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Effects of Shrimp Trawling on Mud Bottom Habitats and Animal Communities of Fishing Grounds in the Gulf of Maine

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Background Information

Although the scientific community has been studying the effects of trawling for several decades, few studies have examined impacts on mud bottom fishing grounds. The impact of trawling on this type of habitat may differ from that on more commonly studied rocky and sandy bottom habitats for several reasons:

- Muddy areas of the seafloor generally experience fewer natural disturbances (such as storm waves) and are therefore likely to be more acutely impacted by disturbance from fishing gear;
- Mud bottoms lack large habitat structural features (such as boulders, sand waves, sponges, corals, etc.) which may get caught or flattened by nets, doors and groundgear; and
- These areas possess many small-scale habitat features (such as tubes and burrows), many of which are found below the seabed surface and serve an important role by bringing oxygen into the sediment.

Resuspension of fine sediments by trawling may destroy many of these small-scale habitat features, thereby affecting chemical processes such as organic matter breakdown. Additionally, sediment resuspension may also cause mortality to mud-dwelling animals by either injuring them directly or by dislodging them from the sediment, rendering them more vulnerable to predation.

Project Objectives

Assess the cumulative impacts of commercial shrimp trawling on the physical structure of mud bottom habitats on fishing grounds.

Determine the impact of commercial shrimp trawling on mud-dwelling animal communities of fishing grounds.

From both an ecological and sustainable fisheries standpoint, it is valuable to understand the impacts of shrimp trawling on mud bottoms. Many species of commercially valuable finfish (including American plaice, *Hippoglossoides platessoides*, and white hake, *Urophycis tenuis*) and shellfish (including northern shrimp, *Pandalus borealis*, American lobster, *Homarus americanus*, and Jonah crab, *Cancer borealis*) are found in this type of

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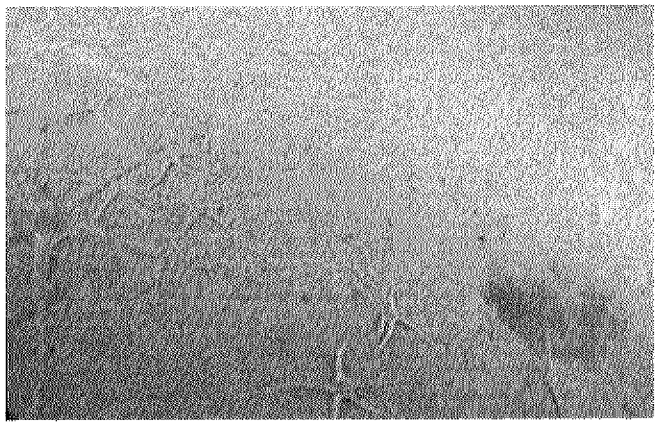


Fig. 1 Typical mud bottom with brittlestars and burrow opening on surface.

habitat. Many of these species derive some portion of their diets from feeding on mud-dwelling animals, such as worms and small bivalves. Furthermore, federal legislation containing the Essential Fish Habitat provision of the Magnuson-Stevens Fisheries Management Act mandates assessing the impacts of fishing gear on crucial habitats. Although shrimp is not a federally managed species, both white hake and American plaice are under federal regulatory jurisdiction. Human activities, like fishing, may have unintended consequences, such as species loss and subsequent effects on ecosystem function.

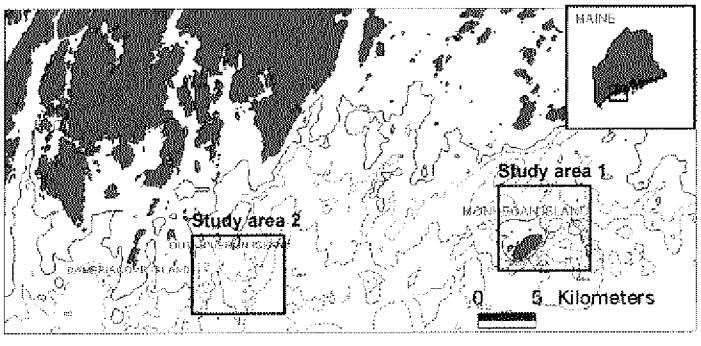


Fig. 2 Location of study areas in the midcoast region of Maine.

Research Methods

Sediment samples were collected with a box core from two different shrimp fishing grounds in the midcoast region of Maine, one near Monhegan Island, and the other near the Outer Pumpkin Ledges (Figure 2). Additional sediment samples were collected in areas adjacent to shrimp fishing grounds that were not known to be trawled. Sample collection took place every 3-5 months from June 2000 – December 2001. A total of 20 box core samples (10 samples per study area; 5 from shrimp fishing ground, 5 from adjacent untrawled area) were collected during each sampling period from December 2000-2001 (fewer samples were obtained in June 2000 and October 2000). Box cores were sub-sampled for sediment x-radiography and water content to measure habitat structure below the sediment surface. Other sub-samples were collected to determine the activity of a naturally occurring radioisotope, ^{210}Pb, to measure sediment mixing and inventory, and to identify and count the animal community (macrofauna). Video quadrats of the sediment surface were recorded in trawled and untrawled areas to determine the number and size of surface penetrating burrows as a measure of surface habitat structure. Video images of shrimp fishing grounds and adjacent untrawled habitats were also obtained using and a remotely operated vehicle (ROV) Phantom 300.

Results

Over the course of this 18-month study, we have been able to document trawling activity only on the Pumpkin fishing ground study site during the 2000-2001 shrimp season. Low shrimp abundance and number of allotted fishing days were responsible for reduced fishing activity that year. Because the Monhegan fishing ground did not appear to have been trawled during the course of the study, we interpreted results from this study area to be representative of longer-term, cumulative trawling impacts, whereas results from the more recently fished study area (Pumpkin) are indicative of the combined effects of long-term, cumulative, and recent disturbance from trawling.

Comparisons between mud bottom shrimp fishing grounds and similar adjacent mud bottom habitats yielded the following results:

- No changes in physical habitat features on fishing grounds were detected in sediment x-radiographs or in water content profiles.
- No significant differences in surface (penetrating) burrow densities, a major habitat structural feature on mud bottom.
- Sediment ^{210}Pb profiles show deep sediment excavation, probably from large burrows which were common in both trawled and untrawled areas (Figures 3 and 4).

- Sediment ^{210}Pb inventories revealed no apparent net loss of sediment resulting from shrimp trawling (Figure 3).

- Seasonal shrimp trawling causes significant changes in animal community structure by reducing both the overall number of taxa and the abundance of disturbance-sensitive groups (such as bivalves and certain polychaetes); however, no longer-term, cumulative changes in community structure were detected (Figures 5 and 6).

Results: Selected Figures

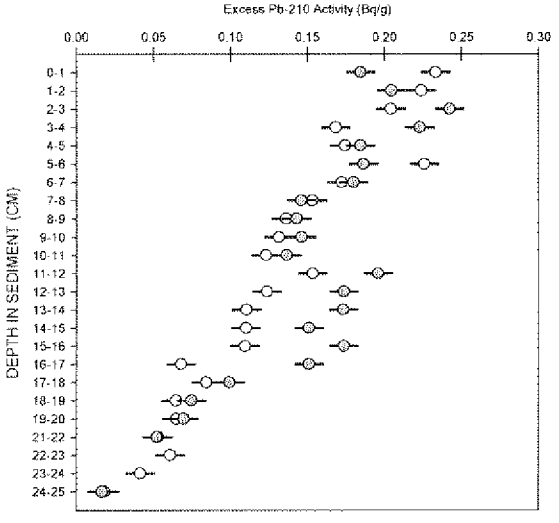


Fig 3. Excess ^{210}Pb activity profiles (Bq/g dry wt.) from untrawled (open circles) and trawled (shaded circles) at Monhegan show deep mixing from sediment excavation. Error bars show total analytical error (± 1 SD).

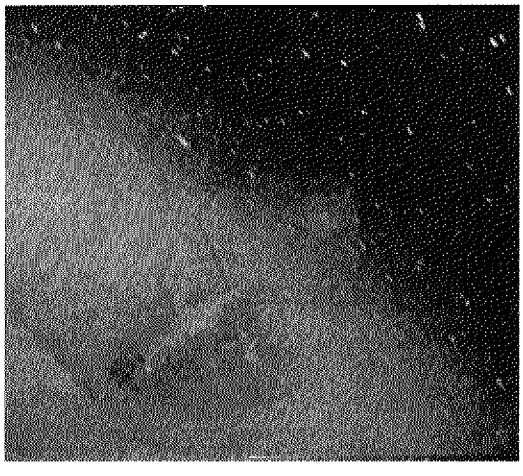


Fig 4. Example of deep sediment excavation; lobster digging pit on Pumpkin shrimp fishing ground.

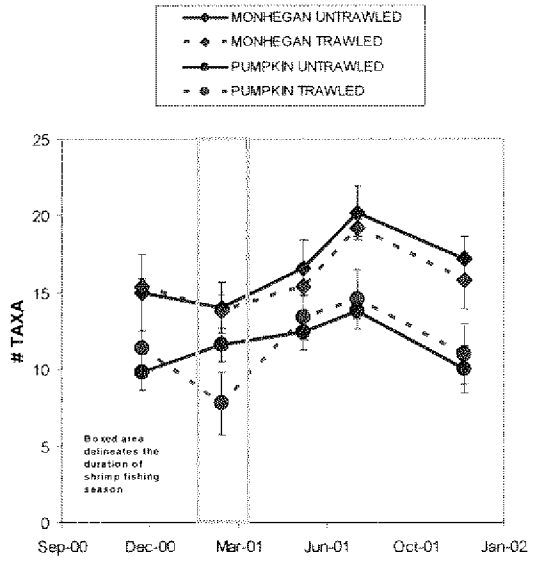


Fig 5. Temporal trends in the average number of taxa in trawled and untrawled areas at Monhegan and Pumpkin. Average number of taxa reduced on activity fished grounds during 2000-2001 shrimp season. Error bars show ±1 SD.

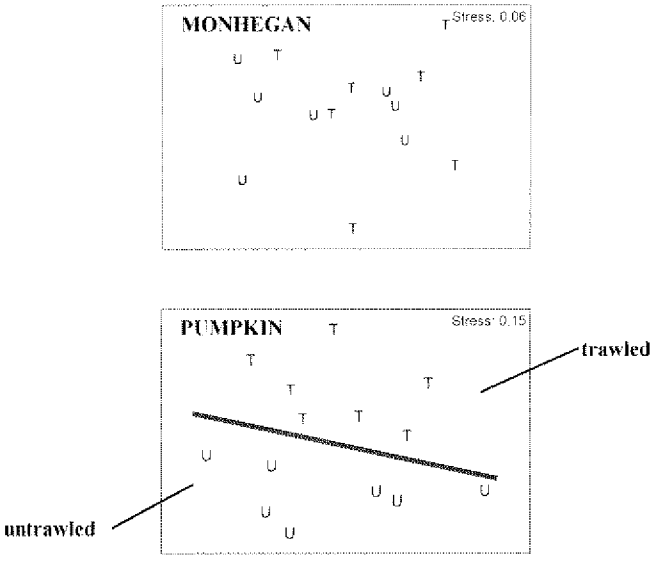
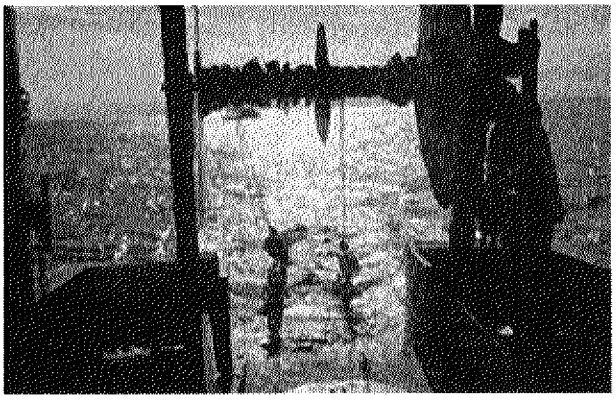


Fig 6. MDS ordination showing significant differences between sediment-dwelling animal (macrofauna) communities on fishing ground (Pumpkin) actively trawled (T) during the 2000-2001 shrimp season and untrawled areas (U). No long-term differences in community structure between fishing grounds not trawled in 2000-2001 and untrawled areas (Monhegan).



Discussion

The results of this study indicate that shrimp trawling does not result in cumulative changes in habitat or sediment-dwelling animal community structure on mud bottom fishing grounds; however, significant short-term (<4 months) changes in community structure were detected on the fishing ground that was actively trawled during the 2000-2001 shrimp season. These changes resulted from an overall reduction in the number of taxa and abundance of disturbance-sensitive groups.

Several factors may contribute to mitigating the impacts of shrimp trawling on mud bottom habitats. First, high levels of natural disturbance from sediment mixing activities of large animals (such as lobsters, crabs, and fishes) appear to perpetuate a disturbance-tolerant community comprised mostly of small-bodied, disturbance-resistant taxa living in the upper 0-2 cm of sediment. This community would be expected to be more resilient to sediment disturbance from shrimp trawling than a higher successional state community. Second, because shrimp live on or above the substrate, shrimp trawling gear may be fished more "lightly" on the bottom and therefore cause less disturbance of the habitat than other types of mobile gear, such as groundfish trawls and scallop dredges. Furthermore, shrimp trawling is restricted to a winter fishing season, so disturbance from this type of gear is limited in duration, allowing for an annual recovery period.

Conclusions

High levels of natural disturbance from the burrowing and pit-digging by lobsters, fishes, and possibly crabs, appears to affect the habitat and sediment-dwelling animal community structure to a greater degree than seasonal, shrimp trawling disturbance.

Shrimp trawling significantly alters the structure of disturbance-tolerant, mud-dwelling animal communities for a limited period (<4 month).

Acknowledgements

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