Climate Change & Commercial Fisheries in Gloucester, MA

Gulf of Maine Research Institute

INTRODUCTION

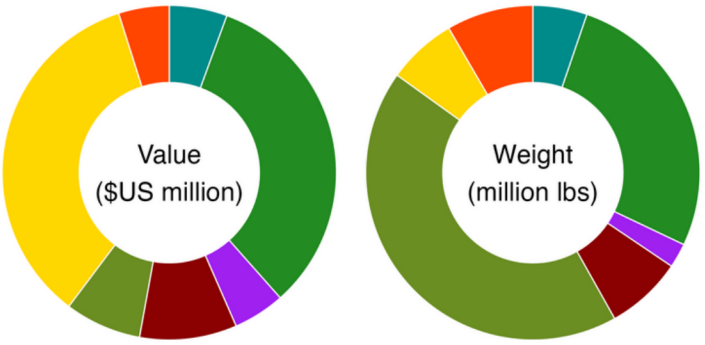
Climate change is altering the physical and chemical characteristics of our ocean and affecting marine ecosystems and fisheries. As environmental conditions continue to change, fishing communities may be affected by changes in the distribution and availability of species. This report summarizes the current status of fisheries in Gloucester and shares information on changes in harvested species that may occur in the future. Used alongside the Climate Adaptation Resource Hub for Fishing Communities, this report provides information for understanding potential impacts on a fishing community, which can be used to consider ways to adapt to a changing climate.

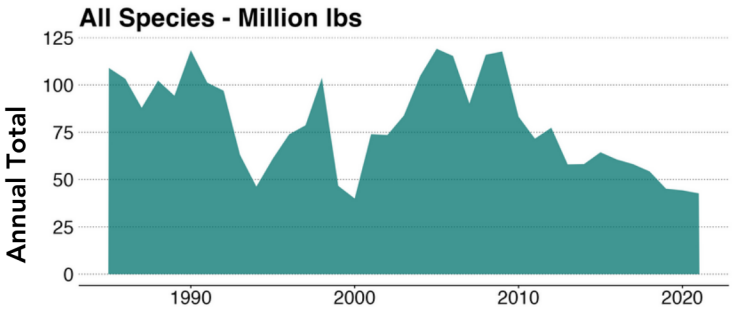
WHAT IS LANDED HERE?

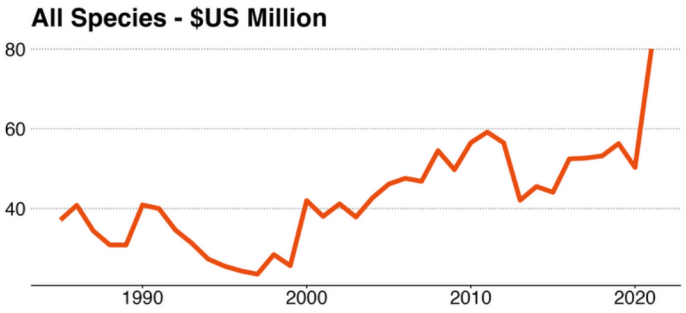
Commercial fisheries in Gloucester landed an annual average of 56 million pounds of finfish and shellfish, valued at $53 million per year, from 2012-2021.* During these years, American lobster represented a large portion of the landed value in the port, averaging $18.6 million in value and 3.7 million pounds in volume per year. Herring represented the dominant species landed by volume, with an average of 24.2 million pounds being landed per year, valued on average at $3.9 million per year. Other important species include haddock, pollock, monkfish and Acadian redfish. The volume of commercial landings in Gloucester has varied substantially over time, showing volatility during several years in the 1990s and steady declines since the late 2000s. In contrast, the value of commercial fishery landings in Gloucester has generally increased since the late 1990s.

Species	Annual Average Value	Annual Average Volume
American lobster	$18,574,817	3,773,766 lbs
Haddock	$5,014,851	4,180,799 lbs
Atlantic herring	$3,947,764	24,245,238 lbs
Pollock	$2,984,801	2,954,251 lbs
Monkfish	$2,668,509	1,331,392 lbs
Acadian redfish	$2,612,654	4,725,947 lbs
Other	$17,515,525	15,110,200 lbs

Above are the annual average value and volume for the top species landed at this port in each year from 2012-2021.







*Landings data were provided by NOAA Fisheries' Greater Atlantic Regional Fisheries Office. Due to confidentiality restrictions, some data may not be fully representative of the historical landings at a given location.

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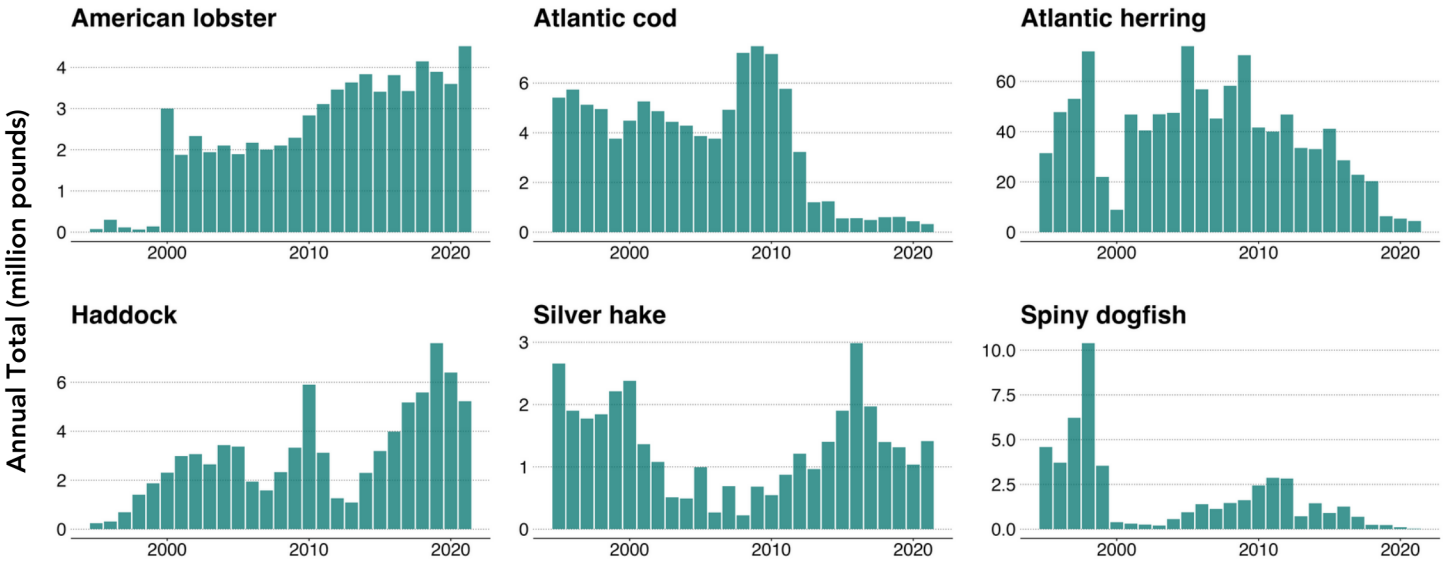
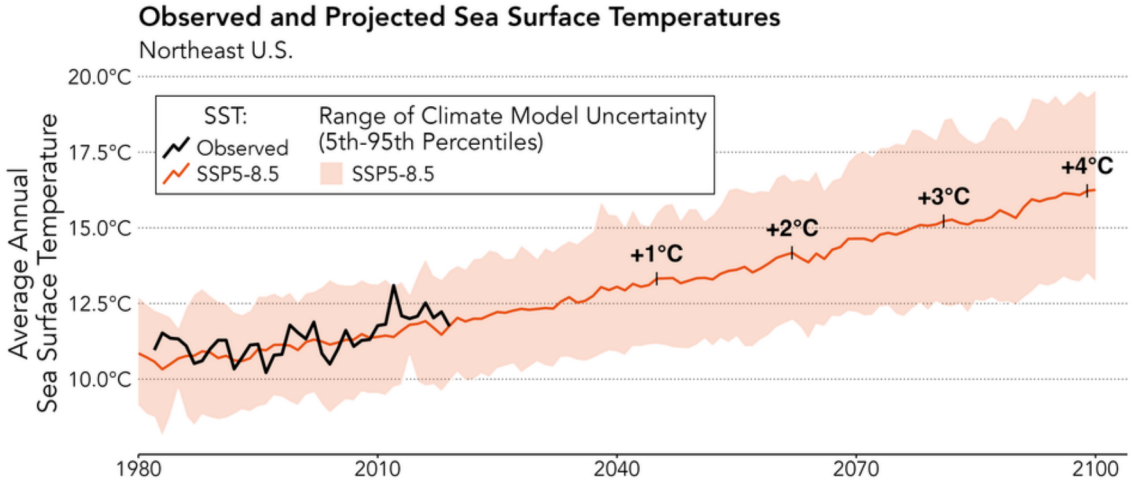
LANDINGS OVER TIME

Landings of cod, a historical mainstay for the port, declined significantly during the 2010s. Haddock landings spiked during 2010, with lower landings in surrounding years, and a recent increase since the mid-2010s. Silver hake landings declined substantially during the 2000s before increasing through the 2010s. Lobster landings increased through the 2000s and remained relatively stable at around 3.5 million pounds per year during the 2010s. Despite a few low years, herring landings were relatively high from 1995 - 2010 but have been declining since. Spiny dogfish landings were high in the late 1990s, but they declined substantially in the 2000s and remain at low levels.



OUR CHANGING CLIMATE AND WARMING WATERS

Greenhouse gas emissions around the world are a primary contributor to the warming the planet has been experiencing over the past century. This warming affects the health and distribution of species that support fisheries in coastal communities. Scientists around the world use a common set of scenarios to project climate impacts into the future. These scenarios represent multiple global social and economic development patterns paired with different levels of greenhouse gases in Earth's atmosphere. The scenario representing the largest build-up of greenhouse gases, labeled SSP5-8.5, indicates global average temperatures will warm by approximately 4°C (7°F) above pre-industrial levels by the end of this century. We use this scenario to understand how species may respond to changes in ocean temperatures in the Northeast U.S. relative to those experienced during 2010-2019. These species projections allow us to explore different potential futures of fisheries and support decisions now that can buffer the severity of future climate change impacts on fishing communities.



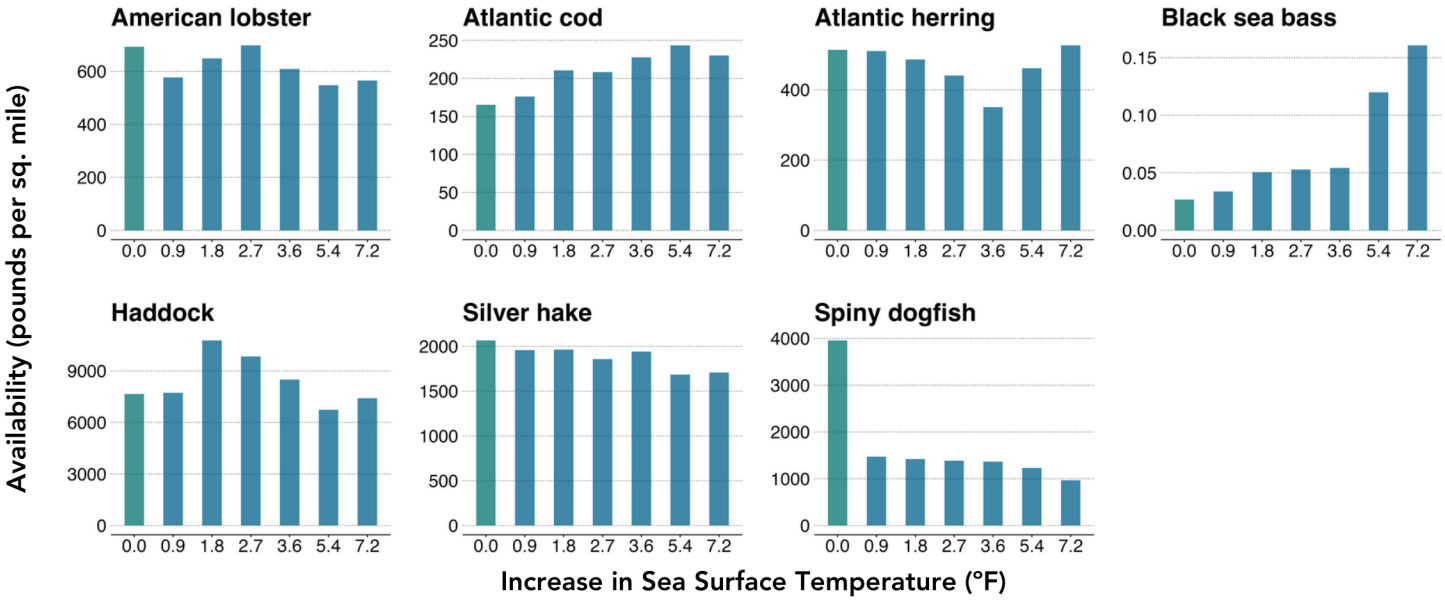
Temperature Crossing Points

Based on SSP5-8.5 Climate Projections

Celsius	Fahrenheit	As soon as
0.5°C	0.9°F	2034
1.0°C	1.8°F	2045
1.5°C	2.7°F	2056
2.0°C	3.6°F	2062
3.0°C	5.4°F	2081
4.0°C	7.2°F	2099

FUTURE CHANGES IN AVAILABILITY

As the abundance and distribution of certain species changes with warming waters, communities may need to respond to ensure the continuity of the fishing industry. By combining historical species observations with future climate information, we can estimate how the availability of certain species may change, and what new opportunities may emerge. Availability is given here as the total estimated weight of a particular species of fish in a given area, as modeled from bottom trawl survey data. Warming ocean temperatures may affect the availability of some commercial species in the waters near Gloucester. Atlantic cod and black sea bass may increase with increasing ocean temperatures. Lobster, herring, haddock, and silver hake may vary with different levels of warming, while spiny dogfish is projected to experience declines at all levels of warming.



EMERGING OPPORTUNITIES AND ADAPTATION OPTIONS

Harvesting emerging species and diversifying catch are some ways individual harvesters can adapt to changing fisheries. In the table below, we outline other potential adaptation options spanning the different scales of the fishery system. As the climate continues to change, new impacts will take shape, requiring re-evaluation and revision of goals in order to respond to climate change. For more information on adaptation options in fishing communities, please visit the Climate Adaptation Resource Hub for Fishing Communities.

Individual Harvester Actions	Industry Actions
• Shifting fishing locations • Shifting harvested species • Diversifying livelihood (alternative fisheries, aquaculture, non-fishing jobs)	• Improving product handling • Developing supply chain capacity • Diversifying markets and building consumer demand
Management Measures	**Community Initiatives**
• Reassessing quota allocations • Altering permit access and availability • Developing adaptive reference points • Applying dynamic and ecosystem-based management	• Maintaining and securing shoreside infrastructure • Improving transportation networks • Developing local seafood initiatives • Conducting vulnerability and resilience assessments • Using early warning monitoring • Community adaptation and resilience planning

Projected Changes in Species Availability in Gloucester

Values represent percent change in modeled species availability at potential levels of warming relative to *2010-2019* baseline conditions.
Species in gray had low availability *(<5 lbs/sq. mile)* during the baseline period.

	Increase in Sea Surface Temperature			
Species	0.9°F	1.8°F	3.6°F	5.4°F
Acadian redfish	−7.3%	−9.5%	−37.5%	−52.5%
American lobster	−16.7%	−6.3%	−12.0%	−20.9%
American plaice	−5.2%	−4.5%	−14.0%	−16.2%
Atlantic cod	6.6%	27.4%	37.7%	47.4%
Atlantic halibut	7.6%	0.9%	−4.1%	−13.1%
Atlantic herring	−0.6%	−5.3%	−31.7%	−10.1%
Atlantic mackerel	23.9%	46.3%	74.7%	57.2%
Black sea bass	26.4%	88.9%	102.5%	348.1%
Butterfish	−5.5%	5.3%	31.7%	37.9%
Deep sea red crab	−13.7%	−8.8%	−30.3%	−22.4%
Haddock	1.1%	40.8%	11.0%	−11.9%
Hagfish	36.4%	74.4%	51.2%	29.2%
Jonah crab	12.4%	−14.7%	−10.5%	−40.7%
Little skate	−18.1%	−21.1%	−18.6%	−11.7%
Longfin squid	15.7%	39.4%	−36.6%	160.9%
Monkfish	−5.3%	−9.7%	−19.6%	−32.0%
Ocean quahog clam	−30.7%	−2.0%	28.4%	−52.4%
Pollock	−23.3%	−13.6%	−19.6%	−35.4%
Red hake	30.2%	14.0%	9.6%	−2.0%
Rock crab	63.3%	75.5%	79.4%	148.7%
Sand lance	−56.1%	−67.4%	−70.3%	−71.1%
Scup	−6.8%	28.2%	75.5%	241.1%
Sea scallop	15.5%	−1.2%	−0.5%	−32.2%
Shortfin squid	−41.1%	−12.9%	−15.5%	4.5%
Silver hake	−5.3%	−5.0%	−6.0%	−18.5%
Smooth skate	−21.0%	−25.5%	−22.7%	−19.8%
Spiny dogfish	−62.8%	−64.1%	−65.5%	−68.9%
Summer flounder	19.8%	53.4%	81.9%	172.0%
Thorny skate	−14.0%	−10.0%	−16.5%	−27.0%
White hake	−24.3%	−17.9%	3.3%	−7.7%
Windowpane	22.8%	43.7%	40.6%	60.1%
Winter flounder	6.7%	10.8%	17.3%	7.9%
Winter skate	−21.7%	−18.0%	−9.8%	−4.3%
Witch flounder	−6.9%	−26.9%	−33.9%	−33.5%
Yellowtail flounder	−22.7%	−25.0%	−35.7%	−32.5%

MAKING SENSE OF CLIMATE PROJECTIONS AND SPECIES DISTRIBUTION MODELS

The species results shown here were developed using a spatio-temporal species distribution model, which can estimate the current and future distribution of marine species through time and space. The model uses projected regional sea surface and bottom temperature data from the globally coordinated Coupled Model Intercomparison Project (CMIP6) and species data from bottom trawl surveys conducted by the Northeast Fisheries Science Center and the Department of Fisheries and Oceans. Estimated species biomass densities are then averaged over an area fished by vessels from the port of interest. This enables us to interpret local changes in availability of a species at a specific time or temperature.

LEARN MORE

For more information regarding climate change, species distribution change, fisheries adaptation options, and adaptation barriers and enablers, please visit:

gmri.org/adaptationhub

ASK QUESTIONS

For specific questions regarding your community, contact Kathy Mills at:

kmills@gmri.org

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Science. Education. Community.