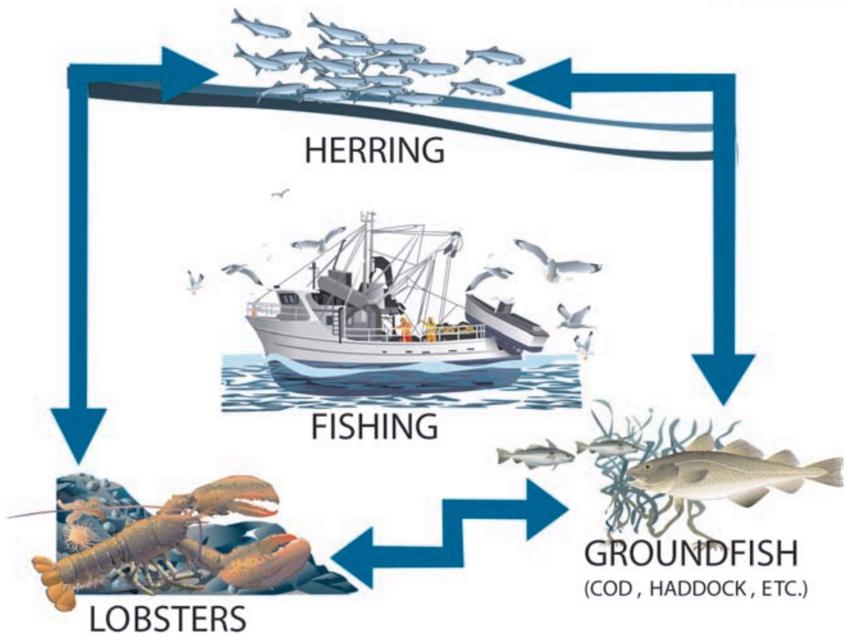
SCIENCE TO ENABLE EFFECTIVE OCEAN STEWARDSHIP

Connecting the Economics and Biology of Three Gulf of Maine Fisheries: GMRI Researchers Collaborate on an Innovative Project to Develop a Broader Management Perspective

Gulf of Maine groundfish, herring, and lobster industries are inextricably linked through biological and economic ties. Current management strategies regulate each species individually by setting catch or effort limits to maintain healthy stocks but may yield higher benefits if considered in combination. A collaborative group of GMRI, University of Maine, and Bowdoin College researchers have introduced a novel approach to understand the linkages within this network of fisheries and direct future management decisions. Funded by the National Science Foundation, the researchers investigate predator-prey relationships, influences of climate variability on early life history stages, and economics within the three fisheries and use the data to construct a broader overview and predictive model for informing management strategies.



The herring and lobster fisheries illustrate the close biological and economic relationships within this system. Herring comprises 90% of lobster bait used in traps. Reciprocally, the herring industry sells 90% of their fish for use as lobster bait. This coupling impacts the population dynamics of the two species, and can have significant market-driven repercussions. If herring availability decreases or the cost of bait increases, then the lobster fishery is affected. If the demand for lobster decreases or the cost of lobstering increases, there could be a smaller market for herring. Similarly, a management change in one fishery could have cascading effects on the other.

Relationships between the species extend beyond supply and demand and reach to more complex bioeconomic connections. The enormous amount of herring bait used in coastal lobster traps could fuel larger lobster populations. Lobsters frequently enter and exit traps, meaning that much of the bait supplies un-trapped lobsters with an ample source of food. Similarly, the reduction of groundfish stocks may have reduced the numbers of important lobster predators, allowing lobster populations to remain high despite intense fishing efforts. Depletion of herring populations may also reduce an important food source for groundfish, especially cod, thus reducing their potential for stock recovery. Overlying all of this, climatic factors can impact populations of these three species. For example, onshore wind and water currents can enhance settlement and recruitment of lobsters at early life history stages. Similarly, water currents and

Gulf of Maine Research Institute
350 Commercial Street
Portland, ME 04101

Phone: (207) 772-2321
Fax: (207) 772-6855
Web: www.gmri.org

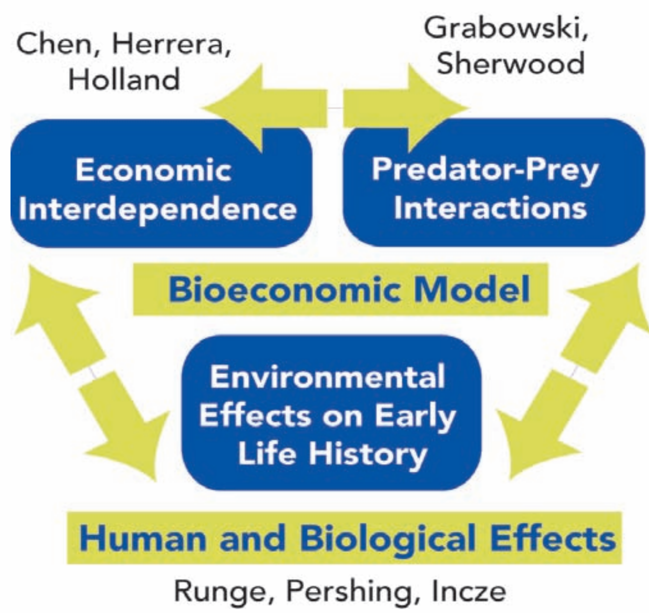
Gulf of Maine Research Institute
Science. Education. Community.

temperatures can alter larval food supply, affecting each of the three organisms directly. These environmental conditions can also alter the food supply of herring, an important prey species in Gulf of Maine food webs.

GMRI Benthic Ecologist Jonathan Grabowski and Demersal Ecologist Graham Sherwood analyze predator-prey relationships within the three fisheries. They want to quantify the extent that lobsters rely on herring from baited traps, and the degree to which groundfish predators control lobster abundance and behavior. Graham and Jonathan use stomach contents and nitrogen isotope analysis, along with field and laboratory experiments to determine the relative importance of herring as a food source for cod and lobster. These data will evaluate some of the predator-prey relationships between the three fisheries and describe a unique human-mediated transport of huge amounts of biological material (in the form of herring) from open water ecosystems to coastal habitats.

Ecosystem Modeler Andrew Pershing and Biological Oceanographer Jeffrey Runge, both joint appointments at GMRI and the University of Maine School of Marine Sciences, along with Lewis Incze of the National Science Foundation, are documenting how early life history stages in each of the three target species vary under different environmental conditions. They establish patterns of cod and herring larval and juvenile abundance over the course of several years. They then collect remote sensing data to reveal patterns of wind direction, water currents, water temperature over the same time period. Continuous biweekly zooplankton and phytoplankton samples establish seasonal and interannual changes in larval food supply. They correlate these physical and biological environmental conditions with the observed fluctuations of larval and juvenile abundance in cod, herring, and lobster. Eventually, these researchers hope to find commonalities between each of the three target species that can then inform interrelated management decisions.

NOAA Fisheries Economist Dan Holland, University of Maine Professor of Marine Sciences Yong Chen, and Bowdoin College Associate Professor of Economics Guillermo Herrera evaluate the bioeconomic interdependence of this network of fisheries. They assess each fishery with data on growth, juvenile recruitment, and natural and human predation over time. They also study the economic behavior and decisions within each fishery (how many traps fished, how many days spent fishing, the amount of bait used, etc) and how behavior is affected by different factors (catch rates, fish price, fuel cost, bait cost, etc) and by regulations. They then simulate this biological and economic system to predict future impacts to the system. How would management policies or natural fluctuations of one fishery affect the others?



The final step in this collaborative project is to synthesize data from each of the three main areas of research: predator-prey, climatic influence on larval and juvenile abundance, and economic modeling. These data will inform an integrated bioeconomic model that both describes the three related fisheries and predicts the effects of specific impacts on the entire system. For example, we may be able to predict the influence of a change in climatic conditions on all three fisheries and adjust management strategies accordingly. The goal of this broader management approach is to increase the overall value generated by this system of fisheries while ensuring their sustainabilty. GMRI researchers and local collaborators hope that this signature research project can be implemented directly to existing single-species management, and support a change to ecosystem-based fisheries management practices and regulations in the future.

Written by: Chad G. Sisson