PROGRESS REPORT

State: **NEW HAMPSHIRE** **Grant:** **F-61-R-22/F19AF00061**

Grant Title: **NEW HAMPSHIRE'S MARINE FISHERIES INVESTIGATIONS**

Project III: **MULTI-SPECIES EVALUATION**

Job 1: **INSHORE TRAWL SURVEY**

Objective: To conduct a long-term fisheries independent monitoring program in the nearshore waters (5–60 fathoms) of New Hampshire and Maine.

Period Covered: January 1, 2019 – December 31, 2019

ABSTRACT

New Hampshire Fish and Game Department and Maine Department of Marine Resources have been cooperatively conducting a trawl survey since the fall of 2000 in the inshore area of the New Hampshire and Maine coastlines. Two virtually identical commercial vessels are contracted to conduct the survey using a modified design of a shrimp net used in Gulf of Maine waters. The survey has a stratified random design with five area and four depth strata. Surveys are conducted every spring and fall with a target of sampling 120 stations during each survey. The Department provides scientific staff when the survey is sampling the Region 1 strata off New Hampshire and southern Maine.

One hundred and twenty stations were sampled in the 2019 spring survey and 99 stations were sampled during the fall. Fifty taxa were encountered during the spring survey in region 1 with Atlantic Herring *Clupea harengus*, Blueback Herring *Alosa aestivalis*, *and* Alewife *Alosa pseudoharengus* being the most abundant finfish by number. Results from the fall survey indicate 55 taxa were encountered with Silver Hake *Merluccius bilinearis*, Atlantic Herring, and Red Hake *Urophycis chuss* being the most abundant finfish by number.

The value of this survey is demonstrated by the request for data received from scientists conducting stock assessments for Atlantic Herring,

American Shad *Alosa sapidissima*, Haddock *Melanogrammus aeglefinus*, and Goosefish *Lophius americanus*.

INTRODUCTION

Declines in abundance of groundfish in the Gulf of Maine have resulted in regulatory restrictions being placed on recreational anglers as well as the for-hire and commercial industries. The lack of fishery-independent survey data from historically important spawning and nursery grounds (Rich 1929; Collette and Klein-MacPhee 2002) in the nearshore waters of the Gulf of Maine has led to substantial gaps in information needed to assess current stock conditions of demersal finfish species for development of effective management strategies.

Fishery-independent trawl surveys are a well-established and accepted method of developing relative abundance indices for fishery resources (Gosslein 1969). They reflect changes in true abundances of fish populations whereas recreational and commercial fishing practices change in response to fish availability, regulations, and fishing power as technological improvements in fish detection equipment and harvest gear are made. Abundance indices derived from research trawl surveys that maintain consistent and standardized efforts are largely free of these biases. Trawl surveys are synoptic investigations that provide comprehensive information on distribution and abundance of all types and sizes of organisms within towable survey areas. Knowledge of distribution and abundance of juvenile fish is critical to the study of recruitment and useful for predicting future abundance. Information about population sizes, instantaneous recruitment and mortality rates, and distributions are essential for effective management of any resource. Such knowledge is critical to understanding both the dynamics and the condition of that resource.

Surveying the inshore waters of Maine (ME) and New Hampshire (NH) has been a long-standing challenge. The rough terrain that characterizes the bottom of the nearshore areas of northern Gulf of Maine along with the great quantity of fixed gear in inshore waters limits the number of tows that can be made. While bottom trawl surveys have been conducted in the Gulf of Maine for many years by the National Marine Fisheries Service primarily in offshore waters and by the Massachusetts Division of Marine Fisheries in their nearshore waters, only sporadic trawl survey data have been collected in nearshore waters of NH and ME (Nelson et al. 1983; Langton et al. 1994).

To fill this information gap, personnel from the NH Fish and Game Department (NHFG) and the ME Department of Marine Resources (MEDMR) collaborated to design and implement a cooperative inshore trawl survey of the nearshore waters of the Gulf of Maine from the NH and Massachusetts state line north to the Canadian border. The first survey took place in the fall of 2000 and has continued every spring and fall with funding provided to MEDMR by the Northeast Consortium and the National Marine Fisheries Service.

PROCEDURES

The Maine/New Hampshire (ME-NH) inshore trawl survey is conducted during the spring and fall using commercial vessels contracted by MEDMR. The two vessels used, the FV *Tara Lynn* and FV *Robert Michael*, are virtually identical 16.50 m Down East vessels with hull displacements of 74 metric tons. The trawl net used is a modified design of the shrimp net used in Gulf of Maine waters and fishes effectively for a variety of near-bottom dwelling species, not targeting any specific component. The net has a 21.35 m rope and 17.38 m head rope and a mesh size of 6.35 cm in the front end, 5.08 cm in the belly and a 1.27 cm mesh codend liner.

The survey is a stratified random design encompassing five regions along the coast based on oceanographic, geologic, and biological features with four different depth strata (5–20 fathoms, 21–35 fathoms, 36–55 fathoms, and greater than 56 fathoms with an outer boundary roughly delineated by the 12-mile limit) (Figure 3.1–1). The survey design has 125 fixed stations with a target of sampling at least 120 stations, which results in a tow density of one tow every 40 square nautical miles. Approximately 25 stations occur in the NH and southern ME region. Standard 20-minute tow durations are conducted at each station.

Historically, about one-third of the tows were fixed stations and the remaining two-thirds were randomly selected stations. Following recommendations of a peer review of the survey methodologies in August 2005, the total number of fixed stations was reduced to only 20 per survey. Fixed stations were removed entirely from the survey in 2015, resulting in all tow sites being selected at random.

Before the onset of each survey, advisors consisting of local commercial otter trawl harvesters and commercial lobster harvesters are consulted to determine if the randomly chosen stations have towable bottom or will result in gear conflicts. If the selected station is not towable,

another station is randomly selected. All tows were conducted during daylight hours.

The catch is sorted by species and total weights for each species are recorded. Individuals of each finfish species (or a subsample) are counted and measured centerline total length to the nearest centimeter with the exception of species with heterocercal caudal fins such as sturgeons *Acipenser* spp. and Spiny Dogfish *Squalus acanthias*. Spiny Dogfish and all sturgeon are measured to the terminus of the upper caudal lobe. Additional biological data such as hard parts for aging, gonads for fecundity, stomachs for trophic analyses, and determining gonad stages (using the methods described in Burnett et al. 1989) are collected on an as needed basis and time permitting. Care is taken to immediately separate, measure, weigh, and release alive all marine specimens. Environmental data including ocean temperature and salinity profiles, air temperature, wind, sea state, tide, and weather are collected at each station.

Department participation in this survey includes the following tasks. Providing up to two scientists to work onboard the survey vessel when the survey is conducted off NH and southern ME waters (Region 1). In addition, a mass mailing is sent out to all NH licensed fixed gear harvesters (e.g., lobster trap, gillnet, etc.) before each survey notifying of the station locations, survey dates, and requesting that gear be temporarily moved if it is located at a station. Also, the mailing is used as an outreach opportunity to disseminate survey results and gain feedback on the survey from harvesters. Lastly, NHFG provides time for coordination and administration of this program. Sport Fish Restoration Funds are used for the tasks outlined for NHFG participation in the survey as MEDMR has secured other funding sources to pay for vessel costs, data analysis, and personnel costs for the survey.

RESULTS

In 2019, the survey was conducted during the spring from April 29 to May 31 and in the fall from September 23 to October 25 using the commercial vessels contracted by MEDMR. Due to various problems such as fixed gear interaction, untowable bottom, weather, and time constraints, not all stations were sampled. During the spring survey 120 stations were sampled, while in the fall survey 99 stations were sampled. In Region 1, 23 of 25 stations selected were sampled in both the spring and fall.

Fifty taxa were encountered in Region 1 of the spring survey. Finfish catches were dominated by Atlantic Herring *Clupea harengus*, Silver Hake *Merluccius bilinearis*, and Blueback Herring *Alosa aestivalis* by weight and Atlantic Herring, Blueback Herring, and Alewife *Alosa pseudoharengus* being the most abundant by number (Table 3.1-1). The fall survey in Region 1 encountered 55 taxa with Spiny Dogfish, Silver Hake, and Red Hake *Urophycis chuss* being the most abundant species by weight and Silver Hake, Atlantic Herring, and Red Hake by number (Table 3.1-2).

The mean number per tow for selected species of interest in Region 1 is shown in Figures 3.1-2 through 3.1-5, while Figures 3.1-6 through 3.1-9 show length frequencies for selected species.

DISCUSSION

The ME and NH Inshore Trawl Survey was first conducted in the fall of 2000 and has continued annually each spring and fall. With over 19 years of surveys, the time series of data is providing usable results. Since 2012, the fall survey has begun a week earlier than in previous years to minimize the impact of bad weather. To obtain better success rates in the fall survey, the same stations towed during the spring survey were towed during the fall survey. These factors contributed to the high completion rate, along with the outreach efforts of MEDMR to the fixed gear fishing community praised in the 2005 peer review of the survey (Chouinard et al. 2005).

The survey has filled a gap in resource monitoring that has existed in the Gulf of Maine. The National Marine Fisheries Service's Northeast Fisheries Science Center has conducted an offshore bottom trawl survey in the Gulf of Maine waters since the 1960's and the Massachusetts Division of Marine Fisheries has surveyed their inshore waters since 1979. This and other inshore surveys tend to sample more of the juvenile or pre-recruit portion of certain fish populations such as Atlantic Cod *Gadus morhua*, White Hake *Urophycis tenuis*, Haddock *Melanogrammus aeglefinus*, and Goosefish *Lophius americanus* (Sherman et al. 2004). To achieve a better representation of the total population size, both surveys should be utilized in future assessments.

The value of this survey has been demonstrated by the data requests for use in the Atlantic Herring, American Shad *Alosa sapidissima*, Haddock, and Goosefish stock assessments.

Haddock while showing an overall decreasing trend early in the time series, displayed an increasing mean number per tow since 2010, with a time

series high in 2018, followed by a sharp decline in 2019 (Figure 3.1–3). Atlantic Cod have shown near time series lows from 2011 to 2019 (Figure 3.1–2). Atlantic Herring and Winter Flounder *Pseudopleuronectes americanus* have shown an overall decreasing trend since 2013 and 2014 respectively, with substantial increases in 2019 (Figures 3.1–4 and 3.1–5).

Length frequency information from the spring survey shows that fish captured are primarily juvenile fish according to length at age and sexual maturity characteristics for each species described in Collette and Klein-MacPhee (2002). Two notable exceptions are the Haddock captured during the spring surveys beginning in 2016, and Atlantic Cod captured during the spring survey in 2017, both displayed length frequencies representative of sexually mature fish in the Gulf of Maine (Figures 3.1–6 to 3.1–9).

In conclusion, the survey has been conducted every spring and fall since the fall of 2000. One hundred and twenty stations were sampled during the spring survey, and 99 stations were sampled in the fall of 2019. Fifty taxa were encountered in the spring survey and 55 in the fall. The most abundant fish by number in the spring and fall surveys were Atlantic Herring, Silver Hake, Blueback Herring, Alewife, and Red Hake. Length frequency information of selected species show that primarily juvenile fish are captured in the survey, although mature Haddock and Atlantic cod have been represented in recent sample years. The survey continues to fill a gap in resource monitoring, and has been valuable in stock assessments for several marine species.

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Table 3.1-1. Mean weight and number per tow of marine species captured in the ME–NH Inshore Trawl Survey in Region 1 (NH and southern ME), Spring 2019.

	Region 1 (NH to Cape Elizabeth)- Spring 2019									
	Stratum 1 5-20 fathoms		Stratum 2 21-35 fathoms		Stratum 3 36-55 fathoms		Stratum 4 56-80+ fathoms		Region 1 all strata	
Species	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow
Acadian Redfish	0.01	0.17	0.41	15.35	0.06	2.00			0.12	4.48
Alewife	3.82	224.89	1.48	127.64	13.35	692.60	12.90	382.00	7.65	342.18
Alligatorfish			0.02	6.51					0.00	1.70
American lobster	10.65	38.26	60.46	246.53	30.19	132.60	6.81	15.00	26.89	107.03
American Plaice	0.00	0.22	0.32	6.41	3.08	41.40	4.24	25.83	1.86	17.47
American Shad	0.10	3.00	0.06	1.67	0.57	12.80	0.18	2.17	0.21	4.57
Atlantic Cod	0.01	0.42	0.24	0.69					0.06	0.29
Atlantic Halibut	0.01	0.17							0.00	0.04
Atlantic Herring	30.23	709.81	31.52	1,229.57	87.65	1,972.20	1.35	15.50	35.52	938.71
Atlantic Mackerel			0.03	0.56	0.15	1.80	0.01	0.33	0.04	0.62
Blood star			0.00	1.58					0.00	0.41
Blueback Herring	6.94	421.33	7.59	471.69	22.26	1,010.00	2.89	78.83	9.38	473.09
Bobtail squid							0.01	0.50	0.00	0.13
Brittle/baskets stars			0.04	0.19					0.01	0.05
Crangon shrimp	0.00	0.67							0.00	0.17
Cunner			0.30	3.65					0.08	0.95
Dichelo shrimp	0.01	7.83	0.11	70.00	0.63	378.00	0.57	521.50	0.32	238.52
Fourspot Flounder			0.11	0.39			0.03	0.33	0.03	0.19
Haddock					1.08	1.60	27.25	36.17	7.34	9.78
Jonah crab							0.12	0.50	0.03	0.13
Little Skate			0.33	0.50	0.64	1.00	0.17	0.17	0.27	0.39
Longhorn Sculpin	1.82	9.75	9.70	89.81	2.42	20.40	0.20	1.50	3.58	30.80
Monkfish			0.70	0.71			0.25	0.83	0.25	0.40
Montagui shrimp					0.00	0.40	0.16	66.50	0.04	17.43
Moon snail	0.02	0.17							0.01	0.04
Northern shrimp					0.04	4.20	11.61	1,610.17	3.04	420.96
Ocean Pout			0.13	3.23			0.09	0.83	0.06	1.06
Pollock			0.01	0.17					0.00	0.04
Radiated Shanny			0.00	0.19					0.00	0.05
Rainbow Smelt	0.03	11.67							0.01	3.04
Red crab							0.02	0.17	0.01	0.04
Red Hake	0.01	0.50	0.27	7.80	0.20	7.40	1.92	23.33	0.62	9.86
Rock crab	0.06	0.33	0.06	0.21					0.03	0.14
Sand dollar unclass.	0.03	5.58			0.00	0.20			0.01	1.50
Sculptured shrimp					0.00	0.20			0.00	0.04
Sea anemone			0.00	0.22			0.00	0.33	0.00	0.14
Sea Raven			0.11	0.77					0.03	0.20
Sea scallop	0.01	0.33	0.06	13.00			0.05	1.00	0.03	3.74
Sea sponges			0.02	*					0.00	*
Sea urchin	0.00	0.17							0.00	0.04
Shortfin squid							0.00	0.17	0.00	0.04
Silver Hake	0.04	2.17	0.35	15.72	4.20	158.80	33.89	778.50	9.86	242.27
Thorny Skate					0.33	0.20	1.83	1.00	0.55	0.30
Toad crab	0.00	0.17	0.00	0.17	0.00	0.20			0.00	0.13
Waved astarte							0.00	0.50	0.00	0.13
White Hake			0.02	0.21	0.06	1.00	0.23	2.00	0.08	0.79
Windowpane	0.37	0.21							0.10	0.05
Winter Flounder	0.89	11.96	3.73	55.89	2.12	18.40	0.05	0.67	1.68	21.87
Witch Flounder					0.02	0.60	0.63	9.50	0.17	2.61
Yellowtail Flounder			1.06	6.72	2.11	14.40	0.51	3.67	0.87	5.84

*Species were weighed but not counted during sampling.

Table 3.1-2. Mean weight and number per tow of marine species captured in the ME–NH Inshore Trawl Survey in Region 1, Fall 2019

	Region 1 (NH to Cape Elizabeth)- Fall 2019									
	Stratum 1 5-20 fathoms		Stratum 2 21-35 fathoms		Stratum 3 36-55 fathoms		Stratum 4 56-80+ fathoms		Region 1 all strata	
Species	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow	kg/tow	#/tow
Acadian Redfish	0.02	0.85	0.86	24.78	0.04	3.23	1.21	13.57	0.52	9.99
Alewife	0.16	1.61	9.24	96.18	16.00	108.74	5.08	27.45	7.55	56.85
Alligatorfish			0.00	0.21					0.00	0.05
American lobster	78.06	348.31	57.10	245.28	39.74	143.27	0.54	2.07	43.28	182.10
American Plaice			0.52	4.82	2.68	45.20	6.50	70.36	2.51	31.19
American Shad	0.04	0.50	0.81	5.80	3.47	17.84	0.39	0.86	1.19	6.27
Atlantic Cod	0.00	0.17			0.74	0.50	0.00	0.17	0.19	0.22
Atlantic Halibut	0.63	1.00							0.16	0.26
Atlantic Herring	2.14	130.89	5.69	414.82	0.22	1.19	0.26	1.84	1.92	125.12
Atlantic Mackerel	3.45	28.41	0.65	3.79	0.08	0.51			1.06	8.37
Atlantic Menhaden			0.15	0.40					0.03	0.09
Atlantic Moonfish	0.00	0.17	0.00	1.87			0.00	0.17	0.00	0.49
Barndoor Skate					1.63	0.17	0.62	0.17	0.59	0.09
Blood star			0.00	0.21					0.00	0.05
Blue mussel			0.02	0.63					0.00	0.14
Blueback Herring	0.05	0.69	0.31	2.41	1.61	10.41	0.13	0.84	0.54	3.64
Butterfish	0.43	8.04	0.41	4.40	0.35	5.27	0.30	2.54	0.37	5.09
Crangon shrimp	0.01	2.83							0.00	0.74
Cunner	0.28	6.17	0.54	9.92	0.08	0.53			0.21	3.90
Dichelo shrimp	0.00	0.56	0.18	109.61	1.49	752.97	1.10	454.44	0.72	338.95
Fourbeard Rockling			0.01	0.20	0.01	0.33	0.05	1.01	0.02	0.39
Fourspot Flounder			0.09	1.40	0.57	2.85			0.17	1.05
Haddock	0.05	3.67	0.01	1.68	5.01	7.00	24.12	28.09	7.61	10.47
Jonah crab	0.00	0.17	0.76	4.09	0.48	3.19	0.29	2.04	0.37	2.30
Little Skate	0.62	0.68	0.24	0.40					0.21	0.26
Longfin squid	0.17	11.76	0.31	57.74	0.28	35.23	0.08	10.17	0.21	27.46
Longhorn Sculpin	1.05	8.15	5.95	55.39	0.62	4.17	0.02	0.17	1.74	15.30
Lumpfish			0.33	1.82	0.27	1.00	0.07	0.17	0.16	0.70
Mantis shrimp			0.00	0.27					0.00	0.06
Monkfish	0.06	0.54	0.47	1.80	4.24	3.75	5.48	4.54	2.65	2.69
Montagui shrimp					0.00	0.18			0.00	0.05
Northern shrimp					0.14	19.78	0.61	61.72	0.19	21.26
Ocean Pout	0.01	0.17	0.05	1.35			0.05	0.17	0.03	0.38
Pollock							0.58	0.50	0.15	0.13
Red Hake	0.20	3.96	2.50	44.06	6.59	42.15	31.84	182.26	10.62	69.15
Rock crab	0.08	1.33			0.00	0.17			0.02	0.39
Sea anemone			0.01	1.07			0.21	1.18	0.06	0.54
Sea Raven	0.16	0.33	0.54	1.05					0.16	0.32
Sea scallop	0.01	1.83	0.04	5.42			0.04	0.84	0.02	1.88
Sea sponges			0.02	0.53					0.00	0.12
Shortfin squid	0.06	0.83	0.75	4.74	1.02	5.54	3.02	16.56	1.23	7.01
Shrimp unclass.			0.00	0.20					0.00	0.04
Silver Hake	3.61	54.35	9.73	169.12	43.53	1,018.56	83.54	1,047.92	36.20	590.03
Smooth Skate					0.00	0.17			0.00	0.04
Spiny Dogfish							158.17	118.04	41.26	30.79
Spoonarm octopus							0.01	0.85	0.00	0.22
Spotted Hake	0.01	0.19							0.00	0.05
Thorny Skate							5.00	1.33	1.31	0.35
Toad crab	0.00	0.17	0.00	1.03					0.00	0.27
Waved astarte							0.00	0.17	0.00	0.04
White Hake	0.39	3.31	1.59	15.40	5.86	35.82	8.80	8.94	4.27	15.89
Windowpane	0.10	0.34							0.03	0.09
Winter Flounder	3.22	34.28	3.05	25.39	0.95	2.95			1.75	15.23
Witch Flounder			0.07	1.20	0.61	8.17	8.58	52.84	2.41	16.18
Yellowtail Flounder	0.29	2.37	2.62	13.93	3.59	16.78			1.58	8.02

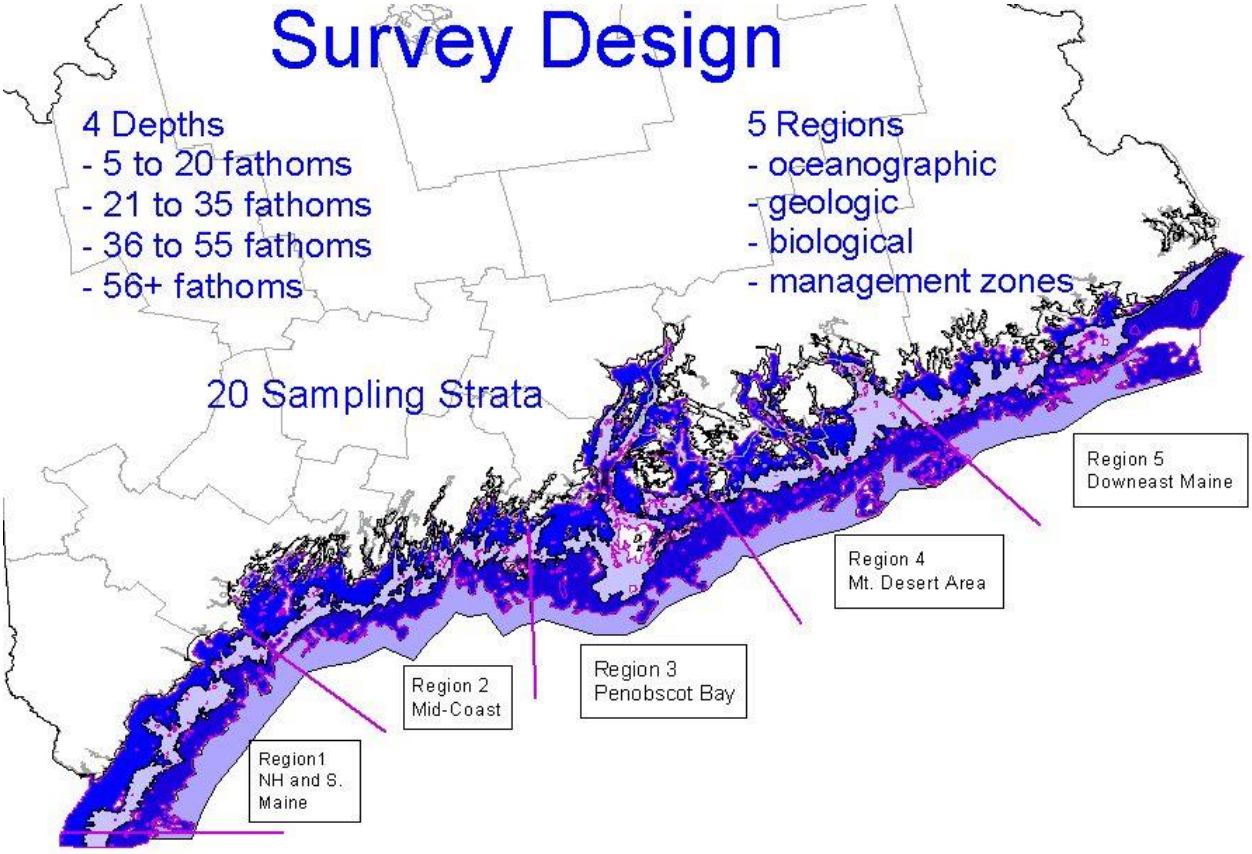

Figure 3.1-1. Sampling strata for ME–NH Inshore Trawl Survey.

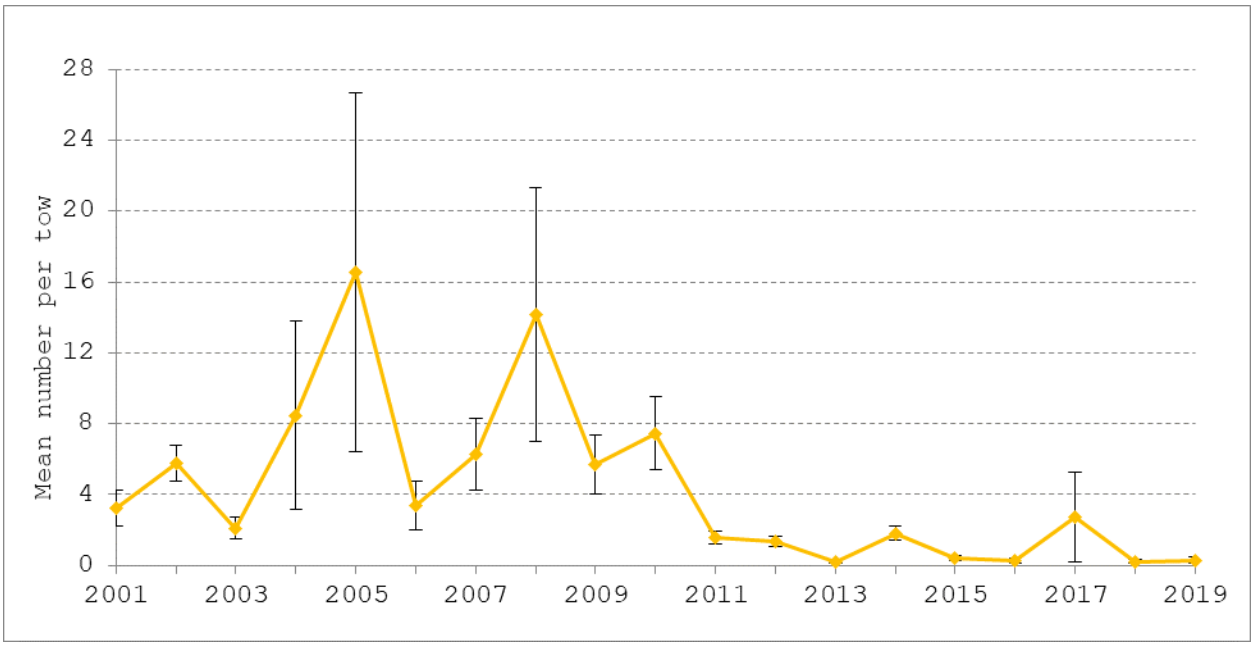

Figure 3.1-2. Mean number per tow of Atlantic Cod from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2001–2019.

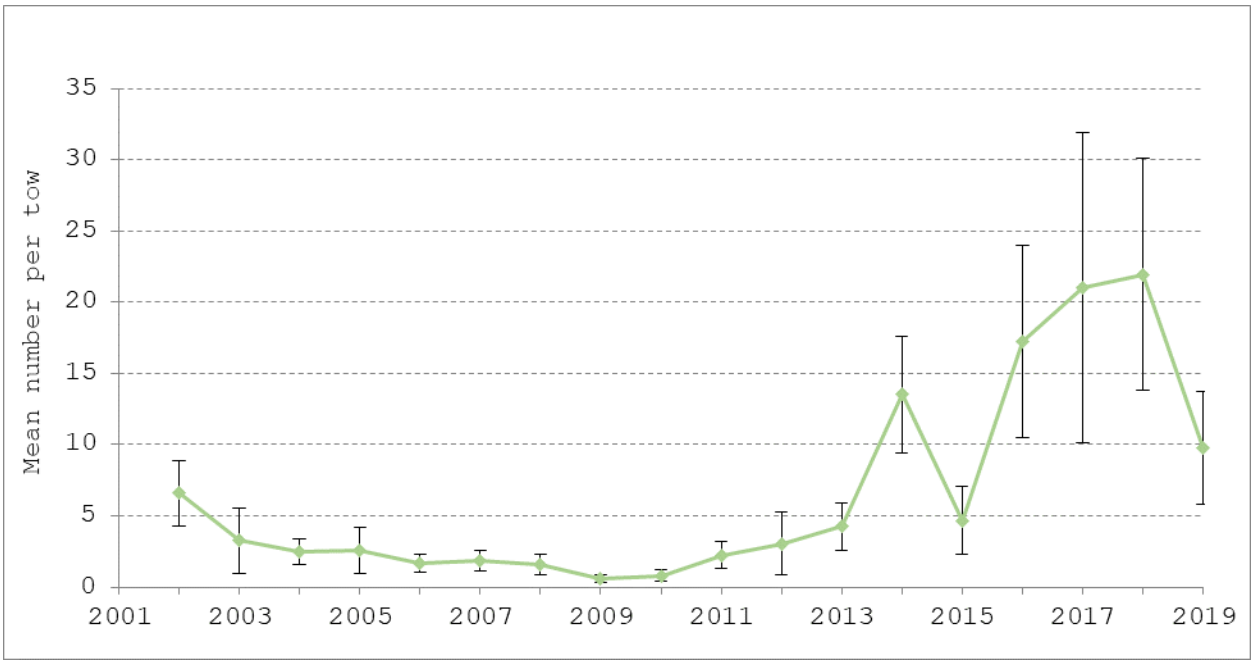

Figure 3.1-3. Mean number per tow of Haddock from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2001–2019.

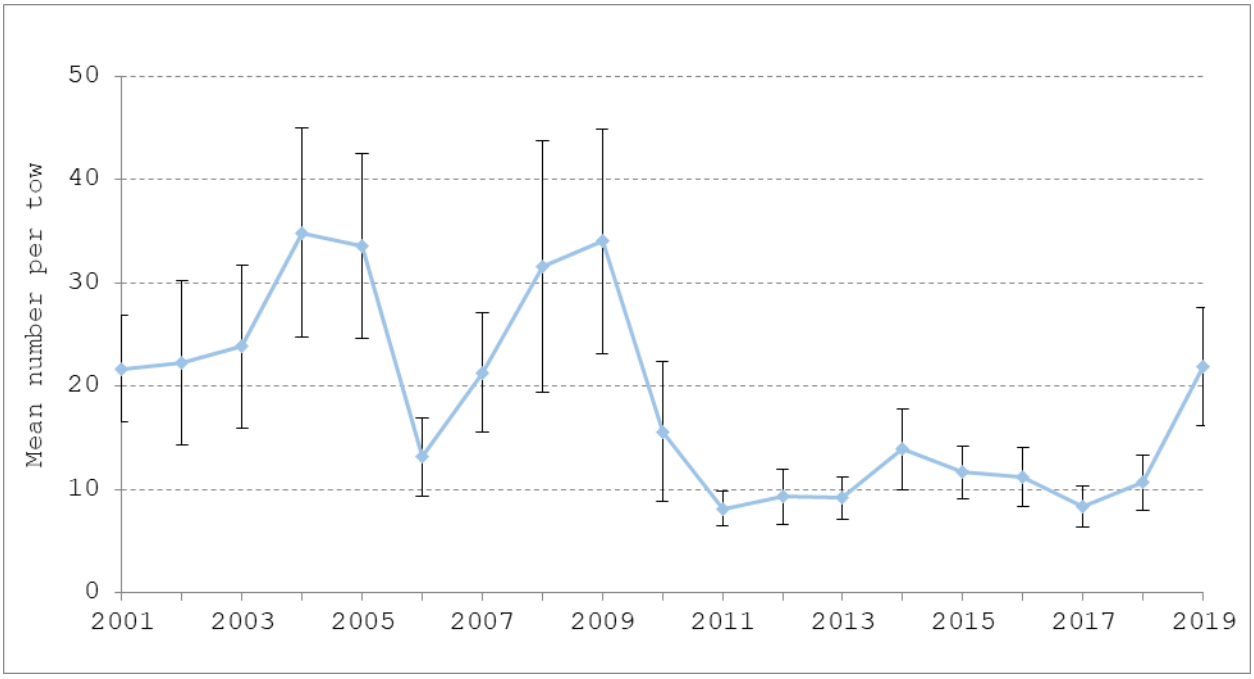

Figure 3.1-4. Mean number per tow of Winter Flounder from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2001–2019.

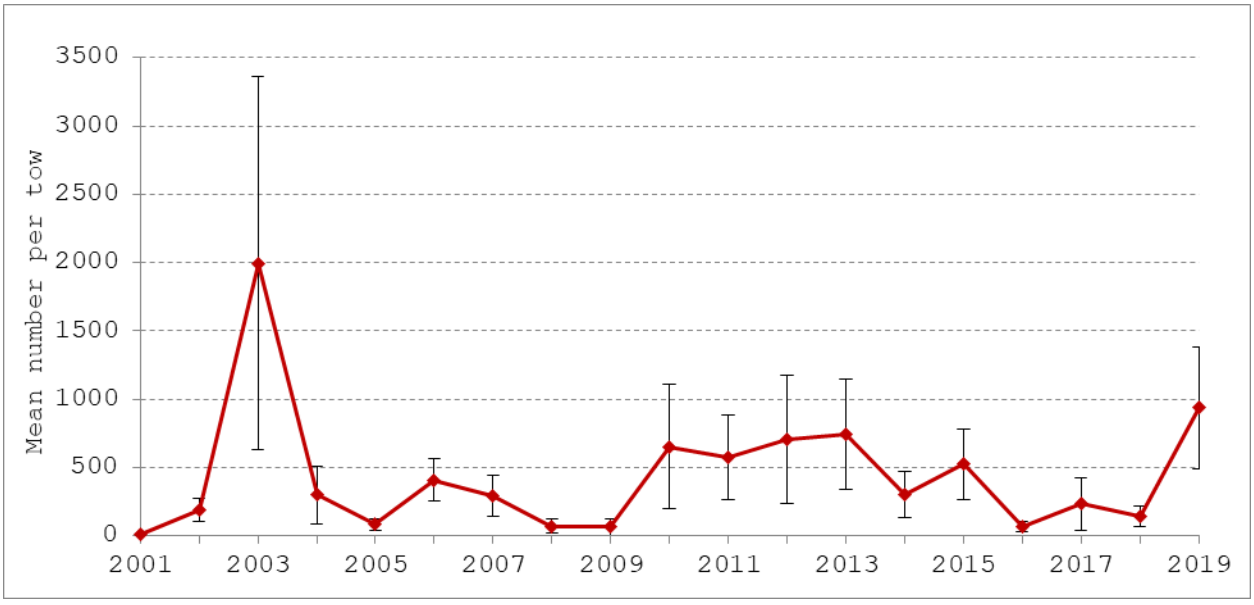

Figure 3.1-5. Mean number per tow of Atlantic Herring from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2001–2019.

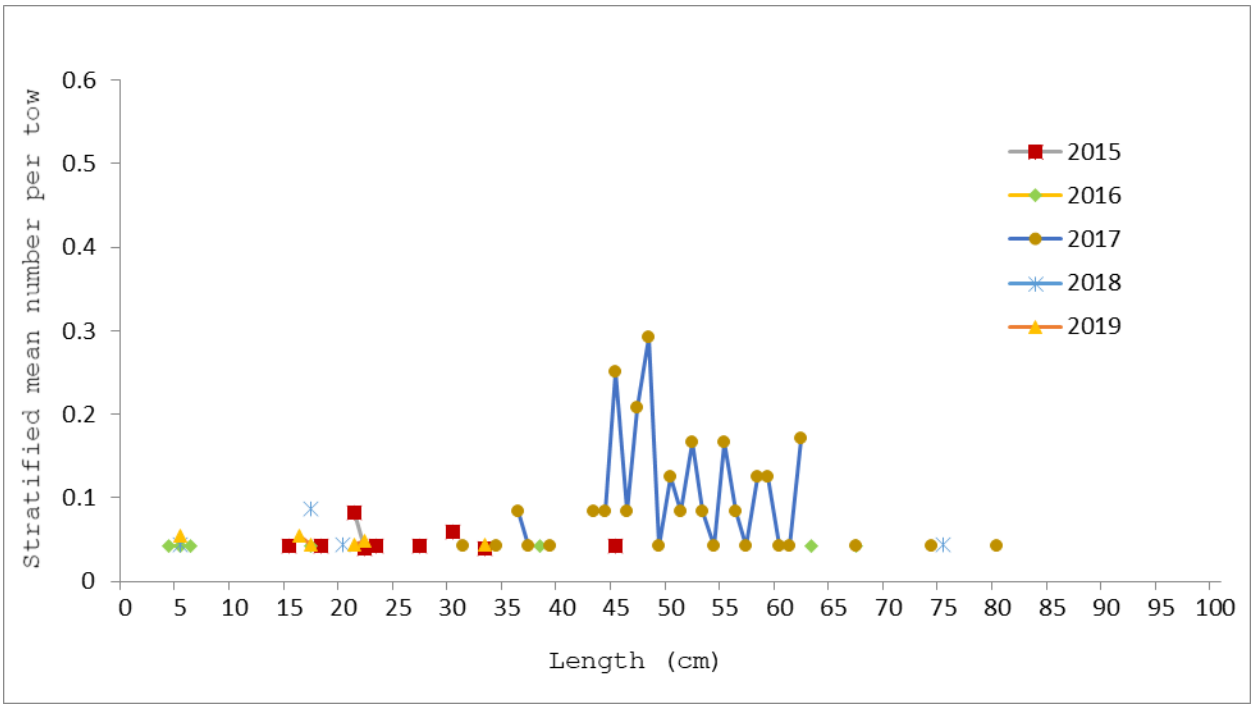

Figure 3.1-6. Length frequencies of Atlantic Cod sampled from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2015–2019.

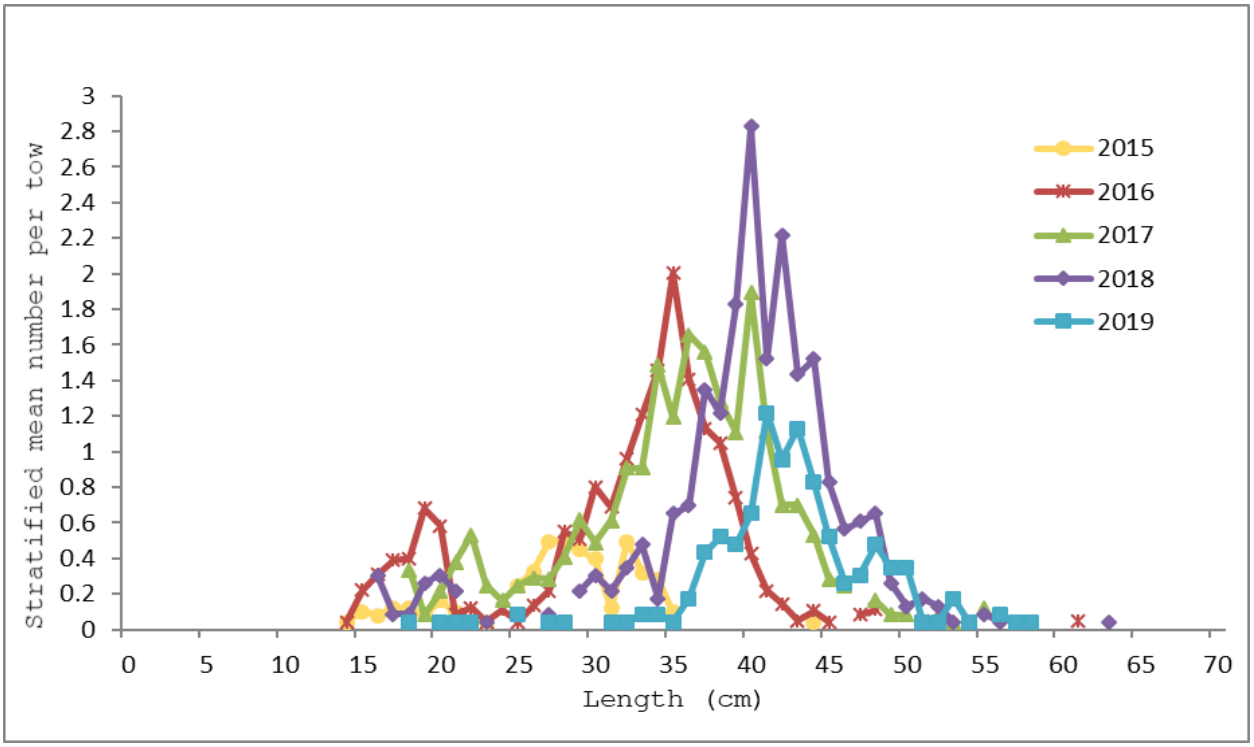

Figure 3.1-7. Length frequencies of Haddock sampled from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2015–2019.

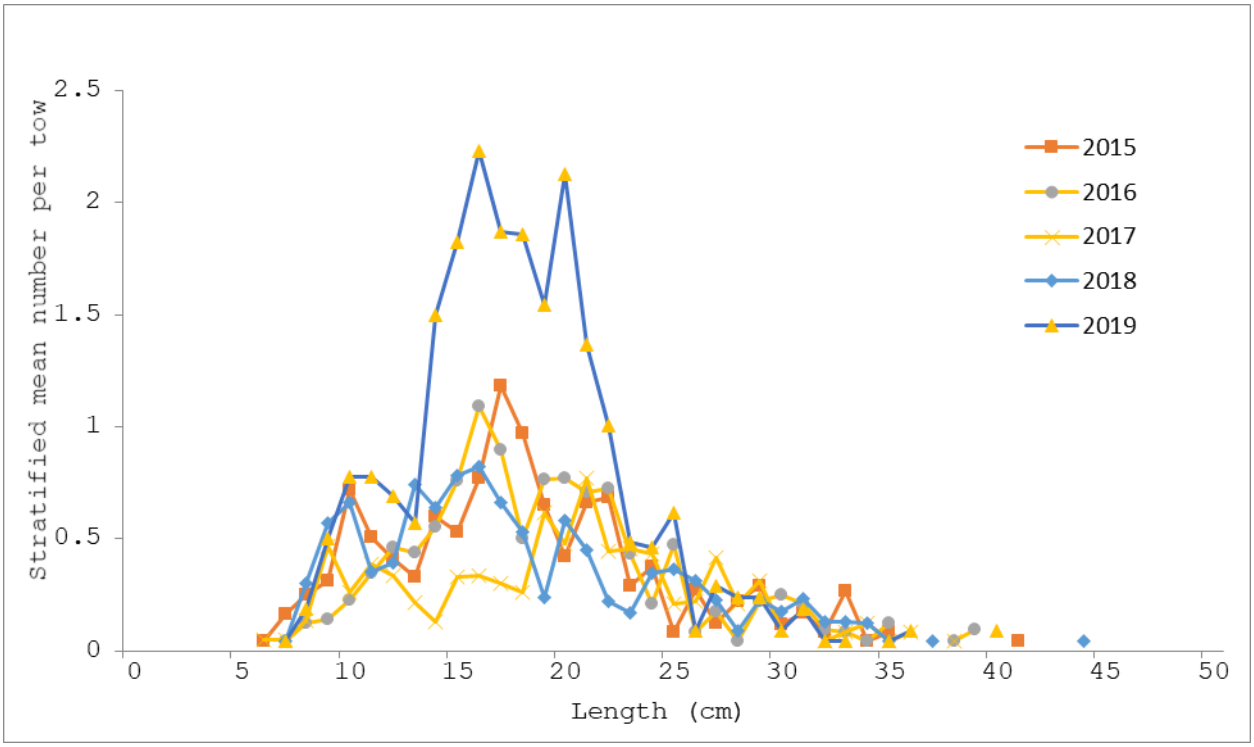

Figure 3.1-8. Length frequencies of Winter Flounder sampled from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2015–2019.

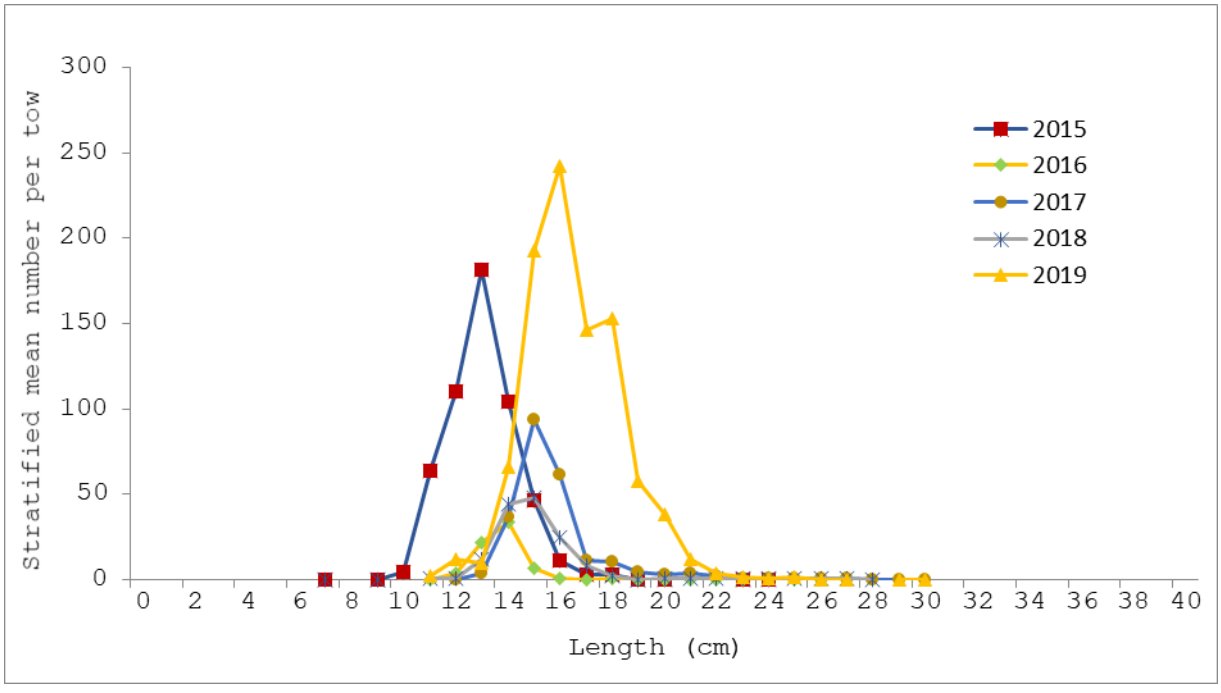

Figure 3.1-9. Length frequencies of Atlantic Herring sampled from Region 1 of the ME–NH Inshore Trawl Survey during spring, 2015–2019.