? Factors that affect transect spacing to consider:
  - ✍ Prior knowledge of seabed variability (e.g. bottom types and patch sizes)
  - ✍ Carefully consider the minimum level of detail needed in the data
  - ✍ Combine two or more acoustically distinct classes into one habitat category if fish respond differently to these bottom types

? Estimated time to complete a habitat classification survey of the slope region in the GOA: 3000 hours. This estimate assumes:
  - ✍ Ship speed: 10 knots
  - ✍ Each acoustically distinct bottom types in the study area is estimated with a CV no less than 0.1
  - ✍ Spacing between transects: 0.125 nautical miles
  - ✍ Average transect length: 3 nautical miles (average width of the 200-500 meter contour area)

Planned project (summer 1999)Dissertation work by Michael Martin (in collaboration with Paul G. von Szalay)

Objective:
Determine groundfish habitat by associating fish density with acoustic seabed data.

In this study we intend to mount an autonomous echsounder-transducer system on the headrope of a trawl net at a constant altitude of approximately 7 meters. The goal of the project is to collect a set of digitized echo returns which are to be post-processed using an unsupervised approach (i.e. no system calibration is required prior to data collection) to seabed classification. The primary algorithms to be used for classification purposes are those developed for the QTC View by the Quester Tangent Corporation. A video camera to collect fish data with will also be mounted on the net. By associating fish density with acoustic seabed data we hope to determine what bottom types constitute preferred habitat for various species of commercially important groundfish. The advantages of this approach to acoustic seabed classification include 1) flexibility/transportability, 2) no a priori knoledge of bottom types in the survey area is required (data can be collected without calibrating the system first), and 3) improved spatial resolution due to small footprint size at low altitude.

Speaker: Brad Stevens (NMFS/RACE/Kodiak)

Title: Feasibility of using underwater laser line scanner systems to visualize the sea floor

Objective:
To compare laser line scanner scanner imagery with video footage

A Laser Line Scanner System was tested in Chiniak and Womens bays off of Kodiak Island. The following pros and cons of the system were identified.

Pros of LLSS

? More detailed (higher resolution) imagery than video or sonar.

? Provides identifiable images for objects circa 10 mm in size (e.g. pandalid shrimp).

? Can be used in more turbid conditions than most cameras.

? Larger footprint size than video (15 m when towed at an altitude of 10 m).

? Tireless operation-no recharge or maintenance of system for days.

Limitations of LLSS

? Vast array of imagery to be quantified manually since no automated method available.

? May require ground-truthing in some applications.

? Problems of distortion with moving objects.

? Sensitive to sea state.

? Limited by visibility.

? Midwater objects cast shadows.

? Limited to objects flat on bottom (within approximately 1 m of the bottom).

Conclusions:

? The LLSS is capable of providing useful assessment data, particularly for macro invertebrates.

? Fills a gap between ROV and high-resolution sonar.

? Operates in more turbid conditions than most cameras but is not immune to visibility problems.

? Daily cost of operation: $5k (incl. equipment and technician)

<u>Future Plans</u>

ABL planned projects –99

? Kodiak project (see Bob Stone's talk): Uncertain whether to continue with submersible or switch to video sled instead. Waiting for 1998 results to make final determination. Conditions were marginal for submersible. Need to be able to control speed when towing video sled: Must not go faster than about 2 knots since data analysis is very difficult to carry out at fast speeds. Alternatively, high speed photography could be used.

? HAPC (Habitat Areas of Particular Concern): Areas identified by the North Pacific Management Council. Conduct exploratory identification work in these areas. Not clear whether it is ecologically important habitats or particularly rare areas that need to be identified for this purpose.

Issues raised during discussion session on long-term direction and development of long-term research plans

? Focus has been primarily on the impact of trawl gear, what about other gear types (e.g. dredge, long line). Concerns about long-line gear impact on corals.

? Funding for seafloor impact studies has recently become part of base funding at $500k per year. Prospects for higher funding levels in the future are promising.

? What is it about the impact of fishing gear that is significant in terms of what the fish need/respond to? (Craig Rose)

? Is there support for basic biology such as identifying the invertebrates (e.g. sponges) that are being affected by the fishing gear? (Mark Zimmerman)

? Prioritize research projects a' la Auster's conceptual model (can be pictured as three-dimensional space with three axes representing gear type, spatial distribution of impact, and sensitivity). (Anne Hollowed)

? If an area is closed to fishing, will it ever return to its original state? (Bob McConnaughey)

? Need for synoptic habitat mapping. (Dan Ito)

? Different types of impact by different gear (Gary Stauffer)

? Look at change/recovery over time since Bristol Bay and the eastern Gulf of Alaska have been closed to trawling.

? Is it worth putting a long-term research plan on gear impact together? (Jon Heifetz)
- ✍ The consensus was a strong YES.
- ✍ Tentative due date for a draft on long-term research plan: Fall 2000

Day-2 Presentations (1/28/99)

Speaker: Craig Rose (AFSC/RACE)

Topic: Analysis of video data from a net-mounted camera

A description of a net-mounted camera to observe bycatch avoidance behavior in fish was given. Video data was analyzed by means of event counting where individual events are identified and their time of occurrence is recorded on file. A fairly old computer program, which is based on designating certain keyboard keys for particular events (e.g. types of avoidance behavior) was used for this purpose. Because the image resolution is significantly reduced in slow motion, it is necessary to run the tape at full speed. Hence, it is best to focus on only one type of event and fish species each time the tape is run.

Motion tracking was tried for some work where a moving object (e.g. fish) was identified and tracked. An attempt was made to develop an Optimus script for this purpose but the outcome was unsuccessful. So far, tools that identify, measure, count, and "weigh" objects in video footage have not been used.

Speaker: Brad Stevens (NMFS/RACE/Kodiak)

Topic: The use of a sled-mounted video camera to estimate Tanner crab abundance and to observe their behavior

A camcorder housed in a cylindrical pressure tube was mounted on a sled with skis to observe Tanner crabs in Chiniak Bay. An external camera was used instead of the one supplied with the camcorder. A commercially available program called Observer was used as a simple event recorder when analyzing the video data. The principle of Observer is similar to that of the described by Craig Rose in that specific events are assigned to particular keys.

Problems/limitations with this set-up:

? The frame-recording mechanism was by-passed when using an external camera.

? The design of the skis (and the fact that the sled wasn't sufficiently heavy) created a lift, causing the sled to frequently fly off bottom.

? The exact position of the sled was not known, only the ship's position was recorded in sea-plot. The sled's position was estimated from the depth and the amount of wire out.

? Depth of field was limited to 1-1.5 meters.

? Towing speed was 2 knots.

? Technical problems associated with slowing down the speed of the tape (reduced resolution). Potential solution: use high-speed camera (more frames per second).

? Lots of time required for processing of video data.

? The sled ran smoothly but had a tendency to get tangled up in large rocks.

? Observer is not compatible with all hardware and is biased toward Panasonic decks.

? Cost of:
  - ✍ Observer: $1000
  - ✍ Video analysis module: $1000
  - ✍ Time code generator etc.: $2000

? Three out of four tows were successful. Problems experienced during unsuccessful tows included forgetting to turn the camera on, sled getting hung up on crab pots etc.

Conclusion:
Despite the limitations of this system, quantitative estimates of crab abundance are possible when the depth of field is taken into account.

Speaker: Peter Munro (AFSC/RACE)

Topic: Net-mounted video camera to estimate the rate of escapement under the footrope

Limitations of set-up

? Difficult to identify species accurately (was only able to distinguish flat fish from round fish).

? Difficult to estimate fish size.

? Fish buried in the substrate not seen.

? Difficult to determine whether fish went under or over the footrope.

? Main contributor to uncertainty in the estimates of avoidance was the variability between tows.

? Not clear whether low-light camera can be used in all types of habitat. Artificial light is not an option because studies have shown significant behavioral responses in fish to artificial light.

Conclusion:
Video camera mounted on trawl net is excellent for observing gear, but not fish behavior.

Speaker: Ken Weinberg (AFSC/RACE)

Topic: Net-mounted video camera to estimate the rate of escapement of flatfish through the gaps between roller gear of a Poly Nor'eastern trawl

The objective of this study was to quantitatively estimate the rates of flatfish escapement at different parts of the net using a net-mounted video camera for data recording. An SIT (low light) camera was initially tried, but insufficient natural light required the use of artificial light with a 50W bulb. Operating depths ranged from 55 to 380 meters.

Different categories of fish behavior were recorded using a program similar to Observer. The "Observer" data were entered into an Excel spreadsheet where the statistical analysis was carried out. A time stamp was dubbed onto the Hi8 tapes which was synchronized with vessel procedures using the GPS/SCANMAR suite. This made it possible to get the positions at which different events occurred.

Since escapement under the net is related to fish size, it was necessary to estimate the lengths of fish seen in the video. Use of the software Optimus (to get exact measurements of objects on the screen) was avoided for this purpose because the camera had a tendency to move back and forth in such a way that the scale changed from frame to frame, making it difficult to get accurate measurements. Calipers in front of the screen were used instead. Fish sizes were divided up into length categories with 3-4 cm intervals.

Limitations:

? Difficult to identify fish species.

? Difficult to obtain quantitative estimates.

? Optimus software did not improve on manual methods of data processing.

Conclusions:
Escapement was very high. Possible reasons include problems with gear control (e.g. tow speed, net off bottom etc.) and behavioral responses to the artificial light.

Experiment #2: Q: Does (artificial) light affect the capture rate of fish?

This study consisted of two experiments, one of which was carried out in the Bering Sea and the other off the US West Coast. A total of 22 paired tows was carried out in the Bering Sea and 20 were conducted off the West Coast. Hauls in the Bering Sea were conducted in two depth strata, one of which had an average depth of 58 meters and a water temperature of 5.2 degrees. The corresponding figures for the other stratum were 140 meters and 3.5 degrees. The West Coast hauls were all conducted at the same depth (approximately 150 meters) and temperature (approximately 7.2 degrees). The net-mounted lights (2 bulbs at 50W each) were turned on for one set of tows and off during the control tows. All other conditions including tow speed and haul duration were the same for the two sets of tows. A bag was placed under the trawl net to capture escaped fish and to estimate the rate of escapement under the footrope.

Fish species included in the analysis were:

- Bering Sea: arrowtooth flounder, flathead sole, rock sole, yellowfin sole, cod, and pollock.

- West Coast: arrowtooth flounder, dover sole, english sole, rex sole, slender sole, spiny dogfish, sable fish, hake, dark blotched rockfish, shad, and yellowtail rockfish.

Results:
Bering Sea: Five out of six species in the Bering Sea showed no light effect on capture rates. The only species that showed a slight effect was flathead sole.

West Coast: With the exception of spiny dogfish whose catch rate increased in lit tows, all species showed a reduced catch rate when the lights were turned on. These results are tentative, as proper statistical analysis has not yet been carried out on these data.

Conclusion:
Catch rates of fish in the Bering Sea are for the most part not significantly impacted by light. The reverse is true on the West Coast where all but one of the species observed (spiny dogfish) showed a reduced catch rate under lit conditions. Two potential explanations for the contrasting influence of light on catch rates in the Bering Sea and the US West Coast are: 1) The lower water temperature in the Bering Sea may reduce the speed with which fish are able to swim and escape from the trawl, 2) Confounding factor of different fish species examined at the two locations.

Speaker: Rich Titgen (Newport, Oregon Fish Behavior Lab)

Topic: The use of video to observe fish behavior under different light and temperature conditions

The objective of this study was to track fish swim paths with video in a controlled setting (tanks) under different conditions of water temperature (varied between 1 and 20 degrees) and light. Fish were photographed in the infrared, which is good for small fish in the shadow against a bright background. Required hardware for this study included a PC, video recorder, monitor, a CCD camera, a low light and infrared-capable frame grabber. Position data was collected for groups of fish at discrete time intervals.

There are presently two methods to analyze the videos:

- JAVA video analysis system to get x and y coordinates of a moving fish.

- TDA (Transparent Digitizer System). This is no longer an option since the manufacturer has recently filed for bankruptcy.

Conclusion:

Current fish tracking technology is inadequate. It is difficult to relate relative positions of two fish since the error in each fish's position is too big. Technology needs to be developed that automatically digitizes paths of several fish simultaneously.

Speaker: Bob Lauth (AFSC/RACE)

Topic: The use of video footage from a bottom-towed sled to quantitatively estimate fish density

The fishing industry claims that current trawl surveys don't estimate fish density accurately. There is a need for an independent estimate such as that obtained from a video mounted on a bottom-towed sled.

In this study, a large sled (12'x7'x5'), weighing approximately 450 kg, was deployed off the stern ramp on the R/V Miller Freeman. The sled was towed at a constant speed of 1.5 knots, and a 12 kHz pinger was used to measure the sled's altitude off bottom. A line-transect sampling regime was used to quantify fish abundance. The line transect method is based on three assumptions: 1) Objects on line are detected with a probability of 1.0, 2) Objects detected at the original position prior to any movement in response to the observer, and 3) distances are measured accurately.

The camera was kept at a fixed height and was tilted at a fixed angle. The swath of the video imagery was 2.2 meters on either side of the transect line for a total swath width of 4.4 meters. The swath, in turn, was divided into 20 cm wide lanes, and the original position of detected fish was assigned to the appropriate lane. The effective strip width was determined from the detection function, and was multiplied by the length of the transect to obtain the area surveyed.

Results:
The distribution of fish was random on a small scale, but aggregated on a large scale. The density estimates were significantly higher for the camera sled than the corresponding trawl estimates.

Conclusion:
The video sled may be a valid alternative assessment tool to trawl sampling. The main limitation with this technique is the time-consuming data processing procedure. The probable advantage of this approach is better accuracy and precision in the density estimates. It can also be used to calibrate the catchability coefficient, q, of the trawl.

Speaker: Skip Zenger (AFSC/RACE)

Topic: Video footage from the TACOS

Video footage taken from the TACOS near Unimak and Unalaska Islands was shown.

Comments:

- TACOS proved to be very maneuverable.
- TACOS works very well on smooth bottom.
- Considering using acoustic positioning pinger in future applications.
- Tow speeds must not exceed about 2 knots due to loss of maneuver ability and difficulties in interpreting data.

Speaker: Robert McConnaughey (AFSC/RACE)

Topic: Limitations of video as an assessment tool

Limitations of video as an assessment tool:

- Very time-consuming to interpret data (40-50 hours to process 1 hour of data).
- Subjectivity introduced in the interpretation of data such as fish size, and species identification. Age structure information is not available.
- Lumping of taxa (which is often necessary when analyzing video data since it is difficult to accurately identify organisms to the species level) can be a problem. For example, some species of crustaceans exhibited an increased density in heavily fished areas, whereas others (relatively similar species) showed the opposite trend. The risk of coming to inappropriate conclusions when assessing the impact of trawl gear on habitat is thus high if these species are lumped together.
- Small field of view/sample area.
- The effective sampling area is potentially a function of visibility.
- Poor resolution since small organisms are likely to go undetected.

Conclusion:
Maybe video data could be used as a secondary tool for assessment purposes?

Speaker: Ken Krieger (NMFS/ABL)

Topic: Video used in submersible work

See Ken Krieger's presentation from Day 1.

Speaker: Linc Freese (NMFS/ABL)

Topic: Quantifying trawl-damaged mega epifauna from a submersible

Two High 8 cameras, one vertical and the other oriented at a 25 degree angle off the horizontal, were mounted on a 2-man submersible. Invertebrate counts and substrate category (pebble, cobble, or boulder) were entered manually in an Excel spreadsheet. Scaling information, which was used to estimate the area sampled, was obtained from a set of laser dots spaced 20 cm apart. The effective area sampled per transect varied between 250 and 500 square meters. Due to condensation problems on the horizontally mounted camera, only the vertical camera was used for quantitative estimates.

Limitations
Decreased resolution as a result of lower lighting levels when the camera moved up in the water column biased the invertebrate counts.

Speaker: Robert Stone (NMFS/ABL)

Topic: The use of video mounted on a submersible to count flatfish

Video footage from a downward facing camera approximately 0.7 meters off bottom was collected along 3000 meter long transects. Visibility was estimated at 8 to 15 feet and the effective swath width was approximately 0.6 meters. The area sampled per transect was thus 1800 m2.

Limitations
? Only one taxon was counted during each run of the tape.

? Submersible speed of 1.4 knots was too fast for proper analysis of video footage.

? Batteries were dead at the end of 3 km transect and required a 3-4 hour period of recharge.

? Few dives were aborted because of overly strong currents.

? Unknown distance outward from horizontally mounted camera.

Discussion of what can and cannot be accomplished with video

Limitations of video:
? High processing time of video footage.

? Technical problems of slowing the video playback speed and still maintain high resolution.

? Problems with tracking towed sleds accurately.

? Cannot reliably collect biomass data with video.

? Estimates can be generated by determining length of fish with laser dots and using length-weight relationship.

? Difficult to accurately identify taxa to the species level. Poor resolution makes it necessary to lump several taxa together.

? Sample area tends to be small and variable due to changes in visibility.

Limitations of trawl

? Lack of exact information on where animals came from. Only get an average over the total area sampled.

? Difficult to follow a prior trawl track with a trawl in seabed impact studies. A camera (mounted on a sled, TACOS etc.) is needed to stay on the track.

? Trawl is ineffective at sampling the benthos. Dredge gear may be more suitable for this purpose.

? A trawl path consists of three parts, each of which has a different impact on the benthic environment: 1) door path, 2) bridle path, and 3) trawl path.

Questions/Comments raised

? Use of multiple ships during a survey, each of which is dedicated to a different gear type: video sled, trawl, dredge.

? Use of digital video? Resolution still good at very low speeds.

? Use of high speed video as an alternative to digital video to address problems with low resolution at low speeds.

? Different video systems for different applications (consider vast differences in price between the alternatives): a) sled, b) TACOS, c) submersible.

? Is it possible to acquire new technology to facilitate video data processing from other fields? (e.g. the military, medical).

Under what conditions can artificial light be used?
(see Ken Weinberg's talk)