EFFECTS OF FISHING GEAR ON THE SEA FLOOR OF NEW ENGLAND

Judith Pederson and Eleanor Dorsey, Editors

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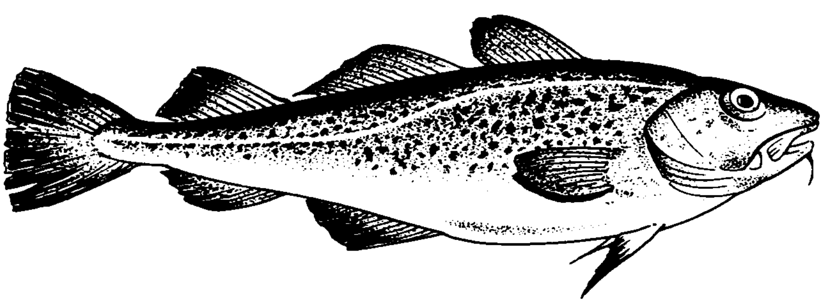
CONFERENCE

EFFECTS OF FISHING GEAR ON THE SEA FLOOR OF NEW ENGLAND

Friday, May 30, 1997
Warren Conference Center of
Northeastern University
Ashland, MA

convened by
Massachusetts Institute of Technology Sea Grant College Program
and
The Conservation Law Foundation



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Conference Sponsors

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John Williamson, New England Fishery Management Council,
New Hampshire Commercial Fishermen's Association
Jon Witman, Brown University

Conference

Effects of Fishing Gear on the Sea Floor of New England
May 30, 1997

Purpose

The purpose of this Conference is to present currently available information about the effects of fishing gear on the sea floor of New England and how they relate to fishing productivity, benthic habitats and biodiversity. Speakers will summarize observations and research findings about the relative importance of natural and fishing-related disturbance to the ocean bottom, and relate these to fishies habitat and ecosystem functioning. Speakers have been asked to identify future research needs and the final discussion will be an opportunity for the audience to contribute to the list and identifying priorities.

The Conference is intended to assist in improving scientific knowledge, promoting fisheries sustainability, maintaining ecosystem health, and informing managers charged with fulfilling the habitat requirements of the Magnuson-Stevens Fishery conservation and Management Act.

AGENDA

FISHING GEAR EFFECTS ON THE SEA FLOOR OF NEW ENGLAND
MAY 30, 1997

8:00 am **Registration and coffee**

8:45 am **Welcome and Introductory Remarks**
Judith Pederson and Eleanor Dorsey, co-chairs

THE NEW ENGLAND SEA FLOOR: DESCRIPTION AND NATURAL DISTURBANCE

Moderator: William Amaru, F/V Joanne-A III

9:00 am **Geology and Chemistry of the Sea Floor**
Joe Kelley, Maine Geological Survey, University of Maine

9:20 am **Benthic Flora and Fauna: Hard Substrates**
Jon Witman, Brown University

9:40 am **Benthic Flora and Fauna: Soft Substrates**
Les Watling, University of Maine

10:00 am **Bottom Habitat Requirements of Commercially Important Species**
Richard Langton, Maine Department of Marine Resources

10:20 am **Break**

SCIENTIFIC STUDIES OF FISHING GEAR EFFECTS ON THE SEA FLOOR:

Moderator: Maggie Raymond, Associated Fisheries of Maine: Groundfish Group

10:50 am **Bottom Tending Gear Used in New England**
Ronald Smolowitz, Coonamesset Farm

11:10 am **Studies in New England**
Jeremy Collie, University of Rhode Island

11:45 pm **Studies in Canada**
Donald Gordon, Bedford Institute of Oceanography, Department of Fisheries and Oceans

12:20 pm **Lunch**

1:10 pm **Ecosystem Effects of Commercial Bottom Trawls in European Waters**
S. I. Rogers, Center for Environment,Fisheries, and Aquaculture Scientce, UK

FISHERMEN'S PERSPECTIVE ON FISH HABITATS AND EFFECTS OF THEIR GEAR ON THE SEA FLOOR

Moderator: James Churchill, Woods Hole Oceanographic Institution

2:00 pm **Bottom Trawling on Hard Bottom**
Bill Gell, F/V Xiphias

2:10 pm **Bottom Trawling on Soft Bottom**
Frank Mirarchi, F/V Christopher Andrew

2:20 pm **Gillnet Fishing**
John Williamson, New Hampshire Commercial Fishermen's Association

2:30 pm **Scallop Dredge Fishing**
James Kendall, New Bedford Seafood Coalition, former scalloper

2:40 pm **Lobster Trap Fishing**
Thomas Morell, Maine Lobsterman

2:50 pm **Bottom Longline Fishing**
Mark Leach, F/V Sea Holly, Cape Cod Commercial Fishermen's Association

3:00 pm **Discussion**

3:15 pm **Break**
Moderator: Roland Barnaby, University of New Hampshire Sea Grant College Program

3:45 pm **Conservation Engineering: Options to Minimize Fishing's Impacts to the Sea Floor**
H. Arnold Carr, Massachusetts Division of Marine Fisheries

4:05 pm **Habitat Requirements of the Magnuson Stevens Act**
Jon Kurland, National Marine Fisheries Service

4:25 pm **Short Takes: Additional Observations by Fishermen and Scientists**
Richard Langan, Experiences with Oyster Dredging

Richard Taylor, Scallop Dredge Experiences
Fred Bennett, F/V Sea Bag III
Peter Auster, University of Connecticut
Kristan Porter, F/V Black Sheep
Page Valentine, U.S. Geological Survey
Bill Doughty, Fishing Vessel Owner and Manager
James Lindholm, Boston University Marine Program
Tom Brancaleone, F/V Paul and Dominec
Mark Butler, Ecology Action Center, Canada
Jáck Merrill, Maine Lobstermen's Association
James Churchill, Woods Hole Oceanographic Institution

5:30 pm **Barbecue (with cash bar)**

6:30 pm **Discussion**
Moderator: Judith Pederson, MIT Sea Grant College Program

Question:

What studies are needed in New England to improve our understanding of fishing gear effects and other disturbances on the sea floor?

What insights have we gained from today's discussions on research and experience with fishing gear effects on the sea floor?

8:00 pm **Adjourn**

GEOLOGY OF THE NEW ENGLAND SEAFLOOR

Dr. Joseph T. Kelley (Maine Geological Survey, 22 State House Station, Augusta, ME 04333-0022 USA)

The New England coast is rock framed, with numerous outcrops of rock at all depths. Submerged rocks, like their counterparts on land, possess considerable bathymetric relief as well as numerous fractures often partly filled with sediment. Glaciation, ending by 11,000 years ago, both eroded the rocks and deposited material on them. The glacial erosion is manifest as many deep gorges ("shelf valleys") cut in rock. Glacial deposits are mainly of two types: till and glacial-marine sediment. Till is a mixture of all particle sizes from mud to boulders, although gravel dominates this material on the seafloor. Glacial-marine mud overlies till, and fills many bathymetric depressions to depths greater than 40 meters. Modern materials are generally reworked from the older glacial deposits. Deltas exist only near the mouths of the region's major rivers, and are generally sandy features.

Sea-level changes followed glaciation in a complex way, with an initial post-glacial drowning of the land north of Boston, followed by emergence of the seafloor to 50-60 m depth, followed by drowning to the present shoreline. South of Boston a more or less continuous rise in sea level has occurred. As the intertidal zone passed over glacial deposits, the mud was easily removed, leaving underlying gravel or bedrock. This is especially true in the Gulf of Maine which experienced two passages of the shoreline across the seafloor shallower than 50 m.

Modern coastal process such as storms, continue to rework glacial and younger materials to depths as great as 55 m. At that depth, wave-formed ripples are common in sandy substrates. Methane eruptions are common and form gas-escape pockmarks in muddy embayments, possibly over the site of drowned bogs and lakes.

BENTHIC FLORA AND FAUNA: HARD SUBSTRATES

Jon D. Witman (Dept. of Ecology & Evolutionary Biology, Box G-W, Brown University, Providence, RI 02912 USA)

Although they comprise a smaller proportion of the total area of the sea floor than soft bottom habitats, hard bottom habitats are ubiquitous throughout the Gulf of Maine and they serve as important fishery habitats. Benthic communities of algae and invertebrates show pronounced changes in abundance along depth gradients on rocky ledges in response to environmental and biological factors. After a brief overview of typical depth zonation patterns in the Gulf of Maine, this talk will describe how natural physical and biological disturbances impact hard bottom benthos across a range of spatial scales, how subsequent recovery (colonization) proceeds and provide examples of species with life histories that are particularly sensitive to physical disturbance.

BENTHIC FLORA AND FAUNA: SOFT SUBSTRATES

Les Watling (Professor of Oceanography, Darling Marine Center, University of Maine, Walpole ME 04573 USA)

My talk will review the major soft bottom communities in the Gulf of Maine and examine the features which determine their distribution. The soft bottom community species composition seems to be controlled by a mix of water mass temperature and substrate grain size distributions. Most of the Gulf of Maine is covered with cold water and the dominant community types are representative of the North Atlantic colder waters. In the deepest waters, however, can be found species which have upper deep-sea distributions and live in warmer (8-10 °C) water.

BOTTOM HABITAT REQUIREMENTS OF COMMERCIALLY IMPORTANT SPECIES

Richard W. Langton (Maine Department of Marine Resources, P.O.Box 8, West Boothbay Harbor, ME 04575-0008 USA)

The marine environment offers a plethora of benthic habitats that support a variety of species of animals. The large scale distributional patterns of many of the commercially exploited species are well documented. The occurrence of finfish, and that of megabenthic invertebrates, for example, has been correlated with depth and sediment types but such correlations do not explain the underlying dynamics of these associations. Linking a species that is a pelagic spawner, such as Atlantic cod, to the benthic habitat that serves as a nursery for juvenile fish reflects a life history stage shift in scale and controls from large physical and oceanographic features to the finer scale of a fishing ground and nursery area. Our understanding of the dynamics of such a shift is often controlled by both the temporal framework and the technology we utilize to study the benthic environment. With the advent of technology that allows for sampling on finer temporal and biological scales we essentially develop the ability to start thinking more like fish. It is also at this finer scale that fishing and other human perturbations have their greatest effect, and it is at precisely this scale where we lack detailed knowledge. Once we appreciate all the processes controlling fish behavior which ultimately result in the large, population scale, patterns we observe then we will be in a better position to predict the long- and short-term impact of human behavior on these commercially important species.

BOTTOM TENDING GEAR USED IN NEW ENGLAND

Ronald Smolowitz (Coonamessett Farm, 277 Hatchville Road, East Falmouth, MA 02536 USA)

This paper presents a brief review of five major gear types used in New England that contact the sea floor during their operation. The gear types covered are bottom trawls, scallop dredges, gill nets, hooks, and lobster traps. Each gear type is outlined in terms of technical evolution, bycatch, selectivity, and management issues. Emphasis in the review is on how the gear interacts with bottom habitat and the possible impacts of this interaction. The paper concludes that cumulative fishing impacts of each gear type need to be identified in order to define appropriate fishing levels/strategies.

TRAWL IMPACT STUDIES IN NEW ENGLAND

Jeremy S. Collie[1], Page C. Valentine[2], and Peter Auster[3] ([1]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882 USA; [2] U.S. Geological Survey, Woods Hole, MA 02543 USA; [3]University of Connecticut at Avery Point, Groton, CT 06340 USA)

Ever since steam trawlers were introduced to New England in the early 20th century, there have been concerns about the denudation of the bottom by otter trawls and scallop dredges. Auster et al. calculated the cumulative area swept by trawls and dredges on Georges Bank and the Gulf of Maine. In recent years (1984-1990) the area swept was equivalent to the entire Gulf of Maine and four times the area of Georges Bank. Hard-bottom habitats (shell, gravel, cobble, boulder) appear to be the most sensitive to disturbance by bottom fishing. Spatial comparisons have been made between disturbed and undisturbed sites (Swan's Island, northern Georges Bank) and before and after disturbance (Jeffrey's Bank).

In general, undisturbed sites are characterized by the presence of emergent epifaunal bryozoans, hydrozoans, sponges, and polychaete and amphipod tubes. This epifauna provides a complex three-dimensional habitat for fragile taxa such as shrimps, brittle stars, nudibranchs and polychaetes. Destruction of the epifauna by bottom fishing reduces habitat complexity and may lead to increased predation on juveniles of harvested species. Results from these studies are compelling, but a more experimental approach is required to directly control the level of fishing disturbance. The closure of two large areas of Georges Bank to all bottom fishing in December 1994, has provided a rare opportunity to monitor the recovery of heavily disturbed sites. In the northern apex of Closed Area II we have observed increases in the abundance, biomass and species diversity of benthic animals since the 1994 closure. Settling trays, to be deployed in summer 1997, will measure the rate of recolonization of defaunated gravel.

References:

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.L.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (northwest Atlantic): implications for conservation of fish populations. Reviews in Fisheries Science 4:185-202.

Collie, J.S., G.A. Escanero, L. Hunke, and P.C. Valentine. 1996. Scallop dredging on Georges Bank: photographic evaluation of effects on benthic epifauna. ICES C.M. 1996/Mini:9, 14p.

Collie, J.S., G.A. Escanero, and P.C. Valentine. 1997. Effects of bottom fishing on the benthic megafauna of Georges Bank. Mar.

STUDIES IN EASTERN CANADA

Donald C. Gordon Jr. (Department of Fisheries and Oceans, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS, B2Y 4A2, Canada)

Beginning in 1990, the Department of Fisheries and Oceans has been conducting an experimental program on the impacts of mobile fishing gear on benthic ecosystems in Atlantic Canada. Much of the initial effort went into developing the imaging and sampling technology needed to conduct controlled disturbance experiments on continental shelf benthic ecosystems. The major accomplishment to date has been a three year experiment (1993-1995) on the effects of otter trawling on a sandy bottom ecosystem of the Grand Banks of Newfoundland (120-140 m). Each year, three 13 km corridors were trawled twelve times with an Engel 145 otter trawl equipped with rockhopper footgear which created a disturbance zone on the order of 150-250 m wide. Changes in physical habitat structure were detected by sidescan sonar, RoxAnnTM , DRUMSTM and video imagery. Trawling did not affect sediment grain size but there do appear to be significant interannual variations of natural origin. The total biomass of epibenthic megafauna in the trawl bycatch decreased significantly with repeated trawling and an influx of scavenging snow crabs was observed after 5-6 trawl passes (approximately 10-12 h). Total biomass of invertebrates sampled by an epibenthic sled was on average 25% lower in trawled corridors than in adjacent, untrawled control corridors and this difference was statistically significant. The biomass of snow crabs, sand dollars, soft corals and brittle stars was significantly lower in trawled corridors. In addition, sand dollars, sea urchins, and brittle stars showed significant levels of physical damage. No significant effects of trawling were apparent in the four dominant mollusc species collected by the epibenthic sled. An extensive series of grab samples was also collected and data are currently being analyzed. Two new mobile gear experiments will be initiated in 1997 on the Scotian Shelf. The first will be another otter trawling experiment on the gravel bottom of Western Bank within the haddock nursery box currently closed to all groundfishing gear for conservation purposes. The second will be a hydraulic clam dredging experiment on Banquereau Bank.

ECOSYSTEM EFFECTS OF COMMERCIAL BOTTOM TRAWLS IN EUROPEAN WATERS

Stuart I. Rogers (Centre for Environment, Fisheries, and Aquaculture Science, Lowestoft Laboratory, Pakefild Road, Lowestoft, Suffolk, NR33 OHT UK)

Fishing in European waters has had a long history, with most activity centered on the North Sea. Important technical developments occurred at the end of the nineteenth century, and improvements in fishing technology have continued to the present day, resulting in greatly increased levels of fishing intensity. Recent international co-operation through the International Council for the Exploration of the Sea (ICES) has enabled estimates of fish abundance to be produced for most of the major stocks, and these data have proved valuable in assessing the effect of fishing on stock size. In addition to the removal of the target species from the community, fishing in European waters has had other direct effects. Discarded fish and benthos, and the damaged organisms in the path of the gear, all become available as food for other members of the ecosystem, both through a general increase in organic production, and by providing food for invertebrate scavengers such as the hermit crab, *Pagurus bernhardus,* and fish species such as the dab, *Limanda limanda*, and dragonet, *Callionymus* spp. Other direct effects of fishing include the physical disturbance to the seabed, and the generation of seabed litter from discarded gears etc. Despite these clear, and in many cases quantifiable, effects, it is still very difficult to separate the effects of commercial fisheries from natural fluctuations in reproductive success and predator-prey interactions. This paper reviews recent European research into the direct effects of fishing on the seabed, with emphasis on experimental work in the North Sea and Irish Sea in areas of both hard and soft substrate. The indirect effects of fishing activity, such as changes to the relationships within a community, are described using analysis of community-based indices to assess the scale of both spatial and temporal variation. These analyses focus on the impact of fishing on size structure of populations, and identify fish species which may be most vulnerable through unfavorable life history characteristics.

BOTTOM TRAWLING ON HARD SUBSTRATES

Bill Gell (F/V Xiphias, Rhode Island USA)

Bill Gell has agreed to read the presentation for Rodney Avila who is unable to attend.

BOTTOM TRAWLING ON SOFT SUBSTRATES

Frank Mirarchi (Captain F/V Christopher Andrew, 67 Creelman Drive, Scituate, MA 02066 USA)

Fishermen identify soft substrate sea floors as "soft bottom". Soft refers more to a lack of obstructions or "hangs" than to the actual consistency of the substrate. Bottom trawling originated on soft bottom. It is only within the last 15 years that technologies which allow trawling over very irregular or rocky bottom have been developed. Soft bottom trawling began in 19th century Europe using beam trawls, (nets held open by a rigid frame) towed by sailing vessels. Otter trawls (nets held open by paravane-like devices) became practical with the introduction of mechanical propulsion. Otter trawling was introduced to the U.S. about 1910. By the advent of World War I it had become the dominant gear for demersal fish.

The impacts of trawling on the productivity of fisheries have not been considered independently of the consequences of fishing mortality on fish populations. It should be noted that the decades between World Wars (1920s and 1930s) produced high and sustainable landing levels along the New England coast. Furthermore, in other areas such as the North Sea, where landings were in decline, the cessation of fishing engendered by war produced a quick return of fish abundance. Thus, non-empirical evidence indicates that if adverse effects on habitat productivity do occur from bottom trawling they are probably density dependent and reversible.

My personal experience seems to corroborate this. I began fishing in 1963. At that time fishing areas or "tows" were located using dead reckoning, land marks, and depths. These tows were safe areas that had been identified and fished for decades. They probably comprised under 25% of the total seabed area. These areas continued to produce high catches until the mid 1980s. By 1980 fishing, driven by capital and technology, became far more pervasive and aggressive. Mortality rates increased and catches declined. In 1997, after three years of direct mortality controls, catches are beginning to increase again.

The linkage between habitat productivity and mortality on abundance of fish is tenuous and difficult to ascertain. Other than cases involving protected species, the habitat impact consequences of fishing have been given little consideration. In the spirit of developing productive and sustainable fisheries these impacts should be investigated with the objective of providing useful information to fishery managers.

GILLNET FISHING

John Williamson (New Hampshire Commercial Fishermen's Association, 201 Wells Road, ME 04043 USA)

This presentation will provide an overview of gillnet fishing on the habitat.

SCALLOP DREDGE FISHING

James Kendall (New Bedford Seafood Coalition, 104 Coop Wharf, New Bedford, MA 02740 USA)

This discussion will review habitat requirements for scallop fishing and offer observations of scallop dredge fishing on the habitat.

LOBSTER TRAP FISHING

Thomas Morell (F/V Patti-M, 64 Parkhurst St. Quincy, MA 02169 USA)

This presentation will provide observations of lobster trap fishing gear effects on the sea floor and discuss habitat requirements for lobsters.

BOTTOM LONGLINE FISHING

Mark Leach (Cape Cod Commercial Hook Fishermen's Association, 870 Orleans Road, Harwich, MA 02645)

This discussion will review a basic description of commercial hook fishing methods. The relationship between hook fishing and the need for critical habitat will be discussed and specific examples of critical habitat will be presented to illustrate the association. Current conditions of critical habitat will be identified and causes that hook fishermen perceive to destroy critical habitats will be offered.

CONSERVATION ENGINEERING: OPTIONS TO MINIMIZE FISHING'S IMPACT TO THE SEA FLOOR

H. Arnold Carr (Massachusetts Division of Marine Fisheries, 50A Portside Drive, Pocasset, MA 02559 USA)

Mobile fishing in New England waters have shown significant advances in recent years. Three important areas of improvement are fishing gear, vessel capability, and navigational instrumentation. Fishing captains have viewed recently available underwater videos of gear functions and fish behavior and used this knowledge concomitant with the three previously mentioned advances to increase fishing efficiency and expand fishable sea bottom.

Advances in fishing technology have also presented opportunities to make gear more selective and less impacting on the juvenile fish, non-target species and the benthos. Reducing mobile gear impacts to the bottom, however, will require decisions related to:

- a) targeting certain species, such as cod, haddock, or whiting with the exclusion of flatfish;
- b) catching flatfish with gear that fishes the sea bottom but with sweeps that are much lighter and less imposing;
- c) reducing sea bottom availability to mobile gear - especially bottom that is irregular; or
- d) opting only for stationary gear, such as long line, fish pots or traps.

Discussion of the impacts and options is aided with underwater video of fishing gear.

IMPLICATIONS OF THE ESSENTIAL FISH HABITAT REQUIREMENTS OF THE MAGNUSON-STEVENS ACT

Jonathan M. Kurland (Habitat and Protected Resources Division, NOAA / National Marine Fisheries Service, One Blackburn Drive, Gloucester, MA 01930-2298)

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act included significant new requirements to improve the consideration of habitat concerns in fishery management decisions. By October 11, 1998 each fishery management plan must identify and describe essential fish habitat (EFH) for managed species, minimize adverse effects on EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH. In New England, the fishery management plans for groundfish, scallops, and Atlantic salmon must be amended to address the EFH requirements, and the new fishery management plan for Atlantic herring will have to include EFH provisions as well.

The Magnuson-Stevens Act also requires each federal agency to consult with NMFS regarding any activity authorized, funded, or undertaken by the federal agency that may adversely affect EFH. NMFS is required to provide conservation recommendations on federal and state agency activities that would harm EFH. Although NMFS' recommendations are not mandatory conditions, for each action the federal agency must respond in writing to describe the measures the agency will take to protect EFH, and to explain its reasons for not accepting any of the recommendations.

The requirement for fishery management plans to "minimize to the extent practicable adverse effects on EFH caused by fishing" will be implemented in New England through the Fishery Management Council. In determining what types of management measures are "practicable" the Council will consider issues such as the nature and extent of any adverse effect on EFH, and whether the benefit to EFH achieved by minimizing the adverse effect justifies the cost to the fishery. Any specific management approaches to mitigating gear impacts will be developed through the Council process, which provides opportunities for public involvement to address concerns between gear sectors and other issues.

The overall goal of the EFH provisions of the Magnuson-Stevens Act is to facilitate more of an ecosystem-based approach to fishery management, whereby habitat protection and harvest management are coordinated better to enhance the sustainability of marine fisheries.

THE EFFECT OF DREDGE HARVESTING ON OYSTERS AND THE ASSOCIATED BENTHIC COMMUNITY

Richard Langan (Jackson Estuarine Laboratory, 85 Adams Point Road, Durham, NH 03824, U.S.A.)

A study was conducted in 1994 to determine the effects of dredge harvesting on oyster populations and as well as the benthic community associated with the oyster bed. The study area was located in the Piscataqua River which divides the states of Maine and New Hampshire. An oyster bed approximately 18 acres in size is located in the river channel and is divided nearly equally by state jurisdictional lines. The difference in the classification of the growing area and permissible uses of the resource between the two states provided a unique study opportunity. At that time, the State of Maine classified the area "restricted for depuration" and allowed commercial harvesting, whereas New Hampshire, where commercial harvest is not allowed, had placed a "prohibited" classification on the area many years prior to the study. The Maine side of the bed had been harvested using a small oyster dredge for five years prior to the study, while the New Hampshire side had not been harvested by any method for years.

Six random samples of oysters were collected by SCUBA divers on each side of the river using a 0.25 m^2 quadrat. All oysters were counted and measured. Five random grab samples were collected on each side of the river using a custom made 0.0625 m^2 grab sampler. All epifaunal and infaunal species in the samples were identified and enumerated. Additionally, near bottom water samples collected in the tracks of the passing dredge were analyzed to assess the impact of the dredge on suspended sediment concentrations.

On the Maine (dredge harvested) side of the river, oyster populations showed a normal size distribution and good recent recruitment while the size frequency of oysters on the New Hampshire (unharvested side) was skewed toward older, larger individuals and recruitment was poor. No significant differences between the two areas were found in the species richness, diversity and number of epifaunal and infaunal invertebrates. The suspended sediment plume created by the dredge was localized and concentrations returned to ambient conditions at a distance of approximately 110 meters behind the dredge.

CHANGING APPROACH TO USE OF THE SEA FLOOR

Richard R. Taylor (F/V My Marie, Box 7002, Gloucester, Mass 01930)

A SHIFT TOWARD AREA MANAGEMENT

Current bottom fishing gears and methods have evolved to be highly efficient at the taking and processing of large numbers of animals when and where found. Although there are valid concerns for such concepts as habitat, biodiversity, and effects on nontargeted animals, we might ask ourselves if we have these same concerns for other areas where we produce food for our large human population. Do we ask for biodiversity in a wheat field, beef ranch, tomato patch or rice paddy? Of course not, but at the same time, we do not run our wheat combines through the countryside looking for a few more wheat stalks.

EFFECTS ON JUVENILES

Two recent increases in ring size used for the chain bags in the scallop fishery have reduced the amount of both bottom debris and juvenile scallop seen on deck of commercial vessels. This might lead us to believe that increased escapement allows scallops less than the 3.5" ring size to remain in these fished areas to grow until they are large enough to be retained by the gear. Experience has shown that if an area has been fished down to the point of low economic return before moving elsewhere, that only very rarely are scallops found in that specific area for several years. This implies that a new larval set must occur and be left alone to grow to capture size.

New provisions to the Magnuson-Stevens Act include a long term effort to identify specific habitats necessary for the different life stages of various species. The common sense approach is to leave the small ones alone to grow. Examination of the literature from New Zealand and Japan suggests that we must look to other concepts such as rotational fishing zones to realize maximum undisturbed growth and thus yield across the normal size distribution of animals. Other specific areas might be designated as reserves, off limits to high impact gear.

CHANGES IN FISHERY HABITAT FROM THE PERSPECTIVE OF A GILLNETTER

Fred Bennett (F/V Sea Bag III, 54 Valley Road, Chatham, MA 02633 USA)

Habitat requirements for fish caught by longline fishing will be discussed in the context of fisheries productivity.

A CONCEPTUAL MODEL OF FISHING GEAR IMPACT ON A WIDE RANGE OF SEAFLOOR HABITATS

Peter Auster (National Undersea Research Center, North Atlantic & Great Lakes, University of Connecticut at Avery Point, Groton, CT 06340 USA) to be read by Ellie Dorsey, Conservation Law Foundation

Concern for, and management of, habitat integrity has been integral to the management of coral reef fisheries, fisheries which depend on sea grasses, and those which occur in kelp bed habitats. Unfortunately, it has only been since the advent of technologies that allow us to make direct underwater observations and seeing the type of structures that fish use in other continental shelf environments that we've begun to obtain an appreciation of the role that seafloor habitat structures play in the production and survivorship of juveniles, which is obviously integral to developing any kind of sustainable fishery resources.

Fish habitat has been defined as the structural component of the environment that attracts organisms and serves as a center of biological activity. I think this is a very workable definition at a very functional level, because it keys it to the level of individual fishes and the role that habitat plays in increasing their fitness.

I start with the common range of habitat types that occur across the northeast U.S. continental shelf and discuss the function of a number of these habitats.

I and a long illustrious list of colleagues have conducted studies at several sites in the Gulf of Maine and have found that fishing gear reduces habitat complexity in several ways: by direct removal of epifauna, by smoothing of sedimentary bed forms, and by removal of species which produce structures, such as lobsters and skates. These conclusions are consistent with other studies conducted here in the northwest Atlantic and in other parts of the world. What we have been trying to develop is some type of "tool" that integrates what we know from our and similar studies, that managers could be able to use as a guide to understand the role that impacts have on the integrity of habitat complexity in a more holistic way, and that could serve to focus research on developing better data on impact and recovery rates on important habitat 'features".

Currently, we have a conceptual model but we are working on quantitative models. The conceptual model shows the response of a range of seafloor habitat types to increases in fishing effort. This predicts reductions in the complexity provided by bed forms from extreme fishing gear impacts.

What we need to do is, at least, gain some knowledge of what fishing gear is doing in terms of maintenance of habitat integrity and then decide on a management level what kind of measures we want to take for different types of habitats in order to provide or maintain the integrity of shelter for species that we harvest. Obviously, this is a contentious issue. What I am suggesting is that it is not that these types of studies and models point to the conclusion that we shouldn't trawl anywhere, but it is perhaps that we, at least, might want to consider not trawling everywhere, limiting the amount of effort to particular types of areas, and developing types of gears that impact the bottom in a much reduced fashion.

GEAR MODIFICATIONS TO INCREASE QUALITY OF PRODUCT; INCREASE CATCH; AND DECREASE HABITAT DISTURBANCE IN THE SEA URCHIN INDUSTRY

Kristan L. Porter (P.O. Box 233 Cutler Maine 04626)

Due to the very subjective market price structure and inshore habitat of the green sea urchin industry, fishermen have modified their gear from the once widely used "chain sweep" to a lighter more monuverable "urchin drag".

These drags, also refered to as "Green Drags" (named after its original designer), increase the quality of the presentation of the product because the lighter chains keep the spines of the sea urchin intact. The design of the head-bail allows the gear to fish rougher areas that ordinarily could not be fished with a traditional chain sweep, so obviously the catch is increased.

These gear modifications may serve another perpose other than catch. The lighter drags may disterb the habitat less than other heavier drags, which could be beneficial to the urhin and other industries.

OBSERVATIONS ON CLAY PIPE IN MASSACHUSETTS BAY

Page Valentine (U.S. Geological Survey, Woods Hole, MA 02543)

What is the role of "clay pipe" habitat in the Massachusetts Bay region? Clay pipe habitat is characterized by hollowed-out pieces of hardened sediment of irregular shapes and sizes that lie scattered on the sea bed. The origin of the clay pipes is unclear. Based on anecdotal evidence, clay pipe habitats once rich in groundfish have been disturbed by fishing gear. Questions for discussion include: Is clay pipe habitat a preferred habitat of groundfish and why? Where does it exist today? Is it accessible and vulnerable to trawling? Is it possible and advisable to enhance the fishery by creating this habitat artificially?

OBSERVATIONS ON FACTORS THAT INFLUENCE MARINE ECOSYSTEMS

William Doughty (PO Box 121, Oraso Island, ME 04066 USA)

As a fisherman and fish spotter, I have spent the last 43 years on the sea. The one constant over that time is that the ocean is constantly changing and it is my observation that man is a small influence on ecosystems. I would like to share a few observations with you.

One species which has considerable influence on nearshore environments is the cormorant. As a protected species, cormorant populations have increased and intensively prey upon cunner, *Tautogolabrum adspersus,* in ledges, nearshore areas where subtidal algal populations are abundant. Removing the cunner from ledges results in decreased predation on one of their prey items, sea urchins, *Strongylocentrotus droebachiensis,* that, in turn, have increased in numbers and decimated these areas. The ledges are good fish habitat, and removal of the algae by urchins creates barren areas that are not protective fish habitat. The lack of algae also contributes to low dissolved oxygen.

Water clarity has also changed during this time. Areas where water clarity was to depths of 20 fathoms are now cloudy, in part, due to white river rafting which continually stirs up sediments that are carried to the sea. Formerly, spring rains carried a heavy load, but this was of short duration compared to the longer periods associated with white river rafting. Similarly, during this period the eider duck has also increased and expanded its range from marine environments to fresh water lakes and ponds. Eider ducks feed on bivalves that, in turn, filter particulates from the water and are responsible for water clarity. Eiders have been observed to feed in intertidal areas that were reseeded with bivalves.

Fishermen are concerned about maintaining productive fish habitat. My skippers have removed debris (plastic garbage bags and other materials) collected in nets long before regulations banned disposal of plastic at sea. They are environmental responsible with oil disposal. My observation is that otter doors and rollers have minimal impact on the sea floor. The most productive areas are those that are reworked, especially so for scallops. Productivity is not necessarily associated with area closures. The region around an underwater cable where fishing is prohibited is not productive and the results are 180° from expected based on personal communication with those conducting studies in the area.

POST-SETTLEMENT SURVIVORSHIP OF JUVENILE GROUNDFISH: IMPLICATIONS FOR THE DESIGN OF MARINE RESERVES AND FISHERY MANAGEMENT

James Lindholm[1,2], Matthias Ruth[2], Les Kaufman[1] and Peter Auster[3] ([1]Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543; [2]Center for Energy and Environmental Studies, Boston University, 675 Commonwealth Ave., Boston, MA 02115; [3]NOAA's Undersea Research Center, University of Connecticut, Avery Point Campus, 1084 Shennecossett Road, Groton, CN 06340)

Recent studies suggest a direct correlation between the survival of newly settled juvenile fish and the complexity of the benthic habitat to which they settle. The use of non-extractive reserves designed to protect such benthic habitat could prove significant for recruitment to exploited fish populations. A spatially explicit dynamic model is presented to explore the significance of marine refugia in the survivorship of 0-year fish over a twelve month period. The model synthesizes knowledge of benthic habitats, the alteration of these habitats by mobile fishing gear, and the role such habitat plays in the survival of juvenile fish. In this simple case, complex benthic habitat is pebble-cobble bottom which develops dense epifauna in the absence of fishing gear impacts. The epifauna provides additional cover from predation for 0-year fish and increases survivorship over bare cobble-gravel. Model results suggest the design of marine refugia must be sensitive to juvenile migration rates and the size of the population targeted for protection. Additionally, because 0-year fish are often migratory, habitat beyond the bounds of refugia must also be considered important for juvenile survival, particularly when one of the goals of the refuge design is to improve recruitment to exploited populations surrounding refugia.

OBSERVATIONS ON THE EFFECTS OF TRAWLING ON FISHERY HABITAT AND PRODUCTIVITY

Thomas Brancaleone (F/V Paul and Domenic, 3 Ocean View Drive, Gloucester, MA 01930 USA)

This paper will review my experiences as a trawler out of Gloucester focusing on fisheries habitats and productivity.

FACTORS AFFECTING ATLANTIC HARD CORALS

Mark Butler (Ecology Action Centre, Halifax, Nova Scotia B3J 2B3 Canada)

It was from fishermen that we first learnt about the existence of hard corals in the deeper waters off Nova Scotia. Like most Nova Scotains we thought that hard corals were only found in warmer waters. Through interviews with fishermen and scientists, we are gathering information on what species of coral exist in Atlantic Canadian waters, where they grow, how big and old they get and development. Research and knowledge of these species appears to be more advanced in the United States and Europe than in Canada.

OBSERVATIONS OF LOBSTER HABITAT

Jack Merrill (Maine Lobstermen's Association, PO Box 994, Northeast Harbor, ME USA)

This presentation will present materials from the sea floor in areas where lobsters are fished. Videos of ghost traps will be discussed.

SEDIMENT RESUSPENSION BY TRAWLING: POSSIBLE IMPLICATIONS

James H. Churchill (Woods Hole Oceanographic Institution, WoodsHole, MA 02543 USA)

A number of underwater observations have indicated that, when moving at normal fishing speeds, trawl doors generate strong turbulent wakes which resuspend clouds of suspended sediment. Coupled observational-theoretical studies of sediment motion over the continental shelf off the U.S. east coast have indicated that trawling may be the primary agent for resuspending sediment in some areas of the outer shelf (at bottom depths of greater than 70m). However, while the importance of trawling in mobilizing sediments is well established, there are a number of unresolved issues regarding the impact of this phenomenon. There is, for example, great uncertainty regarding the amount of sediment put into suspension by trawling over the continental shelf. The studies mentioned above used measurements of trawl resuspension in inshore waters. There are also important, unanswered questions regarding the effect of trawling on nutrient supply to the water column. Many areas in which trawling activity is concentrated receive roughly half their nutrients from sediments. Trawling can potentially greatly enhance the supply of nutrients for primary production. Trawling may also significantly change both the chemistry and animal populations within bottom sediments, which can have both harmful and beneficial effects.

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