Spring 2000 ISSUE # 14

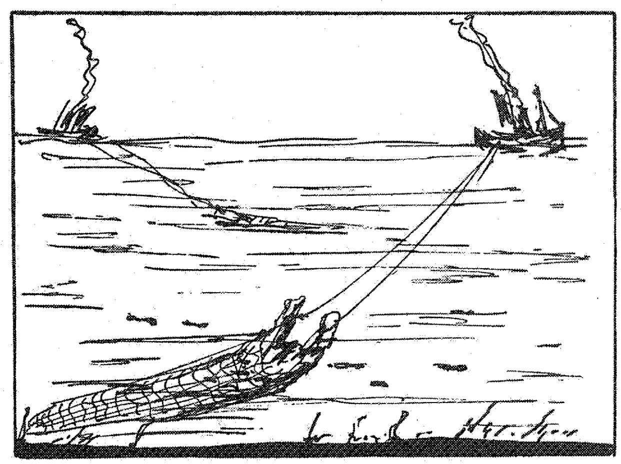
FUNDY ISSUES

Fishing in Fundy

Harming Seafloor Habitats?

Disturbing developments

Slowly, with muffled thuds, the arc of stout steel cable on heavy rubber rollers sweeps across the undulating twilight landscape. Tearing through lush vegetation, it uproots and crushes all in its path, leaving a wide trail of destruction in its wake. Large boulders are torn loose from the ground and roll along, crushing and gouging. At each end of the wire, great steel plates as tall as a person bite into the soft ground, furrowing it like a plough, churning up burrowing animals and stirring up billowing clouds. Between the slowly dissipating plumes, dead and dying creatures of every description lie scattered amongst the tangled vegetation. Hungry predators, ever alert to an easy meal, swoop in and feast voraciously. Unquestionably, if this grim scene were being played out in nearby woodlands for all to see there would be a public outcry and demands for an immediate halt. But remarkably, this same scene is repeated daily on the seafloor in many parts of the Gulf of Maine and Bay of Fundy, invisible, uncontrolled and largely unheeded. In recent decades, alarm has been sounded world-wide over the clearing of vast tracts of tropical rainforest habitat and the extinction of staggering numbers of plant and animal species. Even then, it took the public time to react, because the devastation was happening in remote corners of the world. Now, another ecological upheaval of comparable scale may be taking shape in places that are very much closer to home, yet paradoxically even more remote. Hidden from view beneath our coastal and offshore waters, large areas of productive seafloor, or "benthic", habitat are being regularly scraped and gouged by heavy trawls and dredges towed by fishing vessels seeking groundfish and shellfish. Few dispute the fact that significant areas of the seafloor are being significantly, regularly and roughly disturbed. However, a heated debate rages about whether there are serious, lasting ecological effects of this physical disturbance on benthic habitats, biodiversity or fish stocks.



FMESP Fundy Marine Ecosystem Science Project

BoFEP Bay of Fundy Ecosystem Partnership

Until recently, our ability to even detect, let alone determine the severity and extent of bottom disturbance by fishing gear was limited. Some scientists have long suspected that harm was being done, but found it difficult to demonstrate convincingly with the available oceanographic equipment. However, during the past decade they have acquired the remote sensing tools needed to really see and measure the effects. Many of them are now expressing great alarm at what they are finding on the seafloor. Les Watling, a professor of Oceanography at the University of Maine, studies gear impacts in the Gulf of Maine. He states emphatically that "Nothing humans do to the sea has more physical impact than bottom trawling." Elliot Norse, president of the Marine Conservation Biology Institute based in Washington, goes even further, "We are doing more to the surface of the earth by trawling than perhaps any other human activity except agriculture." Peter Auster, Science Director of the North Atlantic National Undersea Research Centre at the University of Connecticut, has studied trawling impacts for decades and has seen the results first hand. "I've seen bottoms once covered with gardens of corals, sponges, mussels, and worms turned into barren wastelands". There is a rapidly growing portfolio of such before and after pictures of trawled and dredged areas that typically show scenes of great environmental disruption. Even an official with the National Fisheries Institute, a trade association, agrees that there is an "absolutely astounding difference in habitat structure and complexity because much of the biology of that area is taken up in the net". However, he quickly questions the overall ecological importance, noting that it is likely that "those areas would be recolonized relatively quickly". Others in the fishing industry have been more blunt in their defense. The May 1999 issue of Fishing News states that, "Through the clever use of words and statistics, they [the environmental scientists just quoted] are trying to make it appear as if fishing techniques which have been in use for generations are turning huge areas of seafloor into biological deserts, lifeless areas presaging the end of biological diversity in the world's oceans." Yet another article in Fishing News argues that, "in some cases habitat or community changes may have already occurred, such that excluding fishing gears from these areas would achieve little. Clearly a rocky reef community is unlikely to re-establish itself if the reef has been removed by fishing gears". And with a final flourish it concludes, "change is not necessarily deleterious. Agriculturalization of the land has enabled the development of civilization". Passions run high on both sides of this issue, because there is a great deal at stake for both the environment and the fisheries. In exploring the issue, we need to look at the changing nature and extent of gear impacts, consider why the seafloor is an important and sometimes vulnerable part of the marine ecosystem and then discuss what might be done to protect benthic habitats that may be particularly at risk.

> ***"Few dispute the fact that significant areas of the seafloor are being significantly, regularly and roughly disturbed. However, a heated debate rages about whether there are serious ecological effects of this physical disturbance on benthic habitats, biodiversity or fish stocks."***

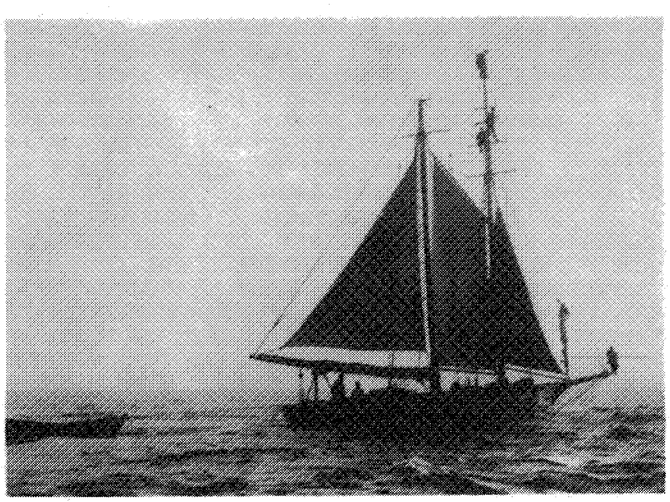
The Spreading Siege

Concern about the towing of fishing gear behind ships to harvest the creatures that dwell in abundance on and above the seafloor is hardly a new issue. As early as the 14th century European fishermen used "a new and craftily contrived kind of instrument" called a *'Wondyrchoun'* to harvest oysters. This device, bearing a heavy iron bar, was dragged across the bottom behind a small sailing vessel. Traditional fishermen were alarmed at the damage that this might be doing to their fishing grounds. They felt that the bar pressed so heavily on the bottom as it scraped along that "it destroys the living slime and the plants growing on the bottom under the water, and also the spat of oysters, mus-

> ***"Nothing humans do to the sea has more physical impact than bottom trawling."***

sels, and of other fish, by which the large fish are accustomed to live and be nourished". A petition was sent to parliament to try to ban such gear. The government response, although couched in antiquated terms, is essentially the same as that still being used today, "Let commission be made by certain qualified persons to inquire and certify to the truth of the allegation made, and thereon let right be done in the Court of Chancery." In other words, let's do an environmental impact assessment before we act! Over the next 600 years, human populations and their fishing activities expanded steadily with little further thought for possible effects on the marine environment. Indeed, for much of this period there was probably little real cause for concern. Small, wind-powered fishing boats could only tow light gear and were largely restricted to shallow, protected, coastal waters with level bottoms. Large tracts of the ocean floor remained undisturbed, well beyond their reach. Even their most aggressive fishing efforts had little noticeable effect on the sea's overall biological production. And, even if there was some environmental degradation taking place it was minor, well hidden and largely "out of sight - out of mind".

"Small, wind-powered fishing boats could only pull light gear and were largely restricted to shallow, protected, coastal waters with smooth, level bottoms. Large tracts of the ocean floor remained undisturbed, well beyond their reach. Even their most aggressive fishing efforts had little noticeable effect on the sea's overall biological production."



For centuries, sail power and light gear limited the ecological impact of fishing on the seafloor habitat.

But by the early 1970s, this comfortable complacency was replaced by nagging doubts in some minds. The invention of the steam engine had led to the use of steam-powered trawlers by the early 1900s. Over subsequent decades these increased in power and size, making it possible to tow much heavier gear and venture farther afield to fish in deeper offshore waters. Spurred on by government-supported research and funding, the size and catching efficiency of fishing vessels and their gear increased steadily. Ever larger areas of seafloor at ever-greater depths felt the relentless scrape of larger and heavier trawls and dredges. Nowadays, trawling down to 200 metres is common and in Australasian waters trawling grounds as deep as 1200 metres are routinely worked. Clearly, advancing technology is making even the deepest, most remote areas of the world's oceans readily accessible to exploitation. Furthermore, when trawl gear was lighter and vessels less powerful, demersal trawling could only be done on level bottoms, to avoid damaging the nets or getting hung up on obstacles. However, with the increased weight and sturdiness of gear and the greater power of the ships, rougher, rockier fishing grounds could be tackled with impunity and most obstacles easily overcome by brute force. Newer "rock-hopper" trawls permit fishing in rough boulder areas that were previously inaccessible. In addition, new electronic tools such as GPS (geographic positioning systems) and sophisticated fish-finders make it easier to find, follow and capture the migrating shoals wherever they go. Nowadays, undisturbed areas that provide refuge for fish and shellfish stocks are becoming increasingly scarce. In light of these trends, it should not be surprising that in recent decades important fish stocks have collapsed throughout the world. Overharvesting or long-term climatic or oceanographic trends are most often blamed for this. However, some scientists now wonder if the expanded use of heavy gear may have played a role, by degrading bottom habitat and interfering with the reproduction and survival of many species of "demersal", or bottom dwelling, fish.

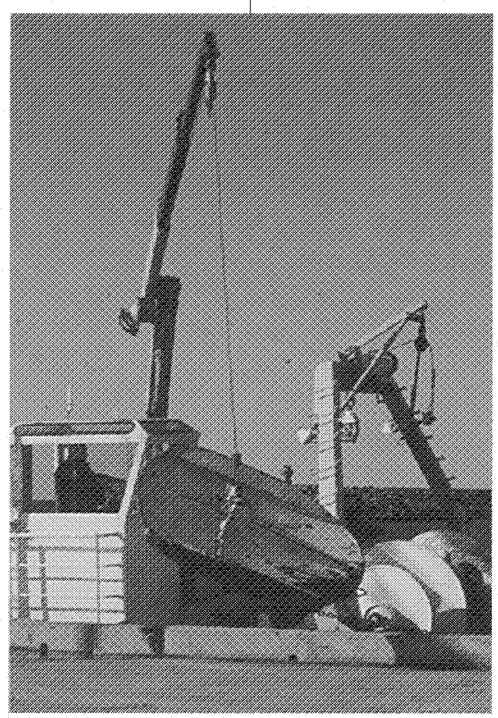
Oceanographers and ecologists have also taken advantage of the developing technologies to acquire new tools that allow them to look deep into the ocean environment with new, sharp eyes. Improved underwater still and video cameras, manned and unmanned submersibles, sidescan sonar and multibeam swath survey techniques, as well as powerful computer mapping facilities, enable them to produce remarkably clear pictures of large areas of the seafloor for the first time. Now the environmental effects of dragging and dredging are no longer "out of sight"; the evidence of disturbance is rapidly accumulating for all to see. The International Council on the Exploration of the Sea (ICES) became sufficiently alarmed in the 1970s that it launched studies on the environmental effects of trawling in Britain, the Netherlands and Belgium. Now, decades later, similar concerns are being voiced in North America about the deteriorating state of east coast fishing grounds, including those of the Gulf of Maine and Bay of Fundy.

The fishing industry responds to the mounting criticism by pointing out that many areas of the seafloor are regularly disturbed by storm waves and strong currents and that the "effects of bottom-tending gear pale by comparison". They are particularly upset by attempts to compare their activities to clear-cutting of forests; they would much prefer the agricultural analogy. "The idea of continuously producing a food crop from an area of ocean bottom … would certainly seem to be more acceptable to the public that 'clear-cutting' the bottom". They are thus quick to emphasize that productive fishing grounds have been trawled or dredged for generations and, "somewhat confoundingly for the antis [*i.e.* those who raise concerns about fishing impacts] these areas continue to produce fish." They further note that many areas of the seafloor remain largely undisturbed because fishermen concentrate on particular fishing grounds, where the bottom is suitable and the fish or shellfish are abundant. However, as we have seen, the ability to fish in "unsuitable" areas has steadily increased. In addition, as traditional species are fished out, attention often shifts to other "under-utilized species" that inhabit different areas of the seafloor. There are now few areas of the seabed on the continental shelf that don't show the telltale signs of scraping and gouging by fishing gear.

"many areas of the seafloor remain largely undisturbed because fishermen concentrate on particular fishing 'grounds', where the bottom is suitable and the fish or shellfish are abundant."

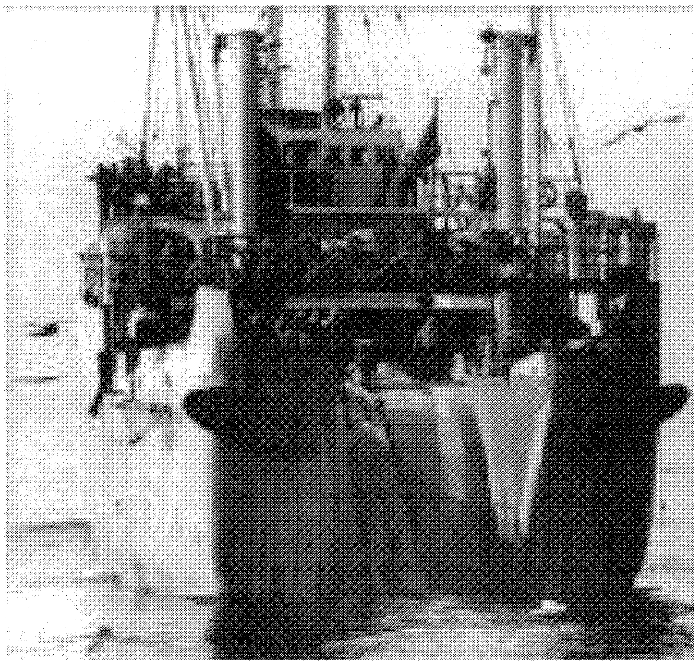
Gauging the Gear

To understand how fishing gear disturbs the seafloor we need to briefly look at the various types commonly used. Not all are found in the Bay of Fundy, but this is no guarantee that they won't ever be. The otter trawl is perhaps the most widely used fishing gear. It consists of a large funnel-shaped net dragged behind a ship by steel cables. The mouth may range from ten to a hundred metres across, depending on the fishery and the vessel size. Trawls are dragged across the seafloor to catch demersal fish such as halibut, flounder and cod, or fished in "mid-water" to catch animals in the water column. A heavy steel cable, or "footline", across the bottom of the mouth is strung with heavy rubber spheres that roll on the seafloor and drive fish upwards into the net. Flanking the



A large steel trawl "door" being loaded aboard a vessel.

© J.Percy



Large, modern factory trawlers fish with much heavier gear and on deeper, rougher fishing grounds that were once inaccessible.
NOAA Fisheries, Northeast Fisheries Science Centre

mouth are large flat steel or wood "doors" that are pushed outwards by water pressure to keep the mouth of the net open. The doors also slide across the ocean bottom stirring up billowing plumes of sediment that scare fish towards the mouth. A commercial model of trawl door is tellingly branded "Canyonbuster", giving an ominous sense of how they are supposed to operate on the seafloor. A tow varies from half an hour to several hours, with fish accumulating in the "cod-end", the rearmost closed-off portion of the net.

"A commercial model of trawl door is tellingly branded 'Canyonbuster', giving an ominous sense of how they are supposed to operate on the seafloor."

Scallops are scraped from the seafloor by large steel dredges that are typically four or five metres wide. They consist of a heavy rectangular steel frame to which is attached a collecting bag of large linked steel rings. The ring diameter is regulated to allow small scallops and other benthic animals to escape. On each side of the frame are runner-like steel "shoes" on which the dredge slides over the bottom. Between these is hung a loose, heavy "sweep chain" that scrapes across the bottom forcing scallops upwards and into the collecting bag. Before 1975, scallop dredges were comparatively small and light, but since then their size and weight have increased, as has the horsepower of the boats towing them. They can be towed faster and used in areas that were formerly avoided. Molluscs that burrow, such as surf clams and ocean quahogs, are harvested by hydraulic dredges and specialized boats. The frame structure is similar to that of a scallop dredge. In addition, a tubular "manifold" fitted with a series of nozzles pointing towards the seafloor is mounted on the leading edge. A pump on the ship forces water through a hose into the manifold and out through the nozzles. These high-pressure jets penetrate into the sand in front of the dredge, vigorously stirring it up and "fluidizing" it into a slurry. The dredge easily slices through the softened sand to sweep up buried animals. Regularly spaced bars behind the mouth of the dredge allow small animals to escape, but retain the larger bivalves which accumulate in the net.

Beam trawls are used on the seabed to catch shrimp and demersal fish such as plaice, sole and flounder. They are more popular in European waters. The trawl has an oblong mouth held open by a rigid steel "beam" that ranges from a few metres up to 12 metres in length. Heavy skids at each end of the beam allow the trawl to be dragged across the seafloor like a giant sled. Sometimes heavy "tickler chains" are suspended across the mouth and dragged on the seafloor to drive bottom-dwelling fish upward into the net. On stony bottoms, heavy chain chafing mats are also added to protect the net and keep out large rocks. In the 1960s beam trawls, with their tickler chains and chaffing mats typically weighed up to 3.5 tonnes, but by the end of the 1980s the weight of the gear had almost tripled. Tickler chains and mats undoubtedly increase the efficiency and durability of the nets, but they also greatly amplify the degree of disturbance of the seafloor.

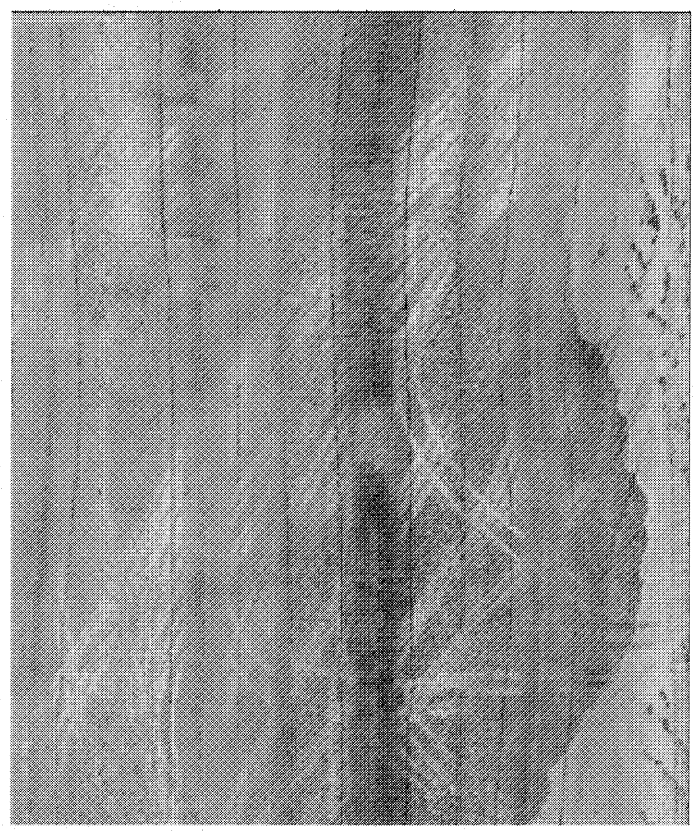
Assessing the Aftermath

Trawling and dredging directly and indirectly affect most marine populations, not just the "target species" being sought. Typically, a large fraction of the target species is removed. In heavily fished areas, such as the North Sea, almost half of the total weight (biomass) of some species may be taken from the system annually. This is bound to have an affect on the populations of organisms that they eat (prey), vie with for food (competitors) and that eat them (predators). Man is an exceptionally effective predator and a notoriously wasteful one as well. Significant quantities of his prey are killed, injured and lost, and species of no commercial interest are dumped, dead and dying, back into the sea in large numbers. Many organisms are killed by the fishing gear, torn by the netting or crushed by heavy frames, chains and cables. These litter the seafloor behind the trawl or dredge, a bonanza for the predators that flock to the track. Within an hour, densities of crabs and predatory fish can be 3 to 30 times higher in trawl tracks than in nearby undisturbed areas. Fishermen have found that if a trawler tows its net along a recently fished track it will often catch more fish. The result of the removal of target species, destruction of non-target species and sharply increased predation is that the abundance and types of animals in the fished area may change markedly. This distorts the natural functioning of the marine ecosystem and may compromise the ability of other fish, seabirds and marine mammals to obtain adequate food. This direct biological impact of fishing on marine communities is itself cause for great concern. But, perhaps even more troubling is the mounting evidence that fishing also adversely affects the habitats that the marine populations need for their survival. Ironically, fishing may be degrading the very habitats that are essential to the continued well being of the species being harvested.

"Man is an exceptionally effective predator and a notoriously wasteful one as well. Significant quantities of his prey are killed, injured and lost, and species of no commercial interest are dumped, dead and dying, back into the sea in large numbers."

Detecting Habitat Disturbance

Ecologists can now readily distinguish the disturbance of the seafloor caused by the major types of fishing gear; they each leave their particular signature on the bottom. Remote sensing tools allow researchers to see the exact nature of the disturbance and measure the area affected. Until recently their ability to "see" the seafloor was limited. Sound waves bounced off the bottom with echo sounders gave only a crude two-dimensional picture. For additional detail they lowered grabs or corers to collect samples of sediments, or used underwater cameras to view small areas. However, since the early 1990s a new survey method has enabled them to map large areas of the seafloor in remarkable detail. This new multibeam "swath" technology is discussed in Fundy Issues Number 5, *Dredging Fundy's Depths: Seabed Mining in the Bay of Fundy*. The survey ship sweeps a wide track on the sea bed with sound waves of different frequencies (hence multibeam) and collects returning



The telltale paired tracks of otter trawl doors are clearly visible on this sidescan sonar image of a portion of Stellwagen Bank in the Gulf of Maine.

US Geological Survey. Stellwagen Bank Information System echoes with an array of sensors. Computers process the information and generate a three dimensional map of a wide strip of the bottom. By steaming along a series of parallel tracks the survey vessel can quickly map a large area. The result is an incredibly detailed picture of the seafloor, almost comparable to an aerial photograph. Details such as boulder fields and sand waves, as well as biological structures, such as mussel reefs, coral "forests" and kelp beds, give some indication of the physical complexity of the bottom habitat in different areas. The images also often show, with remarkable clarity, the tracks of various types of fishing gear in most coastal areas where fishing occurs.

Sidescan sonar surveys of the submarine banks in the Gulf of Maine reveal that Otter trawls leave paired furrows about 40 metres apart, with each furrow being 20-100 centimetres wide and penetrating several centimetres into the sediment. Scallop dredge marks appear as pairs of 5-metre wide swaths penetrating a few centimetres into the bottom. Hydraulic clam dredges leave single 5-metre wide swaths that penetrate as much as 20 centimetres into the sediment. In some areas there is such a profusion of dredge and trawl marks that the original geological structure of the seafloor is largely obscured. As trawls and dredges scrape across the bottom they also overturn and dislodge large rocks and boulders. There are reports of heavy gear displacing boulders weighing as much as 25 tonnes. A rich variety of marine plants and animals heavily colonize the surfaces of most boulders. Les Watling has been down in submersibles in many parts of the Gulf of Maine that have been trawled or dredged and has seen that typically "boulders formerly covered with marine animals are almost lifeless from being rolled around by nets or dredges". In the Bay of Fundy, older fishermen report that there has been a noticeable reduction in the number of "meat rocks" appearing in their trawls. These are rocks that have numerous large, meaty sea anemones and other organisms growing on them. They are particularly aware of their presence, because cod usually congregated in such areas at certain times of the year. The decline could be a result of the constant disturbance of the rocks by bottom dragging, or the smothering of the anemones by the fine sediments that are stirred up.

"Perhaps the most worrisome ecological impact of bottom fishing is that it flattens bottom structures and drastically reduces the physical complexity of the habitat."

The case for complexity

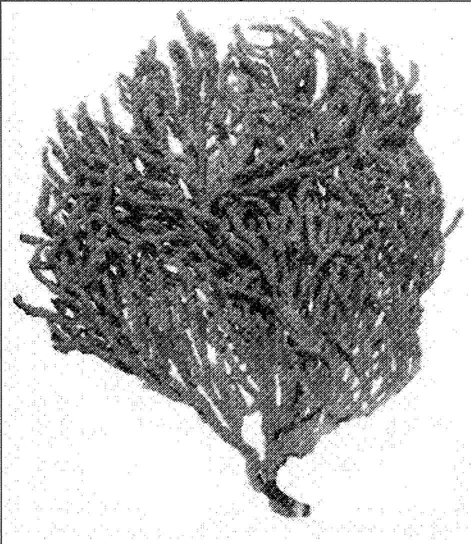
Perhaps the most worrisome ecological impact of bottom fishing is that it flattens bottom structures and drastically reduces the physical complexity of the habitat. Peter Auster, once went scuba diving in an area where a scallop dragger was fishing. After the vessel passed he swam over the bottom scoured by the dredge and found that what had earlier been a complex, irregular stretch of habitat was now "smoothed to a cobblestone street". This loss of structure and complexity may have major consequences for the animals that live there. Animals are not distributed haphazardly or randomly over the seafloor. They occur in groups, patches and clumps, with different species living together in different areas. Each type of animal or plant has needs or preferences for particular conditions or features of the environment; some require less salty water; some prefer warmer temperatures; some survive only on rocky bottoms, while others must have soft mud; some can live on smooth, featureless bottoms while others demand complex bottom structures. The needs and preferences of the different species often change at different stages of the life cycle. Features such as temperature and salinity tend to be relatively similar over wide areas. Thus, in a given region it is the physical differences in the structure of the seafloor habitat that largely determine which animals congregate where. In general, the greater the complexity of physical features in an area, the greater the variety and abundance of marine organisms that are present.

A complex habitat with lots of nooks and crannies is also important as a refuge from predators, particularly for young animals. This was clearly shown in laboratory experiments carried out by scientists at the University of Connecticut. They set up five large aquaria, each with a different artificial seafloor habitat. These ranged from simple to complex as follows: sand, cobble, sparse short sponges, dense short sponges and tall sponges. Several one-year-old cod were placed in each tank. A much larger three-year-old cod was then introduced to each tank; these typically attack and eat the smaller fish. The time taken to consume the young cod and the number left at the end of the experiment were carefully noted. As soon as the predator was placed into the aquarium the small fish immediately tried to hide amongst whatever cover was available. Those on sand had no refuge and usually swam towards the surface where they were quickly consumed. With increasing habitat complexity, the young fish survived longer and fewer were killed. Field studies carried out in Nova Scotia waters confirm these laboratory observations. Young cod settled in various types of bottom habitats. However, their eventual abundance, survival and growth were much higher in the more complex habitats. A similar sort of result has been shown for lobsters and a variety of other marine species. Clearly, any activity that diminishes habitat complexity reduces the chances of survival for many species.

Complex seafloor habitats provide critical refuge for larval and juvenile fish, and a wide range of marine invertebrates

Even bottoms that to us appear fairly uniform usually have some structural features that are critically important to the animals that dwell there. For example, a sandy bottom may seem monotonously uniform, until a closer look reveals that currents have created ripples in the sand, row upon row of low ridges and shallow grooves. Such structures are ecologically important. Small animals can escape the currents in these grooves; anyone who has sheltered from the sea wind behind sand dunes can appreciate this. The protected animal doesn't use as much energy struggling to stay in one place. Anyone who has huddled behind dunes also knows that fine particles tend to collect there. In the sea, small particles of drifting organic matter accumulate in the grooves where they are eaten by many creatures. Fragments of shell and other materials also accumulate in the depressions, providing hiding places for small animals. In places like the Bay of Fundy, where tides are very high and currents are particularly strong, the sand deposits may be moulded into undersea dunes, or megaripples, that can be metres high, providing refuge for correspondingly larger animals.

But it is not just waves, currents or geology that create the structural complexity of seafloor habitats. Some species of animals and plants play a very important role in creating the habitat structure. These are sometimes called "charismatic" or "keystone" species because their presence largely determines the nature of the habitat and its suitability for other types of marine organisms. Seaweeds, such as kelp and rockweed, on stony bottoms, or seagrasses on soft bottoms, form a dense forest-like cover, providing food, shelter and points of attachment for a wide range of animals. Similarly, some animals such as deep-water corals, seafans, mussels, sponges and tube worms can greatly alter the shape of the bottom by creating large mound-, bush- or tree-like structures. For example, on the slope of the offshore banks in the Gulf of Maine, near the mouth of the Bay of Fundy, are beds of large deepwater corals, sponges and similar benthic animals. Unlike their better known tropical relatives, these cold water corals are only now beginning to be studied and much remains to be learned about their biology and ecology. Some of the larger branching treelike species are thought to be many hundreds of years old. Fishermen regularly haul up large chunks of this material in their nets. There is growing concern that these unique, complex communities are being steadily degraded and levelled by fishing gear. Once such ancient coral groves are destroyed, it may be a very long time before the area recovers, if ever. Environmental groups such as the Canadian Ocean Habitat Protection Society (COHPS) are calling for the establishment of a Northern Coral Forest Protected Area in the deep water channel between Georges and Browns banks, where the coral growths are particularly prolific. Within the Bay of Fundy itself, large aggregations of horse mussels form extensive "mussel reefs" in deeper areas. Dave Wildish and his colleagues at the St. Andrews Biological Station are closely studying their structure, distribution and ecological significance. The reefs are formed by thick layers of horse mussel shells overlain by living mussels and a host of other organisms that congregate about them. In some areas the horse mussels account for as much as 80% of the benthic production. Because they feed by filtering particles out of large volumes of water they may be a particularly important ecological link between the water column and the seafloor. These reefs have been described as a "secret garden - colourful, varied and teeming with life". They develop slowly over decades to hundred of years and are also vulnerable to bottom disturbance by heavy fishing gear.



A bushy deep sea coral from the Gulf of Maine.

Derek Jones, Canadian Ocean Habitat Protection Society

Carelessly damaging such slow growing biological structures on the seafloor during the course of normal fishing activities is deplorable. However, even more outrageous are reports of their deliberate destruction in order to make fishing easier and reduce damage to gear. In the German Wadden Sea shrimp fishermen trawled new fishing areas with the nets left off their heavy gear in order to knock down obstacles, such as *Sabellaria* reefs. These large mounds created by massive aggregations of the tube building polychaete worm, *Sabellaria,* have been virtually destroyed, and are not expected to recover. In Asian waters heavy chains are sometimes towed between two boats to knock down coral growths that might damage nets. Closer to home, on the coral bottoms of the Gulf of Maine, there are similar reports of draggers towing heavy wrecking balls or weighted chains to flatten the subsea "forests" of tree-like sea fans and other corals that might snag fishing nets.

Focussing on Fundy

Scallop dragging probably disturbs the greatest area of Fundy's seafloor. It takes place all around the Bay - Chignecto Bay, Minas Basin, St. Croix Estuary, Passamaquoddy Bay - although the greatest activity is on the grounds along the Nova Scotia coast near Digby, where a large scallop fleet is based. A few studies imply that there may be harmful impacts on the seafloor in various parts of the Bay. For example, sidescan sonar surveys by the Bedford Institute of Oceanography indicate that dragging may be responsible for erosion of the seabed in Chignecto Bay. Other scientists suggest that the present low rate of settlement by scallop larvae on the Digby fishing grounds may be because intensive dragging has reduced the abundance of seaweeds on which the larvae initially settle. Similarly, some herring fishermen claim that dragging has destroyed kelp beds that are critical spawning habitat for herring. There are many such speculations about habitat degradation in various parts of the Bay, but few scientific studies of the problem.

The only direct study of the effects of trawling on the Bay of Fundy seafloor was carried out in 1991-

92 by researchers from Acadia University and DFO. In Minas Basin, some areas where trawlers drag for winter flounder at high tide are completely dry at low tide. A clam-digging colleague, who noticed trawl marks on the mud flats, first alerted the researchers to the potential of the area as a study site. Usually such studies require scuba divers or remotely operated gear to make observations and collect samples under many metres of water. In this study, a trawler towed trawls of various sizes along the shore at high tide. When the water receded the researchers simply walked out on the mud flats and directly observed the physical and biological effects of the trawling. They measured the width and depth of the track that had been compacted by the rubber rollers or gouged by the heavy trawl doors. They photographed the area from the ground and from a helicopter. To determine the biological effects, they sampled the mud in the furrows gouged by the doors, in the areas compacted by the rollers and in nearby undisturbed areas. The samples were analyzed for chlorophyll, as a measure of the abundance of microscopic plants (diatoms), very small animals (meiofauna) such as nematodes. and larger animals such as clams and polychaetes (macrofauna). The observations were repeated periodically over several months to monitor the rate of recovery of the disturbed areas. A single trawl passage noticeably disturbed 12% of the 23-metre wide area of seafloor between the trawl doors. The furrows and roller marks remained visible for up to seven months. This was surprising given that the study site is subjected to disturbance by waves and currents on each rising and falling tide. Trawl tracks would probably last even longer in deep-water areas not exposed to waves. The effects on the plants and animals living in and on the sediment were minor. Both chlorophyll and meiofauna decreased initially in the furrows left by the trawl doors, but returned to normal within a month and a half. In fact, by the third month the chlorophyll content in the furrows was even higher than in undisturbed areas, possibly because of an increase in the availability of nutrients (fertilizers) in the disturbed sediments. Larger burrowing animals, such as clams and polychaetes, were largely unaffected by the trawling, probably because they retreated deeper into the mud as the trawl approached. The researchers concluded that "the impact of flounder draggers on the intertidal benthic community of the Minas Basin is minor and not cause for serious concern at the present time". However, they were quick to caution that "this conclusion should not be applied to other benthic habitats". The community of animals living in the mudflat is very different from those in deeper water. The intertidal species are much better adapted to natural disturbances, such as currents, waves, sediment smothering and ice scouring, and are thus also more tolerant of other upsets such as trawling.

Sparing the seafloor

There is undisputable evidence that some types of fishing gear can adversely affect certain types of benthic habitats. Serious efforts must made to try to minimize these impacts where possible. It has been suggested that it may be possible to do this by modifying the fishing gear. For much of the 20th century such modifications were largely directed to increasing the size, robustness and catching efficiency of the gear, with little if any attention paid to reducing impacts on the environment. During the past few decades there have been attempts, primarily in European waters, to modify the design of some particularly destructive types of gear. Thus, heavy tickler chains were banned in some countries and less harmful alternatives such as water jets or electrodes were tried, with only limited success. There has been some encouraging success in increasing the selectivity of various types of gear and thus reducing the indiscriminate destruction of "bycatch" species. However, most trawl and dredge gear by their very nature and modes of operation will inevitably cause considerable disturbance to the seafloor habitat.

It is likely that a more feasible approach will be to restrict the types of gear that can be used in particular habitats. There is enough evidence to indicate that certain types of bottom habitats are particularly vulnerable to disturbance by trawling and dredging. Where the bottom is simple and relatively featureless, such as sand or mud, the overall effects on the habitat seem to be small. However, the more complex the habitat the more ecologically significant and long-lasting are the effects of fishing. Most scientists who are concerned about the issue aren't suggesting an end to all use of heavy fishing gear. Rather, they argue that such destructive gear shouldn't be used anywhere and everywhere with little or no regulation. Peter Auster states that "We don't want to stop people from fishing, but we need some areas that are protected to maintain habitat for fish and other marine life. On land, we have parks and wildlife refuges to protect areas from clearcutting and other activities. We don't do this in the ocean." Even some in the fishing industry concede that such protection is probably warranted. A May 1999 article in Fishing News states that, "There are … areas of the seafloor that should be made off-limits to all types of anthropogenic disturbances - including trawling and dredging…. Any responsible member of the commercial fishing industry would support such a concept if it were based on scientifically supportable, objectively determined criteria." The type of fishing gear that is permitted in a given area should be matched to the nature and vulnerability of the seabed habitat there. Trawls and dredges could continue to be used in areas where there is demonstrably little lasting impact on the seabed or on the benthic communities. However, in areas where the habitat is more complex and vulnerable, such as in kelp beds or coral "forests" fishing would be banned altogether or restricted to more habitat-friendly techniques such as hook and line or fixed traps. Identification of such vulnerable bottom areas will involve mapping the seafloor in great detail to ascertain the distribution of the principal habitat types. It will also require that the existing scientific information be carefully evaluated, and additional studies conducted, to determine the relative sensitivity of different types of habitats to fishing disturbance. The more difficult task might be drafting and enforcing the appropriate regulations restricting activities in these zones.

"Where the bottom is simple and relatively featureless, such as sand or mud, the overall effects on the habitat seem to be small. However, the more complex the habitat the more ecologically significant and long-lasting are the effects of fishing."

The marine protected areas provision in Canada's 1997 Oceans Act may prove to be a useful tool for adequately protecting some of the more vulnerable and ecologically unique benthic habitats. Establishment of such protected areas may also be of great help in studying the long-term ecological impacts of trawling. At present scientists can readily detect the immediate changes in the physical structure of the seafloor after passage of a trawl or dredge. However, to understand the longer-term ecological effects of the disturbance on the bottom habitats, the animals that live there and the commercial species that are harvested is much more difficult. Ideally, one needs to compare an area that has been actively fishing with a "control" areas which has a similar type of bottom, but where fishing has not occurred. At present it is very difficult to conduct such studies because there are few suitable undisturbed areas of the seafloor that can serve as "controls". Protected areas might also provide another important benefit by ensuring the sustainability of commercially important fish stocks. Fisheries management is an enormously complex undertaking given that we don't fully understand the effects of long-term environmental fluctuations, such as in ocean temperatures or current patterns, on marine populations. Neither do we know much about the complicated ecological interactions between most fish species and their prey, predators and competitors. In the face of this uncertainty, the establishment of protected "refuge" areas could be a valuable insurance or "hedge" against poor management decisions, providing some leeway for the inevitable

"the establishment of protected "refuge" areas could be a valuable insurance or 'hedge' against poor management decisions, providing some leeway for the inevitable errors in judgement."

errors in judgement.

Perhaps the greatest need is for increased public awareness of our coastal marine ecosystem and what we humans are doing to it. This is a submarine realm beyond our normal daily experience; a foreign world from which we are largely excluded. Understandably, most of us have never seen and cannot appreciate the ecological complexity of the seafloor habitat. Neither do we fully realize its critical importance to the well being of the community of creatures that dwell there, including those many species that sustain our fisheries. We can't see for ourselves the changes that are taking place beneath the choppy waters of the Gulf of Maine and Bay of Fundy. We have to rely on those who have the proper tools and the necessary skills to inform us about what is happening. It is our responsibility as residents of coastal communities to learn as much as we can from them about the issue. Then, if we feel that the concerns that they express are valid we must lend our support in demanding that prompt action be taken to protect especially vulnerable habitats. Until there is a widespread public outcry, comparable to that raised in defense of the rain forests and tropical coral reefs, unique undersea habitats will continue to be threatened and levelled. The heavy cables, chains, bars and nets will continue to scrape and thump across undersea landscapes, steadily diminishing their physical complexity and rich biological diversity.

Further Reading

The Impacts of Fishing Gear on Seafloor Habitats. P.J. Auster. Sea Wind. Volume 10, number 4, pages 20 to 22. (1996)

Environmental Impact of Trawling on the Seabed: a Review. J.B. Jones. New Zealand Journal of Marine and Freshwater Research. Volume 26, number 1 pages 59 to 67. (1992).

Impacts of Flounder Trawls on the Intertidal Habitat and Community of the Minas Basin, Bay of Fundy. M. Brylinsky, J. Gibson and D.C. Gordon, Jr. Canadian Journal of Fisheries and Aquatic Science. Volume 51 pages 650 to 661. (1994).

The Effects of Trawling, Dredging and Ocean Dumping on the Eastern Canadian Continental Shelf Seabed. S.N. Messieh, T.W. Rowell, D.L. Peer and P.J. Cranford. Continental Shelf Research, Volume 11, numbers 8-10, pages1237 to 1263. (1991).

Sustaining Global Fish Stocks. K. Christen. Environmental Science and Technology News. November 1, 1999. Pages 452 to 457. (1999).

Anatomy of an Anti Fishing Campaign. Fishnet USA. Number 6, May 8, 1999. [available on the web at: <http://wwwfishingnj.org/netusa6.htm>]. (1999).

The Impacts of Mobile Fishing Gear on Seafloor Habitats in the Gulf of Maine (Northwest Atlantic): Implications for Conservation of Fish Populations. P.J. Auster, 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. Reviews in Fisheries Science, Volume 4, Number 2 pages 185 to 202. (1996).

The Fundy Issues series is financially supported by:

The Environmental Conservation Branch
Environment Canada - Atlantic Region
Dartmouth, Nova Scotia
and
Department of Fisheries and Oceans
Scotia-Fundy Region

The views expressed herein are not necessarily those of the supporting agencies.

Written and produced by J.A. Percy, Granville Ferry. N.S.
Tel: (902)532-5129 e-mail: bofep@auracom.com

The Fundy Issues Series is an initiative of the Bay of Fundy Ecosystem Partnership. These publications describe our present scientific understanding of some of the environmental issues confronting the Bay. We hope that they will enhance your understanding of the biological richness and complexity of this unique marine area and the problems confronting it. Such awareness may encourage you to help in protecting it for the use and enjoyment of all, so that future generations may also share and appreciate its bounty and rare beauty.

Fundy Issues are available on the BoFEP Website at
http://www.auracom.com/~bofep