Links Among Cod, Herring, Lobsters and Humans
Understanding connections between fish and fisheries

Summary
Humans interact with the Gulf of Maine ecosystem in many ways, with fishing being one of our strongest influences. However, the state of an ecosystem also affects humans. For example, fishermen change where and when they fish depending on which species are most abundant and the price they're likely to get. With funding from the National Science Foundation's Coupled Natural and Human Systems Program, we have been investigating the consequences of linkages between populations of cod, herring, and lobster, between these populations and their fisheries, and between one fishery and another. While these fisheries are currently managed independently, understanding the linkages between them and with the environment may enable more effective management.

Cod-lobster interactions
Cod stocks are much less abundant now than they were 30 years ago, especially in coastal waters, and over this time, lobster populations have increased (Figure 1). We are investigating how reduced groundfish populations affect lobsters. Using tethering experiments, we found that medium-sized lobsters are less likely to be eaten in coastal waters than on Cashes Ledge, a closed area where cod are still abundant. We also tracked the position of several lobsters in real-time using acoustic tags. When a cod was introduced into the pound, the lobsters spent less time moving around and more time hiding (Figure 2). Even if cod do not eat lobsters, their presence can make it harder for lobsters to forage.

Figure 1: Lobster landings (blue line) and cod abundance (green line).

Figure 2: Lobster movement patterns before and after the introduction of a small cod. Acoustic tags were attached to several lobsters. The dots mark the lobsters’ locations at different points in time before the cod was added. When the cod was present, lobsters were restricted to the deeper part of the pound (shaded area).

Education
GMRI’s LabVenture! program offers an interactive science experience to all 5th and 6th graders in Maine. The next iteration of the LabVenture! experience will consider interactions between humans, lobsters, herring, cod, and climate change. The program will feature several aspects of our research including the effect of herring bait on lobster populations, cod on lobster behavior, and the influence of climate on plankton.
Herring is the preferred bait used by lobstermen in Maine. Although lobsters are not able to catch live herring, in areas that are heavily fished, herring accounts for more than 10% of the diet of small lobsters. These lobsters can enter and leave traps easily, and the easy access to food allows them to grow faster. Understanding the consequences of this human-mediated link on both lobster and herring populations and fisheries is a major goal of our project. We are building computer models of the herring and lobster populations and their respective fisheries (Figure 3). The entire set of models will be used to examine how changes in herring and lobster abundance and their respective prices affect the amount of bait used (which affects the growth of lobsters) and the money made by the lobster industry. We are also exploring how changes in management of one fishery affects outcomes in the other and the overall benefits from this fishery system.

Figure 3: Diagram of the herring-lobster bioeconomic model.

Oceanographic connections

Fishing is not the only process that influences populations of cod, herring, and lobster. Conditions in the ocean (temperature, salinity, currents, and plankton abundance) affect the three stocks in different ways. The influence of these “external drivers” are especially strong during the larval stage, when each of these species is part of the plankton. We have explored how wind-driven ocean currents transport lobster and cod larvae to nursery habitats (Figure 4). We have also investigated how increased supply of relatively fresh water into the Gulf of Maine during the 1990s altered the phytoplankton and zooplankton community. The plankton changes likely contributed to the increase in herring during the 1990s.

Figure 4: Observed lobster settlement (blue squares) and settlement predicted from summer weather conditions (green circles) in Maine and northern Massachusetts. The settlement was measured by diver surveys led by R. Wahle (UMaine).

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