OVERVIEW OF GEAR DEVELOPMENTS AND TRENDS IN THE NEW ENGLAND COMMERCIAL FISHING INDUSTRY

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ABSTRACT - Overall trends and developments in fishing gear in New England show an increasing efficiency in fish capture. This efficiency is being countered through regulatory means and with gear modifications aimed at increased selectivity and reduced bottom impact. The four most economically valuable fishing techniques in New England — otter trawl, scallop dredge, lobster pot, and gillnet — have adopted and continue to adopt and develop modifications that increase selectivity and reduce impact.

INTRODUCTION

The New England commercial fishing industry encompasses a variety of fishing gears, target species, individuals, and communities, all of which have changed dramatically over time. A comprehensive description of the trends and developments for the entire industry would be a Herculean task. This discussion is organized, for the sake of brevity and based on the authors' knowledge, on developments and trends in fishing gear. Following a survey of overall trends, we pay particular attention to four specific gear types.

Landings data for 1997 include forty-nine separate categories and sub-categories of gear (pers. comm., National Marine Fisheries Service, Fisheries Statistics and Economics Division). To narrow this pool of gear types and assign relative importance, fisheries were ranked by economic value of catch landed. Fish dealers who purchase fish and shellfish from fishermen have been keeping records of species and pounds purchased (that is, "landed" by fishermen) since before the 1950s. Analysis of these records ("landings") indicates two opposite but consistent trends. The three most economically important gear types in New England over the past fifty years have remained constant, while the next seven most important gear types have changed dramatically. Table 1 lists the ten most valuable fisheries in New England in 1950 and 1997. Figure 1 diagrams the historical trend in landings value for the ten most economically valuable gear types every five years from 1950 to 1997.

The resolution of the data on gear has increased, but the three highest-ranking gear types have been essentially the same for the last fifty years: otter trawling, lobster pots, and scallop dredges. The next seven gear

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types listed have changed a great deal. For example, weirs were the ninth most economically important gear in 1950 but ranked as the thirty-ninth gear type in New England in 1997. Significantly, gillnets, a very important gear type today, were of much lower importance in 1950.

Following a summary of overall technological trends for New England, our survey will concentrate on the trends for the four major gear types for 1997.

GEAR DEVELOPMENTS AND TRENDS

Overall

The fishing gear expert traditionally assisted the adoption of fishing gear that caught more fish, encouraged further participation, and helped to develop fishing opportunities (see, for example, Massachusetts Division of Marine Fisheries 1967). On its own, technological advancement has opened access to more fishing grounds and permitted more complete exploitation of existing grounds through improvements in fishing vessel construction and style, development of hydraulics, and improvements in navigation aids. Federal loan programs for vessel purchases or upgrades have encouraged increases in numbers and sizes of vessels. Improvements in materials have enhanced such aspects as invisibility of gear, ease of use, and the efficiency of deployment and retrieval.

The result of about one hundred years of increasing ability to catch fish has been the creation of regulations to limit this ability. Regulations sought to control this increasing sophistication over the century, but substantially increased in strength and effectiveness in the late 1980s as a means to protect and to rebuild fish, shellfish, and marine mammal

Table 1. Top ranking economically important New England gear types for 1950 and 1997. The total value of landings is indicated in the last row, adjusted to 1997 dollars. Sources: personal communications, National Marine Fisheries Service (Fisheries Statistics and Economics Division) and Federal Reserve Bank of Minneapolis.

1950	1997
Trawls, Unspecified	Pots and Traps, Lobster Inshore
Dredge, Other	Otter Trawl, Bottom Fish
Pots, Unspecified	Dredge, Scallop Sea
Hoes	Pots and Traps, Lobster Offshore
Lines, Long Set with Hooks	Gill Nets, Sink/Anchor, Other
Encircling Nets (Purse)	Diving Outfits, Other
Rakes, Other	Not Coded
Tongs and Grabs, Other	Lines, Hand Other
Weirs	Dredge, Clam
Stop Seines	Otter Trawl, Bottom Shrimp
Total Value (1997$)	
$403,439,423	$516,080,643

populations (Halliday and Pinhorn 1997). Since then, and continuing on a nearly daily basis, fishing effort has been controlled (mostly reduced) through government purchase of vessels, restricting numbers of fishing permits, closure of fishing grounds, and limiting days at sea (for example, see McKiernan and Creighton 1999). In addition, minimum (and in some cases maximum, e.g., lobster) size limits on fish, highly specific gear requirements, and spawning closures are used to manage populations. The most recent reduction in fishing effort (days at sea) has had, and will probably continue to have, dire economic consequences for fishermen in New England.

Fishermen and others interested in fishing gear have had to change course from improving the ability of nets to catch all fish to fine-tuning gear to catch only the targeted fish (improving "selectivity"). Technological and materials improvements are now used to reduce bycatch or to lessen the bottom impact of gear. These developments have been inspired by a variety of means, including management plans that set virtual or actual quotas for individual species, and legislation that protects "essential fish habitat" (the 1996 Sustainable Fisheries Act), as well as the desire for a sustainable fishery on the part of fishermen.

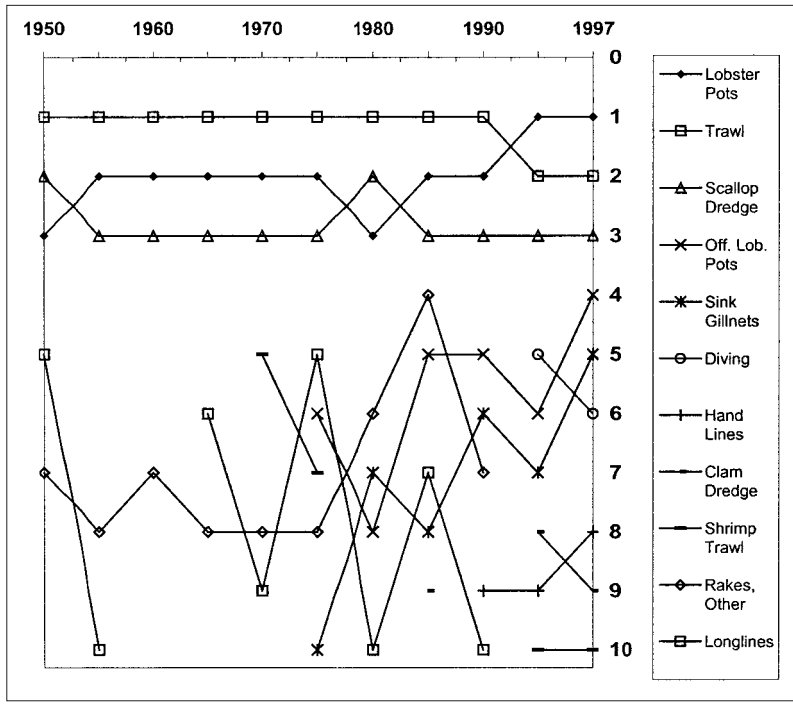

Figure 1. Ranking of the ten gear types with the highest landed value for New England from 1950-1997. The highest rankings are at the top of the figure. Rankings are shown for every five years from 1950 to 1995, and 1997.

Trawls

Trawl nets have been used in New England since about 1915 (Commissioners of Fisheries and Game 1916). Trawl nets are highly efficient, funnel-like nets that are towed behind a fishing vessel. This fishery was limited by the amount of backbreaking labor required until the development of plastic twine and hydraulic hauling equipment in the 1950s, which allowed for faster and easier net deployment and retrieval.

Increasing horsepower of boats, a development that affected all fisheries, has led to new designs in the footrope, or sweep of the trawl net (the leading edge of the bottom half of the net opening). The development of different sweeps (and the power and ability to deploy them) has allowed trawlers broader access to fishing grounds. The introduction of cookie, roller, and rockhopper sweeps allowed access to fishing grounds initially inaccessible to trawlers due to rocky and uneven bottom (Fig. 2).

The development of bristle sweeps and modification of rockhopper sweeps also increased the efficiency of the gear by blocking any escape of fish between elements of the sweep. The bristle sweep, or "street sweeper" gear, appeared in 1995 in New Bedford, Massachusetts and was felt to be so efficient that it was quickly banned.

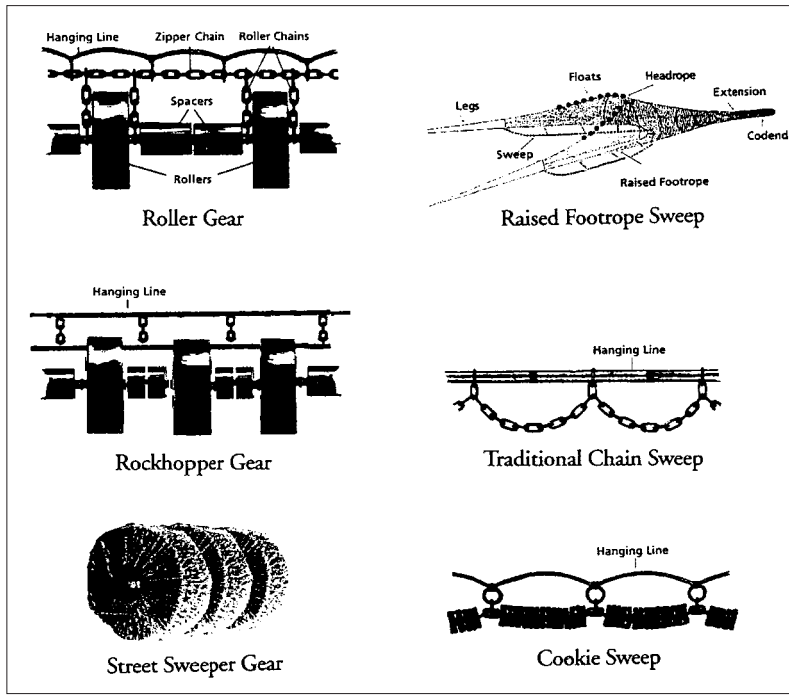

Figure 2. Six types of sweeps used on the footropes of trawl nets in New England. Adapted from Carr and Milliken (1998).

Current trends in footropes are working toward the goals of increased selectivity and reduction in bottom habitat impacts, in part by separating the multiple functions of the footrope. The footrope keeps the net open with its weigh and disturbs bottom-hugging fish through physical contact. In fisheries where bottom-hugging species are not targeted, the footrope can be raised, as is currently being done in the Provincetown whiting (*Merluccius bilinearis* Mitchill) fishery, or even eliminated, as is currently being tested.

The future of trawling may rest on the development of gear that has less bottom impact. The 1996 Sustainable Fisheries Act made protection of "essential fish habitat" (usually interpreted as benthic areas important to fish) a priority (New England Fishery Management Council 1998). A coincident wave of scientific, pseudo-scientific, and popular concern about the bottom impact of trawl nets will probably result in further, significant reductions in fishing grounds open to trawl gear (Carr 1999, Jackson 1999, Schwinghamer et al. 1998, Watling and Norse 1998).

Many other modifications to trawl nets have been made or are being investigated. Deflecting grids inside trawl nets have already been successful at excluding bycatch. Reduction of the amount of chaffing gear (a mat attached to the underside of the net to protect it from abrasion) may allow improved escapement. Codends (the bag where fish collect) constructed of two different mesh types have also been effective in reducing bycatch.

Dredges

Scallop dredges are steel frames pulled along the ocean bottom with a bag made of steel rings attached to the frame. Usually, a scalloper will tow two dredges at a time. The cutting bar, a metal bar in the mouth of the dredge, rides along the bottom to dislodge sea scallops (*Placopecten magellanicus* Gmelin), which pass over the bar and into the bag. Over the years, this "New Bedford" scallop dredge has not changed substantially, except that the cutting bars grew longer as boats became more powerful. Eventually, in 1993, an overall length limit of 9.14 m (30 ft) for both dredges was imposed (New England Fishery Management Council 1993). Modifications that evolved, such as increasing the number of links and the use of pieces of automobile tires as chaffing gear, inhibited the selectivity of the rings. These modifications were prohibited, and further dredge modifications have been required as regulatory measures. For example, the size of the rings in the bag has gradually been increased to 89 mm (3.5 in), to allow escapement of small scallops.

The relatively stable configuration of the "New Bedford" scallop dredge will probably not last much longer. Scallop densities in areas closed to fishing for the past four years are extremely high, but experimental tows in these areas led to substantial bycatch of overfished

groundfish (New England Fishery Management Council 1999). This bycatch has stimulated a great deal of brainstorming and research to eliminate bycatch (as well as reduce bottom impacts). Some success at decreasing the catch of flounder has been achieved by increasing the mesh size in the "twine top," an area of plastic netting just behind and above the cutting bar (R. Smolowitz, pers. comm., Coonamesset Farm). Modifications to dredges are also being encouraged by concern or possible legal action over the status of barndoor skate (*Raja laevis* Mitchill), a fish sometimes caught in scallop dredges. These modifications may have to happen quickly; pressure has been placed on the New England Fisheries Management Council to open the closed areas on Georges Bank as soon as 15 June 1999 (Jackson 1999).

Lobster Pots

As with other gear types, the increasing horsepower and the development of onboard hydraulics had a dramatic impact on the lobster (*Homarus americanus* Edwards) pot fishery. These developments in the 1960s allowed fishermen to handle and set a larger number of pots than was possible to haul and set by hand, and to fish more often (B. Estrella, pers. comm., Massachusetts Division of Marine Fisheries). The development of lobster pots made out of coated wire has greatly reduced the maintenance and replacement costs of traps. The durability of these traps led to the development of escape vents (gaps in the trap to allow small lobsters to escape) and biodegradable panels that fall off over time to allow all lobsters to escape if the trap is lost or abandoned.

The goal of current gear research with lobster pots is to reduce the probability of whale entanglements, especially northern right whales (*Eubalanea glacialis* Muller), in the up-and-down lines used to mark strings of lobster pots, and in the lines between lobster pots. Experimental breakaway devices are being tested at the ends of the up-and-down line; this line needs to be strong enough to allow gear recovery and durability through rough seas, and weak enough to allow a whale to part it in order not to trail the gear. The line used between traps is often buoyant to prevent line damage and possible loss of pots. These floating lines are believed to increase the chance of a whale entanglement. Current research is attempting to find a compromise that reduces the entanglement risk while maintaining line integrity. In both of these cases, the breakaway devices must not result in any obstruction that will prevent the slippage of the line through a whale's baleen (National Marine Fisheries Service 1999).

Gillnets

Gillnets are panels of netting, most often used on the ocean bottom in New England. Fish become gilled, wedged, or entangled in the netting. Nets were initially constructed from cotton twine that absorbed water and was easily visible. The development and use of monofilament nylon

twine greatly decreased the visibility of gillnets and improved catch rates. As with other gear types, improvements in boats, navigation, and hauling equipment allowed nets to be raised more quickly and easily.

This gear has always been extremely size-selective because of the direct relationship between the size of the meshes and the size of the fish that can be caught. By carefully setting the right size gear in the right place at the right time, gillnets captured the 1990s "underexploited" spiny dogfish (*Squalus acanthias* Linnaeus) so well that strong efforts for reduction methods are currently underway.

Targeting spiny dogfish was a result of careful placement of nets. Other modification to gillnets can target flounder. Tie-downs reduce the height of the nets in the water column to approximately 1 m. Further research to use gillnets in order to target flounder (and avoid cod, *Gadus morhua* Linnaeus) is being proposed. Fishermen have experimented with a net that does not stand up at all, but rather lays nearly flat on the bottom.

Gillnets may not need much modification to select the right size fish, but, unfortunately, gillnets have had an unacceptably high level of bycatch of harbor porpoise (*Phocoena phocoena* Linnaeus). Pingers (small beeping devices) are now required on gillnets in many areas to alert harbor porpoise to the presence of the nearly-invisible gillnets. Ironically, another area of research includes the development of net twine that reflects the acoustic signal of *P. phocoena*. This "acoustic visibility" of gillnet twine harkens back to the early days of highly visible cotton twine.

Of all the major gear types in New England, the gillnet fleet faces perhaps the harshest reductions as stronger control measures take effect. Substantial reductions (perhaps over 95% of boats) in the number of gillnetters operating in Maine have already occurred (pers. comm., G. Salvador, NMFS). While few among us would wish it so, it is possible that this fishery will go the way of many others that once were economically important in New England.

CONCLUSION

The commercial fishing industry in New England is in the midst of rapid and significant change. Major gear types face challenges that may or may not be solvable through gear modifications. Trawl nets can be adjusted and modified to fish more cleanly and with less impact. We may reach a time when all fish caught in the net can or must be landed. Scallop dredges will need to be modified to allow them to exploit recovering populations without harming overfished species and to lessen bottom impact. The lobster pot fishery must modify its gear to reduce or eliminate right whale entanglement. Another significant problem for this already overexploited fishery is the absorption of fishermen switching over from other gear types. As more pots are set and left out

longer, conflicts between fishermen using different gear types grow. Gillnetters may need to modify their practices to increase the frequency with which the nets are tended or set their nets to avoid bycatch of recovering stocks such as striped bass (*Morone saxatilis* Waldbaum).

These problems have solutions, we hope, and yet, as populations recover, additional problems will arise as we move toward a sustainable New England commercial fishing industry.

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