



Stellwagen Bank Marine Historical Ecology Final Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
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Office of Ocean and Coastal Resource Management
Office of National Marine Sanctuaries



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Stellwagen bank Marine Historical Ecology Final Report

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Discharging cod fish from vessel Gloucester, MA *circa* 1882.
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Stellwagen bank Marine Historical Ecology Final Report

I. ABSTRACT

This report is provided to the National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program (NMSP) and Gerry E. Studds Stellwagen Bank National Marine Sanctuary (SBNMS), by the Gulf of Maine Cod Project (GMCP) at the University of New Hampshire (UNH). It presents the results of a 3-year survey and analysis of historical documents and manuscripts relevant to the marine historical ecology of SBNMS.

This study of SBNMS history and ecology reinforces the long-term significance of the sanctuary's ecosystems and marine resources to the broader Gulf of Maine system. At the same time, it highlights the historical role of Stellwagen Bank's marine resources in the development and well-being of Gulf of Maine coastal communities. An assessment of the late 19th- and early 20th-century fisheries of Stellwagen Bank, presented in this report, provides baselines for comparison with current ecosystem conditions. Through comparative analysis, long-term trends have been identified that may be useful to direct future management decisions. Our historical research revealed significant declines in animal diversity and abundance, as well as major shifts in the species composition of Stellwagen's fisheries. These findings shift baselines established in the "Condition Report" of the 2008 *Stellwagen Bank National Marine Sanctuary Draft Management Plan and Environmental Assessment*, and should influence the direction of management actions needed to improve overall ecosystem integrity.

Marine animal trophic level, richness, abundance, and habitat quality in SBNMS and the Gulf of Maine declined sharply over an approximately 100-year period (1900-2000). The result of our research into the effects of climate factors such as Sea Surface Temperature (SST) and the North Atlantic Oscillation (NAO) on these baseline shifts was uncertain. Therefore, we focused on documenting anthropogenic impacts, specifically, the effects of fishing upon the sanctuary's marine animal populations and habitats. Indirect factors such as industrial pollution, river damming, and reclamation of wetlands have interfered with spawning and migration of marine species. However, the direct impact of fixed- and towed-net fishing gears on Stellwagen Bank, which has resulted in the removal of biomass and seafloor habitat disturbance, is the primary cause for declines in species richness and abundance within the sanctuary.

Based on quantitative and qualitative analysis of the historical record, our findings are as follows:

- a) Nearshore and microbank fish populations were significantly deteriorated by ca. 1800.
- b) Top predators in SBNMS, such as halibut and swordfish, were overfished to near extirpation by the late 19th and early 20th centuries.
- c) Steady decline in the trophic level of commercial species began in the early 1900s with the advent of steam-powered bottom trawling.

- d) Composition of catch has shifted over time toward exploitation of lower-level trophic animals.
- e) Diversity of bottom-dwelling species in the western Gulf of Maine appears to have declined significantly from ca. 1900 to 2000.
- f) Maximum annual catch levels of historically-important commercial species in SBNMS have declined by nearly 50% from ca. 1900 to 2000.
- g) Proportional catch ratios of haddock and cod in SBNMS have inverted in the last 100 years from 3:1 to 1:7, signaling resurgence in cod but a precipitous decline in haddock catches.

In consideration of these results, we also make the following general research recommendations for SBNMS: 1) extend historical trends and baselines for fish populations, species richness, and habitat conditions back to ca. 1800, 2) refine and extend time series of climate variables that impact biota, and 3) identify socio-economic and cultural drivers and responses related to shifts in historic catch levels, marine climate or biological indicators. Additionally, a ‘compatibility determination’, as defined by the Marine Sanctuary Program, is strongly recommended that identifies the current and cumulative impacts of modern fishing gears on sanctuary resources, habitats and ecological integrity.¹ Finally, as historical sources are explored and analyzed for marine historical and ecological assessments, there will be an increasing need for data management and the development of education and outreach products for public dissemination. Interagency cooperation will be critical to meet these needs and proposed research directives.

¹ U.S. Department of Commerce. National Oceanic and Atmospheric Administration. “Stellwagen Bank National Marine Sanctuary Draft Management Plan / Draft Environmental Assessment,” Silver Spring, MD: National Marine Sanctuary Program, 2008, p. 202.

II. INTRODUCTION

*The lessons of the past are forgotten, or at least they are not considered applicable to present-day fisheries. The story of the virtual extinction of the whale, salmon, and shad are familiar enough to many New Englanders, but few of them can imagine that the now abundant haddock, flounder, and redfish may have a similar fate.*²

– Edward A. Ackerman (1938)

The Stellwagen Bank National Marine Sanctuary (SBNMS) was authorized as a National Marine Sanctuary by the U.S. Congress in 1992 under the National Maritime Sanctuaries Act of 1972 (NMSA). The NMSA authorizes the Secretary of Commerce and the National Oceanic and Atmospheric Administration (NOAA) to establish discrete areas of the marine environment as sanctuaries. These are areas within 200 nautical miles or the Exclusive Economic Zone (EEZ) that “possess conservation, recreational, ecological, historical, scientific, educational, cultural, archaeological, or esthetic qualities, which give them special national, and in some cases international, significance.”³ Currently, there are 14 national marine sanctuaries in the United States.

The goal of this research project was to assess the relative health and historical conditions of the SBNMS marine environment, ecosystems and fisheries. This assessment intends to support and improve sanctuary conservation efforts to “maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes.”⁴ A critical question that arises from this mandate is, to what levels should we restore and maintain these communities, habitats, populations and ecological processes? Without historical perspectives and baselines, resource managers’ restoration and enhancement targets are limited to short-term perspectives derived primarily from modern day fisheries statistical data. Two seminal papers by Daniel Pauly (1995) and Jeremy Jackson (2001) have pointed to the importance of a historical perspective to document the long-term effects of fishing on marine ecosystems.⁵ They call for historical perspectives based on historical, archaeological and paleo-ecological data, as essential tools for “successful management and restoration of coastal marine ecosystems.”⁶ This approach has been echoed in a decade-long, Census of Marine Life (CoML) project called the History of Marine Animal Populations (HMAP), as well as numerous scholarly

² Edward A. Ackerman, “Depletion in New England Fisheries,” *Economic Geography*, 14.3 (1938): 233.

³ National Maritime Sanctuaries Act of 1972, 16 U.S.C. § 1431, Section 301.

⁴ National Maritime Sanctuaries Act of 1972, Section 301.

⁵ Daniel J. Pauly, “Anecdotes and the shifting baseline syndrome of fisheries,” *Trends in Ecology and the Environment*, 10.10 (1995): 430; Jeremy B. C. Jackson et al., “Historical Overfishing and the Recent Collapse of Coastal Ecosystems,” *Science* 293.5530 (2001): 629-637.

⁶ Jeremy B. C. Jackson et al., “Historical Overfishing and the Recent Collapse of Coastal Ecosystems,” *Science* 293.5530 (2001): 636.

works and government reports.⁷ Marine historical ecology studies, as shown in this report, can support sanctuary management and conservation efforts by identifying historical baselines needed in order to set targets, thresholds and goals to restore, enhance, and achieve sustainable fish population levels, as well as provide historical contexts and educational material for understanding and explaining change in the marine environment.

This 3-year study of SBNMS examined historical data in order to identify what can be known about the sanctuary's past abundances and distributions of marine species as well as changes in overall ecosystem health. The first phase of this project, conducted in 2004-2005, focused on identifying historical sources that could be used to document changes in biomass removal and ecosystem conditions. We re-discovered and catalogued hundreds of historical documents in federal, state, and local repositories that relate directly or indirectly to these topics. The documents and sources were annotated in a catalogue and research findings presented in an interim report.⁸ In phase 2, specific historical data sets were extracted and compiled into relational, tabular databases and Geographical Information Systems (GIS). In the final phase of the project, the data sets were analyzed to 1) estimate temporal changes in fish population composition and distribution, 2) compare these estimates to current fish population and ecosystem conditions, and 3) provide a marine environmental history to explain the anthropogenic and environmental factors that have effected fish populations and habitats of SBNMS in the past. Based on this historical analysis, conservation measures are proposed and discussed, and future research directions recommended.

⁷ For project background information about CoML and HMAP see <http://www.hmapcoml.org>. For scholarly works on significance of historical perspectives in resource management see e.g., John M. Pandolfi et al., "Global Trajectories of the Long-Term Decline of Coral Reef Ecosystems," *Science* 301.5635 (2003): 955-958; Heike K. Lotze et al., "Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas," *Science* 312.5781 (2006): 1806-1809; Andrea Sáenz-Arroyo et al., "The Value of Evidence About Past Abundance: Marine Fauna of the Gulf of California Through the Eyes of 16th to 19th Century Travellers," *Fish and Fisheries* 7.2 (2006): 128-146; Andrea Sáenz-Arroyo et al., "Using Fishers' Anecdotes, Naturalists' Observations and Grey Literature to Reassess Marine Species at Risk: the Case of the Gulf Grouper in the Gulf of California, Mexico," *Fish and Fisheries* 6.2 (2005): 121-133. For government reports see e.g., National Research Council, *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options*, Washington: National Academy Press, 2006.

⁸ Stefan H. Claesson and Matthew G. McKenzie, *Stellwagen Bank Marine Historical Ecology, Phase 1: Historical Sources Survey Report*, Durham, NH: Gulf of Maine Cod Project, University of New Hampshire, 2005.

What is marine historical ecology?

People have lived in coastal regions and depended on the ocean's resources for thousands of years, often preserving their experiences through artifacts, artwork, photographs, written documents and oral traditions. These various historical records are not only culturally important but also contain information about the condition of marine environments in the past. 'Marine historical ecology' extracts environmental data from these historical and archaeological records, in order to determine how marine animal populations and habitats, and the ecosystems we live in, have changed over time. These records often come from people who knew the ocean best - fishermen, explorers, and others that have depended on the ocean's resources. Their personal stories preserve scientific information as well as valuable historical and cultural perspectives. The collaboration of history and ecology provides a unique approach for understanding the health of our marine sanctuaries, the diversity of life they protect, and a long-term perspective for future decision-making.

III. RESEARCH METHODS

This project maps marine resources' exploitation and use, and human responses to changes in resource abundance and diversity. Based on historical interpretation and scientific analysis, we document the cumulative impact of human activities on the fish populations and habitats of Stellwagen Bank. Specifically, we document species abundance and diversity over a 100-year period (ca. 1900-2000) in order to provide a measure of the relative health of the regional ecosystem. With detailed knowledge of the cumulative and long-term effects of human activities, we can make rational choices that will help identify sustainable fish population levels and guide future management action. We may also contribute toward assessment of the resilience of SBNMS and Gulf of Maine ecosystems to anthropogenic influences.

Research was conducted in 3 phases: 1) historical sources exploration and identification, 2) data recovery, and 3) analysis and synthesis. The initial research phase examined the availability and limitations of historical sources in providing information about marine animal populations and the environmental history of SBNMS. Documents examined in this study were found in federal, state, and local repositories that relate directly or indirectly to the ecological history of SBNMS. Historical source materials examined included explorers' accounts, fishing logbooks, census records, newspapers, and early marine scientific survey data. Sources were identified through on-line databases, library catalogs and finding aids, references in marine ecology and maritime history publications, and communication with specialists in the fields of maritime history and fisheries science. UNH historians and ecologists traveled to libraries and historical societies throughout New England and visited national archives and libraries in Washington, DC and Maryland. In cases where sources were assessed as valuable or tangentially relevant, samples were photocopied or digitally photographed and archived. The interim report by UNH described the initial findings of the exploratory sources survey.

Following the phase 1 survey, specific historical data sets were identified for recovery and compilation. Data set selection was based on the potential of the historical records to provide a composite of quantitative data that could be used in geo-spatial and statistical analyses, and qualitative, historical context information that would complement and clarify our analyses. Each relevant historical document, manuscript or collection was photographed and the resulting .jpeg images assembled into Adobe Acrobat .pdf files. These files were then compiled into digital .pdf 'libraries.' The source material was then digitized into tabular databases for analysis. Comprehensive metadata descriptions for primary data sets are included in **Appendix A**, however, a summary of primary source materials is also provided in the following section.

The historical source material was then compared to modern data sources. Specifically, this study used Vessel Trip Report (VTR) data (1995-2005) to examine changes in the composition and volume of commercial fishery catches on Stellwagen Bank over a 100-year period. Biological data from National Marine Fisheries Service (NMFS) bottom trawl surveys (1963-2007) was also compared to U.S. Commission of

Fish and Fisheries survey data from the late 19th century. Rarefaction techniques were applied to measure changes in species richness in the western Gulf of Maine based on these data sets. In addition, a suite of statistical and geo-spatial techniques and software were applied to the historical and modern data sets including trophic-level analysis, factor analysis, and time-series and climate modeling. A detailed description of these methods and results is provided in section **V. ANALYSIS**.

Historical Source Material

Monthly Fishery Statistical Bulletins for Northwest Atlantic (1893-1944)

Published by the U.S. Commission of Fish and Fisheries beginning in 1893, and continued by the Bureau of Fisheries in 1903, these records tabulate statistical information including but not limited to *monthly* fish catch by species and weight, name and location of fishing grounds, the number of trips and vessels made to those grounds, fishing gear deployed, days absent at sea, where products were landed, and the values of fish sold. Although the complete range of records date from 1892 to 1944, consistent monthly records for Stellwagen Bank are available for 1901-1935, and annual catch records from as early as 1893. Annual total removals of all fish species on Stellwagen Bank by the primary New England fishing fleets (Boston, Gloucester, MA and Portland, ME) were tabulated over a 42-year period. Monthly data is also available for a number of Northwest Atlantic fishing grounds visited by the New England fleets. A nearly complete set of statistical bulletins are available at National Archives in Waltham, MA and a partial set at National Archives II in Silver Spring, MD. In 2007-2008, the later data set was scanned and digitized under a grant from the Climate Data Modernization Program (CDMP).

U.S. Commission of Fish and Fisheries Publications (1871-1940)

The U.S. Commission of Fish and Fisheries was established in 1871 by Spencer F. Baird to investigate the decrease of fish populations in U.S. coastal and inland waters. Consequently, fisheries data generated by the commission is available for portions of SBNMS beginning as early as the 1870s. Commission publications consist of a series of annual reports, bulletins, as well as occasional monographs or special publications such as the voluminous *The Fisheries and the Fishery Industry in the United States* (1887).

The *Annual Reports of the U.S. Commission of Fish and Fisheries* were submitted to the U.S. Congress each year beginning in 1871. They typically contain a report to Congress on the work of the commission, including field and survey reports from commission scientists, reports on propagation efforts, nationwide fishery statistics, fishery histories, and anthropological studies. Publication of the *Bulletin of the U.S. Commission of Fish and Fisheries*, which began in 1881, is a publication of journal articles primarily by commission-supported scientists. The early bulletin articles often report on specific fisheries and the methods used to harvest or cultivate fish in the United

States and abroad. Subjects include international efforts to develop aquaculture, reports of fish diseases, and fishing technology and techniques. Additionally, correspondence from fishermen, captains, and fishery scientists in the United States, Europe, and Australia was often published in the bulletins. Annual reports (1871/72-1940) and bulletins (1881-1998) are available online through NOAA's Central Library in .pdf format.⁹

The Fisheries and Fishery Industries of the United States, published under the supervision of George Brown Goode in 1887, provides an exhaustive report on the U.S. fisheries at that time. The publication is divided into seven sections: 1) the natural history of marine products, 2) fishing grounds, 3) fishermen and fishing towns, 4) apparatus and methods of capture, 5) products of fisheries, 6) preparation, care, and manufacture of fishery products, and 7) economy of the fisheries. Detailed information is available for all aspects of the fisheries of Cape Cod and Massachusetts Bay, including Stellwagen Bank, or "Middle Bank," its historical name. The 7-volume set is available for download from NOAA websites as .pdf files.¹⁰

Scientific Survey Logbooks (1870-1940)

Scientific marine cruises, explorations and fishery expeditions are an excellent source for marine biological and physical ocean data. Numerous records exist concerning the operation of federal government fisheries research vessels from approximately 1870-1940. These records include research and survey vessel logbooks and reports of U.S. Commission of Fish and Fisheries, U.S. Bureau of Fisheries, and the U.S. Coast and Geodetic Survey. The Gulf of Maine was an important proving ground for early oceanographic studies. Vessel survey logbooks at the Smithsonian Institution and National Archives include data for numerous scientific cruises in the Gulf of Maine and SBNMS: *Speedwell* (1877), *Albatross* (1883), *Fishhawk* (various years 1880-1925), *Grampus* (various years 1886-1917), *Halcyon* (various years 1912-1921), and *Blake* (1880). These sampling and deck logs provide the locations (in latitude and longitude) as well as descriptions of oceanographic and climate data, dredging and bottom trawl sampling, and bottom habitat and conditions. Air and water temperatures, atmospheric pressure, and water column conditions are generally reported in the logbooks.

Maps and Charts (1607-1940)

Often compiled from information collected from fishermen and mariners, charts and maps provide information of where fishermen believed shoals and fishing grounds existed. These sources offer both local and global referencing to fishing grounds. They also serve as cultural indicators of communities' understandings of their environment. Although historical maps and charts typically do not provide statistical data, they do offer

⁹ http://docs.lib.noaa.gov/rescue/cof/data_rescue_fish_commission_annual_reports.html;
http://docs.lib.noaa.gov/rescue/Fish_Commission_Bulletins/data_rescue_fish_commission_bulletins.html

¹⁰ <http://celebrating200years.noaa.gov/rarebooks/fisheries/welcome.html>

a glimpse of how the physical oceanographic characteristics of SBNMS have been interpreted and mapped over the centuries. Maps often depict bathymetric features, where people fished and where fish were caught over time. The spatial and temporal nature of maps is important for keying historical fisheries catch data to specific features such as fishing grounds. Thus far we have located dozens of historical maps/charts, dating to as early as 1734, which document some geographic or bathymetric characteristic of SBNMS.

Early Exploration Narrative Accounts (1524-1700)

Narrative accounts of early European voyages or explorations to New England provide evidence of the region's varied and abundant marine resources prior to wide-scale exploitation. Early published accounts include those of Giovanni da Verrazano (1524), Bartholomew Gosnold and John Brereton (1602), Martin Pring (1603), James Rosier and George Weymouth (1605), Samuel de Champlain (1605-1606), and John Smith (1614). One indisputable point made by these explorers was the richness and potential commercial value of the New England fisheries. Descriptive and qualitative data can be extracted from these narratives to provide a general sense of abundance, distribution, and diversity in Massachusetts Bay prior to large-scale fisheries exploitation. Publications from the second half of the 17th century, such as William Wood's *New England's Prospect* (1634) and John Josselyn's *New-Englands Rarities Discovered* (1672), also document the condition of marine resources observed by early New England settlers. Most early narratives have been re-published and are widely available in literary collections and serials such as the *Hakluyt Society* (London) and the *Proceedings of the Massachusetts Historical Society*.

Fishermen Interviews (1850-1900)

In the late 19th century, the U.S. Fish Commission conducted numerous interviews with fishermen throughout the northeast U.S. including cod and mackerel fishermen from New York, New England and Nova Scotia. Most fishermen interviewed in the 1890s by the commission were over 50 years of age and recollected changes in the marine environment during their lifetimes. These interviews, or oral histories, are an excellent source for observations of Gulf of Maine fisheries. They provide first-hand accounts and observations of fish behavior and fishing activity on specific fishing grounds such as Stellwagen Bank. Most interviewees discuss the migratory patterns and behaviors of mackerel on the east coast. In addition, the fishermen offer descriptions of fish and catch sizes as well as theories for the decline in cod and mackerel in the 19th century. These records are located at National Archives II in College Park, MD and National Archives in Waltham, MA. The complete set of transcripts at National Archives II has been scanned under the Climate Data Modernization Program (CDMP).¹¹

¹¹ <http://www.ncdc.noaa.gov/oa/climate/cdmp/cdmp.html>

Legal Documents and Legislation (1630-1940)

Federal, state, provincial and local laws and regulations directly and indirectly provide information about the state of the Massachusetts and Cape Cod Bay fisheries. Laws and ordinances regulated aspects of the fisheries. We identified almost 150 fishing laws and regulations dating to before 1900, some of which relate to fishing activity in or near SBNMS. Histories of regulatory and legislative efforts provide an indication of the perceived socio-economic and cultural impacts of environmental degradation. The effectiveness of such attempts at curbing fishing efforts and limiting habitat disturbance may also be investigated.

IV. STELLWAGEN BANK'S FISHERIES HISTORY

Prompted by a terrible gale on August 24, 1873, in which nine Gloucester vessels and 128 men perished, George H. Proctor, a wholesale fish dealer, decided to memorialize Gloucester fishermen lost at sea.¹² The mystique of Gloucester fishermen was promulgated in part by his publications, *Fisherman's Memorial Record Book* (1873) *The Fisheries of Gloucester from 1623 to 1876* (1876), and *Fisherman's Own Book* (1882), which provided detailed narratives of the extraordinary dangers and unusual events that occurred in the fisheries. He mixed newspaper stories, poetry and local lore to illustrate and describe how difficult life was for these resourceful, determined men and the hardship of families who waited anxiously at home for their return. Rudyard Kipling's *Captains Courageous* (1897) also set Gloucester fishermen apart from ordinary men by defining their historic maritime traditions, culture of work, and independent character. James B. Connolly furthered the fishing heritage of the city through his prolific sea histories, novels and short stories published in popular magazines in the 1940s.¹³ More recently, Mark Kurlansky in *The Last Fish Tale: The Fate of the Atlantic and Survival in Gloucester, America's Oldest Fishing Port and Most Original Town*, also recalls the legendary fishing port of Gloucester, but separates itself from previous works by calling for an end to destructive fishing practices in order to salvage the historically abundant fish resources in the Gulf of Maine upon which the vanishing fishing culture depends.¹⁴

The stories of New England's (especially Gloucester's) fishing and maritime cultural heritage have been told and affirmed; however, the basis for this heritage and the fishing industry, namely the historical abundance and diversity of marine species in the Gulf of Maine, is poorly documented and misunderstood. The following historical narrative of Stellwagen Bank's fisheries seeks to inform fisheries and ecosystem management, as well as the public at large, of the previous abundance of marine animals and past ecosystem conditions within the sanctuary and the broader Gulf of Maine. Armed with this information, we can celebrate and support the region's cultural heritage, identify the cultural and socio-economic benefits that marine resources have afforded, and document how human behavior has dramatically impacted the richness of these resources. This brief history seeks to not only memorialize and remember the past, but also to deduce from historical records what an abundant and diverse marine environment in SBNMS and the Gulf of Maine may have looked like. It also compares past and present ecosystem conditions and contributes toward the discussion of how conservation measures can be employed to support community culture and economy, and simultaneously conserve marine resources for future generations.

¹² George H. Proctor, *Fisherman's Memorial Record Book*, Gloucester: Proctor Bros., 1873, p. 167-168.

¹³ James B. Connolly, *The Port of Gloucester*, New York: Doubleday, Doran & Co., 1940; *Sea-borne, Thirty Years Avoyaging*, New York: Doubleday, Doran & Co., 1944.

¹⁴ Mark Kurlansky, *The Last Fish Tale: The Fate of the Atlantic and Survival in Gloucester, America's Oldest Fishing Port and Most Original Town*, New York: Ballantine Books, 2008.

Early European Fisheries and Observations in Massachusetts Bay

The earliest known description of Massachusetts Bay's marine environment was recorded by English explorer John Brereton during Bartholomew Gosnold's expedition of the New England coast in 1602. He described schools of cod so dense around Cape Ann that:

“In five or six hours absence, we had pestered our ship so with Cod fish, that we threw numbers of them over-board again: and surely, I am persuaded that in the months of March, April, and May, there is upon this coast, better fishing, and in as great plenty, as in Newfoundland: for the shoals of mackerel, herrings, Cod, and other fish, that we daily saw as we went and came from the shore, were wonderful; and besides, the places where we took these Cods (and might in a few days have laden our ship) were but in seven fathom water, and within less than a league of the shore; where, in New-found-land they fish in forty or fifty fathom water, and far off.”¹⁵

Many early explorers and settlers marveled at the ocean's bounty along New England's shores. In 1614, English explorer John Smith remarked:

“You shall scarce find any bay, shallow water or cove of land, where you may not take clams, or lobsters, or both at your pleasure, and in many places load your boat if you please, nor isles where you find not fruits, birds, crabs, and mussels, or all of them, for taking at low water. And in the harbors we frequented, a little boy might take of cunners, and pinnacks, and such delicate fish, at the ship's stern, more than six or ten can catch in a day; but with a casting-net, thousands when we pleased: and scarce any place, but cod, cusk, halibut, mackerel, skate, or such like, a man may take with a hook and line what he will. And, in diverse sandy bays, a man may draw with a net great store of mulletts, bass and diverse other sorts of such excellent fish, as many as his net can draw on shore: no river where there is not plenty of sturgeon, or salmon, or both; all which are to be had in abundance observing but their seasons.”¹⁶

¹⁵ John Brereton, *A Brief and True Relation of the Discoverie of the North Part of Virginia in 1602*, London: George Bishop, 1602, 1952 reprint in *Early English and French Voyages, 1534-1608*, NY: Barnes & Noble, 1952, p. 331.

¹⁶ John Smith, *A Description of New England: Or the Observations, and Discoveries, of Captain Iohn Smith (Admirall of That Country) in the North of America, in the Year of Our Lord 1614: With the Success of Sixe Ships, That Went the Next Yeare 1615; and the Accidents Befell Him among the French Men of Warre*. London: Lownes, 1616; John Smith, *The Generall Historie of Virginia, New-England, and the Summer Isles: With the Names of the Adventurers, Planters, and Governours from Their First Beginning, Ano 1584 to This Present 1624*. London: ID and IH for Mitchel Sparkes, 1624.

It was possible, John Josselyn observed, to catch 100,000 sea-bass, alewives, tomcod, smelt and shad in just two tides at the Watertown weir on Charles River, or 4.5 million fish over a 45-day season.¹⁷ Thomas Morton reported that lobsters were so plentiful that he gathered them for bait when he went fishing for sea-bass.¹⁸ Francis Higginson, arriving in Massachusetts Bay, wrote:

“the abundance of Sea-Fish are almost beyond believing...Of these (sea-bass) fish our fishers take many hundred altogether...Yea, their nets ordinarily take more than they are able to haul to land...Of these fishes, some be three and some four feet long...The fisherman taking a great cod-line, to which he fasteneth a piece of lobster...the fish biting at it he pulls her to him and knocks her on the head with a stick...Codfish in these seas are larger than in NewFound Land, six or seven here making a quintal, whereas there they have fifteen to the same weight.”¹⁹

Cape Cod and Stellwagen Bank also teemed with whales in the early 17th century. In 1620, William Bradford of the Plymouth Plantation observed:

“Cape Cod was like to be a place of good fishing, for we saw daily great whales of the best kind for oil and bone, come close aboard our ship, and in fair weather swim and play about us. There was once one, when the sun shone warm, came and lay above water as if she had been dead, for a good while together, within half a musket shot of the ship, at which two were prepared to shoot to see whether she would stir or no. He that gave fire first, his musket flew into pieces, both stock and barrel, yet, thanks be to God, neither he nor nay man else was hurt with it, though many were there about. But when the whale saw her time, she gave a snuff, and [went] away.”²⁰

“And every day we saw whales playing hard by us, of which in that place, if we had instruments and means to take them, we might have made a very rich return, which to our great grief we wanted. Our master and his mate, and others experienced in fishing, professed we might have made three or four thousand pounds’ worth of oil. They preferred it before Greenland whale-fishing, and purpose the next winter to fish for whale here.”²¹

¹⁷ John Josselyn, *Two Voyages to New England, 1630 & 1663*, Reprint, Hanover: University Press of New England, 1988, p. 115-116.

¹⁸ Thomas Morton, *New English Canaan*, London: 1632. Quoted in Spencer F. Baird, *Part I. Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington, USGPO, 1873, p. 158-159.

¹⁹ Francis Higginson, 1630, quoted in Spencer F. Baird, *Part I. Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington, USGPO, 1873, p. 161-162.

²⁰ George Morton, *Mourt's Relation: A Journal of the Pilgrims at Plymouth*, Ed. Dwight B. Heath, Cambridge, MA: Applewood Books, 1986, p. 12.

²¹ George Morton, *Mourt's Relation: A Journal of the Pilgrims at Plymouth*, Ed. Dwight B. Heath, Cambridge, MA: Applewood Books, 1986, p. 6.

First Plymouth, and then Massachusetts Bay encouraged fishing to generate export goods for European markets. London merchant Matthew Craddock subsidized one of the earliest fishing efforts between Boston and Salem; his managing partner was Massachusetts Bay Colony Governor John Winthrop. Massachusetts Bay colonists initially fished in Broad Sound, where they found seemingly prolific cod grounds close to the Boston Harbor Islands. In 1629, Higginson upon arriving to Massachusetts and crossing Stellwagen Bank recounts events aboard ship:

“In the afternoon we had a clear sight of many islands and hills by the sea-shore. Now we saw abundance of mackerel, a great store of great whales puffing up water as they go; some of them came near our ship. Their greatness did astonish us that saw them not before; their backs appeared like a little island. . . This day we caught mackerel.”²²

“We saw many schools of mackerel, infinite multitudes on every side of our ship. The sea was abundantly stored with rockweed and yellow flowers, like gulliflowers. By noon we were within three leagues of Cape Ann . . .”²³

The Massachusetts Bay Colony claimed fishing grounds in the northern bay, and Plymouth Colony controlled the fishing grounds of Cape Cod and Provincetown. Boston’s shore-fishermen and merchants consequently moved their operations east to Cape Ann, where they first bought, and then seized, coastal lands previously granted to others, but that were close to more productive and reliable fishing grounds.²⁴ Salem, Gloucester and Marblehead fishermen claimed the shore grounds along southern Cape Ann, probably out to the ‘Northwest Corner’ of Stellwagen Bank. Taking four men to a boat, they fished with hand-lines, brought their catch ashore and turned it over to a shore-man who dressed it and spread it on flakes to dry. The seemingly inexhaustible abundance of codfish, however, appears to have been disrupted by the construction of weirs, dams and shoreline alterations, which limited the catch in Broad Sound and its tributaries so much so that by 1651 Boston experienced a local cod shortage.²⁵

By 1763, all the coasts with the best shore fisheries from Long Island Sound and around Massachusetts Bay, down the coast of Maine and across to Nova Scotia, were settled and their fisheries regularly exploited. In the 18th century, handlines were still used to catch demersals and mackerel, weirs and small seines for anadromous fish, and

²² Francis Higginson, *Nevv-Englands Plantation. Or, a Short and True Description of the Commodities and Discommodities of That Countrey*, London: TC and RC, 1630; Francis Higginson, "A True Relation of the Last Voyage to New England," *A Library of American Puritan Writings, the Seventeenth Century*, Ed. Sacvan Bercovitch, Vol. 9. New York: AMS Press, Inc., 1986, p. 232.

²³ Francis Higginson, *Nevv-Englands Plantation. Or, a Short and True Description of the Commodities and Discommodities of That Countrey*, London: TC and RC, 1630; Francis Higginson, "A True Relation of the Last Voyage to New England," *A Library of American Puritan Writings, the Seventeenth Century*, Ed. Sacvan Bercovitch, Vol. 9. New York: AMS Press, Inc., 1986, p. 232.

²⁴ William Leavenworth, "The Changing Landscape of Maritime Resources in Seventeenth-Century New England," *International Journal of Maritime History*, 20.1 (2008): 33-62.

²⁵ William Aspinwall, *The Book of Possessions, 1644-1651*, Reprint, Boston: Municipal Printing Office, 1902, p. 390-391.

small nets for pelagic baitfish near shore. Netting was limited in durability by the tensile strength of natural fibers – cotton or hemp, and lost nets rotted away quickly without ghost-fishing. In addition to shore grounds, Stellwagen (then called Inner, Middle and Outer Banks) and Tillies Banks and Jeffreys Ledge were accessible in good weather to small vessels and boats from Cape Ann or Provincetown.²⁶ Massachusetts Bay itself was fished by settlements from Swampscott around to Provincetown, and Ipswich Bay and adjacent waters were accessible by small boats from shore and larger vessels from Lynn to Portsmouth, New Hampshire.

From the earliest settlements, virtually all towns with ocean frontage on Massachusetts Bay and a sheltered harbor had sent boats fishing seasonally near shore to supply local consumption. Most towns licensed weirs to supply townspeople with a cheap and reliable supply of fish protein and manure for their fields, as well as bait for the ground fishery. Oxen were the principal source of heavy labor, and dairy products provided essential nutrition, but beef was a luxury. Fresh, smoked or salted fish were the principal sources of animal protein for many settlers. In particular, most settlers of Cape Cod, Nantucket and Martha's Vineyard, where the plow, axe and livestock rapidly wore down the fragile vegetation, were forced to take up maritime pursuits such as fishing and whaling for survival.²⁷ The untenable farming practices also contributed to the silting in of Cape Cod's anadromous fish passages, as well as set erosion in motion that would render some Cape fishing ports unusable.²⁸ However, the shift toward maritime pursuits was sharply curtailed during the Revolutionary War, and many fishermen were forced back ashore or took up privateering.

Marblehead, the premier 18th-century fishing port, lost much of its manpower in the Revolutionary War, and went into decline. Although some post-war ports became best known for their fishing fleets, nearly every harbor in New England sent vessels into the Grand Bank and Scotian Shelf fisheries in the decades between the War of 1812 and the Civil War. Between 1852 and 1866, Beverly-Salem fishermen on the Scotian Shelf conferred with hundreds of vessels at sea from at least 31 Maine, 27 Massachusetts, 3 Connecticut and 4 Rhode Island ports.²⁹

The offshore effort, however, did not include vessels less than 20 tons, and the many boats under 5 tons that weren't required to obtain any license to fish. Vessels under 20 tons made up 2,033 tons of Massachusetts' 59,982 tons of codfishing fleet in 1860 and nearly 6,000 tons of Maine's 74,647 tons of cod-fishing fleet in 1861 (Maine's greatest tonnage year in cod fishing before 1867).³⁰ By 1880, some 5,920 boats fished out of Maine, 211 fished from New Hampshire, and 6,749 boats fished from Massachusetts

²⁶ Capt. Thos. Durrell, *A Large Draught of New England: New Hampshire, York County and Part of Nova Scotia and Accadia*, map, Archived at the UK Hydrographic Office in Taunton, UK, 1734.

²⁷ Anne E. Yentsch, "Farming, fishing, whaling, trading: land and sea as resource on eighteenth-century Cape Cod," *Documentary Archaeology in the New World*, Ed. Mary C. Beaudry, Cambridge: Cambridge University Press, 1988, p. 138-160.

²⁸ Rev. John Simpkins, *A Topographical Description of Brewster, In The County of Barnstable, January, 1806*. MAHS Series 1, Vol. X, Boston: Munroe, Francis and Parker, 1809, p. 74; Anon., *Description of Chatham*, MAHS Series 1, Vol. VIII, Reprint, Boston: T. R. Marvin, 1854, p. 156.

²⁹ Andrew A. Rosenberg, et al. "The History of Ocean Resources: Modeling Cod Biomass Using Historical Records." *Frontiers in Ecology and the Environment* 3.2 (2005): 78-84.

³⁰ Wayne M. O'Leary, *Maine Sea Fisheries: The Rise and Fall of a Native Industry, 1830-1890*, Boston: Northeastern University Press, 1996, p. 346.

ports.³¹ Virtually none of these boats fished more than 15 miles from a harbor of refuge except in the best summer weather, and they typically gathered in fleets on near-shore grounds. The fisheries of southern Maine and New Hampshire in the 1880s, however diminished, were still good enough to attract and keep a large fleet together on small inshore grounds.³² Although catch records for small craft rarely exist and are therefore difficult to quantify, the fact that Maine's small vessel fleet in 1860-61 was more than double that of Massachusetts may indicate the greater productivity of Maine's fisheries compared to Massachusetts at that time.

Massachusetts Bay, though fished for hundreds of years, remained somewhat productive for handliners, and large catches were reported through the first half of the 1800s. D. Humphreys Storer, writing for the *Boston Journal of Natural History* (1839), described seeing in 1837 a striped bass taken in Boston Harbor that was 3'10" long and weighed 36 pounds, a bluefin tuna taken near Pigeon Cove, Cape Ann, in 1838, that was 15 feet long and weighed 1,000 pounds, a tuna taken between Marshfield and Cape Ann (that is, in Broad Sound) in September of 1838, that was 9'3" long, and a swordfish caught in the same area near Marshfield in 1833, that was 11'4" overall, and weighed 650 pounds. Halibut of 500 to 600 pounds were occasionally taken in shore, as were sturgeon 8-10' long and weighing 300 pounds.³³ In Storer's day, about 9,000,000 smelt, 700 barrels of alewives, 2,000 bushels of tom cod, 3,000 pounds of eels and 6,000 shad were annually taken, along with an occasional small sturgeon, at Watertown, on the Charles River. Shore-fishermen in Massachusetts Bay, generally day-fishing from boats and small schooners, still caught large numbers of cod in 1837 – one smack from Lynn taking 7,124 pounds in a day. On Jeffreys Ledge in the fall, 20 or 30 boats would fasten together, attract pollock by throwing bait overboard, and catch 30 to 40 quintals per boat. Cod-fishermen often caught hake and cusk on Stellwagen Bank, they fetching a better price than cod in winter, and less in summer. Flounder were taken year round from wharves and bridges in Boston Harbor, the Deer Island flounder being considered "very fine."³⁴

New England's fisheries had long been very extensive inshore at certain seasons, but according to local fishermen they had decreased noticeably through the second half of the 19th century. The first report of the newly-formed U.S. Commission of Fish and Fisheries, which was devoted to the issue of fishery depletion on New England's coasts, gathered testimonies from fishermen and fish market data to quantify and qualify changes in the Gulf of Maine fisheries. Nathaniel Smith, 73 years old, of Newport, RI, on Aug. 3, 1871:

" . . . Menhaden are decreasing too. In 1819 I saw a school of menhaden out at sea, when I was going to Portland, that was two miles wide and forty miles long. I sailed through them. We were out of sight of land. They

³¹ George Brown Goode, *The Fisheries and Fishery Industries of the United States, Section II: A geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887.

³² Jonathan Bolster, Manuscript, B35 F5, Log 1862V. Essex, MA: Essex Institute, 1862.

³³ D. Humphreys Storer, *A Report on the Fishes of Massachusetts, Journal of Natural History, Vol. II*, Boston: Boston Society of Natural History, 1839.

³⁴ D. Humphreys Storer, *A Report on the Fishes of Massachusetts, Journal of Natural History, Vol. II*, Boston: Boston Society of Natural History, 1839, p. 476.

appeared to be all heading southwest. There were no fish near them. I have seen a school on this coast three miles long . . .”³⁵

Fifty years later, Solomon Rowe, a 44 year old master fisherman, of Gloucester, MA, on Nov. 11, 1893:

“Menhaden on this coast used to be very plenty, but since they got these large oil works started on this coast menhaden seemed to disappear, and are not as abundant as they used to be.”³⁶

Charles H. Pew, a Gloucester fish merchant for 44 years, in 1893 remarked about Georges Bank:

“In 20 years’ time that Bank has been destroyed as a hook and line fishing ground. Used to catch more fish on that Bank than we caught in all the other fishing grounds put together. Today it does not pay to send vessels there hook and line fishing.”³⁷

Describing the impact of seining on Georges Bank, Eliphalet Wharf, a 63-year old fisherman commented in 1893 that:

“Cannot catch near the amount of fish on Georges Bank that they used to. Large quantities of young mackerel have been destroyed by the seines. More destroyed than are ever brought into port; by catching small fish, getting them meshed, and filling the seine, and then drawing the seine and throwing them away. Have had 500 bbls. in the seine, and picked out 20 bbls. and let the rest go. They were all dead. Other vessels catch 4 times as many as I catch - murder barrels where I murder buckets.”³⁸

Fishermen in previous centuries attributed depletion of fish stocks to natural causes, pollution and fishing methods, but were reticent to lay blame to over-fishing as the cause for depleted stocks:

"That it is possible to so diminish their numbers by fishing that those remaining cannot repair the loss, independent of the vicissitudes of ordinary fish-life, we cannot believe. They are scattered over so much ground that all the devices of man can never reduce their number, without some great auxiliary aid from nature more destructive than anything man can devise, although it may be, when natural conditions are such that they must diminish, from year to year, as some species have, to the point of extermination -then it may be that fishing may hasten; but as has been said

³⁵ Spencer F. Baird, *Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington: USGPO, 1873, p. 21.

³⁶ Stefan Claesson, Mackerel Interview Data Set, Obs_ID: 15.039. See metadata, Appendix A.

³⁷ Stefan Claesson, Mackerel Interview Data Set, Obs_ID: 12.042. See metadata, Appendix A.

³⁸ Stefan Claesson, Mackerel Interview Data Set, Obs_ID: 19.090. See metadata, Appendix A.

by others, "Under favorable conditions, no amount or kind of fishing can ever make any material diminution of the fish of the sea: 1, because of the small proportion of the whole number that can be caught by any means possible, scattered as they are over so great an area; 2, because of their vast reproductive powers, requiring but a small number to keep the stock good; 3, because the same means that are used to catch food-fishes are equally destructive to other fish, their enemies, the destruction of one of which saves numbers that would otherwise be destroyed." (J.M.K. Southwick)³⁹

A young fisherman from Portland, ME, Ahmon Mallock, held the widely accepted belief that the sea held an inexhaustible supply of fish: "catch them when you can. Will never catch them all out; it is useless to think of it."⁴⁰

Fishing Technology

Nets have been used in coastal fisheries since prehistoric times. Seventeenth-century New England fishermen used seines and dip nets in the shallow waters alongshore to catch herring, mackerel and bass, both for bait and for food. A 1633 inventory from the Piscataqua River, New Hampshire, listed "1 old seane, 10 herring netts."⁴¹ A probate inventory of 1648, taken at Richmond Island, Maine, listed "one seine and two old nets."⁴² Plymouth lawmakers regulated the use of seines in the Cape Cod shore fishery in 1650, suggesting that it was lucrative and perhaps already seen as destructive. They observed that "Two companies with net boats and other craft are considered as much as the place would bear."⁴³

Seines and nets evolved variously and rapidly, particularly through the 19th century, branching from basic beach seines and dip nets to become purse and haul seines. Much of the evolution may have been made possible by the introduction of machine-made twine. During the textile phase of the Industrial Revolution, mill-sites were evaluated by the number of spindles they could drive, which was accelerated further by the adoption of steam power. At about this time, new netting techniques were being adopted by New England fisheries such as mackerel, which evolved from hooks (or jigs) to seines after 1850:

"Capt. Rowe's father's name is Solomon Rowe. His father first began to use the purse seine in about 1851. Never used to go further south than

³⁹ Spencer F. Baird, *Part I, Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington: USGPO, 1873, p. 81.

⁴⁰ Stefan Claesson, Mackerel Interview Data Set, Obs_ID: 29.018. See metadata in Appendix B.

⁴¹ Nathaniel Bouton, *Provincial Papers. Documents and Records Relating to the Province of New-Hampshire, from the Earliest Period of its Settlement: 1623-1686*. Concord: George E. Jenks, 1867, p. 79.

⁴² James P. Baxter, *Documentary History of the State of Maine, Vol III, Trelawney Papers*, Portland, Maine Historical Society, 1884, p. 374

⁴³ Anonymous, "Plymouth Colony Records," MAHS Collections, Series 2, Vol. 111, Boston, 1815. Reprint, Boston: Charles C. Little and James Brown, 1846, p. 220-21.

Cape Cod and off Barnstable Bay and Cape Ann, with the first seines. When they fished in the beginning around Cape Cod and Cape Ann, used to go about the 1st of May.”⁴⁴

After 1870, purse seines became common offshore in the mackerel fishery, as well as inshore for the menhaden fishery. Goode and Collins stated that “the purse seine can be used to very much greater advantage along our own shores between Cape Hatteras and the Bay of Fundy.”⁴⁵ At that time fishermen used two kinds of purse seines—a large one, up to 225 fathoms long and 25 fathoms deep, and a smaller seine, measuring 150–175 fathoms in length and 10–12 fathoms deep. Mackerel fishing on Stellwagen Bank in the second half of the 19th century was largely abandoned for more profitable and previously unexploited grounds near the Delaware capes, as well as north to the ‘Cape Shore’ (eastern coast of Nova Scotia) and into the Gulf of St. Lawrence.

By 1905, purse seines were adapted to the near-shore cod fishery around Sable and Anticosti Islands, where forage was so plenty that cod would generally not take bait. These seines were retrieved using a geared windlass mounted on the seining vessel.⁴⁶ Early reports told of a single vessel taking 50,000 fish at one lift of the purse, and another Nova Scotia vessel having to cut her purse lines loose because they could not lift the estimated 100,000 lbs. of cod entrapped. Gill nets also proved useful offshore with the advent of steam power, which enabled fishermen to drag the nets through a dispersed school of mackerel or herring difficult to catch with seines. By 1905, mackerel fishermen were stringing 60 to 100 gill nets together and dragging them under power, emptying the catch into dories. Thus gill nets, which as small passive catchers had been abandoned with the mackerel hook fishery, were revived in much enlarged versions with the advent of power draggers.⁴⁷

The hook-and-line fishery also underwent a dramatic technological shift in the 19th century. In the 1850s, fishermen began to abandon the handline fishery in favor of tub trawls, which put down, on average, 500 baited hooks to the handline’s two. With the advent of tub trawling, the hook-and line fishery consumed baitfish at a much greater rate. At the same time, damming, channeling and burying tributaries, coupled with dumping industrial and household wastes, removed anadromous fish from many parts of Boston and Massachusetts Bay, and with them the lower trophic level animals that had supported the first English settlements. Fifty years after Joseph Storer’s 1837 account, Goode’s voluminous report on fishing communities and towns did not merit a single notation of the once abundant anadromous fisheries of Watertown on the Charles River.⁴⁸ Remarkably, these bait fisheries – herring, shad, alewife, and eel – continued to be productive in other regions into the late 19th-century.

⁴⁴ Stefan Claesson, “HMAP Dataset: Fishermen Interviews,” GLOUCESTER_2.PDF, 2007, p. 139.

⁴⁵ George B. Goode and J. W. Collins, “Part III: The Mackerel Fishery of the United States,” *The Fisheries and Fishery Industries of the United States, Section V, History and Methods of the Fisheries, Vol. I*, Washington: USGPO, 1887, p. 247–255.

⁴⁶ George M. Bowers, *Report of the Commissioner of Fisheries for the Fiscal Year 1905 and Special Papers*, Washington: USGPO, 1905–12, p. 30–31.

⁴⁷ George M. Bowers, *Report of the Commissioner of Fisheries for the Fiscal Year 1905 and Special Papers*, Washington: USGPO, 1905–12, p. 30–31.

⁴⁸ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*, Washington: USGPO, 1887.

The newly-formed U. S. Commission of Fish and Fisheries undertook to solve declining yields by introducing new technologies that intensified fishing effort and increased catchability of demersal species. Spencer Baird, the first head of the commission, introduced Norwegian gill-nets to Gloucester fishermen in 1878. Norwegian cod gill nets were originally composed of hemp, cotton and linen twine, the hemp being partly spun at home, while the rest of the twine came from Norwegian and British factories. The first gill nets used in the Gulf of Maine were manufactured for Ipswich Bay fishermen by the American Net and Twine Company of Boston.⁴⁹ The first use of these nets is described in the 1881 annual report of the Boston Fish Bureau:

"The Commissioner having provided the Norway net for them to experiment with, Capt. George H. Martin of Gloucester has been using them to good advantage in Ipswich Bay, fishing with two dories, two nets to a dory, net each fifty fathoms long, three fathoms deep, suspended by glass balls or floats at any required depth. Nets of ten-inch mesh, are set the same as herring nets, being set in the morning or during the day, and are hauled the next morning. As yet no fish caught except at night, and only the largest cod, the catch for the three first trials, with unfavorable weather, was respectively 4,000, 6,000, and 7,000 pounds. Capt. Martin is much pleased with his success and has ordered new nets. These nets can be used on the Grand Banks or in fifty fathoms of water, as well as in Ipswich Bay, where at present used only in 8 to 15 fathoms. We may not be surprised in the near future to see the old and much condemned as well as expensive method of trawling superseded by the gill nets introduced by the U.S. Fish Commission."⁵⁰

From February 1 to May 31, 1879, Ipswich Bay fishermen using tub trawls and handlines took 11,250,000 lbs. of cod "within a radius of 5 or 6 miles" of the shore.⁵¹ In the early years of gill-netting, Ipswich Bay fishermen fishing between October 1883 and April 1884 landed 6,492,000 pounds of cod, 761,000 pounds of pollock, 673,000 pounds of haddock, 56,300 pounds of hake, and 54,000 pounds of cusk.⁵² There were simultaneously hook-and-line removals from the same waters, but the gill-nets were able to catch spawning fish. Gill-nets' ability to catch demersal species without bait, and to catch cod even when they were spawning and refusing to take bait, soon made them an attractive alternative to hook fishing, saving shore fishermen an estimated \$150-\$250 per month in bait in the winter season. However, by November 1886 the Ipswich Bay gill-net fishery reported a greatly reduced catch:⁵³

⁴⁹ George Brown Goode, *The Fisheries and Fishery Industries of the United States, Section V, History and Methods of the Fisheries, Vol. I*. Washington: USGPO, 1887, p. 226-233.

⁵⁰ W. A. Wilcox, *Sixth Annual Report of the Boston Fish Bureau*, Boston: C. E. Ellis & Co., 1881, p. 7-8.

⁵¹ R. E. Earll, "A Report on the History and Present Condition of the Shore Cod-Fisheries of Cape Ann, Mass., Together with Notes on the Natural History and Artificial Propagation of the Species," *Report of the Commissioner of Fish and Fisheries for 1878*, Washington: USGPO, 1880, p. 690.

⁵² U. S. Commission of Fish and Fisheries, *Part XII. Report of the Commissioner for 1884*, Washington: USGPO, 1886, p. 284.

⁵³ U. S. Commission of Fish and Fisheries, *Bulletin of the United States Fish Commission. Vol. VI, for 1886*, Washington: USGPO, 1887, p. 418.

Fish	November 1885 (lbs.)	November 1886 (lbs.)
Cod	336,624	39,850
Pollock	1,923,506	393,400

Gill-nets were very efficient. By 1923, less than 6,000 lbs of groundfish were landed from Ipswich Bay, and in 1924, the bay had disappeared from the list of fishing grounds in the Boston and Gloucester catch returns.⁵⁴ By 1928, Massachusetts gill-nets averaged 269.5 yards in length, and 443.8 yards in 1935. The number of nets deployed increased (irregularly) from 3,788 in 1887 to 12, 037 in 1929, and then began to decline as otter trawls replaced these technologies. By 1950, Massachusetts' gill-nets had decreased in numbers to 988, but they were all drift nets, and their size had increased to 575,601 yards total, or 582.6 yards of length per net. They were also made of synthetic twine, which ghost fishes when it is lost. Today, the 'string' of sink gill nets is more than one mile in length.

What gill-nets did not take, net trawlers would. Beam trawls were first deployed by sailing vessels in the Gulf of Maine in the 1890s. Beam trawls and sails were replaced shortly thereafter by otter trawls and steam power, which spread throughout the Massachusetts fishery, increasing to 331 in 1929, before dropping to 292 in 1935. Massachusetts' 379 trawls in 1928 had 10,288 yards at the mouth, or just over 27 yards per trawl, and the 292 otter trawls in 1935 had a total of 8,502 yards at the mouth, or over 29 yards per trawl. The early trawls had 3-inch mesh, decreasing to 1.25-inch mesh in the cod end.⁵⁵

Although landings reported at the three primary New England fishing ports (Boston, Gloucester and Portland) are not an accurate measure of the total removals of fish from the Gulf of Maine, the trend in Massachusetts fisheries was clear – the weight of effort and catch had moved offshore at the end of the 19th century.⁵⁶ However, in the offshore fisheries, available technology ran into market preferences – hook-and-line catches in distant waters were slow, fresh bait supply was unreliable, expensive when bought, and salt fish was rapidly losing market share to fresh fish, which was preserved on ice and delivered relatively fast from vessel to merchant to retail market. Lacking fast vessels and the infrastructure to compete with urban rail hubs in the fresh fish market, many Massachusetts ports reduced or gave up their fin-fishery effort between the Civil War and the Depression of 1929. Gloucester's fleet declined from 419 vessels averaging 56.34 tons in 1879, to 315 vessels averaging 54.02 tons in 1905, to 126 vessels averaging 41.10 tons in 1935. Barnstable's fleet went from 196 vessels averaging 63.72 tons in 1879, to 140 vessels averaging 24.86 tons in 1905, to 29 vessels averaging 12.48 tons in

⁵⁴ Oscar E. Sette, "Fishery Industries of the United States, 1925," *Report of the United States Commissioner of Fisheries for the Fiscal Year 1926 with Appendixes*, Bureau of Fisheries, Washington: USGPO, 1925, p. 233-241.

⁵⁵ A. B. Alexander, H. F. Moore and W. C. Kendall, "Otter-Trawl Fishery," Appendix VI, *Report of the U.S. Commissioner of Fisheries for 1914*, Washington: USGPO, 1915, p. 22.

⁵⁶ U.S. Commission of Fish and Fisheries, *Bulletin of the United States Fish Commission. VI, for 1886*, Washington: USGPO, 1887, p. 420.

1935. Plymouth's fleet of 63 vessels in 1860 had declined to 25 vessels averaging 45.18 tons by 1879, to 11 vessels averaging 59.18 tons by 1905, and to none in 1933.⁵⁷

What the coastal fishery lost in tonnage, it gained in efficiency. With gill-nets more fish could be caught closer to home, and without the expense of bait. Starting in 1902, motorized vessels that could move against wind and tide and drag a net on the bottom began to appear. The first drag-net, beam-trawling fleet was in the flounder-fishery of Provincetown Harbor:

“The use of beam trawls in the flounder fishery at Provincetown and vicinity is also an interesting feature of the fisheries of Barnstable County. This apparatus is not used elsewhere in the United States in the commercial fisheries. The number of beam trawls in the entire county has increased since 1898 from 27, valued at \$1,610, to 65 [1904], valued at \$3,295, and the catch, consisting wholly of flounders, from 766,850 pounds @ \$8,564, to 1,419,809 pounds @ \$43,169. These nets cost about \$60 each. The beam is from 20 to 30 feet long, the net or bag 75 feet long, and the size of mesh 3.5 inches stretched. The flounders taken average about a pound in weight. They continue to be plentiful on the sandy bottoms of Provincetown Harbor and Cape Cod Bay.”⁵⁸

Net trawls were used initially in waters less than 10 fathoms in depth, according to a 1914 federal government study on the impact of trawling.⁵⁹ This seminal study, the first of a series of trawl surveys conducted by the U.S. Commission of Fish and Fisheries, and continued today by the National Marine Fisheries Service (NMFS), revealed in 1914 that otter trawling resulted in marketing of new species such as flounder, wolffish, and monkfish, as well as a catch of up to 40% of “unmarketably small” fish that would almost all be destroyed.⁶⁰ The report concludes, however, that there is not “any evidence whatever that the banks frequented by the American otter trawlers are being depleted of their fishes,” yet it concedes that the results are “necessarily inconclusive for the reason that the otter-trawl fishery in American waters is too recently established and relatively

⁵⁷ For Gloucester, 1879: G. Brown Goode, *Fisheries and Fisheries Industries of the United States: Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*, Washington: USGPO 1887, p. 138. For Gloucester, 1905: U.S. Bureau of Fisheries, “Document 620,” *Statistics of the Fisheries of the New England States for 1905*, Washington: USGPO, 1907, p. 49. For Gloucester 1935: U.S. Bureau of Fisheries, “Administrative Report No. 27,” *Fishery Industries of the United States, 1936*, Washington, USGPO, 1938, p. 95. For Barnstable in 1879: Goode (1887), p. 224; for Barnstable in 1905: U.S. Bureau of Fisheries (1905), p. 49; for Barnstable in 1935: U.S. Bureau of Fisheries (1938), p. 95. For Plymouth in 1879: Goode (1887), p. 215; for Plymouth in 1905: US Bureau of Fisheries (1905), p. 49; for Plymouth in 1933: U.S. Bureau of Fisheries, *Report of the United States Commissioner of Fisheries for the Fiscal Year 1935 with Appendixes*, Washington: USGPO, 1936, p. 152.

⁵⁸ A. B. Alexander, “Statistics of the Fisheries of the New England States, 1902,” *Report of the Bureau of Fisheries*, Washington: USGPO, 1905, p. 291.

⁵⁹ A. B. Alexander, H. F. Moore and W. C. Kendall, “Otter-Trawl Fishery,” *Report of the U.S. Commissioner of Fisheries for 1914*, Appendix VI, Washington: USGPO, 1915.

⁶⁰ A. B. Alexander, H. F. Moore and W. C. Kendall, “Otter-Trawl Fishery,” *Report of the U.S. Commissioner of Fisheries for 1914*, Appendix VI, Washington: USGPO, 1915, p. 90.

too small to have had material effect on the fish supply of the banks frequented.”⁶¹ Hand- and trawl-line fishermen disagreed, contending that 1) in areas of otter trawl operations fish were depleted, 2) spawn and eggs were being destroyed by the nets, 3) immature fish were taken and great numbers destroyed, 4) bottom habitat and valuable shellfish were being destroyed, 5) and their fishing gear was frequently entangled and lost to otter trawl gear.⁶² While the U.S. Fish Commission disputed these assertions, the impact of inshore trawling must have been noticeable immediately, as it warranted the prohibition of trawling by law within the waters of Boston Harbor in 1911, followed by Salem and Edgartown in 1912, Beverly in 1917, and Marblehead in 1920.⁶³

Bottom trawling, by-catch, and emerging markets

In the Gulf of Maine, beam and otter trawls were first deployed on Stellwagen Bank beginning in the 1890s. These fishing methods on average resulted in a 40-50% by-catch of unmarketable and immature marketable species. To limit discards and maximize profits, these technologies led to new markets for species such as flounder, wolffish, redfish, skate, ray and shark.

Otter trawlers were rapidly built and deployed in the 1910s and 20s, primarily to South Channel, Nantucket Shoals, Georges Bank, Browns Bank, but also nearshore grounds, including Jeffreys Ledge, off Cape Cod, and Stellwagen, Cashes, Platts and Fippenies Banks. By 1919, there were 230 steam otter trawlers in New England; 191 in Massachusetts and 39 in Maine.⁶⁴ Auxiliary schooners or all-power steamers were the mainstay in Boston by 1930, and became all motor-powered by 1935.⁶⁵ On average,

⁶¹ A. B. Alexander, H. F. Moore and W. C. Kendall, “Otter-Trawl Fishery,” *Report of the U.S. Commissioner of Fisheries for 1914*, Appendix VI, Washington: USGPO, 1915, p. 91-92.

⁶² A. B. Alexander, H. F. Moore and W. C. Kendall, “Otter-Trawl Fishery,” Appendix VI, *Report of the U.S. Commissioner of Fisheries for 1914*, Washington: USGPO, 1915, p. 7.

⁶³ “An Act to Prohibit Beam Trawling in Boston Harbor,” *Acts and Resolves Passed by the General Court of Massachusetts in the year 1911*, 1911 Mass. Acts. Ch. 107, Boston: Wright and Potter Printing, 1911, p. 81; “An Act Relative to the Taking of Fish in the Waters of the City of Salem,” *Acts and Resolves Passed by the General Court of Massachusetts in the year 1912*, 1912 Mass. Acts. Ch. 63, Boston: Wright and Potter Printing, 1912, p. 44; “An Act to Authorize the Taking of Flounders by Means of Dredges and Trawls in the Waters of the Town of Edgartown,” *Acts and Resolves Passed by the General Court of Massachusetts in the year 1912*, 1912 Mass. Acts. Ch. 327, Boston: Wright and Potter Printing, 1912, p. 252; “An Act Relative to Taking Fish in the Waters of the City of Beverly,” *General and Special Acts and Resolves Passed by the Legislature of Massachusetts during the Session of 1917*, 1917. Mass. Acts. Ch. 87, Boston: Wright and Potter Printing, 1917, p. 61; “An Act to Prohibit the Catching of Flounders in Certain Waters of the Town of Marblehead,” *Acts and Resolves Passed by the General Court of Massachusetts in the year 1920*, 1920. Mass. Acts. Ch. 284, Boston: Wright and Potter Printing, 1920, p. 291.

⁶⁴ Lewis Radcliffe, “Appendix V to the Report of the U.S. Commissioner of Fisheries for 1921,” *Fishery Industries of the United States: Report of the Division of Statistics and Methods of the Fisheries for 1920*, Bureau of Fisheries Document No. 908, Washington: Gov. Printing Office, 1921, p. 125.

⁶⁵ James B. Connolly, “The Fishing Industry of Boston,” *Fifty Years of Boston: A Memorial Volume Issued in Commemoration of the Tercentenary of 1930*. Boston: Subcommittee on Memorial History of the Boston Tercentenary Committee, 1932. p. 293.

3,000 otter trawling trips (or voyages) were made to these places in any given year between 1929 and 1935; peaking in 1933 with 3,824.⁶⁶

During the period 1929-1935, only one Boston fleet vessel was hand-lining on Stellwagen Bank. The fleets of Boston, Gloucester, and Portland fished Stellwagen 405 times with line trawls, and 63 trips were made with Vigneron-Dahl trawls, 54 with purse seines, 49 with drift gill nets, and 38 with otter trawls.⁶⁷ Line trawls were usually deployed from October to April. Otter trawls, mostly medium-sized vessels, were also used during this season. Purse seines were typically used for mackerel fishing during June and July and to a lesser extent from August to October. By 1950, Maine had 118 otter trawls in use, totaling 3,123 yards at the mouth, or 26.5 yards per trawl, while Massachusetts had 551 trawls, deploying 14,778 yards at the mouth, or 26.8 yards per trawl.⁶⁸ Trawls had leveled off at an optimum size, but they were now used on every feasible inshore and offshore ground.

⁶⁶ See metadata for “Statistical Bulletins of the U.S. Commission of Fish and Fisheries” in Appendix A.

⁶⁷ See metadata for “Statistical Bulletins of the U.S. Commission of Fish and Fisheries” in Appendix A.

⁶⁸ *Fishery Statistics of the United States, 1950*, Statistical Digest No. 27, Washington: USGPO, 1953, p. 58-59.

Technology Timeline⁶⁹

Year	Gear	Description
Ca. 1600	Weir, trap, haul seine, hand line	Native Americans used these fishing techniques for millennia in the Gulf of Maine, where Europeans do not begin a concerted fishing effort by these methods until ca. 1600.
1770	Line trawl	Believed to be a Dutch development. Quickly adopted by the French in Grand Banks and Newfoundland fisheries. Also called a “bultow.” Originally, lines ran from vessels, but later from dories. Line trawling introduced for halibut in 1843 and cod 2 years later. Good at catching all groundfish except for flounder, ocean perch, and small haddock and cod. Not fully adopted by American fishermen until 1850s-60s.
1800	“Drailing” with sinker and hook	Used in mackerel fishery. Poles to which lines were attached. Hook and weight at end of line and baited with pork rind.
1812	“Drailing” with chum	For mackerel fishery.
1815	Mackerel jig	Sinker attached to shank of hook. Attributed to Abraham Lurvey of Pigeon Cove, Cape Ann and Thurlow of Newburyport.
1850	Purse seine	In general use by this date for mackerel fishery. Solomon Rowe one of first fishermen to use the purse seine in Gloucester in 1851. Also credited to Captain Isaiah Baker of Chatham in 1853.
Ca. 1850	Toggle harpoon or ‘Lily-iron’ harpoon	Used by Native Americans in the Gulf of Maine for millennia. Adapted from whaling for the swordfishery sometime in the 1850s.
Ca. 1850	Scallop dredge or drag	Scallop dragging limited in Gulf of Maine in 19 th century to Cape Cod and Buzzard’s Bay, and primarily executed in Rhode Island and New York during this early use period.
1878	Gill net (sink and drift)	Norwegian gill net introduced by Spencer F. Baird for the Cape Ann cod fishery.
1891	Beam trawl	First trials of a beam trawl in New England by 95-ton vessel <i>Resolute</i> on Stellwagen (Middle) Bank.
1905	Otter trawl	First introduced in New England fishery. Beam replaced by boards at each wing or end of trawl net. First steam trawler <i>Spray</i> out of Boston. The steam trawler was first developed by France in 1876 and Britain in 1881.
1908	Great Lakes gill netters (sink and drift)	Vessels arrive from Great Lakes in Gloucester with new technology: mechanical lifter/winch allows set and haul of gill net directly from the vessel, leading to broader use. Used specifically on winter cod east of Ipswich and autumn pollock near Cape Ann.
1924	Vigneron-Dahl trawl	Otter boards are placed forward of the net rather than adjacent to net, improving efficiency. Documented by size of vessel in 1900s (small, medium, and large).
1952	Regulation of trawl mesh	Mesh size regulations for inshore fisheries as early as 1918, but mesh size smaller than 4.5 in for the cod and haddock fisheries is not banned by the federal government until 1952.

Table 1. Technology timeline.

⁶⁹ Albert C. Jensen, *A Brief History of the New England Offshore Fisheries*. U.S. Dept. of the Interior, Fish and Wildlife Service, Fishery Leaflet 594. Washington, D.C.: Bureau of Commercial Fisheries, 1967. Dwight L. Hoy, and George M. Clark, *Atlantic Mackerel Fishery, 1804-1965*. U.S. Dept. of the Interior, Fish and Wildlife Service, Fishery Leaflet 603. Washington, D.C.: Bureau of Commercial Fisheries, 1967; “An Act to Permit the Dragging for Flounders by the Beam or Otter Trawl in Pleasant Bay in the Town of Orleans,” *General Acts Passed by the General Court of Massachusetts in the year 1918*, 1918 Mass. Acts. Ch. 13, Boston: Wright and Potter Printing, 1918, p. 10; George B. Goode, “Section V: History and Methods of the Fisheries,” Vol. 1, *The Fisheries and Fishery Industries of the United States*, Washington: GPO, 1887.

Fishing Ports

The trip and catch data of the New England fishing fleets are derived primarily from the monthly statistical bulletins of the Bureau of Fisheries. A complete description of these historical records and data sets, which span the period 1893-1935, is provided in **Appendix A**, *Statistical Bulletins of the U.S. Commission of Fish and Fisheries/Bureau of Fisheries*. In addition, the socio-economic, climate, and geo-political events that affected the New England ports and their respective fishing fleets from 1914 to 1935 is extracted from the bulletins and included in **Appendix D**.

The three most important Gulf of Maine fishing ports for most of the past two centuries were Boston and Gloucester, Massachusetts, and Portland, Maine. In the late 19th century the Boston fleet fished mostly inshore with occasional trips to the Scotian Shelf and Grand Banks.⁷⁰ These bank fisheries were the work primarily of the Cape Ann and Gloucester fleets. In the first half of the 20th century, New England shore fisheries remained relatively productive, with more than 50% of the fleet catch, but effort of the principal fleets had clearly shifted offshore, primarily to Georges Bank (12%) and South Channel (9%). Trips to Stellwagen Bank and Jeffreys Ledge represented only 8% of total fishing fleet effort from 1901 to 1935. In the late 19th and early 20th centuries, nearly all trips (94%) to Stellwagen originated from Boston (FIG. 1). Gloucester vessels would fish there occasionally, but mostly for mackerel, and Portland fishermen did not visit Middle Bank until 1924 after the advent of gasoline-powered vessels.

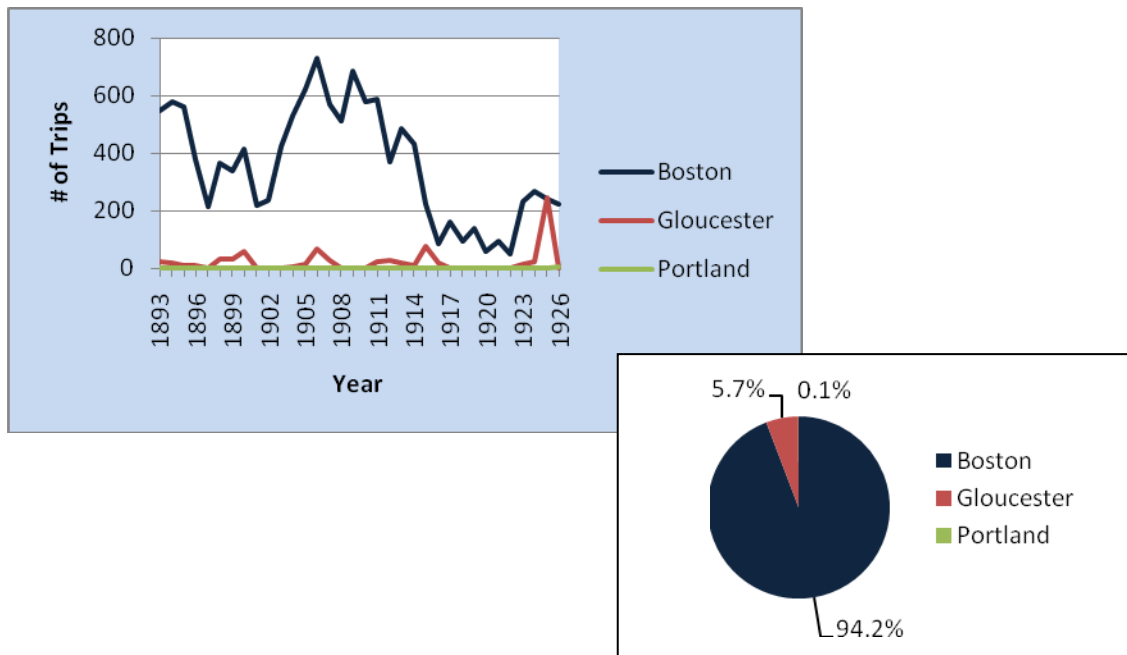


Figure 1. Trips made to Stellwagen Bank 1893-1926.

⁷⁰ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 189.

Gloucester

To the north of Cape Ann lie Ipswich Bay and the Merrimack River delta, which form a featureless flat sandy plain with barrier beaches buffering small estuarine systems. Extending east and seaward from Cape Ann is the historically productive fishing bank, Jeffreys Ledge. To the south are numerous fishing ledges and islands, and Stellwagen Bank. Cape Ann is supplied with freshwater by the relatively small Danvers, Essex, and Ipswich Rivers, which flow into coastal estuaries and protected harbors. In addition, Annisquam River (often referred to as the ‘Squam’), a broad but shallow tidal river that separates Cape Ann from the mainland, connects Gloucester Harbor and Massachusetts Bay to Ipswich Bay. The region includes, from south to north, the towns of Marblehead, Salem, Beverly, Manchester, Gloucester, Rockport, Annisquam, and Ipswich. These maritime-based communities are ideally situated in close proximity to Stellwagen Bank and the Gulf of Maine’s historically most productive fishing grounds.

The first Europeans to arrive and settle Cape Ann established temporary fishing stages or stations along the Cape’s rocky shores and on Annisquam River, but the first permanent English colonies were established at Salem (1626) and Gloucester (1634). By this time, Native American settlements had largely vanished from the region because of an epidemic that hit the Massachuset shortly after John Smith’s historic visit in 1614. Although the initial Cape Ann fishing venture of the Plymouth Colony failed, it took less than a decade for fishermen to familiarize themselves with the maritime landscape and successfully exploit what were once probably the most prolific inshore fishing grounds in the Gulf of Maine. Subsequently, Gloucester became the most storied of all fishing communities in America. The market potential that Smith referred to in his *The Description of New England* was quickly realized, and the fishing industry of Cape Ann was ultimately critical to the survival and development of the New England colonies.⁷¹ The export of codfish to Northern Europe and the Mediterranean nations resulted in large part to the rise of the colonial merchant class.⁷² Codfish were traded for European wine and products that were sold in the colonies. Furthermore, Cape Ann merchants traded fish and agricultural products with the West Indies for coffee, cocoa, sugar, and molasses to make rum.

The development of Cape Ann’s fishing industry was not without difficulty, however. As a result of King William’s War (1689-1697), more than 90% of Salem’s fishing vessels were lost, and consequently merchants shifted emphasis to coastal trade and small boat fisheries.⁷³ Simultaneously, the locus of fishing on Cape Ann shifted from Salem to Marblehead, which incorporated as a separate town in 1639. Reverend John

⁷¹ John Smith, *A Description of New England*, Ed. Paul Royster, London: Humphrey Lowes, 1616, p. 30-31.

⁷² see e.g., Lorinda B. R. Goodwin, *An Archaeology of Manners: The Polite World of the Merchant Elite in Colonial Massachusetts*, Contributions to Global Historical Archaeology, New York: Kluwer Academic/Plenum, 1999; Peter E. Pope, *Fish into Wine: The Newfoundland Plantation in the Seventeenth Century*, Chapel Hill: University of North Carolina Press, 2004.

⁷³ Daniel Vickers, *Young Men and the Sea: Yankee Seafarers in the Age of Sail*, New Haven: Yale University Press, 2005, p. 71; Lorenzo Sabine, *Report on the Principal Fisheries of the American Seas*, Washington: Robert Armstrong, 1853, p. 129.

Barnard became minister of this once dismally poor village in 1714, and by encouraging his most enterprising parishioners to sell their fish on their own account, made them independent of Boston and Salem merchants.⁷⁴ At the outset of the American Revolution, Marblehead sent out 150 cod-fishing vessels averaging 50 tons, 23% of the entire New England vessel fleet by numbers and almost a third by tonnage, mostly to the Scotian Shelf and Georges Bank, where they fished adrift on the strong currents of Georges.⁷⁵ Gloucester, just behind Marblehead in vessel tonnage and men employed in the bank fisheries, was sending schooners to the Grand Banks with some regularity by the 1740s.⁷⁶ In 1775, it was second only to Boston in terms of population and wealth in Massachusetts, and served as a principal port of entry for Cape Ann, where European goods were sold directly in return for cod and other merchantable fish.⁷⁷

In the 1820s, Gloucester grew significantly in population as a direct result of mackerel fishing and exploitation of groundfish stocks on Gulf of Maine fishing banks.⁷⁸ Gloucester fishermen pioneered the merchantable salt-mackerel fishery in 1818, and began to fish for halibut and haddock on Stellwagen Bank in 1819.⁷⁹ These enterprises made up for a lackluster inshore cod-fishery until the late 1830s, when offshore bank vessel fisheries made up for the dwindling cod catch.⁸⁰ By the mid-1840s, Gloucester took the lead as the premiere fishing port in America.

A railroad line established between Boston and Gloucester in 1846 improved the market for Gloucester fish, especially the fresh halibut market, which strengthened the connection between the port and larger urban markets. By the end of the Civil War, Gloucester's fleet comprised 358 vessels, and its fish products were sold directly to merchants in Boston, New York and Philadelphia.⁸¹ Milling and industrial manufactories sprang up in Cape Ann towns such as Beverly, Lynn, and Salem, competing for labor with the fisheries, but Gloucester was able to consolidate its labor and capital investments in the offshore and deep-water bank fisheries (e.g., Grand Banks, Flemish Cap, Greenland and Iceland). By the end of the century, more than half of the Gloucester fleet catch came from these regions.

In the late 1800s, Gloucester competed with Boston to be the foremost commercial trans-shipment point in the Northwest Atlantic. Although Gloucester

⁷⁴ Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 85.

⁷⁵ Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 112, 192.

⁷⁶ Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 88.

⁷⁷ Daniel Vickers, *Young Men and the Sea: Yankee Seafarers in the Age of Sail*, New Haven: Yale University Press, 2005, p. 71; Samuel Eliot Morison, *The Maritime History of Massachusetts 1783-1860*, Boston: Houghton Mifflin, 1961, p. 23.

⁷⁸ Andrew W. German, "History of the Early Fisheries: 1720-1930," *Georges Bank*, Eds. Richard H. Backus and Donald W. Bourne, Cambridge: MIT Press, 1987, p. 409.

⁷⁹ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 62; George B. Goode, *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Vol. 1, Washington: USGPO, 1887, p. 31.

⁸⁰ Manuscript, City of Gloucester Archives, Gloucester, MA.

⁸¹ Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 190-195.

employed more men, paid out more wages, and landed a greater quantity of fish, Boston supported a greater number of mercantile firms with greater capital investment and infrastructure. Rail, ice, and new technologies such as Clarence Birdseye's flash-freezing method, which developed in the 1920s, would benefit both Gloucester and Boston, allowing for rapid delivery of fish products to inland and west coast markets.

Boston

Boston became the first colonial *entrepôt* to consolidate its coastal region. As the center of trade and most populous city, Boston profited enormously from the fisheries, and many towns and villages along the New England shore prospered through their connections with its mercantile establishments. By 1700, Boston merchants were exporting 100,000 quintals of dried codfish annually to Portugal, Spain and Italy, and conducted a brisk but relatively undocumented trade with Europe and the West Indies in fish and other products gathered from its hinterlands.⁸² One of Boston's principal merchants, Peter Faneuil, traded with Englishmen and French Canadians in Canso and Louisburg for fish that was shipped on his account to the Caribbean and Europe. Faneuil Hall Market, his gift to the City of Boston, was built with the profits from that trade.⁸³

Boston would remain the commercial hub for fisheries exports for the next 300 years. An extensive boat fishery from Swampscott to Provincetown developed in the 1700s, which supplied the Boston market with fresh fish. Salted and pickled fish caught by American vessels from the bank fisheries of the North Atlantic were not wholesaled and trans-shipped from Boston until 1815, and increasingly for domestic markets.⁸⁴ Between 1893 and 1927, 90% of all fish caught by the Boston fleet, in contrast to Gloucester, was from Gulf of Maine grounds and banks. Stellwagen Bank represented 7% of the Boston fleet's Gulf of Maine catch at this time, but the majority of landings came from South Channel (30%), Georges Bank (22%) and the shore fisheries (16%).

As fishing and trade expanded, new waterfront facilities and infrastructure were established to direct the landing of fish and outfitting of vessels. In the colonial era, the primary landing place was Long Wharf (built ca. 1711-1715).⁸⁵ From 1838 until 1884, Commercial Wharf accommodated the fresh fishing fleet and fish merchants. In 1884, they moved to T-Wharf and a state-of-the-art commercial warehouse, which was built to accommodate Boston's fish dealers, store fresh fish, and service hundreds of vessels a day.⁸⁶ Except for a few vessels mackerel seining in the spring and fall, the T-Wharf fleets

⁸² Lorenzo Sabine, *Report on the Principal Fisheries of the American Seas*, Washington: Robert Armstrong, 1853, p. 129.

⁸³ Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 87.

⁸⁴ Workers of the Writers' Program of the Work Projects Administration in the State of Massachusetts, *Boston Looks Seaward: the Story of the Port 1630-1940*, Reprint Ed., New York: AMS Press Inc., 1975, p. 93, 108-9, 147.

⁸⁵ Nancy Seasholes, *Gaining Ground: A History of Landmaking in Boston*, Cambridge: MIT Press, 2003, p. 31.

⁸⁶ Wayne M. O'Leary, *Maine Sea Fisheries: The Rise and Fall of a Native Industry, 1830-1890*, Boston: Northeastern University Press, 1996, p. 274; George B. Goode, George Brown Goode, *The Fisheries and*

were mostly trawlers or long-liners with dories.⁸⁷ In 1914, sanitation concerns at T-Wharf prompted the construction of the Boston Fish Pier in South Boston.⁸⁸ The Boston Fish Bureau in 1875, the New England Fish Exchange in 1908, and the Boston Fish Market Corporation in 1914, all worked to modernize Boston's fish business. In the 1920s, the Commonwealth Ice and Cold Storage Company on the Boston Fish Pier distributed approximately 150-175,000,000 pounds of fish yearly.⁸⁹

Portland

Known as Falmouth to early English settlers, Portland, now Maine's largest city, occupies a peninsula between the Fore River and Back Cove at the southwest end of Casco Bay. The city and harbor are situated approximately 6.5 km (3.5 nm) from the Atlantic Ocean and 140 km (75 nm) from Stellwagen Bank. Consequently, Portland vessels rarely voyaged to Stellwagen to fish until the advent of gas-powered vessels in the 1920s.

Portland and Casco Bay grew as a commercial port in the 1800s, but did not experience significant maritime development until the second half of the 19th century. The region emerged as a fisheries market and trans-shipment point following the Civil War, and in the 1880s Portland became a primary fishing port in the U.S. alongside Gloucester and Boston.⁹⁰ Portland maintained a significant portion of the region's mackerel fleet at that time and operated numerous fish-processing and canning facilities. Portland's mid-19th century growth coincided with steam and rail improvements. Maine fish were typically wholesaled in Boston or New York, but with the arrival of the railroad in 1842, Portland was able to deliver its products rapidly to these and other domestic markets.⁹¹

Maine fisheries initially showed much less capital concentration than Massachusetts fisheries, and were prosecuted primarily inshore in the 19th century. However, the Gulf of St. Lawrence would develop as an important destination for Portland fishermen for cod, halibut, mackerel and herring. Other nearby coastal towns thrived off exploitation of their local fisheries and depended on the city to deliver its innovative fish products to domestic and foreign markets. Eastport began canning lobster

Fishery Industries of the United States, Section II: A geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880. Washington: USGPO, 1887, p.193.

⁸⁷ James B. Connolly, "The Fishing Industry of Boston," *Fifty Years of Boston: A Memorial Volume Issued in Commemoration of the Tercentenary of 1930*, Boston: Subcommittee on Memorial History of the Boston Tercentenary Committee, 1932, p. 291.

⁸⁸ Workers of the Writers' Program of the Work Projects Administration in the State of Massachusetts, *Boston Looks Seaward: the Story of the Port 1630-1940*, Reprint Ed., New York: AMS Press Inc., 1975, p. 158, 185.

⁸⁹ Workers of the Writers' Program of the Work Projects Administration in the State of Massachusetts, *Boston Looks Seaward: the Story of the Port 1630-1940*, Reprint Ed., New York: AMS Press Inc., 1975, p. 185.

⁹⁰ Wayne M. O'Leary, *Maine Sea Fisheries: The Rise and Fall of a Native Industry, 1830-1890*, Boston: Northeastern University Press, 1996, p. 182.

⁹¹ Wayne M. O'Leary, *Maine Sea Fisheries: The Rise and Fall of a Native Industry, 1830-1890*, Boston: Northeastern University Press, 1996, p. 120-122, 279-280.

in 1843, oil was first extracted from menhaden in Blue Hill Bay in 1850, and Bristol built the first menhaden oil and guano factory in 1864.⁹² These products as well as the ubiquitous salted cod and smoked herring were shipped on coastal schooners directly to Portland.

The Portland Fish Exchange, begun in 1884, attempted to follow the model of Boston consortiums and increase Maine's piece of the growing fresh fish market. However, Portland fish dealers were in competition with Boston and Gloucester, which were better capitalized, had better infrastructure, and were positioned closer to domestic markets south and west. While Portland was undoubtedly the largest fish market in Maine, Massachusetts handled up to 75% of all fish products landed in New England.⁹³ The shift in market demand from salt to fresh fish products also handicapped Maine vessel fisheries, which remained committed to salt-cured fish. Portland maintained a sizeable trawling fleet in the 20th century, but kept primarily to its shore, herring and increasingly lobster fisheries, which were caught and processed 'Downeast' near the supply. Between 1893 and 1927, 75% of the Portland fleet catch came from the Gulf of Maine. Catch from Stellwagen Bank represented less than 1% of total landings, with the majority of landings from shore grounds (59%) and Jeffreys Ledge (15%).

⁹² Raymond McFarland, *A History of the New England Fisheries: With Maps*, Reprint Ed., Gloucester: Ten Pound Island Book Company, 2002, p. 177-183.

⁹³ Wayne M. O'Leary, *Maine Sea Fisheries: The Rise and Fall of a Native Industry, 1830-1890*, Boston: Northeastern University Press, 1996, p. 274.

Maritime Cultural Landscape of Stellwagen Bank

The maritime cultural landscape of Stellwagen Bank, or places where humans have interacted historically with the marine environment, was well-known to fishermen by the 17th century, as any seagoing vessel could not enter Massachusetts Bay to reach the region's fishing stations and colonies without crossing its fertile fishing grounds. Charts and maps that depict the fishing grounds of Stellwagen Bank date as early as 1734, and provide information of where fishermen believed shoals and fishing grounds existed (FIGS. 2 & 3). Maps and charts were often made without highly sophisticated methods or plotting instruments, and need to be viewed cautiously, particularly in regards to claims of their accuracy as both representations of land forms and locations of fishing banks. Nonetheless, these sources not only assign names and descriptions of fishing grounds, but also serve as indicators of fishing communities' comprehension of the marine environment.

Historical maps and charts typically do not provide quantitative data, but they do offer a glimpse of how the physical characteristics of SBNMS have been interpreted and mapped over the centuries. Maps of the sanctuary often outline features where people fished and where fish were caught over time. The spatial and temporal nature of maps is important for keying historical fisheries catch data and reports to specific bathymetric features. The recent high-resolution mapping of the sanctuary by the USGS, its fishing ledges, bank and ridges, and muddy bottoms, now allows for the association of known geological features and structures to their historical places names (FIG. 4). The interpretation of the landscape is based primarily on two historical works: "The Fishing Grounds of North America" in the multi-volume work, *The Fisheries and Fishery Industries of the United States*, by George B. Goode (1887), and *The Fishing Grounds of the Gulf of Maine*, by Walter H. Rich (1929) (FIGS. 5 & 6).⁹⁴ Their maps were constructed primarily from extensive interviews with fishermen about what, where and when they fished. Their descriptions of the grounds in or near the sanctuary are paraphrased in this section.

⁹⁴ Walter H. Rich, *Fishing Grounds of the Gulf of Maine*, Washington: GPO, 1929.



Figure 2. Earliest known nautical chart of SBNMS fishing grounds including Jeffreys Ledge and ‘Inner,’ ‘Outer’ and ‘Middle’ Banks.⁹⁵

⁹⁵ Capt. Thos. Durrell, *A Large Draught of New England: New Hampshire, York County and Part of Nova Scotia and Accadia*, map, Taunton: UK Hydrographic Office, 1734.

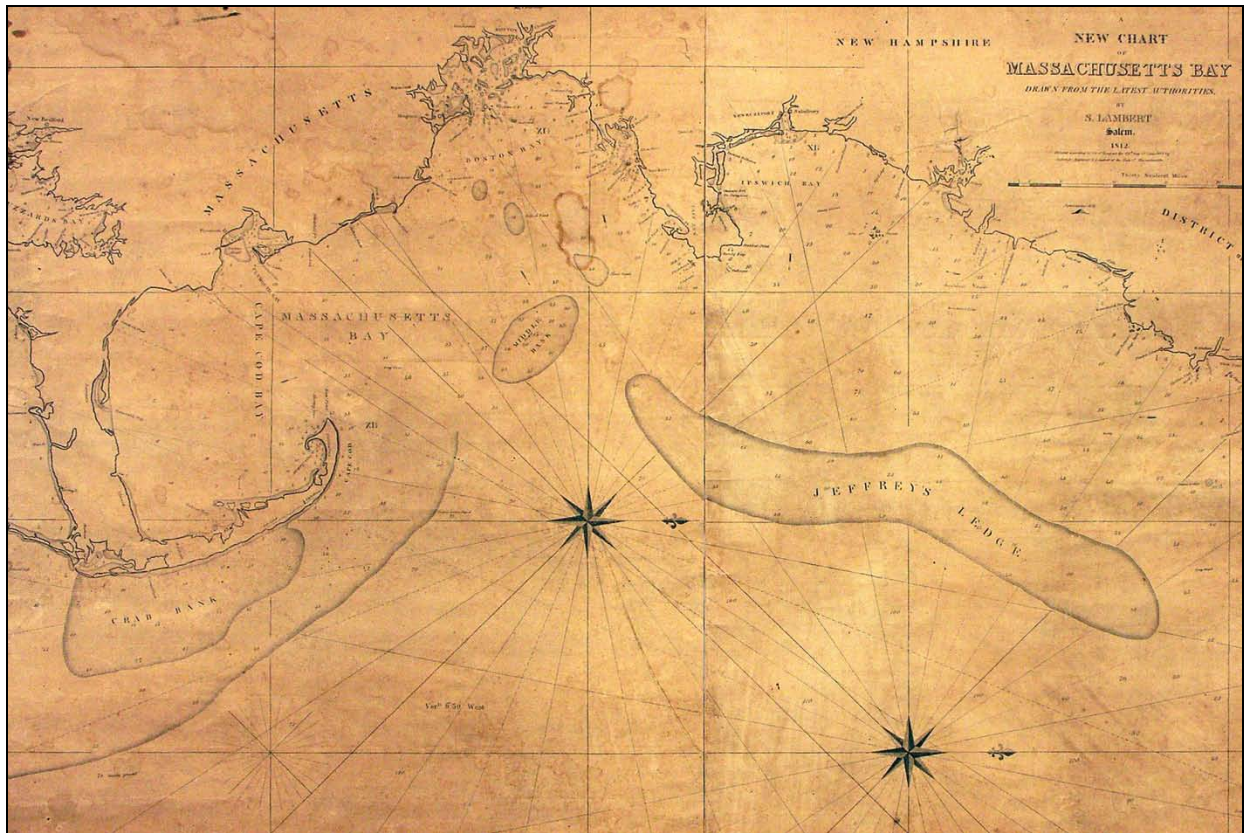


Figure 3. 1812 Lambert nautical chart of Massachusetts Bay fishing grounds, “Middle Bank” and “Jeffreys Ledge.”⁹⁶

⁹⁶ Samuel Lambert, *New Chart of Massachusetts Bay Drawn From the Latest Authorities*, Salem, MA: Cushing, Appleton and Lambert, 1812.

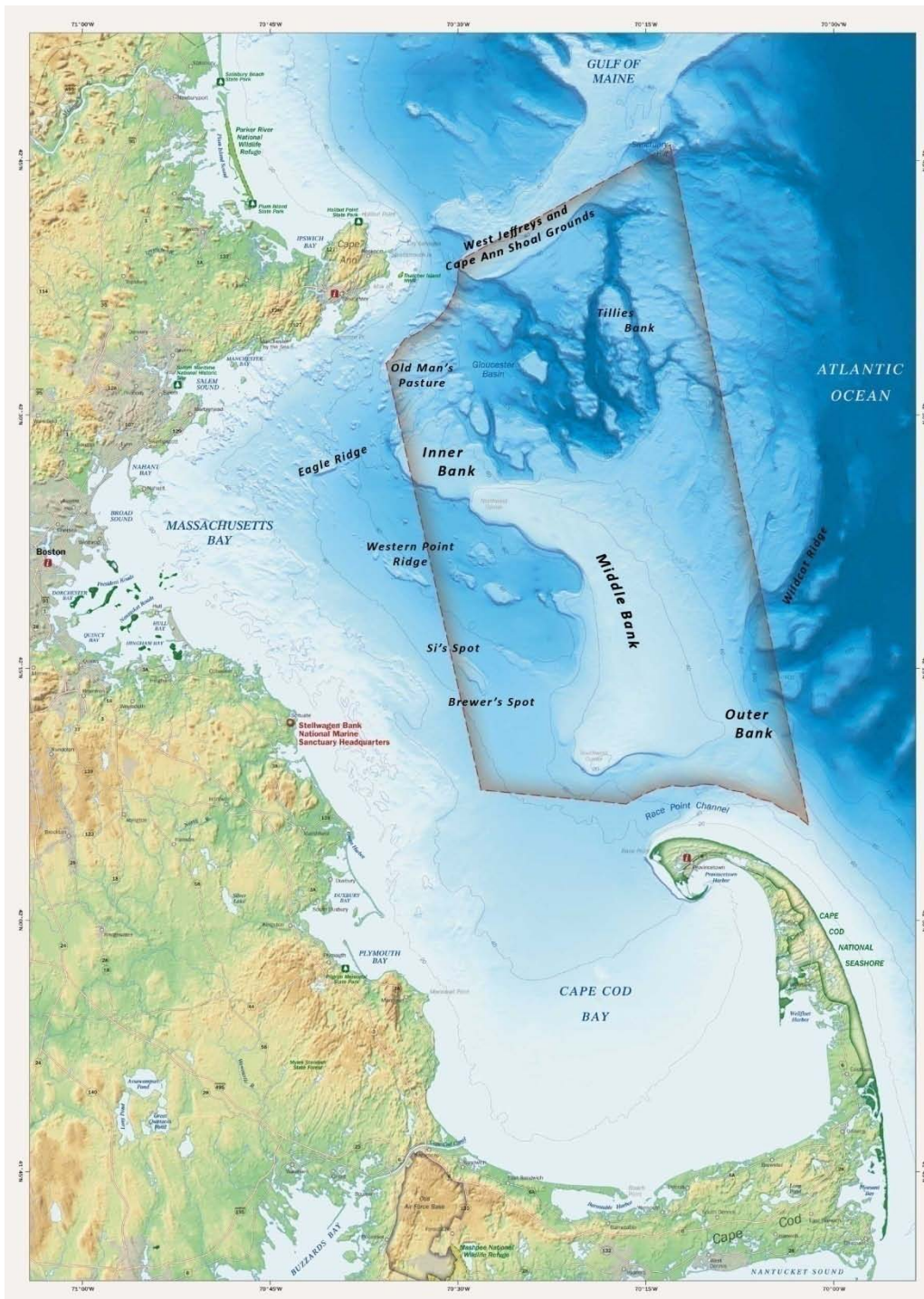


Figure 4. Historic place names of fishing grounds and undersea features superimposed on bathymetric map of SBNMS.⁹⁷

⁹⁷ After http://sanctuaries.noaa.gov/pgallery/atlasmaps/images/sb_2000.jpg.

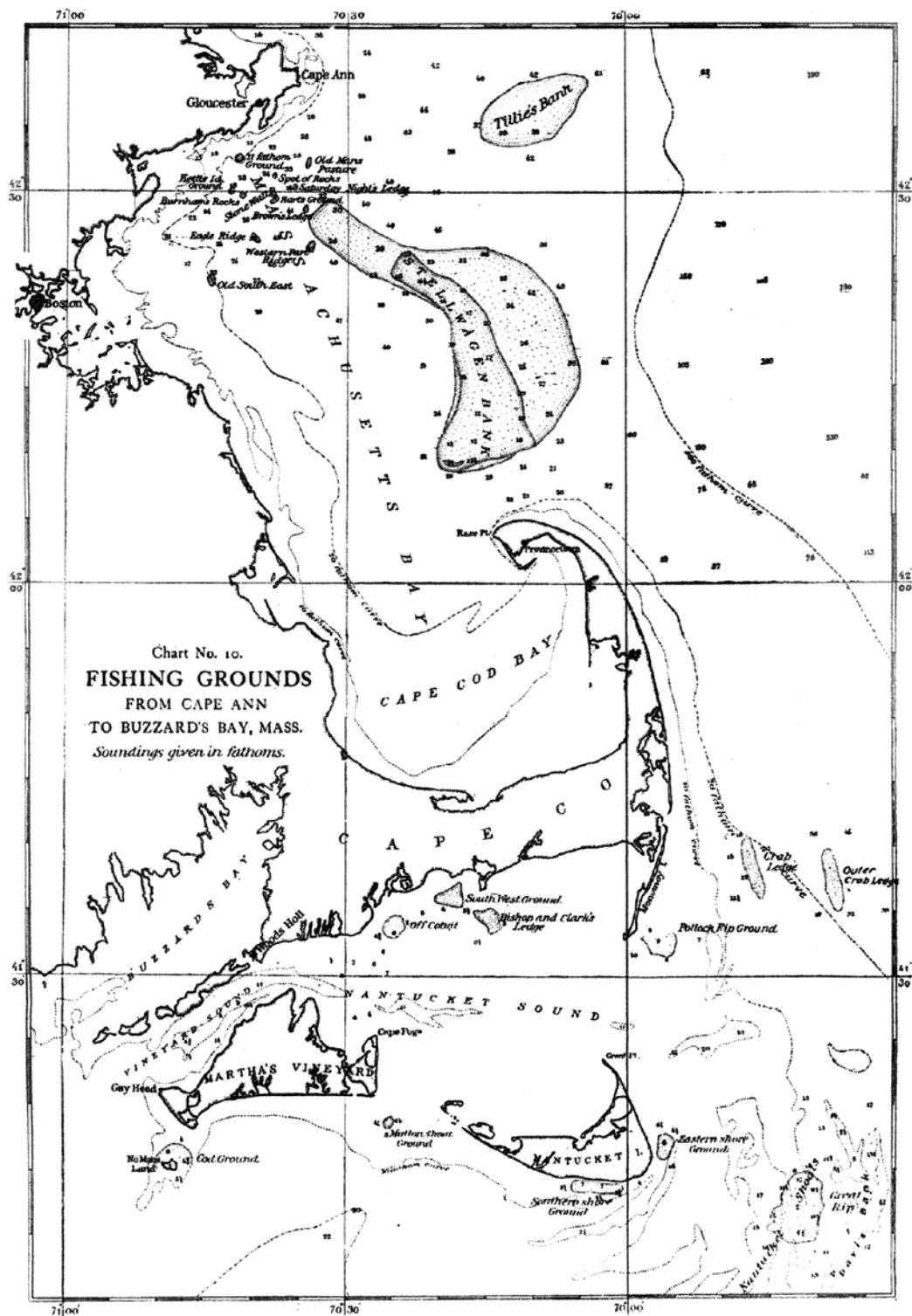


Figure 5. Fishing grounds of Stellwagen Bank and Massachusetts Bay as mapped by Goode (1887).⁹⁸

⁹⁸ George B. Goode, "Chart No. 10. Fishing Grounds from Cape Ann to Buzzard's Bay, Mass.," *The Fisheries and Fishery Industries of the United States, Section III: The Fishing Grounds of North America*, Washington: USGPO, 1887.

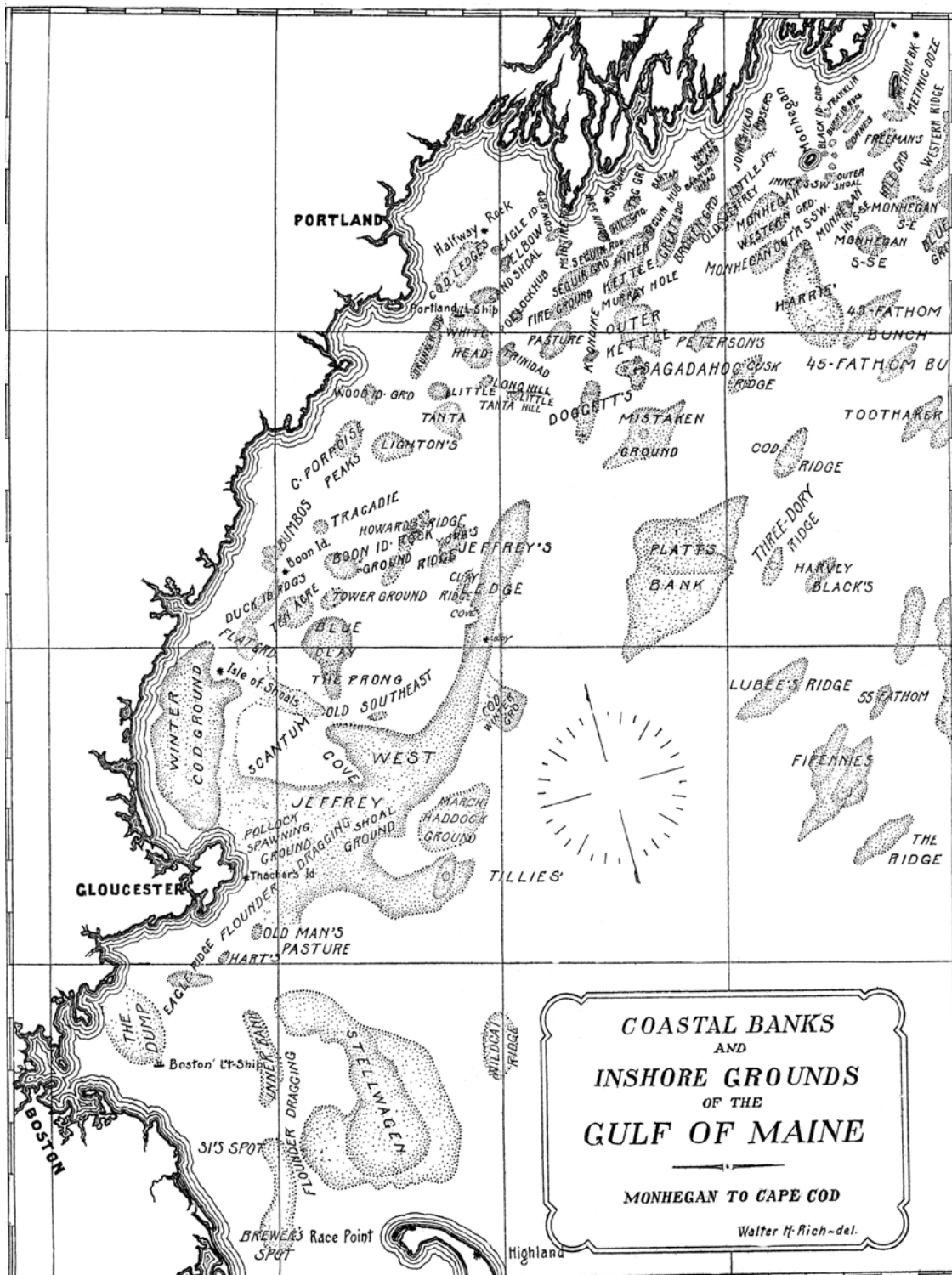


Figure 6. Fishing grounds of western Gulf of Maine as mapped by Rich (1929).⁹⁹

⁹⁹ Walter H. Rich, "Coastal Banks and Inshore Grounds of the Gulf of Maine: Monhegan to Cape Cod," *Fishing Grounds of the Gulf of Maine*, U.S.B.F. Doc. 1059, Washington: USGPO, 1929.



Figure 7. “Stellwagen’s Bank” was first surveyed, mapped and named by the U.S. federal government in 1854.¹⁰⁰

¹⁰⁰ “Preliminary Chart of Stellwagen’s Bank, Massachusetts Bay, Discovered in October 1854 by the Hydrographic Party Under the Command of Lieut. H. S. Stellwagen U.S.N. Assist.,” *Report of the Superintendent of the Coast Survey, Showing the Progress of the Survey During the Year 1854*, 33rd Congress, 2nd Session, Serial Set Vol. 757. Session Vol. No. 12, S. Exec. Doc. 10, Washington: USGPO, 1855.

Middle Bank

The Durrell map of 1734 is the first known historical reference to Stellwagen Bank's historical name of 'Middle Bank.' Middle Bank was so named because of its position relative to Cape Ann – 'Inner Bank' being in close proximity to the cape and 'Outer Bank' nearer to Provincetown at the southern end of the sanctuary. Stellwagen Bank was not officially charted and named as such by the federal government until 1854 (FIG. 7), when Henry S. Stellwagen, then commander of a U.S. Coast Survey team proclaimed that "I consider I have made an important discovery in the location of a 15-fathom bank lying in a line between Cape Cod and Cape Ann"¹⁰¹

The middle, shallowest portion of the bank was described as sandy, but the eastern slope of the bank was coarser with sand, gravel and pebbles. On this slope, cod was caught in the fall and spring seasons and haddock in winter. At the southern end of the bank near Race Point, cod was abundant in fall and winter. Haddock fishing began March 1, but was particularly good from April 20 to May 15. Cod were present year round, but most abundant August-October. The deeper water was a good cusk ground November-March. Mackerel were found across the bank from July through September. Halibut appeared infrequently on the northern slope of the bank. Gill-netting for pollock was extensive in November and December. In the 1920s, the bank was fished mainly by Italian boats and small trawlers out of Boston and Gloucester. They often worked on hard bottom approximately 22 nm southeast of Eastern Point.

Inner Bank

In the northern portion of the sanctuary lies Inner Bank. The bank is described by Rich as a ridge nearly 10 nm in length, 2.5 nm wide, lying 12 nm from Thatcher's Island, and the bottom hard and gravelly. Haddock were taken in the spring, pollock in the fall, and cod in the winter. Fishing was mostly by gill netters out of Gloucester. Between Inner and Middle Bank is a muddy ground, which was fished by flounder draggers from Boston and Gloucester in the early 20th century.

Old Man's Pasture

Because of its proximity to Cape Ann, this fishing ground was perhaps one of the most important and earliest grounds fished within the sanctuary. The 'Pasture' is located due south of Thatcher's Island and 5 nm southeast of Eastern Point Light. The ground is described by Goode as a small rocky area only 0.75 nm in length 0.4 nm in width, oriented northeast to southwest. Rich positions the ground further east and 1.5 by 1.0 nm

¹⁰¹ Nathalie Ward, *Stellwagen Bank: A Guide to the Whales, Seabirds, and Marine Life of the Stellwagen Bank National Marine Sanctuary*, Camden: Downeast Books, 1995, p. 20.

in size, but with similar orientation. The bottom is described as “rough and rocky” with an average depth of 45 m.

Old Man’s Pasture was the principal winter cod ground for Cape Ann fishermen, but cod were taken year round, primarily by gill-netters in November. Additionally, pollock were taken by gill net from October to December. Haddock fishing was good from February to April, but few were caught in the fall season. It was also a lobster ground in the early 1900s. The Pasture was the primary testing ground for new technologies deployed by the U.S. Commission of Fish and Fisheries when it was stationed at Gloucester in the 1870s. Both the gill net and the beam trawl were first deployed and then tested on this once prolific fishing ground.

West Jeffreys and Cape Ann Shoal Grounds

Historically, the shoal area of Jeffreys Ledge near Cape Ann was referred by fishermen as West Jeffreys. It is an area that extends from Cape Ann in a northeasterly direction for a distance of 15-18 nm. Depths on the eastern part of the shoal vary 35-85 m, and the bottom consists of rocks, pebbles, and coarse gravel. Sand and mud are found along its edges. The eastern part of the ground was fished by haddock fleets in the fall and early winter, and other parts visited by vessels and boats from Cape Ann and Boston Portland line-trawlers, gill-netters, and small otter-trawlers over the entire year for cod, haddock, and pollock.

On Jeffreys Ledge, cod, haddock and cusk were taken all winter and spring, with winter providing the best catches. Pollock and hake also constituted a significant portion of the landings. Halibut were taken most years on hard gravel bottom in spring and early summer in 65-120 m. When herring migrated to these waters, seiners made good catches of very large herring. From July 1 through September, mackerel also appeared on these grounds and on smaller grounds close to shore. In most years, a large amount of mackerel was taken on Jeffreys; an especially large catch was taken in 1925.

The haddock fishery was the most productive and important fishery on this ground during the late 1800s and early 1900s. The fishery was conducted almost entirely by hand-liners and line-trawlers, but the gill-net fishery increased significantly by 1900. Because of the weight of the nets in the deep water, however, they were generally not deployed in depths greater than 90 m. Steam-powered otter trawls would eventually dominate the fishery. Although Jeffreys was fished mostly by small trawlers, large otter trawls would also run to Jeffreys (and Stellwagen) for one set and return to port the same day.

The Shoal Ground, east of Thatcher Island, with depths of 35-55 m and a sandy and gravelly bottom, was an important pollock ground during spawning time and a good cod-fishing ground in the fall. The center of the ground was about 12 nm northeast of Thatcher Island. Flounder draggers operated east and southeast of Thatcher Island. Within 8-15 nm of Thatcher Island, where the bottom was sand, gravel and mud, the gill net fleet operated extensively, but mainly in winter and spring. A fishing ground, known as the ‘Cove of Jeffreys’ (ca. 12-15 nm from Thatcher Island), was a favorite haddock ground in the spring (April 20 to May 15).

Tillies Bank

Goode speculates that the name of this bank is owed to Edward Tillie who was part of John Smith's expedition to the region in 1614. Edward 'Tilly' also operated a fishing station on Cape Ann 1624-1625. The center of this ground is located 18 nm from Cape Ann. This mostly rocky ground was described as oriented east to west, 10 nm in length, and 5 nm in width. Depths reportedly ranged from 45-55 m over the bank, but deepened to 75-110 m down to a muddy bottom. A shoal area connects this ground with West Jeffreys. Tillies Bank was revered as one of the best fishing grounds off Cape Ann, particularly for cod and haddock in the spring and fall; hake in the spring, summer and fall; pollock in the spring and fall. The fishing was done mainly by line and otter trawling, but gill-netting also occurred on shoal grounds in less than 90 m of water.

Rocks South of Cape Ann

South of Cape Ann, at an average distance of 2.5 nm from Eastern Point Light was a number of small, rocky patches with depths of 15-45 m. Although Brown's Ledge, Spot of Rocks, Saturday Night Ledge and Burnham's Rocks are located outside of the Sanctuary's boundaries, these nearby fishing rocks and grounds were once highly productive. Approximately 6 nm southwest of Saturday Night Ledge is another ground, Old Tillie. West of Eastern Point is two more small fishing areas: Eleven Fathom Ground and Kettle Island Ledge. These latter grounds have a depth (not surprisingly) of 11 fathoms (20 m). These places were fished for cod in the winter and haddock in the summer. Gill-netters and Italian trawl boats frequented this area.

Brewer's Spot and Si's Spot

Approximately 10-11 nm southeast of Scituate lies a ridge that was a productive cod fishery in February. The northern end of this fishing ground, onto which cod schooled, is known as Si's Spot. The ridge was covered with mussels at a depth of 45-55 m. Si's Spot, at a depth of 55-65 m, is described as rocky and pebbly, and the bottom of Brewer's Spot was composed of stones, gravel, and pebbles in 35-45 m. To the east and west of this ridge is muddy bottom, which was dragged for flounder throughout the year.

Eagle Ridge

This ridge, also known as Little Middle Bank, was described as lying 7.6 nm southwest of Eastern Point Light. Goode and Rich map this feature differently: Goode described the ridge as 1 nm in length and 0.5 nm in width, while Rich maps it as 4.0 by 1.5 nm and oriented east to west. The average depth over the ridge is 45 m. The bottom is rocky and uneven. This ridge, as well as Old Man's Pasture and Browns Ledge were formerly regarded as the best winter cod-fishing grounds, but a decline in cod was noted for these grounds in the 1920s.

Western Point Ridge

This ridge is located 9.25 nm southeast from Eastern Point Light. It is a small ground, described as only 1.5 by 0.75 nm, and oriented northeast to southwest. Small vessels and boats fished here for summer cod and haddock. Gill nets were used to catch large fares of pollock, particularly in the months October-January. The ridge was believed to be a spawning ground for pollock, and the fish would leave abruptly for deeper water at the end of January.

Wildcat Ridge

The ridge is located east of Stellwagen Bank and approximately 18 nm northeast from Highland Light. The feature is oriented north to south, and approximately 7.5 nm in length and 3.5 nm in width. Composed of broken shell and sand, the depths across the ridge vary from 80 to 110 m. Depths extend 180-200 m to either side of the ridge. This was a productive cod and haddock fishery year round, but was fished primarily in the winter. A muddy area between the ridge and Stellwagen Bank, at a depth of 80-100 m, was fished extensively for flounder by draggers from Boston and Gloucester.

Massachusetts Bay

The larger part of this ground, especially inside Stellwagen Bank, has a mud bottom, on which large quantities of fish were rarely taken. However, between Boston Harbor and Plymouth to Sandwich are rocky ledges, which were preferred fishing grounds for cod in winter and fall. In late March, large schools of codfish were reported off Plymouth. Gill netting for codfish was conducted by Gloucester and Boston vessels in December, January and February. There was also a considerable hand-line fishery for pollock in the fall. Gill nets were known to take large fares of pollock on shore grounds around Gloucester, with fares for a single month occasionally reaching 4,000,000 pounds in the early 1900s. November and December were the best months for pollock. Pollock fishers operated mostly between Boston and Gloucester. This pollock fishery ended in January, when the fish moved offshore.

Fisheries

Over the long-term, abundance of fish in the Gulf of Maine had declined, and consequently, new grounds were fished and exploited, species targeted shifted, and techniques were developed to increase catchability. The inshore Massachusetts fishery appears to have peaked in 1832.¹⁰² Post-colonial reports of scarcity, however, near and in Boston Bay were reported at least by 1821.¹⁰³ This appears to have initiated a shift to offshore bank fishing, as well as development of newer technologies to increase catchability. Simultaneously, the fresh fish business began to dominate the market particularly after a large store was opened on Long Wharf in Boston in 1835. Demand was limited to local markets in the summer but in the cold of winter fresh fish was transported as far as Albany, New York and Montreal, Canada. The demand for fresh fish led to construction of live well smacks and the introduction of ice in 1848.¹⁰⁴ The fish came almost entirely from Massachusetts Bay, caught primarily by small fishing vessels. Before 1845 groundfish were caught solely by hook-and-line. While some near-shore grounds fished regularly from 1630 to 1840 continue to produce today, none is as productive as it was before the industrial revolution blocked streams and polluted rivers, destroying most of the anadromous prey in the food-fishes' larder, while dredges uprooted feeding bottoms along with invertebrate prey species, and the introduction of tub trawls, gill nets, and otter trawls sequentially decimated spawning-age cohorts of nearly every commercial species in the Massachusetts Bay.

In the last decade, the concept of "shifting baselines" has become an important measure for understanding long-term changes in marine environments and fish populations.¹⁰⁵ The following qualitative, single-species analyses address this concept as well as the notion of "Fishing Down Marine Food Webs."¹⁰⁶ Reference is made in particular to the temporal period for which precise, monthly statistical data has been extracted from the historical record (1893-1935) for Stellwagen and Gulf of Maine fisheries (FIG. 8). A detailed description of this data set is provided in **Appendix A**. Anecdotal, descriptive, or qualitative information, however, is provided alongside this statistical data before, during and following this era in order to document long-term changes in the fisheries. This contextual data offers an opportunity to identify temporal baselines for commercial exploitation or targeting of particular fish species (TAB. 2). Prior to these baselines, the fisheries were certainly not 'pristine,' as they were exploited for local consumption or were a product of by-catch for hundreds if not thousands of

¹⁰² Proctor Brothers, *The Fishermen's Own Book*, Gloucester: Proctor Brothers, Pub., 1882, p. 7.

¹⁰³ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 66.

¹⁰⁴ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 69-70.

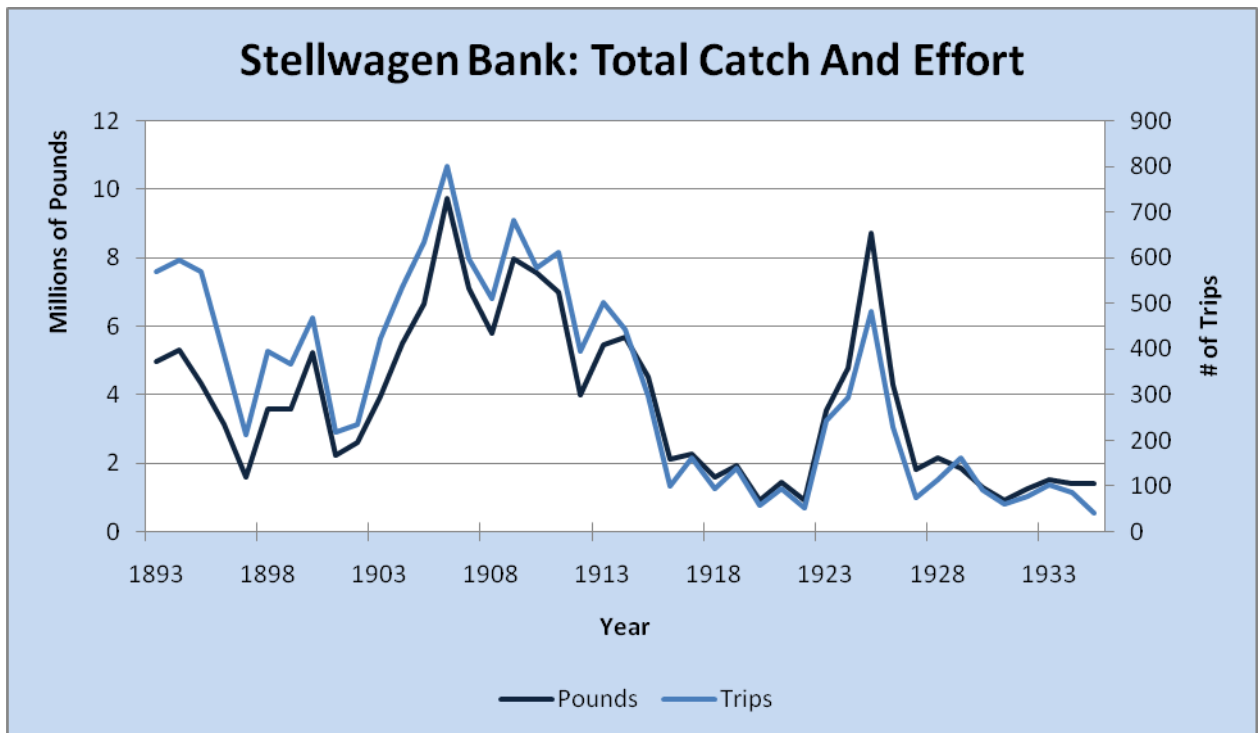
¹⁰⁵ Daniel Pauly, "Anecdotes and the Shifting Baseline Syndrome of Fisheries," *Trends in Ecology and Evolution* 10.10 (1995): 430.

¹⁰⁶ Daniel Pauly, et al., "Fishing Down Marine Food Webs," *Science* 279.5352 (1998): 860-863.

years, but as there were no major commercial markets for their exportation, we assume that they were not overfished. The temporal baselines for individual fisheries shown in Table 2 are provided only for Stellwagen Bank, and they are defined in large part by market and infrastructure developments in Boston and Gloucester. Other grounds such as Georges Bank, for example, which were not fished consistently until the 1830s, may differ considerably from these baselines.

Fishery	Date
Cod	1620
Mackerel	1810
Haddock	1820
Halibut	1820
Herring	1820
Swordfish	1850
Hake	1800
Cusk	1800
Pollock	1800
Flounder	1895
Wolffish ¹⁰⁷	1900

Table 2. Exploitation baseline dates for commercial fisheries on Stellwagen Bank.



¹⁰⁷ The wolffish, or "sea catfish", as it was referred to in 19th-century historical records, had little economic importance until the early 20th century. The fish was caught with some regularity by hook-and-line in the 19th century, but there was neither market nor demand until the early 1900s. The first landings recorded for this fish in the statistical bulletins of the U.S. Commission of Fish and Fisheries was 1905, but it does not appear consistently until 1913.

Figure 8. Total fish catch and trips of Gloucester, Boston and Portland fishing fleets on Stellwagen Bank, re-constructed from U.S. Commission of Fish and Fisheries catch records (1893-1935).

Cod

In the 19th and early 20th centuries the Boston fishing fleet caught codfish by line trawl with market boats primarily on rocky areas south of Cape Ann, Ipswich Bay and Stellwagen Bank. During the summer and fall, codfish was regularly caught on Stellwagen Bank, South Channel and the outside of Cape Cod.¹⁰⁸ Gloucester vessels typically caught cod on La Have, Browns and Georges Banks. Each year in early November, after herring left the coast, a fall school of spawning fish known as the “pasture school” would arrive south of Cape Ann.¹⁰⁹ This school is likely related to the naming of the ground 'Old Man's Pasture' located there. In 1877-1878, small vessels (with 3-12 dories and long lines of 800 hooks) and shore boats would fish this school, with average daily catches of 800-900 lbs. per man.¹¹⁰ The average size of fish was 12-14 pounds. The fishing season would last until January when many fishermen would shift their effort to Ipswich Bay. In the late spring and summer fishermen would again shift their effort to deeper offshore waters on Jeffrey's and Stellwagen Banks.

Spencer Baird, on the depletion and recovery of cod in New England (1871):

“. . . should [cod] be brought back to their original condition, we shall find, within a short time, an increase of wealth on our shores, the amount of which would be difficult to calculate. Not only would the general prosperity of the adjacent States be enhanced, but in the increased number of vessels built, in the larger number of men induced to devote themselves to maritime pursuits, and in the general stimulus to everything connected with the business of the seafaring profession, we should be recovering, in a great measure, from that loss which has been the source of so much lamentation to political economists and well-wishers of the country.”

In the second half of the 19th century, inshore fishermen occasionally caught very large codfish. For example, a 130-pound cod was caught off Eastern Point on July 22,

¹⁰⁸ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 194.

¹⁰⁹ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 204.

¹¹⁰ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 204.

1873.¹¹¹ Reports of large fish were exceptional for the time, however, as hook-caught cod averaged 12-14 lbs. south of Cape Ann and 20.75 lbs. in Ipswich Bay.¹¹² With the introduction of cod gill-nets in the winter of 1880-81, Ipswich Bay catches averaged well over 20 pounds, with numerous 75-80 pound animals caught.¹¹³ Cod-fishing on Stellwagen Bank peaked in 1906 with a total catch of 1,788,100 pounds (FIG. 9). The catch declined steadily until 1916, and between 1916 and 1935 the average annual catch hovered around a mere 200,000 lbs. This decline appears to mirror the effort expended, in terms of trips made to Stellwagen Bank. Simultaneously, an increase in effort and catch occurred on Jeffrey's Ledge. The decline in catch is explained in part by a shift in effort to this latter location as well as other offshore banks. Although travel cost and distance was greater to offshore grounds, steam and diesel-powered otter trawlers likely abandoned Stellwagen for more abundant and profitable grounds. This shift in effort suggests that cod stocks of Stellwagen were less productive, or comparably and relatively degraded by the early 1910s.

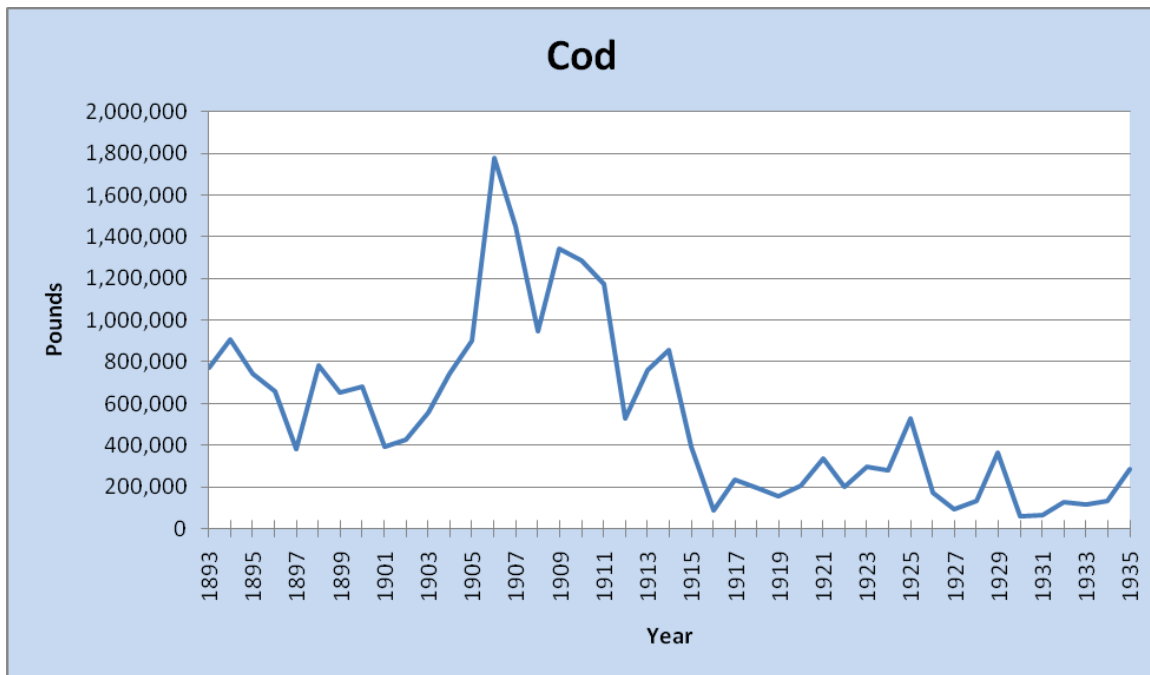


Figure 9. Annual cod catch on Stellwagen Bank 1893-1935.

¹¹¹ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 126.

¹¹² George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 204.

¹¹³ J. W. Collins, "Gill-nets in the Cod Fishery; A Description of the Norwegian Cod-nets, with Directions for their Use, and a History of their Introduction into the United States," *Bulletin of the United States Fish Commission. Vol. I, for 1881*, Washington: USGPO, 1882, p. 15; J. W. Collins, "Success of the Gill-net Cod-fishery on the New England Coast, Winter of 1882-'83," *Bulletin of the United States Fish Commission, Vol. III, for 1883*, Washington: USGPO, 1883, p. 441-443.

Halibut

The earliest known report of halibut caught on Stellwagen Bank was in September 1819, when the schooner *Madison* at anchor cod-fishing, caught 140 halibut, which sold for \$1 each.¹¹⁴ By 1846, the Gloucester halibut fleet had grown to 29 vessels.¹¹⁵ In the early 1870s, halibut abundance inshore was greatly diminished, but its high market value led fishermen to pursue offshore grounds:

“The diminution of inshore fishing is particularly noticeable in the case of the halibut. This fish was formerly taken with great ease in small boats all along the New England coast, and at first was considered of very little value, fish weighting a hundred pounds and over being caught and thrown back into the water as refuse, and classed in the same category with sharks, skates, and rays. Within a comparatively few years, however, the halibut has appreciated in value, and is now one of the principal objects of pursuit by the New England fishermen. The yield of this fish to Gloucester alone in 1879 amounted to over eleven millions of pounds.”¹¹⁶

After 1880, halibut were caught almost entirely offshore in waters of up to 300 fathoms:

“In later years it has been necessary to follow the halibut into deeper and deeper waters, so that while twenty years ago it might taken in water of 10 to 50 fathoms, it is now seldom caught in less than 100 fathoms, and deeper waters are gradually traversed up to 300 fathoms. The increasing depth renders it constantly more difficult for the fishermen to prosecute their labors, and makes it more important that new localities be discovered.”¹¹⁷

This did not preclude, however, large halibut being caught occasionally inshore and within the sanctuary waters (TAB. 3). Schooling halibut rarely occurred in the 20th century, but in April 1926 several small craft were able to catch 2-3,000 pounds per day on the northern slope of Stellwagen Bank (FIG. 10).¹¹⁸

¹¹⁴ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 68.

¹¹⁵ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 69-70.

¹¹⁶ U.S. Fish Commission of Fish and Fisheries, *Report of the Commissioner for 1881*, Washington: GPO, 1884, p. xxvii-xxviii.

¹¹⁷ U.S. Fish Commission of Fish and Fisheries, *Report of the Commissioner for 1881*, Washington: GPO, 1884, p. xxviii.

¹¹⁸ Walter H. Rich, *Fishing Grounds of the Gulf of Maine*, Washington: GPO, 1929.

Year	Location	Description
1873	6 miles ESE of Thatcher's Island	347 lbs. ¹¹⁹
1877	Off Eastern Point	320 lbs. ¹²⁰
June 13, 1873	Old Man's Pasture	377 lbs. (2 halibut) ¹²¹

Table 3. Reports of large halibut caught in SBNMS.

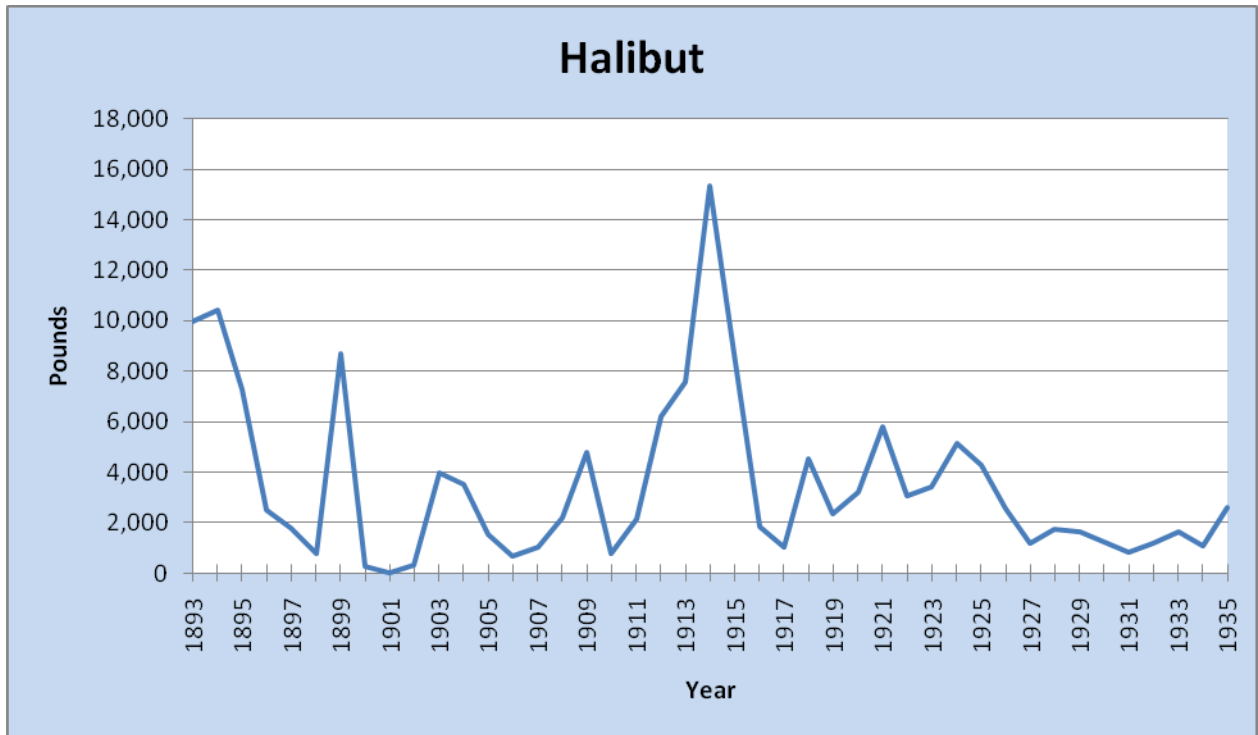


Figure 10. Annual halibut catch on Stellwagen Bank 1893-1935.

¹¹⁹ Proctor Brothers, *The Fishermen's Own Book*, Gloucester: Proctor Brothers, Pub., 1882, p. 51.

¹²⁰ Proctor Brothers, *The Fishermen's Own Book*, Gloucester: Proctor Brothers, Pub., 1882, p. 51.

¹²¹ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 126.

Haddock

Stephen Martin of Gloucester began haddock fishing in the 1830s.¹²² As a boy he had watched Amos Story and Jefferson Rowe fish for haddock from a small dory with hand lines two times most every day of spring: once at 8AM and then again at 4PM. In the 1830s and 40s they fished within the harbor; a ledge between Ten Pound Island and Niles Wharf was one of their favorite spots. Each trip they returned with a full dory of haddock. By the time Stephen Martin had earned his title of Captain in the early 1850s, haddock had all but disappeared from Gloucester Harbor. The fish were now caught 3-4 miles from shore. The tradition of hand-lining for haddock was largely abandoned and superceded by line trawling in the 1860s. The 66-ton schooner *Romp*, considered at that time a large vessel for the shore fishery, fished with four dories, each trawling 500 hooks. *Romp* frequented 'Inner Bank', and regularly landed 40,000 pounds per trip. By the late 1860s all 'shore' spring haddock were caught 20-25 miles offshore; Jeffreys Ledge, Tillies Bank, and Stellwagen Bank were usual fares for Captain Martin and other Cape Ann shore fishermen. In the 1880s, Cape Ann fishermen began to weather the harsh winter seas to catch haddock on banks such as Georges, Browns, and La Have. To contend with longer voyages of greater risk as well as to maximize profitability, average vessel tonnage for haddock fishing nearly doubled in the 1880s with each vessel carrying 6-8 dories with 1000-1500 hooks per dory. With each increase in vessel tonnage, dories and quantity of hooks, record landings were commonplace.¹²³ The distance from homeport and fishing depths to achieve these record-breaking catches, however, also increased.

Up until the last few decades of the 20th century, haddock was the most abundant fishery on Stellwagen Bank (FIG. 11). Beginning at least by 1812, haddock trips were made regularly by a fleet of 'pinky' fishing vessels from Gloucester to Old Man's Pasture, Hart's Ground and Inner Bank, approximately 12 miles off Eastern Point.¹²⁴ The best haddock fishery, however, was reportedly on Stellwagen Bank:

"The principal haddock fisheries are, however, located north of Cape Cod . . . On the outside of Cape Cod the fishing is within 5 to 15 miles of the shore; in Massachusetts Bay, principally on the outer slope of Middle Bank and the southern slope of the shoal ground that lies to the eastward of Cape Ann, usually called 'the Southeast,'"¹²⁵

¹²² George H. Proctor, *Fishermen's Own Book*, Gloucester: Proctor Bros., 1882, p. 213-214. The following paragraph is an interpretation of Captain Stephen J. Martin's first-hand account of the Gloucester haddock fishery.

¹²³ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 85-86.

¹²⁴ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 73.

¹²⁵ U.S. Commission of Fish and Fisheries, *Bulletin of the United States Fish Commission for 1881*, Washington: USGPO, 1882, p. 226.

Haddock remained relatively resilient to fishing pressures through the 19th century, and very large catches were occasionally reported in the early 1880s:

“Haddock are more plentiful this year in the month of April than they have been for eight years. On a fine day the dories get from three to four hundred pounds half a mile from the Point. There were three Lynn boats here yesterday; they had 20,000 pounds of haddock to a boat, caught on Middle bank in two days’ fishing. That has not been done during the past five years.”¹²⁶

“Haddock remain plenty in-shore. The vessels carrying their fish fresh to market do not go farther than Middle bank. They get 10,000, 12,000 and 15,000 a day. The dories, with one man, go one mile from the mouth of the harbor and bring home from 400 to 600 pounds at 2 p. m. This has not been done for the last ten years. In the month of May there is a small school of haddock that comes in-shore and stays about a week. This has been the case for the last four years.”¹²⁷

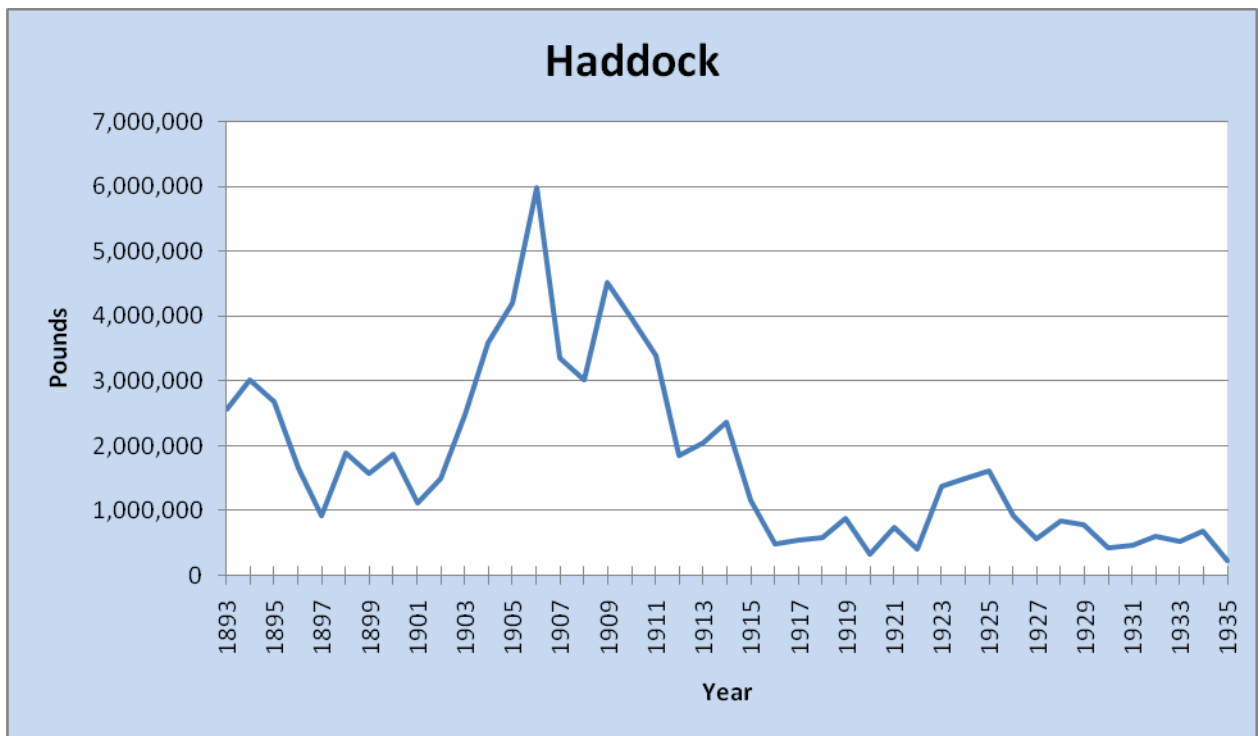


Figure 11. Annual haddock catch on Stellwagen Bank 1893-1935.

¹²⁶ U.S. Fish Commission, *Bulletin of the United States Fish Commission for 1881*, Washington: GPO, 1882, p. 426.

¹²⁷ U.S. Fish Commission, *Bulletin of the United States Fish Commission for 1881*, Washington: GPO, 1882, p. 427.

Mackerel

One of the most important commercial fisheries on Stellwagen Bank and in the Gulf of Maine in the 19th century was mackerel. A migratory species, mackerel catch varied greatly from year to year. At its greatest historical abundance in 1884, 243,000,000 pounds of mackerel were landed by U.S. and Canadian fishermen, and at its worst, in 1910, 12,600,000 pounds were landed.¹²⁸ This variability was a risky, boom-or-bust undertaking for fishermen. The U.S. Commission of Fish and Fisheries was established in 1871 in part to document the causes for this variability, distribution and migratory routes of the species.¹²⁹ A comprehensive study on Atlantic mackerel was finally issued in two parts by Oscar Sette and the U.S. Fish and Wildlife Service in 1943 and 1950.¹³⁰

Mackerel fishing was underway in Massachusetts Bay by the mid-1600s, with concerns of their depletion noted and season of capture regulated by the Plymouth Colony as early as 1670. Cape Ann vessels fished for mackerel on Stellwagen Bank at least by 1800, initially on Inner Bank, and transported their fresh catch to the Boston market.¹³¹ Mackerel catch and landing statistics for Boston and the New England fleet are known beginning in 1804, but a wholesale operation and market was not opened on Long Wharf until 1807.¹³² In 1851, the Massachusetts mackerel fleet numbered 853 vessels, a quarter belonging to Gloucester.¹³³ In 1853 the largest hook-and-line, or jigging catch on record; 329,000 barrels (ca. 67,000,000 lbs.) was recorded. In 1870, Provincetown had 41 vessels in mackerel fishing deployed entirely on the Massachusetts shore and in Cape Cod Bay. By 1876, the fleet declined by one quarter and the catch per barrel was nearly half of previous years, pushing vessels for the first time into the Gulf of Saint of St.

¹²⁸ Oscar E. Sette, "Biology of the Atlantic Mackerel (*Scomber scombrus*) of North America, Part I – Early Life History, Including the Growth, Drift, and Mortality of the Egg and Larval Population" *Fishery Bulletin of the Fish and Wildlife Service*, Vol. 50, Fishery Bulletin 38, Washington: GPO, 1943, p. 150.

¹²⁹ Spencer F. Baird, *Part I: Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, U.S. Commission of Fish and Fisheries, Washington: GPO, 1873, p. xviii-xiv.

¹³⁰ Oscar E. Sette, "Biology of the Atlantic Mackerel (*Scomber scombrus*) of North America, Part I – Early Life History, Including the Growth, Drift, and Mortality of the Egg and Larval Population" *Fishery Bulletin of the Fish and Wildlife Service*, Vol. 50, Fishery Bulletin 38, Washington: GPO, 1943; "Part II – Migrations and Habits," *Fishery Bulletin of the Fish and Wildlife Service*, Vol. 51, Fishery Bulletin 49, Washington: GPO, 1950.

¹³¹ George H. Proctor, *The Fishermen's Memorial and Record Book: Containing a List of Vessels and Their Crews Lost from the Port of Gloucester from the Year 1830 to October 1, 1873*, Gloucester: Procter Brothers, 1873, p. 60. George B. Goode, et al., "IV - Materials for a History of the Mackerel Fishery," *Report of the Commissioner for 1881*, U.S. Commission of Fish and Fisheries, Washington: GPO, 1884, p. 309 [219].

¹³² W. A. Wilcox, *Seventh Annual Report of the Boston Fish Bureau*, Boston: Ellis, Robinson Co., 1882, p. 4.

¹³³ George B. Goode, et al., "IV -Materials for a History of the Mackerel Fishery," *Report of the Commissioner for 1881*, U.S. Commission of Fish and Fisheries, Washington: GPO, 1884, p. 340 [250].

Lawrence.¹³⁴ In 1880, however, mackerel proved more abundant than in any previous decades:

“The vast strike-in of mackerel all long our coast is really phenomenal. Nobody remembers anything like it. Thousands were caught yesterday and the day before, even without bait, as if mackerel were as simple as "Hancock Union soldiers" who snap at a bare rebel hook. Every boat, from the craziest old dory to the fashionable yacht, is pressed into service, and there are as many "kits" going to Boston and Lynn, and Salem and Gloucester, as the unwary boy supposes are on their way to St. Ives, when the famous problem of Pike's old arithmetic is propounded. From any look-out the schools can be seen on the surface of the water, hunting around for somebody to catch them, like bumper politicians seeking for bids. The theory that the mackerel had been depopulated in our waters is annihilated. There are still as good fish in the sea as ever were caught, and apparently more of them.”¹³⁵

Although large catches were reported for the next five years, mackerel abundance quickly dropped and continued to wax and wane, seemingly invariably, through the early 20th century (FIG. 12). The catch was particularly low in the 1910s, with but one period of resurgence in the mid-1920s. Mackerel migrated past Cape Ann during their southern migration in October and November. After leaving the coast of Maine during their autumnal migrations, they passed back through Cape Ann and entered Massachusetts Bay, where they were taken by purse seines, gill and pound nets. There were hundreds of pounds nets in Cape Cod Bay in the early 1900s, which caught a large share of inshore mackerel and herring schools.

¹³⁴ George B. Goode, et al., "IV -Materials for a History of the Mackerel Fishery," *Report of the Commissioner for 1881*, U.S. Commission of Fish and Fisheries, Washington: GPO, 1884, p. 340 [331].

¹³⁵ George B. Goode, et al., "IV - Materials for a History of the Mackerel Fishery," *Report of the Commissioner for 1881*, U.S. Commission of Fish and Fisheries, Washington: GPO, 1884, p. 440 [350].

Mackerel migration across Stellwagen Bank, September 22, 1833:

“I recollect well the great school of mackerel that struck Middle Bank that year. Sept. 22nd at ten o’clock at night, there were some two hundred sail at anchor, twenty-five miles southeast of Eastern Point light, in a dead calm, when our skipper sang out, “Here they are, boys!” At the same moment every vessel in the fleet commenced the catch. We fished for three days and filled everything, even our boat, and struck on deck until we were in fish knee-deep. Then, a breeze springing up, we ran in and packed out two hundred and eighty barrels, and returned to the Bank just as the wind left us. We fished three days more, when they struck off as suddenly as they had come.”

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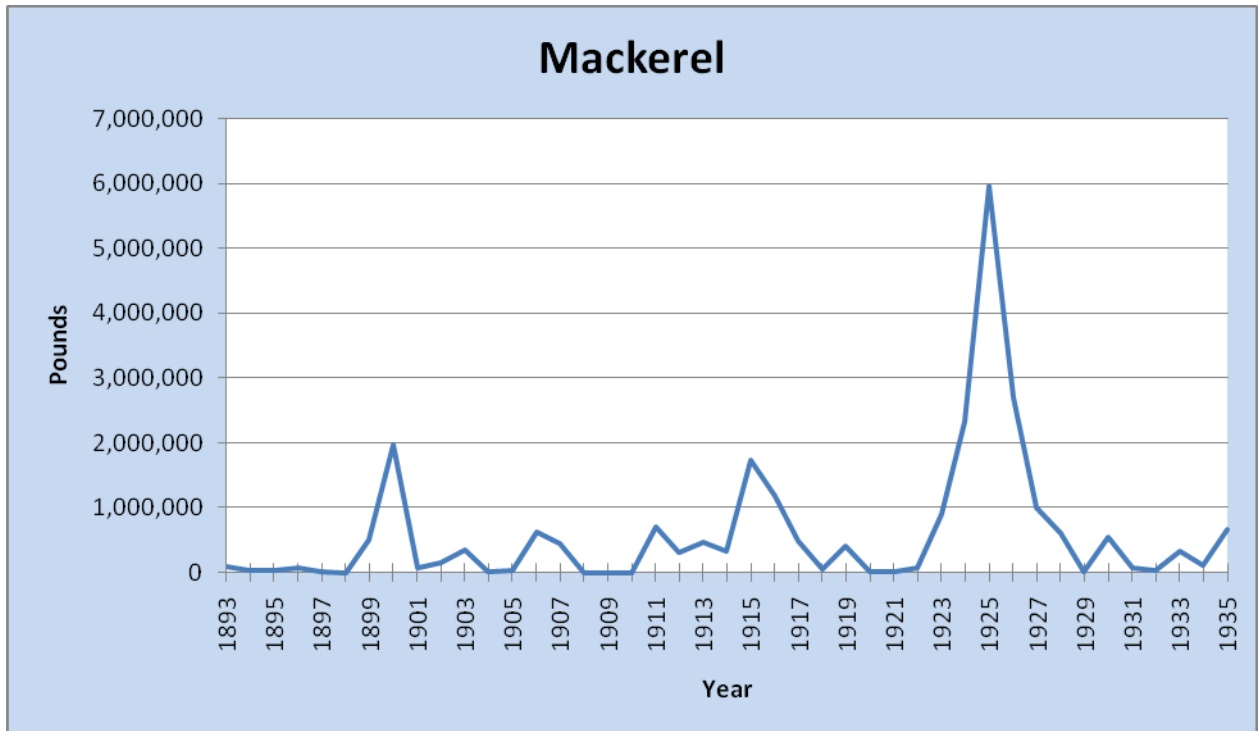


Figure 12. Annual mackerel catch on Stellwagen Bank 1893-1935.

Hake and Cusk

The gadoids cusk (*Brosmius brosme*) and hake (*Phycis chuss* and *Phycis tenuis*) had commercial value beginning ca. 1800. Other Gulf of Maine species known invariably as 'hake,' such as *Phycis chesteri* and *Merluccius bilinearis* (i.e., silver hake or whiting), generally found at depth along the continental margin and slope, were barely marketable

¹³⁶ Ibid., p. 316 [226].

in the 19th century and fetched very low prices. However, they were reportedly caught along the eastern coast of Cape Cod in the mid-19th century at various depths while hook-and-line or net fishing for mackerel. Silver hake were caught and discarded in such significant numbers that "the board of health is sometimes called upon to interfere and to compel the fishermen to bury them from the fear of sickness being produced by their decomposition."¹³⁷ Statistical records of the U.S. Fish Commission generally distinguish the catch of silver hake from the more marketable *Phycis chuss* and *tenuis* species (FIG. 13 & 14).

Large quantities of cusk, occasionally referred to in historical texts as 'tusk,' were frequently caught on Stellwagen Bank in first half of the century:

"at a rocky spot near the eastern portion of Middle Bank, between Cape Cod and Cape Ann, large numbers had been taken prior to 1866, and in that year 400 quintals, or probably 60,000 pounds of Cusk, had that year been taken by one Provincetown firm."¹³⁸

Despite these significant catches, the prices and demand for cusk was especially low in comparison to that of haddock and mackerel. Hake were also remarkable to Massachusetts fishermen because their abundance appeared to be localized, and cusk could be extirpated by fishing within a year or two of their discovery.¹³⁹

Hake fishing was prosecuted primarily between June and November. The coast of Maine was particularly renowned for its abundant, muddy-bottom hake grounds, but hake was also an important fishery in the Stellwagen Bank sanctuary in the 19th and early 20th centuries. Fishing was conducted mostly at night and by tub trawls or long-lining. In the earlier period, the size of fish caught were generally less than 20 pounds, but 30-40 pound specimens were occasionally caught.¹⁴⁰ Hake was split and sold fresh and dried, but the sounds and livers of hake were particularly prized for use in the manufacture of isinglass and oil.

¹³⁷ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Animals*, Washington: USGPO, 1884, p. 241.

¹³⁸ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Animals*, Washington: USGPO, 1884, p. 233.

¹³⁹ ¹³⁹ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Vol. 1, Washington: USGPO, 1884, p. 233, 235.

¹⁴⁰ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Vol. 1, Washington: USGPO, 1884, p. 242.

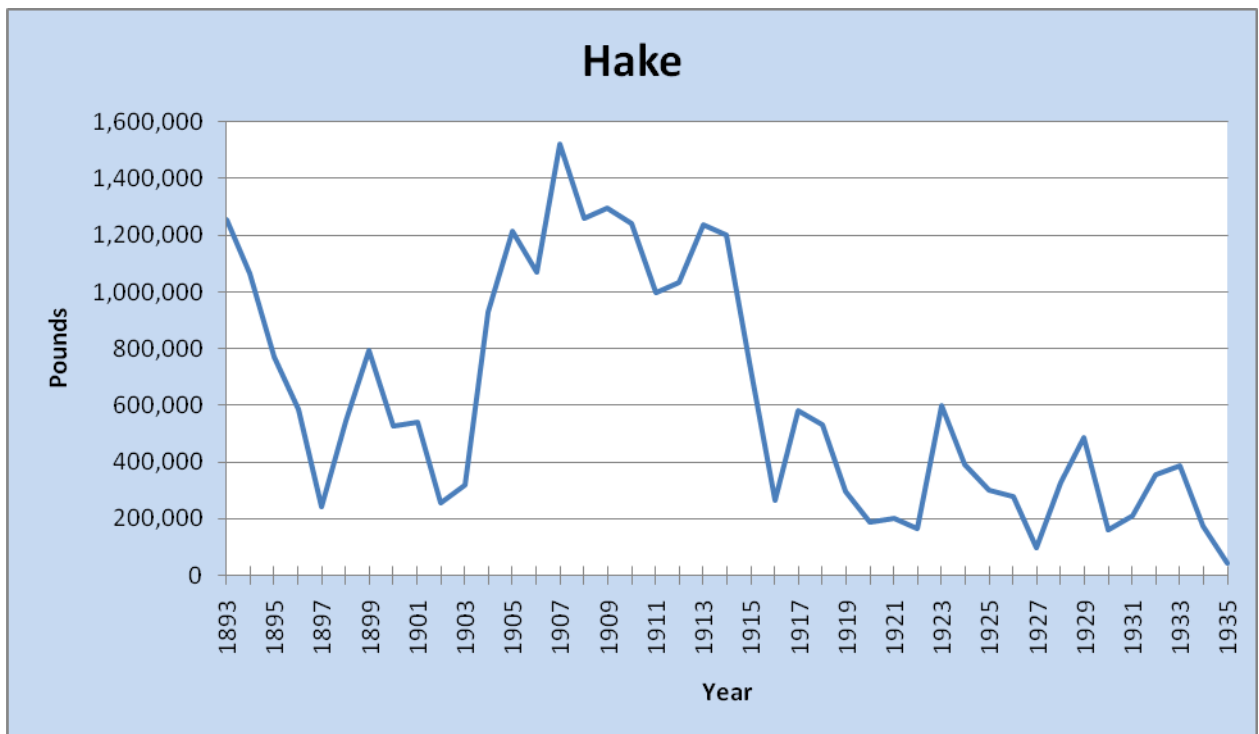


Figure 13. Annual hake catch on Stellwagen Bank 1893-1935.

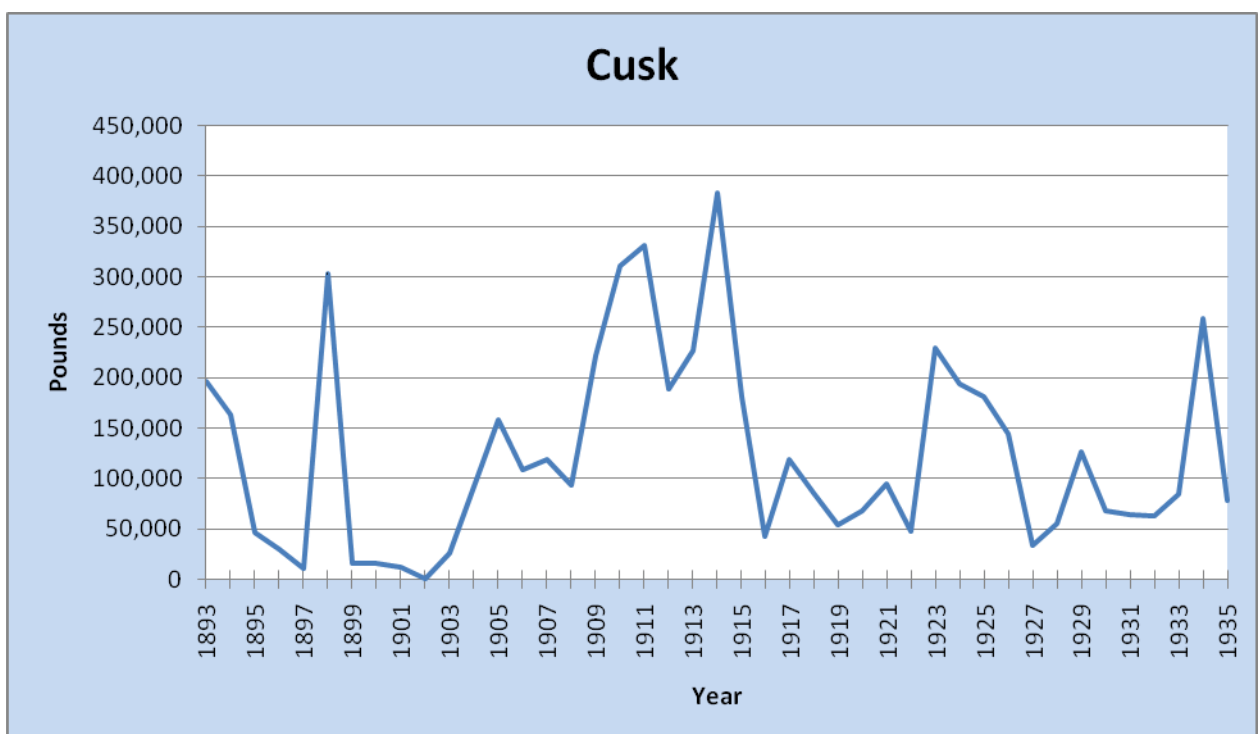


Figure 14. Annual cusk catch on Stellwagen Bank 1893-1935.

Pollock

Pollock was and is today frequently caught within Massachusetts Bay and on Stellwagen Bank (FIG. 15). Historically, schools would round Race Point and enter the bay as early as May, but spawning (and subsequently fishing) for pollock occurred primarily in October and November.¹⁴¹ The fish were known to spawn around the rocky grounds of Cape Ann at this time of year, which was also the prime time for fishing this species. A dramatic shift in pollock abundance on Stellwagen Bank was remarked upon as early as the 1810s by a fishing captain from Gloucester, Captain E. W. Merchant:

"Pollock were very abundant in Massachusetts Bay early in this century – before the war of 1812. They were especially abundant on Middle Bank. They were at that time chiefly caught with bait of herring, taken in seines from the beaches. The fishing boats were of about thirty tons, and carried three men and a boy. Fishing was carried on chiefly at night, when the vessels would all "fleet up," and the bait on their hooks would toll the schools of fish together. The vessels would take about fifty quintals in a night. There were about thirty fish to the quintal. This abundance of Pollock lasted until about 1820. These Pollock were salted, and consumed at home or carried to Maine. They sold for about two dollars a quintal. The oil of their livers was tried out in kettles on the shore. Their roe was exported largely in those days. It was sold by the bushel, at the rate of about sixty cents."¹⁴²

Early in the century the primary means of capture was by surface trolling bait with hook-and-line. By the mid-1800s, long-liners were "seizing-up" their lines a few fathoms from the seafloor to catch the fish.¹⁴³ Beginning in the 1870s, however, the purse seine became the primary method for capturing schooling pollock.¹⁴⁴ The average size of pollock in this latter period was 10-12 lbs., "but individuals of twenty, and even of thirty pounds, [were] by no means uncommon."¹⁴⁵

¹⁴¹ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 230.

¹⁴² George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 229.

¹⁴³ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 230.

¹⁴⁴ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 232.

¹⁴⁵ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*, Washington: USGPO, 1884, p. 231.

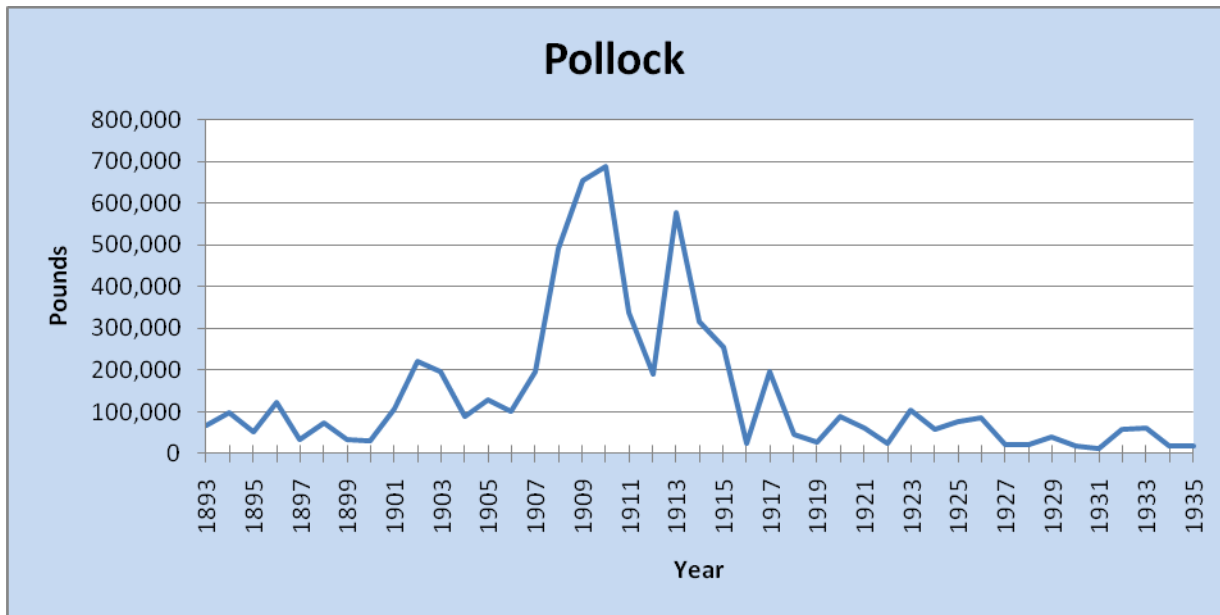


Figure 15. Annual pollock catch on Stellwagen Bank 1893-1935.

'Other' and 'Miscellaneous' Fisheries

The U.S. Fish Commission statistical bulletins, from which landing trends are derived in this report, also list a variety of species and products that were landed and grouped statically into an 'Other' or 'Miscellaneous' fish category (FIG. 16). The data summarized in this category refers to statistics that are footnoted on the bulletins and lists the additional species and products landed for each individual fishing ground or bank. After 1913, however, the footnotes summarize 'other' fish landed for the entire Northwest Atlantic region and do not compile statistics for individual banks or grounds. From 1903 to 1913, species that were included in this category for Stellwagen Bank were primarily swordfish and herring, but other fishery products listed occasionally included shad, menhaden, redfish (rosefish), shark, butterfish, flounder, catfish or wolfish, skate, livers, sounds, and spawn. Because continuous, long-term trends cannot be derived from the bulletins for most of these fisheries, the historical contexts presented in this section are limited to a regional perspective for flounder, swordfish and herring.

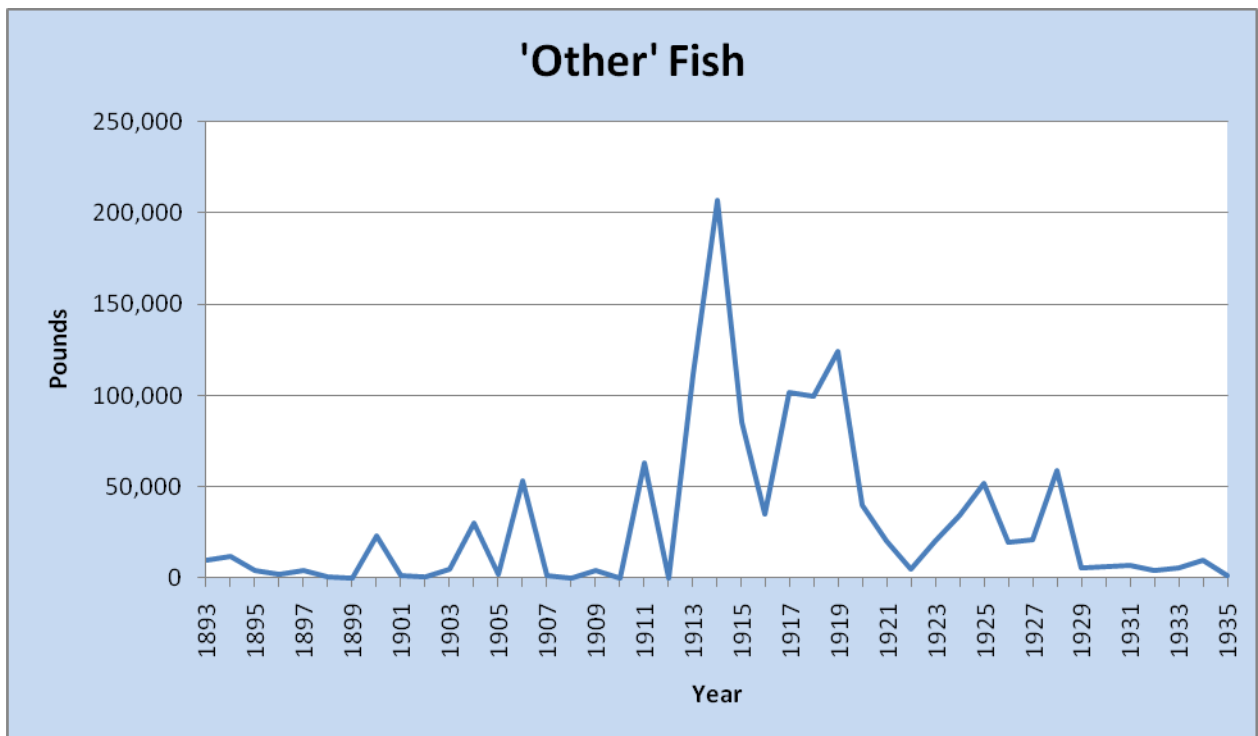


Figure 16. Catch of 'Other' fish category in Statistical Bulletins of the U.S. Commission of Fish and Fisheries (1893-1935).

Flounder

The common flounder, referred to historically as 'plaice' by Provincetown fishermen, was somewhat unsuccessfully marketed as 'turbot' in the 1880s.¹⁴⁶ The flounder population, once abundant in Cape Cod Bay, diminished significantly from 1855 to 1885, but remained prolific elsewhere and on offshore sandy and muddy bottoms.¹⁴⁷ The primary method of catching these fish in the bay at that time was by shore weir, but in 1879, 7-8 boats from Provincetown engaged in the fishery with hook-and-line around Race Point, and mostly in the month of June.¹⁴⁸

As inshore populations plummeted, Provincetown fishermen began to exploit flounder offshore within sanctuary waters on a large scale, particularly in the 1890s following the introduction of the beam trawl. Significant catches of flounder were made by dragging and bottom trawling the muddy bottoms between Stellwagen and Si's and Brewer's Spots (FIG. 4 & 17).

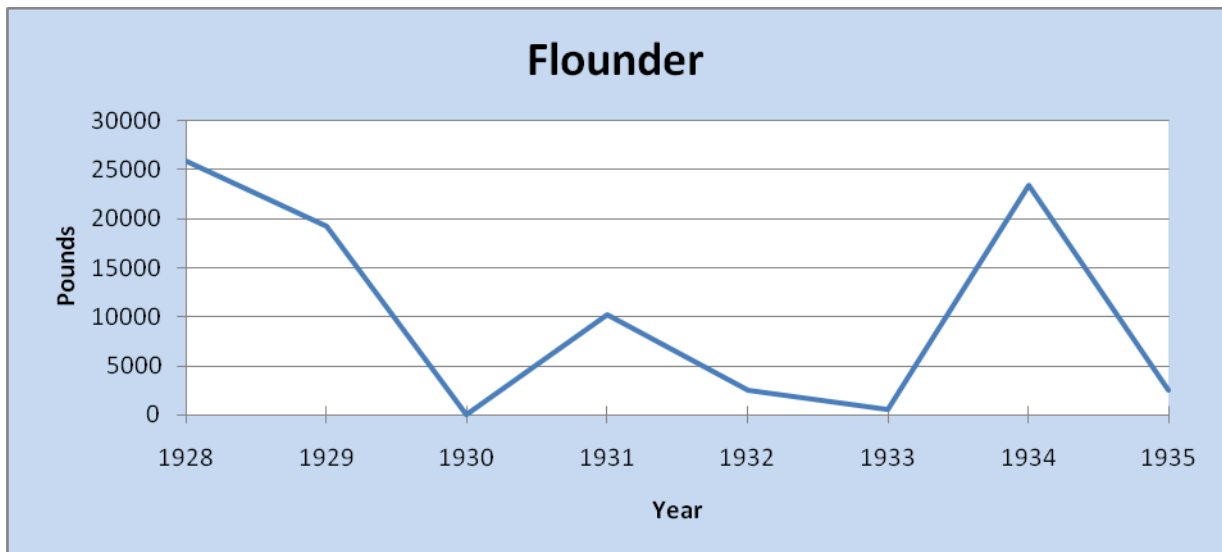


Figure 17. Flounder catch on Stellwagen Bank 1928-1935.

¹⁴⁶ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 175.

¹⁴⁷ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 178.

¹⁴⁸ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 181.

Swordfish

Swordfish inhabited inshore water in the Gulf of Maine for at least 5,000 years, but it took only 50 years of steady fishing pressure for them to be nearly extirpated from these waters.¹⁴⁹ In the early years of the fishery, in the 1840s, swordfish were pursued primarily south of Cape Cod between Block Island and Nantucket. A market in Boston and steady demand for swordfish, however, was not prominent until the 1860s.¹⁵⁰ In the latter half of the 19th century, the best grounds for swordfish were between Cape Ann and Casco Bay, and into the Bay of Fundy. In August, the peak season for swordfishing, the most productive grounds were Inner Jeffreys, 12-15 nm offshore Boone Island, and 3-4 nm from Wood Island and the mouth of the Saco River.¹⁵¹ According to Goode, in the 1870s and 80s there was no evidence of change in their abundance.¹⁵² In 1879, 863,154 pounds of swordfish captured by harpoons were marketed in Boston.¹⁵³ Very large fish were often caught within and near to sanctuary waters including one caught in 1893 that reportedly had a 'dressed' (i.e., gutted, head and tail removed) weight of 850 pounds.¹⁵⁴ The fresh weight must have exceeded 1,000 pounds.

Gloucester and Portland had substantial swordfishing fleets by the 1870s (FIG. 18). In 1900, the Block Island swordfishery was in decline and pursuit of swordfish moved offshore.¹⁵⁵ Georges and Browns Bank became the predominant fishing grounds. The primary method of hunting was by harpoon or 'lily iron' and prosecuted by schooners modified with a stand at the bow for a 'striker' or harpooner. Dories were also deployed from schooners to harpoon and lance these fish, which is surprising considering their reputation for thrashing and piercing both ship hulls and fishermen with their sharp bills. In the early years of the fishery, a single sail would typically take 100 fish over an entire season, but when motorized and diesel-powered craft were introduced in the 20th century, 200-300 could be caught in a single trip.¹⁵⁶ Portland had assembled a significant fleet for the fishery. In 1884, a total of 7,000 swordfish weighing 2,000,000 pounds was

¹⁴⁹ Arthur E. Spiess and Robert A. Lewis, *The Turner Farm Fauna: 5000 Years of Hunting and Fishing in Penobscot Bay, Maine*, Augusta: Maine Historic Preservation Commission, Maine Archaeological Society, 2001.

¹⁵⁰ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 92-94.

¹⁵¹ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 59.

¹⁵² George B. Goode, "Materials for a History of the Swordfishes," *Report of the Commissioner for 1880*, U.S. Commission of Fish and Fisheries, Part VIII, Washington: GPO, 1883, p. 328.

¹⁵³ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 194.

¹⁵⁴ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 32.

¹⁵⁵ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 94.

¹⁵⁶ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 73.

landed in New England.¹⁵⁷ Portland accounted for more than half of this total catch. In 1929, a record 31,044 fish weighing 4.5 million pounds was landed in New England.¹⁵⁸ Georges Bank accounted for 91% of this catch, indicating that inshore swordfish populations were significantly diminished by this time (FIG. 18). In addition, the average weight of inshore fish caught in the 1920s declined to nearly half of that in the 1880s from an average of nearly 300 to 150 pounds.

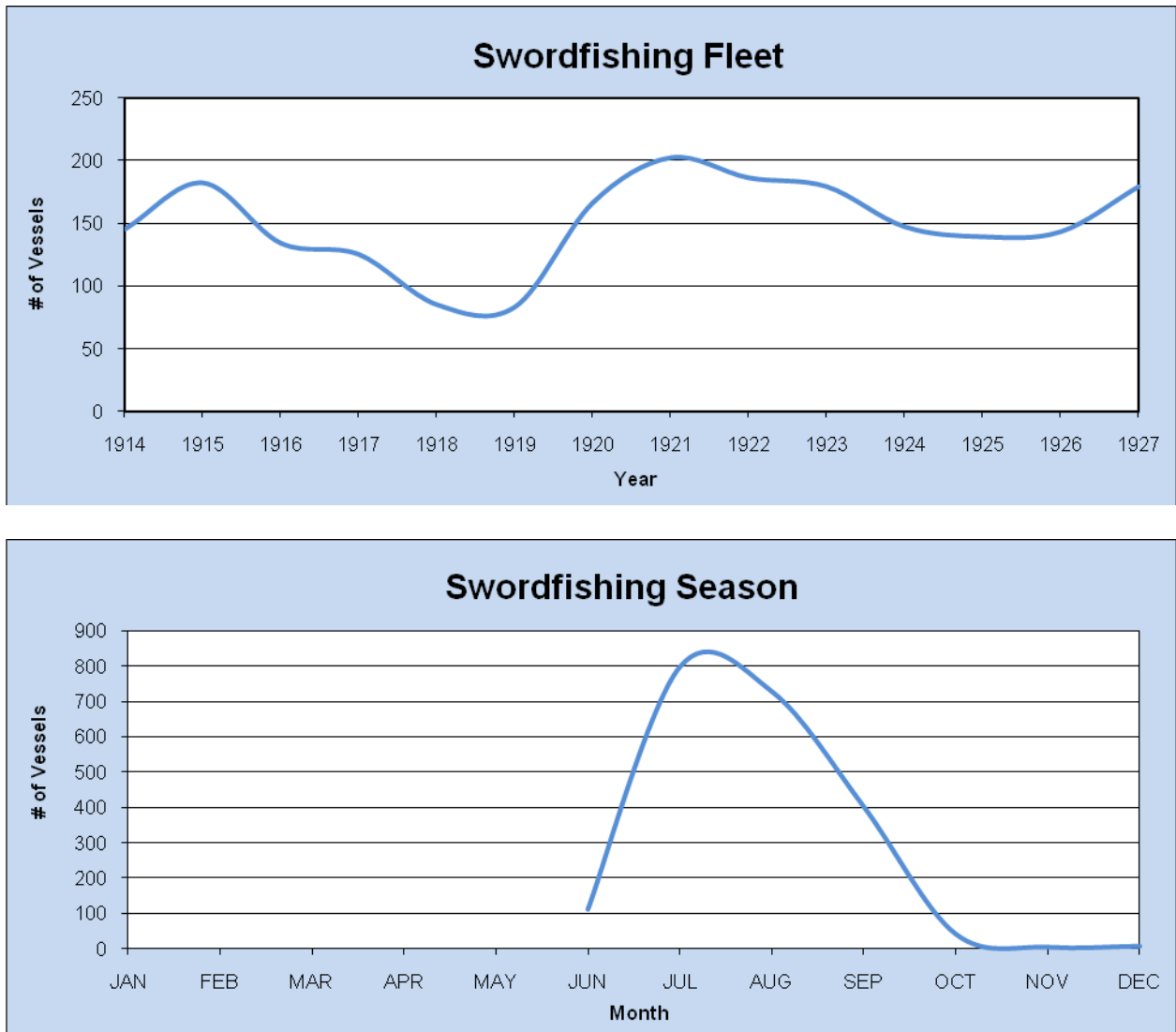


Figure 18. Swordfishing fleet and season in Gulf of Maine 1914-1927.¹⁵⁹

¹⁵⁷ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 96.

¹⁵⁸ Walter H. Rich, "The Swordfish and the Swordfishery of New England," *Proceedings of the Portland Society of Natural History*, Portland: Portland Society of Natural History, 1947, p. 86-87.

¹⁵⁹ Data extracted from "Statistical Bulletins of the U.S. Commission of Fish and Fisheries 1893-1935." See App. C.

Herring

In the Gulf of Maine, Atlantic herring was caught with fixed-gear (e.g., weirs) on inshore grounds "practically continuous" from the Bay of Fundy to Cape Cod.¹⁶⁰ Although Native Americans had fished with weirs in Massachusetts Bay for millennia,¹⁶¹ herring fishing by Euro-Americans using large brush weirs did not begin until ca. 1820.¹⁶² Spurred by a heightened demand for products such as canned 'sardines' (i.e., small herrings), smoked and salted herring, and the need for baitfish for the hand- and trawl-line fisheries, weir fishing was widespread by 1828 and continued to expand through the 19th century.¹⁶³ Eastern Maine, particularly the Passamaquoddy Bay and Grand Manan regions became focal areas for these industries by the mid-1800s. Cape Ann fishermen usually acquired frozen herring bait from Downeast Maine, New Brunswick and Newfoundland,¹⁶⁴ but the traditional Native American method of torching and dip-netting for herring was also conducted around Cape Ann and in Ipswich Bay to supply shore fishermen with bait.¹⁶⁵

The shallow waters of Cape Cod Bay at this time were also littered with pound nets, traps, and weirs (FIG. 19). The Cape Cod traps and weirs focused on supplying the trawl fisheries with a steady stream of baitfish that included herring, alewives and squid. In 1871, some 15 weirs were located in Cape Cod Bay between Barnstable and Wellfleet.¹⁶⁶ By 1880, there were at least 68 weirs or pounds that extended from Gloucester all the way to Truro,¹⁶⁷ and the total Massachusetts herring catch in 1879 was nearly 7.8 million pounds.¹⁶⁸

¹⁶⁰ H. F. Moore, "Observations Upon the Herring and Herring Fisheries of the Northeast Coast, With Special Reference to the Vicinity of Passamaquoddy Bay," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*, Washington: USGPO, 1897, p. 389.

¹⁶¹ Lawrence Kaplan, et al., "The Boylston Street Fishweir: Revisited," *Economic Botany* 44.4 (1990): 516-528.

¹⁶² Ansley Hall, "The Herring Industry of the Passamaquoddy Region, Maine," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*, Washington: USGPO, 1897, p. 445.

¹⁶³ Ansley Hall, "The Herring Industry of the Passamaquoddy Region, Maine," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*, Washington: USGPO, 1897, p. 445-446; H. F. Moore, "Observations Upon the Herring and Herring Fisheries of the Northeast Coast, With Special Reference to the Vicinity of Passamaquoddy Bay," *Part XXII, Report of the Commissioner for the Ending June 30, 1896*, Washington: USGPO, 1897, p. 392-394.

¹⁶⁴ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section II: A Geographical Review of the Fisheries Industries and Fishing Communities for the Year 1880*. Washington: USGPO, 1887, p. 161-162.

¹⁶⁵ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*. Washington: USGPO, 1884, p. 566; R. Edward Earll, "Part VI. The Herring Fishery and the Sardine Industry," *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Washington: USGPO, 1887, p. 499.

¹⁶⁶ Spencer F. Baird, *Part I, Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington: USGPO, 1873, p. xxvi.

¹⁶⁷ Frederick W. True, "The Pound-net Fisheries of the Atlantic States," *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Washington: USGPO, 1887, p. 604.

¹⁶⁸ R. Edward Earll, "Part VI. The Herring Fishery and the Sardine Industry," *The Fisheries Industries of the United States, Section V: History and Methods of the Fisheries*, Washington: USGPO, 1887, p. 432.

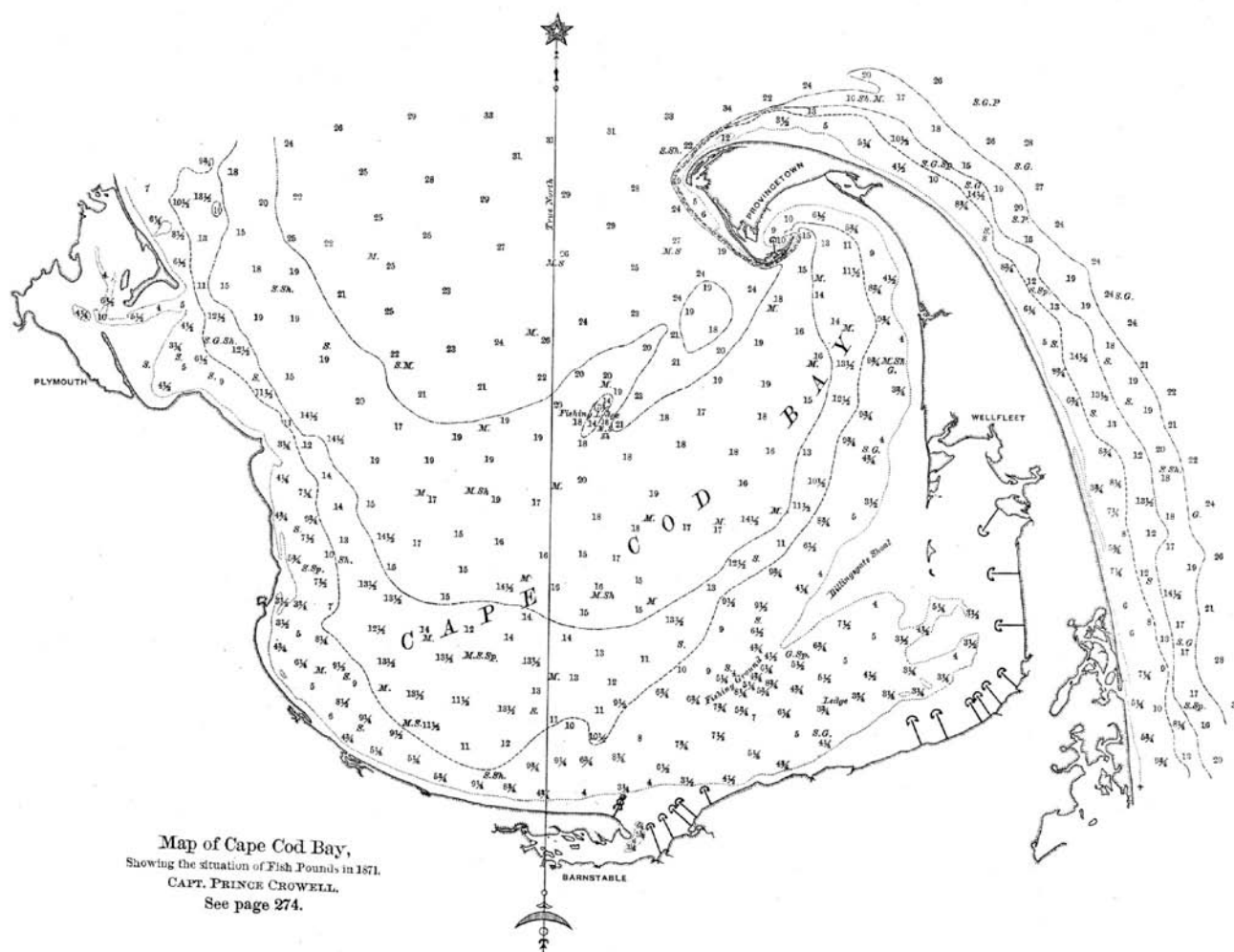


Figure 19. Locations of fish pounds in Cape Cod Bay in 1871.¹⁶⁹

By the 1890s, it was broadly believed that herring populations were healthy, as catches had increased throughout the century.¹⁷⁰ However, fishermen in the second half of the 1800s voiced concern that catches were increasingly sparse and in some cases failed entirely in weirs along the Maine coast. Reports of decreases in herring are known from at least 1850 and continued through the 1890s.¹⁷¹ While good year classes were reported

¹⁶⁹ Spencer F. Baird, *Part I, Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872*, Washington: USGPO, 1873, Plate XXXIX.

¹⁷⁰ Ansley Hall, "The Industry of the Passamaquoddy Region, Maine," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*, Washington: USGPO, 1897, p. 443-487; H. F. Moore, "Observations Upon the Herring and Herring Fisheries of the Northeast Coast, With Special Reference to the Vicinity of Passamaquoddy Bay," *Part XXII, Report of the Commissioner for the Ending June 30, 1896*. Washington: USGPO, 1897, p. 387-442.

¹⁷¹ Emily Klein, "A New Perspective: Atlantic Herring (*Clupea harengus*) as a Case Study for Time Series Analysis and Historical Data," M.A. Thesis, Durham: University of New Hampshire, 2008.

on Stellwagen Bank in the early 1880s, the inshore stocks were comparatively smaller in abundance and size than in previous decades:

"The herring are more plentiful in-shore than they have been during the past fifteen years – I mean spring herring. Eighty barrels were in a trap at Kettle Island on Friday night and 60 barrels last night. Schooner *Phantom* came in this morning with 60 barrels caught with a seine four miles from the mouth of the harbor. The herring caught outside are large – as large as the spawn-herring caught in the fall; those caught in the harbor are half size."¹⁷²

Reasons for declines in catches varied by location and fishermen, but most often herring scarcity was attributed to weirs that captured too many juveniles and kept the fish from reaching their spawning grounds. In addition, gill netters and seiners were accused of breaking up schooling fish, and waste from industries as well as noise pollution from foghorns and steamboats caused herring to avoid certain areas. Whatever the reason, the U.S. Fish Commission concluded in 1871 that net fishing was not to blame for excessive destruction of herring spawn and immature fishes.¹⁷³ Again in 1896, the commission concluded that claims of decline were exaggerated, no significant decrease in the herring populations had occurred, and that weirs and gill nets would not significantly affect the fishery in the future.¹⁷⁴ Despite these general conclusions, no explanations were offered for the extirpation of stocks such as Quoddy River herring in Maine.¹⁷⁵

Historical environmental, socio-economic and political conditions appear to have some explanatory power for dramatic shifts in herring catch, particularly in the 20th century (FIG. 20).

Such information can be valuable for understanding a fishery over time, but does not lend itself easily to quantitative analysis. To incorporate this information, historical events are summarized into a timeline (TAB. 4). This information was restricted to significant social, political, or fishery-related events and ranged from changes in fishing gear and technology to the World Wars.

¹⁷² U.S. Fish Commission, *Bulletin of the United States Fish Commission for 1881*, Washington: USGPO, 1882, p. 426.

¹⁷³ George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Animals*. Washington: USGPO, 1884, p. 567-568.

¹⁷⁴ H. F. Moore, "Observations Upon the Herring and Herring Fisheries of the Northeast Coast, With Special Reference to the Vicinity of Passamaquoddy Bay," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*. Washington: USGPO, 1897, p. 425, 430.

¹⁷⁵ H. F. Moore, "Observations Upon the Herring and Herring Fisheries of the Northeast Coast, With Special Reference to the Vicinity of Passamaquoddy Bay," *Part XXII, Report of the Commissioner for the Year Ending June 30, 1896*. Washington: USGPO, 1897, p. 442.

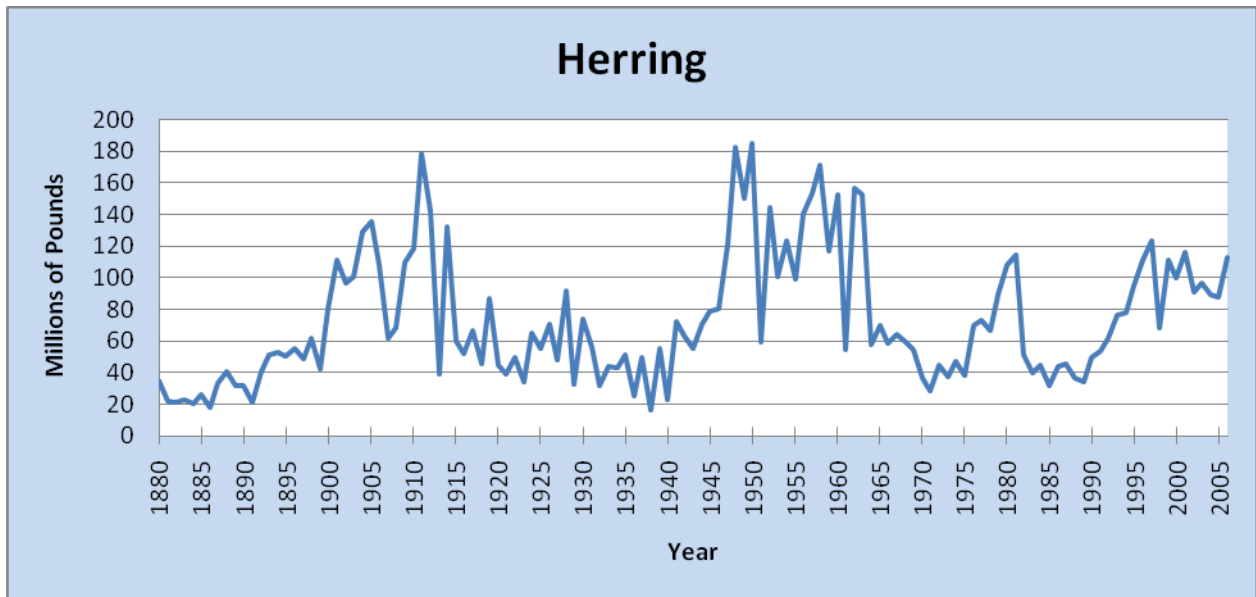


Figure 20. Maine herring landings 1880-2005.¹⁷⁶

The Gulf of Maine herring industry was heavily fished for bait up until the early 1900s. With reduced catches apparent in the late 1800s, and under pressure from the weir fishery, laws were enacted to limit the use of purse and haul seines to catch herring.¹⁷⁷ Although the introduction of net trawls limited the need for baitfish, low prices and an overcrowded market contributed to a broad decline in the herring industries at this time.¹⁷⁸ There was a short-lived boom in the sardine industry as a result of WWI and European sardine embargoes, and simultaneously an increased need for a cheap and nutritious domestic food source.¹⁷⁹ However, lowered demand during the Great Depression forced the closing of numerous canning and processing plants, from which the Maine canning industry did not recover until WWII.¹⁸⁰ Later in the 20th century, the impact of offshore foreign fleets and the collapse of the Georges Bank fishery likely affected landing trends in Maine.

¹⁷⁶ Emily Klein, "A New Perspective: Atlantic Herring (*Clupea harengus*) as a Case Study for Time Series Analysis and Historical Data," M.A. Thesis, Durham: University of New Hampshire, 2008, p. 66.

¹⁷⁷ R. Edward Earll, "Part VI. The Herring Fishery and the Sardine Industry," *The Fisheries and Fishery Industries of the United States, Section V: History and Methods of the Fisheries*, Washington: USGPO, 1887, p. 419-524; F. C. Webber, "The Maine Sardine Industry," *Maine Sardine Industry History: An Anthology*, Brewer, ME: Maine Sardine Council, 1986 (1921).

¹⁷⁸ M. Pike, "A Short History of the Sardine Business in Lubec," *Maine Sardine Industry History 1875-2000*, ed. J. L. Warren, Brewer, ME, 2000, p. 144; J. Gilman, *History of the Sardine Industry*, St. Stephen, NB: Parsons Printing, 2001, p. 66.

¹⁷⁹ H. A. Davis, "Eastport and the Sardine Industry," *Maine Sardine Industry History: An Anthology*, Brewer, ME: Maine Sardine Council, 1986 (1950).

¹⁸⁰ H. A. Davis, "Eastport and the Sardine Industry," *Maine Sardine Industry History: An Anthology*, Brewer, ME: Maine Sardine Council, 1986 (1950); M. Pike, "A Short History of the Sardine Business in Lubec," *Maine Sardine Industry History 1875-2000*, ed. J. L. Warren, Brewer, ME, 2000, p. 145-146.

Period	Trend	Event
1882	▲	Lagged response to growth of Lubec sardine industry, seining begins 1880
1890	▼	Smoked herring industry important, but trade with southern US declines
1897-98	▲	1897 reported as poor year (some sardine factories closed early), improvement reported for 1898
1900-3	▼	Competition up and market overcrowded for sardines, US syndicates attempt but fail to regulate industry
1905	▲	Processing improvements: fish driers replace reel ovens (1901), machine-made, sealed cans replace handmade, soldered cans (1903), factories mass produce drawn cans (1904), sealing machines improved (1905)
1906-8	▼	<i>No corresponding event found</i>
1909-11	▲	Possible lag due to increased production from processing advances, increased use of machines to replace employees, mass-production of cans, railroad reaches Eastport
1912-13	▼	Sanitation legislation in US expanded and enforced
1914-7	▲	World War I – increased demand overseas (esp. sardines)
1917-27	▼	industry slumps with no recovery following WWI,; demand and production declines begins in early 1920s
1928-33	▼	Great Depression 1929-33
1939-48	▲	WWII and end of Great Depression in 1941, boom maintained until 1948
1948-52	▼	Poor run of herring (1948) and decline in demand
1951	▼	Decrease in US reports - <i>no corresponding event found</i>
1953-8	▲	Increase in US reports - <i>No corresponding event found</i>
1955-68	▲	Offshore foreign fleet fishing in early 1960s
1961	▼	Decrease in US reports - <i>No corresponding event found</i>
1968-71	▼	Offshore otter trawling and purse seining, especially by foreign fleet on Georges Bank (decrease reported as early as 1964)
1977-79	▼	Herring crash in 1977 due to intense fishing pressure on Georges Bank; Magnuson Fishery Conservation & Management Act (MFC) passed in 1976; US EEZ established; herring placed on prohibited species list – no-take for foreign fleets within US EEZ
1980-90	▲	Georges Bank populations rebuilds, domestic fleet and fishery re-focus inshore
1990-6	▼	MFC adopts new Fisheries Management Plan (FMP) to address growth of herring resource (1994)
1992	▲	Sudden decrease in US reports - <i>No corresponding event found</i>
1997-8	▲	Possible lagged increase from mid-water trawling that began in 1994
2005-6	▼	Lagged response to MFC & New England Fishery Management Council (NEFMC) amendments in 2003
2007	▲	Amendment 1 to Herring FMP (2006) – limited entry for vessels

Table 4. Timeline of historical events and conditions that may have affected the herring fishery in the Gulf of Maine.

V. ANALYSIS

In the following statistical analyses we use historical data sets, namely the statistical bulletins of the U.S. Commission of Fish and Fisheries (1893-1935) and scientific survey data logged by the Commission's research vessel *Fishhawk* (1880-1925), to examine trends in trophic level, species richness, catch/landing composition, the impact of historical climate variability, and examine inter-bank and -species relationships. We also compare the results of our historical analyses with modern fisheries data, namely Vessel Trip Report (VTR) data recorded from within SBNMS for the period 1995-2005 and National Marine Fisheries Service (NMFS) bottom-trawl survey data (1963-present). Complete descriptions of these data sets are provided in **Appendix A**. Geographically, we explore the relationship of SBNMS fisheries to the broader Gulf of Maine region in order to determine if trends and indicators for the region are representative of sub-regions such as Stellwagen Bank and *vice versa* (FIG. 21).



Figure 21. Fishing banks and grounds in this study that comprise the Gulf of Maine region.

Abundance

Trophic levels of marine ecosystems are widely recognized in marine science as an important abundance indicator and broad measure of relative ecosystem health.¹⁸¹ Using the global database of fish landings of the Food and Agriculture Organization of the United Nations (FAO), Pauly et al. (1998) were able to illustrate an overall decline in the mean trophic level of fisheries worldwide and the process of what is now known as “fishing down marine food webs.”¹⁸² Their analysis assumes that the relative abundance of landings reflect ecosystem conditions, therefore, a decline in mean trophic level would be an indication of declining abundances of top predators or large fishes that consequently impacts biodiversity. These assumptions and the construction of a mean trophic index (MTI) using FAO landing statistics were criticized by Caddy et al. (1998), as lacking taxonomic and spatial resolution.¹⁸³ Caddy postulated that overfishing cannot alone account for trophic level declines – natural oscillations and eutrophication of coastal areas (i.e., bottom-up processes) may contribute to shifts in mean trophic level. In addition, in order to extrapolate safely from “trophic level of landings” to “trophic level of ecosystems,” Caddy argued that knowledge of local fisheries is necessary.¹⁸⁴

The landings and statistical records of the U.S. Commission of Fish and Fisheries (1893-1935) were used to derive a MTI of Stellwagen Bank and for comparison a MTI for the Gulf of Maine (FIG. 22). Modern data sets could not be used for comparison to these historical MTI trends. Modern era landings tabulations available to this study, such as the Northeast U.S. Continental Shelf Large Marine Ecosystems (LME), encompass a significantly larger area than the U.S. Commission of Fish and Fisheries catch records. Additionally, region-wide Vessel Trip Report (VTR) data was not available to this study. Consequently, trends are developed for the historical record set, and only for targeted and long-lived demersal species (halibut, cod, haddock, hake, cusk, and pollock). Species lower in the food chain as well as fisheries with significant natural oscillations, such as mackerel, are not included in the analysis and consequently do not influence trophic level shifts. Therefore, any shifts in this analysis can be attributed primarily to overfishing and changes in fishing technology. In fact, the critique of this method by Caddy et al. notes that “there seems to be few other hypotheses to account for declines in landings of top predators than overfishing.”¹⁸⁵ While changes in trophic levels may also be representative of trends in bio-diversity, this analysis assumes that the Stellwagen Bank and Gulf of Maine MTIs measure and document shifts only in local and regional abundance of commercial fisheries.

¹⁸¹ Convention on Biological Diversity, Kuala Lumpur, February 9-10 and 27, 2004, Montreal: Secretariat of the Convention on Biological Diversity, 2004.

¹⁸² Daniel Pauly, et al. “Fishing Down Marine Food Webs,” *Science* 279: 860-863.

¹⁸³ J. F. Caddy et al., “How Pervasive is “Fishing Down Marine Food Webs?” *Science* 202.5393 (1998): 1383.

¹⁸⁴ J. F. Caddy et al., “How Pervasive is “Fishing Down Marine Food Webs?” *Science* 202.5393 (1998): 1383.

¹⁸⁵ J. F. Caddy et al., “How Pervasive is “Fishing Down Marine Food Webs?” *Science* 202.5393 (1998): 1383.

MTIs for Stellwagen Bank (1893-1935) and Gulf of Maine (1902-1935) were computed for each year based on the following equation:

$$TL_k = \sum_i (TL_i \times Y_{i,k}) / \sum_i Y_{i,k} \dots 1)^{186}$$

where Y_i refers to the landings of species (group) i , as included in fisheries statistics. For example:

$$TL_{1893} = \frac{(TL_{cod} \times \text{landing}_{cod,1893}) + (TL_{haddock} \times \text{landing}_{haddock,1893}) \dots}{\text{catch}_{cod,1893} + \text{catch}_{haddock,1893} \dots}$$

The results of this analysis shows that the trophic level of commercial species in the Gulf of Maine declined steadily from a high of almost 3.89 in 1908 to a low of 3.72 in 1927. The trophic level of Stellwagen Bank exhibits a somewhat similar pattern but with one significant deviation: a steady rise from a low of 3.73 in 1903 to 3.99 in 1917. The marked increase in trophic level on Stellwagen Bank over this period can be explained as a result of a shift in fishing technology, namely the widespread adoption of steam-powered, net-trawling vessels (see e.g., Caddy et al. 1998). This technology shift and resulting increase in fishing pressure acted to artificially drive-up trophic levels. The subsequent decline in 1919 suggests that abundance of commercial species on Stellwagen Bank were significantly reduced within 10 years of net trawling, so much so that trawlers abandoned the bank for more lucrative grounds such as Jeffrey Ledge initially and then further offshore to Georges and Browns Banks.

The trophic level for Stellwagen Bank is on average 0.05 greater in 1925-1935 than 1893-1903. Trophic level and species abundance may have rebounded in the latter period as fishing efforts focused to offshore bank fishing. Dismal economic conditions in the late 1920s and early 1930s may also have contributed to a positive shift in trophic levels. However, fishing technology improvements in the form of gas-powered vessels deploying Vigneron-Dahl trawls (beginning in 1928), we believe account primarily for this shift, just as steam-powered otter trawls had two decades earlier. The decline in trophic level in the late-19th century suggests that the Stellwagen ecosystem was already overfished by this early period, and that new technologies such as net-trawls were needed to meet increased demand for fish products as well as to improve efficiency in the face of declining yields.

¹⁸⁶ http://www.seaaroundus.org/doc/saup_manual.htm#19.

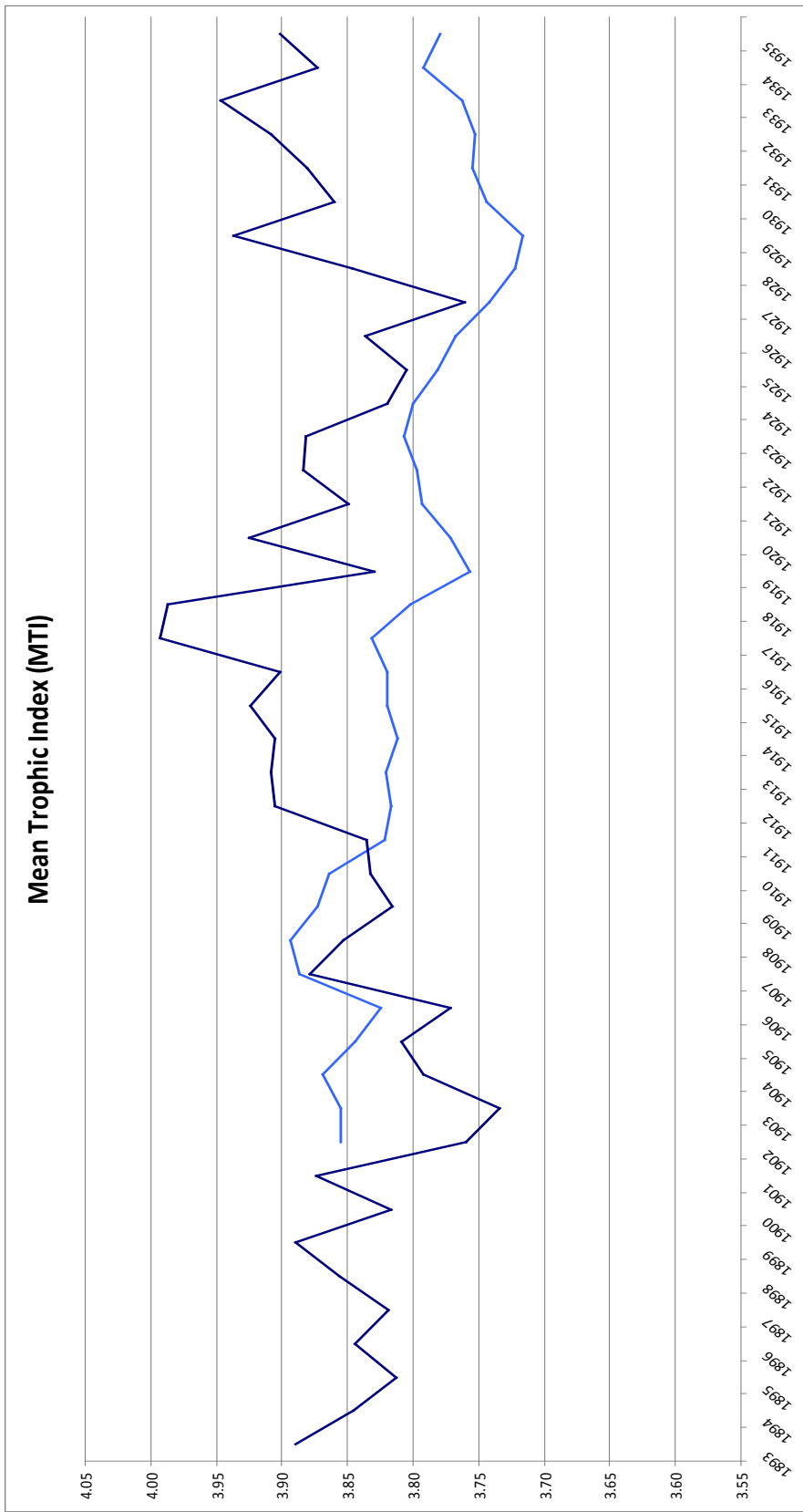


Figure 22. MTI based on USFC statistical bulletin landings 1893-1935 for Stellwagen Bank (in dark blue) and 1902-1935 for Gulf of Maine (in light blue).

Diversity

Ecosystem-based fisheries management integrates sustainable fisheries and marine biodiversity conservation.¹⁸⁷ Establishing ecological baselines can provide indications of possible trajectories for marine fish populations, communities, and ecosystems. In particular, historical baselines may reveal clues about past marine communities and human impacts.¹⁸⁸ One key difficulty, however, is how to compare historical records of marine biodiversity with those from the recent past. Statistical analysis of community level data, as presented here, provides one mechanism for comparing historic survey data and biodiversity from different eras.

Alpha diversity (community diversity) is measured in a variety of ways such as species richness, evenness, and diversity.¹⁸⁹ 'Biodiversity' is defined here by the simplest measure, richness. Richness took three forms throughout this study: genera, fish genera and fish species richness. In all cases, richness was the count of unique genera or species present in a particular sample (or tow). A concurrent objective was to determine if spatial and temporal factors provide evidence for richness patterns in the historical data.

To provide a broad context to the current management of groundfish, this study used rarefaction analysis comparing genus level presence data from two fisheries-independent surveys that span more than 100 years. Comprehensive documentation of the methods, analyses and results of this study are published in the 2009 Ph.D. dissertation by Jamie Cournane.¹⁹⁰ Rarefaction models, developed by Saunders (1968) and refined later by Hurlburt (1971), allow for the removal of sampling bias and comparison of species richness.¹⁹¹ Gotelli and Colwell (2001) explain rarefaction further as a method for standardizing species richness, particularly in instances with unequal sample sizes.¹⁹² It can also be used to analyze richness for various taxonomic levels including genus.

This study incorporated two historical datasets from fisheries-independent research surveys in order to compare species richness in the western Gulf of Maine over the long term. The first dataset was taken from the logbooks of the U.S. Commission of Fish and Fisheries survey vessel *Fishhawk* between 1880 and 1900. The second dataset was derived from National Marine Fisheries Service (NMFS) bottom-trawl monitoring

¹⁸⁷ Jason S. Link, "What does ecosystem-based fisheries management mean?" *Fisheries* 27.4 (2002):18-21; Michael J. Fogarty, *Ecology of the Northeast Continental Shelf: Toward an Ecosystem Approach to Fisheries Management*, Northeast Fisheries Science Center and Northeast Regional Office, National Marine Fisheries Service, 2006.

¹⁸⁸ Jeremy B. C. Jackson, et al., "Historical overfishing and the recent collapse of coastal ecosystem," *Science* 293.5530 (2001): 629 – 637.

¹⁸⁹ A. E. Magurran, *Ecological Diversity and Its Measurement*, Princeton: Princeton University Press, 1988; A. E. Magurran, *Measuring Biological Diversity*, Malden: Blackwell Publishers, 2004.

¹⁹⁰ Jamie Cournane, "Spatial Management of Marine Fish Resources in the Gulf of Maine and Georges Bank," Ph.D. diss., University of New Hampshire, 2009.

¹⁹¹ Howard L. Saunders, "Marine benthic diversity: a comparative study," *American Naturalist* 102 (1968): 243-282; Stuart H. Hurlburt, "The non-concept of species diversity: a critique and alternative parameters," *Ecology* 52.4 (1971): 577-585; Nicholas J. Gotelli and Gary R. Graves, *Null Models in Ecology*, Washington: Smithsonian Institution Press, 1996.

¹⁹² Nicholas J. Gotelli and Robert K. Colwell, "Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness," *Ecology Letters* 4.4 (2001):379-391.

surveys conducted by research vessels *Delaware* and *Albatross* from 1963 to the present. The study area included the western portion of the Gulf of Maine, Georges Bank, and the northern section of the Mid-Atlantic Bight east of Block Island (FIG. 23). Both surveys sampled the bottom community of the Gulf of Maine and contain presence data.

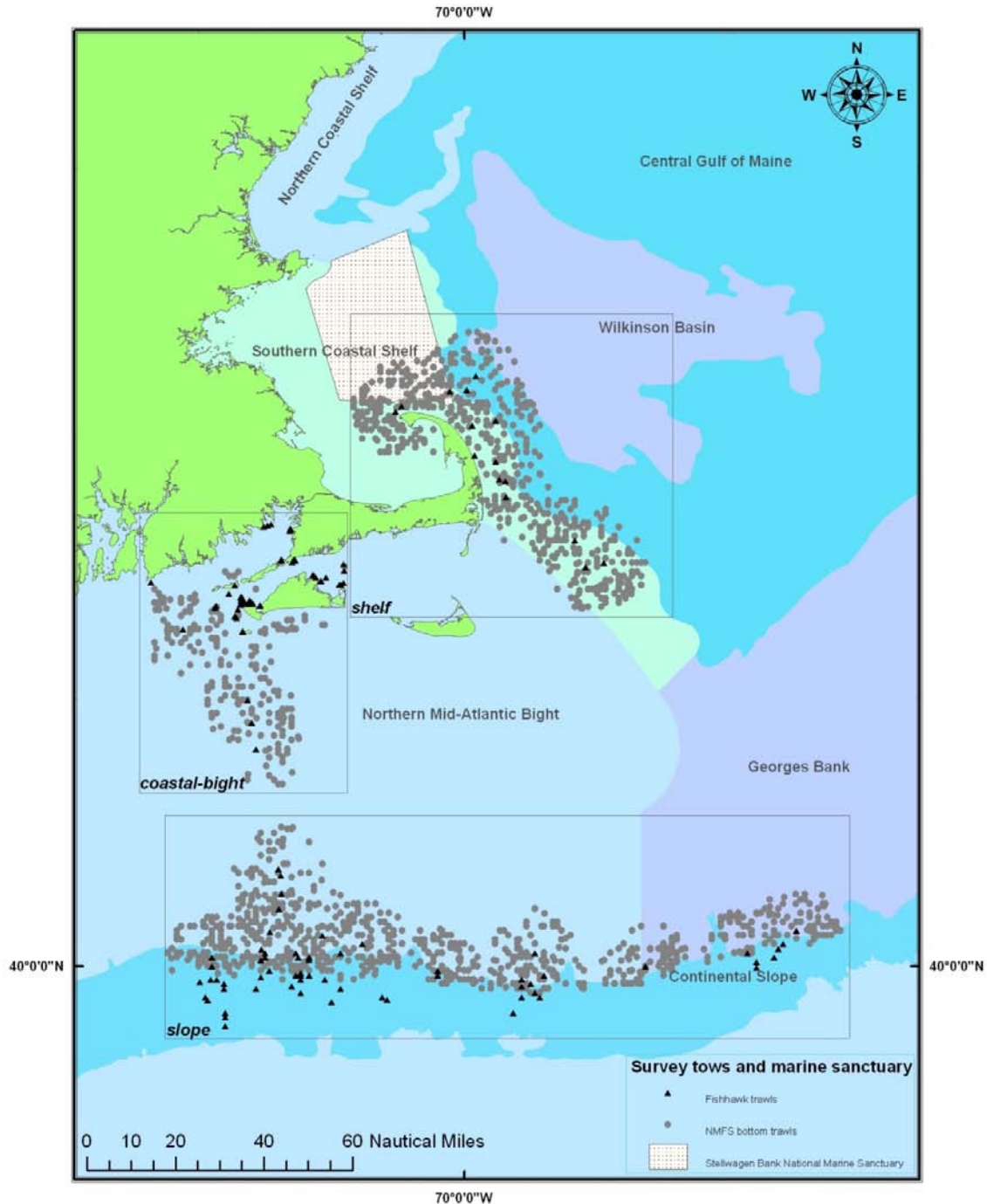


Figure 23. Study area with locations for the *Fishhawk* (black triangles) and NMFS surveys (gray circles) separated into three spatial sub-areas (coastal-bight, shelf and slope) and the location of the Stellwagen Bank National Maine Sanctuary (gridded polygon).

There are several key differences and similarities between the two surveys and data sets (TABS. 5 & 6). Tow sample data (survey station number, year, month, latitude, and longitude) and biological data (genus, species, and common name) were included in this study. Sampling gear were substantially different as the *Fishhawk* surveys used predominantly beam trawls for sampling and NMFS surveys deployed otter trawls, which must be borne in mind in interpreting the results.

For the biological data, taxonomic standardization was a particular challenge. *Fishhawk* surveys and expeditions to discover and identify marine species often resulted in multiple scientific names for the same species. Consequently, taxonomies were constructed by tracing historical naming conventions to the most current taxonomic synonyms. Finally, a total of 140 *Fishhawk* tow samples were selected based on presence of genera, trawl type, and precise geographic coordinates. Using GIS, NMFS data was sub-sampled to tows located within 10 nm (18.5 km) of *Fishhawk* bottom sampling stations. This buffer effectively limits the spatial variability between the two datasets, assuming that nearby locations have more in common than locations farther apart. If more detailed data on habitat were available, alternative assumptions might be possible that are not feasible for the present study. A total of 1,613 NMFS survey sites are compared to the *Fishhawk* data set.

Survey	Sampling	Years	Season	CoML Regions	Gear	Tow Duration
Fishhawk	Targeted sampling	1880-1882, 1889, 1893 1898-1899	Summer Fall	Continental Slope, Central Gulf of Maine, Southern Coastal Shelf, Georges Bank, Mid-Atlantic Bight	Various trawls	Variable and less than 1 hour
NMFS	Stratified random sampling	1963-2007	Winter Spring Summer Fall	Continental Slope, Central Gulf of Maine, Southern Coastal Shelf, Georges Bank, Mid-Atlantic Bight, Wilkinson Basin	Otter trawl	30 minutes

Table 5. Characteristics of *Fishhawk* and NMFS survey operations.

Fishhawk	
Tows with a genus identified	510
Tows with latitude and longitude	202
Tows using only a trawl	140
NMFS	
Tows within 10NM of Fishhawk tows	1,614
Tows with a genus identified	1,613

Table 6. Selected *Fishhawk* and NMFS bottom-trawl samples.

We compared genus diversity for the two time periods and data sets through site-based rarefaction analysis. Community and environmental matrices for *Fishhawk* and NMFS data were developed first and edited in *Microsoft Access* and *Excel* following procedures outlined by Kindt and Coe (2005).¹⁹³ Rarefaction was then run using the statistical software package *R* with the library *BiodiversityR*. Rarefaction was run on all spatial and temporal sub-divisions and data. Output includes accumulation curves with confidence intervals (two standard deviations) for each sub-division. The process was repeated for fish genera richness in order to remove some of the sampling differences between the surveys due to gear effects (TAB. 7).

¹⁹³ Roeland Kindt and Richard Coe, *Tree Diversity Analysis: a Manual and Software for Common Statistical Methods for Ecological and Biodiversity Studies*, Nairobi: World Agroforestry Centre (ICRAF), 2005.

Family	FH fish species	NMFS fish species	Family	FH fish species	NMFS fish species
Acropomatidae	0	2	Myxinidae	1	1
Achiridae	1	0	Nemichthyidae	0	1
Agonidae	1	1	Ogcocephalidae	2	3
Ammodytidae	1	2	Ophichthidae	0	1
Anarhichadidae	0	1	Ophidiidae	1	3
Anguillidae	0	1	Osmeridae	0	1
Antennariidae	0	1	Paralepididae	0	1
Argentiniidae	0	2	Paralichthyidae	3	4
Ariommatidae	0	3	Percichthyidae	0	1
Atherinidae	0	1	Percophidae	0	1
Batrachoididae	1	0	Peristediidae	0	1
Bothidae	1	1	Pholidae	1	1
Caproidae	0	1	Phosichthyidae	0	1
Carangidae	0	6	Phycidae	3	4
Carapidae	0	1	Pleuronectidae	4	5
Carcharhinidae	0	1	Polymixiidae	0	2
Centriscidae	0	1	Pomatomidae	0	1
Centrolophidae	0	1	Priacanthidae	0	1
Chaunacidae	0	1	Psychrolutidae	1	0
Chlorophthalmidae	1	2	Rajidae	5	7
Clupeidae	0	8	Sciaenidae	0	1
Congridae	1	1	Scomberesocidae	0	1
Cottidae	2	3	Scombridae	0	3
Cryptacanthodidae	0	1	Scophthalmidae	1	1
Cyclopteridae	1	2	Scorpaenidae	0	1
Cynoglossidae	0	2	Scylliorhinidae	0	1
Engraulidae	0	3	Sebastidae	2	1
Epigonidae	0	1	Serranidae	0	3
Etmopteridae	1	0	Sparidae	1	1
Gadidae	2	3	Sphyrinae	0	1
Gasterosteidae	0	1	Squalidae	0	1
Gempylidae	0	1	Sternoptychidae	0	2
Grammicolepididae	0	1	Stichaeidae	0	3
Hemitriptidae	1	1	Stromateidae	0	1
Labridae	1	3	Synphobranchidae	2	0
Liparidae	1	0	Syngnathidae	1	2
Lophiidae	1	1	Synodontidae	0	1
Lotidae	1	2	Torpedinidae	0	1
Macrouridae	3	2	Triakidae	1	1
Malacanthidae	0	1	Trichiuridae	0	2
Merlucciidae	1	2	Triglidae	2	3
Monacanthidae	0	1	Zeidae	0	1
Moridae	1	2	Zoarcidae	2	3
Myctophidae	0	2			

Table 7. Fish species sampled by *Fishhawk* (FH) and NMFS surveys.

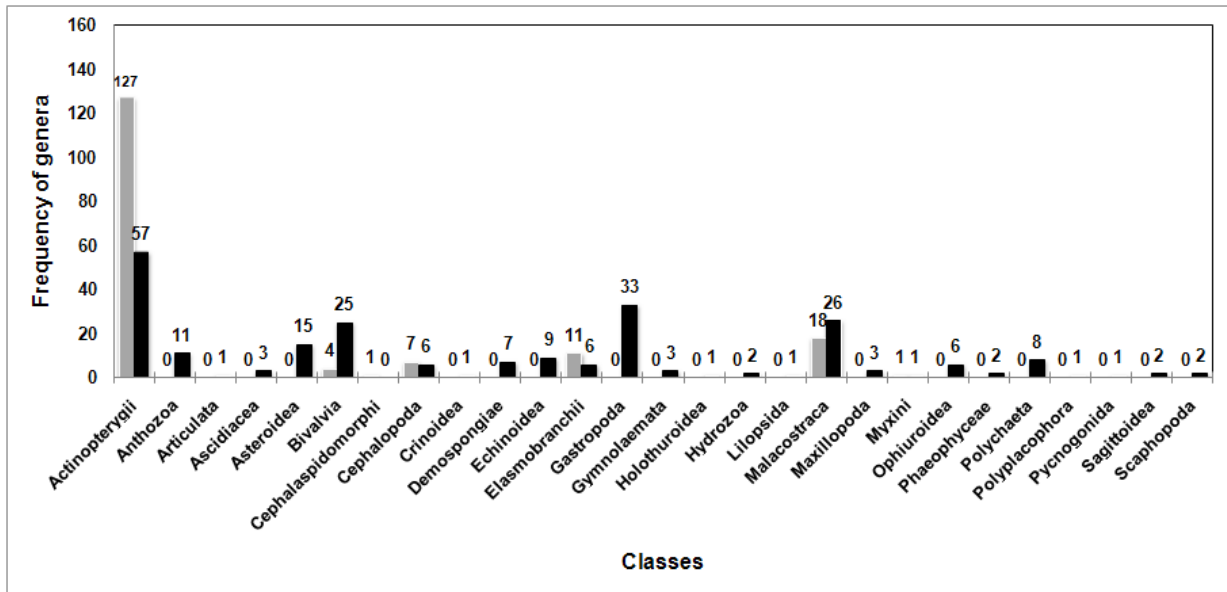


Figure 24. Frequency of genera by class for *Fishhawk* (black) and NMFS (gray) surveys.

Rarefaction reveals the expected genera accumulation curve over both sample sets, indicating that genus richness was far greater during the *Fishhawk* surveys (FIG. 25). When scaled to the total number of *Fishhawk* tows, the expected genus richness after 40 tows is 139, while the diversity in NMFS tows is 72 – a difference in genus richness of almost half over a period of approximately 100 years. However, *Fishhawk* surveys sampled many more invertebrate species than NMFS surveys (FIG. 24), which is expected from a beam trawl compared to an otter trawl.

In the analysis of fish genera, the trajectory of rarefaction curves is more similar, falling within the 95% confidence intervals of each other (FIG. 25), with slightly higher richness in the later NMFS survey. The two-fold difference in genera overall is likely a result of more sampling and recording of benthic species by *Fishhawk*. Alternatively, it may suggest predator release due to increased fishing pressure or extirpation of community types. It is important to note that the trajectory of the *Fishhawk* rarefaction curve does not approach a maximum expected genus diversity; therefore, more genera would be expected with additional sampling by *Fishhawk* but not NMFS surveys. Simulated guild analysis using contingency tables and re-sampling demonstrates further that NMFS surveys sampled many more pelagic species than *Fishhawk* as may be expected from the difference in gear type.¹⁹⁴

¹⁹⁴ Jamie Cournane, "Spatial Management of Marine Fish Resources in the Gulf of Maine and Georges Bank," Ph.D. diss., University of New Hampshire, 2009.

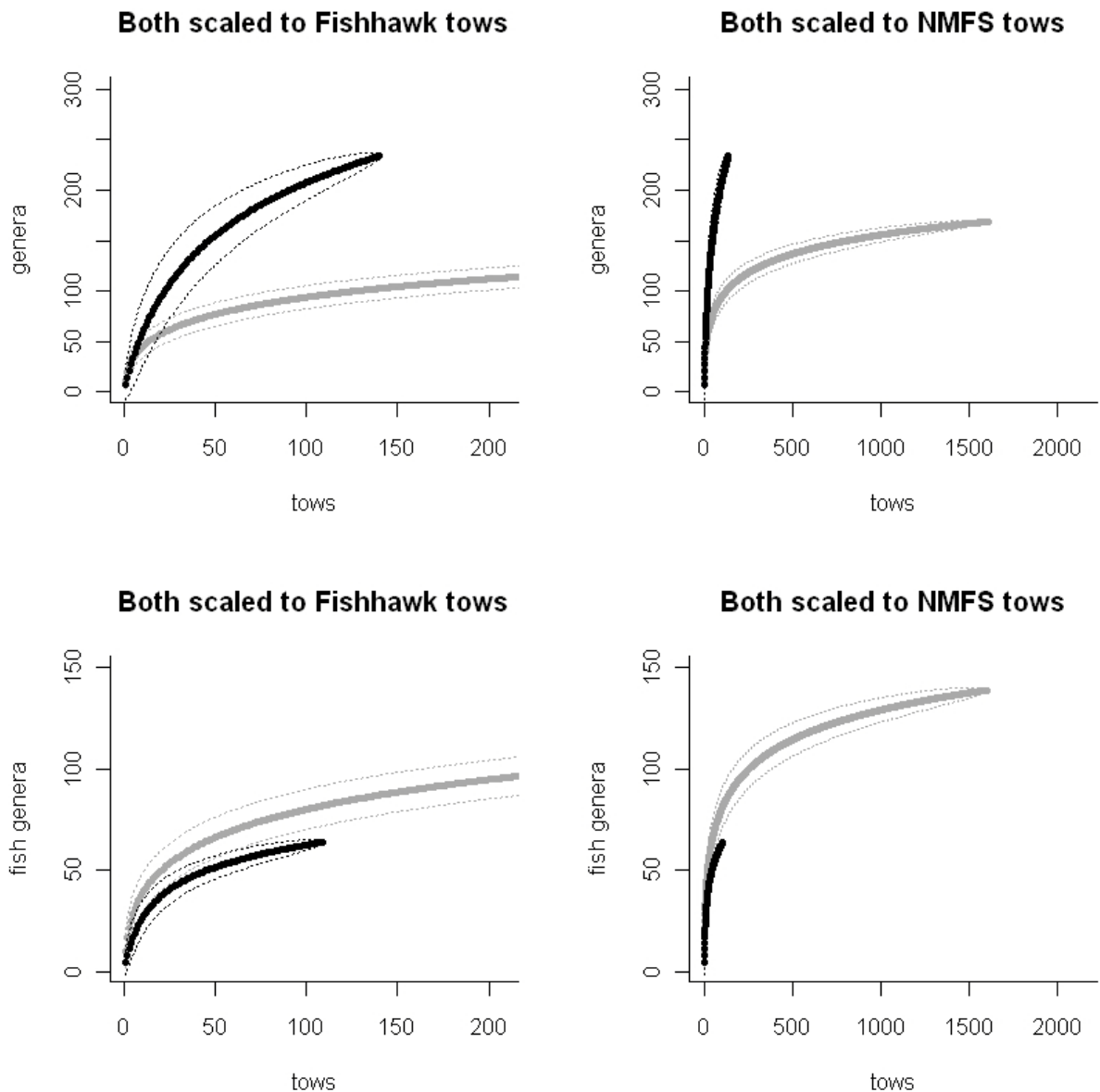


Figure 25. Site-based rarefaction results for the entire study area for *Fishhawk* (black) and NMFS (gray) surveys. Expected genera richness located in the top two panels and expected fish genera richness in the bottom two panels. Results scaled to *Fishhawk* survey tows in the left two panels and to NMFS surveys tows in the right two panels. Confidence intervals (dashed lines) based on 2 standard deviations.

There are key assumptions to consider in this analysis. We reviewed the survey methods used by the *Fishhawk* and NMFS research vessels and determined that they both used standardized sampling and collection methods, so that differences are more likely to be gear related than due to other sampling factors. We also assume samples collected within close spatial proximity to each other (i.e., 10 nm) are more alike than those collected further apart despite their temporal distance. Moreover, we assume that locations sampled are broadly representative of community type. Finally, from presence

data we infer patterns across the community without necessarily having information about abundance.

Richness patterns may be a result of differences in sampling technology and intent of the two surveys. *Fishhawk* surveys sought to characterize bottom habitats and identify species new to science while NMFS surveys have traditionally focused on groundfish abundance sampling. Also, the swept areas and mesh sizes of *Fishhawk* trawls are considerably smaller than NMFS trawls. Consequently, the differences in diversity as a result of fishing gear and sampling strategy must be considered. Despite the sampling gear differences in the surveys, it is notable that fewer pelagic species in the *Fishhawk* dataset is consistent with other published analyses that show that increased fishing pressure over time on large pelagic species and commercially valuable demersal species has impacted trophic structures resulting in an increase of smaller pelagic species.¹⁹⁵

¹⁹⁵ M. J. Fogarty and S. A. Murawski, Large-Scale Disturbance and the Structure of Marine Systems: Fishery Impacts on Georges Bank. Supplement: Ecosystem Management for Sustainable Marine Fisheries. *Ecological Applications*, 8.1 (1998): S6-S22.

Species Composition

Using landings data from the USFC statistical bulletins and Vessel Trip Report (VTR) data, we examined changes in the composition of landings over time on Stellwagen Bank, and between Stellwagen Bank and the Gulf of Maine region. In order to provide estimates for the magnitude of the relative changes in the catch composition between these two areas as well as the uncertainty of these estimates, a multinomial model was developed and analyzed using the software program WinBugs. The statistical significance of the changes in distribution may be assessed from the posterior distributions shown in APP. B (FIGS. A-F). In each analysis, we compared the catch of cod, haddock, hake, cusk, pollock, mackerel, and ‘other’ fish.

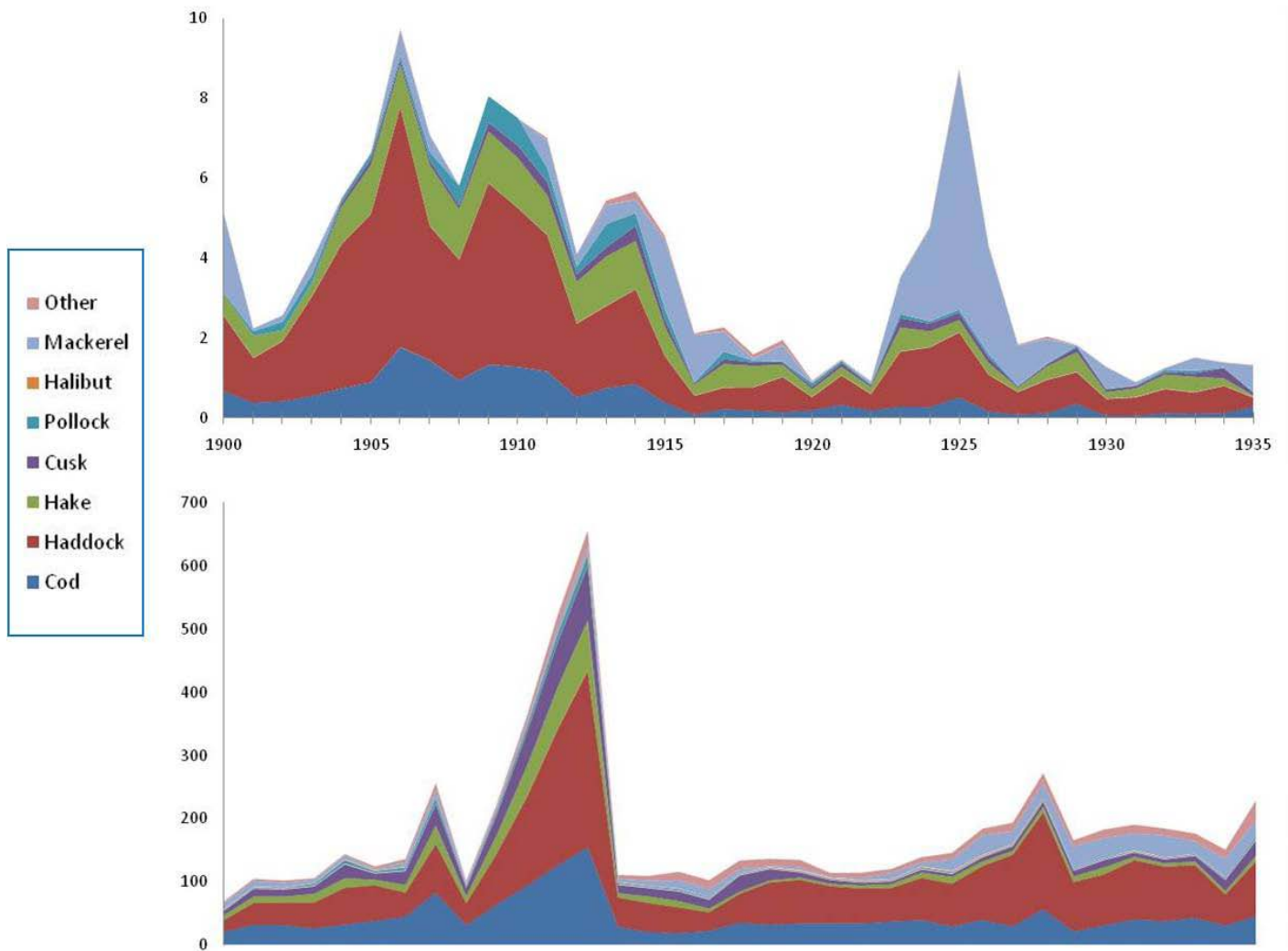


Figure 26. Catch composition of historically valuable commercial species on Stellwagen Bank (top) and Gulf of Maine (bottom). Catches are in millions of pounds.

In the first analysis we modeled the 1902-1935 landings data. The data was divided into two eras: 1902-1915 and 1916-1935. These eras were assigned to examine how catch composition may have changed before and after the widespread adoption of steam-powered, net-trawling vessels, ca. 1915. For each era, we estimated the composition of the catch for the Stellwagen Bank area and for the Gulf of Maine (excluding Stellwagen). The 1902-1915 landings on Stellwagen Bank were dominated by haddock, with cod and hake also making up significant proportions of the catch (FIG. 25). From 1916-1935, haddock and mackerel comprised the larger share of landings; cod and hake also making up a significant proportion of the catch.

We then compared the composition of catch between Stellwagen Bank and the Gulf of Maine for each era. This was accomplished by subtracting the estimated proportion for a given species on Stellwagen from the estimated proportion for that species in the Gulf of Maine. Our results show that in 1902-1915, cod, pollock and ‘other’ comprised a larger proportion of the catch in the Gulf of Maine, while haddock and hake comprised a larger proportion of the catch on Stellwagen (FIG. 26). In 1916-1935, cod, haddock, pollock, cusk and ‘other’ comprised a larger proportion of the catch in the Gulf of Maine, while hake and mackerel comprised the larger proportions of the Stellwagen catch.

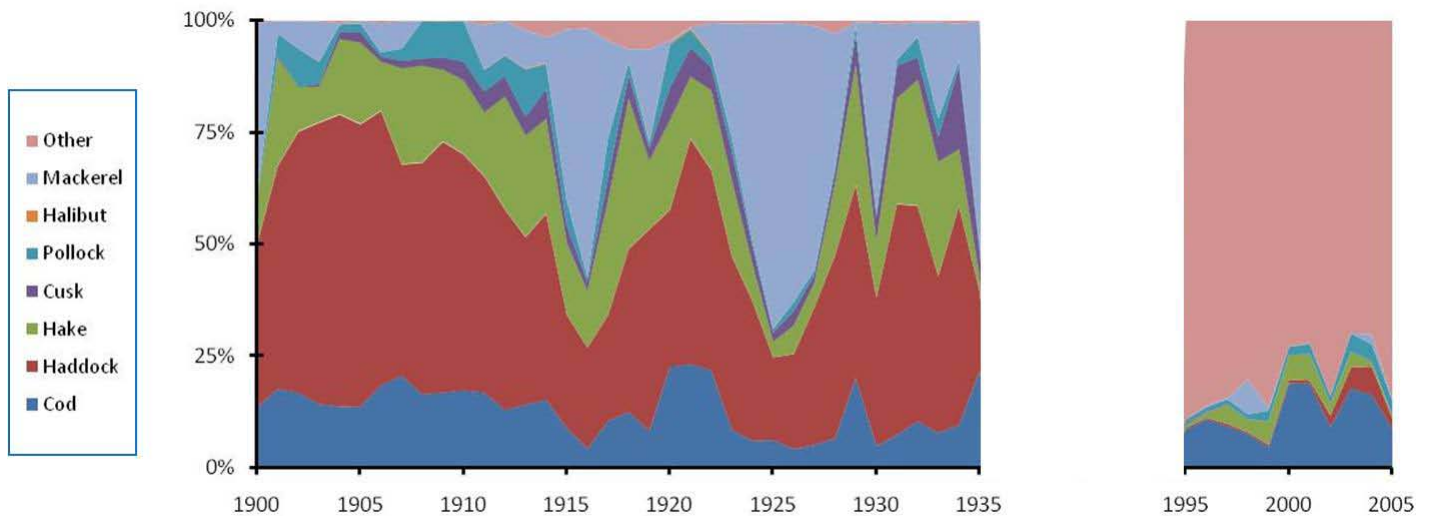


Figure 27. Change in catch composition of commercial species on Stellwagen Bank over time.

The second analysis compared catch composition on Stellwagen Bank for the 1901-1915 and 1916-1935 eras to a modern era: 1995-2005, based on VTR data which was ‘clipped’ to the sanctuary’s boundaries and also categorized by cod, haddock, hake, cusk, pollock, mackerel and ‘other’ fish. In stark contrast to the earlier eras, the catch from Stellwagen in 1995-2005 was dominated by the ‘other’ category, with only cod making a significant contribution (FIG. 26). However, if we exclude the ‘other’ category, a very different picture emerges. In comparing the proportions in 1901-1915 to 1995-2005, the proportion of cod has increased considerably while haddock catch has plummeted (APP. B, FIG. G). The change in all other species was relatively minor. Similar results were revealed when comparing the proportions of the catch in 1916-1935

to 1995-2005, except that there is a significant decrease in the proportion of haddock as well as mackerel caught in the modern era (APP. B, FIG. H).

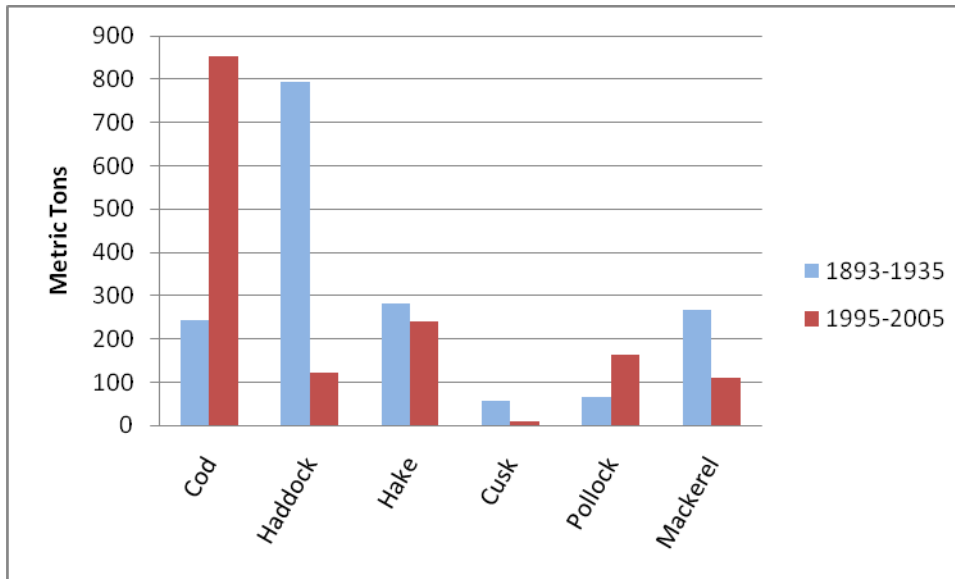


Figure 28. Average annual catch for commercial species on Stellwagen Bank 1893-1935 compared to 1995-2005.

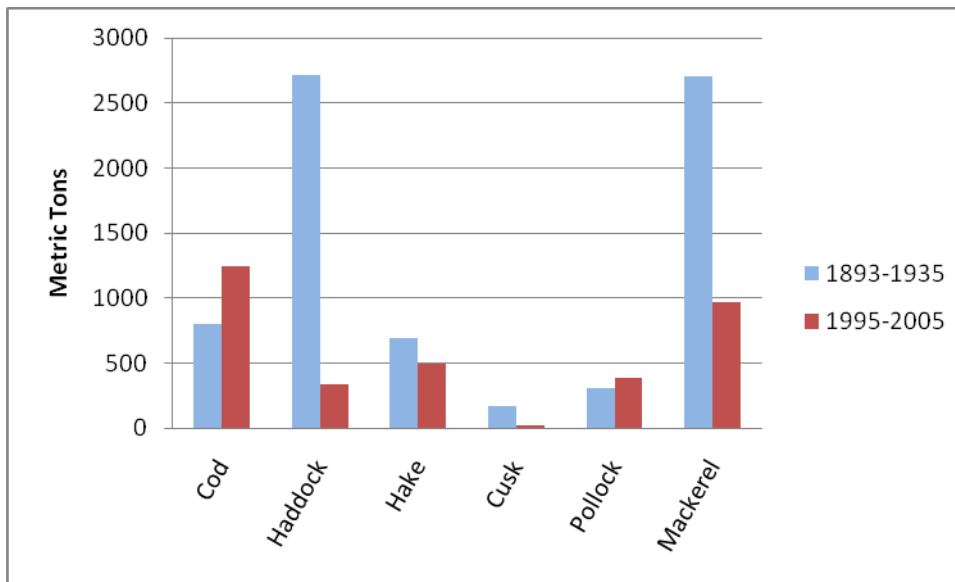


Figure 29. Maximum annual catch for commercial species on Stellwagen Bank 1893-1935 compared to 1995-2005.

Historic haddock catches on Stellwagen Bank far exceed the modern era in volume and proportion; however, cod landings and its proportion of the catch in the modern era is far greater than all other historically important commercial species (FIGS. 27 & 28). Compared to historic levels, haddock, cusk, hake, halibut and pollock make up a surprisingly small proportion of the modern era catch on Stellwagen Bank, in relative

comparison to earlier eras. The decline in these species proportions and landings and concomitant increase in cod in the modern era may be explained by multiple factors. First, in the late 1800s and early 1900s, haddock was preferred by consumers over cod. Therefore, this shift may be a result of consumer taste and market demand, with cod a more prized, valued and targeted species in the modern era. Although market analyses are not included in this study, a comparative analysis of historical prices and values for these fish would identify the influence of this externality. The catchability and efficiency of modern fishermen to target and fish cod may also account for greater volumes and proportions of catch, but it cannot be ruled out that the dramatic increase in catch in the modern era means that local cod populations on Stellwagen Bank are recovering to pre-1900 levels. The resurgent abundance and proportion of cod caught suggests further that there are significant sub-regional variations in the Northwest Atlantic Ocean where the presence of a trophic cascade phenomenon, as illustrated in the previous report section, and that has been broadly identified in other regional studies.¹⁹⁶ On the other hand, dramatically lower catches of all other commercial species, haddock in particular, indicates that fishing pressure and possibly climate fluxes are disrupting and re-organizing the Stellwagen system. As far back as the 1830s, and through the 19th and early 20th centuries, the proportional catch ratio of haddock to cod in Massachusetts Bay was consistently 3:1.¹⁹⁷ Contrary to regional trends, VTR data collected from the sanctuary between 1995 and 2005 shows a ratio on average of 1:7, signaling that haddock populations are in broad decline in this Gulf of Maine sub-region.

¹⁹⁶ Kenneth T. Frank et al. "Trophic Cascades in a Formerly Cod-Dominated Ecosystem," *Science* 308.5728 (2005): 1621-1623.

¹⁹⁷ George B. Goode, George B. Goode, *The Fisheries and Fishery Industries of the United States, Section I: Natural History of Useful Aquatic Animals*. Washington: USGPO, 1884, p. 224.

Marine Climate

Sea surface temperature (SST) in the SBNMS has risen nearly 2°C between 1900 and 2000, with a particularly dramatic rise in SST in the first half of the 20th century (FIG. 29). Climate indicators such as SST and the North Atlantic Oscillation (NAO) play a dominant role in shaping marine ecosystems and the abundance, diversity and migratory patterns of fish in the Northwest Atlantic Ocean.¹⁹⁸ However, there is currently a lack of tools and methods, and substantial uncertainty about projecting or back-casting, and correlating climate variables with historic marine animal population data.¹⁹⁹ For example, visualization of SST and cod landings from SBNMS and the Gulf of Maine for the period 1900-1935 suggest a positive correlation between SST and Gulf of Maine cod landings but a negative correlation in the case of Stellwagen Bank (FIGS. 30 & 31).

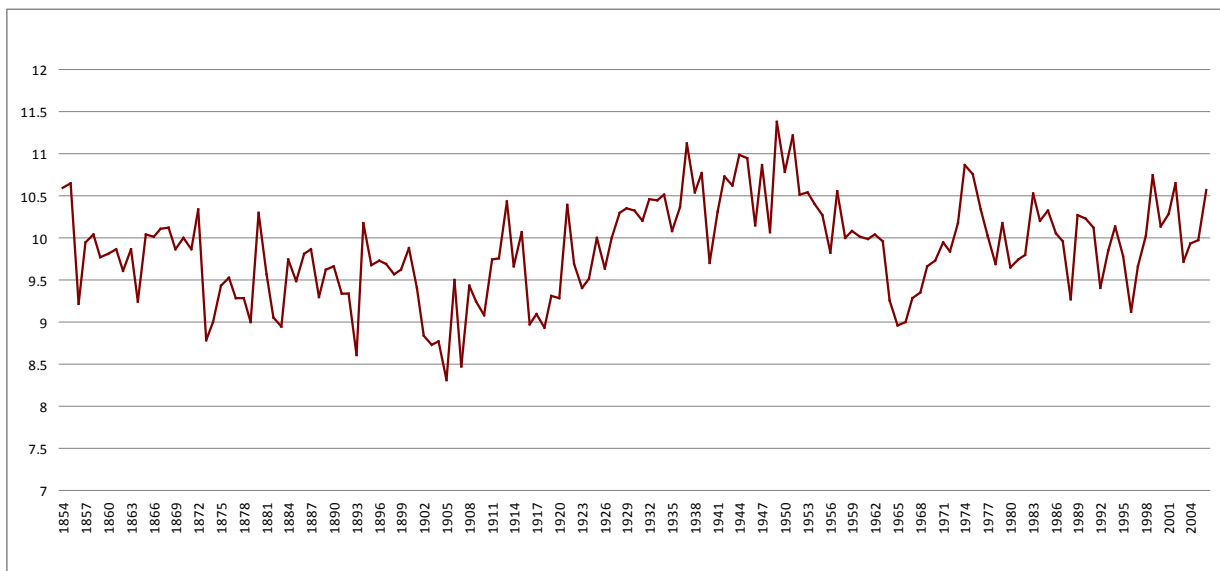


Figure 30. Sea Surface Temperature (SST) for SBNMS 1854-2004.²⁰⁰

¹⁹⁸ J. Hurrell, NAO Index Data, Boulder: Climate Analysis Section, NCAR, 1995, <http://www.cgd.ucar.edu/cas/jhurrell/indices.html#refinfo>; T.M. Smith, R.W. Reynolds, Thomas C. Peterson, and Jay Lawrimore, "Improvements to NOAA's Historical Merged Land-Ocean Surface Temperature Analysis (1880-2006)," *Journal of Climate*, 21 (2008): 2283-2296, <http://www.ncdc.noaa.gov/oa/climate/research/sst/ersstv3.php>.

¹⁹⁹ Michael Fogarty et al., "Potential Climate Change Impacts on Marine Resources of the Northeastern United States," *Northeast Climate Impacts Assessment*, Union of Concerned Scientists, 2007, p. 26-27, http://www.northeastclimateimpacts.org/pdf/miti/fogarty_et_al.pdf.

²⁰⁰ Extracted from ERSST.V2 using LAS server <http://nomads.ncdc.noaa.gov:8085/las/servlets/dataset>. T.M. Smith and R.W. Reynolds, "Improved Extended Reconstruction of SST (1854-1997)," *Journal of Climate*, 27 (2004): 2466-2477, <http://www.ncdc.noaa.gov/oa/climate/research/sst/ersstv3.php>.

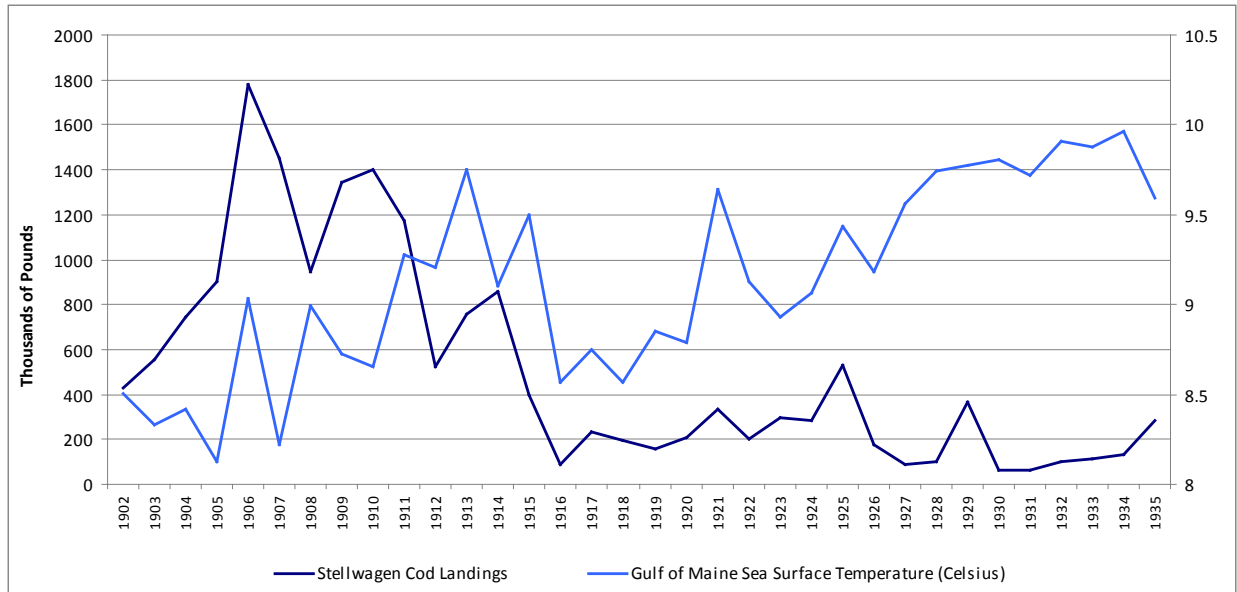


Figure 31. Visualization of sea surface temperature (SST) and cod catch on Stellwagen Bank 1902-1935.

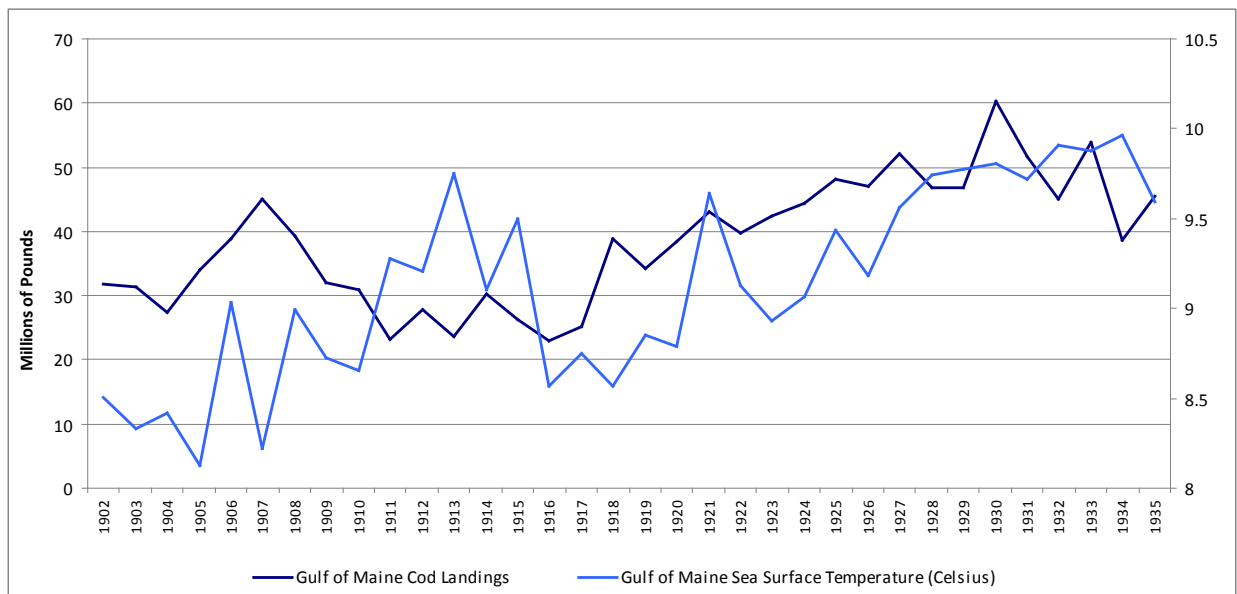


Figure 32. Visualization of sea surface temperature (SST) and cod catch in the Gulf of Maine 1902-1935.

We investigated whether environmental factors such as SST and NAO were correlated with changes in catch over time. As preliminary analysis, we applied hierarchical clustering to the full suite of bank-specific and species-specific time series. Results clearly indicate that groundfish taken from a particular bank tend to group together, as opposed to the same species from multiple banks grouping together (FIG. 32). To reduce the dimensionality of our dataset, we applied factor analysis, an approach commonly used in financial time-series models to examine a large suite of indicators, referred to as latent variables, to extract trends. As with the hierarchical cluster analysis, factor loadings grouped the groundfish species within each of the 13 banks analyzed (APP. B., FIG. I). In addition to this, we created time series for the monthly catch of individual species (cod, haddock, mackerel, hake, pollock, cusk, and halibut) by applying factor analysis to the suite of time-series for that species across multiple banks (APP. B., FIG. J). In each case, the time series spanned from April 1901 through December 1935. We treated each factor as dependent variables and SST and NAO indices as independent variables. We allowed the indices to lag up to 24 months. In no time series, including migratory species such as mackerel which are known to respond to temperature gradients, did we find a significant correlation between environmental indices and any groundfish factors. Although climate databases provide regional perspectives and trends back into the 1800s, methods are still needed to refine long-term, coarse-scale climate models and trends, and to correlate these models with biological data for specific geographic locales such as Stellwagen Bank. Our findings are therefore inconclusive regarding the contribution of climate change to historical catch trends in SBNMS.

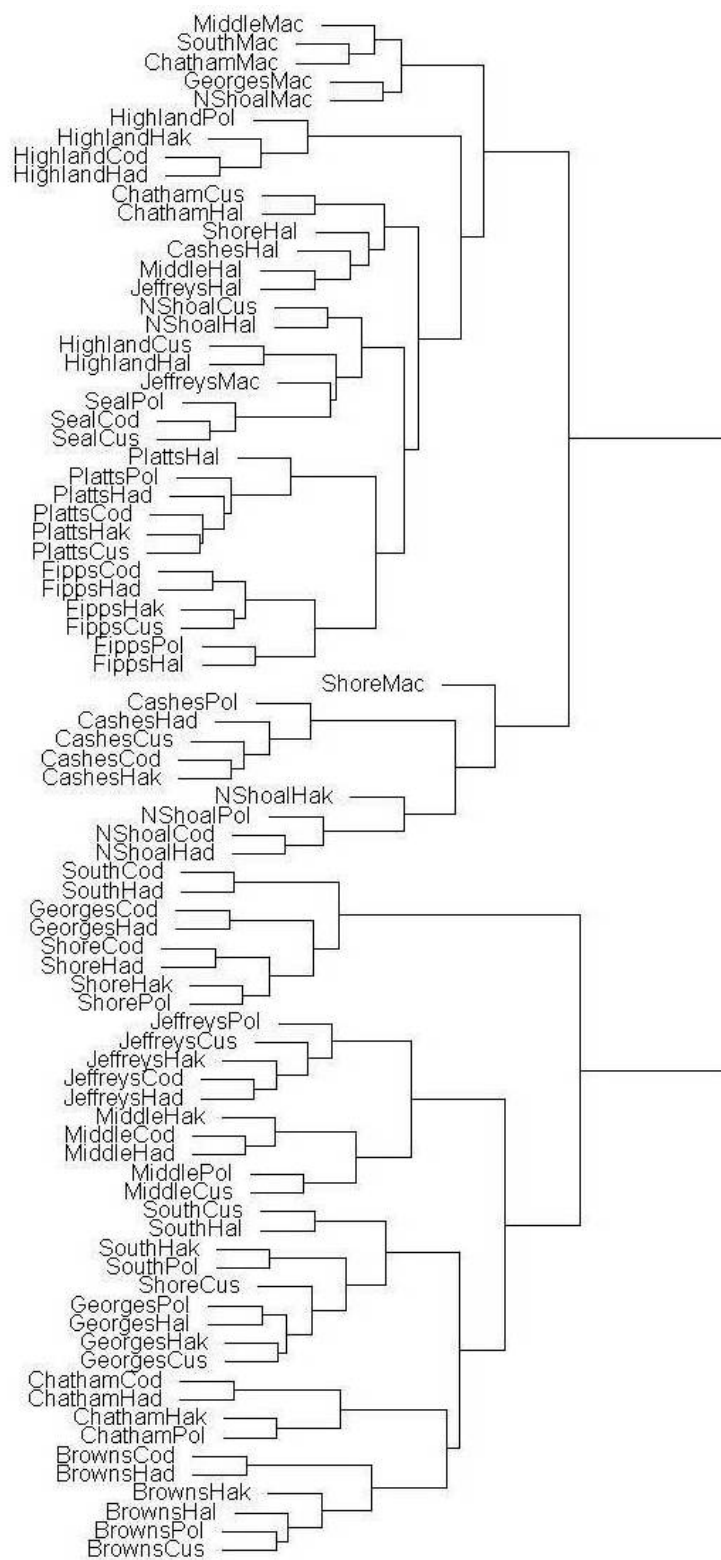


Figure 33. Hierarchical cluster analysis of 13 fishing banks in the Gulf of Maine for the period 1901-1935.

Place-based and Species Indicators

By grouping indicators using factor analysis, as described above, we investigated if certain indicators (i.e., species and ground/bank locations) were correlated with any underlying system processes that occurred within the Gulf of Maine ecosystem and affected catch rates. Specifically, we asked whether catches on Stellwagen Bank (as defined by the Stellwagen Bank factor) were correlated with catch on other banks, either contemporaneously or with time lags. In this case, the groupings (or ‘factors’) created by factor analysis were defined by applying weights to time series and then adding them together. Ideally, each factor consists of only a few time series with very large weights, and the latent processes can then be defined by the commonalities in those heavily-weighted time series.

As in our marine climate study, time series were created for each fishing ground/bank and the monthly catch of cod, haddock, mackerel, hake, pollock, cusk, and halibut that spanned from April 1901 through December 1935. If a species was caught less than 35 times in the series for a particular bank (i.e., once per year on average), that bank was excluded from the analysis. A total of 82 monthly species- and bank-specific time series were analyzed. The analysis produced 41 factors, with each factor explaining less than 10% of the overall variance in Gulf of Maine catch. Of the first 16 factors, 14 of them were bank-specific groupings of groundfish (APP. B, TAB. A & FIG. I).

The first factor, which explained the most variance in overall catch, was the sum of the cod, cusk, hake, pollock, haddock, and halibut catch from Platts Bank. The second factor was the sum of catch of cod, cusk, haddock, hake, pollock, and halibut from Fippenies Bank. The groundfish catch from Stellwagen Bank was the third most-dominant factor. Two of the top sixteen factors were grouped by species, specifically mackerel and halibut on a variety of banks. Factors 17-41 largely consisted of a single variable that was bank and species specific (e.g. cusk caught on near-shore banks). Given that the historical records provide statistics for a multi-species fishery, it is not surprising that the dominant latent processes are related to geography, or ecosystem, rather than single species caught across the region. Unlike groundfish which may exist in somewhat isolated populations, mackerel are migratory and it was not unexpected that mackerel would comprise a separate factor. Although providing little explanatory power, the halibut factor provided the strongest species indication of the variance in groundfish across all banks and grounds in the region.

Multi-dimensional scaling (MDS) plots were used to compare the 41 factors we derived and examine which factors were most similar to one another. MDS weights the sum of species- and bank-specific landings for each factor. The factors were projected onto a 2-dimensional space to visualize which factors are weighted similar to one another (FIG. 33). Interestingly, the factors close to one another also tend to be proximal in geographic space. For example, the Stellwagen Bank groundfish factor and Jeffreys Bank groundfish factor are similarly weighted and far from other groups of banks and grounds. Additionally, to examine whether there were latent patterns that might link species across banks, we repeated the factor analysis for single species independently (e.g., cod, haddock, hake). However, the grouping of these time series into factors did not produce any patterns or clearly identifiable factor loadings. It appeared to be random groupings of seemingly-unrelated banks that were inconsistent across species.

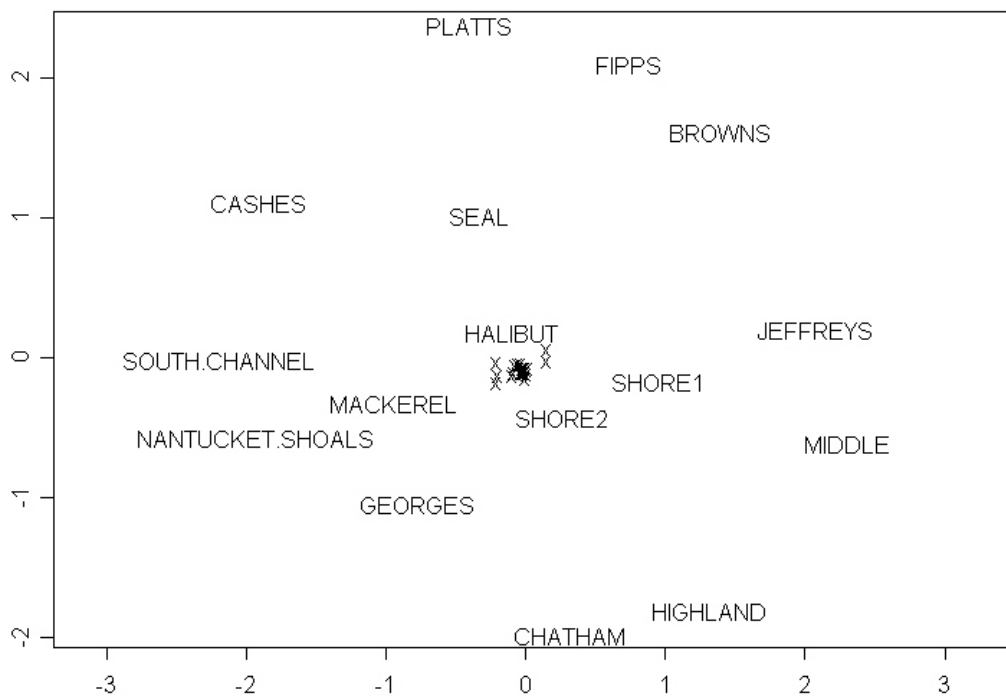


Figure 34. Multi-dimensional scaling (MDS) of the 41 factors identified through factor analysis. Factors close to one another are more similar than factors farther apart. Similar bank factors appear to relate closely to geography.

While the above approach is suitable for interpreting time series data, it does not account for time lag relationships. Consequently, we performed a standard time series study using the results of the factor analysis (APP. B, FIG. J). In this approach, the series were modeled to ensure stationarity. Stationarity is intended to remove trends and make variance constant over time. To remove the trends in each of the time series we seasonally differenced the data. Seasonal differencing was performed by subtracting one time point from another with a lag of 12 months. For example, the factor score in April 1902 was subtracted from the factor score in April 1901, the factor score from April 1903 was subtracted from the factor score from April 1902, and so on. This is carried out across all years and months to produce differenced time series. However, the variance produced was not constant throughout the time series. This non-constant variance, also called heteroskedastic variance, is extremely problematical to model.²⁰¹ Therefore, rather than use a seasonal auto-regressive moving average model, we opted to use an Ordinary Least Squares regression (OLS) analysis. When combined with a Newey West correction,

²⁰¹ Peter Romilly, "Time series modeling of global mean temperature for managerial decision-making," *Journal of Environmental Management* 76.1 (2005): 61-70; Mary W. Downton and K.A. Miller, "Relationships between Alaskan salmon catch and North Pacific climate on interannual and interdecadal time scales," *Canadian Journal of Fisheries and Aquatic Sciences* 55 (1998): 2255-2265; Christelle Ravier and Jean-Marc Fromentin, "Are the long-term fluctuations in Atlantic bluefin tuna (*Thunnus thynnus*) population related to environmental changes?" *Fisheries Oceanography* 13.3 (2004): 145-160; A.F. Zuur, et al., "Dynamic factor analysis to estimate common trends in fisheries time series," *Canadian Journal of Fisheries and Aquatic Sciences* 60 (2003): 542-552.

OLS allowed us to make valid statistical inferences irrespective of heteroskedastic variance and without having to specifically model this variance.²⁰² This approach was particularly applicable because we were more concerned about the correlation between ground/bank series rather than correctly modeling within-bank, time-series correlations.

For this analysis, we treated each bank's factor as a dependent variable. We then tested for the presence of time lags within each factor. With these lags included, we examined whether the Stellwagen Bank factor had any explanatory power either contemporaneously or at a 1-month lag. Because we were looking at Stellwagen Bank according to these two criteria, we applied a Bonferonni correction for multiple comparisons to each of the 15 bank/ground time series. The test was significant at an alpha level of 0.00167, which is above the norm of 0.05. Within each dependent factor, significant lags were found at 1 month, 1 year, 2 years, and most factors also showed a significant 3-year lag. With these lags included in the model, contemporaneous catch on Stellwagen Bank was negatively correlated with catch on Jeffreys Ledge, but positively correlated with region-wide mackerel and halibut catches (TAB. 7). That is to say, if mackerel or halibut catch was good throughout the region for a particular year, a good groundfish catch would be expected for the following 1-3 years on Stellwagen Bank.

Factor	Correlation
Halibut	0.158
Mackerel	0.142
Georges Bank	0.131
Nantucket Shoals	0.091
South Channel	0.068
New England Shore	0.056
Seal Island Bank	0.033
Cashes Bank	-0.001
Platts Bank	-0.022
Browns Bank	-0.034
Nova Scotia Shore	-0.044
Off Chatham	-0.075
Fippenies Bank	-0.079
Off Highland Light	-0.131
Jeffreys Ledge	-0.363

Table 8. Estimated correlations between Stellwagen Bank groundfish factor and other factors.

The negative correlation between Stellwagen Bank and Jeffreys Ledge is likely a result of fleet dynamics rather than ecology. Given the close geographic proximity of these fishing grounds, it is probable that the same fleet fished both banks – if the fleet was on Stellwagen it was not on Jeffreys, and *vice versa*. If the catch is only slightly better on one bank than another, then this could also produce a strong negative

²⁰² Whitney K. Newey and Kenneth D. West, "A Simple Positive Semi-definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica* **55** (1987): 1029–1054.

correlation. The magnitude of the correlation, however, suggests a spatial component to the correlation. The closer a bank is to Stellwagen the stronger the negative correlation; banks more distant have a stronger positive correlation. Months in which catch is good (or bad) on Stellwagen Bank, catch is also good (or bad) on distant banks. While this correlative structure may signal fleet dynamics, alternatively the positive correlation with distant banks point to a regional pattern in overall catch levels. Future research into cross-bank correlations may determine if spatial structure is related to these temporal correlations.

Summary

Qualitative as well as quantitative methods and analyses of historical records in this study has shown that the fish populations of SBNMS are resilient but have declined significantly in abundance and diversity over time. SBNMS was fished by Europeans for nearly 400 years. Cod were the primary targeted species until the 1800s, at which time public demand, markets and infrastructure were developed for other fisheries including haddock, halibut, hake, cusk, pollock, mackerel, herring and swordfish. Human interaction with the Stellwagen ecosystem shifted significantly in the late 19th and early 20th century, with the development of new technologies such as gill and trawl nets, steam and gas-powered sea-going vessels, refrigeration as well as improved infrastructure, resulting in the expansion of markets for the region's fisheries, increased fishing pressure, and consequently a degraded ecosystem. The findings of our SBNMS historical marine ecosystem assessment are as follows:

- a) Decline of near-shore fish populations and micro-banks occurred by ca. 1800.
- b) Top predators in SBNMS, such as halibut and swordfish, were overfished to near extirpation in the late 19th and early 20th centuries.
- c) Decline in the abundance (i.e., MTI) of commercial species suggests the presence of a cascading trophic level phenomenon in the Gulf of Maine in the first half of the 20th century, but with specific historical events and technological innovation of fishing gear affecting MTI trends in sub-regions such as SBNMS.
- d) Diversity of bottom-dwelling species in the western Gulf of Maine appears to have declined significantly from ca. 1900 to 2000.
- e) Composition of catch in the Gulf of Maine is variable across geographic space, but catch for the entire region has shifted over time toward exploitation of lower-level trophic animals.
- f) Maximum annual catch levels of historically-important commercial species in SBNMS have declined by nearly 50% over a 100 year period.
- g) Proportional catch ratios of haddock and cod in SBNMS have inverted in the last 100 years from 3:1 to 1:7, signaling a resurgence of cod but concomitant decline of haddock.

In consideration of the relatively short period of time (ca. 100 years) that these changes have occurred, and qualified by the historical observations and descriptions presented in this report, we conclude that the introduction and deployment of net fishing technologies is the primary cause for the change in the condition of SBNMS ecosystems and marine animal populations. The decline of near shore populations led not only to expansion of shore fishing to offshore areas, but also development of new fishing technologies (i.e., seines, gill nets, trawl nets), which were developed and adopted to improve efficiency and catchability in an environment of declining catch per unit of effort and increasing market demand.

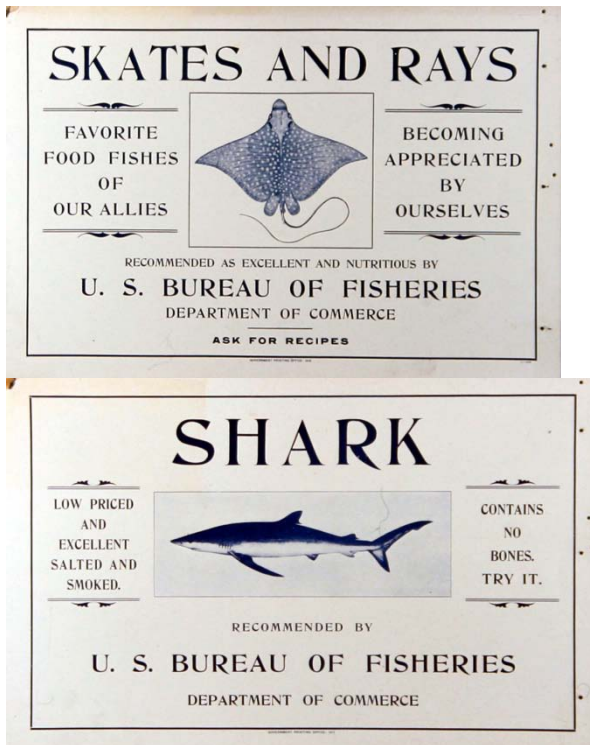


Figure 35. Advertisements of the federal government to market net-trawled by-catch.²⁰³

Net fishing also created markets for historically unmarketable species such as flounder, silver hake, monkfish, wolffish, skate and dogfish. In the early years of steam-powered net trawling, the federal government assisted with the marketing of immature commercial species and unmarketable by-catch, which represented more than 50% of net trawl catches (FIG. 34).²⁰⁴ Fisheries science also developed at this time in part out of the need to assess the assertions of hook fishermen that trawling was detrimental to the fisheries. Net fishing, by mechanical means and steam-powered vessels, was overwhelmingly decried by mackerel ‘jiggers’ and hook-and-line fishermen as destructive to benthic habitats and biota, and that it disturbed feeding grounds and caught spawning fish. Armed with historical and contextual information about the development of fisheries in SBNMS and the Gulf of Maine, and the catch and diversity data analyses presented here, we conclude that the caveats issued and impacts of net fishing described by the vast majority of fishermen of the past were largely correct. Dismissal of their warnings and observations as subjective, unscientific and untenable has to some degree resulted in the relatively degraded condition of marine environments and animal populations today.

²⁰³ *United States Fisheries Heritage Digital Collection*. <http://docs.lib.noaa.gov/rescue/USFISH/>. Silver Spring, MD: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, 2005.

²⁰⁴ A. B. Alexander, H. F. Moore and W. C. Kendall, “Report on the Otter-Trawl Fishery,” Doc. No. 1519, 63rd Congress, 3rd Session, Washington: USGPO, 1915, p. 27-33.

VI. RESEARCH RECOMMENDATIONS

There are numerous additional research opportunities and topics that can expand and improve upon understanding of the cumulative and long-term changes in SBNMS resources. These research areas include (but are not limited to) 1) *establishing baselines* for fish populations, biodiversity and habitat conditions, 2) *documenting climate change* drivers that impact biota, and 3) *identifying socio-economic and cultural drivers and responses* related to marine climate and baseline shifts. Additionally, as historical and archaeological records are explored for these purposes, there will be an increasing need for *data management*, as well as for the development of *education and outreach products* for broad public dissemination. The following research directives are recommended:

Catch Trends and Baselines

Our study provided a broad-based assessment of Stellwagen Bank fisheries, but it was focused temporally on the period 1890-1935. Both historical and archaeological records may contribute toward the in-filling of temporal gaps. Historical research into earlier periods may provide rebuilding targets for specific fisheries, and long-term catch trends for Stellwagen Bank and the Gulf of Maine may be extended feasibly to ca. 1800. Archaeological data, namely faunal material from fishing stations and fish-processing sites may be used to extend size-based indicators (see below) to earlier eras, but will generally be limited to meta-analyses and establishing regional baselines.²⁰⁵ Research into the recent past is also needed, as a significant data gap exists between 1935 and the 1990s – a time when scientific survey data is increasingly available and standardized. Monthly catch records are available for Stellwagen Bank and Gulf of Maine sub-regions up until 1944.²⁰⁶ The National Archives in Waltham, MA, contain thousands of daily catch records for vessels that fished out of Boston, which was the primary homeport for vessels fishing on Stellwagen Bank. If these records are correlated with vessel registrations, they may provide a precise measure of effort, fish removals, and biomass estimations for specific species in the early- to mid-20th century.²⁰⁷ The mid-20th century is surprisingly understudied, and may be an important era to assess the rate of habitat and stock recovery in times of decreased fishing pressure resulting from economic stagnation, war and depressed post-war, socio-economic conditions.

²⁰⁵ Matthew W. Betts and Herbert D. G. Maschner, "Zoo-archaeology of the 'Fish that Stops': Using Archaeofaunas to Construct Long-term Time Series of Atlantic and Pacific Cod Populations," Paper Presented at the 73rd Society for American Archaeology Annual Conference, Vancouver, BC, March 29, 2008. Unpub.

²⁰⁶ The National Archives in Waltham, MA, contain the monthly statistical bulletins of the U.S. Bureau of Fisheries (i.e., U.S. Commission of Fish and Fisheries). Records for 1935-1944 were not recovered by this project. See metadata in Appendix B for a complete description of this historical data set.

²⁰⁷ Record Group 22, "Records of the U.S. Fish and Wildlife Service," National Archives, Northeast Region, Waltham, MA.

Climate

Setting targets and thresholds for rebuilding and sustaining ecological integrity requires consideration of the long-term effects of climate change on fish stocks and habitats.²⁰⁸ This means developing climate models and re-constructing long-term climate trends in order to document how stocks and habitats responded to climate change in the past and ultimately to predict how they may be affected in the future. Historical surveys and explorations of the U.S. Commission of Fish and Fisheries, U.S. Navy, and U.S. Coast Survey, as well as foreign vessel surveys contain atmospheric and oceanographic data that can be used to extend and refine climate trends and models for Stellwagen Bank and the Gulf of Maine. For these purposes, protocols and standards for data recovery and digitization are needed so that historical and legacy marine environmental data may be easily incorporated into existing marine climate models and database formats such as the International Maritime Meteorological Archive (IMMA) format, which has been adopted by the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) and the Joint WMO-IOC Technical Committee for Oceanography and Marine Meteorology (JCOMM).

Size-Based Indicators (SBI)

The statistical bulletins of the U.S. Commission of Fish and Fisheries may be used to derive size-based and size-spectra indicators. Pinpointing where size and abundance decline in tandem as a result of overfishing, as opposed to declines or increases in size which are inversely correlated to abundance (likely as a result of climate change), will be important thresholds to establish.²⁰⁹ SBIs may also be derived from analysis of archaeo-faunal collections that could be used to extend regional SBI baselines hundreds and probably thousands of years into the past.

Biodiversity

Biodiversity has been identified as an essential measure for setting conservation targets and ensuring environmental stability.²¹⁰ The rarefaction methods applied to historical fisheries survey data and presented in this report effectively measured changes in species richness or biodiversity over time. We strongly recommend that historical

²⁰⁸ Michael Fogarty, et al., *Potential Climate Change Impacts on Marine Resources of the Northeastern United States*, Northeast Climate Impacts Assessment, 2007; Michael Fogarty, et al., "Potential Climate Change Impacts on Atlantic Cod (*Gadus morhua*) off the Northeastern United States," *Mitigation and Adaptation Strategies for Global Change* 13.5-6 (2008): 453-466.

²⁰⁹ See e.g., Yunne-Jai Shin, et al., "Using size-based indicators to evaluate the ecosystem effects of fishing," *ICES Journal of Marine Science* 62 (2005): 384-396.

²¹⁰ Katherine J. Willis, et al., "Biodiversity hotspots through time: an introduction," *Philosophical Transactions of the Royal Society B* 362 (2007): 169-174.

fisheries survey logbooks and data be mined and extracted for biological data and to refine rarefaction analytical techniques. This type of analysis provides a measure of change in biodiversity as well as targets for rebuilding.

Habitat Conservation

Fishing is determined by this study as a major driver for change in species richness, catch composition and bottom habitat. Therefore, establishment of no take, no drag, net or trawl-fishing areas in representative habitats of Stellwagen Bank is recommended in order to assess and understand the impacts of these fishing methods and recovery potential.²¹¹ Establishing these areas with higher levels of protection would provide an opportunity to assess the compatibility of these fishing techniques with the sanctuary goals of maintaining ecological integrity. Furthermore, areas could be designated in areas adjacent to maritime heritage resources such as shipwrecks, which would serve the dual purpose of cultural heritage protection and opportunity to measure habitat recovery and food web conditions after long-term seafloor disturbance by net trawling and scallop dragging. A variety of species richness assessment techniques, including those applied in this study, and habitat assessment methods could be used to compare ecological characteristics over space and time.²¹²

Socio-economic Indicators

Our research indicated that the warnings and concerns voiced by fishermen in the past about deteriorating stocks, poor catches, unusual weather conditions, and social/cultural conflict are significant indicators of marine ecosystem changes. As fishers' familiarity with the maritime landscape provides first-hand knowledge and observations of the environment, any such warnings should be investigated and addressed with urgency. The observations of historic (and living) fishers may also offer an added measure of certainty in decision-making and policy formulation, in that they may stand alongside quantitative analyses, as well as offer sub-regional perspectives that are often over-shadowed by broad, regional quantitative assessments. We support sanctuary efforts to provide a forum and process for fishers to submit, or sanctuary staff to collect, qualitative observations of fishers about the sanctuary's marine resources and ecosystem conditions, and incorporate these observations and perspectives into resource assessments.

Although we did not perform any historical economic analyses for this study, the data tabulated from the statistical bulletins of the U.S. Commission of Fish and Fisheries allows for supply-and-demand analyses of specific fisheries. Such measures could help to

²¹¹ S. R. Palumbi, *Marine Reserves: A Tool for Ecosystem Management and Conservation*, Arlington, VA: Pew Oceans Commission, 2002.

²¹² B. Gratwicke, M. R. Speight, "The relationship between fish species richness, abundance and habitat complexity in a range of shallow tropical marine habitats," *Journal of Fish Biology*, 66.3 (2005): 650-667; J. S. Collie, G. A. Escanero & P. C. Valentine, "Effects of bottom fishing on the benthic megafauna of George's Bank," *Marine Ecology Progress Series* 155 (1997): 159-172.

identify trends and isolate socio-economic externalities that affected catch rates on Stellwagen Bank and in the Gulf of Maine. The bulletins can be used further to make intra- and inter-regional fishing ground comparisons, studies on the catchability of specific fishing gears, and identification of fleet efforts and patterns, based on the number of vessels and trips made to specific fishing grounds and days absent from port. Research into the affects of various fishing-gear technologies on the demographics of individuals employed in the fisheries is also a relevant research area. The results of this research could be used to predict and gauge the impact of new fishing gears, and regulations that may restrict use of certain types of gear, on fishing communities.

Research Coordination and Data Clearinghouse

A challenge for future historical ecology research and scientific analyses will be the management and warehousing of scanned and digitized historical source materials. While archives such as NOAA's National Climatic Data Center (NCDC) provide storage of historical climate-related records, there are currently no clearinghouses for storage of and access to historical ecology source materials.²¹³ Historical record formats are non-standardized, diverse, and disparate, and standard protocols and methods for document scanning, file formatting, digitization, tabulation, and compilation are needed. The development of a 'metadata' standard for historical data sets is also strongly recommended to facilitate future research and analysis of historical and archaeological source materials.

²¹³ <http://www.ncdc.noaa.gov/oa/climate/cdmp/cdmp.html>

VII. MANAGEMENT IMPLICATIONS

*If New England wishes to fish in the future it must begin to harvest with discretion in New England waters no regulation, no limitation is undertaken until a fishery is not merely threatened, but seriously impaired.*²¹⁴

– Edward A. Ackerman (1938)

Critical to the restoration of Stellwagen Bank is the identification of historic stable states and the services and benefits afforded by its productive and diverse ecosystems. This study of SBNMS marine history and ecology reinforces the importance of the sanctuary's ecosystems and marine resources to the broader Gulf of Maine system, and highlights the historical role of Stellwagen Bank's marine resources in the development and well-being of the Gulf of Maine's coastal communities. To this end, the assessment of late 19th- and early 20th-century fisheries of Stellwagen Bank, as presented in this report, provides baselines for comparison to current ecosystem conditions. Through this comparative analysis, long-term trends have been identified, which may be used to direct future management decisions. For example, our research has shown significant declines in biodiversity and abundance as well as major shifts in the composition of the Stellwagen fisheries. These baselines are significantly different from the SBNMS "Condition Report (2006)" and consequently the direction of management actions needed to improve these conditions and overall ecosystem integrity (TAB. 8).²¹⁵

The widely held belief that SBNMS and Gulf of Maine haddock populations are healthy and sustainable is of particular concern.²¹⁶ While the scientific consensus is likely correct for the post-1960s haddock populations in the Gulf of Maine, historical data suggests that a decline in abundance for this fishery occurred first in the 19th century and then a more abrupt drop in productivity in the early-20th century, especially for near-shore, sub-regional ecosystems such as Stellwagen Bank. Although climate plays a major role in long-term shifts in abundance and diversity, the historical record and our analyses suggest that fishing pressure is the primary reason for changes in SBNMS haddock distribution and catch declines. The inverted proportional catch of cod-haddock may also signal that the Stellwagen system has shifted from its historical 'steady state,' is unstable, and undergoing trophic level re-organization.

²¹⁴ Edward A. Ackerman, "Depletion in New England Fisheries," *Economic Geography*, 14.3 (1938): 233, 236.

²¹⁵ *Stellwagen Bank National Marine Sanctuary Draft Management Plan and Environmental Assessment*, Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, April 2008, p. 174-175.

²¹⁶ <http://www.nefsc.noaa.gov/sos/spsyn/pg/haddock>;
<http://www.nmfs.noaa.gov/fishwatch/species/haddock.htm>

Table 9. 2006 condition report for specific resources from the SBNMS Draft Management Plan, compared to the 1900-period baseline and findings from this marine historical ecology assessment.²¹⁷

	Questions/ Resource	2006	1900	Basis for Judgment	Description of Findings
Habitat					
	What is the abundance and distribution of major habitat types and how are they changing?	—	▼	Alteration of microhabitat due to bottom dragging & dredging.	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable, but not severe declines in living resources or water quality.
	What is the condition of biologically-structured habitats and how is it changing?	—	▼	Fishing gear impacts.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some, but not all living resources or water quality.
	What are the contaminant concentrations in sanctuary habitats and how are they changing?	—	?	Limited monitoring results.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
	What are the levels of human activities that may influence habitat quality and how are they changing?	▼	▼	Fishing gear impacts, shipping.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
Living Resources					
	What is the status of biodiversity and how is it changing?	—	▼	Long-term changes in fish diversity.	Selected biodiversity loss has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity.
0	What is the status of environmentally sustainable fishing and how is it changing?	—	▼	Published and unpublished literature on regional and local groundfish populations.	Extraction has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity.

²¹⁷ After “Condition Report (2006)” table in *Stellwagen Bank National Marine Sanctuary Draft Management Plan and Environmental Assessment*, Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, April 2008, p. 174-175.

Table 9. Continued.					
1	What is the status of non-indigenous species and how is it changing?	▼	?	Recent invasives discovered.	Non-indigenous species exist, precluding full community development and function, but are unlikely to cause substantial or persistent degradation of ecosystem integrity.
2	What is the status of key species and how is it changing?	▲	▲	Cod	Cod catch has increased significantly from early 1900s levels.
3	What is the status of key species and how is it changing?	?	▲	Haddock	The reduced abundance of haddock has caused or is likely to cause severe declines in some, but not all ecosystem components, and reduce ecosystem integrity; and prospects for recovery are uncertain.

Status: ■ Good, ■ Good/Fair, ■ Fair, ■ Fair/Poor, ■ Poor, ■ Undetermined.

Trends: ▲ Conditions appear to be improving toward one of the higher categories.
— Conditions do not appear to be changing.
▼ Conditions appear to be declining toward one of the lower categories.
? Undetermined trend.

The lack of specific conservation measures for living resources within the SBNMS is a major impediment to restoring and maintaining Gulf of Maine fisheries for fishermen and the general public. In fact, there presently are no regulations to mitigate damage to benthic habitats, spawning grounds, as well as destruction of cultural resources such as shipwrecks, and entanglement of whales caused by dragging and net trawl fishing. Additionally, there are no restrictions on fishing vessel sizes, fishing gears and areas of operation in sanctuary waters. This lack of restrictions has led in part to the deterioration of the region's fishing communities. Lower impact fishing methods, which coastal communities' social and economic structures were based upon for centuries, have given way to higher-impact methods such as net trawling causing significant damage to the abundance and diversity of marine resources, and consequently deterioration of coastal communities' maritime cultural heritage. Therefore, a compatibility analysis and determination, as outlined in the SBNMS "Compatibility Determination Action Plan," of fixed and towed fishing gears relative to the goals of the sanctuary, is warranted and necessary.²¹⁸ A compatibility determination should also consider the cultural and socio-economic impacts of these fishing methods. Without such a determination, as well as

²¹⁸ *Stellwagen Bank National Marine Sanctuary Draft Management Plan and Environmental Assessment*, Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, April 2008, p. 203-205.

inter-agency cooperation between NMFS and NMSP,²¹⁹ efforts to restore fish populations to historic levels or even maintain current levels of ecological integrity in SBNMS are unlikely.

To restore SBNMS resources to historic levels, and sustain these productive capabilities for future generations, will require the collective effort of fishermen, scientists, government and an informed and concerned public. In the past, uncertainty in the condition of fishery resources was rarely approached with precaution. Rather, uncertainty and lack of scientific data resulted in business-as-usual management responses. Today, fishery regulations are implemented for broad regions (e.g., Gulf of Maine), without consideration of sub-regional population, habitat and forage base affects. The results of our historical study show that significant differences exist between the condition of large and sub-regional marine ecosystems. In addition, it shows that sub-regional baselines do not parallel one another temporally and may vary significantly in exploitation rates and biological trends. The application of regional indicators to sub-regions should not be made without sub-regional assessments, as lifting of regional regulations may result in further deterioration of localized stocks and habitats. Ultimately, not only are the opinions of stakeholders relevant and necessary in any future discussion of sanctuary management and conservation efforts, but also the voices of past explorers, fishermen and scientists, whose observations document the shifting baselines in the condition of marine resources and environmental quality.

²¹⁹ See e.g., "Interagency Cooperation Action Plan," *Stellwagen Bank National Marine Sanctuary Draft Management Plan and Environmental Assessment*, Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, April 2008, p. 192-196.

VIII. APPENDICES

APPENDIX A: Metadata for Primary Historical Data Sets

Statistical Bulletins of the U.S. Commission of Fish and Fisheries/Bureau of Fisheries

This data set is derived from statistical bulletins printed by the historic federal fisheries management agencies, U.S. Commission of Fish and Fisheries and U.S. Bureau of Fisheries. The bulletins contain monthly commercial fish landings for the Boston and Gloucester, MA, and Portland, ME, fishing fleets between 1898 and 1935. The data set was developed by Stefan Claesson of the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH), for the purposes of documenting the maritime history and marine ecology of the Stellwagen Bank National Marine Sanctuary (SBNMS). These historical data are used further to map and track changes in the population and composition of marine species in the vicinity of SBNMS.

The complete set of U.S. Fish Commission and Bureau of Fisheries statistical bulletins is believed to date from 1892 to 1944. This tabular data set includes only the monthly records from 1898 to 1935. Bulletin records for the years 1892-1897 and 1899-1900 are missing, but will be updated if located in archives. Other data gaps include all the months of 1898 except January, and the 1901 months of January, February, March and May. Additionally, a change in the format of the statistical sheets in December 1928 omitted landing data by fishing bank or ground for June-December. The annual landings by species for 1928 are available, however. Cod and haddock landings for December 1932 are also missing. The fishing banks and grounds were re-organized into regional zones beginning in 1936 and therefore the landings 1936-1944 are not included in this data set.

The formats of the bulletins, or statistical sheets, are inconsistent and vary in layout from month to month depending on the types and places of fish caught. The pounds and values of fresh and salted fish landed are recorded for each fishing bank, ground, or area. It is noted on some bulletins sheets that “the weight of salted fish landed has been converted to the basis of fresh fish.” The number of vessel trips made to each fishing area is also recorded.

There are significant format changes to the bulletins in 1913. In this year, some species are categorized by size according to weight: cod (large [10 and over], market [under 10 and over 2½], scrod [1 to 2½]), haddock (large [over 2½], scrod [1 to 2½]), hake (large [6 and over], small [under 6]), and mackerel (large [over 2½], medium [1½ to 2½], small [under 1½]). These size categories are consistent throughout the series (1913-1935). Landing statistics for flounder, wolffish and rosefish are added to the data tables beginning in 1928. From November 1913 to May 1928, the bulletins note the number of vessels engaged in the bank, market, mackerel, swordfish, herring, and shore fisheries. Only the fishing fleets of Boston and Gloucester, MA, are included from October 1913 to December 1915; from January 1916 to May 1928, the records also include the fishing fleet of Portland, ME. Beginning in August 1914, a summary of each month’s fishing industry-related events is described. The summaries address weather conditions, abundances and qualities of various fisheries and fishing locations, overall size of landings, size and operations of fishing fleets, market supply and demand, and socio-political events that affected the fishing industry. Temporally, these summaries extend to December 1935.

This data set does not include species listed in the footnotes of the bulletins. Generally, footnotes record catches of herring, large fish (e.g., swordfish, shark, tuna), and lesser-caught species in the “Other” or “Miscellaneous” data column. Footnotes in this column provide detailed information about the quantities and values of other types of fish landed, but they are not included in this data table. This data is accessible and may be extracted from the transcribed Microsoft Excel workbooks (described below).

The landing tables are printed on standard 8.5 x 11-inch sheets of paper from 1929-1935. Previously, the statistical tables were printed on variable-sized paper; some sheets as large as 30 x 20 inches. There are important additions and alterations to the data tables beginning in 1929. First, there is a table that presents a summary of the fish landed at each port during the month, and a summary of and comparison to the previous year’s landings. The second set of tables is similar to the original bulletin format; however, the later tables provide statistics not only by fishing location but also fishing gear. Fishing gear categories include Danish seines, purse seines, drift gill nets, sink gill nets, harpoons, hand lines, line trawls, scallop drags, otter trawls (large, medium, small [according to vessel size]), and Vigneron-Dahl trawls (large, medium, small [according to vessel size]). Additionally, there are data columns for the number of “Vessels Fishing” on each bank and the number of “Days Absent” from shore or the lengths of the fishing trips. A second table at the bottom of each page summarizes the landing data by fishing bank.

The original statistical bulletins are located at National Archives and Records Administration (NARA) in Waltham, MA (Record Group 22, “Monthly Fishery Statistical Reports, 1901-1944” [Location: 15/16/11-5 – 15/16/11-6]). Digital photographs were taken of all monthly bulletin sheets and saved as .jpg formatted files. Each annual set of bulletin tables was imported into Adobe Acrobat 7.0, saved as .pdf files and named by year (e.g., 1901.pdf, 1902.pdf, etc.). Microsoft Excel 2003 workbooks were created for each year of data with a single worksheet representing each month’s bulletin data. The months are indicated on the worksheet tabs (e.g., Jan, Feb, etc.). Excel files (.xls) are also named according to year (e.g., 1901.xls). Data was manually transcribed from the .pdf files into the Excel worksheets. The worksheets are an exact transcription of the original documents including all tabular data, as well as headers, footers, and sidebar notes. Finally, from these sheets a single tabular database was populated with all statistical bulletin data (1898-1935). The database was imported into ArcGIS and exported as an ESRI .shp (Shapefile) format. Data field definitions are provided below. A quality check of the data was performed four times by three different individuals.

Point locations of all fishing grounds, banks, and areas referred to in the bulletins were derived from geographic name databases such as Geographic Names Information System (GNIS) and the Canadian Geographic Names Data Base (CGNDB). When names were not present in these databases, historical fishing maps published by Goode et al. in *The Fisheries and Fishery Industries of the United States* (1887) and Rich in *Fishing Grounds of the Gulf of Maine* (1929) were used to identify fishing places referred to in the bulletins. The locations represent centroids of fishing bank and grounds, and are not exact but rather approximate locations of where fish were caught.

The spatial coverage of the data is the Northwest Atlantic Ocean from approximately Long Island, NY, in the south and north to Iceland, Greenland and the

Davis Straits. Landing data are available for the following locations: Gulf of Maine, Grand Banks, Massachusetts Bay, Bay of Fundy, Scotian Shelf, Bacalieu Bank, Bank Comfort, Bay of Islands, Block Island, Browns Bank, Burgeo Bank, Canso Bank, Cape North, Cape Shore, Cashes Bank, Clark Bank, Curdo Bank, Davis Strait, Emerald Bank, Fippenies Bank, Flemish Cap, Georges Bank, German Bank, Grand Bank, Grand Manan, Green Bank, Greenland, Iceland, Gulf of St. Lawrence, Ipswich Bay, Jeffreys Ledge, La Have Bank, Labrador, Middle Bank, Stellwagen Bank, Misaine Bank, Nantucket Shoals, Chatham, Funks, Highland Light, Newfoundland, Race Point, Platts Bank, Quereau Bank, Roseway Bank, Sable Island Bank, Sambro Bank, Scatari Bank, Seal Island Grounds, South Channel, St. Anns Bank, St. Peters Bank, Strait of Belle Isle, The Gully, Tillies Bank, and Western Bank.

Data Fields and Attributes:

Month	Month
Year	Year
Landing	City/Place where fish landed (Gloucester, Boston, or Portland)
Gear	Fishing gear type
Ground	Description of location where fish caught (e.g., Middle Bank)
X	Longitude (decimal degrees)
Y	Latitude (decimal degrees)
Add_Comment	Additional comments – e.g., Canadian or American landings
Vessels	Number of vessels fishing
Trips	Numbers of trips made
Absent	Days absent from port
cod_flp	Cod Fresh Large Pounds
cod_flv	Cod Fresh Large Value
cod_slp	Cod Salted Large Pounds
cod_slv	Cod Salted Large Value
cod_fmp	Cod Fresh Medium Pounds
cod_fmv	Cod Fresh Medium Value
cod_smp	Cod Salted Medium Pounds
cod_smv	Cod Salted Medium Value
cod_fsp	Cod Fresh Small Pounds
cod_fsv	Cod Fresh Small Value
cod_ssp	Cod Salted Small Pounds
cod_ssv	Cod Salted Small Value
cod_fp	Cod Fresh Pounds
cod_fv	Cod Fresh Value
cod_sp	Cod Salted Pounds
cod_sv	Cod Salted Value
had_flp	Haddock Fresh Large Pounds
had_flv	Haddock Fresh Large Value
had_slp	Haddock Salted Large Pounds
had_slv	Haddock Salted Large Value
had_fsp	Haddock Fresh Small Pounds
had_fsv	Haddock Fresh Small Value
had_ssp	Haddock Salted Small Pounds
had_ssv	Haddock Salted Small Value

had_fp	Haddock Fresh Pounds
had_fv	Haddock Fresh Value
had_sp	Haddock Salted Pounds
had_sv	Haddock Salted Value
hak_flp	Hake Fresh Large Pounds
hak_flv	Hake Fresh Large Value
hak_slp	Hake Salted Large Pounds
hak_slv	Hake Salted Large Value
hak_fsp	Hake Fresh Small Pounds
hak_fsv	Hake Fresh Small Value
hak_ssp	Hake Salted Small Pounds
hak_ssv	Hake Salted Small Value
hak_fp	Hake Fresh Pounds
hak_fv	Hake Fresh Value
hak_sp	Hake Small Pounds
hak_sv	Hake Small Value
pol_fp	Pollock Fresh Pounds
pol_fv	Pollock Fresh Value
pol_sp	Pollock Salted Pounds
pol_sv	Pollock Salted Value
cus_fp	Cusk Fresh Pounds
cus_fv	Cusk Fresh Value
cus_sp	Cusk Salted Pounds
cus_sv	Cusk Salted Value
hal_fp	Halibut Fresh Pounds
hal_fv	Halibut Fresh Value
hal_sp	Halibut Salted Pounds
hal_sv	Halibut Salted Value
flou_fp	Flounder Fresh Pounds
flou_fv	Flounder Fresh Value
wolf_fp	Wolffish Fresh Pounds
wolf_fv	Wolffish Fresh Value
rose_fp	Rosefish Fresh Pounds
rose_fv	Rosefish Fresh Value
mac_flp	Mackerel Fresh Large Pounds
mac_flv	Mackerel Fresh Large Value
mac_slp	Mackerel Salted Large Pounds
mac_slv	Mackerel Salted Large Value
mac_fmp	Mackerel Fresh Medium Pounds
mac_fmv	Mackerel Fresh Medium Value
mac_smp	Mackerel Salted Medium Pounds
mac_smv	Mackerel Salted Medium Value
mac_fsp	Mackerel Fresh Small Pounds
mac_fsv	Mackerel Fresh Small Value
mac_ssp	Mackerel Salted Small Pounds
mac_ssv	Mackerel Salted Small Value
mac_fp	Mackerel Fresh Pounds
mac_fv	Mackerel Fresh Value
mac_sp	Mackerel Salted Pounds
mac_sv	Mackerel Salted Value

her_fp	Herring Fresh Pounds
her_fv	Herring Fresh Value
her_sp	Herring Salted Pounds
her_sv	Herring Salted Value
swo_fp	Swordfish Fresh Pounds
swo_fv	Swordfish Fresh Value
swo_sp	Swordfish Salted Pounds
swo_sv	Swordfish Salted Value
oth_fp	Other Fish Fresh Pounds
oth_fv	Other Fish Fresh Value
oth_sp	Other Fish Salted Pounds
oth_sv	Other Fish Salted Value
total_fp	Total Fresh Pounds
total_fv	Total Fresh Value
total_sp	Total Salted Pounds
total_sv	Total Salted Value

Fishermen Interviews

The data set was developed by Stefan Claesson of the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH), for the purposes of documenting the maritime history and marine ecology of the Stellwagen Bank National Marine Sanctuary (SBNMS). These historical data are used further to map and track changes in the population and distribution of marine species in the vicinity of SBNMS. Geographic coverage of the data set is from Virginia to Newfoundland, but most data points are located within the Gulf of Maine.

Nineteenth-century fishermen interview data were extracted from a set of five volumes that included interviews with fishermen, dam and mill owners and operators, fish commissioners, and wardens and customs districts' officials. Fishermen interviews were conducted in 1893-1895 by U.S. Commission of Fish and Fisheries (USFC) officers Hugh M. Smith, Richard Rathbun, and William Wakeham pertaining primarily to the mackerel fishery in the northwest Atlantic Ocean. Other species addressed to a lesser extent include cod, herring, alewife, shad, menhaden, and salmon. Interviews regarding the mackerel fisheries were conducted in Gloucester, MA (25 interviews), Portland, ME (6), Woods Hole, MA (1), Yarmouth, NS (4), Lunenburg, NS (5), Magdalen Islands (1), and Prince Edward Island (2). Additionally, a group of interviews investigates the problem of sawdust from mills hindering fish runs in Downeast Maine and New Brunswick. These interviews were performed in New Brunswick at St. John (3), Campobello (1), and Milltown (2), and in Maine at Eastport (1), Calais (18), Forest City (3), Grand Lake Stream (1), and Princeton, ME (4). The total number of interviews included in this data set is 42.

The interviews were one part of a comprehensive study of the Northwest Atlantic mackerel fisheries. The study was issued in 1893 because the "recent serious decline in the mackerel fishery, and the great attention which the scarcity of mackerel had received, made it desirable to have full statistics and other information upon these subjects" (*U.S. Commission of Fish and Fisheries 1893* [1895]: 13). Additionally, 1893 marked the end of the "close-time" law, which had suspended mackerel purse-seine fishing before June 1, for a period of 5 years (1888-1892) (*U.S. Commission of Fish and Fisheries 1893* [1895]: 75-76). At the time, this was one of the only legislative measures enacted by the U.S. Congress to regulate a fishery, and the USFC wanted to evaluate "if any immediate benefits had resulted from this series of close seasons" (*U.S. Commission of Fish and Fisheries 1893* [1895]: 46). USFC research vessels *Grampus* and *Fishhawk* were commissioned in 1893-1895 to conduct oceanographic and biological studies pertaining to the mackerel fishery. Numerous shore studies were also instituted all along the northeastern U.S. coastline from North Carolina to Maine. Fishermen interviews were a small but important part of the USFC study into the migratory patterns and life history of mackerel, the impacts of various fishing techniques on their populations, and the perceived effectiveness of the aforementioned legislation, *An Act Relating to the Importing and Landing of Mackerel Caught During the Spawning Season*.

The original bound volumes of interviews are part of Record Group 22, Records of the U.S. Fish and Wildlife Service of the National Archives. These volumes are located at National Archives II in College Park, MD; however, one partial volume of

Canadian interviews is stored at the New England Regional National Archives in Waltham, MA. The volumes were photographed with a digital camera at the archives and compiled into Adobe Acrobat (.pdf) files. These files were then transcribed into Microsoft Word. The Microsoft files were then printed to Adobe Acrobat (.pdf) documents. Source location information is provided in the headers of these transcribed documents. Pagination within the documents is organized by the page number of the digitized pdf volumes and by the internal pagination of the original bound volumes. Internal pagination is indicated by brackets in the transcribed documents.

The fishermen's observations were compiled into a Microsoft Excel workbook file ("FishermenInterviews.xls") containing 4 worksheets. Worksheet 1, the "Observation" table, includes the observations of the fishermen that were mapped in ArcGIS. Worksheet 2 lists the "Subjects" interviewed and the corresponding pdf source file information. This table can be used for reference to the original transcribed interview document. Worksheet 3, "PlaceNames", contains a list of the place names or locations referred to by fishermen, the latitude and longitude of each place, and the source for the coordinate data. Coordinate information was generally taken from the USGS Geographic Names Information System (GNIS) or Geographical Name Search Service (GNSS) of Natural Resources Canada. Other sources for fishing bank locations include the fishing ground maps published by George B. Goode et al. and the U.S. Fish Commission in *The Fisheries and Fishery Industries of the United States* (1887). Worksheet 4, "Metadata," is a description of the headers or fields used in the "Observation" table:

Obs_ID	Number of interview subject in Subject Table and to 3 decimal places.
Subj_ID	Identification number of interviewee in Subject Table (1-42).
ObsType	abundance, bait, behavior, diet, distribution, effort, predator, regulation, seasonality, size, spawning, technology.
Month	Month (1-12).
Day	Day (1-31).
Year	Year (4 digits).
Season	spring, summer, fall, winter.
Locality	Location of observation.
FishType	Fish observed.
Pdf_Page	Page of transcription document referred to in Subject Table.
Description	Observation extracted from transcribed pdf document. Observations are repeated if they fell into multiple categories (ObsType).

From the Observation Excel worksheet, a Shapefile (.shp) was generated in ESRI ArcGIS. The GIS data layer, "Interviews.shp", is identical to the Excel data table except that the field 'pdf_Page' is excluded from the Shapefile.

Fisheries Legislation

This data set was developed by Stefan Claesson and Katherine Magness of the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH), for the purposes of documenting the maritime history and marine ecology of the Stellwagen Bank National Marine Sanctuary (SBNMS). This historical data set is used to map Massachusetts fisheries legislation and management efforts in the late 19th and early 20th centuries.

The data set contains fishery-related legislation enacted in Massachusetts coastal waters 1890-1935. *The Report of the Commissioners on Inland Fisheries and Game* was used as the primary source for the database for the period 1890-1901. These reports contain a list of all fisheries laws (sorted by subject) enacted in Massachusetts. The serial set, *General and Special Acts Passed by the Legislature of Massachusetts*, was used to cross check the accuracy of the information contained in the Commissioners' reports. *Acts and Resolves Passed by the General Court of Massachusetts*, *General Acts Passed by the General Court of Massachusetts*, and *Special Acts and Resolves Passed by the General Court of Massachusetts* were also consulted, and contain similarly-formatted inventories of legislation listed in the Commissioners' reports. These latter sources were used to inventory state fisheries legislation from 1901 to 1935. The *United States Statutes at Large* provided federal/international treaties, acts and resolves relevant to Massachusetts for years 1893 to 1935. Generally, the data set contains a complete inventory of Massachusetts state fisheries legislation enacted for the period 1890-1935; however, amendments to laws made during government hearings were not inventoried or included in this database.

The 'Year', 'Title' and 'Description' of each historical legislative record were manually transcribed into a Microsoft Excel worksheet. Places and locations that legislative efforts referred to were given geographic coordinates (Longitude, Latitude) derived primarily from the USGS Geographic Names Information System (GNIS). Legislation that was applicable to a region or the entire state was assigned a single, centroid geographic coordinate. If a legislation data record referred to multiple places, it was repeated in the data table and assigned an additional sequential decimal GMCP_ID number (e.g., 3.1 [Berkshire County], 3.2 [Franklin County], 3.3 [Hampshire County], 3.4 [Hampden County]). Each legislation record was classified according to type of 'Legal' instrument, 'Fish' species, fishing 'Gear', and 'General' theme (see field descriptions below). The source, physical location, and legal reference of each record are also provided.

The Excel data table was imported into ArcGIS and converted to an ESRI-formatted Shapefile (Legislation.shp). The 'Description' field is excluded from this Shapefile, as ArcGIS had difficulty handling this lengthy text field. Currently, the 'Description' field must be accessed via the Excel database (Legislation.xls).

Data fields are as follows:

GMCP_ID	Internal sequential numbering or order of data entry by Gulf of Maine Cod Project staff (1.0-437.0)
Year	Contains year the legislation was passed, repealed, or amended
Title	The title of the act, bill, resolve, etc.
Location	Place name, region, or area where legislation applicable
GeoSource	Geographic name database consulted (e.g., Geographic Names Information System [GNIS])
GeoID	Geographic name database identification number
X	Longitude (decimal degrees)
Y	Latitude (decimal degrees)
Legal	Type of legal instrument
Fish	Type of fish or species
Gear	Type of fishing gear or technology
General	General theme of legislation (see detailed descriptions below): Enforcement/Penalty, Government/Management, Fishing Gear, Pollution, Dams/Obstructions, Catch Limits, Trade/Economy, Aquaculture, Property Rights, and Vessel Regulation/Licensing
Source	Historical source of legislation
Citation	Legal reference
SourceLoc	The library, archive, or institution of source (Woods Hole Oceanographic Institute [WHOI], Boston Public Library [BPL], or University of New Hampshire [UNH])
Description	Text of the legislation or legal instrument

The database includes fisheries-related laws from Massachusetts' waters including the following place names: Adams, Agawam River, Angelica Point, Barlows Pond, Barnstable, Barnstable County, Bass River, Berkley, Berkshire County, Beverly, Beverly Harbor, Black Point Pond, Blankinships Cove, Boston, Boston Harbor, Bristol County, Buzzards Bay, Cape Cod Bay, Cape Cod Canal, Chain Bridge, Charles River, Chilmark Pond, Clarks Cove, Cohasset, Cohasset Harbor, Connecticut River, Cottage City, Crystal Lake, Dartmouth, Deerfield River, Dukes County, Duxbury, Duxbury Bay, Duxbury Harbor, Eastern Harbor, Eastham, Edgartown, Essex County, Essex River, Fairhaven, Farm Pond, Five Pound Island, Franklin County, Gloucester, Gloucester Harbor, Great Pond, Hadley, Halfway Pond River, Hampden County, Hampshire County, Herring Pond, Herring River, Hingham Harbor, Holmes Hold Harbor, Hull Bay, Hummock Pond, Ipswich, Ipswich River, Katama Bay, Kingston, Kingston Bay, Kingston Harbor, Lake Chaubunagungamaug, Lake Quinsigamond, Laurel Lake, Lawrence Dam, Lewis Bay, Little Black Point Pond, Lynn Harbor, Manchester Harbor, Marblehead Harbor, Marion, Marshfield, Mashpee, Mattapoisett, Mattapoisett River, Menemsha Pond, Merrimack River, Middlesex Fells, Mill Creek, Mill Pond, Mill River, Missisquoi Bay, Monument River, Moon Island, Mystic River, Nahant Bay, Nantucket, Nantucket County, Nantucket Sound, Nashaquitsa Pond, Neponset River, New Bedford, Newbury, North River, Orleans, Oyster Pond, Palmer, Palmer River, Parker Mills Pond, Parker River, Pasque Island, Pemberton, Pines River, Planting Island Cove, Pleasant Bay,

Plum Island Bay, Plum Island River, Plum Island Sound, Plymouth, Plymouth Bay, Plymouth County, Plymouth Harbor, Potanimicot River, Powder Hole, Quacumquasit Lake, Queenames Cove, Quincy Bay, Quincy Shore Reservation, Revere, Rochester, Rowley, Salem, Salem Bay, Saugus River, Scituate, Sherman Pond, Somerset, Squawbetty Village, Squibnocket Pond, Swan Pond River, Swansea, Tashmoo Pond, Taunton Great River, Tihonet Pond, Tisbury, Tisbury Great Pond, Vineyard Sound, Wachusett Reservoir, Wankinco River, Wareham, Weir River, Wellfleet, Wellfleet Bay, West Falmouth Harbor, Westport, Westport River, Weweantic River, Weymouth, Weymouth Back River, Weymouth Fore River, and Winthrop.

The 'General' data field may include any one or more of the following 11 primary themes as well as sub-categories of the primary themes:

Theme	Sub-Category
<i>Enforcement/ Penalty</i>	Conviction, Detection, District Police, Evidence, Enforcement, Fines, Fish Seizure, Fish Wardens, Fish-Forfeiture, Forfeitures, Imprisonment, Law Enforcement, Liability, Materially Injure, Penalties, Permits, Prohibition, Prosecute, Punishment, Regulate, Riparian Proprietor Control, Trespassers, Violations, Warrant, Written Permits
<i>Government/ Management</i>	Ecosystem, Fish Commission(er), US Fish Commission(er), Massachusetts Fish Commission(ers), Powers, Fishing Regulations, Fish-Protection, Free Passage, Governor, Local Jurisdiction, Local Regulations, , Preservation, State Fish Commissioners, Town Limits, Town Petition
<i>Fishing Gear</i>	Angling, Apparatus, Artificial Fly (Bait, Hook, Light), Beam Trawl, Boat, Craft, Circular Net, Contrivance, Dip Net, Drag Net, Drag Seine, Dredge, Dynamite, Eel-Pots, Firearms, Float, Fork, Gill Net, Hand Line and Hook, Hand-Nets, Hanging Net, Hand Line, Hand Net, Hoe, Hook, Hoop Net, Instruments, Lamp, Light, Line, Mesh, Natural (Bait, Hook), Net, Otter Trawl, Pole, Pot, Pound, Purse Net, Purse Seine, Rake, Rectangular Net, Rod, Single Hand Line, Salmon Pot, Set Net, Shovels, Spear, Spoon, Stationary Apparatus, Steamer, Sweep Net, Sweep Seine, Toggle, Tong, Torch, Trap, Trawl, Vessel, Weirs, Yard
<i>Pollution</i>	Acids, Alkalies, Drugs, Dye-Stuffs, Pollution Control, Sawdust, Substance Deposit Limits
<i>Dams/Obstructions</i>	Dam, Dam Disturbance, Dam Examining, Dam Repair, Fish Weirs, Fishway Repairs, Fishway, Obstruction, Outlets, Outlet Construction, Saw-mills
<i>Catch Limits</i>	Catch Limits, Closed Seasons, Closed Times, Daily Fishing Limits, Legal Fishing Limits, Limitations, Restricted Fishing Areas, Restricted Propagation Areas, Restricted Seeding Areas, Seasonal Sale Limits, Size Limits, Size Restrictions, Sustenance Fishing, Weekly Limits
<i>Trade/Economy</i>	Commerce, Improvements, Leases, Lease Permits, Price

	Control, Taxation, Treasury, Water Rental
<i>Aquaculture</i>	Fish Cultivation, Fish Hatchery, Fish Hatching Station, Fish Propagation, Oyster Culture, Quahaug Culture, Pisciculture, Propagation, Stocking, Stocking Regulations
<i>Property Rights</i>	Common Property Resource, Corporate Fishing Rights, Possession, Private Land Protection, Private Property, Public Access, Public Fishery, Public Interest, Public Meeting, Public Property, Public Rights
<i>Vessel Regulation/License</i>	Boats, Licenses, Vessel Limits, Vessel Seizure, Vessel Transportation
<i>Fish-General</i>	Refers to generalizations about fish and their role within society, economy, and industry

Marine Scientific Survey Logbooks

This data set contains sea temperature and salinity measures taken by U.S. Fish Commission research vessels in the 19th and early 20th centuries. The data set was developed by Stefan Claesson of the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH). Data set development focused on survey stations made within or adjacent to Massachusetts Bay, for the purposes of evaluating changes over time in the ecosystem of the Stellwagen Bank National Marine Sanctuary (SBNMS) and the greater Gulf of Maine. Geographic coverage of the data set, however, is inclusive of the northeastern United States from Chesapeake Bay to Nova Scotia.

Temperature and salinity measurements include those recorded by *Bluelight* (1873), *Bache* (1872-1874), *Speedwell* (1877-1879), *Grampus* (1913-1916), *Halcyon* (1912-1921), *Yvonne* (1924), *Gannet* (1924-1925), and *Fishhawk* (1882-1905). These measurements were transcribed from digital images of the original survey logbooks, which are archived at the Smithsonian Institution Archives, Record Unit 7184. This data set does not include survey logbooks *Lookout*, *Albatross*, and only a partial listing for *Yvonne* is included. These U.S. Fish Commission survey vessels operated through the late 19th and early 20th centuries. Also, approximately 350 stations of *Grampus* and *Halcyon* are not included in this data set. Although the logbook formats vary over time and the data recorded variable to the purpose of the research cruise, generally logbooks contain the following fields and information:

Station No.
Date
Time of day
Tide (condition of tide, e.g., ebb or flood)
Locality (general description of location)
Position (latitude/longitude, or origin point, bearing and range)
Nature of bottom (description of bottom type and sediment)
Sampling instrument used (e.g., nets, dredges)
Direction and distance of drift (this is rarely recorded)
Temperature of air (usually in Fahrenheit, occasionally Celsius)
Temperature of surface water (usually in Fahrenheit, occasionally Celsius)
Temperature at depth (depth variably fathoms, feet, meters)
Density
Water color/visibility
Equipment type and identification number
Barometer/Pressure
State of sky and sea (qualitative description)
Wind direction (compass heading)
Wind force (numerical scale, typically Beaufort, occasionally qualitative description)
Rain (rarely given, typically noted under 'state of sky' field, qualitative description)
Direction of surface and bottom currents (knots)
Speed of surface and bottom currents (knots)
Name of vessel, commanding officer, and observer
Notes relating to station (lists of marine species sampled or counted, observations of marine mammals, additional notation of unusual at-sea conditions, sketches, etc.)

Sea temperature measures are mostly surface temperatures, but there are numerous stations with water column and bottom temperature readings. There are, comparably, a dearth of salinity measurements taken in the Gulf of Maine by *Grampus* (1914-1916) and *Halcyon* (1912-1914).

Data from *Bluelight*, *Bache*, and *Speedwell* were transcribed from survey tables published in “Lists of the Dredging Stations of the United States Fish Commission from 1871 to 1879, Inclusive, with Temperature and Other Observations,” *Report of the Commissioner for 1879* (1882), p. 559-615. The report further documents the activities of these survey vessels and the intent of their survey work. Regarding the precision and accuracy of vessel position of these early steamers the report offers the following:

“From the nature of the operations of dredging and trawling, it becomes almost impossible to estimate exactly the changes of position caused by currents, &c., especially when out of sight of land, and in a few cases the positions were not placed on the charts at the time, and the bearings given do not suffice to fix them very accurately. It is believed, however, that but few positions laid down on the chart are rendered uncertain to any great extent by either of these causes.” (p. 559-560)

Temperature measurements for these early surveys are also described in the report:

“The temperature observations recorded in the two following tables were mostly taken with much care. Former experiences had proved that the Miller-Casella thermometers were slow in acting, requiring from three to ten minutes (according to the depth of water) to obtain a correct reading, and they were, therefore, always left down a suitable length of time. The bottom and surface temperatures, in nearly all cases, were taken with Miller-Casella self-registering thermometers; occasionally a United States naval thermometer was employed for surface temperature, and the same instrument was generally employed for the air.” (p. 574)

It is noted further that:

“The bottom temperatures in 1877 were mostly taken with Miller-Casella self-registering, deep-sea thermometers, but in 1878 and 1879 Negretti-Zambra thermometers were used for that purpose. All the temperatures for 1879 were taken with more than usual care, the thermometers employed being frequently compared with a reliable standard.”

The Negretti-Zambra thermometers became the standard measuring device for most U.S. Fish Commission cruises following on the work of *Speedwell* in 1879: “We received some new Negretti-Zambra thermometers to-day, which seem to perform their work perfectly, so that our observations will; doubtless, be more satisfactory in the

future.” (p. 604-605). An exhaustive description of the Negretti-Zambra thermometer and its methods of use on *Fishhawk* is provided in the *Report of the Commissioner for 1883* (1885), p. 71-77. A description of vessel navigation and methods is also found in this report (p. 212-217).

Logbooks were photographed by digital camera and compiled into Adobe Acrobat .pdf files. These documents were then manually transcribed into Microsoft Excel workbooks and compiled into a master spreadsheet (‘EnviroData.xls’). Water depths, typically given in fathoms, were converted to meters, and temperatures, often provided in Fahrenheit, were converted to Celsius. Position coordinates recorded in degrees, minutes and seconds were converted to decimal degrees. Positions referenced by shore features (e.g., lighthouses), bearings (which are boxed into 213 compass directions [e.g., N by W ¼ W]), and range (in nautical miles) were converted to decimal degrees and kilometers. Bearings were adjusted further for magnetic variation using National Geophysical Data Center (NGDC) declination/variation calculators (see e.g., <http://www.ngdc.noaa.gov/geomagmodels/USHistoric.jsp>). These adjustments were calculated based on the location of origin points and dates of observations.

GMCP developed an Internet calculator (<http://fishhistory.org/LatLonRngBrg.php>) in php scripting language to compute coordinates based on latitude and longitude of the origin point, decimal bearing, and kilometer range (based on quadratic mean radius [see e.g., http://en.wikipedia.org/wiki/Earth_radius#Quadratic_mean_radius:_Qr]). A quality check of geographic positions in ArcGIS revealed that reverse bearing were occasionally and incorrectly recorded in the logbooks. In such cases, bearings were adjusted and positions of survey stations re-calculated.

The final data table was imported into ArcGIS and saved as an ESRI Shapefile (‘PhysicalData.shp’).

Data Fields and Attributes in this data set:

Vessel	Name of research vessel
Station	Identification number of station where observation made
Year	Year of observation
Month	Month of observation
Day	Day of observation
X	Longitude in decimal degrees
Y	Latitude in decimal degrees
Z	Depth in meters
SeaTemp	Water temperature in Celsius
Salinity	Salinity measure
Source	Location and reference of historical source material

Biological Specimens

This data set contains marine species sampled, collected or reported during fishing and research expeditions 1875-1935. The data set was developed by Stefan Claesson of the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH). The geographic extent of the data set includes the Scotian Shelf and Grand Banks to the east and the Continental Shelf to the south and west. However, data recovery focused on areas within or adjacent to Massachusetts Bay, for the purposes of documenting the maritime history and marine ecology of the Stellwagen Bank National Marine Sanctuary (SBNMS). These data were compiled primarily for the purpose of modeling historical species distributions in SBNMS and the greater Gulf of Maine.

This data set is a collection of disparate historical sources:

Gloucester Donations. Gloucester fishermen participated in a U.S. Fish Commission survey in the late 1870s that sought to collect unusual or particularly exquisite examples of marine species for study and curation. The 1879 Annual Fish Commission Report, which was printed in 1882, contains an annotated list of 532 specimens collected at Gloucester, MA, during the 1870s (*Report of the Commissioner for 1879* [1882], p. 787-835). The report provides the following information:

“The fishes included in the following list were identified by Mr. G. Brown Goode and Dr. T. H. Bean. The Invertebrata were either originally identified or have subsequently been revised by Prof. A. E. Verrill, who is, therefore, to be considered responsible for the accuracy of the names. The nomenclature adopted for the Invertebrata is very nearly that of the Preliminary Check-list of the Marine Invertebrata of the Atlantic Coast, by A. E. Verrill, Edition of 1879.” (p. 787)

Additionally:

“When the United States Fish Commission established its station at Gloucester, Mass., in 1878, from which to prosecute its researches into the history and condition of the fisheries, the opportunity of securing the co-operation of the fishermen of the port in collecting the deep-sea animals was gladly embraced. With scarcely an exception, the captains and crews of the vessels engaged in the Banks fisheries undertook to preserve all the miscellaneous objects brought up on their lines or trawls and place them in alcohol furnished by the Commission. Such was the extent and variety of their collections that it was found expedient to keep an agent at Gloucester permanently, at the office occupied at first by the Commission.” (p. 787)

Although the program did not officially begin until 1878, a few specimens are dated as early as 1875, but most specimens (1-532) published in the U.S. Fish Commission report are undated. Undated specimens were assigned a *terminus ante quem*

of 1879. A total of 972 specimen numbers were assigned during the Fish Commission collection project, but the latter half of the specimen list went unpublished. Specimens 533-972, which are included in this database, were tabulated from an unpublished manuscript found at the National Museum of Natural History, Division of Fishes Cataloguing Room (Smithsonian Institution Archives, Record Unit 7220). The latter unpublished list provides month and year of capture and date 1879-1881.

U.S. Fish Commission Survey Logbooks. These historical specimen reports were gathered from U.S. Fish Commission survey logbooks belonging to the *Grampus*, *Gannett*, *Halcyon*, *Fishhawk*, and *Josie Reeves*. The logbook data included here include specimens and reports on benthic and pelagic species, marine mammals, birds, and zooplankton, mostly from the Gulf of Maine. Logbook records date from the early 1880s to the mid 1920s. In addition to specimens collected during various marine surveys, the logbooks contain physical oceanographic data. This information was compiled in a separate data set. The original logbooks are located at the Smithsonian Institution Archives, Record Unit 7184.

Natural History Museum Collection Databases. Although databases such as OBIS and Fishbase.org were utilized to query museum collections, the origin databases, specifically the National Museum of Natural History (NMNH), Fisheries Department, eMu database <http://www.nmnh.si.edu/vert/fishes/fishcat/index.html> was cross-validated for specimen identifications, geographic coordinates, and descriptions. Most of the NMNH specimens lack precise geography. Point coordinates are not provided for these specimens, but a description of their geographic location is included.

Unpublished Papers and Reports. A NOAA-sponsored publication, *An Annotated List of the Fishes of Massachusetts Bay* (B. B. Collette and K. E. Hartel, 1988), contains a comprehensive list of historical fish specimens collected from Massachusetts Bay. A very few of these specimens have exact coordinates, but their geographical or place-name descriptions are included in the data set.

With the exception of USNM and Fishbase.org data sets, historical sources and texts were manually transcribed into Excel workbooks, and integrated into a single specimen table ('Specimens.xls'). This table was imported into ArcGIS and converted to an ESRI Shapefile ('Specimens.shp'). The data set includes scientific as well as common names for species, as provided in the original historical sources. Coordinates for specimens are listed only if they are given in the original data source in latitude and longitude, or provide exact location descriptions in the form of a known origin point (e.g., a lighthouse), bearing, and range. In the latter case, latitude and longitude was derived by measuring these factors as well as magnetic variation at the origin point and date of the specimen location description. Generally, coordinates for place names, towns, rivers, regions, fishing banks or grounds were not used to derive point coordinates, as they are unreliable for the purposes of modeling species distributions. However, if a place name could be tied to a specific place that could be located, e.g., "specimen caught in a net off Doanes Wharf in Gloucester", coordinates were assigned. Typically, place names refer to larger bodies of water (Gloucester Harbor) and regions (Eastern Georges Bank, Nova

Scotia coast), which lack the spatial precision needed for species distribution modeling. However, these records are included within the database, as they may be useful for broader ecosystem studies or analyses.

Data Fields and Attributes:

ID	Sequential identification number assigned by GMCP
Database	Database that specimen data was extracted
CatNum	Catalog number of specimen, according to database
Month	Month specimen collected or reported
Year	Year specimen collected or reported
Scientific	Genus and species
Common	Common name for species
Longitude	Longitude in decimal degrees
Latitude	Latitude in decimal degrees
Location	Place name or description of location
Source	Source of historical material, archive location, or document reference

APPENDIX B: Supplementary Analysis

Figure A. Species composition of catch from Stellwagen Bank, 1901-1915. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis.

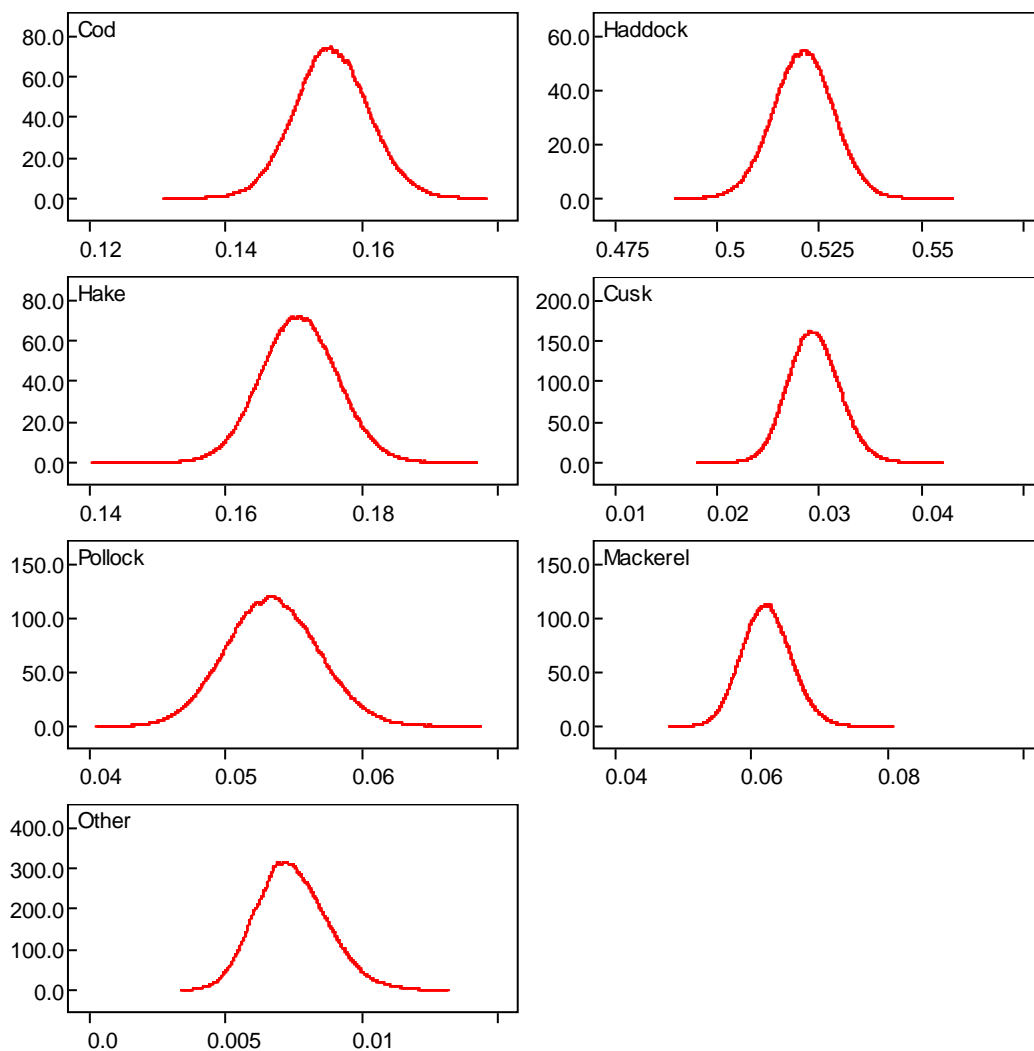


Figure B. Species composition of catch from Stellwagen Bank, 1916-1935. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis.

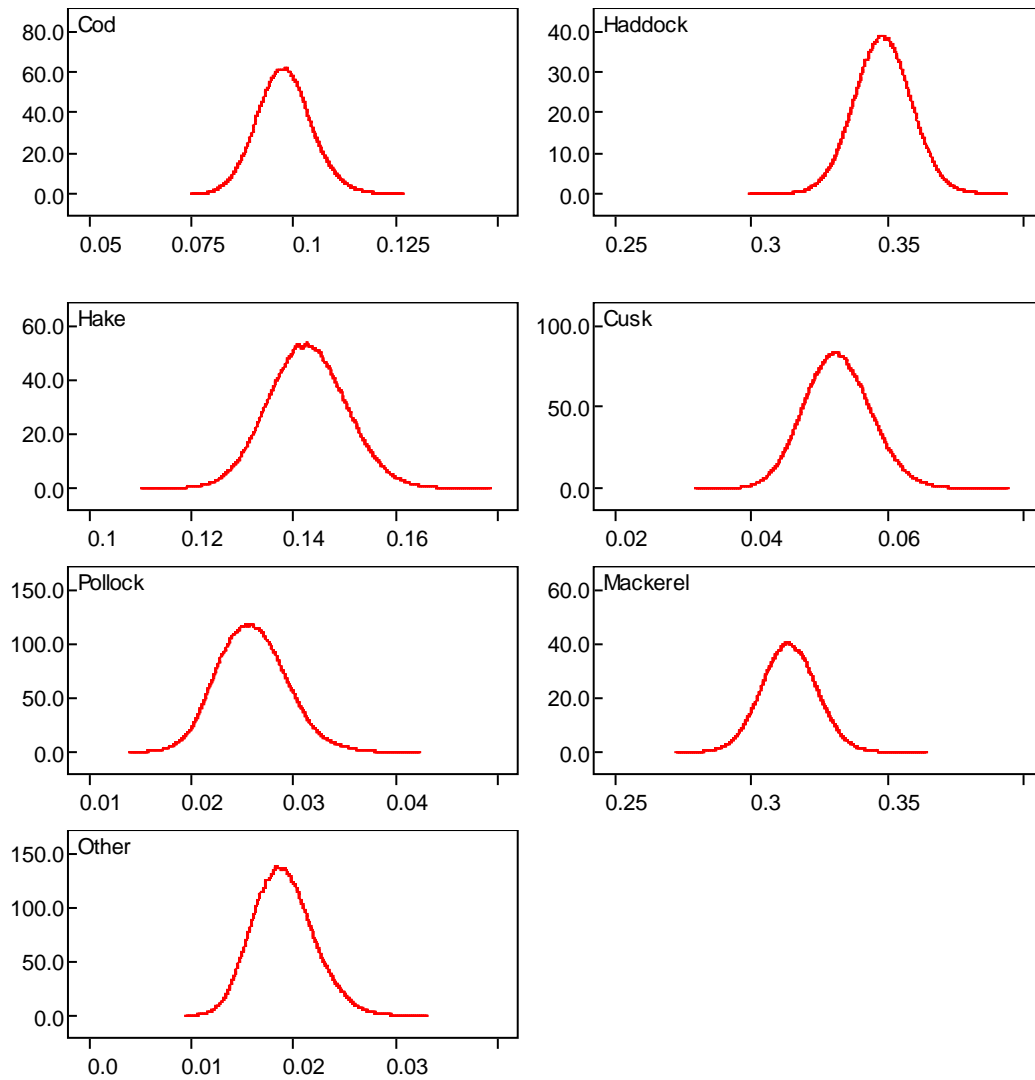


Figure C. Change in the proportions in the catch from Stellwagen Bank, 1901-1915 vs. 1916-1935. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis. Positive values indicate and increase in the proportion from the earlier era to the later.

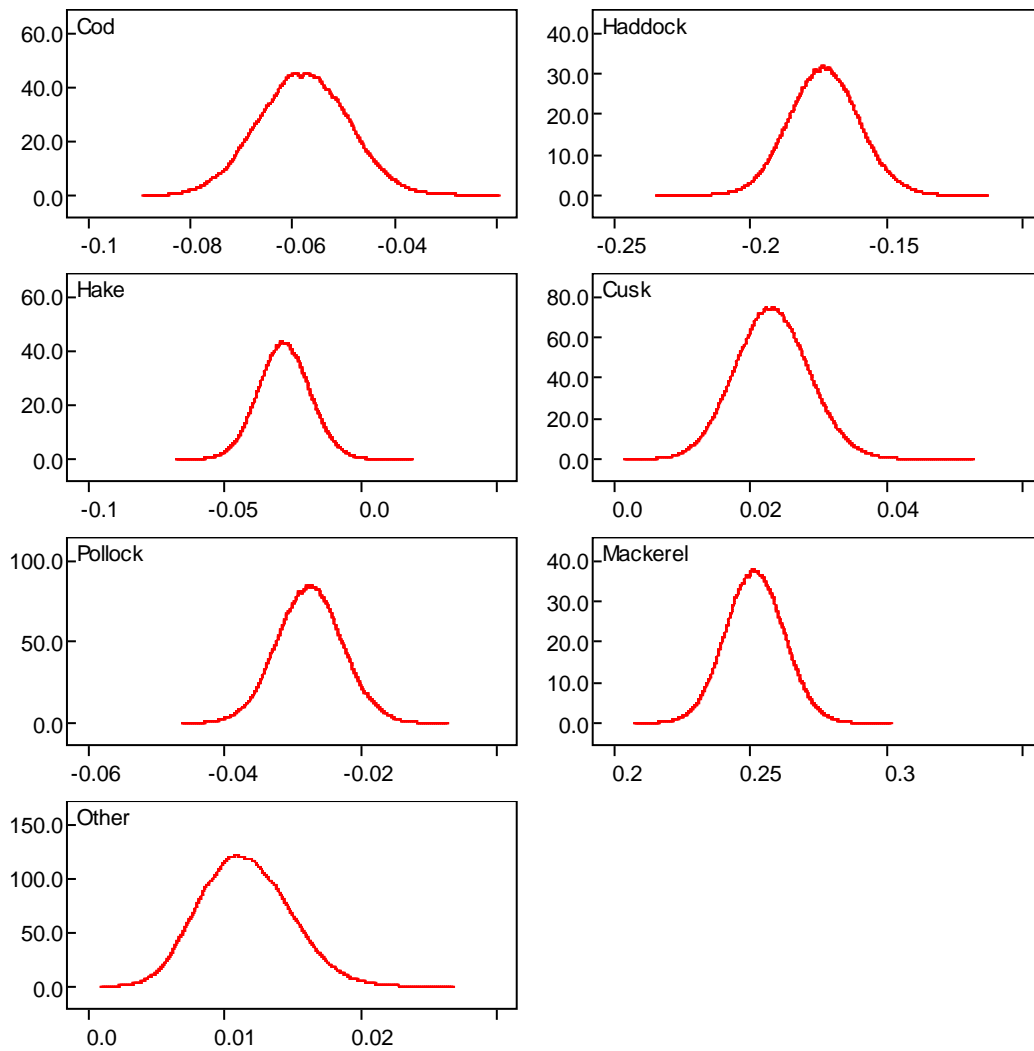


Figure D. Difference in the proportions in the catch from Stellwagen Bank and Gulf of Maine, 1901-1915. The estimated difference in the proportion in the catch is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis. Positive values indicate a greater proportion from the Gulf of Maine than from Stellwagen.

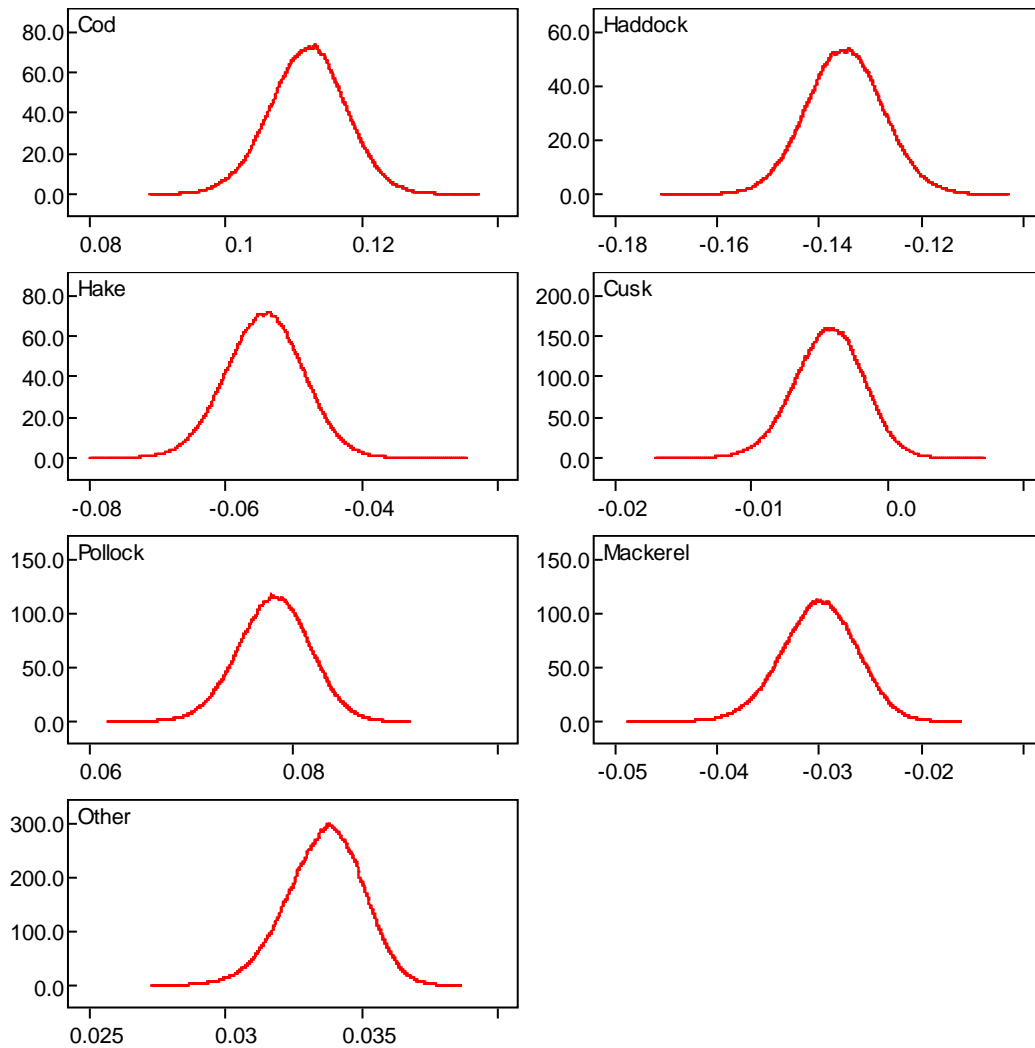


Figure E. Difference in the proportions in the catch from Stellwagen Bank and Gulf of Maine, 1916-1935. The estimated difference in the proportion in the catch between the two areas is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis. Positive values indicate a greater proportion from the Gulf of Maine than from Stellwagen.

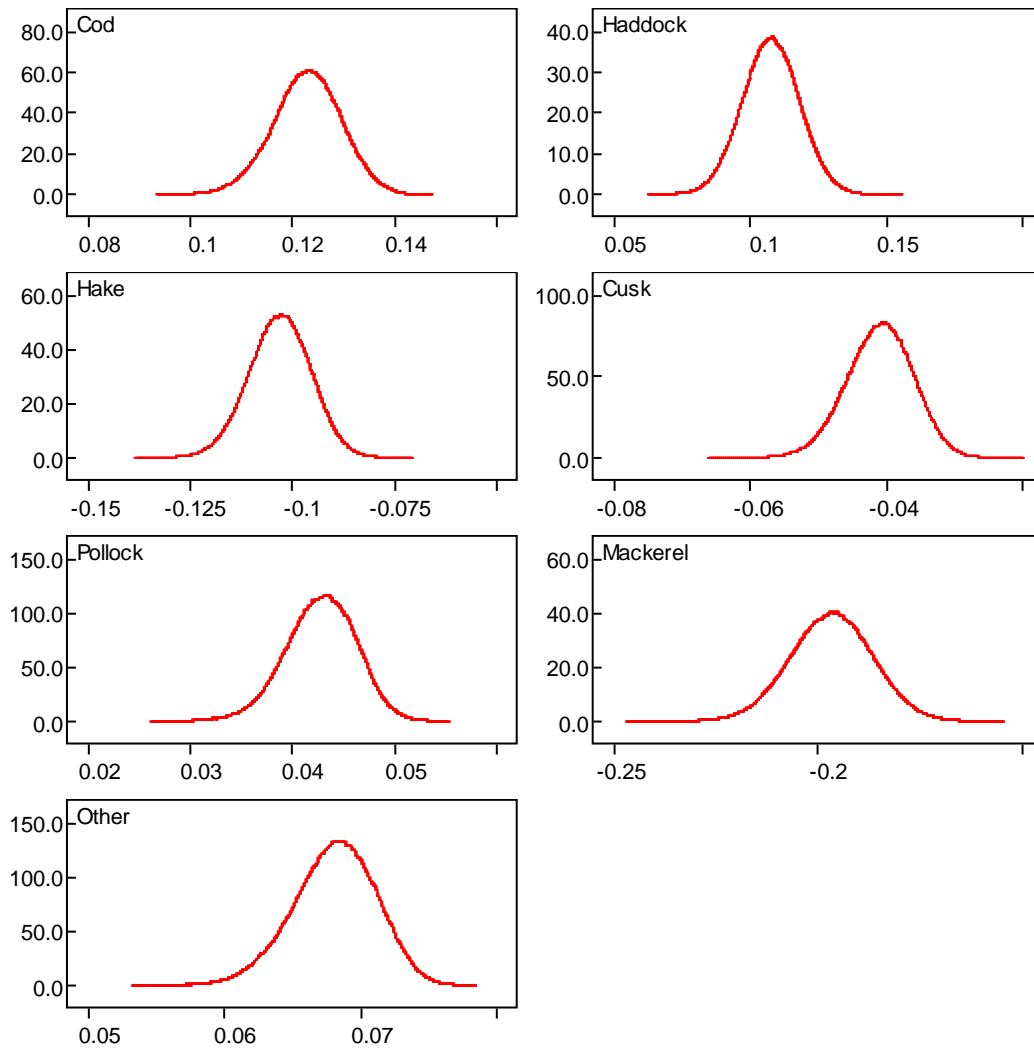


Figure F. Species composition of catch from Stellwagen Bank, 1995-2005. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis.

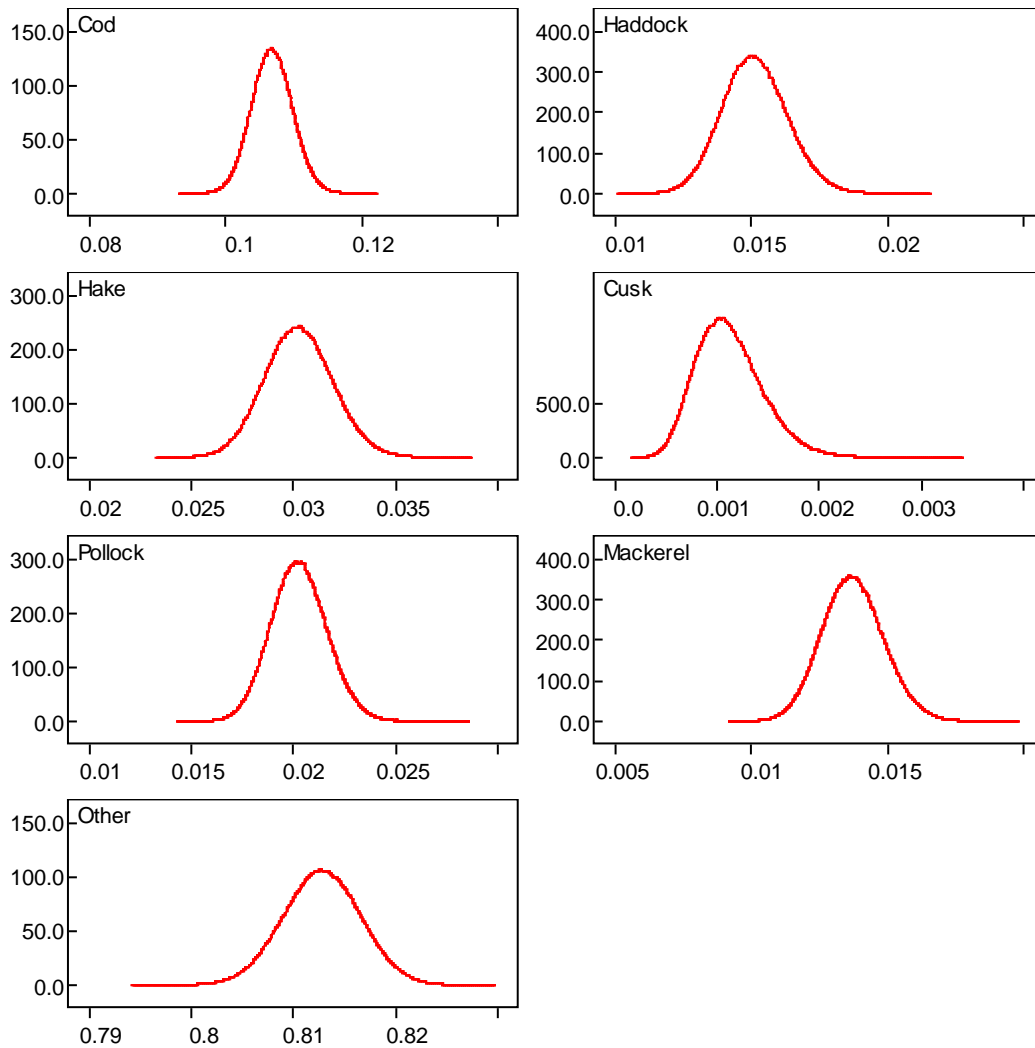


Figure G. Change in the proportions in the catch from Stellwagen Bank if we ignore the “other” category, 1901-1915 vs. 1995-2005. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis. Positive values indicate and increase in the proportion from the earlier era to the later.

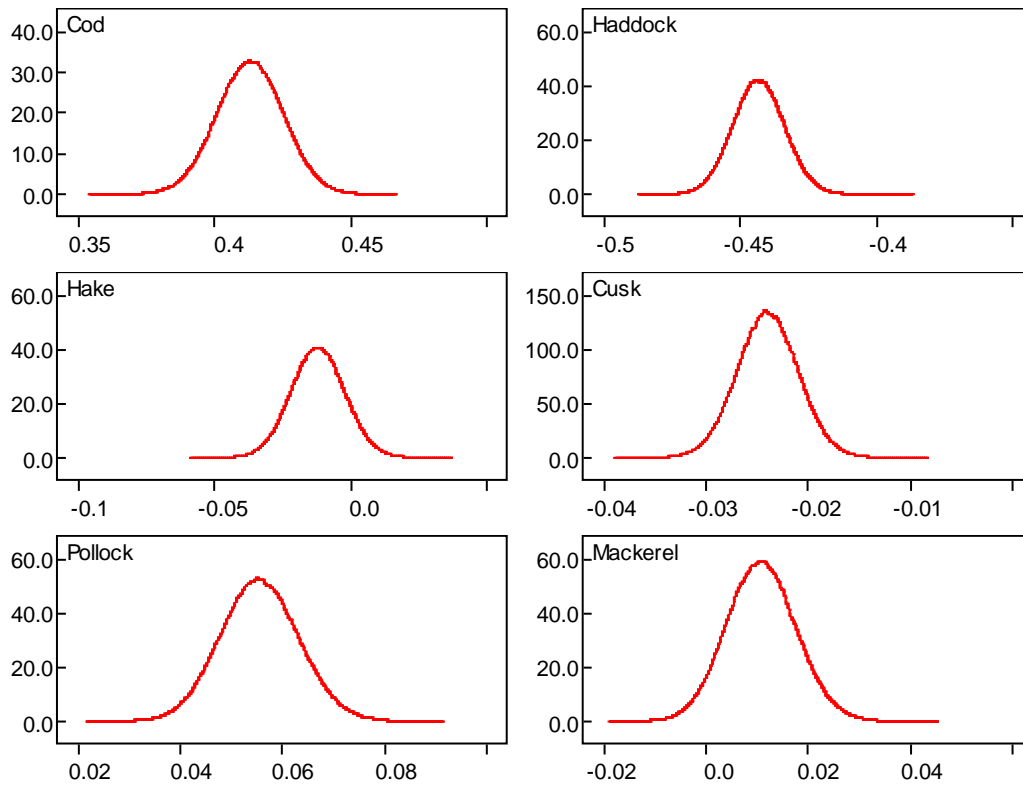


Figure H. Change in the proportions in the catch from Stellwagen Bank if we ignore the “other” category, 1916-1935 vs. 1995-2005. The estimated proportion is on the X-axis, the frequency of this value from the MCMC chain is on the Y-axis. Positive values indicate an increase in the proportion from the earlier era to the later.

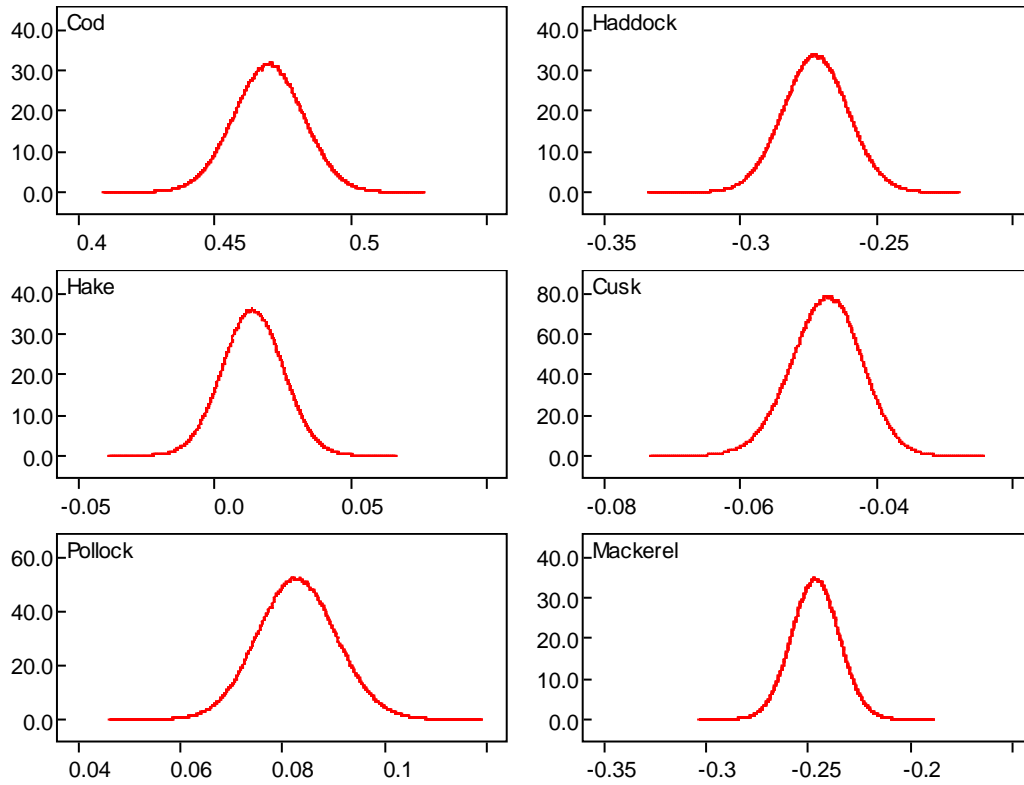


Table A. Grounds and species codes used in factor analysis.

Fishing Grounds	Code
Stellwagen (Middle) Bank	MIDDLE
Platts Bank	PLATTS
Fippenies Bank	FIPPS
Cashes Bank	CASHES
Jeffreys Ledge	JEFFREYS
Georges Bank	GEORGES
Browns Bank	BROWNS
Off Chatham	CHATHAM
Off Highland Light	HIGHLAND
South Channel	SOUTH.CHANNEL
Nantucket Shoals	NANTUCKET.SHOALS
Seal Island Bank	SEAL
New England Shore	SHORE 1 (Shore)
Nova Scotia Shore	SHORE 2

Species	Code
Cod	Cod
Haddock	Had
Halibut	Hal
Hake	Hak
Cusk	Cus
Pollock	Pol
Mackerel	Mac

Figure I. Factor loadings for species- and bank-specific monthly catch from the Gulf of Maine, 1901-1935.

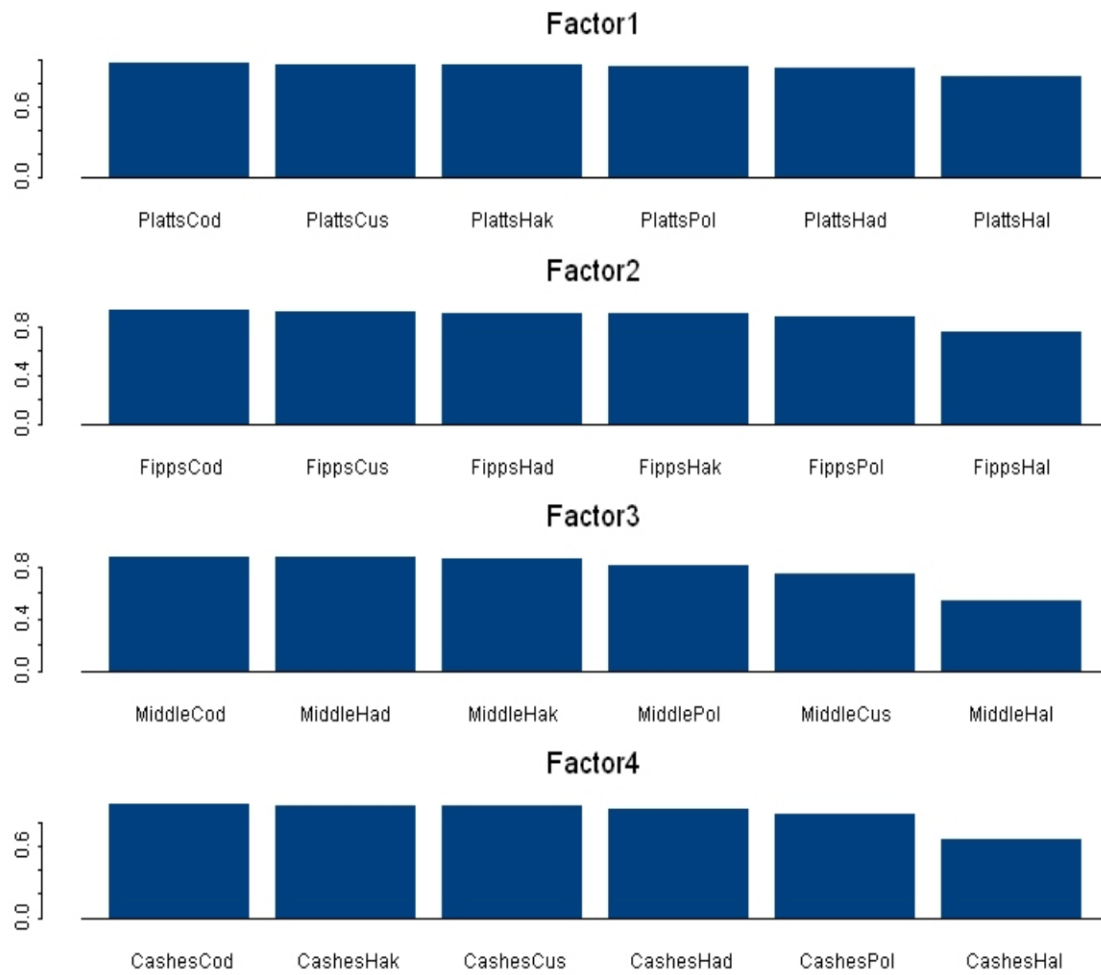


Figure I (continued)

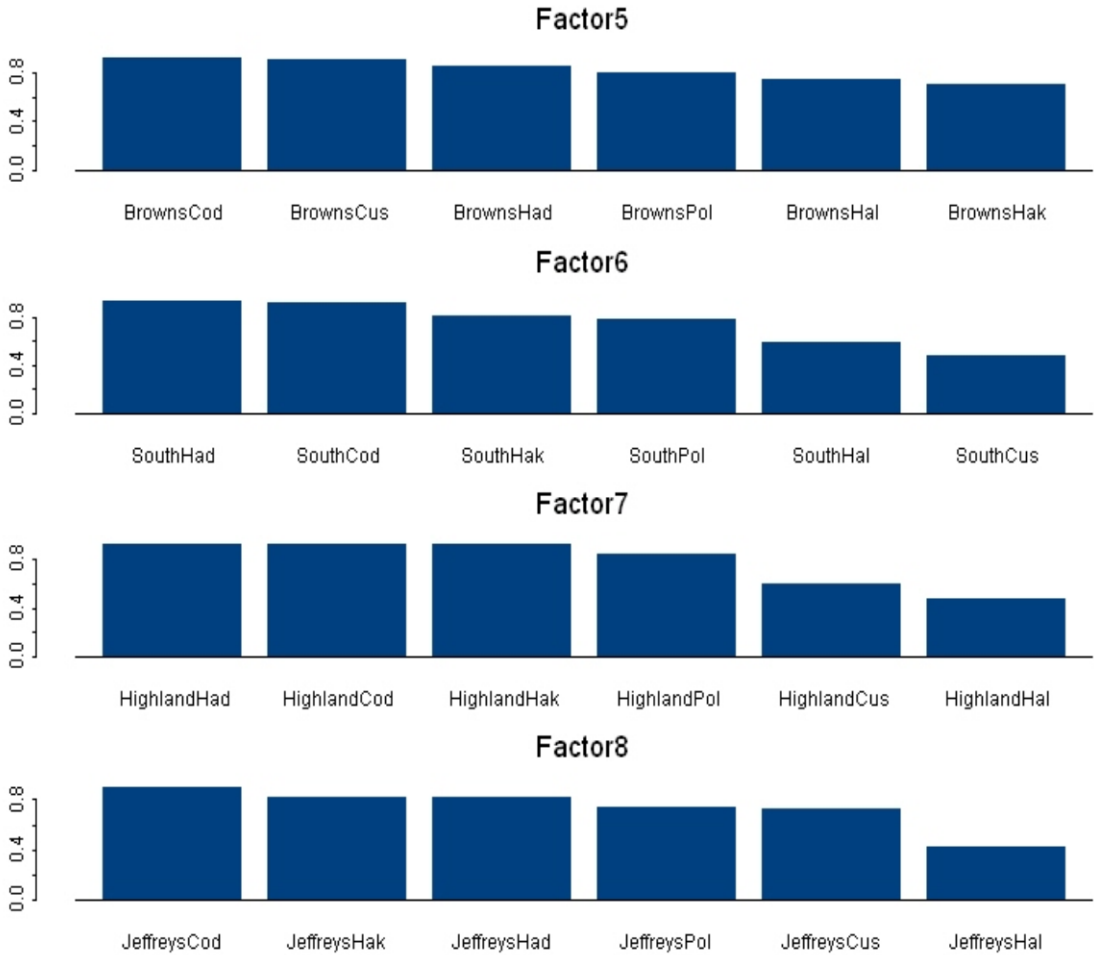


Figure I (continued)

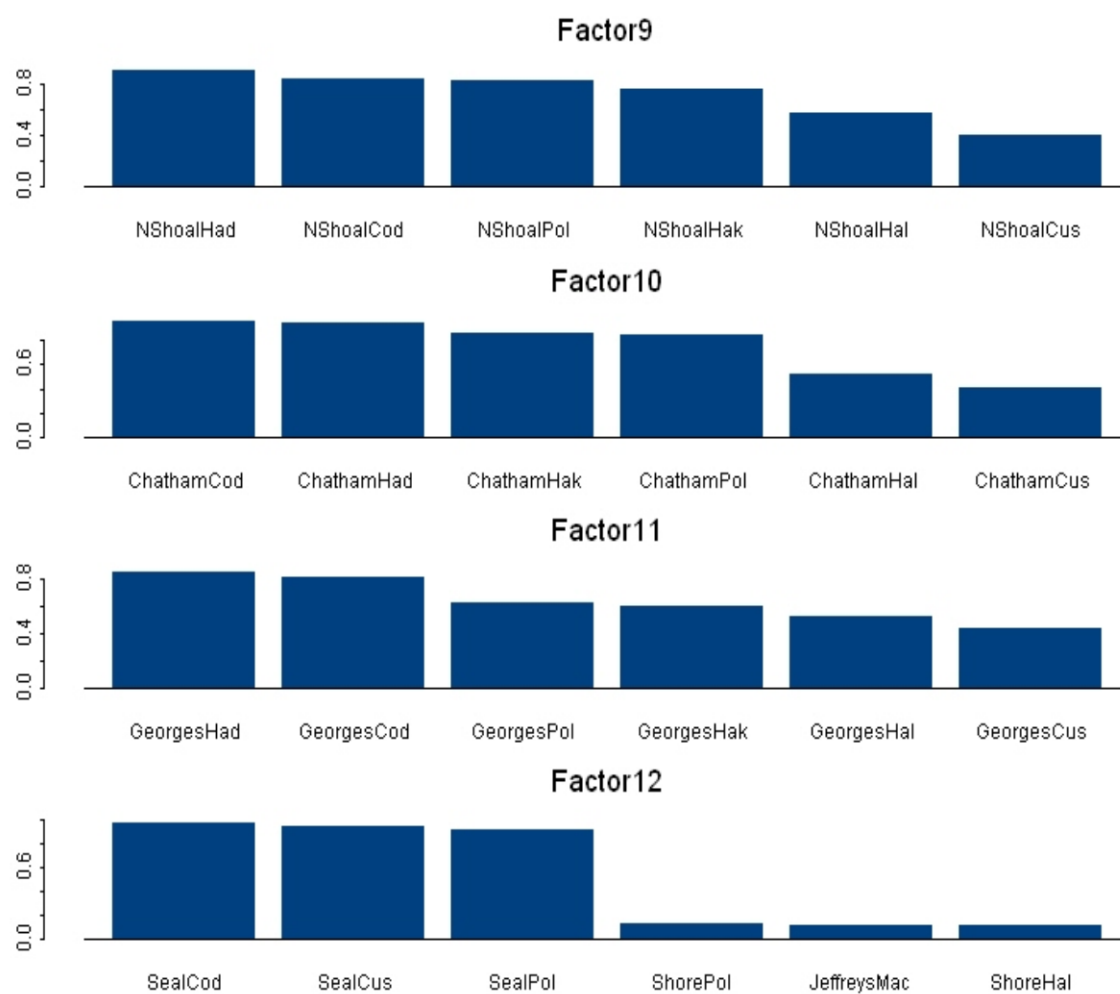


Figure I (continued)

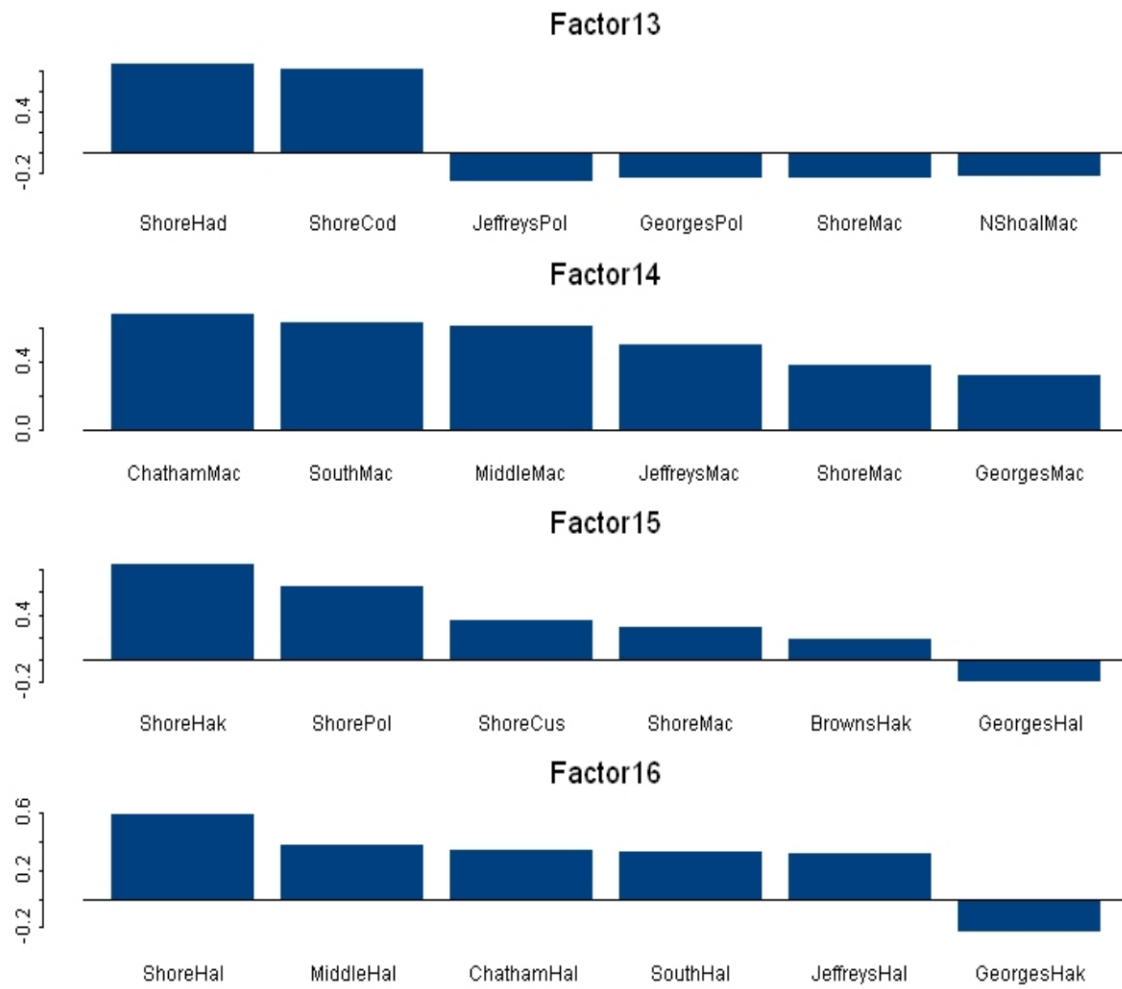


Figure I (continued)

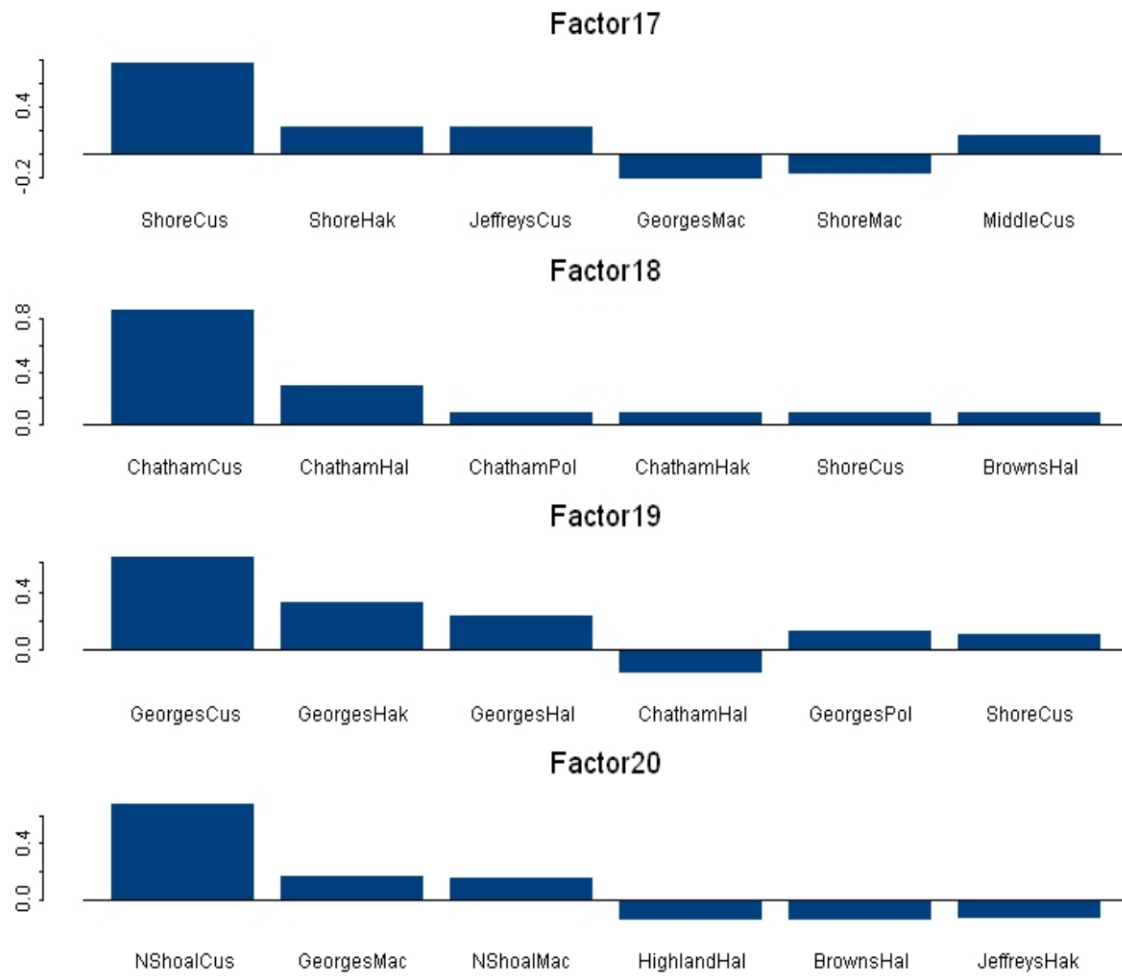


Figure J. Time series for fishing banks created by the factor analysis.

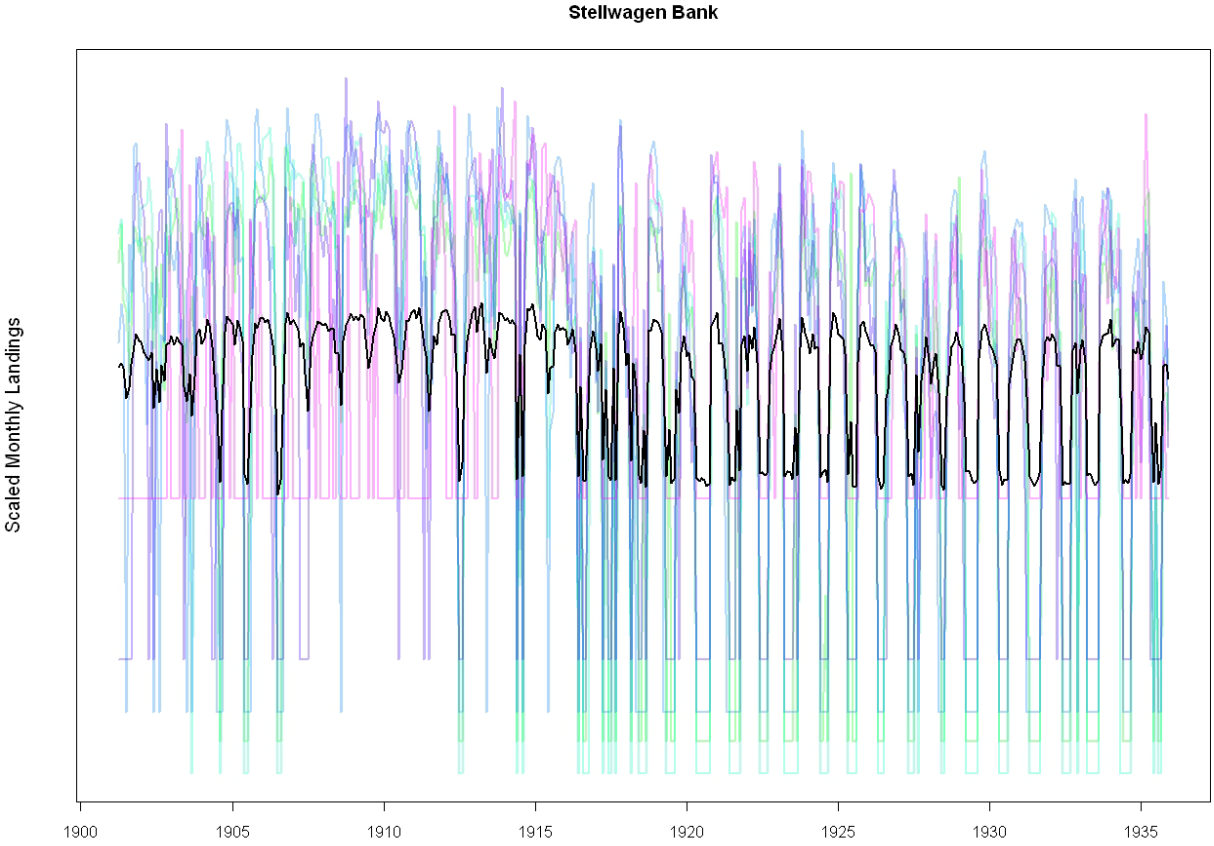


Figure J. (continued)

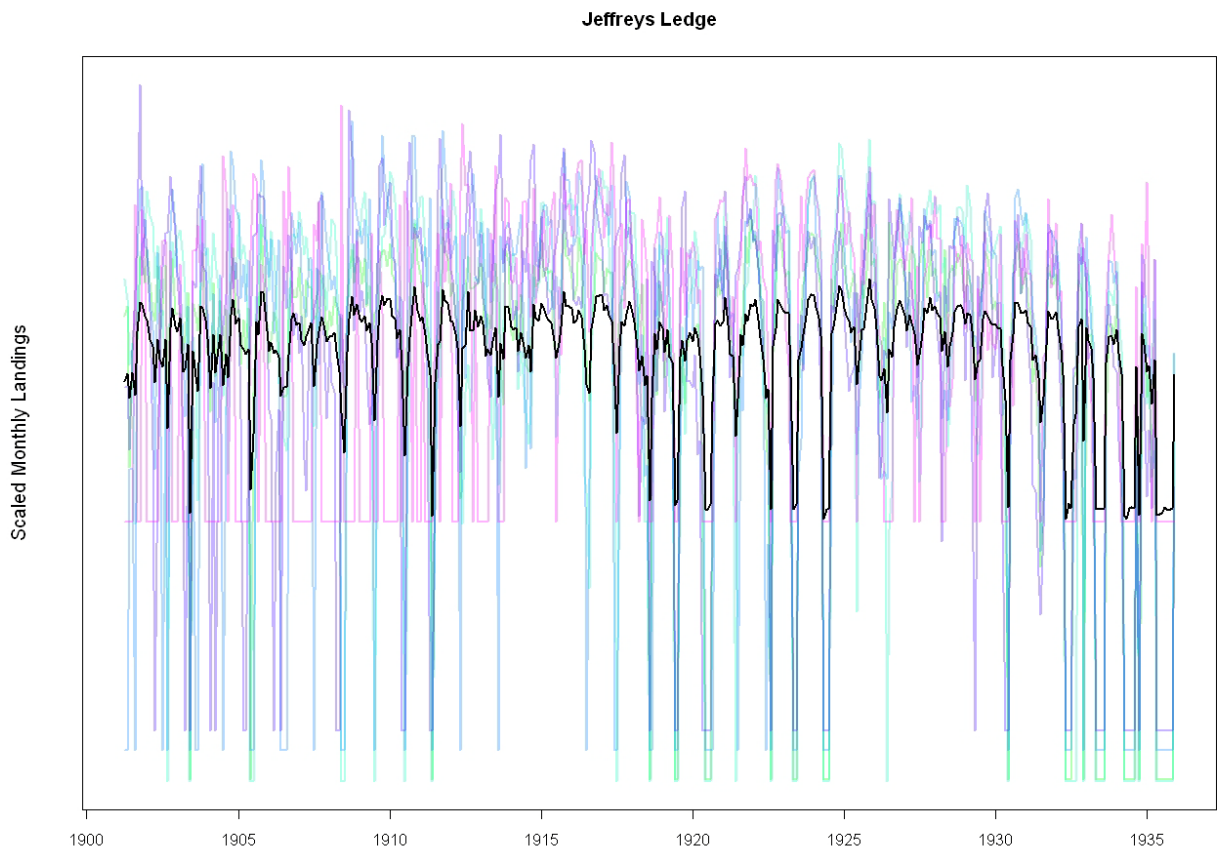


Figure J. (continued)

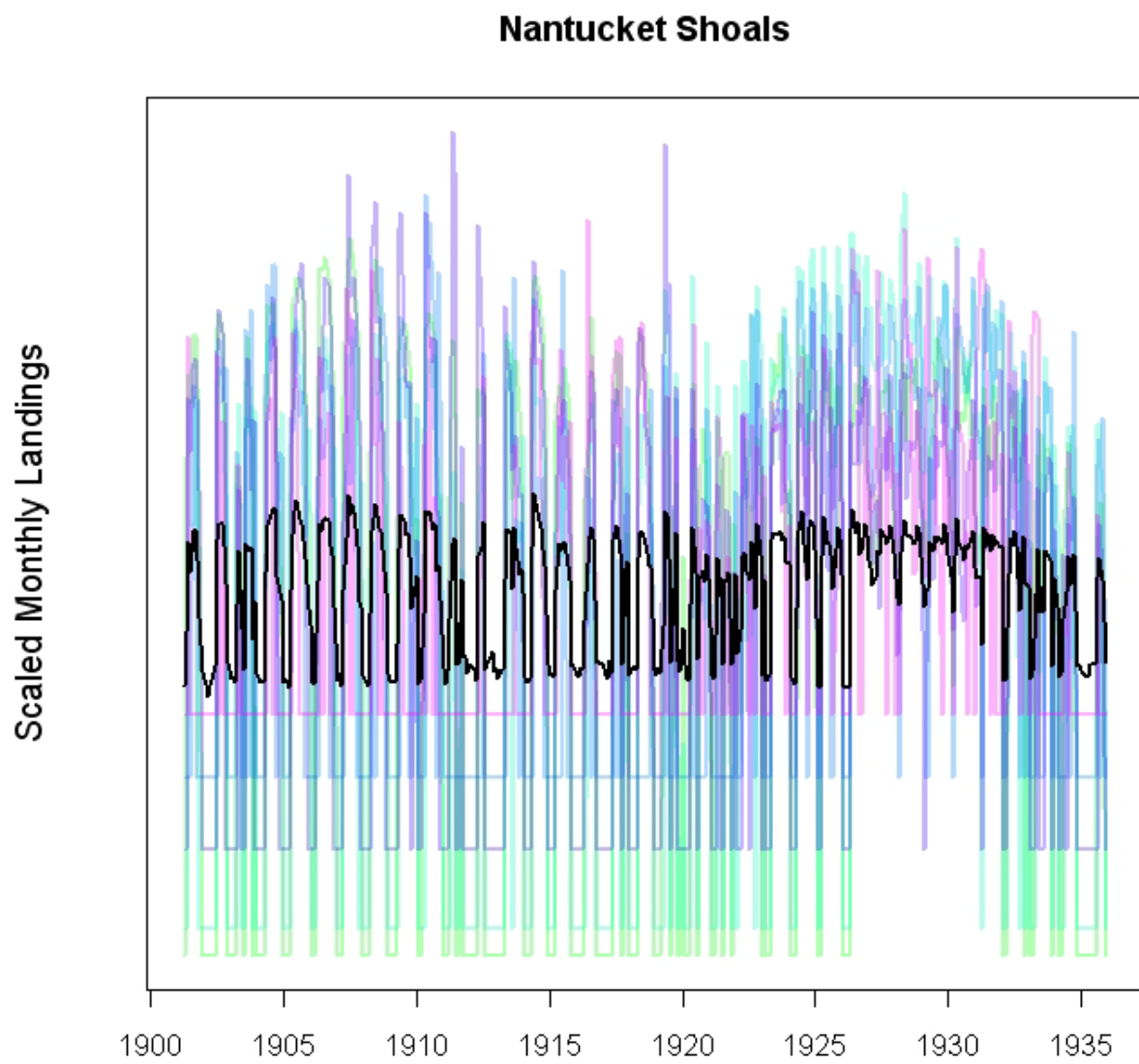


Figure J. (continued)

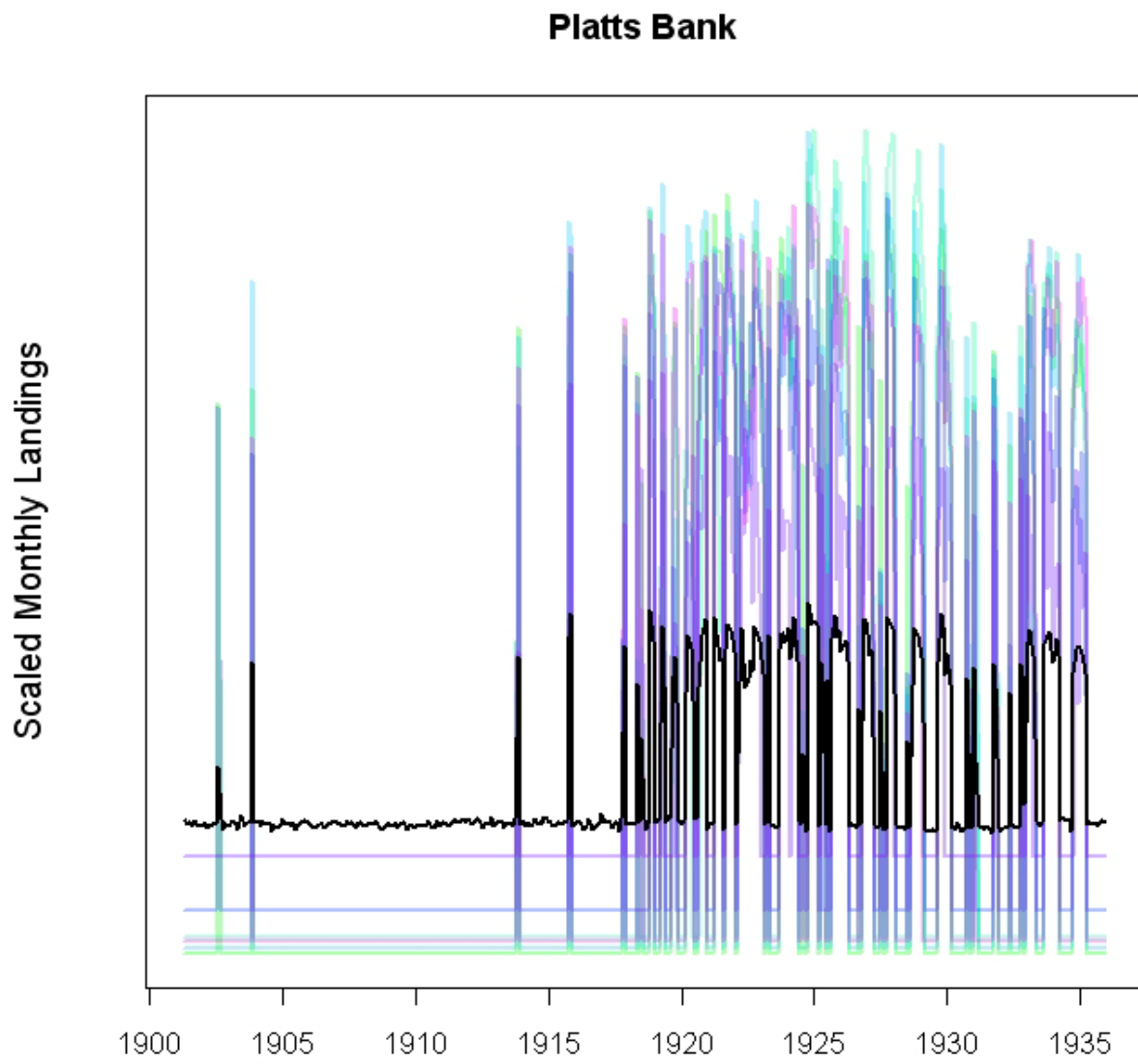


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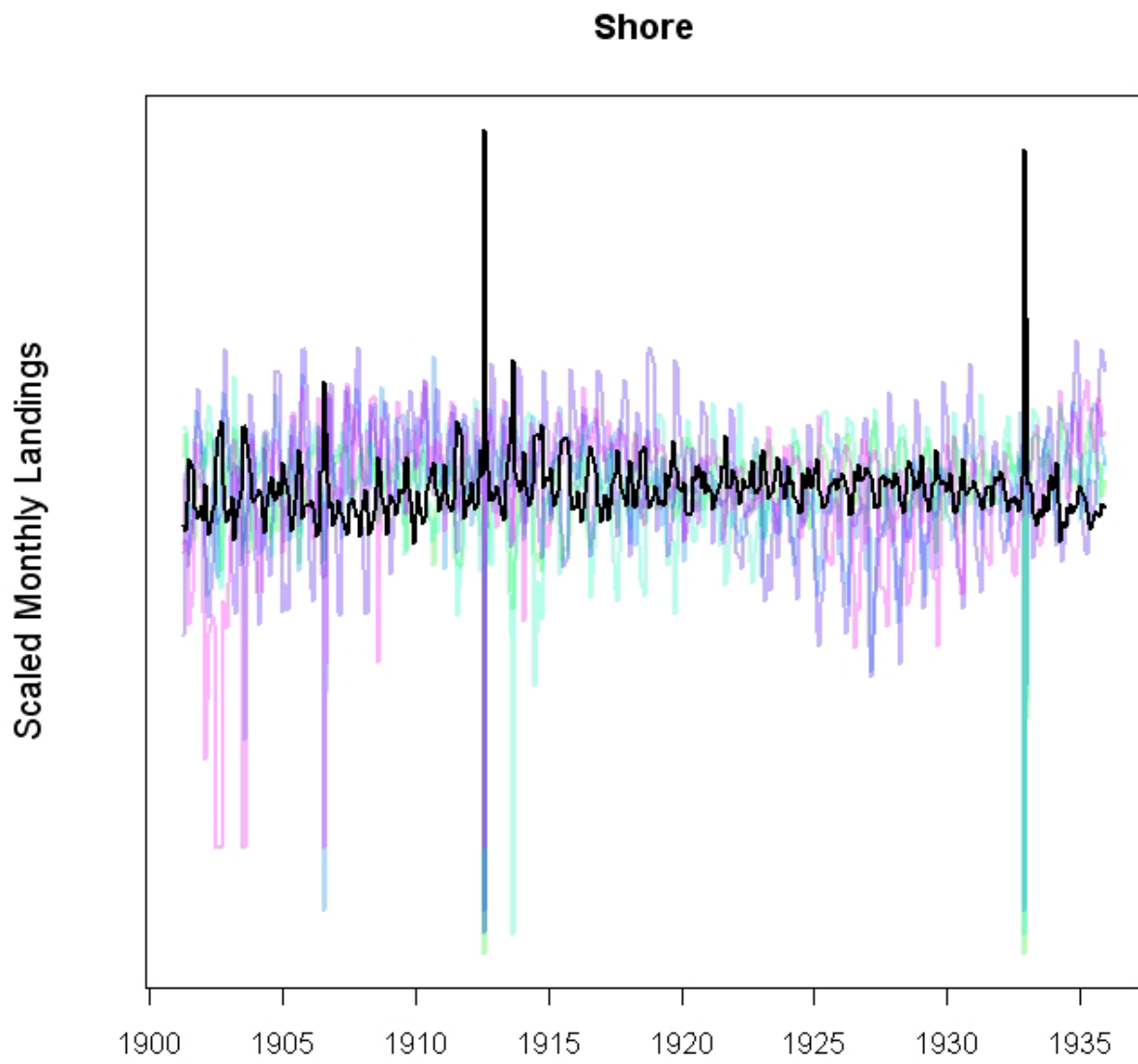


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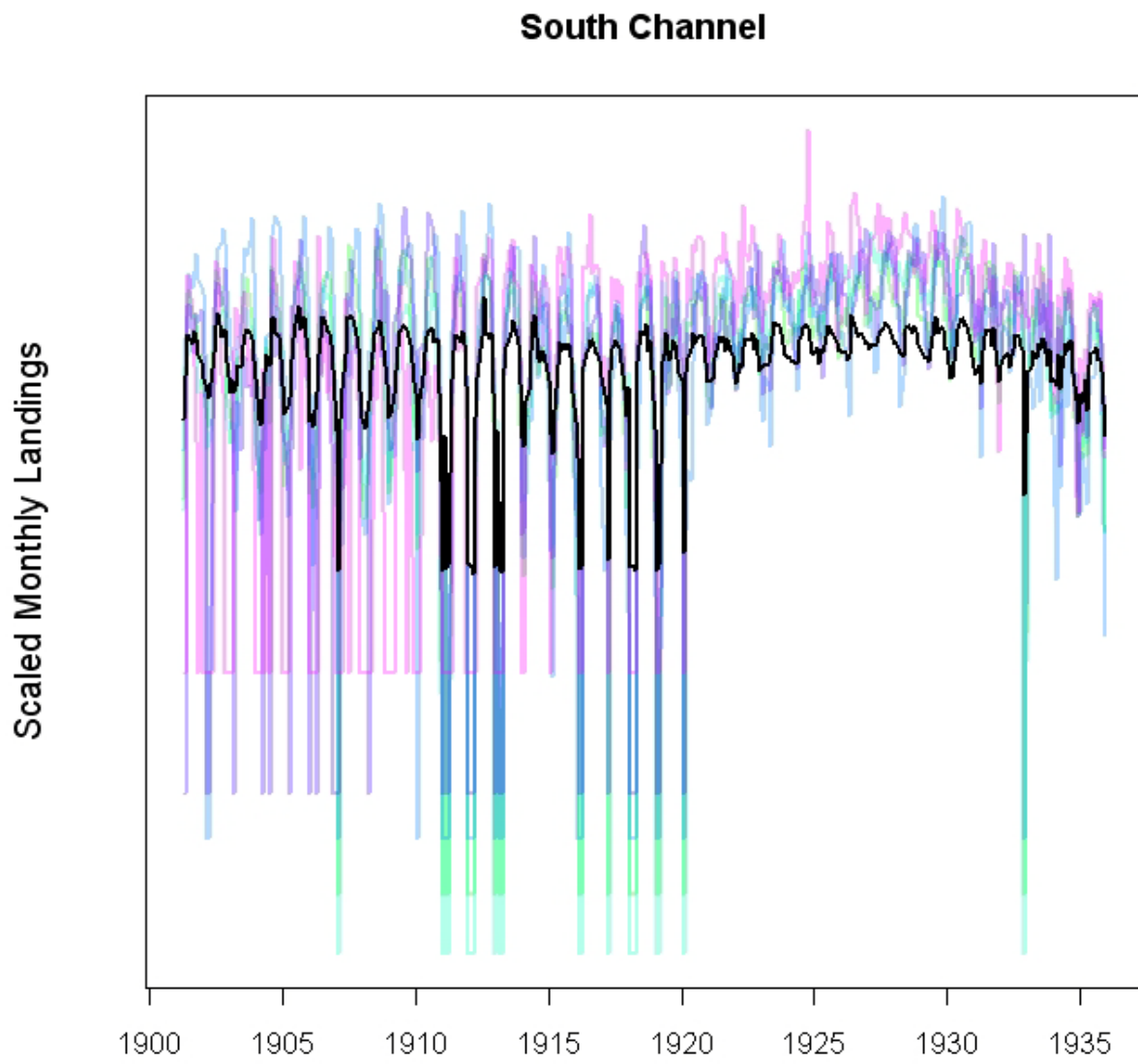


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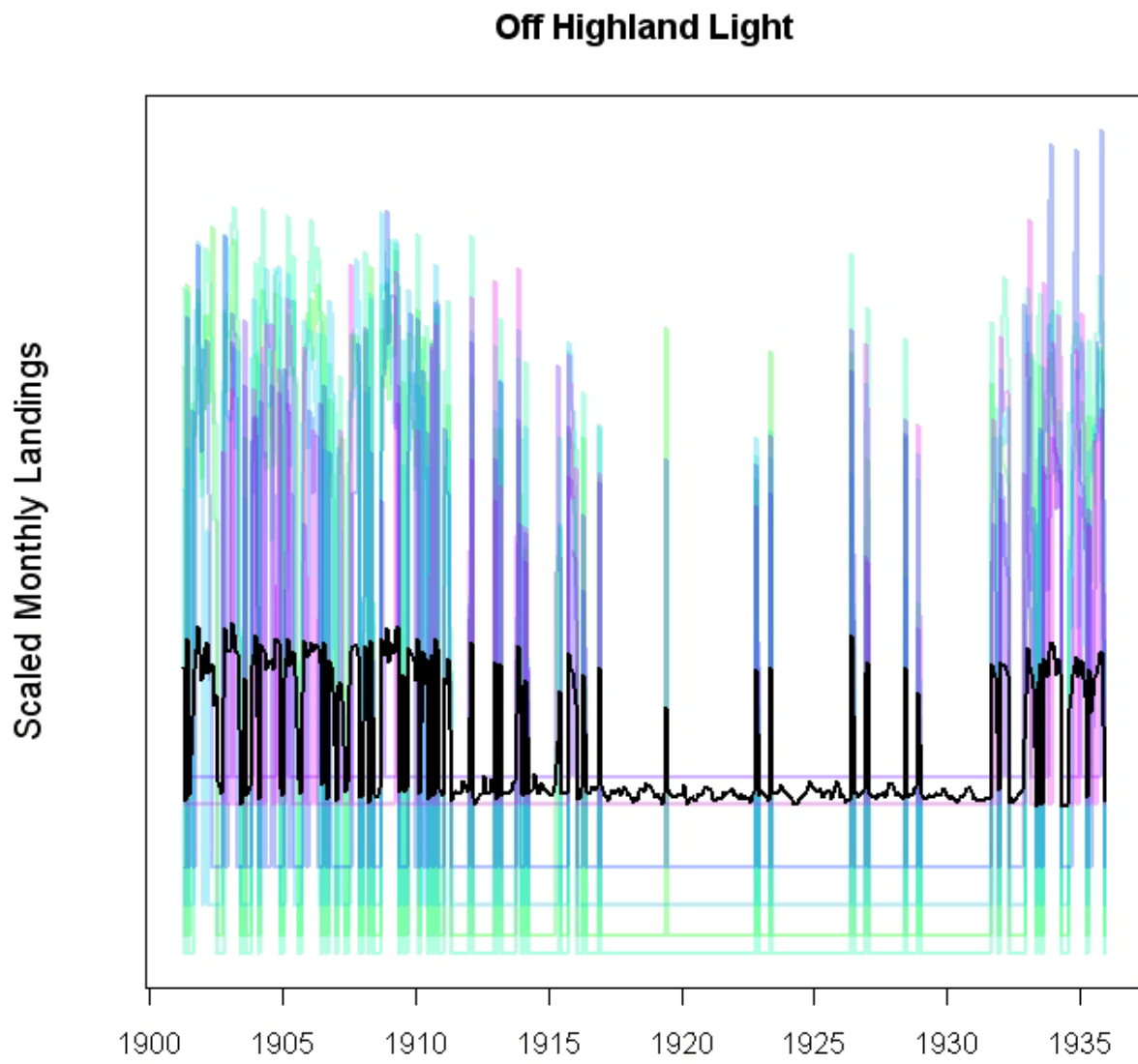


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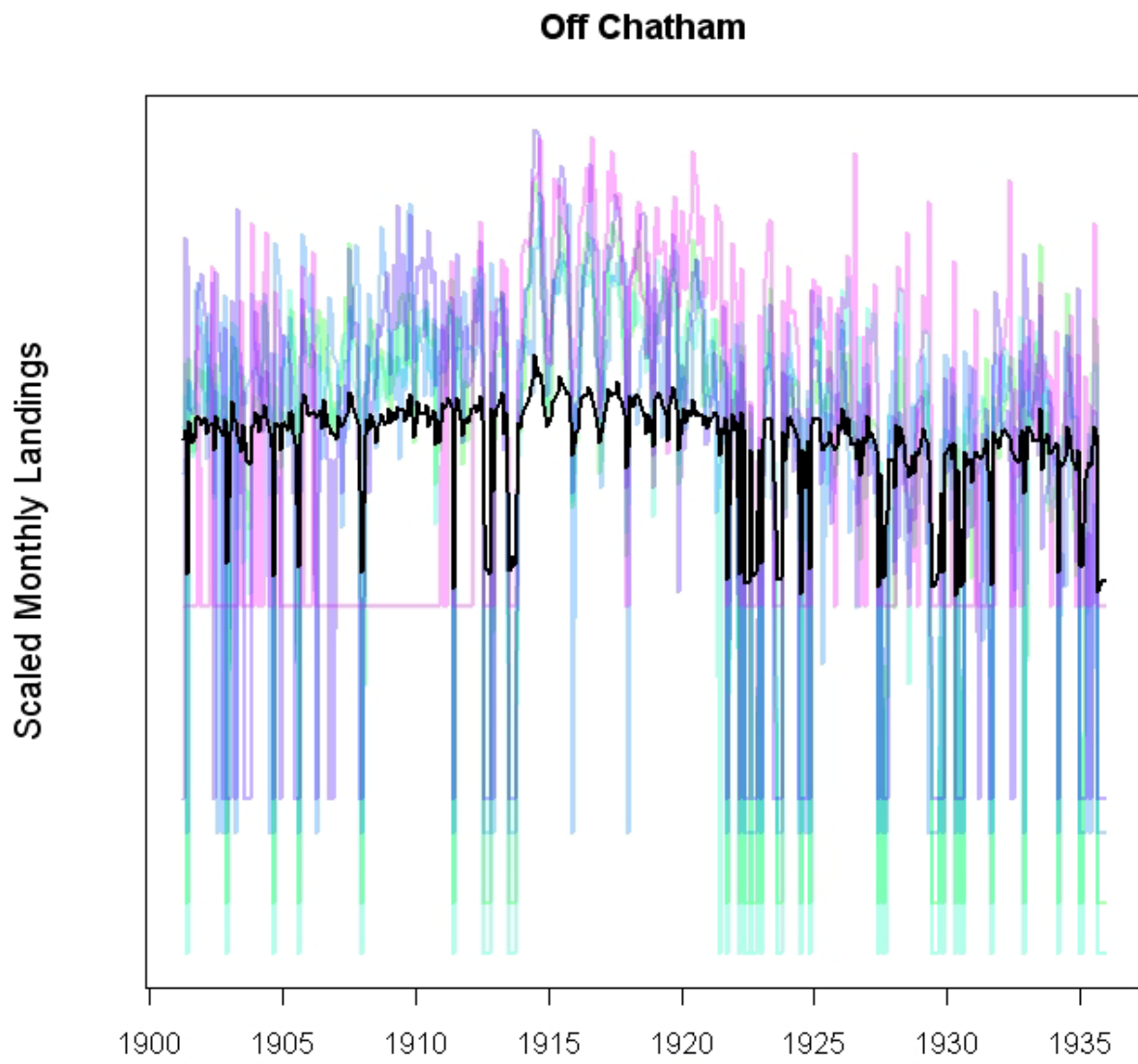


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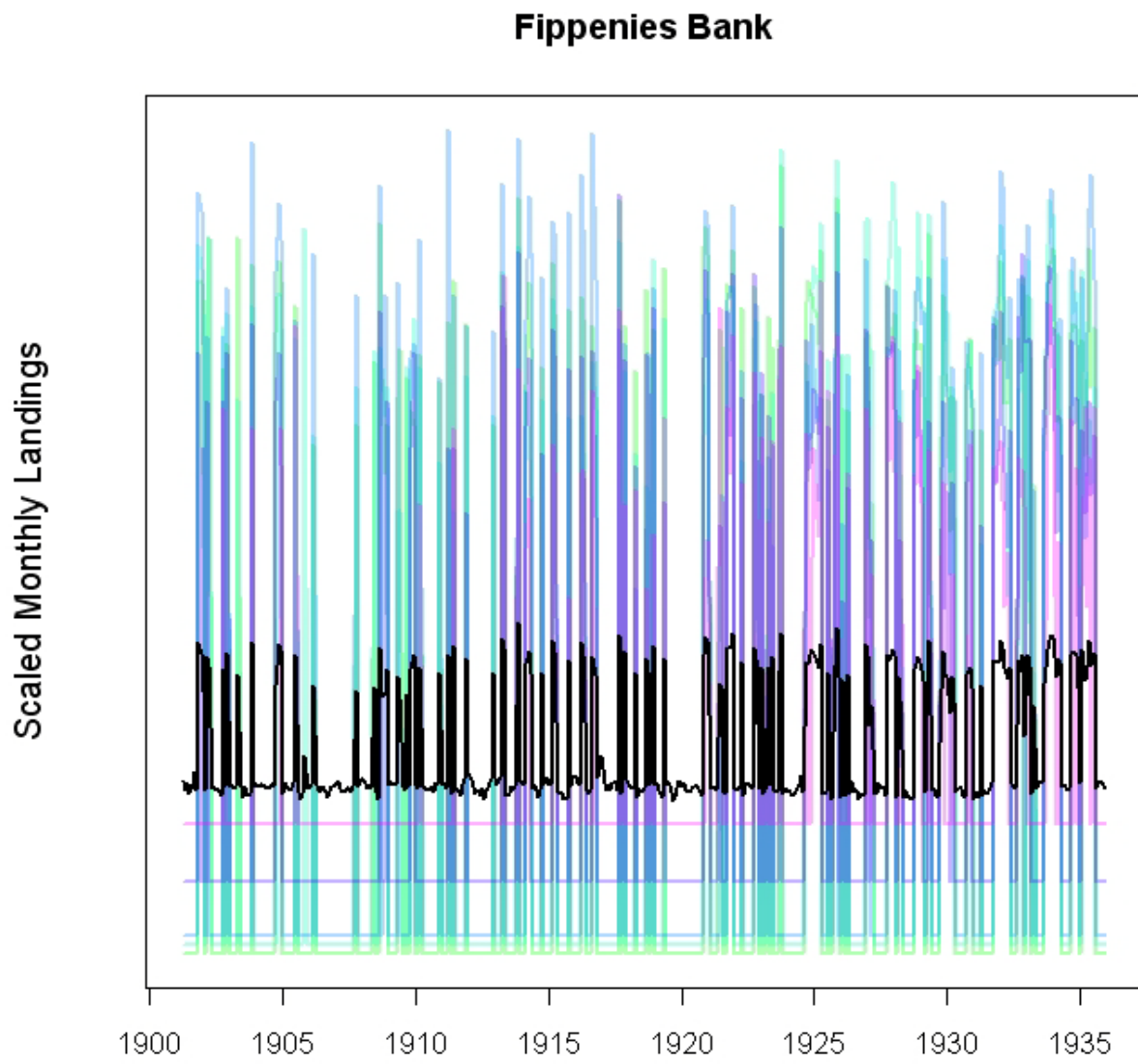


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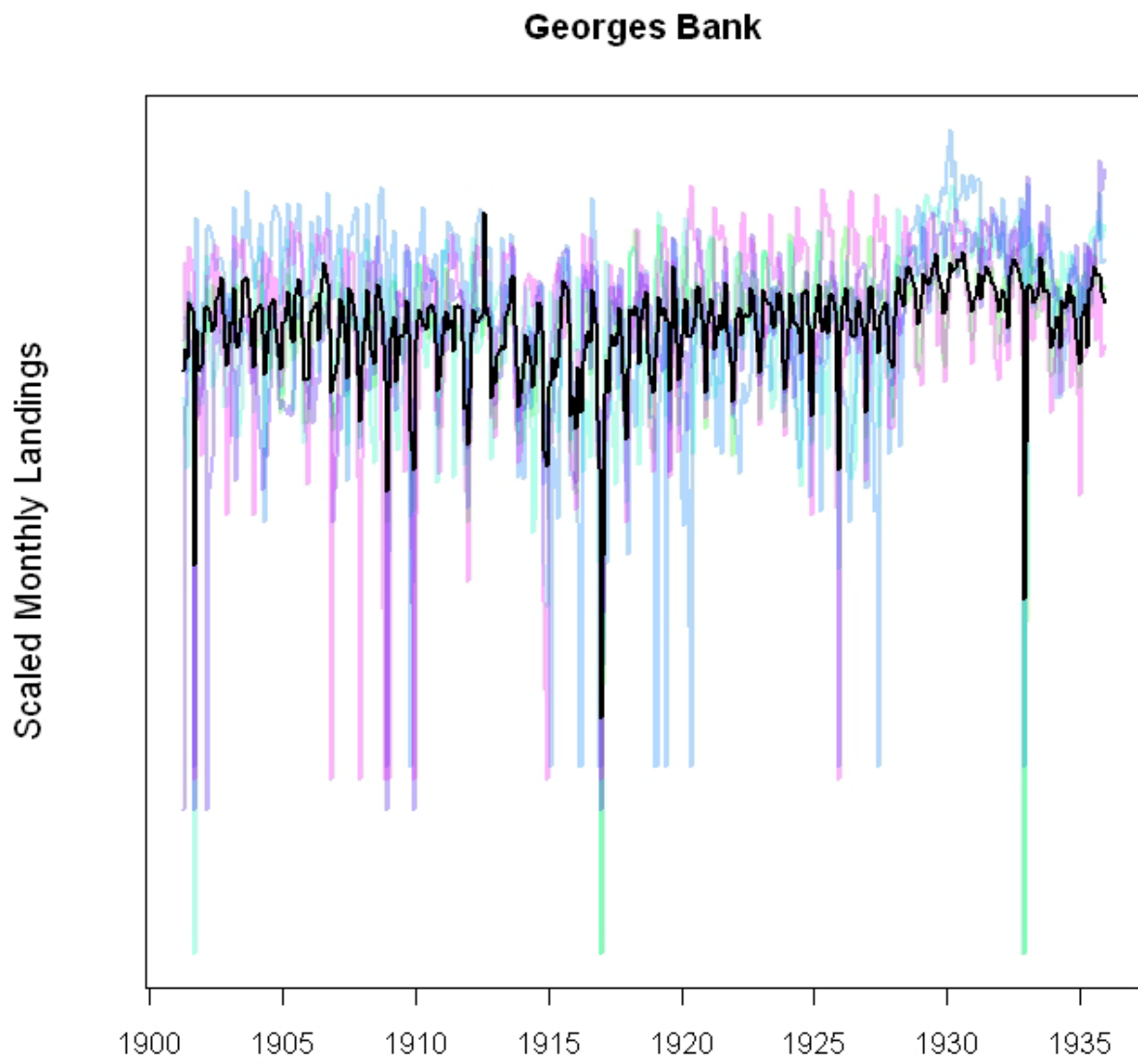


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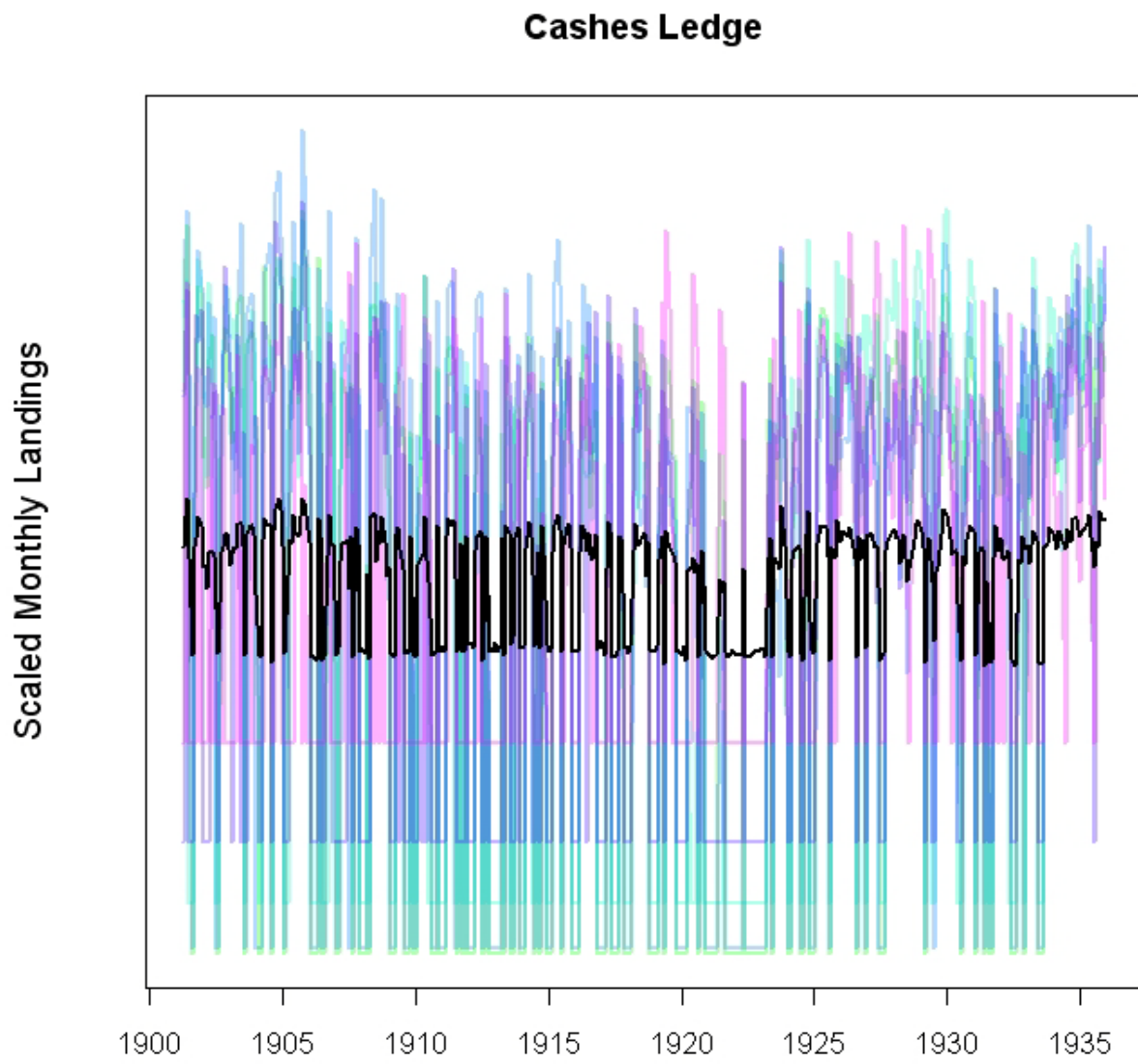


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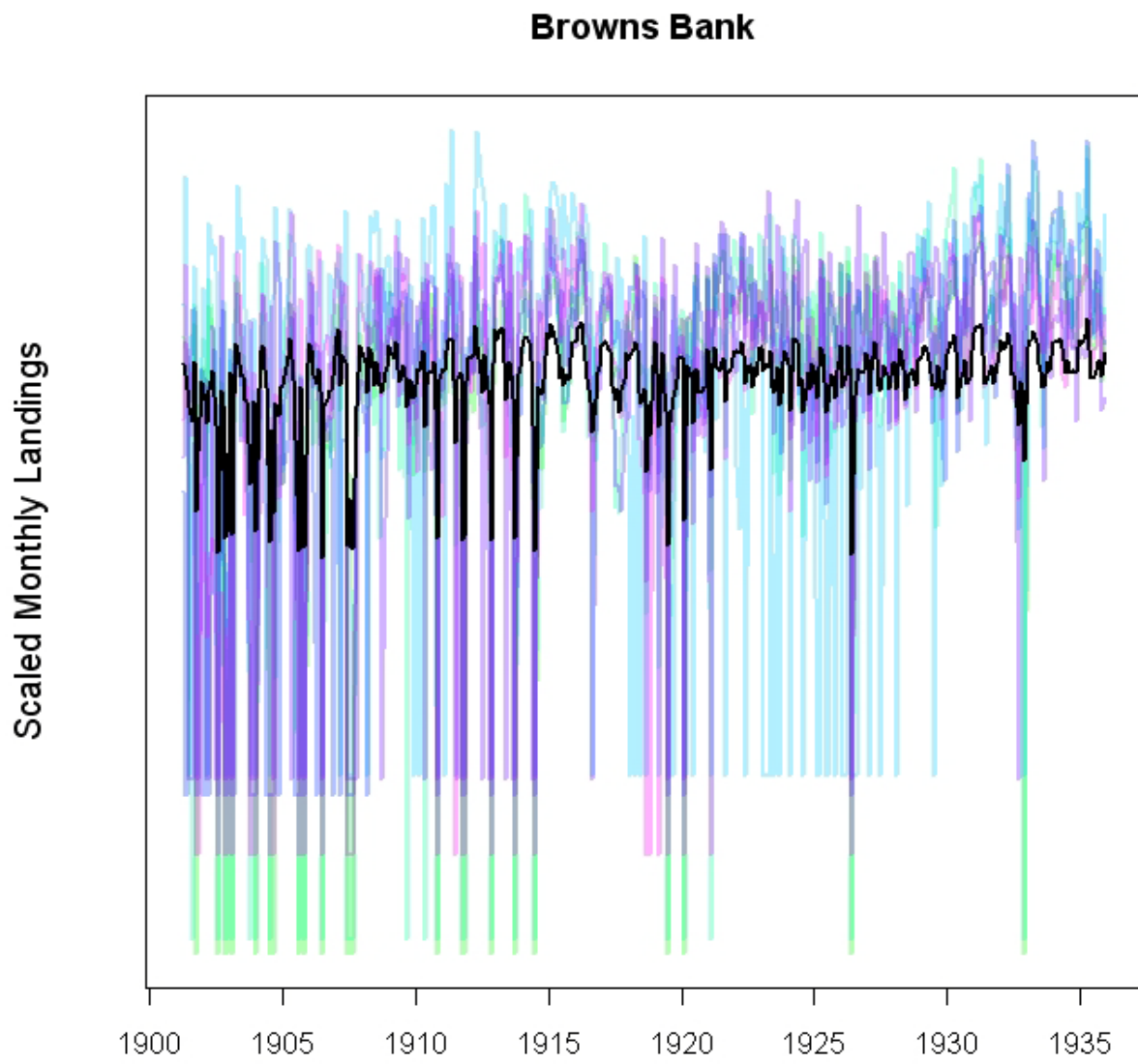
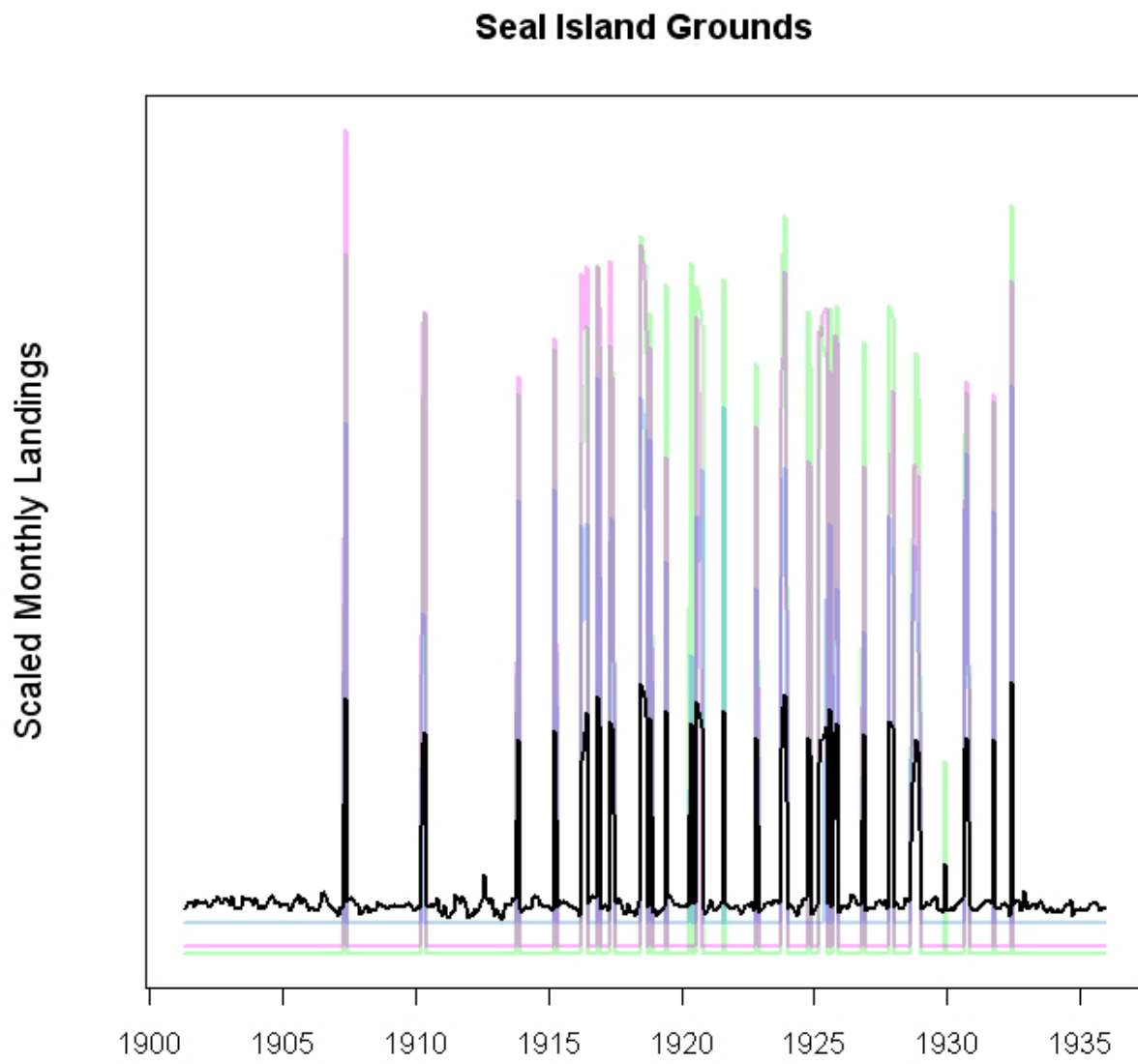


Figure J. (continued)



APPENDIX C: New England Fishing Fleet Operations 1914-1935
(Extracted from the Statistical Bulletins of the Bureau of Fisheries)

Month	Year	Summary
8	1914	Foggy weather interfered with fishing operation to a consideration extent during the month. Herring have been scarce, and the bait supply has been short. The line trawlers have continued to meet with good success fishing off Chatham, on a rocky bottom, where fishing has been the best for a number of years. The otter trawlers fishing in the South Channel have reported fish scarce. The mackerel fleet has been quite successful off the Cape Shore. Swordfish have been less plentiful than they were last year at this time.
9	1914	Weather condition have been good for fishing this month. Arrivals from Georges early in the month reported fish very scarce, but this fishing improved later in the month. Large sharks have been numerous in South Channel, and greatly hindered fishing operations. Mackerel have been scarce. Large school of blueback herring appeared, and good catches were made. Most of the salt halibut fleet has arrived from the North, and, owing to adverse conditions, brought home light catches. The swordfish fleet, which is now mostly in, has had small catches, but the fish have run large in size.
10	1914	The weather conditions during the month of October were unfavorable on Cape Shore and in the Gulf of St. Lawrence, but good on the western and shore grounds. Dogfish have been numerous and bothersome on the shore grounds. The catches of cod, haddock, and other ground fish have been light. Mackerel and herring have been scarce. Quite a number of halibut vessel have changed over to haddock fishing. The swordfish fleet has all returned, and the total catch is much smaller than last year. Twelve vessels of the Newfoundland herring fleet have sailed. The gill netters have commenced fishing, but the fleet promises to be much smaller this year owing to poor success last year.
11	1914	Fishing during the month of November has been hindered by high winds, especially to the eastward. The Provincetown fleet has discontinued the market fishery for the season, and, as a rule, the vessels have made good stocks. The gill netters for pollock, and the mackerel netters, have made good catches off Cape Ann. Some of the vessels in the shore fishery for fresh ground fish have also made good stocks.
12	1914	Weather conditions during the month of December were unfavorable for fishing. Vessels fishing on Browns Bank and Cape Shore report good indication of fish, but those fishing on Georges and in South Channel report fish scarce. One steamer went to Cape Shore, but, owing to bad weather and lack of coal, the voyage was unsuccessful. A large part of the gill-net fleet has discontinued fishing, but will resume operations when the haddock strike in on the shore. Herring fishing by American vessels at Bonne Bay has been a failure, but good cargoes have been secured at Bay of Islands.
1	1915	During the month of January the weather was not very cold, but much windy weather prevailed, interfering with fishing operations along the coast and on the fishing banks. Steamers fishing in South Channel and on Georges Bank reported fish scarce. The vessels from Cape Shore and Browns Bank brought in moderate trips. The herring vessels operating on the west coast of Newfoundland all left for home, but some of them had to leave with partial trips to avoid being caught in the ice. The hospital ship, Androscoggin, made her first cruise among the fishing vessels on Cape Shore and Browns Bank and rendered valuable aid.
2	1915	Unusually mild weather prevailed during the month of February, and quite a number of large trips of ground fish were landed from the offshore grounds. The steam trawlers operated on Georges Bank, and brought in some good catches. The offshore fleet fished mostly on Browns Bank, and reported good fishing. The gill netters have met with indifferent success, and at the end of the month only a few were fishing. The shore fishermen reported fish scare. The first vessel of the bank fleet for salt cod sailed from Gloucester on the 27th of the month.
3	1915	The month of March was very windy, and vessels fishing to the east-ward reported frequent snow storms. The operations on the shore grounds were light, owing to windy weather. The gill netters reported good catches of haddock. The southern seining fleet for mackerel is being put in readiness, and the first vessel sailed March 29, sixteen days earlier than last year.
4	1915	Bad weather prevailed much of the time during April and hindered fishing operations, especially on the shore grounds. The steam trawlers, however, had good fishing on Western Bank, where all of these vessels have been fishing. The haddock taken by these steamers have been of larger size than usual. The hand liners have begun fishing on Georges Bank and the Rips, and have reported moderate catches. The shore fishermen reported fish scarce. The first mackerel of the season were seined April 8, the catch consisting of 3,240 fish, taken 100 miles east by south of Cape Henlopen in 40 fathoms of water, and landed at Lewes, Del. The mackerel taken so far this season by the southern fleet of seiners have been of small size. The greater part of the catch has been landed at New York, and the remainder at Lewes, Del.

5	1915	Considerable fair weather prevailed during May, but in most cases the vessels brought in light catches, due to the scarcity of fish on the fishing grounds. The dogfish gave the fishermen much annoyance on the shore grounds, especially in South Channel and off Chatham, where more or less fishing gear has been lost. The southern mackerel fleet, which has landed its catch mainly at New York and Newport, both seiners and netters, has had the best season for several years.
6	1915	During the month of June there was considerable foggy weather, which interfered with fishing operations. The hand-line cod fleet, fishing mostly on Georges, brought in small catches, and reported fishing not so good as last year. Some of the vessels of the Cape North fleet arrived home and brought good catches. The Cape Shore mackerel fleet landed good catches, and a number of vessels made two trips for fresh mackerel from that ground, the first time that this has ever been done. The catch of shore mackerel has been largely tinkers. The first vessel of the swordfish fleet arrived from Georges June 21 with a fare of 21 fish.
7	1915	During the month of July the weather was foggy and calm almost continuously, which greatly hampered the movements of the fishing fleet. Catches of ground fish as a rule have been good. The shore fishermen report the dogfish numerous and bothersome. The mackerel fishermen have made good catches of mixed mackerel on the northern part of Georges Bank. While most of the swordfish have been caught on Georges Bank the fishermen report these fish moving farther to the eastward every year.
8	1915	Unusually foggy weather prevailed on the fishing banks during the month of August. Large catches of haddock have been taken by line and other trawlers in South Channel. Georges Bank also furnished a considerable supply of this species. Small mackerel have been very plentiful on the inshore grounds off the coast of Massachusetts, where good catches have been made by some of the small vessels. Large mackerel have been abundant on Georges Bank, but reported to be exceptionally "wild," in consequence of which few schools were captured. The swordfish fleet operated mostly on the Cape Shore grounds, and reported good fishing.
9	1915	There was considerable stormy weather during the month of September, and fishing operations were hampered by heavy gales the latter part of the month. The mackerel fleet made good catches of small mackerel off Cape Cod and in Massachusetts Bay. Most of the swordfish vessels arrived home, and have had a very good season. One of the bank fleet arrived at Gloucester with the largest trip of hand-line salt cod landed since 1909.
10	1915	During the month of October the shore fishermen had considerable good weather, but on the off shore grounds there was more or less bad weather which to some extent hindered fishing. Vessels engaged in taking ground fish made moderate catches. There was a large body of small and medium mackerel on Middle Bank and off Cape Cod, and seiners made the biggest catches of the season. The North Bay mackerel fishermen met with poor success owing to bad weather. A number of the herring fleet on the west coast of Newfoundland reported that they were getting some fish.
11	1915	During the month of November fishing operations were interrupted to some extent by stormy weather, especially on the off-shore grounds. Moderate trips of ground fish were landed. Early in the month the fishermen were bothered considerably by dog fish on Georges Bank. The gill netters made good catches of pollock. A strike the latter part of the month tied up most of the otter trawlers. The mackerel seiners have all discontinued fishing, but the netters are making unusually good catches for this time of the season.
12	1915	A number of violent storms occurred during the month of December. The vessels arriving have as a rule had small catches. Most of the steamers were not fishing owing to a strike. The first fares of tilefish were received direct from the fishing fleet and met with a ready sale. The fish varied in size from 8 to 40 pounds each and were caught 90 miles southeast of New York. Herring are reported plentiful at Bonne Bay, Newfoundland, and indications point to a successful season. Netters made good catches of mackerel early in the month, but were obliged to discontinue fishing on account of the stormy weather.
1	1916	Rough weather with snow storms interfered with fishing operations during January. Both the shore and off-shore fleet as a rule landed small catches of ground fish. Many of the gill netters discontinued fishing owing to the scarcity of fish. At the beginning of the season there were 28 vessels engaged in gill-net fishing, but now there are only five or six. The steam trawlers that were idle because of a strike have resumed operations and are fishing on Georges. The Newfoundland herring fleet is returning with good fares, and the season promises to be a successful one.
2	1916	Cold and stormy weather prevailed during February, especially the latter part of the month, when snow storms were frequent. Both the shore and offshore vessels landed light catches. Some of the otter trawlers fishing on Georges brought in good catches of haddock. The gill netters landed chiefly catches of cod during the latter part of the month.

3	1916	The weather during March was very stormy until the last week of the month, when it was fine, and the vessels made good catches. The otter trawlers operated on Western and Georges banks, and landed some big trips. The first trawl salt-cod bankers sailed during the month from Gloucester. The first vessels of the mackerel seining fleet sailed south the latter part of the month.
4	1916	The weather during April was favorable for fishing operations. Good trips of fish were landed by vessels from Western and Browns banks. The hand liners fishing on Georges reported finding a larger school of fish than at any time for a number of years, and a considerable proportion of the fish were large. The first catch of mackerel of the season consisted of 7 barrels of small fish taken by a seiner April 5, 80 miles south of Cape Henlopen in 50 fathoms of water. Schools of herring were reported along the shore. Shore fishermen reported hake scarce in the Gulf of Maine.
5	1916	Weather conditions during May were good, and an unusually large quantity of ground fish was landed by the fishing fleet. Dogfish, however, have greatly hampered fishing operations in South Channel. The southern mackerel fleet has met with good success. The catch consisted chiefly of large and medium fish. The large vessels engaged in seining have shifted to Cape Shore. Herring have been schooling along the shore, and good catches have been made.
6	1916	Although there was considerable rain during the month of June the weather was quite favorable for fishing. The arrivals of fresh ground fish have been largely from shore grounds and South Channel. Fishermen have been bothered more or less by dogfish. Mackerel fishermen have been successful on Cape Shore, and a large body of mackerel was reported along the shore from Nantucket to South Shoal Lightship. The first vessels of the swordfish fleet arrived and reported fish scarce. Mackerel are now all sold in the Boston market by the pound instead of by count as formerly.
7	1916	The weather was foggy much of the time during the month of July. Small mackerel are schooling off the Massachusetts coast and the vessels have landed good catches. The swordfish fleet has landed good catches from Georges Bank. As sharks are very numerous in the south, and have done much damage to fishing gear, it is probable that some of the tilefish vessels will abandon that kind of fishing for the present.
8	1916	Considerable foggy weather and easterly winds prevailed during the month of August, but in the intervals of favorable weather the fishermen have made some good catches. The steam trawlers, as a rule, have done well. The mackerel fishermen have made good hauls on Georges and off the Massachusetts shore. Swordfish have been scarce. Owing to the high prices received by the fishermen for mackerel and swordfish, large stocks and shares have been made.
9	1916	Considerable good weather prevailed during the month of September, and the line and steam trawlers, as a rule, landed good catches of fish. The principal catches of mackerel were made off the coast of Maine. The weather was unfavorable for taking swordfish on Cape Shore, where the swordfish fleet was operating, and consequently the vessels in that fishery made poor catches. The tilefish fishermen were greatly bothered by sharks.
10	1916	Although good weather prevailed during the month of October, the arrivals of groundfish were only moderate. There was a large body of mackerel, mostly large and medium fish, off the coast of Massachusetts. A large quantity of these fish was landed, yielding profitable return to the fishermen. Only a small quantity of herring was landed. The gill netters have begun active preparations for the fall fishing season.
11	1916	During the month of November the operations of the groundfish fleet were hampered by rough weather, and moderate trips have been landed. There was a large body of mackerel on Middle Bank the first part of the month and the mackerel fleet made good catches of large and medium fish. The gill net fleet has been successful in making catches of pollock. A number of vessels have been engaged in taking tilefish, but have made small catches owing to the abundance of dogfish.
12	1916	The fares of ground fish in December have averaged small on account of unfavorable weather conditions most of the time during the month. The weather was especially bad the first part of the month on Cape Shore where the haddock fleet was mostly fishing. The mackerel netters caught a few mackerel in Cape Cod Bay. The gill netters have done well catching pollock off Cape Ann. Reports from the Newfoundland herring fleet so far are rather disappointing.
1	1917	Bad weather hampered fishing operations during the month of January. The prices paid to the fishermen have ruled high. The steam trawlers nearly all fished on Western Bank, but as a rule have had moderate catches. The schools of pollock have struck off from Cape Ann. The Newfoundland herring fleet has experienced the poorest season for many years, and its arrival has been delayed by bad weather. The Atlantic halibut fleet is getting away and from present indications will be smaller than last year.

2	1917	Weather conditions during the month of February were unfavorable for fishing. The harbors along the coast were frozen over, which greatly hindered the movements of the fishing fleets. The steam trawlers operated chiefly on Western Banks, and landed some good trips. Part of the fresh halibut fleet has sailed, and indications are that the fleet this year will be small, the gill netters have met with indifferent success.
3	1917	At the beginning of March a very heavy snowstorm retarded fishing operations, and during the month there has been much bad weather. The strike of the fishermen, begun last month and still unsettled, has had a deleterious effect on fishing operations, and a large number of vessels are idle. The steam trawlers, so far not included in the strike, have landed good trips from Georges and Western banks. High prices have prevailed, and the fishermen have made large shares. No tilefish were landed owing to bad weather and the abundance of grayfish. None of the mackerel fleet has sailed thus far.
4	1917	Seasonable weather prevailed during the month of April, but as the strike of the fishermen was not called off until the latter part of the month the receipts were light. Owing is the fact that the Government has taken over a number of the steamers for war purposes there are only five steam trawlers now fishing. Mackerel are reported schooling in southern waters and about 20 vessels have sailed south is engage in that fishery. Hand liners fishing on Georges Bank for cod report good catches. Schools of spring herring have appeared off the coast of Massachusetts. Good catcher of flounders have been made by the dredgers south of Nantucket.
5	1917	Weather conditions during a large part of the month of May were unfavorable for fishing. Ground fish were in light receipt except cod, which were in good supply from Georges by the hand liners. Good catches of large herring were made by the fleet on Cashes and Jeffreys Bank. The latter part of May the grayfish struck in along the shore, and the boats changed from trawling to seining. The mackerel seiners. numbering 32 sail, are now on Cape Shore.
6	1917	Weather conditions during the month at June have been quite favorable for fishing. The Cape Shore Fleet all arrived home with good catches of mackerel, having found mackerel in abundance on that ground. Quite a number of the vessels made two trips, and one vessel made three trips. The first vessels of the salt codfish fleet have arrived at Gloucester. The first vessel of the swordfish fleet arrived this month, eight days earlier than last year. Fishing vessels are making record stocks and shares in almost every branch of the industry.
7	1917	During the month of July the weather was unusually foggy especially an Georges Bank where the fishermen reported continuous fog for seventeen days. The steamers and sail vessels have landed moderate catches of ground fish, but owing to the high prices received have continued to make large stocks. Good catches of medium mackerel have been taken off No Man's Land and vicinity, and small mackerel off Chatham. Swordfish have been in moderate supply from Georges. Herring have been scarce. The fisherman report a scarcity of tilefish. Grayfish are quite numerous, but of small size.
8	1917	The weather was favorable for fishing during the month of August except that in the latter part of the month there was more or less fog. The fishermen continue to make unprecedented shares in all branches of the fisheries. There was a large body of small and tinker mackerel off Chatham and South Shoal Light where the fishermen made good catches, but were bothered by sharks which were quite numerous. The swordfish fishermen report fish scarce on Georges, and have mostly gone to the eastward. Shackers have landed good catches of ground fish.
9	1917	The weather was unusually cold and windy during the month of September. Encouraged by the high prices of fish, the groundfish fleet fully utilized the periods of favorable weather, landing considerable quantities of fish. Grayfish were troublesome, particularly in the Gulf of Maine, interfering with the taking of hake. Good catches of mackerel were made off Monhegan and Portland. The catch of swordfish on the Cape Shore has been light. Large spawn herring have been abundant off Cape Ann.
10	1917	The weather conditions were favorable for fishing during the month of October, and the market fishermen landed fair catches of ground fish that sold at high prices. Good catches of mackerel, mostly medium and large fish, were made off Cape Cod by the mackerel fishermen. Good catches of salt codfish were landed by the Bank fishermen. Gill netters fishing off Cape Ann made good catches of pollock. The vessels of the Newfoundland herring fleet are sailing daily. A number of vessels are fitting for tilefish fishing, and the indications are that the fleet this winter will be large.
11	1917	Fishing operations during the month of November were hampered to some extent by high winds, and unusually cold weather the latter part of the month. The catches of ground fish were light. The netters, when able to lift their nets, made good catches of pollock. The mackerel vessels have all discontinued fishing, but boats have made small catches of large mackerel off Cape Ann. Herring have been scarce.
12	1917	Weather conditions have been unfavorable for fishing much of the time during the month of December, resulting in light receipts from the fishing fleet. Prices have ruled high for all kinds of fish. Herring are plentiful on the west coast of Newfoundland, and indications are that the American vessels will obtain good fares.

1	1918	The weather was unusually cold during the month at January, and fishing vessels found navigation difficult, as the harbors were frozen over part of the time and there were great fields of ice along the shore. A number of good trips of fish were landed from Georges Bank. Vessels arriving from Cape Shore and shore grounds landed very light fares. The herring fleet has been quite successful on the coast of Newfoundland.
2	1918	The weather during February was cold and stormy, and the shore fleet was hampered by large fields at ice along the shore. Provincetown and Gloucester Harbors were frozen over much of the time. Large codfish were more abundant on Georges Bank than for many years, and some of the shore fleet engaged in that branch of fishing. The fishermen reported fish scarce on the shore grounds. The latter part of the month, trawlers fishing off Chatham caught some very large herring on their haddock trawls.
3	1918	Weather conditions during the month of March were better than ordinarily prevails during this month. A noteworthy fact was the large receipts of large codfish from Georges Bank. The catch has been the best for many years, and the spring schools have remained much longer than usual. Shore fishing has been light, and many vessels that usually fish on the shore grounds turned to Georges fishing. The first vessels of the bank salt codfish fleet for the coming season sailed this month. The flounder fishermen have landed good catches of flounders from Massachusetts Bay.
4	1918	Seasonable weather prevailed on the northern fishing grounds during the month of April. The catch of ground fish has consisted chiefly of large codfish from Georges Bank, where the catch of this species has exceeded all expectations. On April 11, a vessel from Yarmouth, N.S., brought into Boston a fare of ground fish direct from the fishing grounds, the first to arrive at that port under the new regulations. Two trips by Canadian vessels were landed at Boston and two at Portland during the month. Gill netters have landed good catches of codfish. The tilefish fishermen report fish scarce, and dogfish bothersome.
5	1918	The weather was favorable for fishing during the month of May. Good prices were received for all kinds of fish and the vessels made good stocks. The steamers fishing on Western Bank have landed large catches, but those fishing in South Channel and on Georges Bank had moderate catches. The shore seiners landed good catches of herring and pollock. The mackerel seiners, returning from the South, report quite a body of fish there this spring, but they were wild and could not be caught, and schooled only in the daytime. The tilefish fishermen report fish scarce, and are changing to other branches of fishing.
6	1918	The weather was unfavorable for fishing during the month of June. The mackerel fleet made good hauls of large and medium mackerel off the coast of Nova Scotia, but reported fish in smaller schools than usual. Good catches of mackerel were also taken off South Shoal Light the latter part at the month. Ground fish hare been in moderate receipt, and sold at good prices. The first swordfish of the season were landed this month. The vessels made good catches of herring of large size, and the spring schools are remaining late this year. The shackers arriving at Gloucester report good catches.
7	1918	There was a good deal at foggy weather during the month of July, which interfered with fishing operations. The steamers fishing in South Channel landed good trips of haddock. Mackerel seiners landed good catches of large and medium mackerel from off South Shoal Light, and light catches of small mackerel were taken in the vicinity of Newport. The swordfish vessels landed small catches of swordfish from Georges. The catch of herring was light.
8	1918	Considerable foggy weather prevailed during the month of August, which was very unfavorable for seining operations. The catch of mackerel and herring was light. The fleet engaged in the market fishery landed good catches of haddock from South Channel. Swordfish have been in light receipt. During the month 17 vessels were sunk by enemy submarines, 8 of which were swordfish vessels. The vessels fishing in South Channel lost considerable gear owing to strong tides.
9	1918	Much inclement weather prevailed during the month of September. Haddock were more abundant than usual at this season of the year in South Channel, and the steam trawlers made good catches the latter part of the month. Cod, hake, pollock, and other kinds of ground fish have been scarce. The mackerel fleet made moderate catches of mixed fish, mostly mediums. Herring fishing has been light. The swordfish fleet has practically all arrived, and the catch has been light.
10	1918	Weather conditions during the month of October were quite favorable for fishing. The steam trawlers landed good catches of haddock. One new steamer began fishing this month, and it is expected that by next winter seven or eight new steamers will be in operation. The mackerel seiners have hauled up for the season, but a few netters are still operating, and report fish scarce. The gill netters are making unusually good hauls of fish off Gloucester, mostly pollock. A number of vessels are now engaged in fishing for tilefish, and have met with fair success.

11	1918	Weather condition during the month at November were good, except the last two weeks of the month, when heavy winds retarded fishing operations. Good catches of mackerel were made by the netters on Middle Bank and in the vicinity of Provincetown, and these fish are being caught later than usual this year. Pollock have been plentiful off Cape Ann, and the gill netters have made large catches of these fish. The last vessel of the Bank salt codfish fleet has arrived at Gloucester. A number of vessels of the herring fleet have cleared for Newfoundland.
12	1918	Unsettled weather interrupted fishing operations to some extent during the month of December, although it was unusually mild. Moderate catches were landed by the fishing fleet. Owing to a strike, night steamers were idle nearly the whole month. Mackerel were caught by netters near Provincetown up to the middle of the month, which was later than usual. The herring fleet reported good fishing on the west coast of Newfoundland. Herring were scarce along the shore.
1	1919	The weather was unusually mild during the month of January, but heavy winds interfered more or less with fishing operations. The trawlers landed good catches of haddock from off Chatham. Some unusually large haddock were landed from Georges. Eight fishing steamers were idle owing to the strike. Most of the gill netters are hauled up for the present as the fish have struck off. The Newfoundland herring fleet had a successful season.
2	1919	Weather conditions during the month of February were quite favorable for fishing. Good trips of groundfish, largely cod, were landed from Georges Bank. Most of the steam trawlers continued idle owing to the strike of the masters and mates. A small number of gill netters operated, securing fair catches of haddock. Large schools of herring were reported on Middle Bank, but only a few were taken.
3	1919	During the month of March the weather was unusually mild, and large catches of cod and haddock were landed from Georges Bank, where most of the large vessels and steamers operated. Fishing on the shore grounds was hampered the greater part of the month by unsettled weather. Low prices prevailed for cod and haddock. The strike of the fishermen, which was to take place on March 15, has been referred to the National War Board for arbitration. A number of the bank salt cod fleet sailed during the month.
4	1919	Weather conditions during the month of April were quite favorable for fishing, and the steamers and other vessels landed good catches of haddock, which sold at low prices. A number of good catches of cod were landed from Western Bank. Encouraging reports have been received from the South as to the presence of schools of mackerel in those waters. The southern fleet will be about the same size as last year. Good catches of large herring were taken the latter part of the month by boats fishing off Thatchers Island.
5	1919	The weather during the month of May was unusually warm, and quite favorable for fishing. The vessels landed good catches of cod and haddock, which sold at low prices. The pollock seiners landed good catches of pollock from Nantucket Shoals. The southern mackerel fleet, both seiners and netters, have been quite successful. The mackerel landed were practically all large and medium fish.
6	1919	Seasonable weather prevailed during the month of June. The steam trawlers landed good catches of haddock from South Channel, and prices ruled low. Owing to the low prices, three of these steamers have gone on salt fish voyages. The first sail bankers arrived with good catches of salt codfish. All of the Cape Shore mackerel vessels arrived home with good catches. Mackerel, mostly tinkers, were taken on the shore from Cape Ann to Chatham.
7	1919	Owing to a strike of the fishermen, which began July 3, and was still in progress at the end of the month, fishing operations have been very light. Tinker mackerel have been quite plentiful along the shore, and some of the small vessels engaged in shore seining, that were not in the strike, made good catches. Part of the swordfish fleet continued fishing and landed good catches, for which they received high prices.
8	1919	The strike of the fishermen which began July 3 was finally settled for a period of two months from August 15, 1919, to October 15, 1919. Prior to August 15 very few fish were landed direct from the fishing fleet, but good trips of haddock from South Channel were landed after that date. The weather was unfavorable for seining and very few mackerel were landed although these fish are reported along the shore. Swordfishermen from Georges Bank report that the weather was unfavorable and the fish scarce.
9	1919	The prevalence of rain and wind during the month greatly retarded mackerel fishing. Some large mackerel were landed from the coast of Maine, and monthly small mackerel from the coast of Massachusetts. As there was a large school of haddock in South Channel, quite a number of good catches were landed from that fishing ground, and considerable quantities were disposed of for salting. The gill netters have begun operations, but so far the catches have been light.

10	1919	The weather was quite favorable for trawling during the month of October and the steam trawlers and other vessels landed good catches of ground fish, principally haddock. The price of haddock ruled low, and considerable quantities were disposed of for smoking and salting. The mackerel catches were light during the month, only small schools of these fish being seen. The catch of herring has been light this fall. The fill netters made good catches of pollock.
11	1919	Rough weather, especially the first part of the month, retarded fishing operations during the month of November, and the steamers and other vessels landed moderate catches of ground fish. The gill netters fishing off Cape Ann landed good catches of pollock. Small boats landed good catches of mackerel from Boston Bay. Herring are reported plentiful on the west coast of Newfoundland, but present indications are that the American fleet in this fishery will be small.
12	1919	During the month of December the weather was unusually cold, and many of the vessels coming in were heavily coated with ice. As a rule they had light catches of ground fish, as fish are not taken in so great abundance on the fishing grounds at this season of the year. Most of the netters fishing on the shore grounds have discontinued operations, and will not start out again until the haddock strike in. Shore fishing of all kinds has been very light.
1	1920	The weather was unusually cold, unsettled, and stormy during the month of January, but during the latter part of the month the steam trawlers landed good catches of haddock from Georges Bank. All kinds of shore fishing operations were very light. Four vessels of the herring fleet are caught in the ice on the west coast of Newfoundland with no chance of release until spring.
2	1920	During the month of February the weather was cold and stormy with heavy winds, which greatly interfered with fishing operations. The weather on Georges Bank, where the steamers were mostly fishing, was not so severe as on the shore grounds and to the eastward. The steamers fishing on that bank landed most of the fish. Sailing vessels, owing to the bad weather, had poor success. The gill netters landed small catches of ground fish, and operations on the shore grounds were very light. Four vessels of the herring fleet are still held in the ice at Bay of Islands, Newfoundland, with no chance of release until the latter part of April.
3	1920	The weather was stormy during the early part of March, but was more favorable for fishing the remainder of the month. The fleet landed good catches of cod and haddock, but, as is usual at this time of the year, prices ruled low and were unremunerative. Preparations began for the southern mackerel fishery, and the fleet will probably be about the same size as last year. The gill netters made larger catches of ground fish than for many weeks.
4	1920	The weather during the month of April was unusually cold and rainy, retarding fishing operations. The demand for ground fish was moderate, and prices ruled low. Owing to the low prices a number of the steam trawlers discontinued fishing and will not resume until the market improves. The gill netters have landed moderate catches of ground fish. The southern mackerel fleet is about the same size as last year. The netters have been quite successful, but the seiners have not done so well. The draggers have landed good catches of flounders, which were sold at low prices.
5	1920	The weather conditions were quite favorable for fishing during the month of May, and the steamers and other vessels landed good catches of ground fish, but prices ruled low and large quantities were sold for curing. The Georges hand liners landed good trips of codfish. Never in the history of the mackerel fishery has the fleet landed so many mackerel at Boston direct from the fishing grounds as in the present month. Mackerel fishermen reported large bodies of menhaden in the South. Shore fishermen have been hampered by grayfish.
6	1920	During the month of June weather conditions for the most part were favorable for fishing operations. The fleet landed good catches of ground fish, but prices were unremunerative and quite a number of the steam trawlers were not operated. The Cape Shore mackerel fleet experienced the poorest season for a number of years owing to the scarcity of fish on that ground this season. The first vessels of the swordfish fleet arrived June 29, and reported fair fishing.
7	1920	The weather during the month of July was favorable for fishing operations. Owing to the moderate demand for ground fish, and the low prices prevailing, the fleet engaged in this branch of fishing has been small. The shackers have brought in good catches from Western Bank. The mackerel fishermen report sharks, bonito, and blackfish on the fishing grounds, and have landed but few fish. The swordfish vessels have been very successful, landing good catches of swordfish from Georges Bank.
8	1920	The weather was unusually foggy during the month of August. The swordfish fleet landed good catches of swordfish early in the month. The latter part of the month the fish were not found so plentiful and fog interfered with the fishing. Mackerel fishing this month has been very light. Only about 25 per cent of the steam trawlers were operating, but they landed good catches of haddock from South Channel.

9	1920	Weather conditions were quite favorable for fishing operations during the month of September. The catches of haddock and other ground fish were good, but the market prices ruled low and were unsatisfactory to the fishermen. Mackerel have been scarce, schools showing occasionally off Chatham and off Cape Cod. The swordfish season ended this month, and the fishermen engaged in this fishery have done well. The gill netters began operations, but so far have landed small catches. Some spawn herring have been taken off Cape Ann, but so far the catch of fall herring has been very light.
10	1920	During the month of October the weather was unusually fine for the time of year on Georges Bank and the Shore grounds, but fishing vessels arriving from the eastward reported more or less unsettled weather. The steamers and other vessels landed good catches of ground fish, consisting mainly of haddock of larger size than usual. The mackerel seiners landed only a few fish, but the netters have had fair success catching mackerel off Cape Ann. The catch of the gill netters improved, and larger catches of pollock were landed.
11	1920	As is usual during the month of November, the winds and stormy weather interfered to some extent with fishing operations. The prices of ground fish showed some improvement. Both the steam trawlers and line trawlers landed moderate catches. The gill netters operating at Cape Ann reported light fishing. Small boats made good catches of large and medium mackerel from Thatchers to Boon Island. Herring were reported plentiful on the west coast of Newfoundland, but the number of American vessels in this fishery will be small.
12	1920	As usual during the month of December windy weather interfered to some extent with fishing operations, but the weather was unusually mild. The steam trawlers fished principally in South Channel and landed light catches of fish, mostly haddock. The sail vessels fishing to the eastward landed light catches consisting chiefly of codfish. The fleet of gill netters is smaller than last year, and have had indifferent success.
1	1921	During the early part of January the weather was cold and stormy, retarding fishing operation, but the latter part of the month finer weather prevailed and good catches of fish were made, especially on Georges Bank. Prices have ruled low. The halibut fleet is making preparations for the season's fishing and will be larger than last year. The operations of the gill netters have been light.
2	1921	The weather conditions were favorable for fishing operations except on the eastern banks. There was a large school of codfish on Georges Bank, and the vessels landed good catches of these fish. The steamers landed good catches of haddock. The gill netters, beginning about the middle of the month, made good catches of haddock on the shore grounds. Other kinds of ground fish were in light supply. The steamers fishing in South Channel and on Georges Bank reported seeing unusual quantities of herring and squid for this time of the year, and also got a few mackerel in their trawls.
3	1921	Considerable unfavorable weather was experienced during the month of March, but vessels landed good trips of codfish from Georges Bank. The steam trawlers have all discontinued fishing, as the fishermen declined to accept the lower scale of wages offered to them by the owners. The flounder dredgers have landed good catches, but prices have ruled low, and this fishing has not been very profitable. The mackerel seiners and netters are getting ready for the southern fishery, and the fleet will be a little larger than last year. The first seiner sailed March 30.
4	1921	The prevalence of easterly winds and rain during the month of April was unfavorable for fishing operation. The vessels landed moderate catches, and haddock sold at high prices. The American steam trawlers were not in operation owing to the reduced compensation offered to the fishermen. The gill netters landed small catches. The mackerel fishermen report seeing considerable quantities of mackerel in the South this spring, but have landed light catches owing to the unfavorable weather conditions. The mackerel taken so far have been of large size. The halibut fleet as a rule has had small catches and reports fish scarce.
5	1921	During the month of May easterly winds prevailed much of the time, and seriously interfered with mackerel fishing in the South. About 28 vessels have sailed for Cape Shore, and the reports from that locality are quite encouraging. The vessels taking ground fish have landed good catches, largely from South Channel, but prices have ruled low. A number of steam trawlers have resumed operations. Herring, suitable for canning and bait, are being caught along the shore.
6	1921	The weather during early of the month of June was quite favorable for fishing operations. The vessels and steamers landed good catches of ground fish, but prices ruled low. The Cape Shore mackerel fleet returning with good catches owing to the good weather and abundance of mackerel in that locality during the first part of the month. The catch of mackerel on this shore was light. A number of halibut vessels arrived, and prices of halibut ruled low. During the latter part of the month schools of menhaden were observed in Boston Bay.
7	1921	The weather was favorable for fishing during the month of July, and the vessels landed good catches of ground fish, but prices ruled low. Some large mackerel were taken in Boston Bay and also on the coast of Maine, but the catch has been disappointing. The fishermen reported swordfish scarce. The emergency war measure permitting Canadian fishing vessels to land their fares at American ports direct from the fishing grounds was canceled to take effect July 15, 1921.

8	1921	The weather was quite favorable for fishing during the month of August and the fleet landed large quantities of fish. The vessels engaged in mackerel fishing have found fish very scarce, and most of the large vessels remained in port. The swordfish fleet reported fish scarce, and, as a rule have had small catches. The halibut fleet has kept the market well supplied and prices were low. A number of cargoes of halibut were sold for freezing.
9	1921	Weather conditions were favorable for fishing during the month of September, and the catches of haddock and other groundfish were good. Mackerel continued scarce. The landings of the swordfishing fleet were light and the fishermen have had a comparatively poor season. Good catches of the halibut were landed. Sharks were reported to be numerous in the South Channel.
10	1921	The first part of October was favorable for fishing and the fleet landed good catches of ground fish, but the latter part of the month heavy winds greatly interfered with fishing operations. The mackerel netters report a very poor season to date, and only a few seiners are fishing. The gill netters landed large catches of fish, mostly pollock. A number of the halibut vessels have discontinued this branch of fishing for the year. The catch of herring on the shore grounds has been light.
11	1921	Weather conditions during the month of November were quite unfavorable for fishing. Easterly winds with rain prevailed, and vessels from the eastward reported much snow. Consequently the arrivals have had small catches but realized good prices. The gill netters, when weather permitted, made fair catches of ground fish, mainly pollock. The seiners discontinued mackerel fishing, but the netters have taken small catches off Cape Ann. The halibut vessels have about all discontinued fishing for the season.
12	1921	The weather was quite cold and windy during the month of December and unfavorable for fishing operations. The steamers and other vessels landed light catches of fish, but prices were good. Only a few vessels are now engaged in halibut fishing, and these have met with poor success. Herring have been plentiful on the west coast of Newfoundland, and the small fleet engaged in this fishery has obtained full cargoes. The gill netters have had indifferent success.
1	1922	The weather was unfavorable on the fishing grounds during the month of January, and as a consequence the catch of fish was light, and prices ruled high. The first part of the month some of the ground-fish vessels were tied up owing to labor trouble. The gill netters found fish scarce, and had poor success. Many of the halibut vessels that have been hauled up since the latter part of 1921 have sailed for the fishing grounds.
2	1922	The weather conditions were unfavorable for fishing early in February, but improved the latter part of the month. Good catches of fish were taken on Georges and other banks, but prices ruled low. Shore fishermen landed some good trips of haddock, but hake, cusk, and pollock were in light receipt. The gill netters landed considerable quantities of haddock.
3	1922	Weather conditions during the month of March were better than usual, and large catches of fish were landed from Georges and other banks. The halibut vessels fishing to the eastward and south of Newfoundland reported large fields of ice interfering with fishing operations. The first of the mackerel vessels has sailed south, and the seining fleet will be a little smaller than last year. The gill netters made fair catches of haddock.
4	1922	Weather conditions were favorable for fishing during the month of April. The mackerel fleet began operations in southern waters and have landed several thousand barrels of large and medium mackerel at New York, Cape May, and other ports. Ground fish were in good supply from the fishing fleet. The draggers made good catches of flounders, which were sold at low prices. Only a few gill netters are now engaged in fishing.
5	1922	Weather conditions during the month of May were fairly good for fishing, and the steamers and other vessels landed good catches of haddock from South Channel. The Southern mackerel fleet, though far from successful, landed more mackerel than last year. The fishermen reported seeing large schools of very small fish. A steam trawler, the first one is shift into mackerel fishing, landed a good trip of mackerel from Cape Shore. The halibut fleet as a rule had light catches and reported fish scarce.
6	1922	The prevalence of fog and rain during the month of June hampered fishing operations on the shore grounds. Ground fish have been in moderate supply by steamers and other vessels. The demand for these fish at this season of the year is light. The first vessel of the swordfish fleet arrived June 21, nine days earlier than the first arrival last year. Swordfish are more abundant this year than for several years. The first salt banker arrived at Gloucester, June 23, two days later than the first arrival last year. The catch of mackerel by the fleet on Cape Shore was less than last year owing to the abundance of jellyfish, which prevented the seining of mackerel.
7	1922	There was considerable foggy weather during the month of July, but otherwise fishing conditions were quite favorable. The steamers and other vessels landed good catches of ground fish. Very few mackerel were caught, and those taken were mostly "tacks" running three or four to a pound. The swordfish fleet had good fishing on Georges Bank, and the catch promises to be a record one. The halibut fleet landed good catches of halibut, mostly from Grand Bank, but prices have ruled low.

8	1922	The weather was unusually foggy and rainy during the month of August, but when favorable the fishing fleet made good catches of ground fish, mostly on Georges Bank and in South Channel. Mackerel were scarce, and those taken were mainly "tacks," running three fish to a pound. The swordfish fleet has continued to do well on Georges Bank. The halibut receipts were largely from Grand Bank, but halibut were not as plentiful there as last year.
9	1922	Weather conditions were favorable for fishing during the month of September. Steamers and sailing vessels landed good catches of ground fish, mostly haddock. Some at the sailing vessels made unusually quick trips. The latter part of the month the fishermen reported sharks and dogfish bothersome in South Channel. Handliners landed moderate trips of fish from Georges Bank. Halibut have been in moderate supply. Mackerel weighing about one-half pound each were quite plentiful inshore from Boon Island to Cape Porpoise, and a large number of small seiners made good catches.
10	1922	Heavy winds greatly retarded fishing operations during the month of October, and the prices received for groundfish have been higher in consequence. Returning halibut fishing vessels landed small catches and report scarcity of fish. Small mackerel were quite numerous inshore on the coast of Maine, and small vessels made good catches.
11	1922	Weather conditions during the month of November were better than usual for this time of the year. More steam trawlers were operating than for a number of years, but as a rule they landed moderate catches of ground fish. A few steamers landed good catches of haddock from off South Shoal Lightship. Mackerel netters landed good catches of large and medium mackerel from off Cape Ann. A few seiners went to Cape Shore but met with indifferent success. Prices of ground fish have ruled low for this season of the year.
12	1922	Heavy winds with snow and rain interfered to a large extent with fishing operations in December. The steam trawlers landed moderate catches of fish, and some of the steamers made good catches of pollock in South Channel, where there was a large school of these fish. A number of the sailing vessels landed good catches of ground fish from Browns Bank. Owing to the bad weather the gill netters landed small catches. Herring were plentiful on the west coast of Newfoundland, but only a few American vessels were engaged in that branch of fishing.
1	1923	During the month of January snowstorms and windy weather interfered with fishing operations. Fish were reported scarce on most of the fishing grounds. Owing to the light receipts, prices ruled high, especially during the first three weeks of the month. The halibut fleet usually sails during this month, and the indications are that the fleet will be about the same size as last year. Two American vessels on herring voyages were caught in the ice on the west coast of Newfoundland with no prospect of getting out until April.
2	1923	The weather during the month of February was unusually cold, and the snow and rough weather interfered with fishing operations. The harbors were filled with ice and conditions in that respect were worse than in any year since 1918. Fishermen fishing on the eastern fishing grounds reported seeing much field ice. During a moderate spell the latter part of the month the vessels made good catches of codfish on Georges Bank. Shore fishing was very light.
3	1923	Weather conditions during the month of March were unfavorable for fishing operations, being unusually cold with snow and heavy winds. The vessels from the eastward, with light catches of halibut, reported that large fields of floating ice extending farther south than usual interfered with fishing. Gill-net fishing improved somewhat, but the catches are still running light. Some preparations are being made by the southern mackerel fleet, but the first vessels are not expected to leave before the first of April.
4	1923	Windy weather interfered considerably with shore fishing during the month of April. The steamers landed good prices of haddock from Western Bank, and other vessels landed some good trips of haddock and codfish from Georges and Browns Banks. The operations of the gill netters were light. Flounder draggers landed considerable quantities of fish. Mackerel seiners landed several trips of tinker mackerel at southern ports, and the netters landed small catches of medium and large mackerel. Trips along the shore made good catches of herring.
5	1923	Weather conditions during the month of May were better than usual, but the vessels and steamers fishing for ground fish reported fish scarce to South Channel and on Georges Bank. The vessels from Browns Bank and Western Bank reported good fishing. Although a number of big trips of halibut were landed, the catches on the average have not been large. Fishermen from Grand Bank reported halibut scarce. Mackerel fishermen in the south have had indifferent success. The seiners made some catches of tinker mackerel, which is regarded as an encouraging sign. Preparations are being made for swordfish fishing, and a few vessels have already sailed.

6	1923	During the month of June ground fish were in good supply, and prices ruled low. The handliners landed good trips of codfish from Georges Bank. Most of the vessels fishing on Cape Shore returned with light catches of mackerel, and the total catch in those waters was the lightest for many years, owing to bad weather and scarcity of fish. Shore vessels made small catches of tinker mackerel. The catch of swordfish on Georges Bank so far has been very light, owing to a scarcity of fish. The catch of large shore herring was also very light.
7	1923	Weather conditions were quite favorable for fishing during the month of July, and vessels landed good catches of ground fish from the certain fishing grounds. Handliners landed good catches of codfish from Browns Bank. Light catches at small mackerel were made off Cape Ann and Cape Cod. The catch of swordfish on Georges Bank was light compared with last year, and the fishermen reported fish scarce. The halibut fishermen also reported fish scarce. Menhaden were schooling off this coast, and some of them were seined.
8	1923	Weather conditions during the month of August were quite favorable for fishing operations except on Georges Bank, where the fishermen reported much fog, especially the sword fishermen. The ground-fish fleet as a rule made moderate catches of small mackerel on Middle Bank. Most of the larger mackerel vessels, discouraged with the outlook, discontinued mackerel fishing. The swordfish fishery improved, but the fishermen experienced much foggy weather and reported fish scarce.
9	1923	Good weather prevailed during the month of September, resulting in good catches of almost all kinds of seasonable fish. More mackerel were caught this month than at this season for many years. The fish were practically all small, weighing about 1 pound each, and were caught them from Boston Light to Boon Island. Hand-line pollock fishermen, starting fall operations, report fish scarce.
10	1923	Weather conditions were favorable for fishing during October until the latter part of the month when heavy winds and rain retarded fishing operations, especially the seining of mackerel. Receipts of ground fish, however, were large. Small mackerel have been in good supply and were caught monthly in the vicinity of Cape Cod. Herring have been scarce. Mackerel netters have begun fishing but so far have made light catches. Only a few halibut vessels are now operating.
11	1923	The weather during the month of November was unusually mild, and favorable for fishing operations. Ground fish were in good supply from both steamers and sailing vessels. The mackerel receipts were light as seiners have quit fishing, and the fall netters have had an unsuccessful season. Gill netters report an improvement in fishing and are catching mainly pollock. The catch of herring has been very light.
12	1923	The weather during the month of December was milder than usual and favorable for fishing operations. The mackerel netters fished later in the season than for many years, making small catches of large mackerel chiefly off Cape Ann. Ground fish were in good supply. Only a few gill netters operated this season, and their catches were mostly pollock. A number of cargoes of herring were received from the west coast of Newfoundland.
1	1924	Early in January ground fish were in light supply and sold at comparatively high prices, but during the mild weather that prevailed about the middle of the month the receipts of ground fish were heavy. The latter part of the month cold and stormy weather prevailed. A number of the halibut vessels have sailed for the fishing grounds. The Newfoundland herring catch has been very light.
2	1924	Although the weather during the month of February was unusually cold and more or less stormy, the arrivals of ground fish were large, especially from Georges Bank. The arrivals from Georges had good catches running from 40 to 50 per cent codfish, mostly large fish. Hake, cusk, and pollock were in light supply. Operations on the shore grounds were light. A few vessels of the halibut fleet arrived and, as usual at this season of the year, brought in small catches of fish.
3	1924	During the month of March much stormy weather prevailed, including the worst northeast blizzard of the winter, and there was a long period of windy weather. The vessels, however, landed some good catches from Georges Bank, practically all haddock and codfish. The first seiner of the southern mackerel fleet sailed south on the 24th of the month, 11 days earlier than the first vessel sailed last year. The fleet will be about the same size as last year.
4	1924	Easterly winds with rain and snow squalls interfered with fishing operations during the month of April. Near the end of the month the mackerel fleet fishing in southern waters made good catches of small fresh mackerel, which were landed at New York. The mackerel netters, however, have done very little to date. A number of the vessels this month changed from ground-fish fishing to mackerel or halibut fishing. Herring of medium size, suitable for bait, appeared off this coast and good catches were made at Provincetown.

5	1924	The fishermen reported grayfish very bothersome along the shore the latter part of May from Fire Island to Browns Bank. Some of the vessels have returned with small catches of ground fish and mackerel, owing to the presence of grayfish on the fishing grounds. The mackerel seiners in the south have landed good catches of small mackerel, and the netters have landed good catches of large and medium mackerel. The season has been quite successful. The swordfish fleet is fitting out. Good catches of herring of a size suitable for bait have been taken along the shore.
6	1924	The mackerel netters have landed better catches of large and medium mackerel caught off this coast than far many years. The catch of fresh mackerel on Cape Shore was about 75 per cent as large as that of the previous year. The early arrivals had small-sized fish, which was unusual. Good catches of herring have been made, which were disposed of for salting and freezing purposes. Two vessels of the swordfish fleet, the first arrivals, landed 119 fish on June 25. There have been good catches of ground fish landed.
7	1924	There was considerable foggy weather during the month of July which interfered with fishing, especially on Georges Bank, where the swordfish fleet operated. Good catches of codfish were taken on Western Bank. The mackerel fleet made good catches of blink mackerel along the shore from Block Island, R. I., to Portland, Me. The latter part of the month, when the fog disappeared, good catches of swordfish were taken on Georges Bank.
8	1924	Mackerel weighing about three-fourths of a pound each were quite plentiful on Middle Bank and the mackerel fleet landed good catches of these fish. Mackerel of a larger size were taken on the Maine coast near Matinicus. The catches of swordfish have been moderate. The swordfish fleet suffered considerable damage in a heavy gale the latter part of the month. Good catches of cod and haddock, but small catches of halibut, were landed during the month.
9	1924	There was considerable windy weather during September which interfered with the fishing operations of the mackerel fleet. Mackerel of mixed sizes, but mostly about one pound in weight, have been schooling along the shore from Chatham, Mass., to Seguin, Me. Good catches of ground fish were landed, and a considerable number of steam trawlers operated, as market conditions have improved. Gill-net fishing and halibut fishing have been light. Small catches of large herring have been taken along the shore.
10	1924	The weather during the month of October was quite favorable for fishing, and the catch of ground fish, particularly haddock, was large. The arrivals were largely from South Channel. A number of steamers that have been laid up for some time resumed operations. The landings of the mackerel, which have been moderate, comprised mostly small fish. Gill netters made moderate catches of fish, largely pollock. The halibut fleet have nearly all discontinued fishing. Boats landed only a small catch of herring.
11	1924	The mackerel seiners made good catches of small mackerel off Block Island the first part of the month, but did very little thereafter, and discontinued fishing for the season. The mackerel netters made light catches of large and medium mackerel off Cape Ann. They have had a poor season. Ground fish have been in good supply, especially from the shore grounds, from which more fish have been taken than for many years. The fishermen report grayfish remaining on the grounds later than usual this year. A few small salmon were caught off Gloucester, which is unusual.
12	1924	During the month of December rain, snow, winds, and cold weather curtailed fishing operations, especially on the offshore fishing grounds. Most of the vessels, however, operated on the shore grounds, making short trips. Light catches of large and medium mackerel were made off Cape Ann up to about the middle of the month by the netters. The fishing operations of the gill-netters have been light.
1	1925	Owing to the stormy weather during a large part of January, fishing operations were light. One vessel out eleven days had only one and a half days of fishing. Some trips of good-sized fish were brought in from Browns Bank. One vessel landed a haddock from Browns Bank that weighed 16 pounds and measured 38 1/2 inches in length, probably the largest ever landed from there. The fishermen reported fish scarce on Western Bank.
2	1925	Fishing operations at this season of the year are confined almost entirely to ground fish. A very long spell of moderate weather prevailed during February and resulted in good catches of fish, especially on Georges Bank. Steamer Whitecap, while fishing on Georges Bank, caught a large mackerel in her otter trawl. A number of vessels of the halibut fleet have resumed fishing, having been laid up for several months.
3	1925	The weather was unusually good during March and resulted in good trips of fish being landed, especially from Georges Bank and South Channel. The gill-net fishing has also improved. The first vessel of the southern mackerel seining fleet sailed March 24. The present indications are that the southern fleet will be larger than last year. Vessels arriving from the eastward with ground fish as a rule have had moderate catches. Schooner "Ingomar" landed a big trip of halibut which weighed out 79,930 pounds and stocked \$16,828.74.

4	1925	Good trips of ground fish were landed by the fishing fleet from Browns Bank, Georges Bank, and South Channel. Vessels fishing on shore grounds made good catches of haddock and flounders. The southern seining fleet, which is larger than last year, landed more mackerel from that locality than for several years. The mackerel varied in size from blinks, weighing 1/4 of a pound, to large, weighing 3 pounds each. The halibut fleet landed small catches as a rule, and reported fish scarce. Herring made their appearance off Cape Cod and Cape Ann.
5	1925	During the month of May the weather was mild and conditions were favorable for fishing operations. Good catches of ground fish were landed by vessels operating on Browns Bank, South Channel, and Georges Bank. Larger catches were landed by vessels fishing on Western Bank and the eastern fishing banks. Vessels of the mackerel fleet that went south are returning home, and report the most successful season for many years. The halibut fleet as a rule have landed small catches, and report fish scarce. Preparations are now being made for the swordfishery.
6	1925	The Cape Shore mackerel catch was quite successful, being about 60 per cent larger than last year. The fish landed were all of large and medium size. The shore fleet have landed some good catches of mackerel weighing about a pound each, caught from Block Island to Cape Ann. Small catches of swordfish have been landed from Georges Bank, and more have been taken this season in the Block Island region than for several years. Hand-line fishermen have landed moderate catches of codfish, principally from Georges Bank. The bank halibut fleet has landed light catches.
7	1925	Small mackerel, weighing from 1 to 1 1/4 pounds each, were plentiful in South Channel and off South Shoal Light, and the mackerel seiners made good catches. Sharks were numerous and quite bothersome off South Shoal, and did considerable damage to the seines. The groundfish fleet landed good catches of haddock from South Channel and Western Bank. Hand-line fishermen for cod had fair fishing on Georges and Browns banks. Halibut fishermen reported fish scarce. Swordfish fishermen have had moderate success. Swordfish are more scattered this season than usual.
8	1925	More mackerel were landed in August than for many years. They weighed from 1 to 1 1/4 pounds each, and were caught mostly off Chatham and on Middle Bank. The largest mackerel landed weighed 7 1/4 pounds and was the largest one landed in a number of years. The swordfish catch has been light. Good catches of haddock were taken in South Channel. The halibut vessels continue to land light catches of fish.
9	1925	Weather conditions were good during September and ground fish were in good supply. The Gloucester gill netters landed good catches of cod and pollock. The mackerel seiners were very successful, landing catches of medium mackerel caught from Thatchers Island to South Channel. The halibut fleet as a rule brought in small catches. The swordfish vessels are all in, and the catch is about 20 per cent less than last year.
10	1925	The weather during the month of October was unusually cold and windy. The mackerel fleet landed good catches of medium mackerel caught mostly off Chatham and Block Island, but the latter part of the month the schools disappeared. The ground-fish vessels are now operating largely on the shore grounds. Vessels operating in South Channel have had moderate catches. The fleet has been augmented by the addition of a number of steamers. Gill netters have landed some good catches of pollock. Vessels fishing in South Channel have been bothered by small grayfish.
11	1925	Heavy winds interfered with fishing operations during the month of November. The mackerel netters made light catches of large and medium mackerel off Cape Ann. Shore mackerel seiners had very little chance to fish, and discontinued operations. Three seiners went to Cape Shore, but returned without any fish. Ground-fish arrivals were largely from shore grounds, but the steamers landed some good fares of haddock from South Shoal. Handline fishermen for cod reported good fishing on Georges Bank when the weather permitted fishing, but all except two of these vessels have discontinued fishing for the season.
12	1925	During the month of December the fishermen experienced one of the longest spells of windy weather on record, and had very little chance to operate. The receipts were landed largely by the steam trawlers. Fish were not very plentiful in South Channel and on the shore grounds, but fishing vessels from La Have Bank and the eastward reported good fishing. The hand-line vessels have all discontinued fishing, and have had quite a profitable season.
1	1926	The weather during the month of January was very windy, which interfered with fishing operations. Moderate catches of ground fish were landed from Georges Bank and the fishing banks to the eastward. Steamers and vessels landed some good catches from South Channel and from off Chatham. Light catches were landed from the shore grounds. A cargo of frozen herring was received at Gloucester from Newfoundland. There is only one vessels engaged in that fishery this season.

2	1926	During the month of February the weather was very unfavorable for fishing operations, especially on the shore grounds. The snow fall was the largest in twenty years, and strong winds prevailed most of the time. The receipts were largely codfish from Georges Bank, from which a number of vessels landed good catches. The steamers landed some good trips of haddock, which were in good demand. The first arrivals of the halibut fleet had small catches, and reported rough weather.
3	1926	The fishing fleet, during the month of March, landed a large amount of fish from South Channel and Georges Bank. The steamers operating in South Channel made good catches of haddock, and the vessels operating on Georges Bank made good catches of codfish. The vessels fishing on shore grounds, as a rule, landed small catches. The first vessels of the mackerel fleet sailed south on March 27, four days later than the first vessels sailed last year. Indications are the southern fleet will be the largest for many years.
4	1926	Weather conditions during the month of April were not very favorable for fishing. The mackerel fleet operating in the south is larger this year than for a number of year. The first catch of mackerel was landed at Cape May on April 11, two days earlier than last year. The mackerel were of mixed sizes, but mostly medium. Ground fish have been in good supply from both shore and offshore grounds. The fishermen in the hand-line cod fishery on Georges Bank reported fish scarce. The draggers made good catches of haddock off Chatham.
5	1926	Weather conditions were fairly good during the month of May, and the steamers landed good catches of ground fish. Other vessels landed good catches of codfish from Western Bank. A handline vessel arrived having 100,000 pounds of large codfish, the largest trip of large codfish ever brought in from that place by a handline market fisherman. Mackerel seiners fishing in the south landed good catches of medium and small mackerel. The halibut vessels fishing on Georges Bank made fair catches of halibut.
6	1926	Ground fish have been in good supply during June, especially by steamers of South Channel. A larger number of vessels than usual engaged in the Cape Shore mackerel fishery, and landed good catches of mackerel of mixed sizes. The first arrival was five days later than the first arrival last year. Seiners landed good catches of small mackerel from off No Man's Land. The netters as a rule landed small catches from shore grounds. The first swordfish trips were landed on June 23; the first last year on June 25.
7	1926	Weather conditions during the month of July were quite favorable for fishing operations, and the fishing fleet landed good catches for mackerel, swordfish, and ground fish. The mackerel which were caught along the shore from Cape Ann to Chatham were nearly all small and medium fish, very few tinkers, and practically no large. Swordfish vessels from Georges Bank landed the best trips for years, but the fish averaged small in size. The large vessels operating on Western Bank landed good catches of codfish.
8	1926	Mackerel seiners landed good catches of small and medium mackerel, which were caught from Chatham, Mass., to Portland, Me. The price of mackerel owing to the large receipts, has ruled low. The swordfish fleet landed good catches of swordfish from Georges Bank. Only a small number of steam trawlers are now operating, but have landed good catches of haddock from South Channel and Nantucket Shoals.
9	1926	Easterly winds and fog hampered fishing operations more or less during the month of September. The mackerel fleet made catches of mackerel from Boon Island southward to Chatham. The fish were practically all of medium size, with a few large. The swordfish season is closed and the catch is about 60 per cent larger than last year. The vessels engaged in this fishery had a successful season. Gill netters now operating are making light catches of ground fish. The halibut fleet has found fish scarce. Steamers and vessels have landed fair catches of ground fish.
10	1926	During the first two weeks of this month fair catches of mackerel were made by the fleet off Chatham and as far north as Jeffreys Ledge, but during the latter part of the month mackerel fishing was interrupted by unfavorable weather. Ground fish were largely from South Channel. Vessels that came from La Have and Browns Banks reported grayfish bothersome, and lost more or less fishing gear. The gill netters the latter part of the month made good catches of pollock. A few good trips of halibut were received from Quereau Bank.
11	1926	The weather in November was favorable for fishing operation. Early in the month there was a large school of mackerel off Cape Cod, and the mackerel seiners landed the best catches ever landed so late in the season. The fish were 1½ to 2 pounds each in weight. Most of the seiners discontinued fishing the middle of the month. Netters made some fair catches the latter part of the month off Cape Cod. The ground-fish vessels and steamers have made moderate catches, and have been bothered by grayfish. The steamer "Wave," while fishing 50 miles southeast of Highland Light, November 24, caught a 6-pound tilefish in her trawl.

12	1926	Much stormy weather interrupted fishing operations during the month of December. The mackerel netters landed small catches of large and medium mackerel the first part of the month, caught off Cape Cod and Thatchers Island. The last netters arrived on December 10. Vessels engaged in the market fishery landed moderate catches from shore and offshore grounds. Gill netters landed fair catches, mostly pollock. The draggers landed moderate catches of flounders.
1	1927	The fishermen reported the weather unusually mild on the fishing banks for the month of January, and obtained good catches of fish, especially codfish on Georges Bank. Codfish struck in on Georges Bank early this year. Steamers from off South Shoal Light brought in good catches of haddock. The first vessel of the halibut fleet sailed January 27, about two weeks earlier than the first vessel sailed last year.
2	1927	Owing to mild weather on the fishing banks during the month of February, the fishing fleet landed a large quantity of fish. The steamers landed good catches of haddock from South Channel, and other vessels landed good catches of large codfish from Georges Bank. Prices ruled low. A vessel of the halibut fleet arrived February 2, with a good catch from St. Peters Bank, and was the first arrival from there this year. Gill netters landed light catches of fish, mostly codfish.
3	1927	Mild weather prevailed during the month of March, and conditions were favorable for fishing operations. The steamers landed good catches of haddock from South Channel, and other vessels landed good catches of codfish from Georges Bank. The southern mackerel fleet will be the largest for many years, and quite a number have already sailed south. The halibut fleet which is now operating has landed some good catches, and gill netters have landed fair catches, mostly codfish.
4	1927	During the first half of the month of April the weather conditions were unfavorable for fishing, and steamers and vessels were more or less hampered in their operations. The ground-fish fleet landed moderate catches. The mackerel fleet operating in the South the latter part of the month was very successful in making catches of mackerel that averaged about 1 1/4 pounds each in weight. Gill netters landed good catches of haddock. Prices of fish have ruled low.
5	1927	The mackerel fleet made good catches of Medium mackerel in the month, but prices ruled low. More mackerel were received from the fleet direct than ever before. Owing to the lighter demand for ground fish and haddock, a number of the steamers have hauled out of this branch of fishing. Hand-line fishermen fishing for cod on Georges Bank have averaged small catches and report fish scarce. A number of the swordfish fleet have sailed for the fishing grounds.
6	1927	The mackerel fleet landed good catches of mackerel of small and medium size from off No Mans Land, Block Island, and South Shoal Light. Steamers landed good catches of haddock from South Channel. Handliners reported codfish scarce on Georges Bank, and trawlers reported fish scarce on Western Bank. There have been only 3 arrivals this season from Cape Shore with mackerel compared with 53 last year. The first arrival from Georges with swordfish was on June 16, a week earlier than the first arrival last year. Swordfish fishermen reported bad weather and landed small catches.
7	1927	The weather was unusually foggy during the month of July. The mackerel fleet made good catches of mackerel averaging about 1 1/2 pounds in weight each, which were caught from South Channel to Middle Bank. Catches of mackerel were made on Middle Bank the latter part of the month. Trawlers made good catches of haddock in South Channel. Codfish fishermen from Georges and Western banks reported light fishing. The swordfish catch has been about 40 per cent less than last year, and the fish have run small in size.
8	1927	Much foggy and rainy weather prevailed during the month of August, and one of the worst gales on record was experienced August 24, in which three of the swordfish fleet were lost on the Nova Scotia shore and many of the seiners lost seines and boats. Mackerel have been quite plentiful, the fleet making the best catches in South Channel, but some catches were made as far north as Jeffreys Bank. Steamers and vessels have made fair catches of haddock in South Channel. The handliners fishing for codfish as a rule have had light catches of fish. The swordfish catch has been light, but improved some during the month.
9	1927	The mackerel seiners landed fair catches of mackerel weighing 1 1/2 to 2 pounds each, which were caught mostly in South Channel and on Georges Bank. Bull's-eye mackerel weighing about half a pound each have been quite plentiful in the vicinity at Cape Cod. These fish have been more abundant than for many years. The swordfish season is practically over, and the catch by the fleet is about 10 percent less than last year. Haddock have been in good supply by steamers and vessels. The halibut fleet, as a rule, has landed light catches of fish. Some large spawn herring have been landed by the shore seiners.

10	1927	The weather was unusually good during the month of October and the fishing fleet landed good catches of haddock, but other ground fish were not so plentiful on the fishing grounds as during the summer months. The handliners fishing on Georges Bank reported codfish scarce. Gill netters made light catches of cod and pollock. Mackerel seiners made light catches, mostly on Georges Bank. Mackerel netters made light catches off Cape Ann.
11	1927	Owing to rough weather and the scarcity of fish, the vessels and steamers engaged in catching ground fish averaged small catches during the month of November. The mackerel seiners landed very few mackerel, but the netters made light catches off Thatcher's Island. The gill netters landed good catches of pollock. The vessels of the halibut fleet have all discontinued fishing for the season. except eat, and will not resume operations again until after the beginning of next year.
12	1927	The mackerel netters made catches of large and medium mackerel off Cape Ann much later this season than usual, making catches nearly to the close of the year. Haddock, codfish, and other kinds of ground fish were in moderate supply, and sold at good prices. Fish were reported source on the fishing grounds, and the weather was unsettled much of the time. The catch of the gill netters consisted largely of codfish, and trips were small.
1	1928	Weather conditions during the month of January were unfavorable for fishing operations owing to heavy winds, but arrivals reported good fishing on Georges Bank, and in South Channel when the weather permitted. The gill netters all discontinued fishing except a few boats that made light catches of codfish. All kinds of operations on the shore were very light.
2	1928	Weather conditions during the first part of the month were quite favorable for fishing, but during the latter part of the month there was considerable wind and some foggy weather. A number of vessels hauled out of haddock fishing to get ready for the southern mackerel fishery, and will sail the first week in April. The halibut fleet landed good catches. Gill netters made moderate catches of haddock and codfish.
3	1928	The fishing fleet landed good catches of fish, especially haddock, from Georges Bank during the month of March, although there was considerable wind and some foggy weather. A number of vessels hauled out of haddock fishing to get ready for the southern mackerel fishery, and will sail the first week in April. The halibut fleet landed good catches. Gill netters made moderate catches of haddock and codfish.
4	1928	Notwithstanding the fact that the weather was unusually windy on the fishing grounds during the month of April, the fishermen made good catches. Prices of ground fish ruled low. Mackerel were received overland from the northern fleet, and comprised fish weighing mostly 1 1/4 to 1 3/4 pounds each. The first catch was landed April 12, a week earlier than last year. Handline codfish vessels landed light catches of fish from Georges Bank. The gill netters landed good catches of cod and haddock.
5	1928	The mackerel seiners landed good catches of mackerel, weights from 1 1/4 to 2 pounds each, that were caught mostly south of Long Island, in the vicinity of Fire Island and Shinnecock. The mackerel netters the latter part of the month also landed good catches of large mackerel. Steamers landed good catches of haddock, principally from South Shoal Light. The handliners fishing on Georges Bank and the line trawlers from Western Bank reported improved fishing. The gill netters landed light catches of fish, mostly codfish. Flounders were in good supply from the draggers.
6	1928	Much foggy weather prevailed during the month of June, especially on the southern fishing grounds. The mackerel seiners landed fair catches of large mackerel that were caught mostly southeast and southwest of No Man's Land. The mackerel netters landed good catches, doing better than for several years. A large fleet was engaged in the swordfish fishery on Georges, and had fair success, as well as steamers and vessels fishing for groundfish. Arrivals of the halibut fleet reported fish scarce.
7	1928	Foggy weather hampered fishing operations in South Channel and on Georges Bank, but good weather prevailed on the fishing banks to the eastward. Quite a number of steamers engaged in otter trawling, hauled out for repairs or inspection, and thus operations were somewhat curtailed. Fishermen reported a large body of mackerel in South Channel and on Georges feeding on live bait, but they were wild and hard to catch. The catch of swordfish promises to be the best for a number of years, but the fish are running small in size. The cod gill netters have discontinued fishing. The handline cod fishermen reported fish scarce.

8	1928	Foggy weather has hampered fishing operations during the past month, especially in the mackerel fishery. Quite a body of mackerel were reported in South Channel and on Georges Bank, but they were feeding down deep in the water and were hard to locate. Some good catches of large mackerel were made on the coast of Maine. Steamers and vessels have landed good catches of haddock from South Channel. Late arrivals from the swordfish fleet reported fish scarce, and have had small catches. Hand line codfish vessels have had light catches, and the fishermen reported bait scarce on the fishing grounds. Halibut fishermen, both on Georges and Grand Bank, reported fish scarce.
9	1928	During the month of September fishing operations were hampered more or less by unsettled weather, especially in the mackerel fishery, Blink or tinker mackerel, averaging about three-quarters of a pound each, were caught in the vicinity of Cape Cod and Nantucket. Large mackerel were reported on Georges Bank, but wild and hard to catch. Bulls-eye mackerel, weighing about a half pound each, were caught in the Block Island region. Seiners made an unusual catch of butterfish off Cape Cod; they weighed about a pound each. Groundfish vessels as a rule reported fish scarce. The swordfish fleet are all in, and the last arrivals from Cape Shore had light catches.
10	1928	During the month of October mackerel operations were light. Very few large mackerel were landed. Catches of blinks and bulls-eye mackerel were made in the Block Island region, and quite a lot of spike mackerel also were reported in those waters. Netters landed small catches of large mackerel caught off Cape Ann. Ground fish were in good supply. Steamers landed good trips of haddock from Georges Bank. Good catches of codfish were landed from the Rips, where these fish were caught in larger quantities than for quite a number of years. Handline cod fishermen reported good fishing on Cape Shore when weather permitted. Gill netters made moderate catches of pollock, cod, and hake. Grayfish bothered the fishermen in South Channel.
11	1928	Early in the month mackerel netters made fair catches of large and medium mackerel off Cape Cod. The mackerel netters have been quite successful operating off Cape Ann, and the latter part of the month made unusually good catches. Very few mackerel were landed by seiners, and this class of vessels have discontinued operations for the season. The gill netters made good catches of pollock. In the ground-fish fishery the steamers and vessels as a rule have had moderate catches, reporting fish on the fishing grounds scarcer than usual this fall. Dogfish have been bothersome in some parts of the South Channel.
12	1928	The weather was quite mild during the month of December, but periodic winds hampered fishing operations. A large number of steamers and vessels landed moderate catches of ground fish. Mackerel netters were quite successful early in the month fishing off Cape Ann, catching large and medium mackerel, but by the middle of the month practically all had given up operations. The gill netters landed fair catches of pollock when weather permitted fishing. With the exception of a few vessels the hand liners have given up fishing for the season.
1	1929	During the month of January heavy winds prevailed almost continuously, and greatly interfered with fishing operations. One steamer, the Seiner, was lost with her entire crew of 20 men. The shore vessels were confined in port most of the time. The gill netters landed small catches of groundfish, mostly codfish. Vessels fishing off Newfoundland were successful in obtaining fares of herring. A few vessels of the halibut fleet have fitted and sailed.
2	1929	Moderate weather during the month of February, on the off shore grounds, favored fishing operations, and as a result the steamers, as well as the vessels, landed good catches of codfish and haddock. Operations on the shore, however, were on a moderate scale. The gill netters landed moderate catches of codfish and haddock. A few trips of halibut arrived, the first arrivals of the year, and had good catches. Draggars operating in South Channel reported catching in the trawl a few straggling mackerel about 8 inches in length.
3	1929	During the month of March good catches of haddock were landed from Georges Bank by the fishing fleet. The fleet operating on Browns Bank reported fish scarce. The Georges hand-line fleet is getting ready for fishing, and the indications are that it will be smaller than last year. The first mackerel seiner sailed south for mackerel fishing March 29, about a week earlier than the first sailed last year.
4	1929	Heavy rains and winds hampered fishing operations to a greater extent than usual during the month of April. Good catches of haddock were made on Georges Bank the first part of the month, but later they were found scarce. A few codfish handliners operating reported finding fish scarce. The mackerel seining fleet is now operating in southern waters, and is about the same size as last year. The netting fleet is a little larger. The first mackerel were taken April 8, a small catch of two-pound fish. The gill netters have shifted over to haddock nets, and have made some fair catches. The halibut fleet report fish scarce.

5	1929	Most of the mackerel seiners returned from the south during the latter part of the month of May reported having a poor season as they experienced much bad weather. The netters, however, had a comparatively good season. The mackerel caught averaged about two pounds each. The fishermen reported seeing quite a lot of spike mackerel in the south this spring. Groundfish have been in good supply, but fishing has been rather "spotty" on Georges Bank and in South Channel. Gill netters made moderate catches, mostly codfish.
6	1929	Weather conditions were quite favorable for fishing operations during the month of June and consequently the fishing fleet landed good catches of ground fish, mackerel, and swordfish. Prices have been low, owing to the large supply. Good catches of large mackerel were landed from No Man's Land, and from South Channel. The vessels fishing with handlines on Georges Bank, for codfish, reported better catches. The gill netters have practically all discontinued fishing for ground fish. The halibut fleet reported fish scarce.
7	1929	Weather conditions were unusually good for fishing operations during the month of July. Due to the good weather the swordfish fleet fishing on Georges Bank has been very successful and the production of these fish this season promises to be a record. The receipts to date are nearly 100 per cent larger than last year. Ground fish have been in good supply. The mackerel fleet made good catches early in the month, but later did not do so well. The halibut fleet landed light catches from Georges Bank.
8	1929	The production of most kinds of fish during the month of August was large, and is ascribed in a large measure to the good weather conditions that prevailed this period. The receipts of ground fish the week ending August 22 were the largest of any week since April 4. Good catches of large mackerel were made in South Channel, and tinker mackerel nearer the shore. The swordfish fishermen are now hauling out of that branch of fishing, and have had a very successful season. The halibut catch has continued light. Gill netters have begun operations, and recent catches have comprised largely codfish.
9	1929	The mackerel fleet has been quite successful along shore during the past month in the area from Highland Light, Cape Cod, as far east as Boothbay Harbor, Maine. The catch has consisted mainly in mackerel weighing from three-quarters to one and one-quarter pounds each. Craft engaged in catching groundfish report finding them scarce in most cases. The swordfish fleet has completed a very successful season. Only a few vessels are now operating in the halibut fishery and are finding these fish scarce.
10	1929	There was a large body of small mackerel in Cape Cod Bay in the month of October, and seiners made good catches of mackerel that were of small size. Netters made good catches of large mackerel off Cape Ann the latter part of the month when the weather permitted. There were 73 arrivals at Boston from the fishing fleet on October 14, and was, without doubt, the largest number of arrivals on record for one day. Recent arrivals of groundfish vessels report cod and haddock scarcer than usual this fall. Some good catches of hake have been landed. Gill netters landed good catches of pollock.
11	1929	Mackerel netters made light catches off Cape Ann, while the mackerel seiners have done practically nothing during the past month. Gill netters operating off Gloucester have made good catches of pollock as well as good catches of shad that weighed from 3 to 5 pounds each. The groundfish fleet as a rule have had light catches of fish, and report fish scarcer than usual on the fishing grounds. Grayfish on the southern part of Georges Bank interfered somewhat with fishing operations.
12	1929	The fleet engaged in catching groundfish landed light catches, as a rule, during the month of December. At this season of the year these fish are usually not found in such large numbers on the fishing grounds as in the other seasons. Prices paid the fishermen have ruled high. The gill netters made good catches of pollock. The light catches of groundfish were ascribed, in a large measure, to the bad weather conditions that prevailed this month. The mackerel netters continued fishing until the latter part of the month, but made light catches, and had the poorest season for many years.
1	1930	The early part of the month the weather was mild, but the vessels of the fishing fleet made moderate catches owing to the scarcity of fish on the fishing grounds. A large part of the month the usual January weather prevailed. Some of the best catches were brought in from La Have Bank and Browns Bank, but the rough bottom on these banks is very destructive to the otter trawls of the draggers. Gill netters made moderate catches of groundfish, mostly pollock and codfish. Several vessels of the halibut fleet have sailed for the fishing banks.
2	1930	There was an unusually long spell of mild weather around February 20, and the fishing fleet made good catches of groundfish at that time. The landings by the fleet at Boston February 24 were the largest ever recorded landed there in one day. Catches during the month came mostly from Georges and Browns Banks. Operations on the shore grounds were very light. The gill netters made light catches of fish, mostly codfish and pollock.

3	1930	During the month of March the weather was unusually windy, much more so than in several years. For this reason fishing was somewhat restricted. Some good catches of haddock were landed from various parts of Georges Bank, where fish were found quite plentiful. The gill netters made light catches of haddock, codfish and pollock. The handline fleet, which usually fishes on Georges Bank, is making preparations for the season, and will be about the same size as last year. The southern mackerel fleet now outfitting will be the largest for a number of years. This is undoubtedly due to the optimistic report of the government which has stated that a larger catch of mackerel is expected this year than last year.
4	1930	The mackerel fleet, which is larger than last year, began operations in the south, and the first catch was landed by a netter at Cape May on April 11, three days later than the first mackerel were landed last year. It is the first time that a netter ever landed the first catch of mackerel in the south. Good catches of groundfish were landed from Georges and Browns Banks during the periods of moderate spring weather that prevailed during the month of April. Handline codfish vessels, a few of which are now operating on Georges Bank, reported moderate catches.
5	1930	During May the weather was quite favorable for fishing operations, as it was unusually clear for this season of the year. The mackerel fleet operating in the south reported mackerel quite plentiful, but low prices have been received for the catch. Quite a large number of vessels have sailed swordfishing, and this fleet promises to be the largest that ever engaged in that branch of fishing. As a rule the vessels employed in the groundfishery reported fish scarce, as did the Georges handline codfishermen.
6	1930	The mackerel seiners made good catches of small mackerel off No Mans Land the first part of the month, and the latter part of the month made good catches of large mackerel off No Mans Land and in South Channel. Only a few seiners operated on Cape Shore as mackerel were abundant on the shore. So far this season the swordfish fleet has landed moderate catches, and reports fish scarce. Many of the large trawl vessels are now being overhauled. Those vessels operating for groundfish, as a rule, find fish scarce.
7	1930	Favored by good weather conditions, the fleet engaged in catching groundfish landed a large quantity of fresh fish during the month. A feature of the receipts was the large amount of market codfish caught in South Channel. The catch of mackerel continued to increase, and comprised mostly large mackerel caught in South Channel. The catch of swordfish increased over last month but is only about 62 per cent as large as that for July of last year, when the catch was abnormally large.
8	1930	Good weather prevailed during the month of August, except for a short period. Mackerel fishing was carried on largely in the vicinity of Cape Cod. Tinker mackerel dominated the receipts. Small and medium sized trawlers fishing on Georges Bank reported fish scarce. Handliners have experienced a poor season so far this year. Line trawlers fishing to the eastward have landed good catches of groundfish.
9	1930	The weather conditions during the month of September were better than the average. Mackerel seiners landed good catches of tinker mackerel, averaging a little less than a pound each in weight. They were caught mostly from Cape Ann to the Rips. Vessels engaged in fishing for swordfish found them more abundant toward the end of the season. The Gloucester gillnetters made moderate catches of fish, mostly pollock.
10	1930	During the first part of the month a long spell of easterly winds retarded fishing operations. The groundfish fleet, augmented somewhat by vessels from the mackerel and swordfish fleets, landed moderate catches of groundfish, and reported finding fish scarce. Vessels fishing to the eastward reported grayfish numerous and bothersome. The halibut fleet has returned for the season of 1930. Most of the mackerel seiners have changed over to netting. Gill netters have made good catches of pollock.
11	1930	Mackerel netters made good catches of large and medium mackerel off Cape Ann the latter part of the month. A few mackerel seiners operated but were unsuccessful. The groundfish vessels in all branches of that fishery found fish scarce and brought home light catches. Grayfish were bothersome to the fishermen, especially on northern Georges Bank, and on eastern fishing banks. The late departure of these fish is ascribed in a measure to the higher temperature of the water this season on the fishing banks. Gill netters made good catches of pollock.
12	1930	Except for a short time at the beginning and the end of December weather conditions were quite unfavorable for fishing operations. Mackerel fishing was entirely suspended about the middle of the month. Operations of steamers and vessels engaged in the groundfish fishery, reported finding fish scarce, and therefore landed light catches. The prices for fish ex vessel during December ruled higher than for a number of years. The gill netters landed good catches of pollock when the weather permitted.

1	1931	Weather conditions were worse than usual during the month of January, and catches by the fishing fleet averaged small, although a few good catches consisting mostly of codfish and pollock, were brought from Sable Island Bank. Owing to the unfavorable conditions there has been some curtailment in steamer operations, and owing to the scarcity of fish on the shore only a small number of gill netters were operating. Two of the vessels of the bank halibut fleet sailed from Gloucester on the 27th, the first to sail this year.
2	1931	During the month of February the weather conditions proved very unfavorable to fishing operations. However, with the approach of spring fish are beginning to appear on the fishing grounds, and some of the vessels are making better catches. Very few gill-net vessels operated on the shore grounds, these catching mostly codfish. The first trip of halibut landed this year from the banks arrived on February 17. This first trip was five days later than the first trip landed in the year 1930.
3	1931	Almost continuous easterly winds during the month of March, hampered fishing operations, especially those along the shore. Fishing for groundfish improved during the brief intervals when fishing was permitted and resulted in a number of good catches being made. The gill-netters made moderate catches of fish, mostly haddock. The southern mackerel seiners have practically all sailed. This fleet is about the same size as last year. The mackerel-netters are preparing, and will sail shortly. According to present indications this fleet will be a little larger than last year.
4	1931	During the month of April weather conditions were quite favorable for fishing operations. Groundfish were in good supply, but owing to moderate demand sold at low prices. The gill netters made good catches of groundfish, mostly haddock. Mackerel seiners and netters operating in the south have made moderate catches of medium mackerel. The first catches of mackerel were the size known as spikes, four or more to a pound. Only a few of these fish, however, were landed.
5	1931	Quite a lot of rainy and foggy weather characterized the month of May. The mackerel seiners and netters made moderate catches of large and medium fish. Near the end of the month there was a larger percentage of medium fish. Owing to the low prices that prevailed for ground fish the operations by this fleet were curtailed. The swordfish fleet this year promises to be larger than ever before.
6	1931	Foggy weather hampered fishing operations to a large extent during the month of June. The mackerel fleet operated mostly in the vicinity of No Man's Land, but the latter part of the month made catches in South Channel. The mackerel caught were practically all large and medium sizes. The catch of swordfish to date has been less than half of what it was to the corresponding date last year. The fishermen state that the fish are not as plentiful as last year. Ground-fish craft continue to report fish scarce, and as a rule have light catches.
7	1931	During the month of July fog and unfavorable winds hindered fishing operations. Large mackerel were reported in quite large schools on the off shore grounds, but were wild and hard to catch. Tack mackerel, or fish about three to a pound, were plentiful along the shore. Large and medium mackerel were taken in small Quantities from Portland to South Shoals. The swordfish vessels landed light catches, owing largely to unfavorable weather conditions. As usual in the summer the gill netters landing at Gloucester have discontinued fishing. Groundfish operations were on a moderate scale.
8	1931	Mackerel seiners landed good catches of large and medium mackerel during the past month. These fish were caught on the coast of Maine between Seguin and Mr. Desert Grounds, largely off Matinicus Grounds, where weather conditions were very favorable. Small fish, about one-half pound in weight, have been plentiful along the shore. Vessels fishing for ground fish report fish scarcer than usual at this season of the year. The catch of swordfish has been disappointing.
9	1931	During the past month the weather has been fairly good for fishing operations. As a result the mackerel fleet made good catches, especially of large and medium fish, off the coast of Maine from Seguin Grounds to Mt. Desert Grounds. This was the best catch made on that coast for many years. Swordfishing operations are practically over for the season. The amount of this species landed through September is only about 50 percent of the landings for the same period of last year. Draggars continue to report haddock, and other ground fish scarce on the fishing banks. Line trawlers operating on hard bottom in South Channel have landed large quantities of fish. Mackerel netters have begun fall fishing, but so far have made light catches.
10	1931	Good weather conditions early in the month resulted in somewhat increased receipt of ground fish. However, the fishermen continue to report fish scarce on the fishing banks. This is especially true with those operating small otter trawls, which gear as a rule has made light catches. Grayfish were reported more bothersome than usual at this season of the year. Mackerel fishing has been moderate. Some fishermen seining for mackerel have quit fishing for the season, while those engaged in netting mackerel have made only light catches. Fishermen operating sink gill nets have made fair catches of pollock. The halibut fleet has discontinued operations for the season.

11	1931	During November the weather was milder than usual. Late in the month a large fleet of mackerel netters operated 20 to 30 miles east and southeast of Cape Ann, making fair catches of large and medium mackerel. Fishermen seining for mackerel landed only a small amount of this species, as all except a few fishermen have hauled out of this branch of fishing. The ground-fish fleet, although bothered more or less by grayfish, continued to land moderate catches of haddock and cod. Gill-net fishermen made fair catches of ground fish, mostly pollock.
12	1931	During the month of December the weather was unsettled, and heavy winds prevailed much of the time, especially on the off-shore banks. Netters made good catches of large and medium mackerel 20 to 30 miles east and southeast of Eastern Point when the weather permitted. After the middle of the month only a few mackerel were landed. Gill netters landed small catches of ground fish. A few vessels engaged in the Newfoundland herring fishery obtained full cargoes of herring.
1	1932	The month of January was marked by unsettled weather. The weather was also mild, in fact the mildest weather in the history of the weather bureau for the month of January. Small haddock were reported more abundant in some localities, but large haddock continued scarce. The gill netters, only a few of which operated, made light catches of ground fish. The draggers fishing off South Shoal Light reported catching a few mixed mackerel in their trawls, and those fishing to the eastward caught scattering eight inch mackerel.
2	1932	The weather during February was more unsettled than usual. However, when the weather permitted the fishing fleet made somewhat improved catches on practically all the banks. Catches by a few vessels still fishing for halibut have been light, although one vessel landed a good catch from St. Peters Bank. Gill netters landed light catches of ground fish, but are now catching a little larger percentage of haddock.
3	1932	The weather was very severe during the month of March, especially during the first of the month. The fishing steamers operated largely on Georges Bank and Sable Island Bank, where they made good catches of haddock and cod. Operations on the shore were very light. Prices paid to vessels ruled low. The vessels that will engage in the southern mackerel fishery in seining, began to fit out the latter part of the month, and the indications are that the fleet will be at least 20% larger than last year, and will be one of the largest of recent years. The first seiners will sail south early in April.
4	1932	Weather conditions were quite favorable for fishing operations during the month of April, and many of the steamers and vessels landed good catches of groundfish. The fishermen had better fishing on some of the eastern banks than for a number of years. A large number of vessels are engaged in the southern mackerel fishery, and the first catch was landed at Cape May April 15, six days later than the first catch last year, and comprised half-pound mackerel. Prices of all kinds of fish have ruled low owing to a light demand.
5	1932	Weather conditions were quite good during the month of May. Good catches of mackerel, mostly of large fish, were made by the southern mackerel fleet off Fire Island the early part of the month, and the latter part of the month off Block Island and No Man's Land. The early catch landed at Cape May was about 50 per cent of the quantity landed there last year. Many of the vessels in the swordfish fleet have sailed. The fleet will number 50 or more vessels this year. Gill net fishermen are landing light catches of groundfish. Other groundfish operations are on a moderate scale, and fishermen report fish scarce on the fishing banks.
6	1932	The first catches of swordfish this season were landed during the month about the same time of the year as usual. The vessels, however, made light catches because of bad weather, and scarcity of fish. Early in the month, and up to the middle of the month, the mackerel fleet made fair catches of large and medium sized fish, but the latter part of the month very few of these fish were caught as they were reported wild and hard to catch. The fleet, however, landed moderate catches of tinker mackerel throughout the month. The catch of mackerel on Cape Shore was the best for a number of years. The catch of groundfish has been light, fishermen reporting fishing spotty. Unusually foggy weather obtained on South Channel during the month.
7	1932	The mackerel fleet have landed good catches of tinker mackerel that were caught, mostly off the coast of Massachusetts, but recently some good catches of these fish were made as far east as Mt. Desert. Vessels report finding large mackerel very scarce. Due to low prices some of the mackerel fleet contemplate hauling up for a short time. Swordfish boats have had better catches which are attributed to better weather conditions. Groundfish production is moderate. The vessels fishing to the eastward report unseasonably cold weather for this season of the year.
8	1932	Good weather conditions prevailed during the month of August, but sharks and dogfish were bothersome. Mackerel seiners operating from Cape Cod to Mt. Desert made good catches of tinker mackerel early in the month, but from the middle to the latter part of the month found fish scarce. The fishing steamers operating large otter trawls, have operated monthly on Georges Bank, and obtained fair catches of groundfish. The small draggers have found fish scarce. The swordfish fleet landed some good catches, but prices of these fish have ruled low as well as all other kinds of fish landed.

9	1932	During the month of September there were two heavy gales; otherwise weather conditions were quite favorable resulting in good catches of mackerel, swordfish, and ground fish. The mackerel were taken from a school located off the Massachusetts coast, and comprised of fish weighing from three-quarters to a pound catch. Prices ruled low. The fleet fishing for ground fish made fair catches largely on the northern edge of Georges Bank. The season for swordfish is practically over. More of these were landed by the fleet than last year, but prices have ruled low.
10	1932	During the month mackerel seiners found tinker and small mackerel plentiful in Massachusetts Bay and landed large fares of these fish. They sold at low prices and were bought mainly for salting and freezing, mostly for the latter purposes. Large mackerel were very scarce. Netters are making preparations for the fall mackerel fishery. Fishermen engaged in catching ground fish reported dogfish bothersome, and that they found fish scarce. Gill netters for ground fish obtained light catches. The halibut fleet is all in except for one or two vessels, this branch of fishing being over for the season.
11	1932	During the month of November there was considerable rough weather on the fishing banks which interfered with fishing operations. The vessels engaged in the haddock and other ground fish fisheries had moderate catches, and fish were reported scarce. Dogfish were bothersome to the fishermen in the many localities. The mackerel netters made fair catches of large and mediums-sized mackerel, the schools of fish being mainly off the coast of Massachusetts. The mackerel seiners have practically all quit fishing.
12	1932	During the month rough weather interfered somewhat with fishing operations. However, good catches of large medium mackerel were made by the netters off Eastern Point the first part of the month. Most of the netters quit fishing by the middle of the month, but a few continued until the end of the year. Some good catches were made by the ground fish fleet the latter part of the month on Sable Island Bank. Driggers fishing on Georges Bank and shore grounds reported fishing fish scarce.
1	1933	Considerable mild weather prevailed during the month of January, but at times the weather was windy and interfered with fishing. During the mild weather small otter trawl vessels fishing near shore caught and landed more ground fish than usual. Gill netters made light catches of ground fish along the shore. Several vessels have departed for the banks to fish for halibut.
2	1933	During the month of February the weather was in general mild and warm, which was favorable to fishing operations, especially for small boats operating on the shore grounds. Steamers and vessels operating on Georges Bank brought home larger catches of fish. The line trawl vessels operating on Browns Bank and Cape Shore encountered some bad weather. Gill net fishermen operating off Gloucester had light catches of ground fish. The first arrival of halibut this year, direct from the banks, arrived February 7, five days earlier than last year.
3	1933	During the month of March heavy winds and rough seas greatly interfered with operations of the fishing fleet. There were only a few days favorable for fishing operations during the whole month. However good catches of cod and haddock were made on Sable Island, La Have, Brown, and Georges Banks. A fare of halibut exceeding 80,000 pounds was landed by a vessel from the Grand Banks. This was one of the best catches of halibut in recent years. The mackerel fleet is preparing for the southern fishery, but indications are that the size of this fleet will be much smaller than last year.
4	1933	Vessels engaged in fishing for cod, haddock, and other ground fish made good catches during the past month, especially those fishing on Browns Bank. Prices ruled low on these fishes. Vessels in the mackerel fleet fishing in southern waters landed good catches of three-quarter pound mackerel which also have sold at low prices. The gill netters landed fair catches of cod and haddock.
5	1933	During the month of May weather conditions were quite favorable for fishing operations, and good catches of ground fish and mackerel were made. Prices ruled low. The mackerel fishermen have organized an association to stabilize production. The first mackerel catches direct from the South were landed two weeks earlier than last year. The dogfish appearing on the fishing banks are bothersome to the fishermen. Operations of the swordfish fleet are making preparations for the summer fishery, and the fleet will probably be larger than last year.
6	1933	During the month of June weather conditions were quite favorable for fishing operations on most of the fishing banks. The mackerel seiners found schools of mackerel plentiful along the coast from South Shoal Light to Middle Bank. They comprised large fish weighing about two pounds each and small fish weighing about one pound each. The association of mackerel fishermen limited the catch of each mackerel vessel to 20,000 pounds a week, but even in view of this, difficulty was experienced in marketing the catch. Vessels engaged in catching ground fish have found fish scarce. Gill netters, only a few of which are now operating, have landed light catches of cod. The swordfish fleet landed small catches. The weather has not been very good in the South where the swordfishing vessels are operating.

7	1933	During the month of July the weather was unusually foggy on the fishing banks. This condition was very unfavorable for the fleet engaged on Georges Bank in the swordfishery, and the catch of these fish to date has been comparatively light. The vessels engaged in catching groundfish have made fair catches, but prices have ruled low. Mackerel vessels have landed good catches of mackerel that were caught mostly off the Massachusetts Coast where there has been a large body of small mackerel. The fishing fleet on July 4 experienced a heavy gale, and of the severest of recent years.
8	1933	Considerable foggy weather prevailed during the month of August. Fishermen also were bothered by sharks and grayfish. Groundfish boats as a rule had moderate catches, and the fishermen reported fishing "spotty". There were large schools of small mackerel off the coast of Massachusetts and good catches were general. Light catches of swordfish were made off Georges Bank where most of the fleet operated.
9	1933	The weather was unusually foggy during September and interfered with fishing operations, especially for swordfish. Small mackerel were plentiful along the coast, but the fish were close in shore and seiners damaged their nets in some cases. The groundfish fleet as a rule reported fish scarce on the banks, but in a few instances good fishing was found on Western and Georges Banks. The swordfish season is practically over.
10	1933	During the month of October weather conditions varied considerably. The vessels engaged in catching groundfish as a rule found fish scarce on the fishing banks, and were bothered considerably by dogfish. The gill netters made fair catches of codfish and pollock. Mackerel seining catches are diminishing as usual at this season of the year. Mackerel gill netters are making preparations for the fall fishery.
11	1933	The weather was unusually cold during the month of November and heavy winds and rough seas retarded fishing operations, resulting in a sharp decline in the receipts. Quite a number of catches were received from Western Banks where groundfish boats found the best fishing. Seining operations for mackerel were suspended early in the month. From the middle to the latter part of the month mackerel netters made fair catches of large and medium-sized mackerel. The gill netters made good catches of pollock and cod.
12	1933	Weather conditions were unfavorable for fishing operations, especially the latter part of the month when very cold weather prevailed. The first of the month the mackerel netters made fair catches of large and medium size mackerel off Cape Ann. Good catches of pollock were landed by the gill netters and draggers. Steam trawlers operated largely on Sable Island Bank where they made good catches of codfish.
1	1934	Receipts of fish during January were affected by unusually cold weather, which retarded fishing operations on the fishing banks and by a strike of the fishermen which lasted the greater part of the month, tying up nearly all the large trawlers. Some fair catches of fish were made on the eastern banks, but vessel fishermen found fish scarce on shore grounds and Georges Bank. The halibut fleet this season promises to be small as in other recent years. The first vessels sailed this month.
2	1934	The cold weather and heavy winds during February retarded fishing operations, resulting in good prices. The gill netters landed light catches of fish, mostly codfish. The first vessel of the halibut fleet arrived with a good catch.
3	1934	News from the South indicates that mackerel have been seen schooling off the Virginia Capes, and several vessels of the mackerel fleet have sailed South. The mackerel fleet will number about the same as last year from present indications. Good catches of haddock and codfish have been made by the groundfish fleet on Western and Browns Banks; however, the fishermen report fishing "spotty". Fish on the shore grounds as well as on Georges are scarce. The gill netters have made light catches of codfish. The price level has been well maintained, and many of the fishing boats have made good stocks.
4	1934	The mackerel fleet is now practically all in southern waters and have made moderate catches of mackerel averaging in weight about one pound each. Cod and haddock have been plentiful on Sable Island Bank where the steamers have made good catches. The line trawlers have been hampered by the scarcity of desirable bait. The gill netters are making fair catches of codfish on shore grounds. shore boats report haddock scarce.
5	1934	During the month of May the weather was unusually moderate, and quite favorable for fishing operations. There was a body of large, medium, and small mackerel off shore, general. Owing to the large quantities caught and landed prices ruled low. The swordfish boats are fitting out, mostly at Gloucester, and the first will sail about June 1. Herring, which were much needed by the line trawl fishermen for bait struck in at Provincetown and are now plentiful. The dogfish are a considerable bother to the fishermen.
6	1934	Excepting for fog, weather conditions were favorable for fishing operations during June. Mackerel of mixed sizes were plentiful along the coast, and good catches were landed. The fishermen reported seeing large schools of "spike" mackerel on the fishing grounds. The sword fishermen found fish scarce on the banks until late in the month, at which time some good catches were made. There have been good supplies of groundfish.

7	1934	With the exception of some very foggy spells weather conditions were fair during the month of July. Small mackerel, weighing about a pound each, were plentiful along the shore from Chatham to Gloucester. Large mackerel are now scarce, and the groundfish fleet report finding fish scarce. The catch of swordfish on Georges Bank has been disappointing, but recent landings from Browns Bank indicate an improvement in fishing.
8	1934	The mackerel fleet has continued to find large mackerel scarce on all fishing grounds. Small mackerel or "tacks" that weigh about a half pound each have comprised a large percentage of the catch. Schools of small tuna fish or albacore, were reported on the coast of Maine. Prices of mackerel have been low owing to the large production. The catch of swordfish has been disappointing, and the fish caught were smaller in size than usual. The fishermen report groundfish scarce on the banks, and much annoyance from sharks this summer. Small boats have made good catches of whiting which are in good demand.
9	1934	The mackerel fleet has landed fair catches; however, mackerel are wild and harder to catch and are mixed with blueback herring. The receipts comprise 85 to 90 percent small fish that weigh about 3/4 of a pound each. The larger mackerel average about 1 3/4 pounds each. The catch of swordfish has been less than last year, and they have been smaller in size than for a number of years. The catch of haddock by the groundfish fleet has been very light. Groundfish boats have been molested by sharks and dogfish, there being more sharks than usual this year.
10	1934	Record missing.
11	1934	The weather was unusually wild during the month of November, and conditions unusually favorable for fishing operations. As customary at this season of the year the fishermen found fish scarce on the banks. Pollock which are commonly found on the coast at this season of the year have been plentiful. Codfish or rosefish which are found in 60 fathoms of water or deeper, are in better demand than formerly, and boats landed more of these fish than usual. With the strike over, conditions are now back to normal.
12	1934	During the month of December there were many snow storms and heavy winds that retarded fishing operations on the fishing banks. The fall mackerel netting season was very disappointing and all craft have now quit this type of fishing. The boats engaged in catching groundfish continue to find fish scarce on offshore grounds; however, the pollock boats have made good catches of these fish on shore grounds.
1	1935	Weather conditions during the month of January were more severe than usual, and the latter part of the month there occurred a snow storm that hampered fishing operations as well as the distribution of fish. Steamers operating on Western Bank made good catches when the weather permitted fishing. One or two vessels of the halibut fleet have sailed. Some of the fleet will try fishing with the halibut long line such as used on the Pacific Coast.
2	1935	Weather conditions during the month of February were unsettled much of the time, cold weather making fishing operations difficult. The gill netters ceased operating save for a few boats. Steamers landed some good catches of haddock and codfish from Sable Island Bank, and the catch of fish on Georges Bank showed an improvement.
3	1935	During the month of March the weather was unusually cold on the eastern fishing Banks. Windy weather and floating ice hampered fishing operations. The groundfish fleet of steamers operated mainly on Sable Island Bank where they had good fishing when the weather was favorable. Groundfish were scarce on Georges Bank and Shore grounds.
4	1935	The mackerel seiners went South, as usual at this season of the year, but had bad weather most of the month. The latter part of the month they made some good catches of small mackerel off Cape May. Groundfish have been plentiful, but sold at low prices. Good catches of haddock were made on Sable Island Bank. The first vessel of the Georges handline codfish fleet arrived, and reported finding fish scarce. The gill netters are making moderate catches of cod and haddock.
5	1935	The mackerel fleet made good catches of large and medium mackerel during the month, principally off No Man's Land and Fire Island. Towards the end of the month, however, the percentage of large fish was smaller. The swordfish fleet has sailed, but after cruising in the South several weeks report no fish. Some good catches of groundfish have been landed by the fleet operating on Sable Island and Quereau Banks, but the fleet operating on Georges Bank and New England Shore grounds report fish scarce.
6	1935	The weather conditions during the month of June were quite favorable for fishing operations with the exception of some foggy weather that prevailed part of the time. The mackerel fleet that are now operating off Cape Cod are making fair catches of mackerel of mixed sizes. The catch of swordfish to date has been light, and most of the fleet have gone to Georges Bank. Gill netters are making light catches of codfish.

7	1935	During the month of July the weather was foggy most of the time. There was a large school of mackerel off the coast of Massachusetts and the boats engaged in this fishery landed good catches of mackerel weighing from one to two pounds each. The boats engaged in swordfish fishing are making fair catches when the weather permits. Owing to the fact that many of the boats engaged in catching groundfish are being overhauled, this branch of fishing is somewhat curtailed. The gill net fishermen have discontinued operations due to the abundance of dogfish on the shore.
8	1935	Vessels engaged in mackerel seining have made fair catches of small mackerel in Cape Cod Bay and also off No Man's Land. Large mackerel were scarce. Foggy weather the first part of the month made seining difficult. The groundfish fleet, especially the line trawlers, are finding fish scarce, and report numerous sharks in South Channel. The gill netters are making light catches of cod and pollock. The swordfish fleet have been quite successful.
9	1935	The mackerel fleet during the past month has landed moderated catches of mackerel from Cape Cod Bay, off No Man's Land and South Shoal Light; however, they comprised mostly small fish. Supplies of large fish have been small. The late arrivals of the swordfish fleet had small catches, and reported bad weather. Line trawlers report good weather conditions as a rule, but are finding fish scarce. The gill netters operating off Gloucester are making fair catches of groundfish, mostly pollock.
10	1935	The first part of the month of October was cold and a bad northeast storm occurred in which a number of fishing boats were lost. The latter part of the month, however, was mild. Mackerel of mixed sizes but mostly small were plentiful off No Man's Land, and boats landed some good catches. Few haddock and codfish were reported on the fishing banks, but some good catches of hake were landed. Gill netters made good catches of pollock. Good catches of rosefish have been landed from off Cape Cod.
11	1935	During November weather conditions for operating on the fishing banks were better than usual at this time of the year; however, haddock and codfish are usually scarce on the fishing banks during this month and consequently vessels landed light catches. There were good catches of pollock which are usually plentiful at this season. Mackerel seiners and netters have landed moderate catches; however, many of the seiners now have discontinued operations for the season. The fishermen in the haddock fishery report much annoyance from dogfish.
12	1935	The mackerel netters, a few of which operated up to the end of December, made fair catches; however, seining operations were discontinued the first part of the month. Stormy weather prevailed a large part of the month, and temperatures were lower than usual for this time of the year. Some of the craft landed good catches of pollock from off Cape Cod, and some made good catches of haddock on Georges Bank. Most of the groundfish vessels found fish scarce.
1	1936	The first half of the month was quite mild, and on several days the fishing fleet made better catches on Georges Bank than for a number of years, however, during the latter part of the month the weather was cold and stormy and fishing operations very light. Two vessels of the halibut fleet have sailed for the Banks, leaving about a week earlier than the first sailed last year. A number of the medium-sized draggers have sailed South, and others are preparing to go.

APPENDIX D: Phase I Report

STELLWAGEN BANK MARINE HISTORICAL ECOLOGY

Phase 1: Historical Sources Survey Report

Gulf of Maine Cod Project
University of New Hampshire
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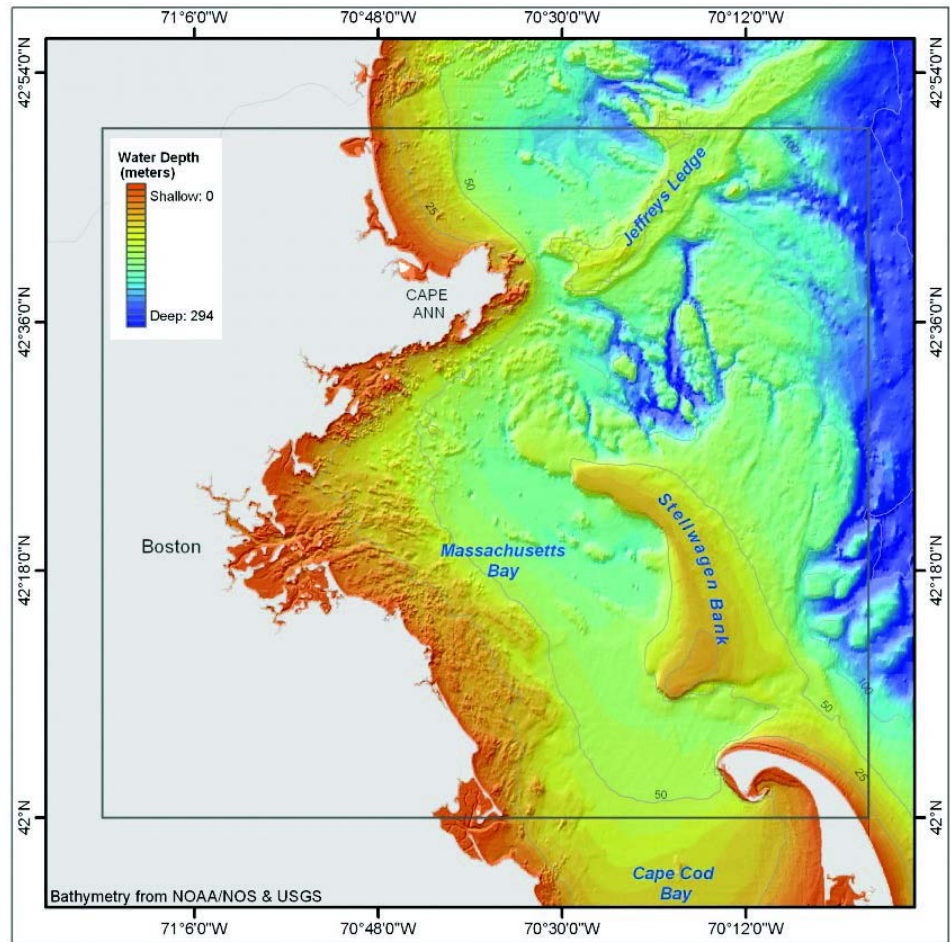
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ABSTRACT

This report is provided to National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program and Gerry E. Studds Stellwagen Bank National Marine Sanctuary (SBNMS), by the Gulf of Maine Cod Project (GMCP), University of New Hampshire (UNH). The report presents the results of a historic sources survey of documents and manuscripts relevant to SBNMS marine historical ecology. The initial research phase, as reported on here, examines the efficacy and limitations of these sources in providing information about the marine animal populations and environmental history of SBNMS. This report presents a summary of the hundreds of documents found in federal, state, and local repositories that relate directly or indirectly to the historical ecology of SBNMS and from which biological indicators and fish population trends may be derived.

*Figure 1.
Stellwagen Bank,
shown at scale
1:125,000 (U.S.
Geological Survey,
Geologic Investigation
Map I-2734, 2003).*



1. INTRODUCTION

Covering 638 square nautical miles (or 842 square miles), Stellwagen Bank National Marine Sanctuary is a marine threshold between the Gulf of Maine and the sheltered waters of the Massachusetts and Cape Cod Bays (FIG. 1). The bank is 18.75 miles long and roughly 6.25 miles across at its widest point. The depths vary from approximately 300 ft at the base of its northerly edge near Cape Ann, MA, to just under 61 ft at its shallowest mid-point. As the bank extends south near the tip of Cape Cod, its depth drops back down to approximately 200 ft. Upwellings caused by the dramatic shifts in

Stellwagen Bank's bathymetry create a particularly productive environment for plankton, species that feed on plankton, and the species that feed on them. A variety of ground-fish species can be found on the bank, including cod, pollock, haddock, skate, yellowtail flounder, winter flounder, goosetfish, sculpin, and dogfish. Migratory species include sea herring, alewives, bluefish, tuna, and mackerel. The bank is also famous for its many visiting whale species, including finbacks, minke, humpbacks, and North Atlantic right whales.¹

¹. Nathalie Ward, *Stellwagen Bank: A Guide to the Whales, Seabirds, and Marine Life of the Stellwagen Bank National Marine Sanctuary* (Camden, ME: Downeast Books, 1995).

This interim report describes the initial results of research conducted by the Gulf of Maine Cod Project (GMCP) at the University of New Hampshire (UNH) to review the potential of historical sources in providing biological indicators and population trends for fishes in the SBNMS. GMCP is a multi-year research project within the History of Marine Animal Populations (HMAP) program of the Census of Marine Life (CoML) that uses historical documents as well as paleo-ecological and archaeological data to document long-term changes in the marine environment of the Gulf of Maine. As part of this broader research mission, GMCP is working with NOAA's National Marine Sanctuary Program to survey historical documents that contribute significantly to the history and understanding of marine resource exploitation in SBNMS. The methods used in this study may serve as a model for extracting data about the historical ecology or environmental history of other marine sanctuaries.

This three-year study of SBNMS seeks to extract historical data and identify what can be known about the sanctuary's past abundances and distributions of marine species as well as changes in overall ecosystem health. Historically, marine mammals, anadromous species, and demersal species have been the primary marine resources harvested in and around SBNMS. However, targeted species and rates of removal on Stellwagen Bank have changed over time and significantly affected the quality of the marine environment.

In Phase 1 of this research project presented here, conducted in 2004-2005, GMCP focused on identifying historical

sources that document fish population composition, and changes within the distribution and diversity of these fish populations. To date, GMCP researchers have found and catalogued hundreds of historical documents present in federal, state, and local repositories that relate, directly or indirectly, to SBNMS fisheries and marine ecology. The research findings presented in this report are annotated as a catalogue of these sources.

In Phase 2 of this research project, data from the historic source material will be extracted and compiled into relational or tabular databases and Geographical Information Systems (GIS). In Phase 3 of this project, the data will be used to analyze and reconstruct the ecological and fishery history of the region, estimate temporal changes in fisheries and fish population composition and distribution. Moreover, the ecological knowledge of fishermen gleaned through historical records will provide critical information about the impact of specific gear on fish populations, descriptions of local bathymetry, local differences in natural and human-induced ecological change, the relations between fishermen, as well as the relations of fishermen, government and the scientific community. To this end, a marine environmental history of Stellwagen Bank will be developed that not only documents anthropogenic or environmental factors that have affected fish populations in the past, but also a history that illustrates the social, cultural and economic consequences of declining marine animal resources for Gulf of Maine fishing communities.

2. MARINE HISTORICAL ECOLOGY AND SANCTUARY MANAGEMENT

SBNMS was authorized as a National Marine Sanctuary by the U.S. Congress in 1992 under the National Maritime Sanctuaries Act of 1972 (NMSA). The NMSA authorizes the Secretary of Commerce and the National Oceanic and Atmospheric Administration (NOAA) to establish discrete areas of marine environment, out to 200 nautical miles or the Exclusive Economic Zone (EEZ), as sanctuaries which “possess conservation, recreational, ecological, historical, scientific, educational, cultural, archaeological, or esthetic qualities which give them special national, and in some cases international, significance.”² Currently, there are 13 national marine sanctuaries in the United States.

A historical perspective can be a significant contribution toward the goals of the NMSA and sanctuary conservation efforts, which are also to “maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance

natural habitats, populations, and ecological processes.”³ But at what levels should such communities be maintained? Without historical baselines, resource managers’ restoration and enhancement determinations are limited to extrapolation of modern fisheries statistical data. Jeremy Jackson et al. in the journal *Science* point to the importance of a historical perspective to document the long-term effects of fishing on marine ecosystems.⁴ They also call for historical perspectives, based on historical, archaeological, and paleo-ecological data, as essential tools for “successful management and restoration of coastal marine ecosystems.”⁵ Marine ecological histories can support sanctuary management and conservation efforts by providing historical baseline data needed to restore, enhance, and achieve sustainable fish population levels, provide contexts for understanding and explaining change in the marine environment, as well as the impact of such changes upon fishing communities.

². National Maritime Sanctuaries Act of 1972, 16 U.S.C. § 1431, Section 301.

³. National Maritime Sanctuaries Act of 1972, Section 301.

⁴. Jeremy B. C. Jackson et al., “*Historical Overfishing and the Recent Collapse of Coastal Ecosystems*,” *Science* 293.5530 (2001): 629-638.

⁵. Jackson et al. 636.

3. DEVELOPING A HISTORIC CONTEXT FOR THE STELLWAGEN BANK FISHERIES

Our research starts with the premise that although SBNMS is a specific marine area, it is intrinsically related to land-based activities and the ecosystems that surround it. Quantitative data extracted from historic sources may provide identifiable trends or fish population estimates. However, without a historical context to explain why or how fish populations have changed over time, biased interpretations and poor resource management or research decisions may result. Therefore, a concise historic context for the SBNMS region is provided here in order to assist in interpreting the state of past fish populations that may have been affected by specific historical events.

Although it is relatively certain that Native Americans fished or whaled the waters of Stellwagen Bank, there is a dearth of historical records relating to any such activity.⁶ The

documentation of fish populations and human exploitation efforts prior to European exploration and settlement will only be gleaned through archaeological and paleo-environmental data. Consequently, this research project focuses solely on the study of European and American fishing efforts on Stellwagen Bank as seen through historical documents beginning in the early 1600s.

There are numerous sources, both primary and secondary, regarding the maritime and fishing history of Massachusetts Bay, Cape Cod Bay and the larger Gulf of Maine ecosystem, of which SBNMS is a part. Secondary sources that broadly address the region's maritime history include:

Albion, Robert Greenhalgh, William A. Baker, and Benjamin W. Labaree. *New England and the Sea*. Mystic, CT: Mystic Seaport Museum, 1994.

Burrage, Henry S. *Early English and French Voyages, Chiefly from Hakluyt 1534-1658*. New York: C. Scribner's Sons, 1906.

Hall-Arber, Madeleine. *New England's Fishing Communities*. MITSG 01-15. Cambridge: MIT Sea Grant College Program, 2001.

Holmes, Richard D., Carolyn D. Hertz, and Mitchell T. Mulholland. *Historic Cultural Land Use Study of Lower Cape Cod: A Study of the Historical Archeology and History of the Cape Cod National Seashore and the Surrounding Region*. Amherst: University of Massachusetts, Archaeological Services, 1998.

Innis, Harold Adams. *The Cod Fisheries: The History of an International Economy*. New Haven: Yale University Press, 1940.

McFarland, Raymond. *A History of the New England Fisheries*. Philadelphia: University of Pennsylvania, 1911.

Morison, Samuel Eliot. *The Maritime History of Massachusetts 1783-1860*. Boston: Houghton Mifflin, 1961.

Vickers, Daniel. *Farmers and Fishermen: Two Centuries of Work in Essex County, Massachusetts, 1630-1850*. Chapel Hill: Institute of Early American History and Culture, University of North Carolina Press, 1994.

⁶. Alexander Starbuck provides a brief summary on indigenous whaling in New England based on explorer accounts in *History of the American Whale Fishery* (Secaucus, NJ: Castle Books, 1989) 5-6.

A general history for fishing, based primarily on secondary sources, is also provided in the *Stellwagen Bank National Marine Sanctuary Site Characterization Report 1995* (<http://stellwagen.nos.noaa.gov/about/sitereport/toc.html>). This characterization report provides detailed information about the natural resources and environmental characteristics of the sanctuary.

A background in regional history, particularly maritime and fishing history, is a prerequisite for interpreting data and comprehending short and long-term changes in the marine environment. The information provided in this section serves primarily as an introduction to the fishing history of the Massachusetts Bay region. As research progresses and data is extracted from primary source materials, a more complete and detailed historic and environmental context for Stellwagen Bank will be developed in Phases 2 and 3 of this project.

3.1 Introduction

As the codfish displayed on the Massachusetts statehouse once symbolically reminded law makers, much of the early survival of the Massachusetts Bay and Cape Cod Bay settlements depended heavily upon the region's rich fish resources. While most historical studies of the area's early European settlement acknowledge this, these same studies have seen Massachusetts' connection to the fisheries mediated through the offshore fleets that brought profits in from the Scotian Shelf and the Grand Banks.⁷ Inshore waters such as those in and around Stellwagen Bank played a pivotal, but more mundane role, especially in the early stages of English settlement. These inshore fisheries allowed Massachusetts settlers to develop a complex

subsistence blending farming and small-scale manufacturing with inshore fishing and coastal trade, and supported a brisk economy by 1650.⁸

Even after the American Revolution, when inshore fisheries were in all likelihood constituting a preponderance of fish products landed, inshore fishery operations were still too routine to attract much attention in printed materials. For example, "marine intelligences" published in newspapers such as the *Barnstable Patriot*, while noting the arrival and departure of larger vessels, rarely, if ever, mention the small inshore boats fishing for a day that returned with a small catch for domestic consumption or sale in local markets. Harbor master records from Plymouth in the 1820s also neglect to mention the catch of small inshore fishing boats, even though journals and notebooks kept by Plymouth residents from the same period document daily "cunnering" trips. Ironically, while generating few explicit records of inshore fish landings, and failing to even be worthy of governmental record keeping until the 1870s, the small boats of the inshore fisheries of Massachusetts, including the waters of Massachusetts Bay and Stellwagen Bank, historically constitute a significant portion of fish caught. Although bank fishermen had greater returns per trip or vessel, a far greater number of vessels and fishermen plied the near shore of the Gulf of Maine. Preliminary analysis of data collected by the U.S. Fish Commission in the late 1890s and early 1900s reveals that landings for the inshore Gulf of Maine fisheries were minimally equal to, but generally greater than, Scotian Shelf and Grand Bank landings.⁹ Consequently, it is the human impact upon the inshore or near shore fisheries, including Stellwagen Bank, which will help to understand and document long-term changes in the

⁷. See e.g., Harold Innis, *The Cod Fisheries: The History of an International Economy* (New Haven: Yale University Press, 1940); Samuel E. Morison, *The Maritime History of Massachusetts, 1783-1860* (Boston: Houghton Mifflin, 1961); Robert G. Albion, William A. Baker, and Benjamin W. Labaree, *New England and the Sea* (Mystic, CT: Mystic Seaport Museum, 1994).

⁸. Daniel F. Vickers, *Farmers and Fishermen: Two Centuries of Work in Essex County, Massachusetts, 1630-1850* (Chapel Hill: University of North Carolina Press, 1994).

⁹. The statistical bulletins of the U.S. Fish Commission are reviewed in the sources section of this report.

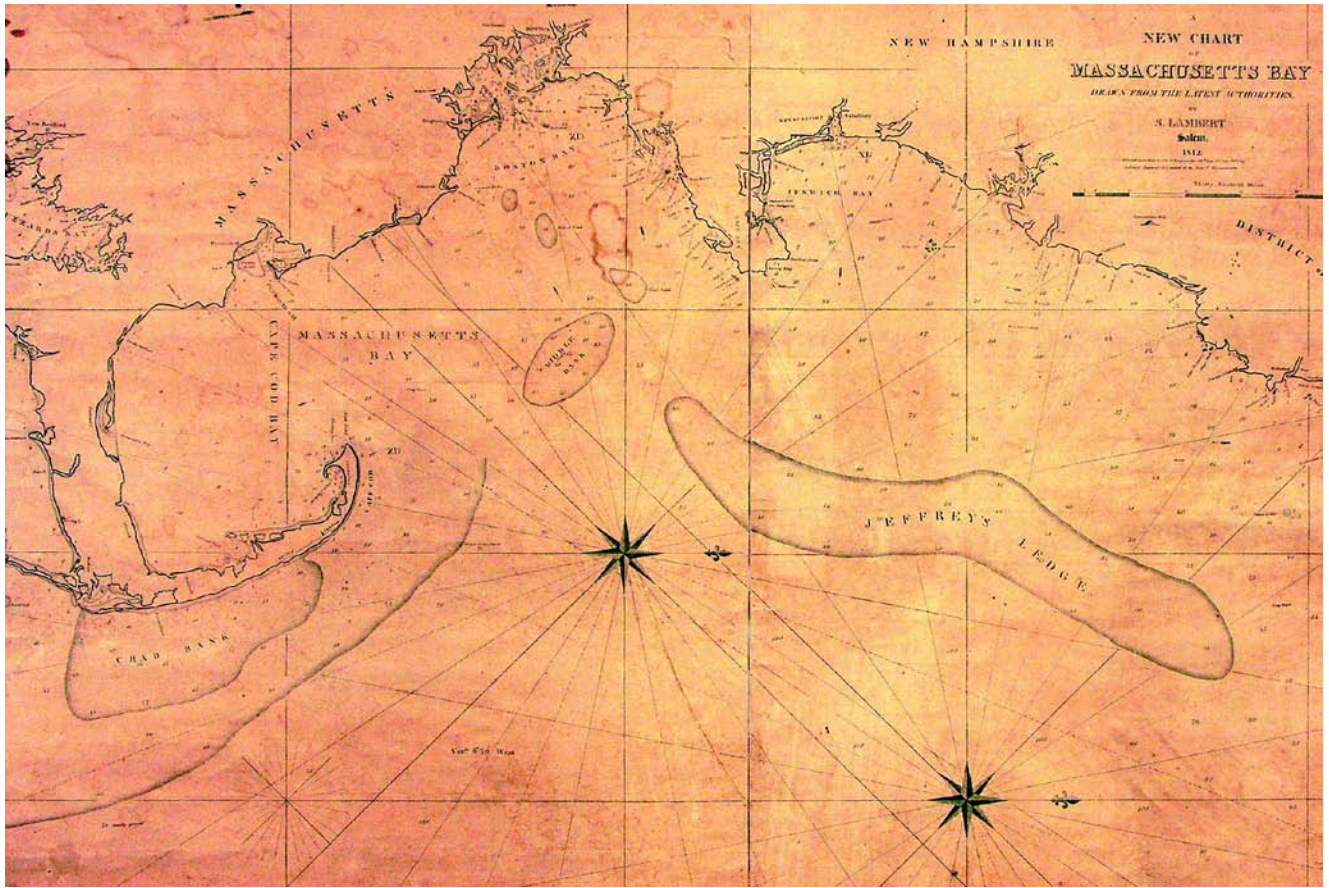


Figure 2. Lambert Map of Stellwagen or “Middle Bank” in 1812 (Library of Congress).

region’s marine environment, as well as illuminate how environmental conditions and events shaped the culture and economy, and furthered the development of this maritime region.

3.2 Human Environment

The population of marine animals prior to European settlement and resource exploitation is difficult to determine, if not impossible to imagine, particularly in light of early historical accounts that conveyed an unbelievable abundance of fish. Numerous European explorers, such as Bartholomew Gosnold, who in 1602 charted New England’s coasts and waters, brought back to Europe news of the area’s rich marine

resources.¹⁰ John Smith, who sailed to New England in 1614 and mapped the coast from Penobscot Bay to Cape Cod, also promoted the New England fisheries, noting that “here is ground also as good as any lyeth in the height of forty one, forty two, forty three, &c.”¹¹

Certainly, Stellwagen Bank was well-known to fishermen by the 17th century, as any seagoing vessel could not enter into Massachusetts Bay to reach the region’s plantations and colonies without crossing its fertile fishing grounds. However, maps from the early 1800s refer to the fishing area there as “Middle Bank”¹² (FIG. 2). Stellwagen Bank was not officially charted by the federal government until 1854, when Henry S. Stellwagen, then commander of a U.S. Coast

¹⁰. Henry S. Burrage, *Early English and French Voyages, Chiefly from Hakluyt 1534-1658* (New York: C. Scribner’s Sons, 1906).

¹¹. John Smith, *A description of New-England, or, The observations, and discoveries, of Captain John Smith, in the north of America, in the year of our Lord 1614* (London, 1616) 14.

¹². Samuel Lambert, *New Chart of Massachusetts Bay Drawn From the Latest Authorities* (Salem, MA: Cushing, Appleton and Lambert, 1812).

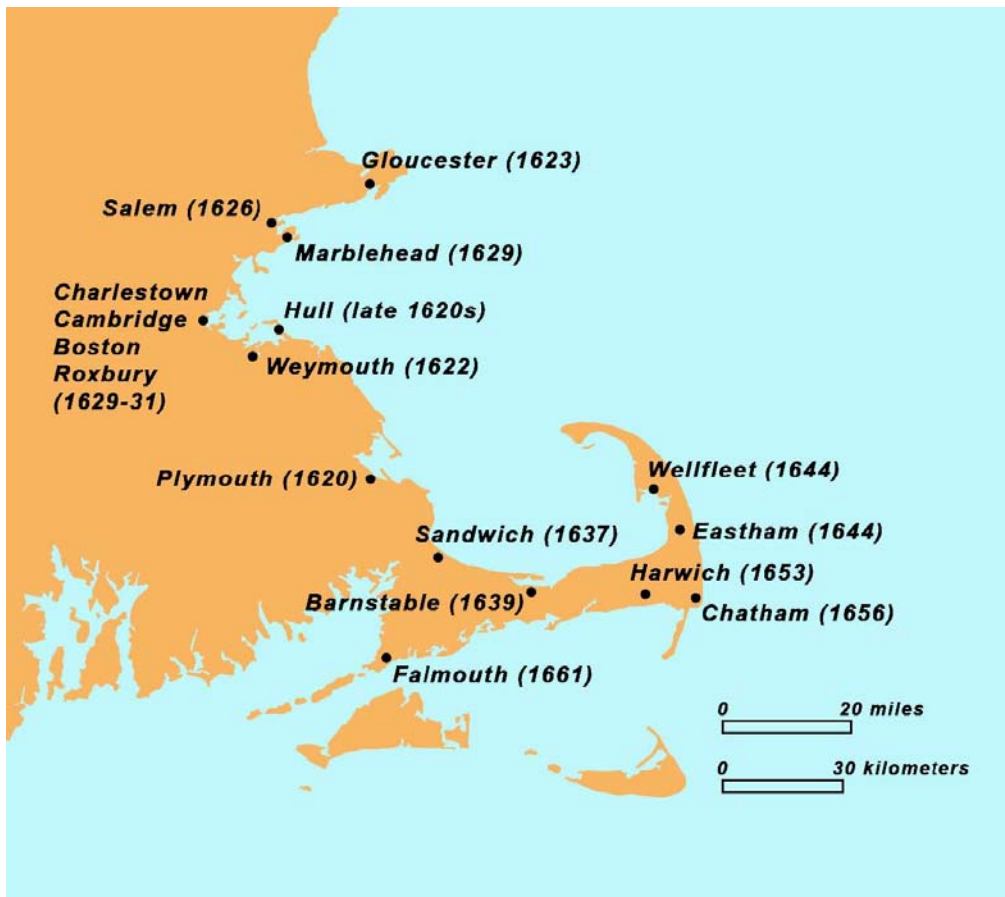


Figure 3. English fishing colonies and settlements in Massachusetts.

Survey team informed Survey Superintendent Alexander Dallas Bache that “I consider I have made an important discovery in the location of a 15-fathom bank lying in a line between Cape Cod and Cape Ann . . .”¹³

Undoubtedly, the bank’s rich marine resources helped the residents of all nearby Massachusetts towns fill out diets and make livings from the time of the earliest European settlement. The coastal geography and marine resources of Stellwagen Bank, Cape Cod and mainland Massachusetts helped shape the direction of this settlement (FIG. 3). The first towns on Cape Cod that spread along its shores were primarily places that had protected harbors and easy access to fishing grounds. South of Plymouth (1620), Sandwich was settled in 1637. In 1639, colonists moved into areas around what became Barnstable Harbor to create the towns of Barnstable and Yarmouth.

Further east, both Wellfleet and Eastham, abutting Wellfleet Harbor, were settled in 1644. Lands on the southeast corner of Cape Cod Bay were organized into the town of Harwich in 1653. Only after the areas along Cape Cod Bay were settled was it that other areas on the south shore of the Cape organized into towns including Chatham (1656) and Falmouth (1661).¹⁴

To the north of Plymouth, fishing camps and plantations were established in the vicinity of Boston Harbor including Weymouth (1622), Hull (late 1620s), and Salem (1626). The towns of Charlestown, Boston, Roxbury, and Cambridge were incorporated between 1629 and 1631. Further along the north shore and Cape Ann the fishing towns of Gloucester and Marblehead were settled in 1623 and 1629,

13. Ward 20.

14. Simeon L. Deyo, ed., *History of Barnstable County* (New York, 1890); H. Roger King, *Cape Cod and Plymouth Colony in the Seventeenth Century* (Lanham, MD: University Press of America, 1994).

respectively. As described by Raymond McFarland in 1911, “by the time the settlement of Massachusetts Bay colony was well established, there was a chain of settlements . . . from Plymouth on the south to farthest bounds of territory claimed by the English on the coast of Maine.”¹⁵ Many of the early fishing communities of Massachusetts Bay still remain faithful to the industry and retain some level of economic dependency on the region’s fisheries.¹⁶

3.3 Economy

During the 17th and into the 18th centuries, as Massachusetts towns developed a strong agricultural base and continued to pursue the fisheries, dried and salted fish emerged as one major commodity that the New England colonies could export into the Atlantic trading network. Cod, in particular, linked European capital and manufactures, African slave labor and West Indian tropical products. Best quality “merchantable” dried cod was sent to Southern European ports for trade in wine,¹⁷ while lower quality “jack and jill” or “junk” fish was sent to the Caribbean to feed growing slave populations. “Junk” fish was traded for molasses. The prosperous fishing industry also helped develop New England’s industrial base. As shipbuilding needs grew, so did the need for mills, foundries and other related maritime industries, adding to the region’s burgeoning manufacturing operations.

Fishing in New England rapidly emerged as an economic mainstay. By the 18th

century, Marblehead had developed into a major fishing center, followed by Salem, Boston, and Plymouth. For most every other minor town, however, inshore fishing offered both occasional employment and sustenance.¹⁸ In *Farmers and Fishermen* Daniel Vickers has shown that small day boat fishing operations played an essential role in fleshing out annual subsistence strategies that also involved agriculture, farm labor, and small-scale manufacturing.¹⁹

In the last quarter of the 18th century, the American Revolution disrupted the traditional export-based economy in which New Englanders had exported fish products to Europe and the Caribbean. After peace negotiations in Paris (1783), the British government closed its Caribbean ports to American vessels, and while French colonies stepped in to fill the gap to some degree, the prosperous international trade never truly returned. However, by the 19th century, New England was again at the center of a growing demand for fish. But this time domestic industrial centers began to spring up with large numbers of urban factory workers seeking fish as a cheap source of protein. An expanding plantation system in the southern United States also sought a steady food supply to feed slaves. Finally, in the late 1830s, railways that linked Cape Ann towns to Boston would soon make fresh fish available in domestic markets as far away as Chicago. With the expansion of railroads and the ability to keep ice, domestic markets for salt and fresh fish grew as Euro-Americans migrated west.

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15. Raymond McFarland, *A History of the New England Fisheries* (Philadelphia: University of Pennsylvania, 1911) 51-52. See also Emerson Baker, “Salem as Frontier Outpost,” *Salem: Place, Myth, and Memory*, eds. Dane Morrison and Nancy Schultz (Boston : Northeastern University Press, 2004) 21-40.
 16. Madeleine Hall-Arber, *New England’s Fishing Communities* (Cambridge: MIT Sea Grant College Program, Report #MITSG 01-15, 2001).
 17. Peter E. Pope, *Fish into Wine: the Newfoundland Plantation in the Seventeenth Century* (Chapel Hill: North Carolina University Press, 2004).
 18. Benjamin Bangs, Diary, 1742-1765, Massachusetts Historical Society, Boston, Microfilm P-363.
 19. On the New England economy and the role of fishing, see Vickers (1994), John J. McCusker and Russell R. Menard, *The Economy of British America, 1607-1789* (Chapel Hill: University of North Carolina Press, 1985), and Anne E. Yentsch, “Farming, fishing, whaling, trading: land and sea as resource on eighteenth-century Cape Cod,” *Documentary Archaeology in the New World*, ed. Mary C. Beaudry (Cambridge: Cambridge Univ. Press, 1988) 138-160.

3.4 Politics and War

Throughout the Colonial and early Federal periods, fishing was significantly affected by conflict and war. Following King William's War (1689-1697) the New England fisheries were relatively depressed.²⁰ It was not until after Queen Anne's War and the expulsion of the French from Nova Scotia and Newfoundland under the Treaty of Utrecht in 1713 that New England expanded its fishery.²¹ However, King George's (1744-1748) and the French and Indian Wars (1754-1763) would again disrupt fishing activities. Although these early conflicts disturbed offshore fishing, New England fishermen likely fished inshore grounds such as Stellwagen more intensely, choosing to stay closer to home rather than risk the voyage to the profitable but internationally disputed fishing grounds off Nova Scotia and Newfoundland.

The presence of the British Navy throughout New England waters all but ended fishing during the American Revolution. As profitable targets for information, food supplies, labor, and commercial rewards, naval and privateering forces targeted American-based fishing vessels. Significant declines in Cape Cod fishing fleets were reported.²² After the Treaty of Paris in 1783, Americans were allowed to fish the Grand Banks and areas of Newfoundland and the Gulf of St. Lawrence, but were not allowed to dry their fish on Newfoundland or establish any settlements for fishing purposes on Nova Scotia, the Magdalen Islands, and Labrador.

However, by 1670, European settlers along Cape Cod began to raise concerns about depleting the bay's fish resources. Citing "the providence of God" for making "Cape Cod commodious for us fishing with seines," lawmakers banned the dumping of ballast

CONFLICT TIMELINE

King William's War	1689-1697
Queen Anne's War	1702-1713
King George's War	1744-1748
French and Indian Wars	1754-1763
American Revolution	1775-1783
War of 1812	1812-1814
American Civil War	1861-1865
Spanish-American War	1889
World War I	1914-1918

Additionally, the British prohibited trade with American vessels in the West Indies.

Because of the British closure of the trade network and the loss of what was for nearly two centuries an essential export-based commodity, the federal government began in 1789 to help fishermen recover costs incurred from the exorbitant taxes placed on imported salt.²³ Government bounties served to sustain the region's fishing fleets and preserve the cod-fishing industry. Although fish trade would resume with the British West Indies in the early 19th century, domestic demand for fish would eventually eclipse European and Caribbean market demands. In the latter 19th century, few political events –not even the Civil War – hampered fishing efforts, as the Massachusetts coast and fishery was located relatively far from any war front.

3.5 Legislation and Regulation

As early as 1623, Plymouth colony enacted laws ensuring all private citizens free access to fishing and hunting, and in 1633 assured their right to invest, if they chose, in stocking ponds and streams with fish.²⁴ and fish offal and required a license fee for mackerel seining. Furthermore, "Whereas we have formerly seen inconvenience of taking mackerel at unseasonable times, whereby their increase is greatly diminished," the court imposed seasonal limits upon fishing

20. McFarland 81.

21. Richard D. Holmes, Carolyn D. Hertz, and Mitchell T. Mulholland, *Historic Cultural Land Use Study of Lower Cape Cod: A Study of the Historical Archeology and History of the Cape Cod National Seashore and the Surrounding Region* (Amherst: University of Massachusetts, Archaeological Services, 1998) 71.

22. H.C. Kittredge, *Cape Cod, Its People and Their History* (Boston: Houghton Mifflin, 1930) 172.

23. Morison 134-135.

mackerel.²⁵

Numerous regulations have governed the fisheries over the past three centuries. Although the battle between industrial development and anadromous spawning runs shaped much of the fisheries laws of the 19th century, both fishermen and early fisheries scientists perceived open ocean fish stocks to be inexhaustible. Only a few laws limited catches of ocean fish before the late 20th century.²⁶ This laissez-faire climate reflected beliefs about the limits of governmental control over offshore fishing and the reluctance of the federal government to impose regulations or back the science behind such regulations until well after the Civil War. What little regulatory energy was linked to the fisheries was promoted by fishing bounties, fishing ground explorations, and aquaculture. Not until the later 20th century did state and federal authorities impose restrictions that affected fishermen on the bank.

3.6 Technology

Cape Cod and Massachusetts Bay inshore fishermen used simple technologies from the 17th through the 19th century. Schooling fish—mackerel and sea herring—were caught with baited hooks and lines, or fishermen “shot” long seine nets out from the beach to encircle fish and haul them inshore. Persistent laws banning the use of traps and bush weirs also indicate that settlers used these stationary devices to catch fish swimming up streams and within a couple of miles of the

shore. Most commonly, day fishermen utilized dories and clam-baited hooks and lines to catch cod, pollock, haddock and cunner (or tautog).

Beginning in the late 1850s, bank fishermen shifted over to tub trawls (now commonly referred to as long-lines). Trawls were made of long lines to which hundreds of hooks were attached by short lines called gangings (FIG. 4). Inshore fishermen took to trawling by the 1870s, dramatically expanding the number of hooks in use and the inshore area covered by hooks. Unlike hand-lining, in which sufficient bait for a day’s use could be caught the previous night at sea, tub-trawling required vast quantities of pre-packaged, ready-to-use bait to pre-bait trawls. Consequently, extensive inshore weir and trap fishing developed in Cape Cod Bay and Massachusetts Bay to meet this new demand.

Beginning in the early 20th century, steam otter-trawlers and gas-screw boats began to replace tub-trawling operations in the Stellwagen Bank area. Steam trawlers began operating out of Boston in 1910. Although inshore fishermen began installing oil engines in their boats after World War I, they continued to fish Stellwagen Bank primarily with long-lines well into the 1940s (FIG. 5). Access to the fisheries of Stellwagen Bank changed dramatically after this period, as internal combustion-powered fishing vessels with gill nets and otter trawls were able to reach the fishing grounds within a few hours.

25. Secretary of the Commonwealth of Massachusetts 3-4.

26. Tim D. Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855-1955* (New York: Cambridge University Press, 1994).

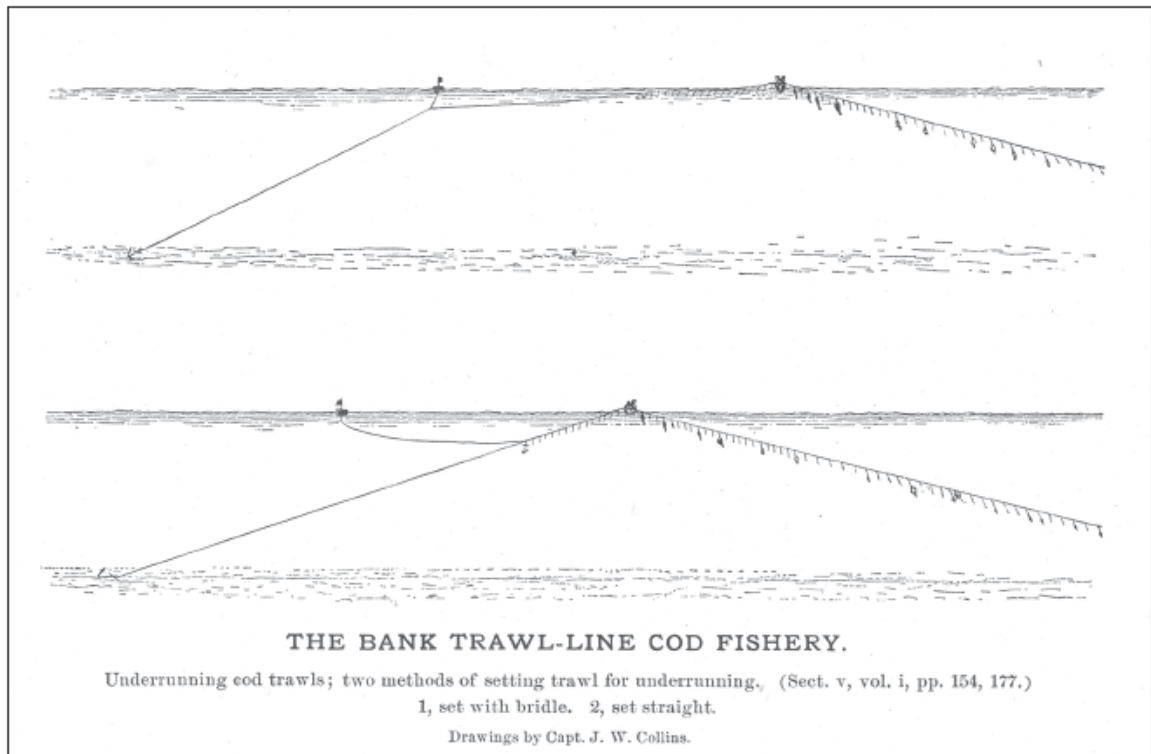
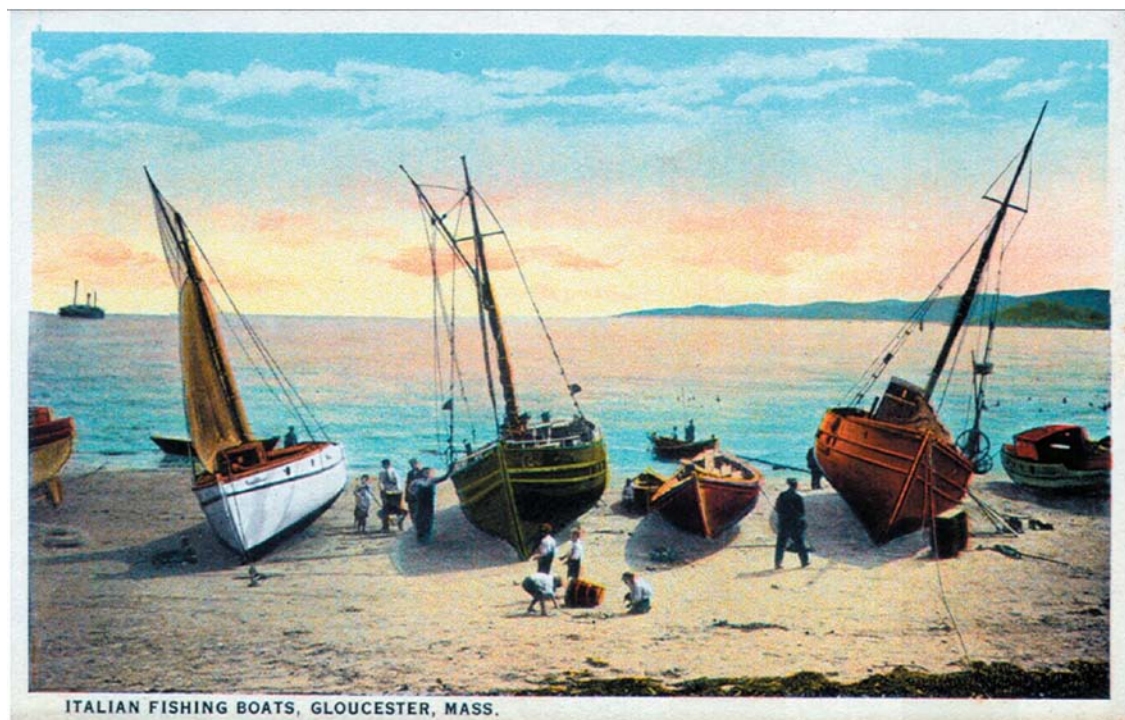


Figure 4. (above) Schematic of long-lines with gangings (from Goode, *The Fisheries and Fishery Industries of the United States* [1887] Sec. V, Plate 27).

Figure 5. (below) Postcard of early 20th-century inshore fishing boats in Gloucester (private collection of W. Leavenworth).



3.7 Fisheries Science

Over a century before the designation of Stellwagen Bank as a marine sanctuary in 1992 and the directed fisheries conservation efforts of the Magnuson Fisheries Conservation and Management Act of 1976, New England's explorers, settlers, fishermen, scientists, conservationists and politicians collectively recognized and recorded numerous declines in fish species. For example, "A Report on the Fishes of Massachusetts," in the Boston Journal of Natural History by David Humphreys Storer (1839), one of the earliest catalogues of marine animals in Massachusetts Bay, records numerous changes in the composition, size, and distribution of the region's fish populations. Much of that report was based upon the accounts and concerns of fishermen, who informed scientists of the disappearance of inshore and riverine fish. For example, he writes that "upon some portions of our coast, herring have been limited in quantity for the last few years, and during the years 1835 and 6 very few, comparatively speaking, were taken. Their scarcity has been attributed by the fishermen to torching them at night" (Storer 1839: 436).

. In another example he reports on the decline of salmon in the Merrimac River: "The building of dams and manufacturing establishments, by preventing the fishes from going up the rivers to deposit their spawn, has almost entirely annihilated this species in our State. Forty-five years since, it was very abundant in the Merrimac river, so much so that nine individuals have been taken in an afternoon by one person with a dip net; and the usual price was eight cents per pound. About seventeen years since, two wagons, each bringing from 30 to 40 fine salmon from the Merrimac river, supplied the Boston market every week during the

season of the fish. Now the few specimens taken are looked upon as rarities, and our market is supplied by the fishery of the Kennebec." (Storer 1839: 426)

The foundations of fisheries science in New England were established in part on the efforts of Storer; however, Louis Agassiz (1807-1873) who established the Museum of Comparative Zoology at Harvard University in 1859 was instrumental in promoting marine biology and the study of the Gulf of Maine fisheries. In the 1850s and 60s, relatively little was known about the physiology and behavior of fish, and scientists relied predominantly upon the accounts of fishermen, who also provided them with samples of fish species for dissection. Many New England samples collected by Agassiz remain at the Museum of Comparative Zoology.²⁷

With mounting evidence that human-induced problems such as river damming contributed to the decline of fish populations, solutions were needed by government officials to resolve public concerns. Scientific data was necessary for 1) understanding the impacts of manufacturing pollution from tanneries and saw mills upon the fisheries, 2) determining the potential response of fish from fish-egg propagation and stocking efforts, and 3) predicting the effectiveness of technological solutions such as fish ladders to support fish migrations. Rarely was scientific or anthropological data collected to study the impact of offshore overfishing.

Not until the late 1860s and early 1870s, when inshore trap and weir fishing interests conflicted with the livelihood of groundfishing fishermen in Massachusetts and Rhode Island, did the state and federal governments resolve to establish a scientific research institute to study declining fish populations.²⁸ At the initiative of Spencer Fullerton Baird (1823-1887), the U.S. Fish

27. Bruce B. Collette and Karsten E. Hartel, *An Annotated List of the Fishes of Massachusetts Bay*, NOAA Technical Memorandum NMFS-F/NEC-51. Woods Hole, MA: Northeast Fisheries Center, 1988.

and Fisheries Commission (commonly referred to as the U.S. Fish Commission) was established in 1871 for the purposes of determining whether there was in fact an overall decline in fish populations, identifying the causes for these declines, and recommending any necessary protective measures. The collective work and activities in marine biology, oceanography and anthropology by the commission was published in annual reports and bulletins of the U.S. Fish Commission. In addition, a defining multivolume work on the latest fisheries science was published by the commission in 1887, *The Fisheries and the Fishery Industry of the United States*. The U.S. Fish Commission would eventually be replaced by the Bureau of Fisheries in 1903 and the U.S. Fish and Wildlife Service (FWS) in 1940. Out of the FWS evolved the Bureau of Commercial Fisheries (1956). Finally, in 1970, with President Richard M. Nixon's Executive Order 11564, the National Marine Fisheries Service was established as part of the Department of Commerce's new National Oceanic and Atmospheric Administration (NOAA).

Beginning in the 1880s, the U.S. Fish Commission, Museum of Comparative Zoology, and the Marine Biological Laboratory at Woods Hole intensively studied New England waters, including Stellwagen Bank. Late 19th- and early 20th-century scientists such as George B. Goode, A. E. Verrill, Henry B. Bigelow, William C. Schroeder, and Alexander Agassiz, undertook investigations of the Gulf of Maine from Cape Cod Bay to the Bay of Fundy. They produced some of the most detailed information about marine life then known about any specific body of water. Much of the fisheries statistics and environmental data catalogued for this research project includes the early records detailed information about the condition of fish stocks and local environmental

and publications of these institutions.

3.8 Conclusion

The relationships, issues, and interests of stakeholders in the fisheries as well as the goals of fisheries science today mirror many of the conditions of the 1870s. Today, fish populations are mostly in decline and remedial efforts continue to focus on the development of technological solutions and fish stocking programs. What is most different today is that legislation and policy beginning in the 1990s severely curtailed offshore fishing activities. Legislative action at least in the short-term appears to have prevented any wide-scale extinctions of groundfish in the region. Fishermen willingly contributed information and data to scientists through the 1960s, but during the 1970s, as policies resulting from scientific research were perceived by fishermen as threatening their livelihoods, fishermen and scientists grew suspicious of each other. In recent years, as the fisheries crisis intensified, guarded collaboration between fishermen and scientists has resumed. Charting the changing nature of the relationship between scientists and fishermen is a crucial component of Stellwagen Bank's marine environmental history.

By developing a historical perspective derived from accounts of fishermen and scientists, this research project hopes not only to document trends in fish populations but also contribute to understanding why changes in fish populations occur and how people are affected by these changes. Fishermen, in particular, possess on-the-water, first-hand and in-depth knowledge of marine ecosystems. Their voices and experiences, which have been documented in historical records such as interviews by scientists, or narratives in journals and diaries, offer conditions, as well as how changes in these conditions have affected their livelihoods.

The strategic location of Stellwagen Bank between the southerly Massachusetts Bay and northerly Gulf of Maine, its proximity to land, and abundant fish resources, have made it a primary food source and point of resource extraction for approximately 400 years. While other bays and banks within the Gulf of Maine historically have yielded significantly greater amounts of fish

products, few banks in the gulf have the consistent, well-documented, and long-term fishing history of Stellwagen Bank. Consequently, Stellwagen Bank presents an excellent case for studying the affects of 400 years of continuous human interaction with this marine environment

4. RESEARCH METHODOLOGY

In this initial research phase, we located primary source materials such as explorers' accounts, fishing logbooks, census records, newspapers, and early marine scientific survey data. These types of historic data may be used to extract information and posit the marine environmental conditions as well as the composition and distribution of historic fish populations on Stellwagen Bank. Sources were identified through on-line manuscript databases, library catalogs, references published in marine ecology and history books and journal articles, and communication with specialists in the fields of maritime history and fisheries science. Researchers traveled to libraries and

historical societies in New England and visited federal archives in Washington D.C. and Maryland. Upon identification, sources were investigated in-person and catalogued in software such as Microsoft Excel or EndNote. In the cases where sources were assessed as valuable or tangentially relevant to the research project, a sample of the documents were photocopied or digitally photographed. The following is a summary of the primary sources found to date. A discussion of their potential as well as limitations in reconstructing the historic marine environment and fish populations of SBNMS is provided.

5. SOURCES

Source (see FIG. 6)	Date Range	# of Records (ca.) *	Archives **
Maps and Charts	1614-1940	100	NARA, NOAAACL, OSHER
Early Exploration Narrative Accounts	1524-1700	30	BPL, HLBO
Newspapers	1720-1940	1,000+	AAS
Fisheries' Customs Records	1780-1940	600 (record sets)	NARA I, NARANR
Scientific Survey Logbooks	1870-1940	25	NARA I and II, SIL
U.S. Fish Commission Publications	1871-1940	200	NOAACL
Bulletin of the Museum of Comparative Zoology	1863-1940	77	MCZ
Massachusetts Records of Fish and Game	1866-1940	74	MCZ, MBL
Boston Society of Natural History	1834-1942	100	MCZ, HLBO
Portland Society of Natural History	1862-1947	40	MHS
Treasury Circulars	1886-1890	100	NARANR
Monthly Fishery Statistical Bulletins	1892-1944	600	NARANR
Census Records	1835-1940	22	MA
Commercial Accounts	1790-1940	unknown	NARANR
Letters and Correspondences	1860-1940	1,000+	NARA II, SIL
Diaries or Daily Journals	1600-1940	unknown -	-
Fishermen Interviews	1850-1900	6 bound volumes	NARA II, NARANR
Legal Documents and Legislation	1630-1940	1,000+	MBL

* Numbers of records shown are approximate

** Lists only the main archives where these sources are available. Many of these sources can also be found in university libraries, historical society collections, and city and state libraries or archives.

ARCHIVE ACRONYMS AND WEB SITES

MBL – Marine Biological Laboratory, Woods Hole Oceanographic Institution Library
(www.mblwhoilib.org/)

MCZ – Museum of Comparative Zoology, Ernst Mayr Library, Harvard University
(<http://library.mcz.harvard.edu/>)

NARA I – National Archives, Washington, DC (www.archives.gov/)

NARA II – National Archives, College Park, MD
(www.archives.gov/facilities/md/archives_2.html)

NARANR – National Archives, Northeast Region, Waltham, MA
(www.archives.gov/northeast/waltham/waltham.html)

SIL – Smithsonian Institution Libraries (<http://siarchives.si.edu/>)

AAS – American Antiquarian Society, Worcester, MA
(www.americanantiquarian.org/)

BPL – Boston Public Library (<http://www.bpl.org/>)

HLBO – Hancock Library of Biology and Oceanography, University of Southern California
(<http://www.usc.edu/isd/archives/arc/libraries/hancock/archives.html>) Osher – Osher Map Library, Portland, ME (<http://www.usm.maine.edu/maps/home.html>)

NOAACL – NOAA Central Library, Silver Spring, MD (<http://www.lib.noaa.gov/>)

MA – Massachusetts Archives, Boston (Dorchester), MA
(<http://www.sec.state.ma.us/arc/arcidx.htm>)

MHS – Maine Historical Society, Portland, ME
(http://www.mainehistory.org/library_overview.shtml)

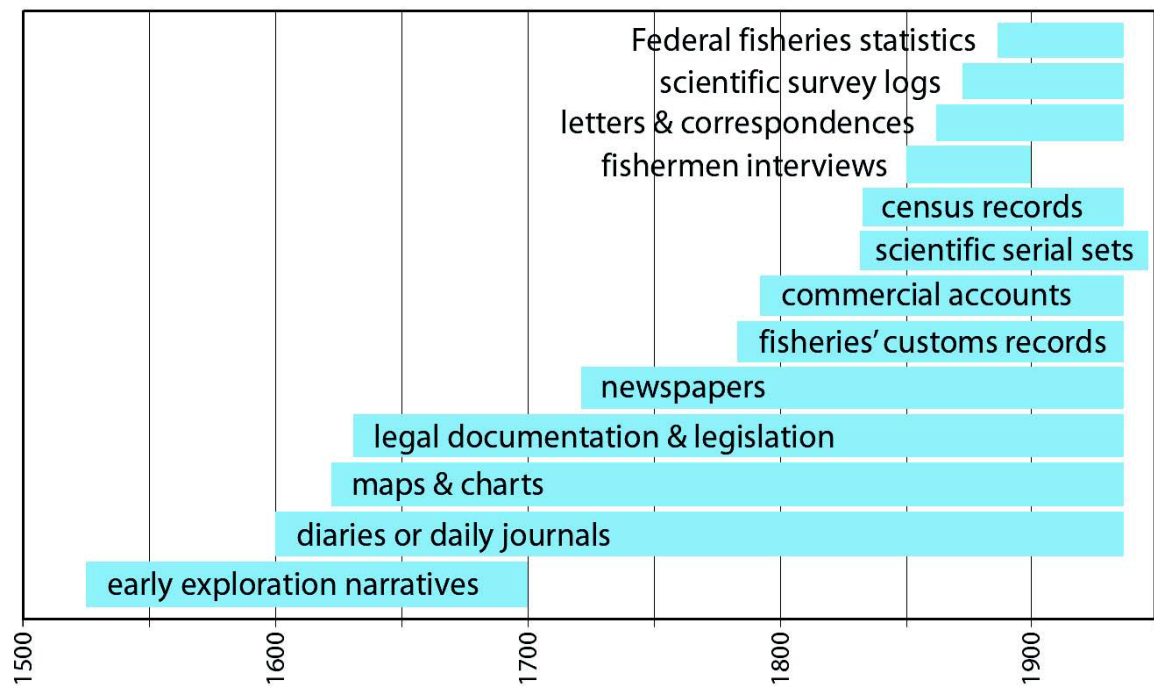


Figure 6. Timeline of primary source materials relevant to SBNMS.

5.1 Maps and Charts (1614-1940)

Often compiled from information collected from fishermen and mariners, charts and maps provide information of where fishermen believed shoals and fishing grounds to exist. These sources offer both local and global referencing to fishing grounds, but also serve as cultural indicators of communities' understandings of their environment. Maps and charts were often made without highly sophisticated methods or plotting instruments, and they need to be viewed cautiously, particularly in regards to claims of their accuracy as both representations of land forms and locations of fishing banks.

Although historical maps and charts typically do not provide statistical data, they do offer a glimpse of how the physical oceanographic characteristics of SBNMS have been interpreted and mapped over the centuries. Maps often depict bathymetric features, where people fished and where fish were caught over time. The spatial and temporal nature of maps is important for keying historical fisheries catch data to specific features such as fishing grounds. Dating to as early as 1734, nearly 100

historical maps/charts have been located thus far that document some geographic or bathymetric characteristics of SBNMS (FIG. 7).

5.2 Early Exploration Narrative Accounts (1524-1700)

Narrative accounts of early European voyages or explorations to New England provide evidence of the region's varied and abundant marine resources prior to wide-scale exploitation (FIG. 8). Early published accounts include those of Giovanni da Verrazano (1524), Bartholomew Gosnold and John Brereton (1602), Martin Pring (1603), James Rosier and George Waymouth (1605), Samuel de Champlain (1605-1606), and John Smith (1614). One indisputable point made by these explorers was the richness and potential commercial value of the New England fisheries. Descriptive and qualitative data can be extracted from these narratives to provide a general sense of abundance, distribution, and perhaps diversity in Massachusetts Bay prior to large-scale fisheries exploration. Publications

Figure 7.
(right) *The Durrell Map from 1734 depicting fishing grounds of Stellwagen Bank (U.K. Hydrographic Office).*

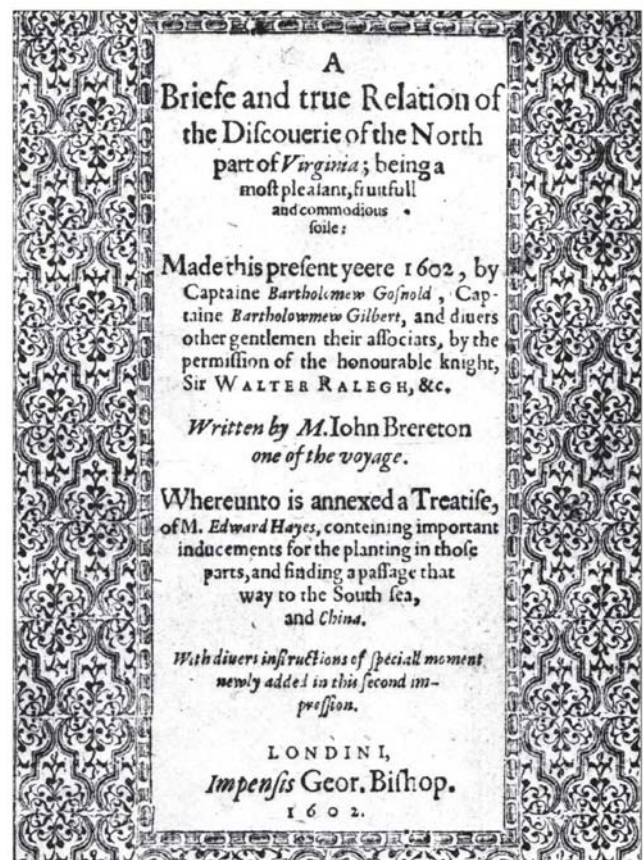


Figure 8. (bottom) *John Brereton's A Briefe and True Relation, on the 1602 Bartholomew Gosnold expedition.*

from the second half of the 17th century, such as William Wood's *New England's Prospect* (1634) and John Josselyn's *New-Englands Rarities Discovered* (1672), also document the condition of marine resources observed by early New England settlers. Most early narratives have been re-published and are widely available in literary collections and serials such as the Hakluyt Society (London) and the *Proceedings of the Massachusetts Historical Society*.

5.3 Newspapers (1720-1940)

Most Massachusetts coastal towns ran a newspaper beginning in the 19th century, and these smaller publications often contain fisheries data. For example, *Hingham Journal* (1850-1880) in 1852 published a list of Massachusetts mackerel vessels and fish catches by town. Thus far, over 50 local Massachusetts and New England regional newspapers have been identified that may contain fisheries data



Prior to the 1900s, newspaper columns or “marine intelligences” typically detail the dates of arrivals, departures, and in some cases vessels spoken to at sea, as such information came into port (FIG. 9). These columns also list the names of vessels, masters, rigs, and either destinations or last ports of call. In the case of fishing vessels, they intermittently mention whether they were “fishing” (meaning in the cod fishery) or “mackereling.” These columns offer snapshots of where, when, and what vessels were operating out of which ports. Occasionally, they provide a statement about the composition of a specific town’s fishing fleet; however, these descriptions usually focus on the larger bank fishing operations. Columns and intelligences surveyed to date tend to overlook inshore fishing activity except to report on storms, shipwrecks, and other unusual phenomena. Examples of papers specific to maritime news in the region include the following:

<i>Boston Gazette,</i>	1719-1742, 1803-1816
<i>Barnstable Patriot,</i>	1830-1915
<i>Cape Ann Advertiser,</i>	1856-1901
<i>Cape Cod Advocate and Nautical Intelligencer,</i>	1850-1860
<i>Whaleman’s Shipping List,</i>	1843-1894

5.4 Fisheries Customs Records (1780-1940)

This data set comprises an overwhelming number of documents, which are referred to collectively here as customs records. Customs records relevant to SBNMS include fishing agreements and journals (or logbooks), crew lists, vessel licenses and enrolment records. Records are available for numerous Massachusetts ports. There are also ledgers or accounting books that document the costs associated with owning, operating, and outfitting fishing vessels. Thus far, nearly 600 sets of customs records for the

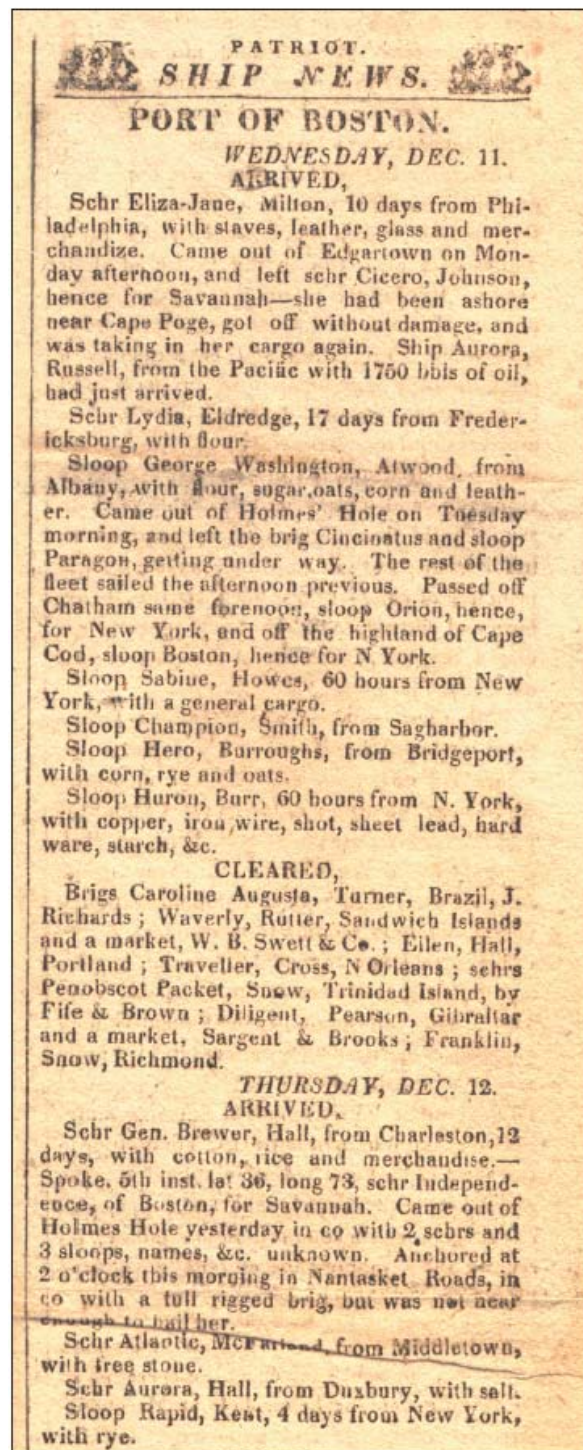


Figure 9. A typical marine intelligence column or “Ship News” from the *Independent Chronicle and Boston Patriot* (Dec. 14, 1822).

Massachusetts Bay region are catalogued in the National Archives. Numerous documents are also located in the collections of historical societies and local libraries in eastern Massachusetts. These records may provide landing figures, allow for the estimation of removals for some species, and contribute to the calculation of Catch Per Unit Effort (CPUE) based on data about vessel size, fishing gear, and crew composition.

5.5 Scientific Survey Logbooks (1870-1940)

Scientific marine cruises, explorations and fishery expeditions are an excellent source for marine biological and physical ocean data. Numerous records exist concerning the operation of federal government fisheries research vessels from approximately 1870-1940. These records include logbooks and reports of U.S. Fish Commission and Bureau of Fisheries vessels (FIG. 10). The Gulf of Maine was an important proving ground for early oceanographic studies, and vessel trawls and survey logbooks in the Smithsonian Institution and National Archives are available for scientific cruises in the gulf and SBNMS, including:

Speedwell (1877)
Albatross (1883)
Fish Hawk (various years 1880-1925)
Grampus (various years 1886-1917)
Halcyon (various years 1912-1921)
Blake (1880)

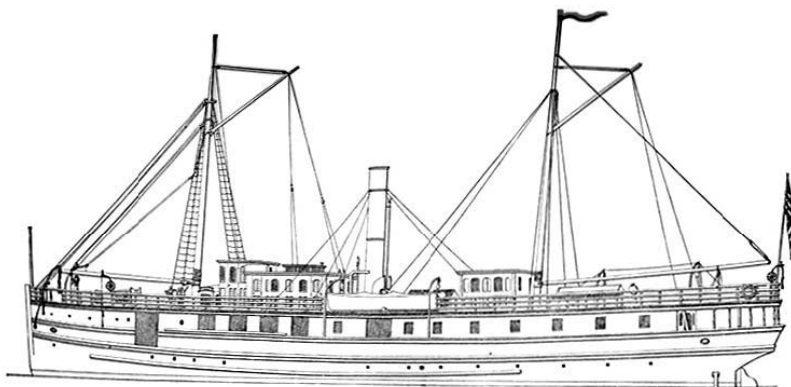


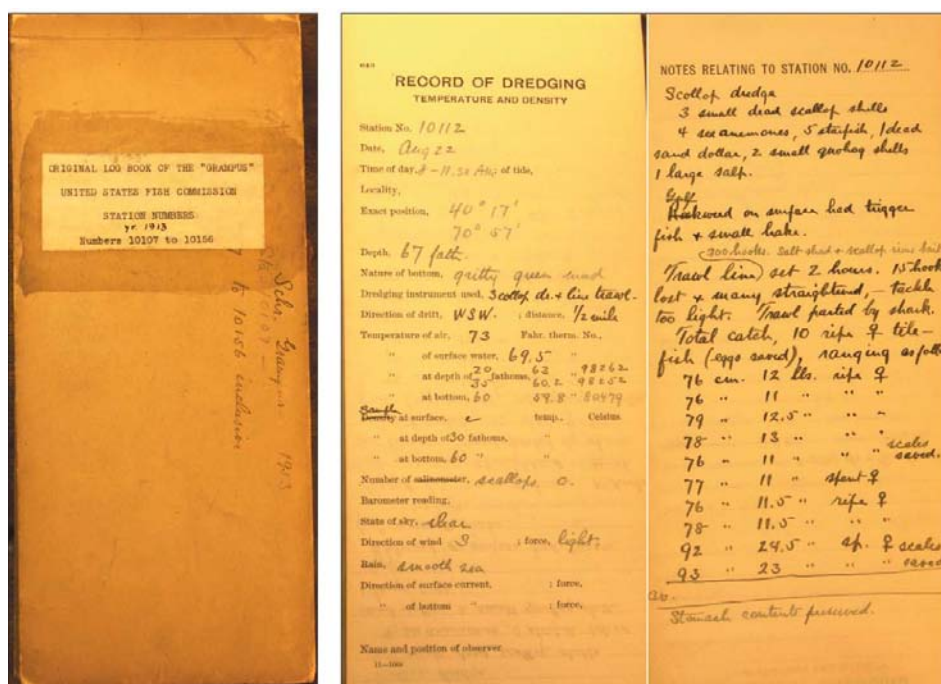
Figure 10. U.S. Fish Commission Steamer Fish Hawk (from Z.L. Tanner, "Report on the Construction and Work in 1880 of United States Fish Commission Steamer FISH-HAWK," Annual Report of the Commissioner [1881] Part IX, Plate I, p. 53)

Survey reports published in serial sets such as the Annual Report or Bulletin of the U.S. Fish Commission and Museum of Comparative Zoology (see below) recount survey and sampling work undertaken by research vessels. More importantly, original sampling and deck logs now archived at the National Archives and Smithsonian Institution Libraries provide the locations (in latitude and longitude) as well as descriptions of hydrographic data, dredging samples, and surface trawls taken at sea (FIG. 11). These sources provide detailed surface, bottom, water column conditions, and species distribution data for the Gulf of Maine in the latter half of the 19th and the early 20th centuries.

5.6 Serial Sets

5.6.1 U.S. Fish Commission Publications (1871-1940)

The U.S. Fish Commission was established in 1871 to investigate causes for the decrease of fish populations in U.S. coastal and inland waters. Fisheries data generated by the Commission is available for portions of SBNMS beginning in the early 1870s. U.S. Fish Commission publications consist of a series of annual reports, bulletins, as well as occasional monographs or special publications such as the 7-volume set of *The Fisheries and the Fishery Industry in the United States* (1887).



The *Annual Reports of the U.S. Fish Commission* were submitted to Congress each year beginning in 1871. All annual reports, from 1871/72 to 1940 are available online through NOAA's Central Library in PDF format at: http://docs.lib.noaa.gov/rescue/cof/data_rescue_fish_comission_annual_reports.html. They generally contain a report to Congress on the work of the commission, including field and survey reports from commission scientists, reports on propagation efforts, nationwide fishery statistics, fishery histories, and anthropological studies.

Publication of the Bulletin of the United States Fish Commission began in 1881 (first printed in 1882). The bulletin is a publication of journal articles primarily by commission-supported scientists. Articles often report on specific fisheries and the methods used to harvest or cultivate fish in the United States and abroad. Subjects include international efforts to develop aquaculture, reports of fish diseases, and fishing technology and techniques. Additionally, correspondence from fishermen, captains, and fishery scientists in the United States, Europe, and Australia was often published in the bulletins.

Finally, *The Fisheries and Fishery Industries of the United States*, published under the

supervision of George Brown Goode in 1887, provides an exhaustive report on the fisheries of the United States at that time (FIG. 12). The publication is divided into seven sections: 1) the natural history of marine products, 2) fishing grounds, 3) fishermen and fishing towns, 4) apparatus and methods of capture, 5) products of fisheries, 6) preparation, care, and manufacture of fishery products, and 7) economy of the fisheries. Detailed information is available for all aspects of the fisheries of Cape Cod and Massachusetts Bay, including Stellwagen Bank, or “Middle Bank,” as it is more commonly referred to in commission publications.

5.6.2 Bulletin of the Museum of Comparative Zoology (1863-1940)

The *Bulletin of the Museum of Comparative Zoology* began publication in 1863 under the direction of Louis Agassiz, a zoologist from Neuchatel, Switzerland, who served as director of the Museum from 1859-1873. The bulletins contain numerous article reprints from the U.S. Fish Commission annual reports and bulletins. The Museum of Comparative Zoology (MCZ) bulletins also contain survey operation reports, lists of sampling and dredging stations of survey

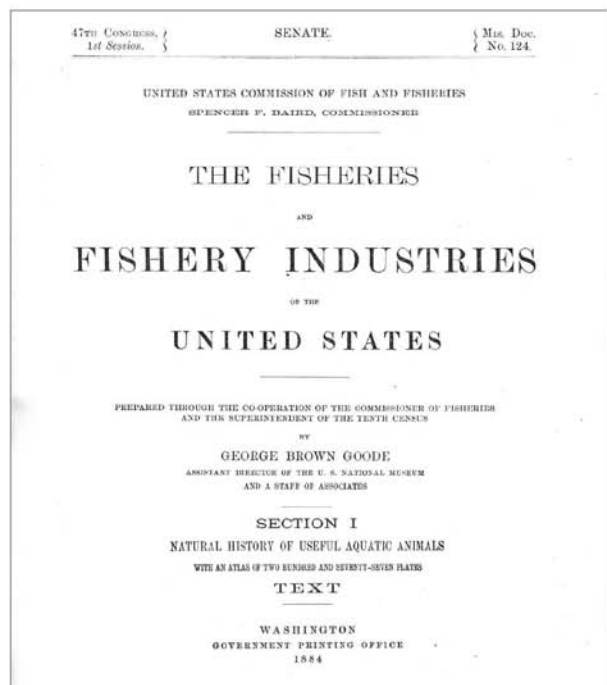


Figure 12. (above) *The Fisheries and Fishery Industries of the United States*, published in 1887.

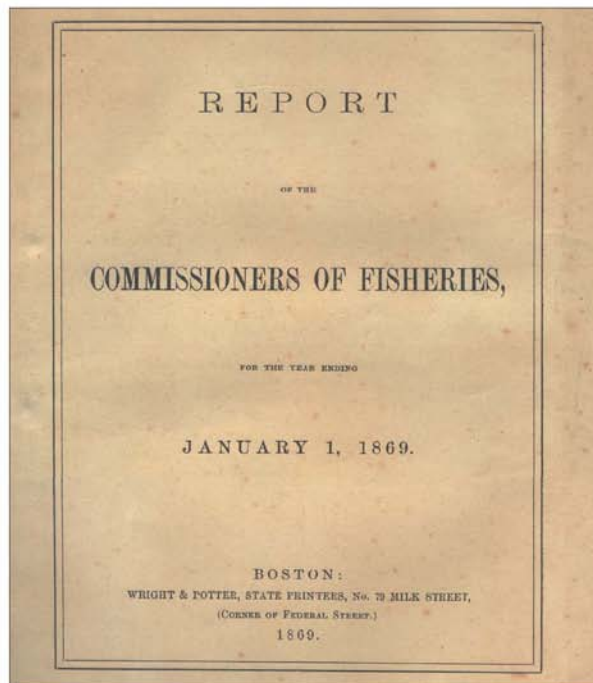


Figure 13. (right) Cover of the 1869 volume of the *Report of the Commissioners of Fisheries*

vessels, articles on Pacific and northwest Atlantic explorations, and notes and reports on specific animals such as sharks and skates in the Gulf of Maine. The MCZ ichthyological collection also remains one of the best in the world, and its collections include specimens taken in New England waters beginning in the late 1700s by Harvard naturalists.²⁹

5.6.3 Massachusetts Records of Fish and Game (1866-1940)

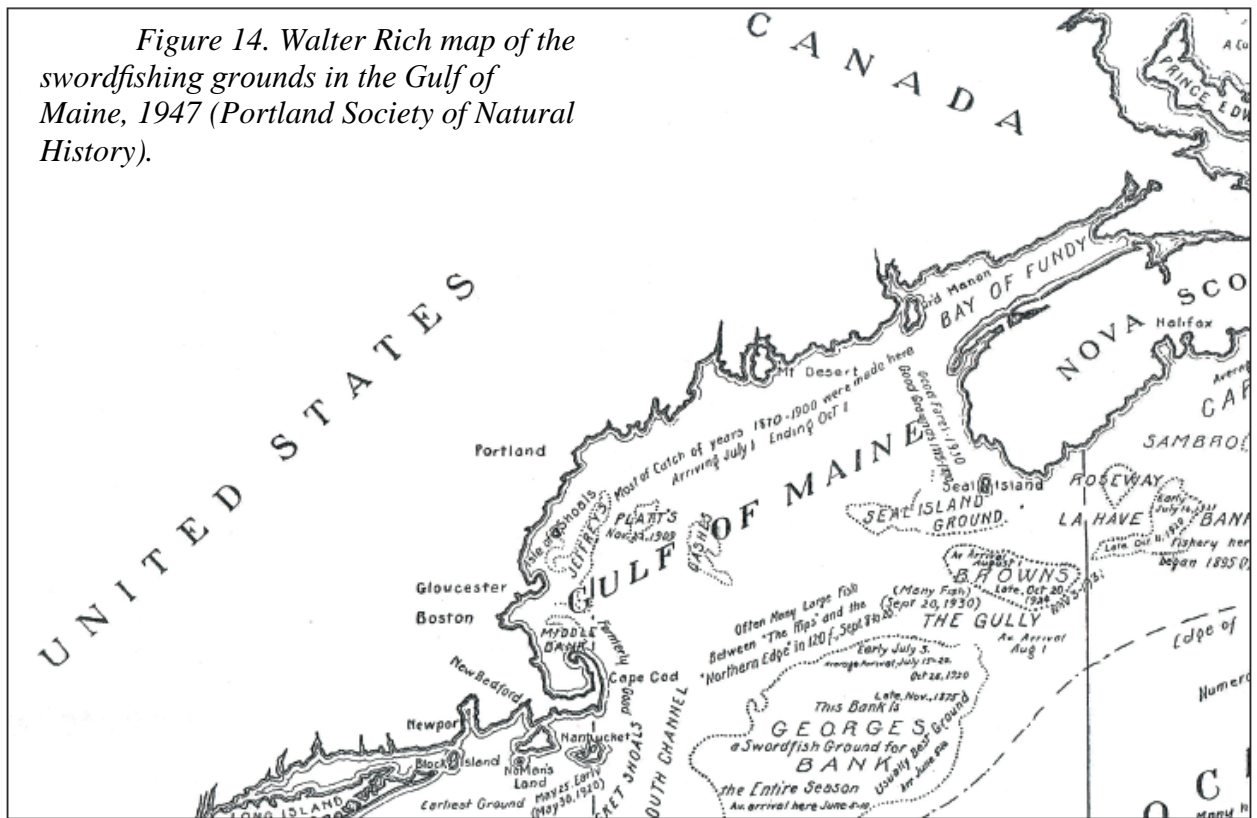
The reports of this serial set, printed for the Commonwealth of Massachusetts Commissioners of Fisheries, are generally referenced as in the following example:

Report of the Commissioners of Fisheries, for the year ending January 1, 1869.
Massachusetts Commissioners on Fish and Game. Boston: Wright & Potter, State Printers, 1869.

The reports focus predominantly on the inland and river fisheries (FIG. 13). In addition, they inventory relevant fishery regulatory and legislative actions taken within the state. Detailed statistics are available for the coastal and riverine fisheries in the reports, which may help provide a relative measure of the condition of fish populations on Stellwagen Bank. The annual reports were issued beginning in 1866. Subsequent titles for the reports in the late 19th and early 20th centuries are *Report of the Fish and Game Commissioners of Massachusetts* and *Annual Report of the Division of Fisheries and Game*.

29. Collette and Hartel.[Type text]

Figure 14. Walter Rich map of the swordfishing grounds in the Gulf of Maine, 1947 (Portland Society of Natural History).



5.6.4 Boston and Portland Societies of Natural History (1834-1942, 1862-1947)

Originally formed as the Linnaean Society by Jacob Bigelow at Harvard University in 1814, the once fledgling organization would become the Boston Society of Natural History in 1830, the New England Museum of Natural History in 1864, and finally the Boston Museum of Science in 1951. The Boston Society amassed one of the largest collections of natural history publications in the world, which is now housed in the Hancock Library of Biology and Oceanography at the University of Southern California. The society began publication of the *Boston Journal of Natural History and Proceedings of Boston Society of Natural History* in 1834. The journal ran irregularly until 1942. Seminal proceedings publications, such as David Humphreys Storer's *A Report on the Fishes of Massachusetts* (1839), are an excellent source for qualitative or descriptive information about the condition of fish species within Massachusetts Bay well

before any systematic fisheries science or government survey operations were established.

The Portland Society of Natural History was founded in 1843 with the purpose of collecting and studying specimens and educating its members about the region's natural history. To this end, it began a publication of the proceedings of occasional meetings and lectures titled *Proceedings of the Portland Society of Natural History* (1862-1947). Some papers of the society, such as Walter H. Rich's article on "The Swordfish and the Swordfishery of New England," published in 1947, which incidentally was also the last publication by the society, provides a historical synthesis and maps of the traditional sword-fishing grounds in the Gulf of Maine (FIG. 14). Beginning in 1881, the Portland society also issued a "Circular To Sea Captains and Other Seafaring Men" that encouraged fishermen and merchants to bring natural history specimens home from their voyages and donate them to the society.³⁰ Many

TREASURY DEPARTMENT.

STATISTICS of the Vessel Fisheries of the United States furnished by
William R. Higgins, Collector of Customs for the Port of
Weymouth. Date of Record, *June 16, 1888*

Name of vessel, *Edwin A. Minist*; net tonnage, *14.62*
 Present value of vessel, \$ *700*; value of apparatus and outfit, \$ *100*
 Hailing port, *Weymouth*; fishing port, *Weymouth*
 Papers about to be surrendered or renewed were issued *April 28*, 188*8*, and
 given up *June 16*, 188*8*
 Name of owner or agent, *John S. Cole*; P. O. address, *Weymouth*
 Name of master, *John S. Cole*; P. O. address, *Weymouth*
 Number of persons on vessel, as follows: American subjects (white), *4*; American subjects
 (colored), *0*; British provincials, *0*; other foreigners, *0*; total, *4*
 Name separately all fisheries engaged in during period covered by papers mentioned above.

Where fishing, and on what grounds, *Cod fishing Massachusetts Bay*
 Kinds of apparatus used, *Hand lines*
 Date of starting on first trip under above papers, *April 28, 1888*; date of return from last trip
 under same, *June 6, 1888*
 Total number of trips made, *1*; how long idle during period covered by above papers, *11 days*
 Quantity of fish or other products taken or transported during period covered by above papers, as follows:

Pounds sold fresh: Mackerel, *0*; cod, *1000*; haddock, *0*; lake trout, *0*; menhaden (blbs.), *0*
 haddock, *0*; white fish, *0*; lake trout, *0*; menhaden (blbs.), *0*
 other fish (specifying kinds and quantities), *0*
 Pounds dry-salted or split for salting: Cod, *0*; lake, *0*; haddock, *0*
 pollack, *0*; other fish (specifying kinds and quantities), *0*
 Barrels brine-salted (sea packed): Mackerel, *0*; sea herring, *0*; white fish
 (4 blbs.), *0*; lake trout (4 blbs.), *0*; lake herring (4 blbs.), *0*; other fish, *0*
 Bushels of shell-fish: Oysters caught for market, *0*; oysters caught for transplanting, *0*
 oysters (not caught by crew) transported only, *0*; clams caught by crew, *0*; clams
 (not caught by crew) transported only, *0*; scallops, *0*; other shell-fish, *0*
 Number of lobsters: Lobsters caught by crew, *0*; lobsters (not caught by crew) trans-
 ported only, *0*
 Gallons of oil (specify kind and quantity), *0*
 Miscellaneous products: Seal-skins, *0*; sponges, *0*; other products (specify
 kind and quantity), *0*

Total value of fish and other products taken, before deducting any expenses, \$ *3.50*
 Disposition made of fish or other products (where landed), *Weymouth*
 Has the vessel entered foreign waters for any purpose whatever during the above period? *No*. If so,
 please answer fully the questions on the following page; if not, they may be neglected.

Figure 15. A treasury circular issued by Spencer Baird in the late 19th century (National Archives, Waltham, MA).

5.7 Federal Fisheries Statistics

5.7.1 Treasury Circulars (1886-1890)

Department of the Treasury circulars were issued by Spencer Baird and the U.S. Fish Commission in the last quarter of the 19th century, which required customs agents and fishermen to document the amounts and types of fish caught, vessel and crew information, approximate areas fished, and fishing methods employed (FIG. 15). These records can be used to extract catch and CPUE data for the largest bank vessels offshore as well as the smallest inshore boats. Unfortunately, only about 100 of these documents have been located representing only a snapshot of fishing efforts from 1886 to 1890. A few of these records mention

specimens were sent to the Delaware Museum of Natural History when the society disbanded in 1971, but most are presumed lost.³¹

Middle Bank as an area fished, but typically only a general location is given (e.g., Massachusetts Bay).

5.7.2 Monthly Fishery Statistical Bulletins for Northwest Atlantic (1892-1944)

These records, produced first by the U.S. Fish Commission in 1892 and then by the Bureau of Fisheries beginning in 1903, provide statistical information such as fish catch variety and volume, name and location of fishing grounds, the number of trips made to those grounds, where products were landed, and the values of fish sold (FIG. 16). The bulletins are unique in that they specify this information per month. Therefore, total removals of all fish species on Stellwagen or Middle Bank can be calculated for a 35-year period. Although the catch records range in date from 1892 to 1944, consistent monthly records for Stellwagen Bank are available from 1901 to 1935. Over this period, these records can also be utilized to track changes in species composition and seasonality. Furthermore, data is available for a number of fishing grounds in the Gulf of Maine, and Stellwagen Bank could be compared to total removals on other grounds. Spatial and comparative analysis could reveal the relationships between local and regional fish populations. Beginning in 1928, the bulletins also specify the type of fishing gear used to fish the various banks and grounds of the Gulf of Maine. If CPUE data can be derived from other historical sources for this same period, biomass estimates for various species on Stellwagen Bank are possible. GMCP has begun to extract data from the statistical bulletins to map change in catch/fish composition over time on Stellwagen Bank. We have also begun to integrate this data into a GIS in order to examine the spatial relationships of fish populations on Stell-

³⁰. Herbert Adams, "The First 150 Years," *Habitat* (Falmouth, ME: Maine Audubon Society, 1993).

³¹. Paula Work, Maine State Museum, personal interview, 7 July, 2005.

wagen to other banks fished in the Gulf of Maine.

5.8 Census Records (1835-1940)

Massachusetts census records are available for the fishing industry beginning in 1835 with the Abstract of the Census of Massachusetts, which was later published as the Census of the Commonwealth of Massachusetts. These censuses were taken every 5-10 years until present times and document investments and products in and of the fisheries, the number of fishing vessels per town or county, tonnage and costs of outfitting, hands employed, amounts and values of specific fisheries, and where fish were caught, for each town. The data allow for five-year or decennial reconstructions of fleet sizes, inshore and banks landings, as well as rough calculations of CPUE. This data set can be used to broadly measure

changes in the labor force, fishing effort, and catch for towns and counties in Massachusetts, and seems quite promising for assessing the changing nature of Stellwagen Bank (and Massachusetts Bay) fish stocks.

5.9 Commercial Accounts (1790-1940)

Perhaps some of the finest-grained information available about marine resource use is in the form of private business records that often provide fishermen's names, catches, bait used, vessel outfitting, and financial settlements. Most of these records typically focus only on large, highly-capitalized bank fishing operations; however, business and personal papers also provide snapshots of smaller inshore and riverine fisheries, which may be used to develop proxies for catch and CPUE for certain Massachusetts Bay or Stellwagen Bank fisheries in the 18th and 19th centuries.

Figure 16. A U.S. Fish Commission monthly statistical bulletin, January 1898 (National Archives, Waltham, MA).

U. S. COMMISSION OF FISH AND FISHERIES.

FISHERY STATISTICS.

STATEMENT of Quantities and Values of certain Fishery Products landed at Gloucester and Boston, Mass., by American Fishing Vessels during the month of January, 1898.

FISHING GROUNDS.	No. of Tons.	COD.		CHIEF.		HADDOCK.		HAKE.		MULLOCK.		HALLIBUT.		HERRING.				TOTAL.			
		Pounds.		Value.		Pounds.		Value.		Pounds.		Value.		Pounds.		Value.		Pounds.		Value.	
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
<i>East of 66° W. Longitude.</i>																					
La Have Bank.....	40	785,500	\$15,430			141,750	\$1,522	1,409,800	\$14,468	185,000	\$1,770			17,350	\$2,948					2,584,350	\$35,358
Western Bank.....	1													9,500	1,193					9,500	1,193
Queen Bank.....	19			52,000	\$1,720									478,941	\$2,910					478,941	\$2,910
Green Bank.....	1													28,000	3,300					28,000	3,300
Off New Foundland.....	17													2,030,500	\$30,916	761,025	\$10,150			2,030,500	\$30,916
Cape Shore.....	1	10,000	300					37,000	370	5,000	50									49,000	600
<i>West of 66° W. Longitude.</i>																					
Georges Bank.....	54	100,000	2,641	345,100	8,008	34,000	280	1,389,000	18,790	47,000	254	4,630	\$112	15,525	1,493					1,493,125	\$1,691
Cadmus Bank.....	3	42,000	736			42,000	473	37,000	348	75,000	750									197,000	2,360
Middle Bank.....	17	39,000	720			148,400	1,714	7,000	105	5,700	126									190,100	2,674
Jeffrey's Ledge.....	41	133,700	2,870			22,500	247	216,000	3,561	35,700	405	5,000	53							381,900	6,608
Twelve Bay.....	1	4,000	80																	4,000	80
South Channel.....	11	74,500	901					345,000	2,545	100,000	1,275	5,000	40	1,000	150					422,500	3,961
Off Highland Light.....	14	34,000	794					86,500	1,720	12,000	190	3,000	65	1,000	150					136,500	2,959
Off Chatham.....	4	11,000	270					45,000	900	5,000	43	1,000	22	300	45					60,300	1,281
Off Race Point.....	5	50,000	900					17,000	340	400	8									52,400	1,501
Shore General.....	303	407,425	16,664			30,500	336	451,800	7,669	132,500	1,444	15,200	265	1,500	275					1,278,355	36,458
TOTAL.....	592	1,965,352	41,802	398,100	9,761	251,700	2,758	4,698,000	51,543	617,300	6,372	85,500	888	551,616	41,417	7,029,500	29,916	761,025	10,150	9,894,371	190,267
TOTAL LANDED AT GLOUCESTER.....	377	1,564,155	28,510	296,100	9,761	251,700	2,545	3,571,300	29,636	326,000	3,189			545,991	40,696	964,500	9,441	761,025	10,150	5,932,746	112,965
TOTAL LANDED AT BOSTON.....	215	401,200	13,292			20,500	226	1,464,500	22,707	291,300	3,203	32,500	808	5,125	721	1,033,000	39,475			4,959,625	70,722

J. J. BAIRD,
Commissioner.

5.10 Letters and Correspondences (1860-1940)

Collections of papers, for notable government officials such as Spencer Baird and George Goode of the U.S. Fish Commission and Theodore Lyman (fish commissioner of Massachusetts 1865-1882) contain hundreds of letters and correspondences with field scientists, captains, and fishermen. Although many letters were published in U.S. Fish Commission bulletins and reports, hundreds went unpublished and contain snippets of information that can be used to build historical contexts or fill in the historical gaps for specific fisheries and fishing grounds. Moreover, they often document conflicts between government, fishermen, and commercial or manufacturing enterprises, and provide reports of fish disease and pollution as well as observations of fishermen and captains in and around Massachusetts Bay (FIG. 17). Libraries and archives do not generally catalogue the contents of letters and correspondences; therefore, gleaning relevant historical information from these records is a labor-intensive and time-consuming process.

5.11 Diaries or Daily Journals (1600-1940)

Personal accounts such as diaries or journals detail the daily routines, events, observations and life-ways of people relying upon fish resources and interacting with the marine environment. While other sources offer numerical or analytical descriptions of fish resources, diaries or journals document not only daily life of people that fished, but also how they viewed their place within the marine ecosystem and their reactions to environmental change. These rare documents offer valuable insights into the social, cultural and economic contexts in which decisions about resource use were made. While not offering systematic data susceptible to rigorous analysis, personal diaries and

journals are important primary sources that complement the analysis of numerical data. To date, no diaries or journals pertaining specifically to Stellwagen Bank have been located.

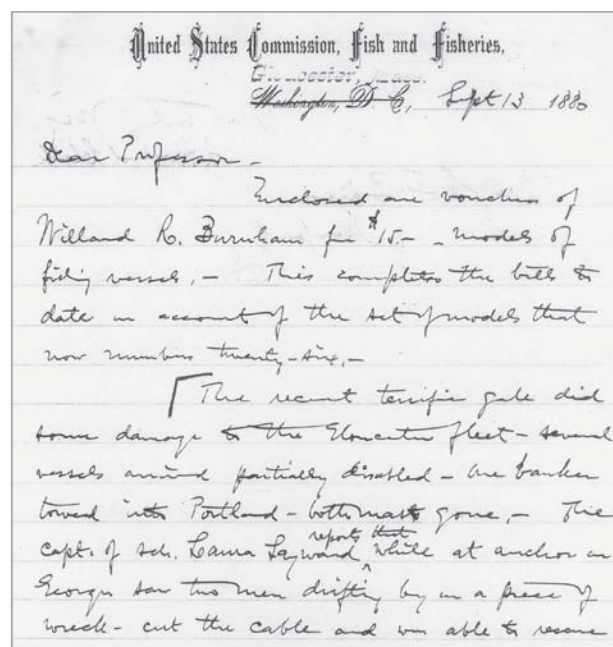


Figure 17. Sample of Baird correspondence records (National Archives, College Park, MD).

5.12 Fishermen Interviews (1850-1900)

In the late 19th century, the U.S. Fish Commission conducted numerous interviews with fishermen throughout the northeast United States including cod and mackerel fishermen from New York, New England and Nova Scotia. Most fishermen interviewed in the 1890s by the commission were over 50 years of age and recollected changes in the marine environment. These interviews, or oral histories, are an excellent source for observations of Gulf of Maine fisheries. They provide first-hand accounts and observations of fish behavior and fishing activity on specific fishing grounds such as Stellwagen Bank (FIG. 18). Most interviewees discuss the migratory patterns and behaviors of

mackerel on the east coast. In addition, the fishermen offer descriptions of fish and catch sizes, the effects of certain gear on fish populations, as well as explanations and causes for the decline in cod and mackerel in the 19th century. These records are located at National Archives II in College Park, MD and National Archives in Waltham, MA.

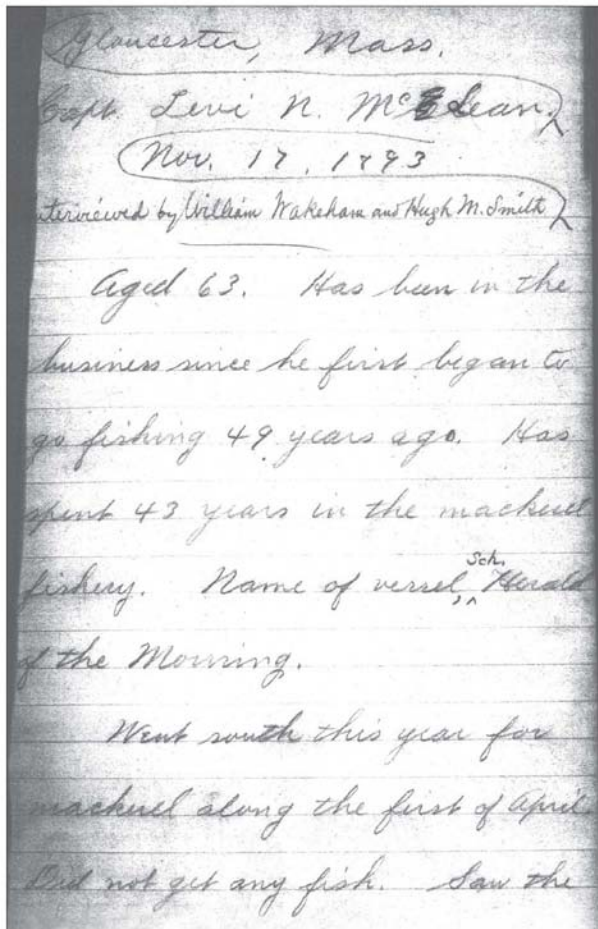


Figure 18. Page from a 1893 interview with a mackerel fisherman from

Gloucester (National Archives, College Park, MD).

5.13 Legal Documents and Legislation (1630-1940)

Federal, state, provincial and local laws and regulations directly and indirectly provide information about the state of the Massachusetts and Cape Cod Bay fisheries. Laws and ordinances regulated aspects of the fisheries. For example, a law prohibiting fish catch before spawning was drafted in the late 17th century:

“It is ordered by this court and the authority thereof, that no man shall henceforth kill any codfish, hake, haddock, or pollock, to be dried for sale in the month of December or January, because of their spawning time, nor any mackerel to barrel up in the month of May or June, under penalty of paying five shillings for each quintal of fish, and five shillings from each barrel of mackerel; nor shall any fisherman cast the garbage of the fish they catch overboard at or near the ledges or grounds where they take the fish” (1668)

To date, GMCP researchers have identified almost 150 fishing laws and regulations dating to before 1900, some which may relate to the fisheries and fishing activity in SBNMS. By tracing regulatory or legislative efforts over time, we may be able to see how effective such efforts were at promoting or curbing fishing efforts and landings.³²

³². Katherine Magness, *Development of Fishing Policy in the Gulf of Maine, Late 19th Century* (M.A. thesis, August 2005 Dept. of Natural Resources at UNH).

6. PROPOSED HISTORICAL RESEARCH

Based on the review of available historical resources, GMCP will extract data from the following primary source material for further analysis:

1. Early Exploration Narrative Accounts
2. Scientific Survey Logbooks
3. U.S. Fish Commission Publications
4. Monthly Fishery Statistical Bulletins for Northwest Atlantic
5. Fishermen Accounts and Interviews

This determination is based on the condition and integrity of the records, and their potential to yield specific and detailed information about fish population, changes affecting the populations, composition, distribution, and diversity within SBNMS and Massachusetts Bay. In addition, these records explore the social, cultural and economic consequences of over-exploitation, pollution, and government regulation of marine resources.

Extraction and analysis of scientific survey logbook data will help to interpolate species richness on Stellwagen Bank. Because trawl and dredging sample logbooks provide both quantitative and qualitative data, it is possible to integrate this information into a relational database and Geographic Information System (GIS). Such a GIS can be used to model species abundance, diversity and changes in seafloor or surface characteristics in and around Stellwagen Bank in the late 19th and early

20th centuries.

An analysis of quantitative and qualitative information provided by fishermen as well as scientists will compare and contrast two historically different perspectives. From the scientific point of view, statistical data will be extracted from monthly statistical bulletins and other U.S. Fish Commission survey reports. Although information provided by fishermen in the 19th century was collected by scientists, interviews with fishermen relay first-hand experiences within the marine environment and therefore they are attuned to subtle changes in environmental conditions. Combined, these etic and emic perspectives will be important for both quantifying and qualifying fish population trends over time.

While data extraction in Phase 2 and data analysis in Phase 3 will focus on the primary sources listed above, the remaining complementary sources will help build a historic context that will contrast and bridge observations of the marine environment made in the 17th century through to the rigorous collection of fisheries data made in the late 19th and early 20th centuries. Additionally, a detailed historic context for the period 1870-1935 will help to interpret the social, cultural, economic, political, legal, and technological factors that may have affected fish catch and landings during these times.

7. SUMMARY

This project seeks to create a historical map of marine resource use and exploitation, human responses to environmental change, and the effects of regulatory and management actions on Stellwagen Bank. Because fisheries tend not to adhere strictly to marine sanctuary jurisdictional boundaries, documenting the temporal and spatial change within a localized marine environment such as SBNMS is difficult. However, based on the best available historical research, data, and scientific analysis, we can begin to document fish population trends and comprehend the impact of human activities on Stellwagen Bank. Documenting change in species composition and distribution over time may provide a measure of local as well

as regional ecosystem health, now and in the past. Moreover, a marine historical ecology of Stellwagen Bank may serve as a case study and model for documenting the cumulative and long-term effects of human activities on specific fisheries. Additionally, it documents the relationship of marine animal populations to social, cultural and economic stability and the human consequences of a declining marine resource base. With this knowledge, rational choices can be made that will help to identify sustainable fish population levels, guide future management action, and contribute toward the region's long-term ecosystem health.

ONMS CONSERVATION SERIES PUBLICATIONS

To date, the following reports have been published in the Marine Sanctuaries Conservation Series. All publications are available on the Office of National Marine Sanctuaries website (<http://www.sanctuaries.noaa.gov/>).

The Application Of Observing System Data In California Current Ecosystem Assessments (ONMS-10-01)

Reconciling Ecosystem-Based Management and Focal Resource Conservation in the Papahānaumokuākea Marine National Monument (ONMS-09-04)

Preliminary Comparison of Natural Versus Model-predicted Recovery of Vessel-generated Seagrass Injuries in Florida Keys National Marine Sanctuary (ONMS-09-03)

A Comparison of Seafloor Habitats and Associated Benthic Fauna in Areas Open and Closed to Bottom Trawling Along the Central California Continental Shelf (ONMS-09-02)

Chemical Contaminants, Pathogen Exposure and General Health Status of Live and Beach-Cast Washington Sea Otters (*Enhydra lutris kenyoni*) (ONMS-09-01)

Caribbean Connectivity: Implications for Marine Protected Area Management (ONMS-08-07)

Knowledge, Attitudes and Perceptions of Management Strategies and Regulations of FKNMS by Commercial Fishers, Dive Operators, and Environmental Group Members: A Baseline Characterization and 10-year Comparison (ONMS-08-06)

First Biennial Ocean Climate Summit: Finding Solutions for San Francisco Bay Area's Coast and Ocean (ONMS-08-05)

A Scientific Forum on the Gulf of Mexico: The Islands in the Stream Concept (NMSP-08-04)

M/V *ELPIS* Coral Reef Restoration Monitoring Report Monitoring Events 2004-2007 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-08-03)

CONNECTIVITY Science, People and Policy in the Florida Keys National Marine Sanctuary (NMSP-08-02)

M/V *ALEC OWEN MAITLAND* Coral Reef Restoration Monitoring Report Monitoring Events 2004-2007 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-08-01)

Automated, objective texture segmentation of multibeam echosounder data - Seafloor survey and substrate maps from James Island to Ozette Lake, Washington Outer Coast. (NMSP-07-05)

Observations of Deep Coral and Sponge Assemblages in Olympic Coast National Marine Sanctuary, Washington (NMSP-07-04)

A Bioregional Classification of the Continental Shelf of Northeastern North America for Conservation Analysis and Planning Based on Representation (NMSP-07-03)

M/V *WELLWOOD* Coral Reef Restoration Monitoring Report Monitoring Events 2004-2006 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-07-02)

Survey report of NOAA Ship McArthur II cruises AR-04-04, AR-05-05 and AR-06-03: Habitat classification of side scan sonar imagery in support of deep-sea coral/sponge explorations at the Olympic Coast National Marine Sanctuary (NMSP-07-01)

2002 - 03 Florida Keys National Marine Sanctuary Science Report: An Ecosystem Report Card After Five Years of Marine Zoning (NMSP-06-12)

Habitat Mapping Effort at the Olympic Coast National Marine Sanctuary - Current Status and Future Needs (NMSP-06-11)

M/V *CONNECTED* Coral Reef Restoration Monitoring Report Monitoring Events 2004-2005 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-06-10)

M/V *JACQUELYN L* Coral Reef Restoration Monitoring Report Monitoring Events 2004-2005 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-06-09)

M/V *WAVE WALKER* Coral Reef Restoration Baseline Monitoring Report - 2004 Florida Keys National Marine Sanctuary Monroe County, Florida (NMSP-06-08)

Olympic Coast National Marine Sanctuary Habitat Mapping: Survey report and classification of side scan sonar data from surveys HMPR-114-2004-02 and HMPR-116-2005-01 (NMSP-06-07)

A Pilot Study of Hogfish (*Lachnolaimus maximus* Walbaum 1792) Movement in the Conch Reef Research Only Area (Northern Florida Keys) (NMSP-06-06)

Comments on Hydrographic and Topographic LIDAR Acquisition and Merging with Multibeam Sounding Data Acquired in the Olympic Coast National Marine Sanctuary (ONMS-06-05)

Conservation Science in NOAA's National Marine Sanctuaries: Description and Recent Accomplishments (ONMS-06-04)

Normalization and characterization of multibeam backscatter: Koitlah Point to Point of the Arches, Olympic Coast National Marine Sanctuary - Survey HMPR-115-2004-03 (ONMS-06-03)

Developing Alternatives for Optimal Representation of Seafloor Habitats and Associated Communities in Stellwagen Bank National Marine Sanctuary (ONMS-06-02)

Benthic Habitat Mapping in the Olympic Coast National Marine Sanctuary (ONMS-06-01)

Channel Islands Deep Water Monitoring Plan Development Workshop Report (ONMS-05-05)

Movement of yellowtail snapper (*Ocyurus chrysurus* Block 1790) and black grouper (*Mycteroperca bonaci* Poey 1860) in the northern Florida Keys National Marine Sanctuary as determined by acoustic telemetry (MSD-05-4)

The Impacts of Coastal Protection Structures in California's Monterey Bay National Marine Sanctuary (MSD-05-3)

An annotated bibliography of diet studies of fish of the southeast United States and Gray's Reef National Marine Sanctuary (MSD-05-2)

Noise Levels and Sources in the Stellwagen Bank National Marine Sanctuary and the St. Lawrence River Estuary (MSD-05-1)

Biogeographic Analysis of the Tortugas Ecological Reserve (MSD-04-1)

A Review of the Ecological Effectiveness of Subtidal Marine Reserves in Central California (MSD-04-2, MSD-04-3)

Pre-Construction Coral Survey of the M/V Wellwood Grounding Site (MSD-03-1)

Olympic Coast National Marine Sanctuary: Proceedings of the 1998 Research Workshop, Seattle, Washington (MSD-01-04)

Workshop on Marine Mammal Research & Monitoring in the National Marine Sanctuaries (MSD-01-03)

A Review of Marine Zones in the Monterey Bay National Marine Sanctuary (MSD-01-2)

Distribution and Sighting Frequency of Reef Fishes in the Florida Keys National Marine Sanctuary (MSD-01-1)

Flower Garden Banks National Marine Sanctuary: A Rapid Assessment of Coral, Fish, and Algae Using the AGRRA Protocol (MSD-00-3)

The Economic Contribution of Whalewatching to Regional Economies: Perspectives From Two National Marine Sanctuaries (MSD-00-2)

Olympic Coast National Marine Sanctuary Area to be Avoided Education and Monitoring Program (MSD-00-1)

Multi-species and Multi-interest Management: an Ecosystem Approach to Market Squid (*Loligo opalescens*) Harvest in California (MSD-99-1)