6-2023

2024 Yellowtail Flounder Research Track Assessment Working Paper: Yellowtail Flounder Estimates from the VIMS Industry-Based Scallop Dredge Surveys

Sally Roman
Virginia Institute of Marine Science

David Rudders
Virginia Institute of Marine Science

Recommended Citation

Roman, S., & Rudders, D. (2023) 2024 Yellowtail Flounder Research Track Assessment Working Paper: Yellowtail Flounder Estimates from the VIMS Industry-Based Scallop Dredge Surveys. Marine Resource Report No. 2023-6. Virginia Institute of Marine Science, William & Mary. https://doi.org/10.25773/364j-v827

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Yellowtail Flounder Estimates from the VIMS Industry-Based Scallop Dredge Surveys

VIMS Marine Resource Report No. 2023-6

Sally A. Roman and David B. Rudders

Virginia Institute of Marine Science
P.O. Box 1346 Gloucester Point, VA 23162

June 1, 2023

VIRGINIA INSTITUTE OF MARINE SCIENCE
MARINE ADVISORY PROGRAM

Introduction

The U.S. Atlantic sea scallop fishery is supported by an extensive research program, referred to as a Research Set-aside (RSA) program. The RSA program administers a competitive grants program through the allocation of a portion of the annual fishery quota to fund sea scallop research. A high priority of this program has traditionally been to fund fishery-independent surveys that employ different gears types including commercial dredges, a standardized sea scallop survey dredge, and cameras to assess the sea scallop resource across the species range in U.S. waters. The Virginia Institute of Marine Science (VIMS) has been funded through this program to conduct cooperative industry-based dredge surveys at varying spatial scales since 2000. Broad scales dredge surveys of the Mid-Atlantic (MA) and Georges Bank (GB) have been conducted by VIMS since 2015 and 2016, respectively. The VIMS dredge survey follows standard protocols similar to the Northeast Fisheries Science Center (NEFSC) sea scallop dredge survey that has surveyed the resource since the 1970s. The primary objectives of the VIMS surveys are to provide data on sea scallop abundance, spatial distribution, length structure, and other biological parameters. The surveys also have several secondary objectives, with one such objective being to collect information on finfish species encountered during the survey, including the number of animals and length data. The VIMS scallop surveys often overlap areas of historic yellowtail founder distribution, such as the Nantucket Lightship (NL) and Closed Area II (CA II). Catch data collected since 2015 by the VIMS dredge surveys were examined for trends in yellowtail flounder abundance and distribution by stock unit.

Data and Methods

Survey Domains

The MA sea scallop resource has been surveyed annually since 2015, and the survey domain remained consistent across time (Figure 1). Surveys were typically conducted in May to early June. The 2020 survey was delayed until July and August to due COVID-19 pandemic travel related restrictions (Table 1). Throughout the time series, the MA survey consistently covered portions of the Southern New England (SNE) yellowtail flounder stock (Figure 1).

The NL survey has been conducted annually since 2016. The area surveyed has been dynamic in response to changes in the sea scallop resource and resultant management measures (Figure 1). In 2020, VIMS surveyed the South Channel to ensure the sea scallop resource in this area was surveyed by dredge gear. The NEFSC dredge survey was not conducted in 2020 due to the COVID-19 pandemic. Surveys have typically been conducted in June or July, with the exception of 2020, when the area was surveyed in September (Table 1). These surveys have covered a portion of the SNE stock for all years, and the GB yellowtail flounder stock in 2016, 2017, and 2020 (Figure 2).

The survey of CA II has also been conducted since 2016 with some changes to the survey domain over time (Figure 2). These surveys has typically been conducted in June, but in 2020 the survey was completed in August (Table 1). These surveys covered a portion of the U.S. component of the GB yellowtail flounder stock to the Hague line.

The survey of Closed Area I (CA I) was conducted in 2018, 2019, 2020, and 2021, with some changes to the survey domain over that time (Figure 3). These surveys were typically conducted in June, but in 2020 was completed in August (Table 1). The survey domains covered portions of the Cape Cod/Gulf of Maine (CC_GOM) yellowtail flounder stock and the GB yellowtail flounder stock.

Survey Design and Station Allocation

The surveys employed a stratified random design, with strata based on NEFSC shellfish strata designations. For the MA survey, stations were allocated using proportional allocation based on stratum area in 2015. For the GB surveys, this approach was used in 2016 for the NL and CA II surveys and in 2018 for the CA I survey. In subsequent years, a hybrid approach utilizing scallop data from the prior year was used to allocate stations to individual strata. This hybrid approach consisted of both proportional and optimal allocation techniques (Neyman allocation) to determined station allocation (Cochran, 1977). A portion of the stations were allocated based on individual stratum area and both the number and biomass of scallops observed in the previous year. To ensure all strata in a survey domain were sampled, each stratum was allocated a minimum of two stations.

Survey Protocols

The VIMS dredge survey follows operational protocols similar to the NEFSC dredge survey. One difference between the two surveys is that since the VIMS surveys are conducted on commercial vessels, each vessel tows two dredges simultaneously. The standard NEFSC sea scallop survey dredge, 2.4 m in width equipped with 5.08 cm rings, 10.16 cm diamond twine top, and a 3.8 cm diamond mesh liner was towed on one side of the vessel. On the other side of the vessel, a 3.96 m, 4.27 m or 4.57 m commercial scallop dredge equipped with 10.16 cm rings, a 25 cm diamond mesh twine top and no liner was fished. For each paired tow, the dredges are simultaneously fished for 15 minutes with a towing speed of approximately 3.8-4.0 kts, and a scope to depth ratio of 3:1. A Star Oddi tilt sensor (records angle of inclination, temperature, and depth) was used to determine dredge bottom contact time. High-resolution navigational logging equipment was used to accurately determine vessel position and speed over ground. Synchronous time stamps for both the inclinometer and the navigational log determined the location and duration fished by the dredges. Bottom contact time and vessel location were integrated to estimate the swept area for the survey dredge.

Catch Sampling

Sampling of the catch was conducted in the same manner described by DuPaul and Kirkley (1995) and DuPaul et al. (1989), which has been utilized during all VIMS scallop surveys since 2005. For each paired tow, the entire scallop catch from both the survey and commercial dredges was kept separate and placed in scallop baskets to quantify total catch. Total scallop catch, or a subsample depending upon catch volume, was measured. Other species sampled included groundfish, monkfish, skates, crabs, and starfish. All groundfish (flatfish, cod, haddock) were counted and measured (total length (TL)) to the nearest millimeter (mm) by species for each dredge. All station-level data was entered into the data acquisition program Fisheries Environment for Electronic Data (FEED). Data collected included number of animals, length measurements, and station-level information. Length data were recorded using an electronic measuring board integrated with the FEED program that allows for automatic recording of length measurements. Station level information collected included location, time, tow time (break-set/haul-back), tow speed, water depth, weather, and comments relative to the quality of the tow.

Scallop Dredge Efficiency

Survey dredge efficiency estimates for yellowtail flounder are limited, with literature on this topic coming from Transboundary Resource Assessment Committee (TRAC) working papers (Hennen, 2013; Shank et al., 2013). Shank et al. (2013) and Hennen (2013) each provided several yellowtail flounder efficiency estimates for the survey dredge from data collected by the NEFSC sea scallop Habcam optical and dredge surveys. Shank et al. (2013) estimated efficiency values of 0.43 for 2010 data and 0.82 for 2012 data, with a mean value of 0.62. The authors suggested the 2012 estimate of 0.82 may be more accurate for several reasons related to the timing between the dredge and Habcam surveys, yellowtail flounder seasonal migration patterns, and gear avoidance observed by yellowtail flounder in relation to the Habcam gear (Shank et al., 2013; Shank and Duquette, 2013). Hennen (2013) also provided the following efficiency estimates: 0.46, 0.49, 0.77, and 0.83. These values were also estimated with the NEFSC Habcam dredge data. The author noted the efficiency estimates "provide some limited information on the efficiency of the scallop survey dredge for YTF. It is, however, important to incorporate the cv's of these estimates as they are highly imprecise." The efficiency values from Shank et al. (2013) have been applied to VIMS yellowtail flounder catch data to scale relative abundance to absolute abundance in the past, and presented at several annual TRAC meetings (Roman and Rudders, 2022).

Biomass Estimation

Yellowtail flounder length data collected from the survey dredge were converted to cm. Length-weight parameters from Wigley et al. (2013) were used to calculate individual yellowtail flounder weight in kg. Depending on the time of year a survey was conducted, either spring parameter estimates (ln a = -12.35 and b = 3.21) or the average of spring and autumn estimates (ln a = -12.09 and b = 3.13) were used, since no estimates for summer months are available (Barkley et al., 2013; DeCelles et al., 2014). The total number per tow and weight per tow was the sum of all individual fish at a given station. Area swept for each station was calculated by multiplying the dredge width by the tow distance (km). Station-level yellowtail catch were assigned to stock units with the points.in.poly R function in the spatialEco R package (Evans and Murphy, 2021; R, 2021).

Swept-area total biomass (kg/tow) and abundance (number/tow) estimates for each year were calculated from station-level density estimates. Density was scaled to estimate absolute biomass or abundance with a range of dredge efficiency estimates (q). The following q values were used for the survey dredge: 0.43, 0.62, 0.83, and 1 (Shank et al., 2013). Hennen's estimates were not considered based on the author's conclusions regarding the values. A q of 1 represents the minimum area swept biomass estimate and should be considered the lower bound of biomass estimates. The absolute density of yellowtail flounder (kg/km^2 and number/km^2) for station i, year y, and q q was calculated as:

$$density_{i,y,q} = \frac{yellowtail\ flounder_{\ i,y}(kg)}{area\ swept_{i,y}\ \ (km^2)} * \frac{1}{q_q}$$

Total biomass (mt) or total number for each year, stock unit, and q was calculated as the mean yellowtail flounder density in stock unit s multiplied by the sum of all area surveyed within a given stock area:

$$Total\ Biomass_{y,s,q} = \overline{density_{y,s,q}} * Survey\ Area_{y,s}\ (km^2)$$

The variance and 95 percent confidence intervals were calculated for all estimates. Stratification of the survey domain was not considered in biomass estimation, since strata were NEFSC shellfish strata.

Results

The spatial distribution of yellowtail flounder catch by year and stock area are shown in Figures 1-3. Yellowtail flounder were only observed in the MA survey in 2015, 2018, and 2022. All other SNE yellowtail flounder were captured in the NL survey in all years. For the GB stock, the majority of fish were captured in CA II, with a few fish in CA I in 2018, 2019, and 2020. CC_GOM yellowtail flounder were consistently observed in CA I in all years, and in the South Channel in 2020. A large number of small yellowtail flounder were captured off of Cape Cod in 2020.

Length frequency distributions by year and stock are shown in Figures 4-6. The number of fish at length was low across all years and stocks, with the exception of 2019 for the SNE and GB stocks and 2020 for the CC_GOM stock. The number and mean length of SNE large fish generally declined since 2015 (Table 2). For the GB stock, the length range was relatively stable from 2016 to 2022, with the exception of 2019, where smaller fish were captured (Table 2). Mean length also declined for this stock over time. The smallest mean length was in 2019. The largest length range and smallest mean length for the CC_GOM stock was in 2020 (Table 2). This corresponds to the catch of small fish off of Cape Cod.

The number and total weight (kg) of yellowtail flounder by year and stock are provided in Table 3. The number and weight of SNE and GB yellowtail flounder declined over the time periods surveyed, although there was an increase in the number of fish observed for both stocks in 2019. For the SNE stock, there was a similar trend in total weight. For the GB stock, the greatest number of fish observed in 2019 corresponded to a lower total weight relative to 2020, 2021, and 2022. This is due to the number of smaller fish encountered. The greatest number of yellowtail flounder observed was in 2020 for the CC_GOM stock.

Absolute biomass and abundance estimates with the different q values by year and stock are provided in Tables 4-7. Biomass for the SNE stock was greatest in 2019, and has generally declined over the time period examined. For the GB stock, biomass has also generally declined, with the exceptions of 2020 and 2021. The 2020 estimates are the greatest in the time series. The 2020 estimate for the CC_GOM stock was also the largest in the four years of the survey.

Discussion

The VIMS scallop surveys provide detailed spatial coverage of a portions of all three yellowtail flounder stocks. With its consistent and well-documented methods, it can provide additional information on the status of these stocks. While these data can offer supplementary information on yellowtail flounder, there are several drawbacks of this dataset. With the exception of the MA survey, survey domains have changed over the time and were not static. Surveys also did not cover the entire portion of any stock area. All surveys also have relatively short time series. The longest time series is the MA survey at eight years, followed by two of the surveys in the GB stock area at seven years. Information for the CC_GOM stock only covers four years. More information on data from VIMS surveys conducted in the GB stock area starting in 2005 can be found in a 2022 TRAC working paper by Roman and Rudders (2022). However, the area covered by these surveys include areas long-recognized as important for yellowtail flounder. The surveys operate at a high intensity of stations per survey area which should increase detection of yellowtail flounder if present in the areas during the time period surveyed. Since survey protocols are similar to the NEFSC dredge survey, data could be combined from both surveys for more comprehensive coverage of stock areas. The information from the VIMS survey can be used as ancillary information to assist with the interpretation of assessment results and trends from surveys traditionally used for management. The spatial distribution of catches and length data may also be useful data sources to understand potential shifts in distributions and where biological information on yellowtail flounder is limited.

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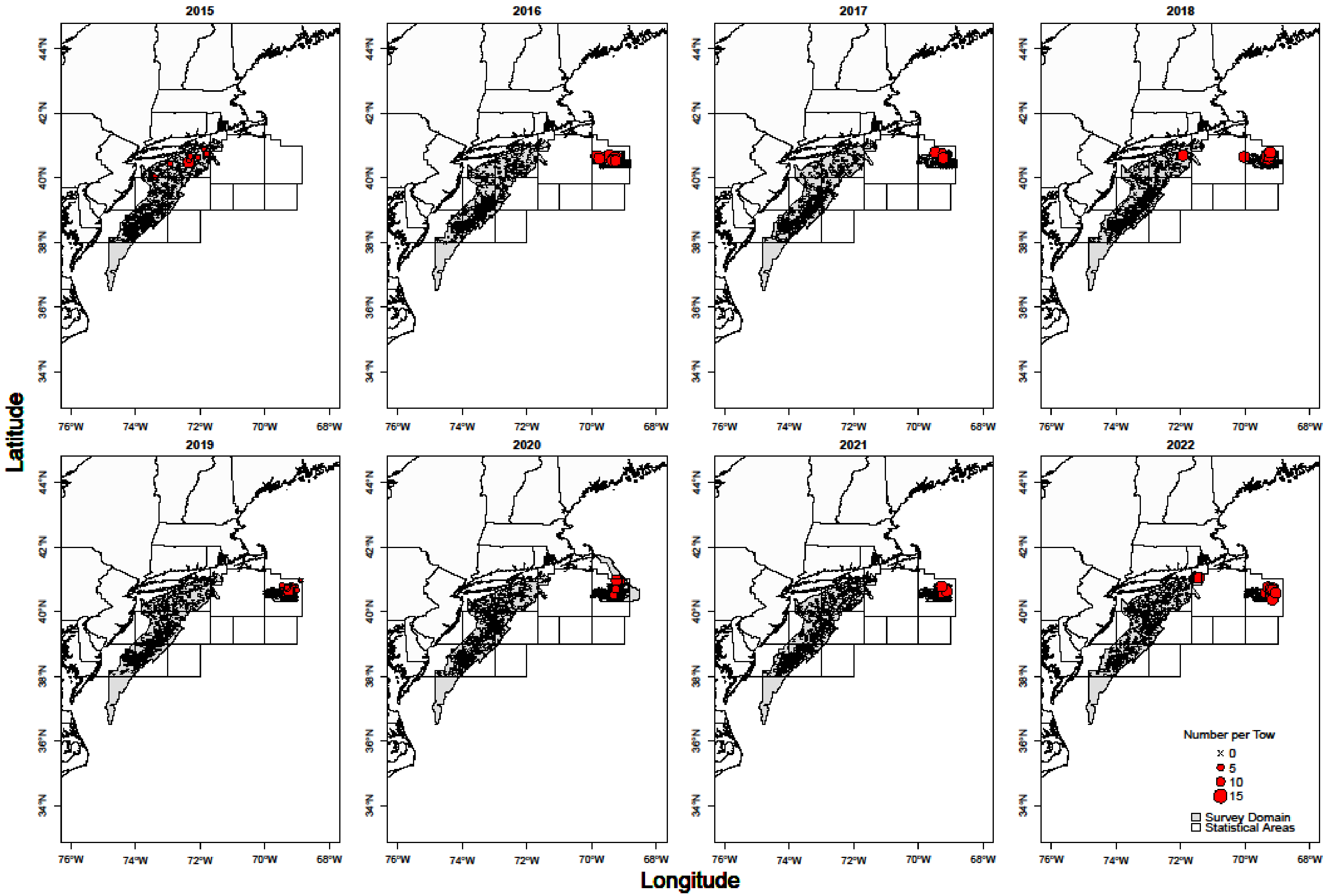

Figure 1. Spatial distribution of the number of yellowtail flounder caught in the VIMS sea scallop dredge survey by year for the Southern New England stock. Survey domains by year are in gray.

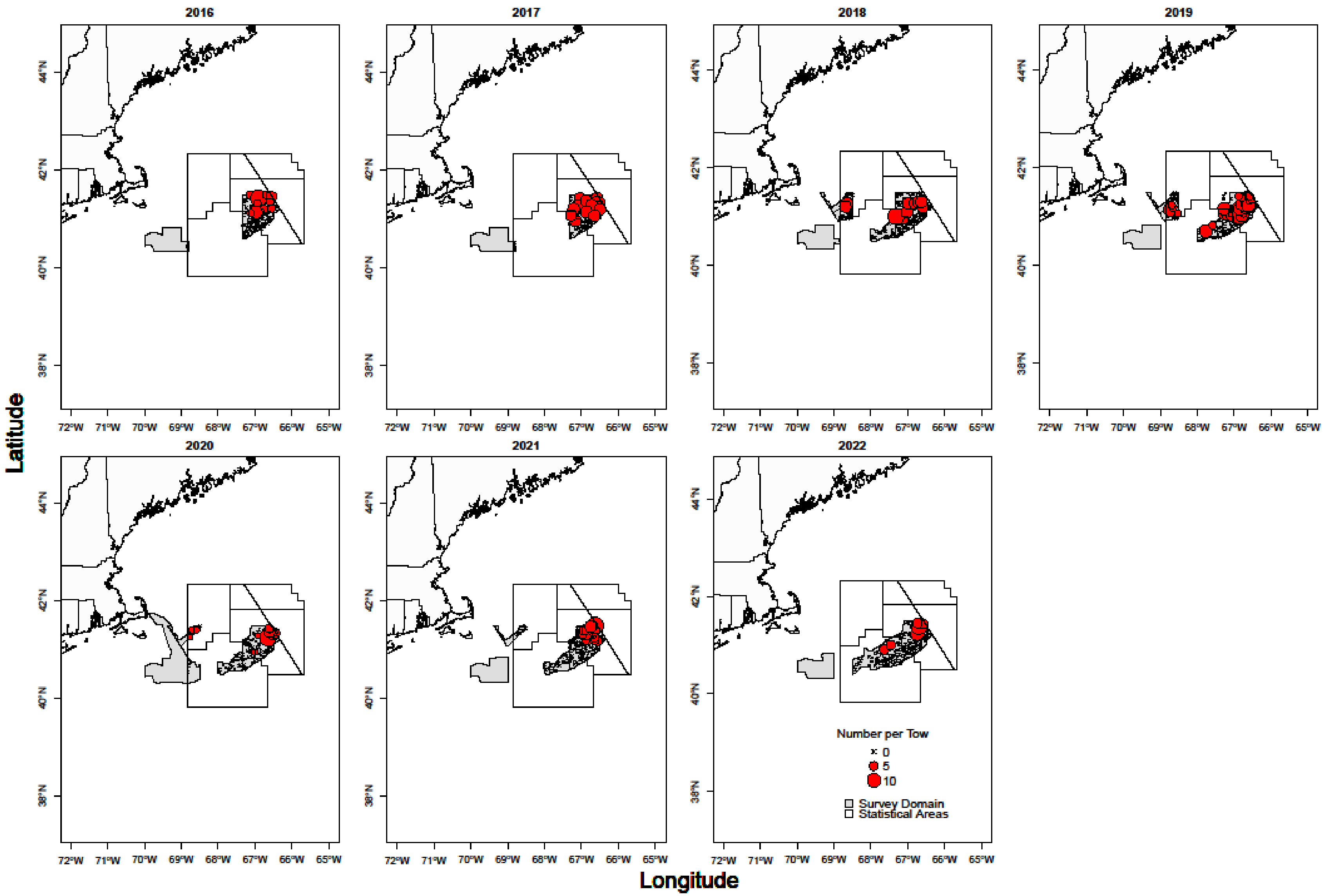

Figure 2. Spatial distribution of the number of yellowtail flounder caught in the VIMS sea scallop dredge survey by year for the Georges Bank stock. Survey domains by year are in gray.

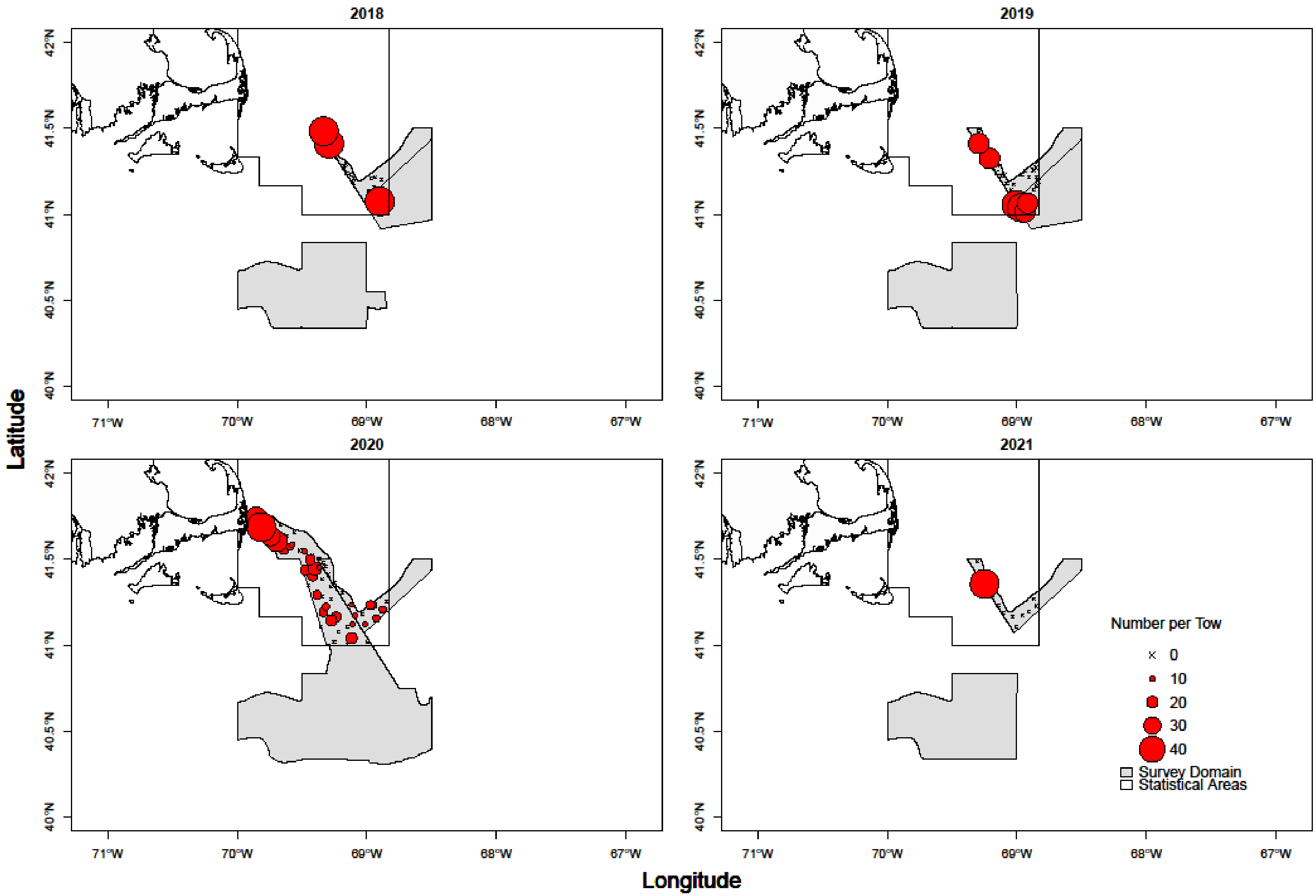

Figure 3. Spatial distribution of the number of yellowtail flounder caught in the VIMS sea scallop dredge survey by year for the Cape Code Gulf of Maine stock. Survey domains by year are in gray.

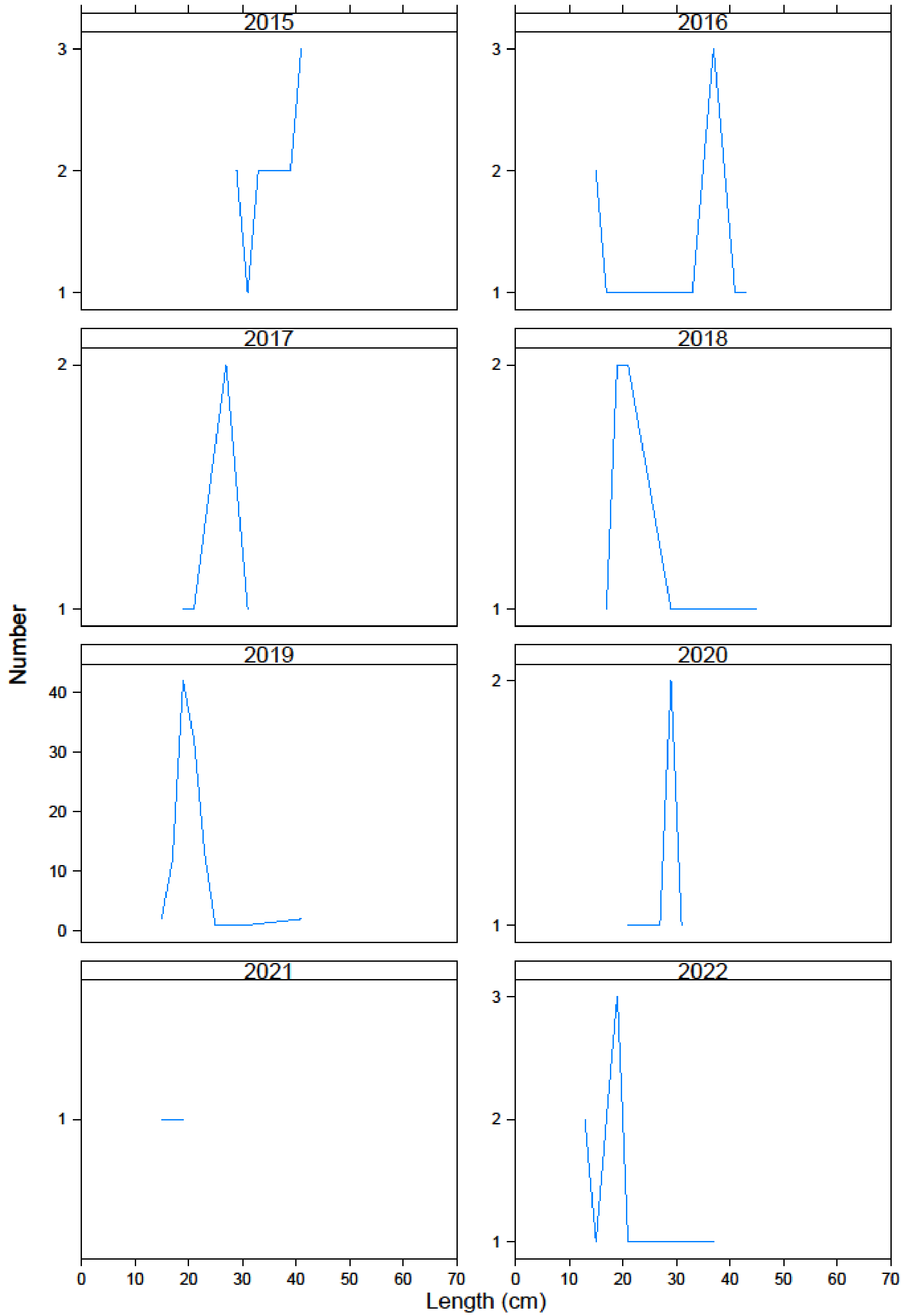

Figure 4. Length frequency distributions by year for the Southern New England stock.

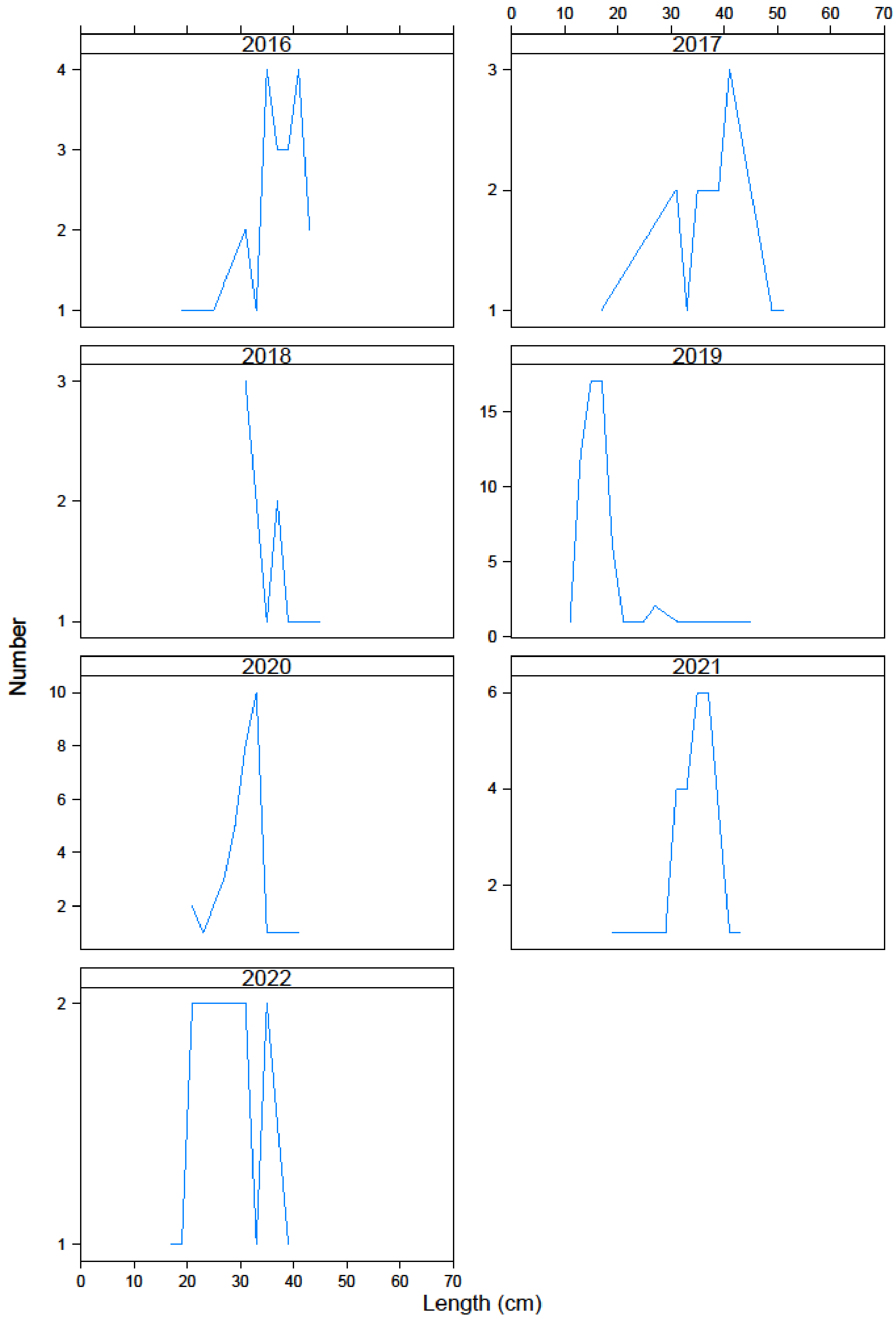

Figure 5. Length frequency distributions by year for the Georges Bank stock.

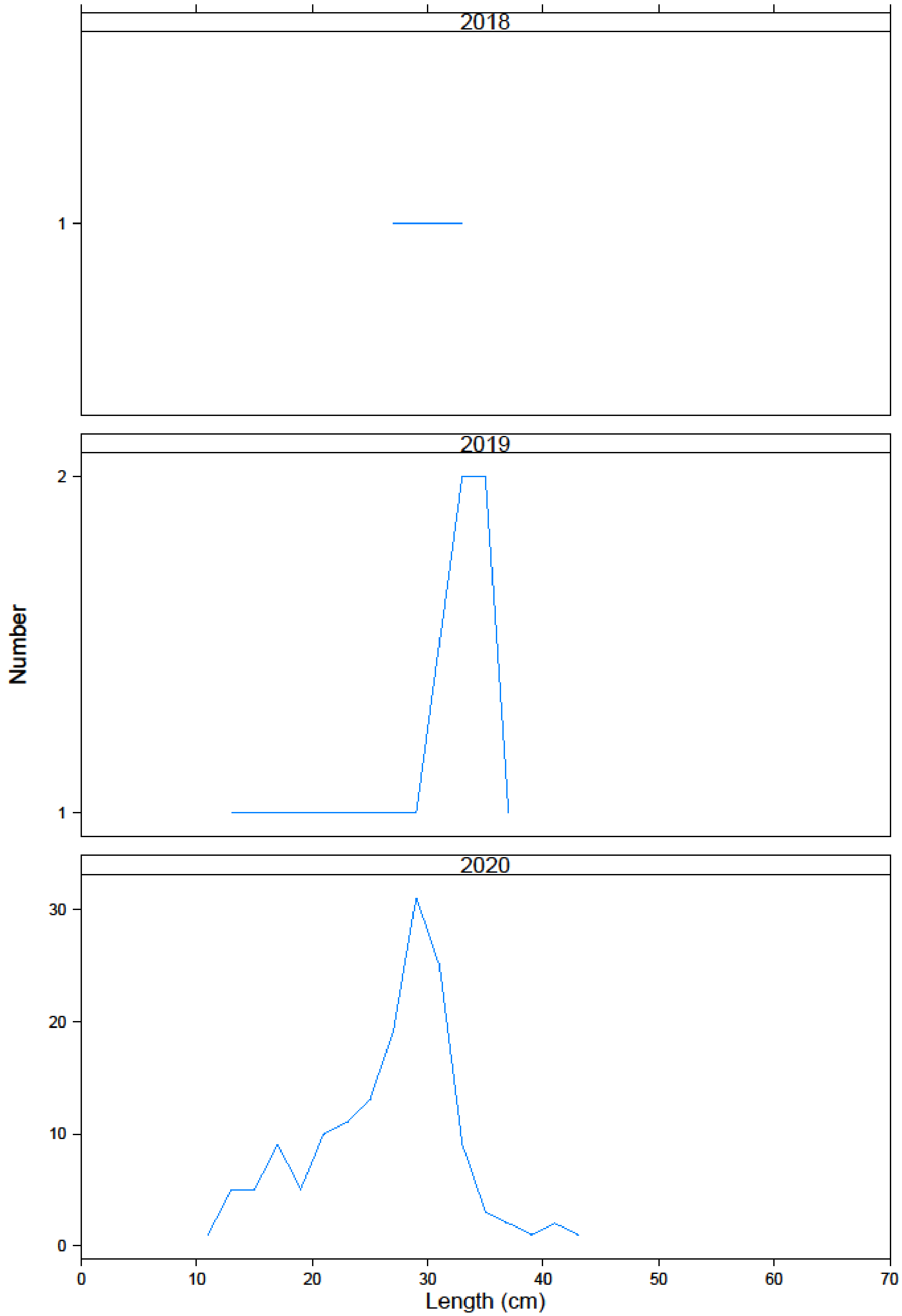

Figure 6. Length frequency distributions by year for the Cape Cod Gulf of Maine stock.

Table 1. Summary survey information by year and stock. The survey domains column is the sum of all surveyed area for each stock unit across the surveys conducted within a year.

Year	Stock	Number of Stations	Mean Area Swept (m^2)	Survey Domains (km^2)	Surveys	Months
2015	SNE	543	1,802.38	3,316	MA	May, June
2016	GB	101	1,854.49	6,474	NL, CA II	June
2016	SNE	511	1,804.49	7,468	MA, NL	May, July
2017	GB	105	1,695.95	6,474	NL, CA II	June, July
2017	SNE	508	1,754.45	7,468	MA, NL	May, July
2018	CC_GOM	24	1,701.91	672	CA I	June
2018	GB	160	1,701.84	9,103	CA II	June
2018	SNE	527	1,674.68	7,491	MA, NL	May, July
2019	CC_GOM	31	1,496.41	672	CA I	June
2019	GB	164	1,482.61	9,103	CA II	June
2019	SNE	553	1,676.85	7,491	MA, NL	May, July
2020	CC_GOM	54	1,834.17	2,296	CA I, NL	August, September
2020	GB	100	1,769.51	9,053	NL, CA II	August, September
2020	SNE	557	1,831.07	8,603	MA, NL	July, August, September
2021	CC_GOM	12	1,745.82	445	CA I	June
2021	GB	113	1,754.14	7,831	CA II	June
2021	SNE	530	1,770.39	7,473	MA, NL	May, June
2022	GB	130	1,866.98	9,866	CA II	June
2022	SNE	520	1,862.42	6,881	MA, NL	May, June

Table 2. Length range and mean length (cm) by year and stock.

Year	SNE		GB		CC_GOM	
	Length Range	Mean Length (cm)	Length Range	Mean Length (cm)	Length Range	Mean Length (cm)
2015	29 - 41	35.83				
2016	15 - 43	30.56	19 - 43	36.05		
2017	19 - 31	25	17 - 51	37.13		
2018	17 - 45	24.43	31 - 45	35.73	27 - 33	30.33
2019	15 - 41	20.39	11 - 45	17.98	13 - 37	29.5
2020	21 - 31	27.4	21 - 41	30.48	11 - 43	26.41
2021	15 - 19	17	19 - 43	33.72	35 - 35	35
2022	13 - 37	22.4	17 - 39	28.2		

Table 3. Number of yellowtail flounder, total weight (kg), and mean fish weight (kg) by year and stock.

Year	SNE			GB			CC_GOM		
	Number	Weight (kg)	Mean Weight (kg)	Number	Weight (kg)	Mean Weight (kg)	Number	Weight (kg)	Mean Weight (kg)
2015	12	5.42	0.45						
2016	9	3.23	0.36	21	9.6	0.46			
2017	5	0.72	0.14	15	7.84	0.52			
2018	7	1.34	0.19	11	4.76	0.43	3	0.77	0.26
2019	105	8.31	0.08	63	4.75	0.08	8	2.11	0.26
2020	5	0.93	0.19	31	8.17	0.26	152	28.28	0.19
2021	3	0.12	0.04	25	8.92	0.36	1	0.36	0.36
2022	10	1.39	0.14	10	2.46	0.25			

Table 4. Absolute biomass estimates (mt) by year, stock, and catchability value.

Year	Stock	q = 0.43			q = 0.62			q = 0.83			q = 1		
		Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI
2015	SNE	17	4	30	12	3	21	9	2	16	7	2	13
2016	GB	322	119	525	223	83	364	169	63	275	139	51	226
2016	SNE	25	5	44	17	3	31	13	3	23	11	2	19
2017	GB	295	116	473	204	81	328	155	61	248	127	50	204
2017	SNE	5	0	12	4	0	8	3	0	6	2	0	5
2018	CC_GOM	12	0	26	9	0	18	6	0	14	5	0	11
2018	GB	157	53	261	109	37	181	82	28	137	68	23	112
2018	SNE	11	0	27	8	0	18	6	0	14	5	0	11
2019	CC_GOM	31	4	58	21	2	41	16	2	31	13	2	25
2019	GB	172	77	267	119	54	185	90	41	140	74	33	115
2019	SNE	60	34	86	42	24	60	31	18	45	26	15	37
2020	CC_GOM	635	297	973	440	206	675	333	156	510	273	128	418
2020	GB	394	146	642	273	101	445	207	77	337	169	63	276
2020	SNE	7	0	15	5	0	11	4	0	8	3	0	7
2021	CC_GOM	7	0	21	5	0	15	4	0	11	3	0	9
2021	GB	345	158	531	239	110	368	181	83	279	148	68	228
2021	SNE	1	0	2	1	0	1	0	0	1	0	0	1
2022	GB	96	4	188	66	2	130	50	2	98	41	2	81
2022	SNE	9	1	18	6	1	12	5	0	9	4	0	8

Table 5. Absolute number of yellowtail flounder by year, stock, and catchability value.

Year	Stock	q = 0.43			q = 0.62			q = 0.83			q = 1		
		Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI	Biomass (mt)	LCI	UCI
2015	SNE	37,945	7,398	68,493	26,317	5,131	47,503	19,898	3,879	35,917	16,316	3,181	29,452
2016	GB	702,045	259,213	1,144,877	486,902	179,777	794,027	368,146	135,929	600,362	301,879	111,462	492,297
2016	SNE	68,145	23,917	112,373	47,262	16,588	77,936	35,735	12,542	58,927	29,302	10,284	48,320
2017	GB	532,977	259,326	806,628	369,645	179,855	559,435	279,488	135,988	422,988	229,180	111,510	346,850
2017	SNE	37,252	0	80,910	25,836	0	56,115	19,535	0	42,428	16,018	0	34,791
2018	CC_GOM	47,983	0	98,790	33,279	0	68,516	25,162	0	51,805	20,633	0	42,480
2018	GB	355,543	133,821	577,266	246,587	92,811	400,362	186,444	70,174	302,713	152,884	57,543	248,225
2018	SNE	57,098	14,770	99,425	39,600	10,244	68,956	29,942	7,745	52,138	24,552	6,351	42,753
2019	CC_GOM	119,861	20,502	219,220	83,129	14,219	152,039	62,854	10,751	114,957	51,540	8,816	94,264
2019	GB	2,263,901	1,461,519	3,066,284	1,570,125	1,013,634	2,126,616	1,187,168	766,406	1,607,929	973,478	628,453	1,318,502
2019	SNE	742,523	463,208	1,021,838	514,975	321,257	708,694	389,372	242,902	535,842	319,285	199,179	439,390
2020	CC_GOM	3,387,588	1,587,077	5,188,100	2,349,456	1,100,715	3,598,198	1,776,418	832,248	2,720,589	1,456,663	682,443	2,230,883
2020	GB	1,496,814	499,624	2,494,004	1,038,113	346,513	1,729,712	784,915	261,998	1,307,831	643,630	214,838	1,072,422
2020	SNE	39,824	0	80,503	27,620	0	55,833	20,884	0	42,215	17,125	0	34,617
2021	CC_GOM	20,323	0	58,461	14,095	0	40,546	10,657	0	30,657	8,739	0	25,138
2021	GB	952,940	460,010	1,445,869	660,910	319,039	1,002,780	499,712	241,225	758,200	409,764	197,804	621,724
2021	SNE	21,721	0	46,242	15,064	0	32,071	11,390	0	24,249	9,340	0	19,884
2022	GB	388,335	71,875	704,795	269,329	49,849	488,810	203,639	37,691	369,588	166,984	30,906	303,062
2022	SNE	68,614	26,484	110,744	47,587	18,368	76,806	35,980	13,888	58,073	29,504	11,388	47,620