Final Report

2018 Vineyard Wind Groundfish Bottom Trawl Survey

Report prepared by:

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In August 2018 the University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST) was contacted by Vineyard Wind to conduct a pilot survey of their lease area (675 km^2) and an adjacent control area (306 km^2). The SMAST video trawl survey was started in 2013 and has shown success on Georges Bank and the Gulf of Maine using video technology placed in the codend of an otter trawl. The design includes open codend tows with a camera used to observe and count fish as they pass through the net along with periodic closed codend tows to collect biological data. The overall goal is to improve estimates of the abundance, spatial distribution, size structure, and length-weight relationship of the groundfish community. The pilot study was used to see if the video trawl survey would work in the area and act as baseline data for a before after control impact study. The initial plan was to use a combination of open and closed codend tows on 19 transects that were 8nm long and 2nm apart within the Vineyard Wind lease area and control area (Figure 1).

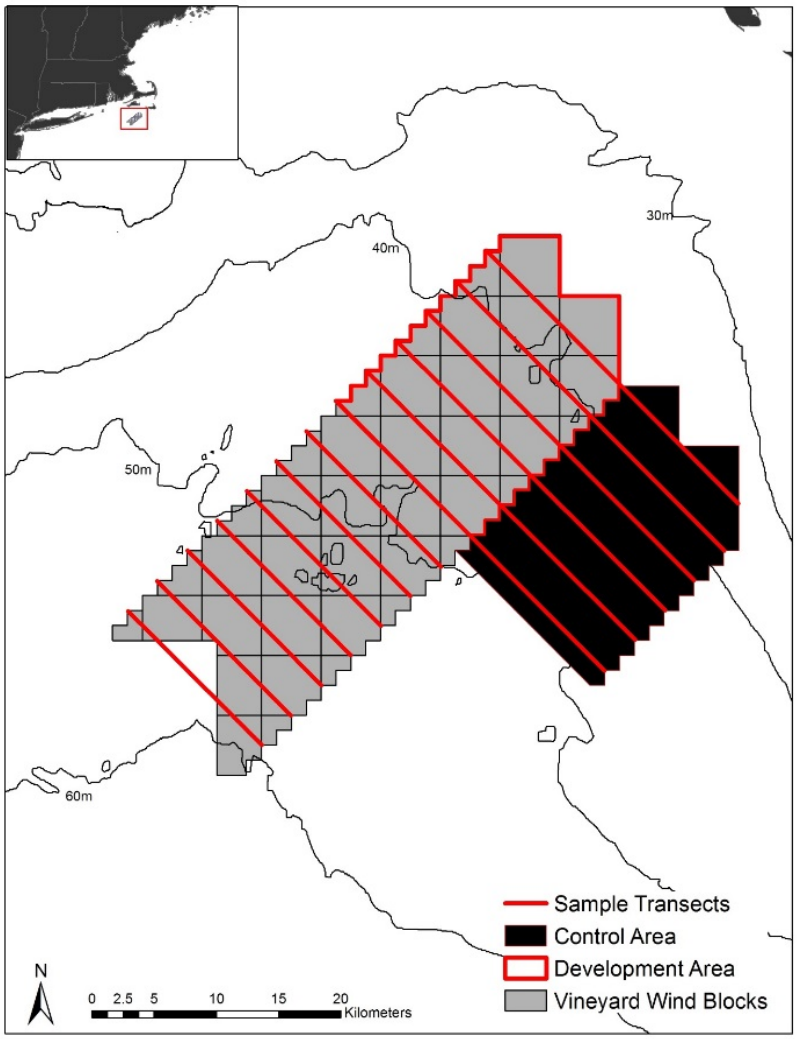

Figure 1. Proposed transect locations in the Vineyard Wind lease area and adjacent control area.

The pilot survey took place from September 26th to October 4th, 2018 on the F/V Justice out of New Bedford, MA. The survey team consisted of a captain, three crew members, and three SMAST scientists. During the first set of tows we realized the video was obscured by mud clouds which made it difficult to see any fish species passing thorough the net. The crew tried several iterations to the net such as adjusting the headrope, sweep, and adding several floats to the codend without success. The last resort to increase the visibility in the camera was to add an extra 15 fathoms of groundcable. We hoped the groundcable would place the net farther behind the doors therefore the mud cloud would be diminished by the time it reach the camera and visibility would increase. This also was not successful and we realized the video component would not work in the Vinyard Wind lease area due to the soft sediment type.

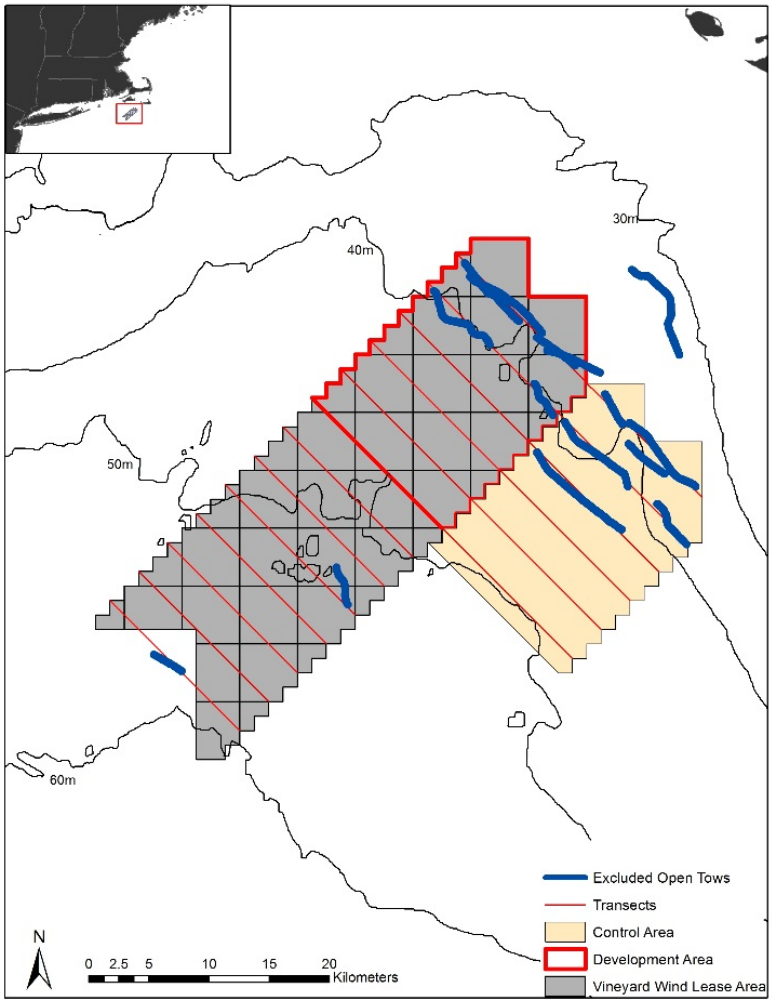

Figure 2. Open tow locations in the Vineyard Wind lease area and adjacent control area. The open codend tows are indicated by blue lines. The 14 open tows were excluded from analysis.

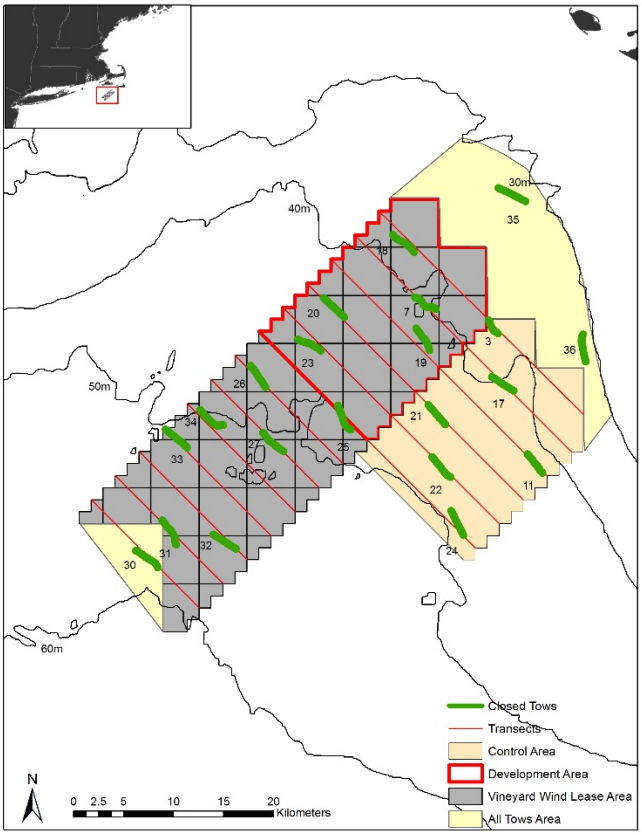

Figure 3. Closed tow locations in the Vineyard Wind lease area and adjacent control area. The entire Vineyard Wind lease area is in grey, the development area is within the red boundary, the adjacent control area is in beige, and the control area including all tows is in yellow.

Table 1. Tow location from the 21 successful closed codend tows completed. The data includes tow number, location, duration, depth, themperature, doorspread, speed, and area swept.

Tow Number	Start Latitude	Start Longitude	End Latitude	End Longitude	Tow Duration (hrs)	Mean Depth (m)	Mean Temperature (Celsius)	Mean Doorspread (km)	Vessel Speed (km/hr)	Area Swept (km^2)
3	41.01909	-70.3567683	41.03115	-70.3684483	0.35	36.99	16.46	0.039	4.82	0.07
7	41.05064	-70.4562883	41.04009	-70.4311767	0.50	37.93	16.24	0.042	5.33	0.11
11	40.8945	-70.3013583	40.91126	-70.319565	0.50	39.91	17.55	0.043	5.21	0.11
17	40.96775	-70.3368167	40.98029	-70.3633867	0.50	39.70	17.35	0.051	5.38	0.14
18	41.10641	-70.4838517	41.09119	-70.4581033	0.48	37.27	16.16	0.051	5.66	0.14
19	41.00304	-70.4379	41.02271	-70.454465	0.50	39.22	16.07	0.044	5.06	0.11
20	41.04866	-70.5652033	41.03151	-70.5398317	0.50	42.91	15.55	0.047	5.80	0.14
21	40.95415	-70.4383967	40.93676	-70.41797	0.50	42.07	15.86	0.050	5.20	0.13
22	40.8894	-70.4102933	40.9072	-70.4326017	0.50	45.12	15.38	0.054	5.40	0.14
23	41.00094	-70.56727	41.01086	-70.5952383	0.50	44.08	15.29	0.052	5.37	0.14
24	40.83722	-70.3940967	40.85907	-70.409155	0.50	47.21	15.52	0.052	5.70	0.15
25	40.93042	-70.5299667	40.9519	-70.5457917	0.52	45.66	14.83	0.050	5.59	0.14
26	40.98632	-70.65055	40.96746	-70.6323317	0.48	45.36	14.89	0.052	5.26	0.13
27	40.92631	-70.6344633	40.90998	-70.60967	0.50	49.65	14.34	0.051	5.60	0.14
30	40.81794	-70.78242	40.80348	-70.75621	0.50	53.99	13.50	0.057	5.73	0.16
31	40.82412	-70.7347283	40.84579	-70.752055	0.52	51.94	14.08	0.054	5.93	0.16
32	40.83411	-70.6911667	40.82138	-70.66355	0.50	53.89	15.65	0.058	5.50	0.16
33	40.91172	-70.7240583	40.92753	-70.7498783	0.52	51.06	13.84	0.057	5.52	0.16
34	40.94577	-70.7094733	40.93271	-70.6813783	0.52	49.37	13.95	0.051	5.93	0.16
35	41.13834	-70.3263283	41.15004	-70.3589467	0.50	30.24	17.51	0.033	6.22	0.10
36	41.01955	-70.25557	40.99517	-70.2520267	0.50	29.89	17.78	0.048	5.53	0.13
Mean					0.49	43.50	15.61	0.049	5.51	0.14
Total					10.38					2.84

During the survey we employed a combination of open and closed codend tows. A total of 14 open tows resulting in 17 hours of video could not be used for analysis due to visibility (Figure 2). We completed a total of 21 closed codend, one tow at each of the 8nm transects and two tows north of the lease and control areas (Figure 3). The closed codend tows (n=21) ranged from .35 to .52 hours in duration, and the mean vessel speed ranged from 4.82 to 6.22 km/hr. The mean doorspread was .049 km with a total area swept of 2.84 km^2. The mean temperature was 15.61 °C and the mean depth was 43.50m.

Skates were the most abundant species in the catch followed by scup, butterfish, spotted/red hake, silver hake, and sea robin (Table 2).

Table 2. Count and weight of each species observed in the catch of the 21 completed tows from fall 2018 survey. * were estimated by basket counts.

Tow #	Total Count	Total Weight (kg)
Skates	21978	NA
Scup	13973*	4415.25
Butterfish	11878*	1175.12
Spotted/Red Hake	9845*	1527.13
Silver Hake	9078*	893.17
Sea Robin	3059	NA
Windowpane Flounder	1443	241.36
Fourspot Flounder	1175	207.03
Summer Flounder	967	1439.61
Gulfstream Flounder	890	14.33
Dogfish	838	NA
Squid	724	47.96
Crabs	627	NA
Winter Flounder	624	227.75
River Herring	294	30.64
Yellowtail Flounder	221	38.65
Monkfish	206	423.99
Barndoor Skates	149	30.36
Scallops	122	NA
Black Seabass	109	91.71
Haddock	30	32.28
Sculpin	30	NA
Lobster	11	7.74
Bluefish	8	20.37
Ocean Pout	8	NA
American Eel	3	3.44
Filefish	3	0.03
Sea Raven	2	NA
Mackerel	2	NA
Torpedo Ray	1	7.80
White Hake	1	0.73
Sea Cucumber	1	NA

Estimates of density (kg/km^2) and biomass (mt) were calculated for twelve species by examining the observed catch and the area swept by the survey net during each of the closed codend tows. Speed during fishing activity was aimed at 3 knots. The data was used to calculate the mean speed (km/hour) of the vessel during each survey tow. The duration of each tow was converted from minutes to fraction of an hour for area swept calculations.

Net mensuration equipment (NOTUS sensors) was placed on the trawl doors and the headrope to monitor the dimensions of the net and allow for the area swept to be calculated during each tow. The mean doorspread (m) observed on each survey tow was calculated from the data files and converted to km. The area swept (km^2) by the survey net was calculated for each tow as follows:

$$Area\ swept\ (km^2) = doorspread\ (km) * tow\ speed\ \left(\frac{km}{hr}\right) * tow\ duration\ (hr)$$

The density for the species of interest was calculated for each survey tow as follows (Gunderson 1993):

$$density\ \left(\frac{kg}{km^2}\right) = \frac{catch\ (kg)}{area\ swept\ (km^2)}$$

The size of the study area was estimated in ArcGIS by calculating the area of a polygon for the development area, control area, and entire area for all tows.

The biomass for the species of interest in the study area was estimated as follows:

$$biomass\ (kg) = \ density\ \left(\frac{kg}{km^2}\right) * size\ of\ survey\ area\ (km^2)$$

The efficiency of the survey net has not been investigated to date. Therefore, our calculations of density and biomass are highly conservative because they assume that the survey net is able to catch 100% of the fish that are within the path of the trawl doors (i.e., the net has 100% herding and capture efficiency).

Table 3. Summary of the density (kg/km^2) and biomass (mt) estimates for twelve species using doorspread during the fall 2018 survey. The estimates were calculated for tows completed in the development area, control area, and area encompassing all tows.

Species	Density (kg/km2)								
	Development Area			Control Area			Whole Area		
	n	$\bar{x}$	SD	n	$\bar{x}$	SD	n	$\bar{x}$	SD
Scup	6	1999.6	757.4	6	1875.8	1216.6	21	1570.3	1375.8
Butterfish	6	1052.7	848.2	6	365.2	284.3	21	455.6	612.8
Summer Flounder	6	501.7	163.5	6	496.0	296.8	21	507.8	296.5
Silver Hake	6	236.3	133.4	6	265.5	143.3	21	294.5	193.2
Monkfish	6	75.8	83.9	6	58.4	73.8	21	134.9	145.6
Winter Flounder	6	170.0	113.7	6	55.6	40.8	21	79.9	85.7
Windowpane	6	155.9	127.6	6	156.4	95.1	21	97.4	107.2
Fourspot	6	72.0	65.9	6	61.5	28.4	21	69.4	43.0
Black Seabass	6	80.7	100.9	6	62.6	102.5	21	40.9	80.9
Yellowtail	6	27.5	19.5	6	1.6	2.0	21	13.4	21.0
Squid	6	12.2	9.0	6	22.5	11.7	21	17.0	10.5
Haddock	6	6.3	11.0	6	9.4	12.0	21	10.7	12.7

Species	Biomass (mt)								
	Development Area (306 km^2)			Control Area (306 km^2)			Whole Area (1251 km^2)		
	n	$\bar{x}$	SD	n	$\bar{x}$	SD	n	$\bar{x}$	SD
Scup	6	602.1	228.1	6	564.8	366.3	21	1933.0	1693.6
Butterfish	6	317.0	255.4	6	110.0	85.6	21	560.8	754.3
Summer Flounder	6	151.1	49.2	6	149.3	89.4	21	625.1	365.0
Silver Hake	6	71.2	40.2	6	79.9	43.1	21	362.5	237.8
Monkfish	6	22.8	25.3	6	17.6	22.2	21	166.0	179.2
Winter Flounder	6	51.2	34.2	6	16.7	12.3	21	98.4	105.4
Windowpane	6	46.9	38.4	6	47.1	28.6	21	119.9	131.9
Fourspot	6	21.7	19.8	6	18.5	8.5	21	85.4	52.9
Black Seabass	6	24.3	30.4	6	18.8	30.9	21	50.4	99.6
Yellowtail	6	8.3	5.9	6	0.5	0.6	21	16.5	25.9
Squid	6	3.7	2.7	6	6.8	3.5	21	20.9	12.9
Haddock	6	1.9	3.3	6	2.8	3.6	21	13.2	15.6

The density and biomass estimates were higher in the development area than the control area for most species (8 of 12 species). There was a significant difference between the development and control area for yellowtail flounder and winter flounder (t-test p=.009 and .043 respectively).

From the baseline data obtained from the pilot study we were able to make a recommendation for future surveys in the Vineyard Wind area. The sample size needed moving forward was determined as follows (Krebs 1989):

$$n = \left(\frac{200CV}{r}\right)^2$$

Where:

r = desired relative error (width of confidence interval as percentage)

CV= coefficient of variation

The number of samples needed was calculated using a relative error of 25% and CV from the density (kg/km2) for the top four most abundant species (Scup, Butterfish, Summer Flounder, and Silver Hake). This is also assuming random distribution. We recommend a minimum of 20 samples in the development area and 20 samples in the control area be completed for each survey.

Distribution Maps and Length Frequency for Groundfish Species

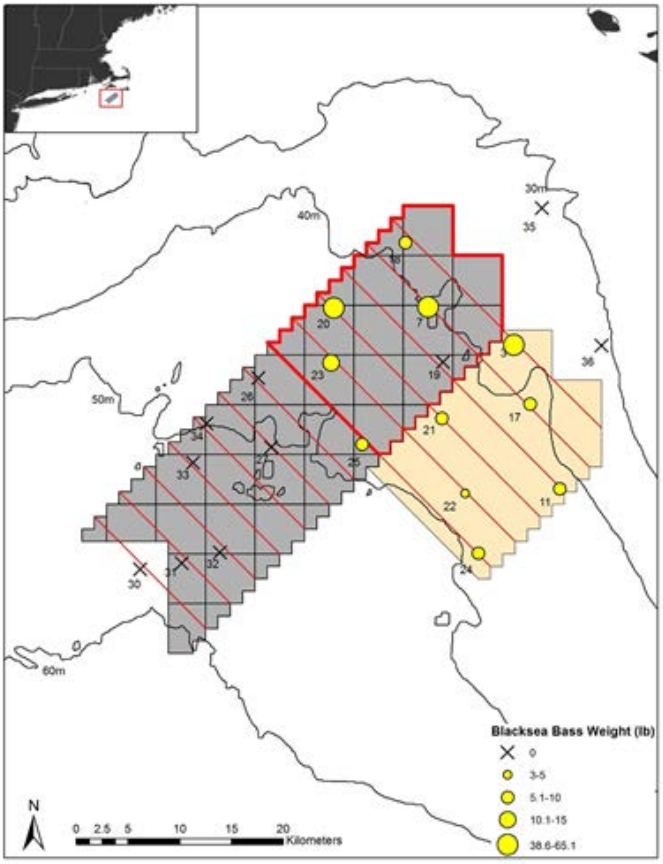

Figure A1. Distribution of black seabass catches observed during the fall 2018 survey.

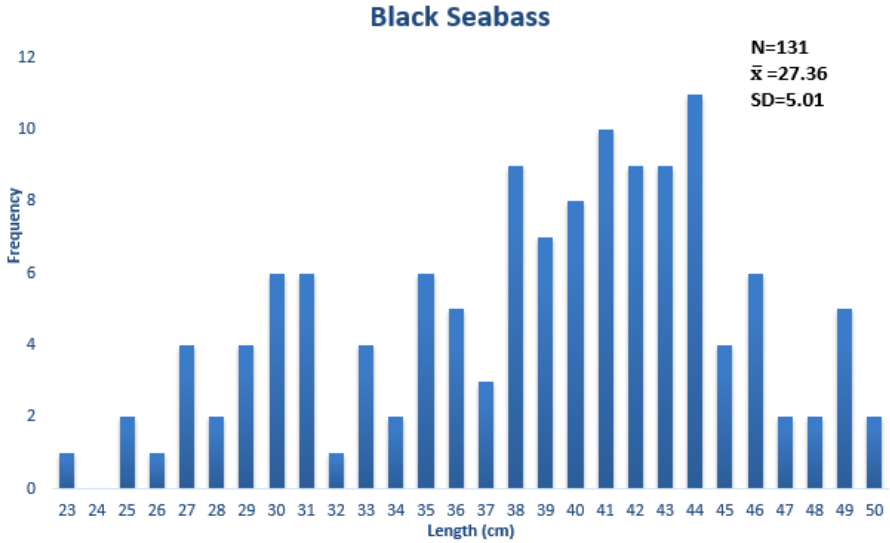

Figure A2. Length frequency distribution of black seabass observed during the fall 2018 survey

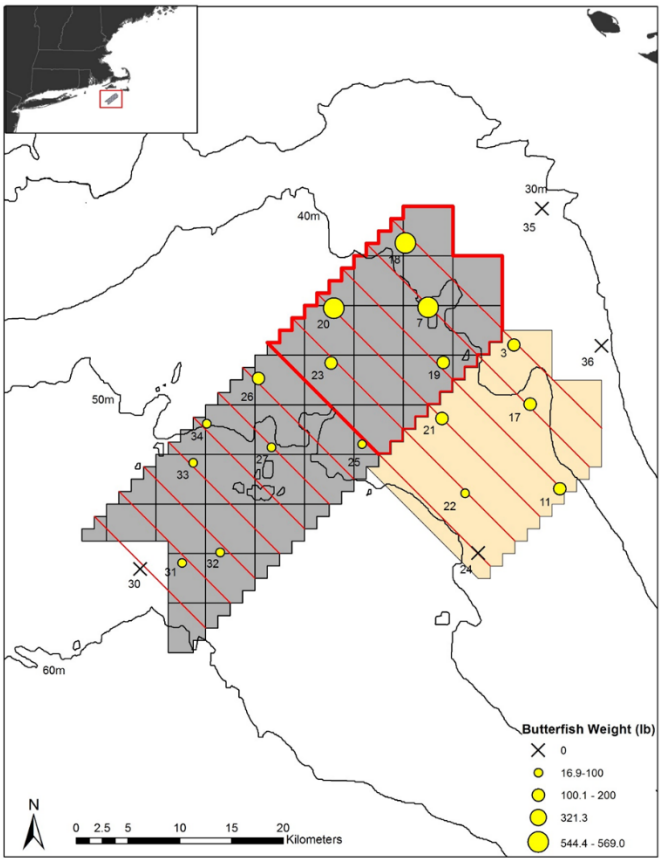

Figure A3. Distribution of butterfish catches observed during the fall 2018 survey.

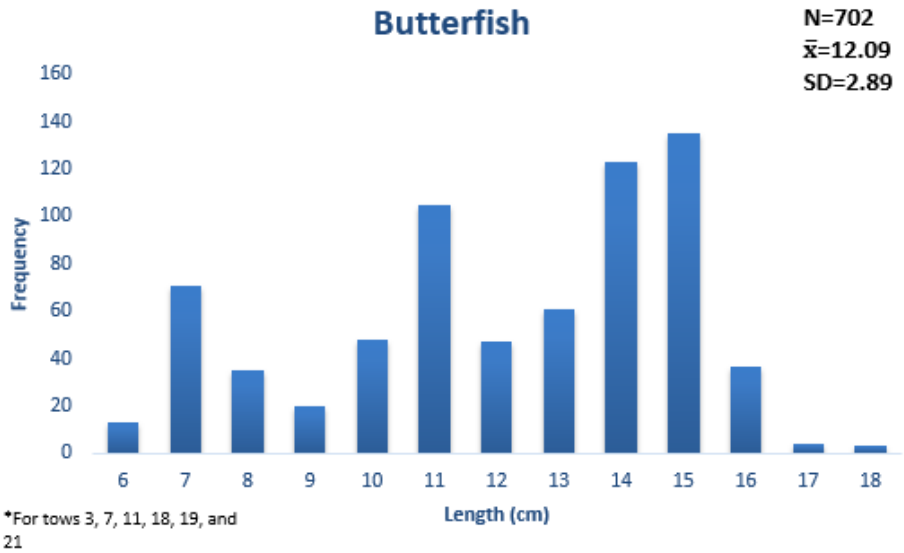

Figure A4. Length frequency distribution of butterfish observed during the fall 2018 survey.

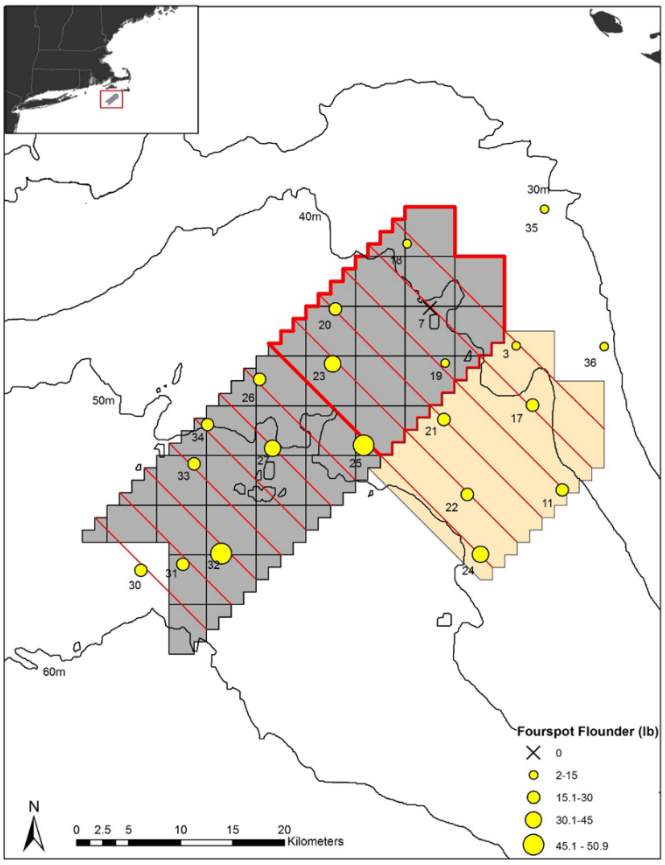

Figure A5. Distribution of fourspot flounder catches observed during the fall 2018 survey.

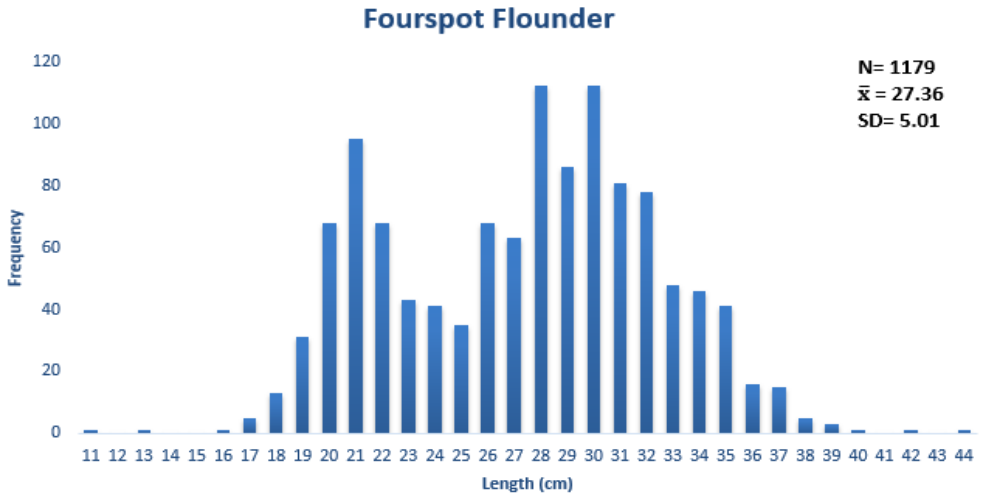

Figure A6. Length frequency distribution of fourspot flounder observed during the fall 2018 survey.

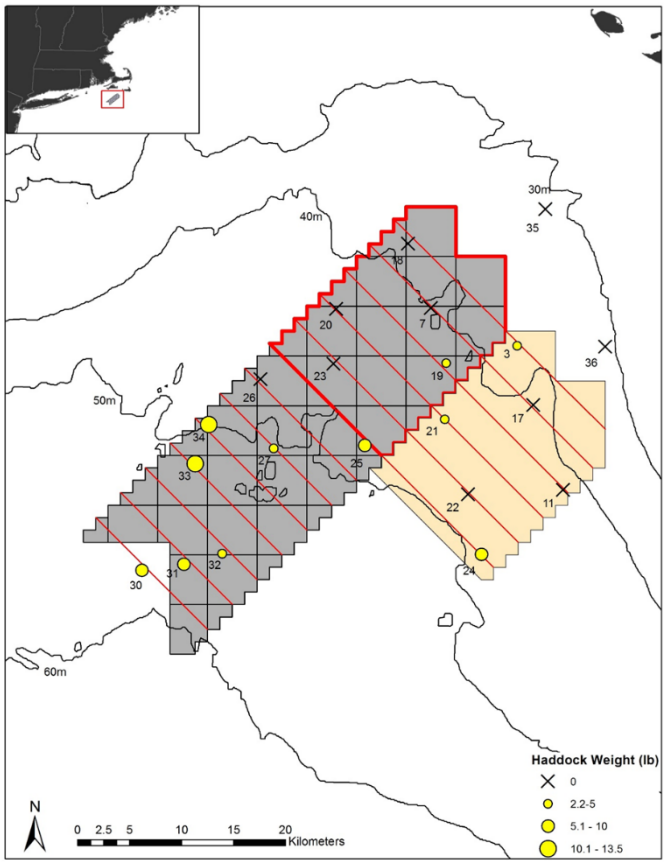

Figure A7. Distribution of haddock catches observed during the fall 2018 survey.

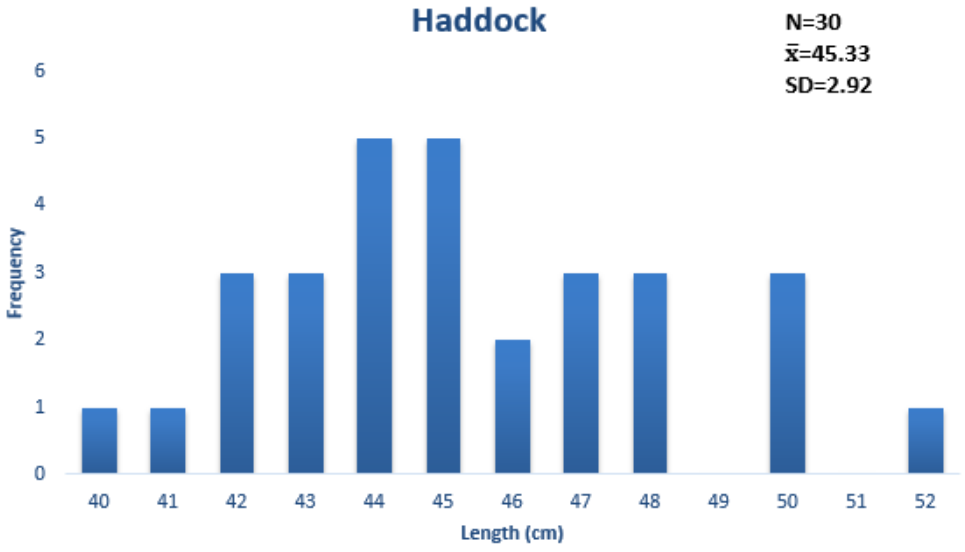

Figure A8. Length frequency distribution of haddock observed during the fall 2018 survey.

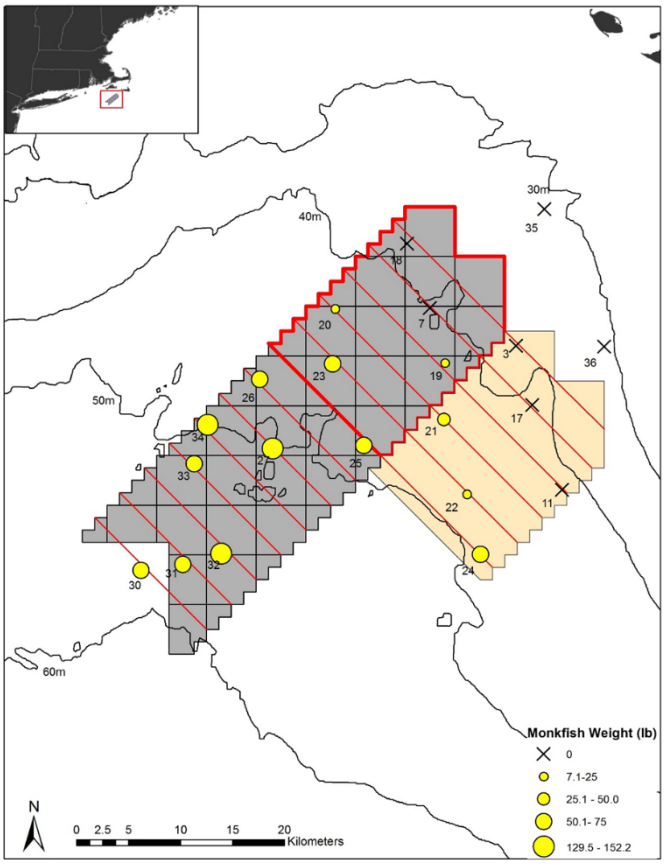

Figure A9. Distribution of monkfish catches observed during the fall 2018 survey.

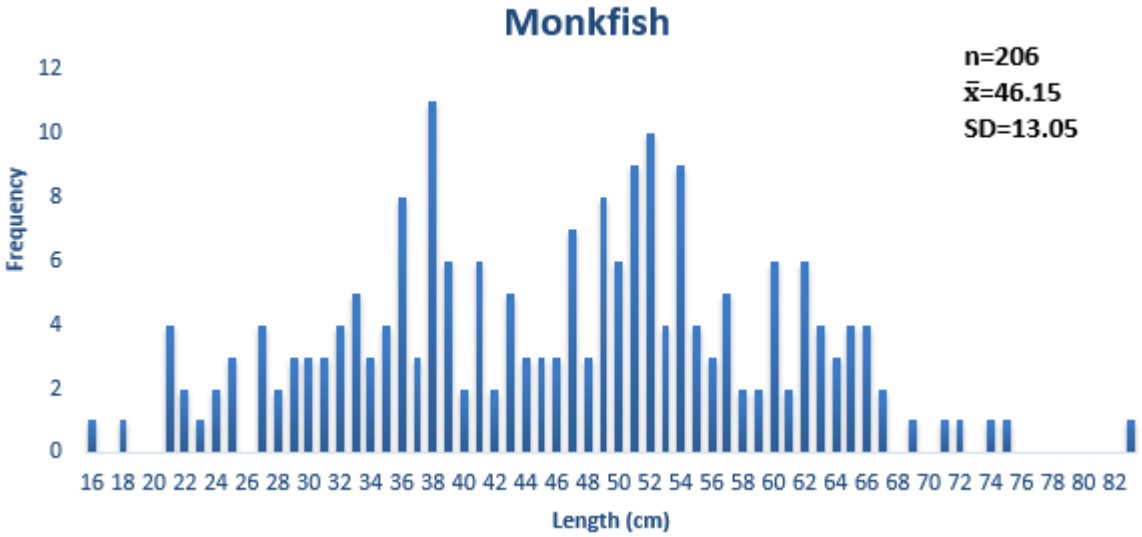

Figure A10. Length frequency distribution of monkfish observed during the fall 2018 survey.

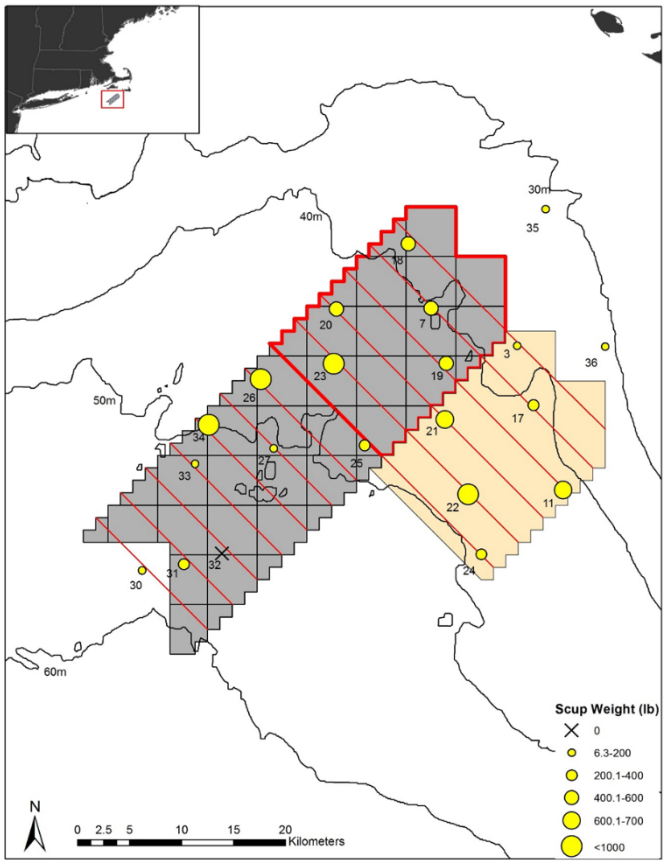

Figure A11. Distribution of scup catches observed during the fall 2018 survey.

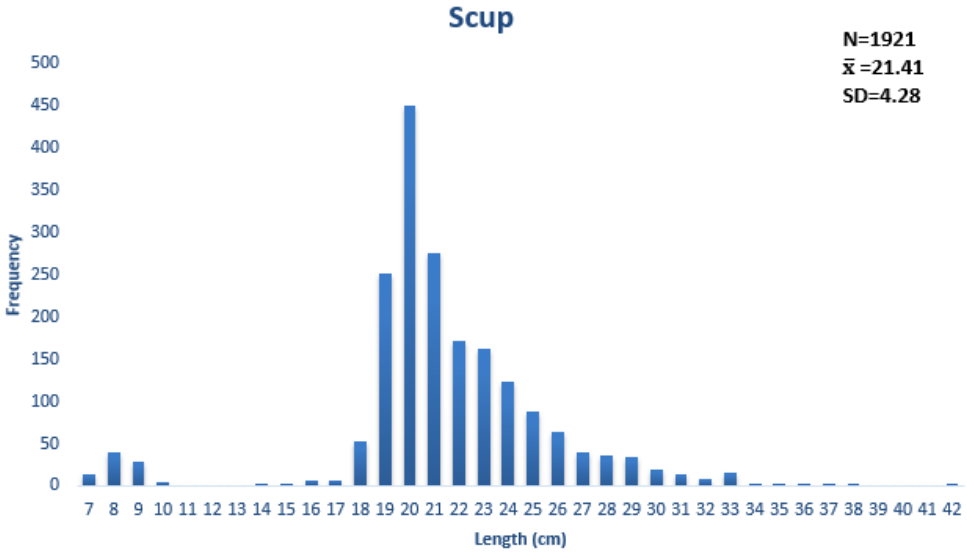

Figure A12. Length frequency distribution of scup observed during the fall 2018 survey.

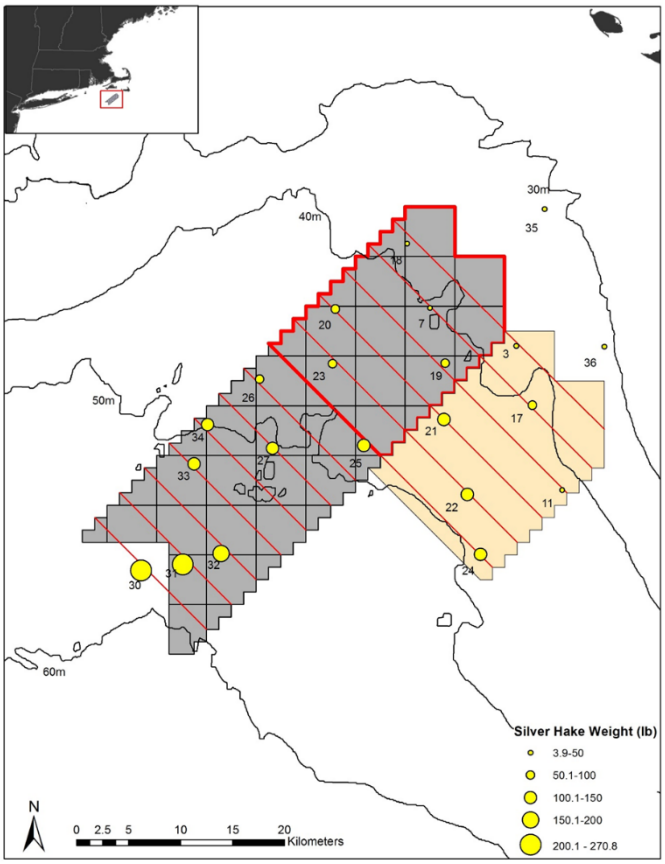

Figure A13. Distribution of silver hake catches observed during the fall 2018 survey.

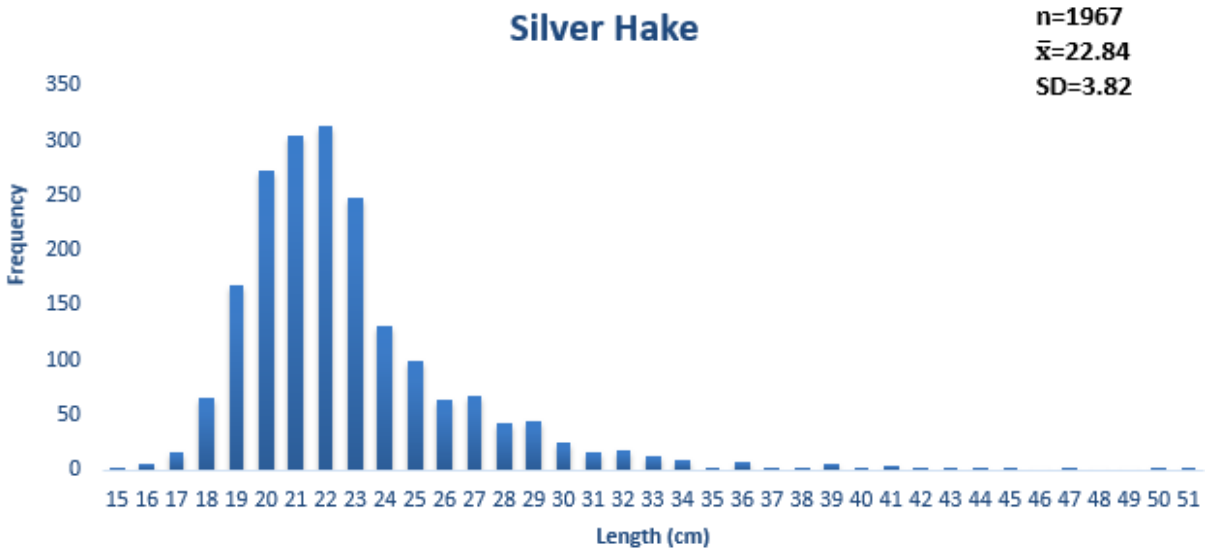

Figure A14. Length frequency distribution of silver hake observed during the fall 2018 survey.

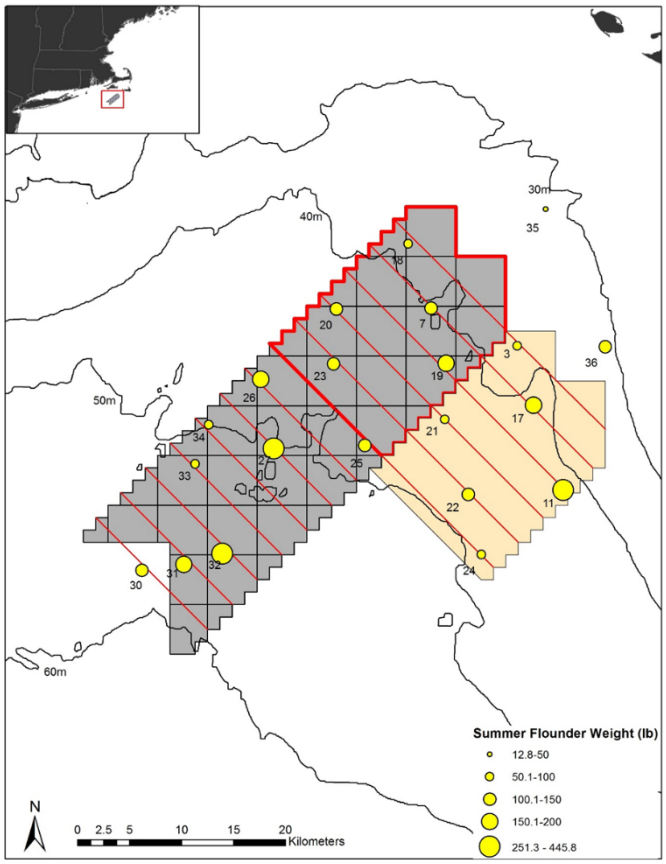

Figure A15. Distribution of summer flounder catches observed during the fall 2018 survey.

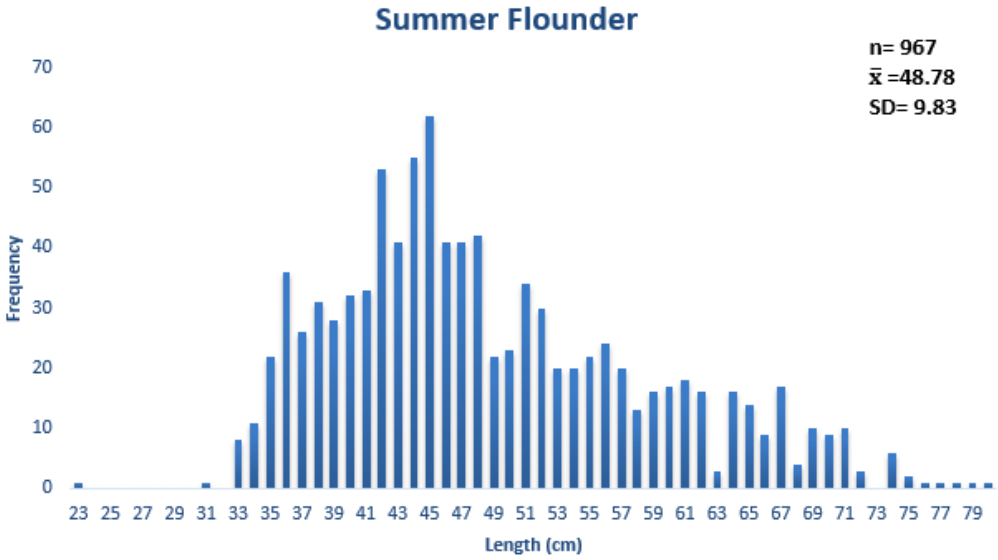

Figure A16. Length frequency distribution of summer flounder observed during the fall 2018 survey.

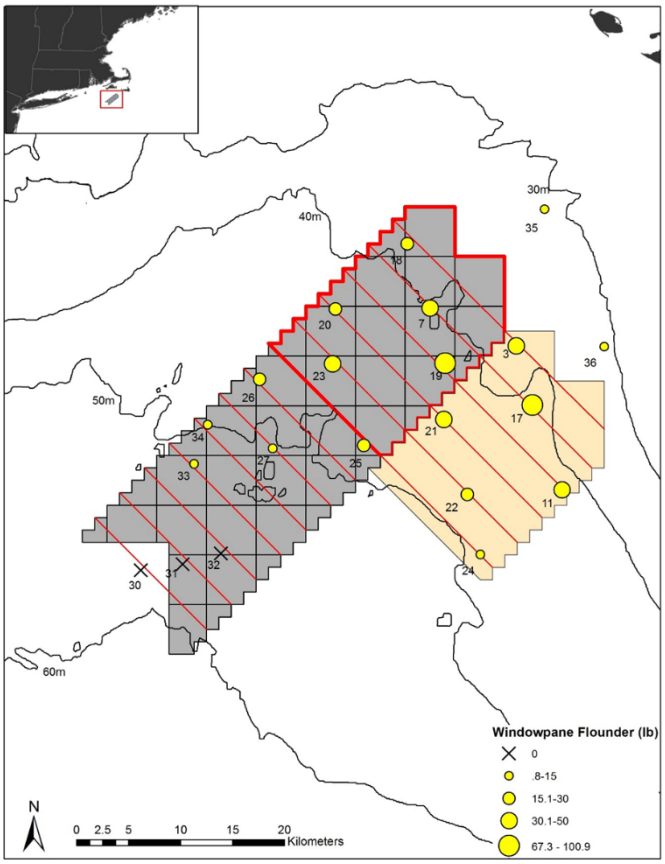

Figure A17. Distribution of windowpane flounder catches observed during the fall 2018 survey.

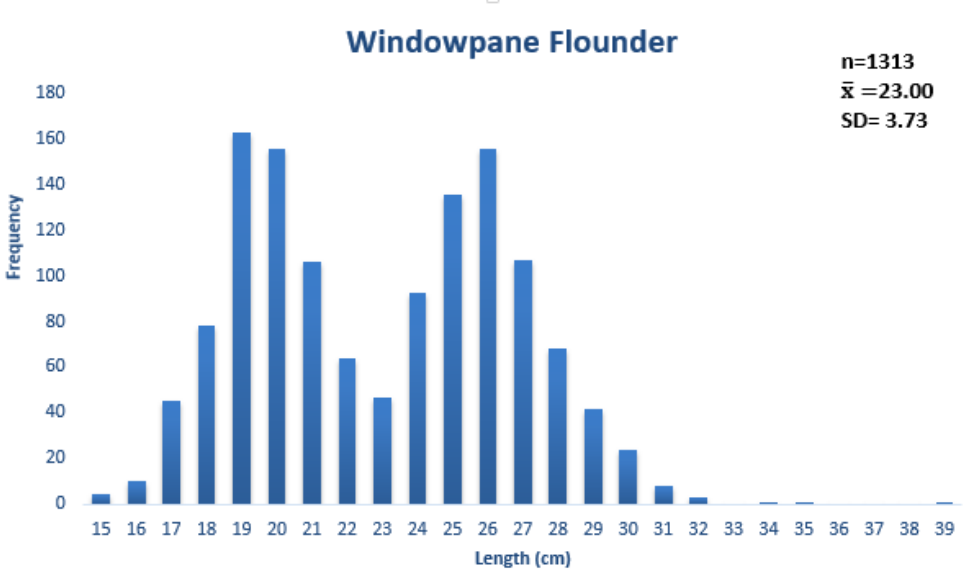

Figure A18. Length frequency distribution of windowpane flounder observed during the fall 2018 survey.

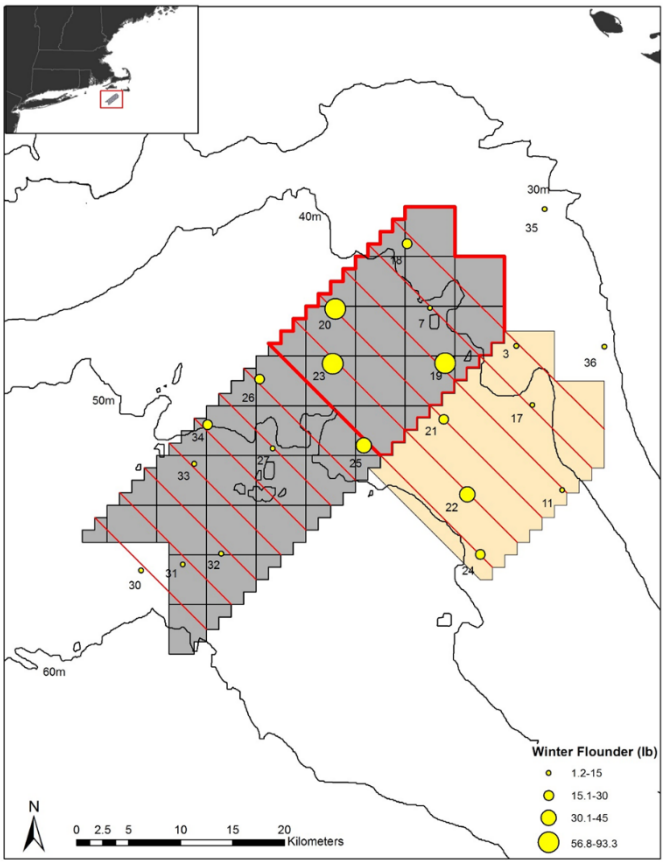

Figure A19. Distribution of winter flounder catches observed during the fall 2018 survey.

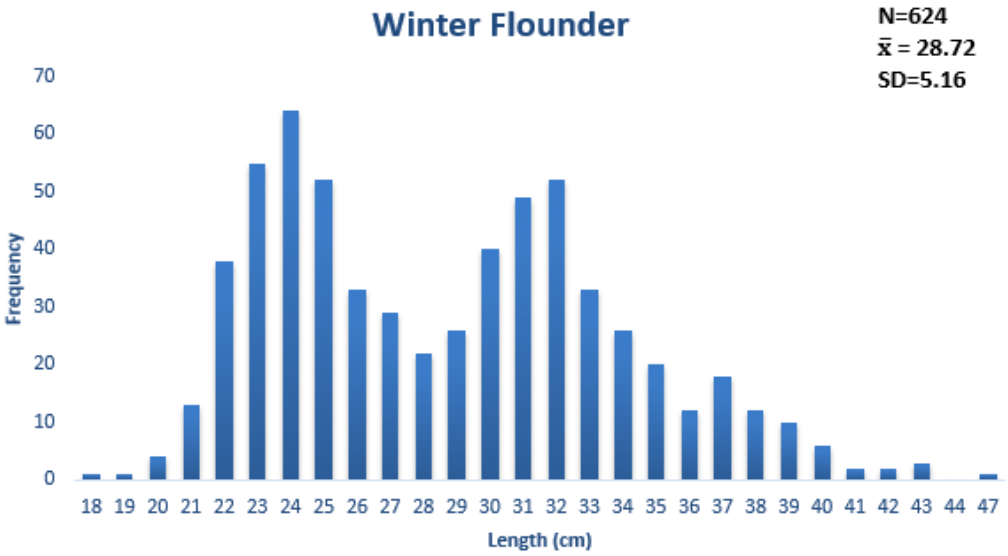

Figure A20. Length frequency distribution of winter flounder observed during the fall 2018 survey.

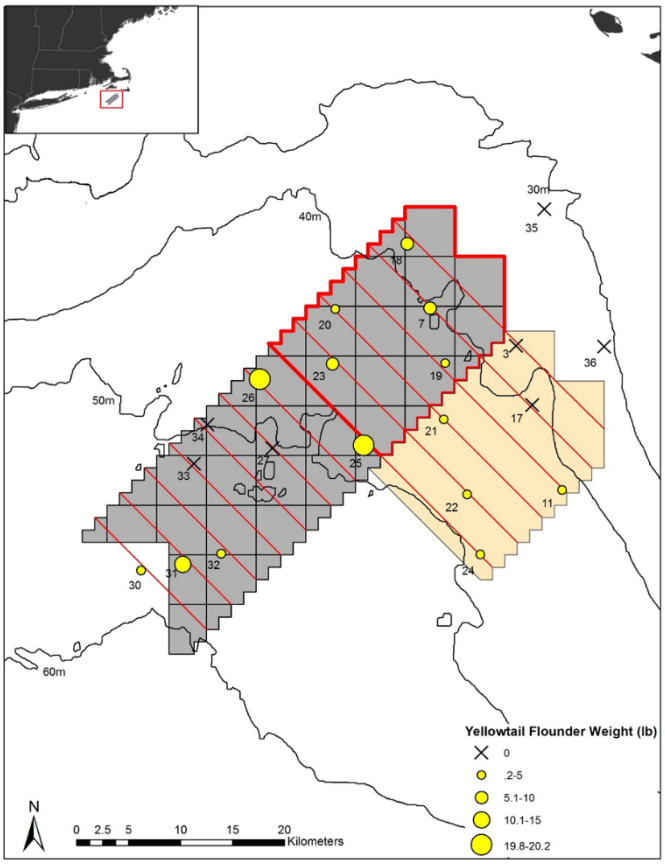

Figure A21. Distribution of yellowtail flounder catches observed during the fall 2018 survey.

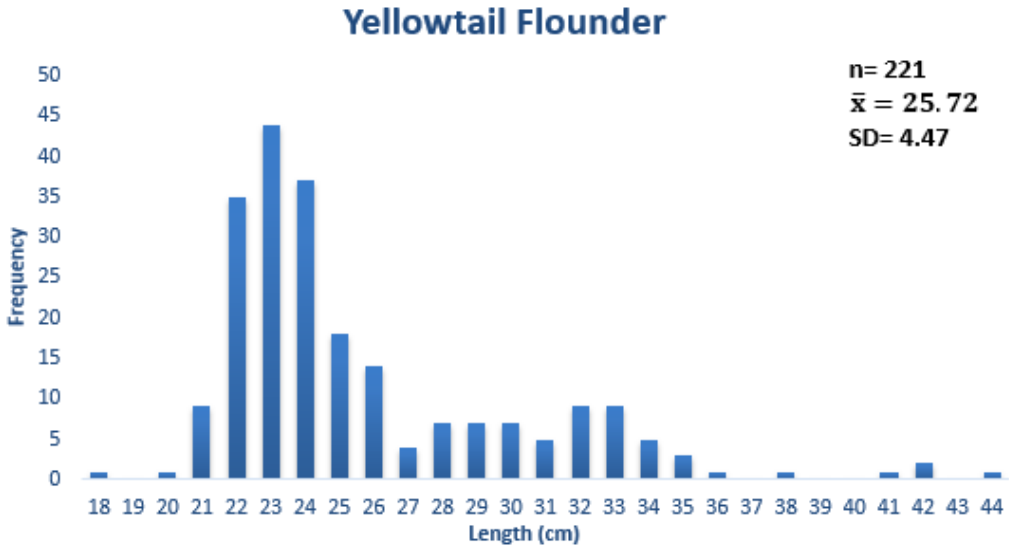

Figure A22. Length frequency distribution of winter flounder observed during the fall 2018 survey.

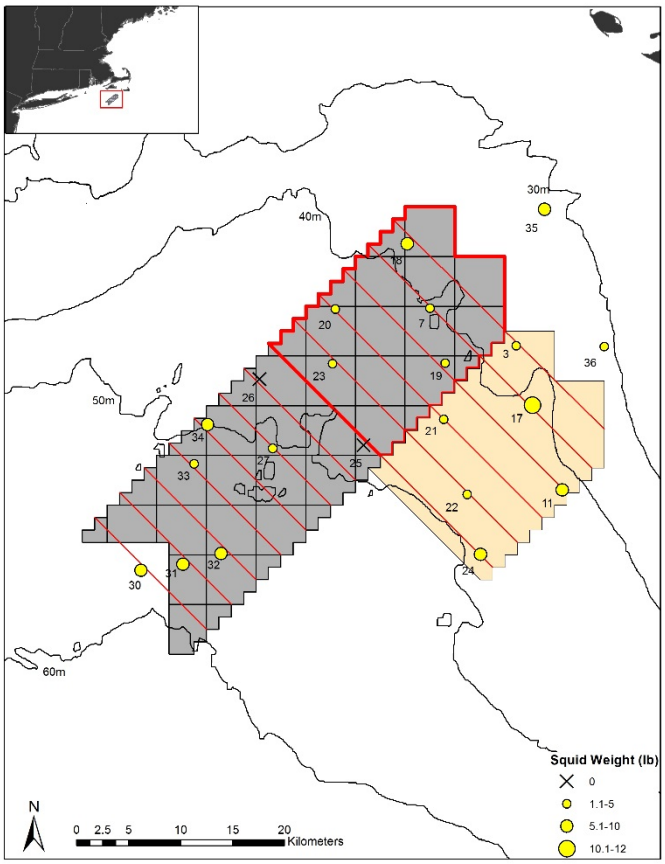

Figure A23. Distribution of squid catches observed during the fall 2018 survey.

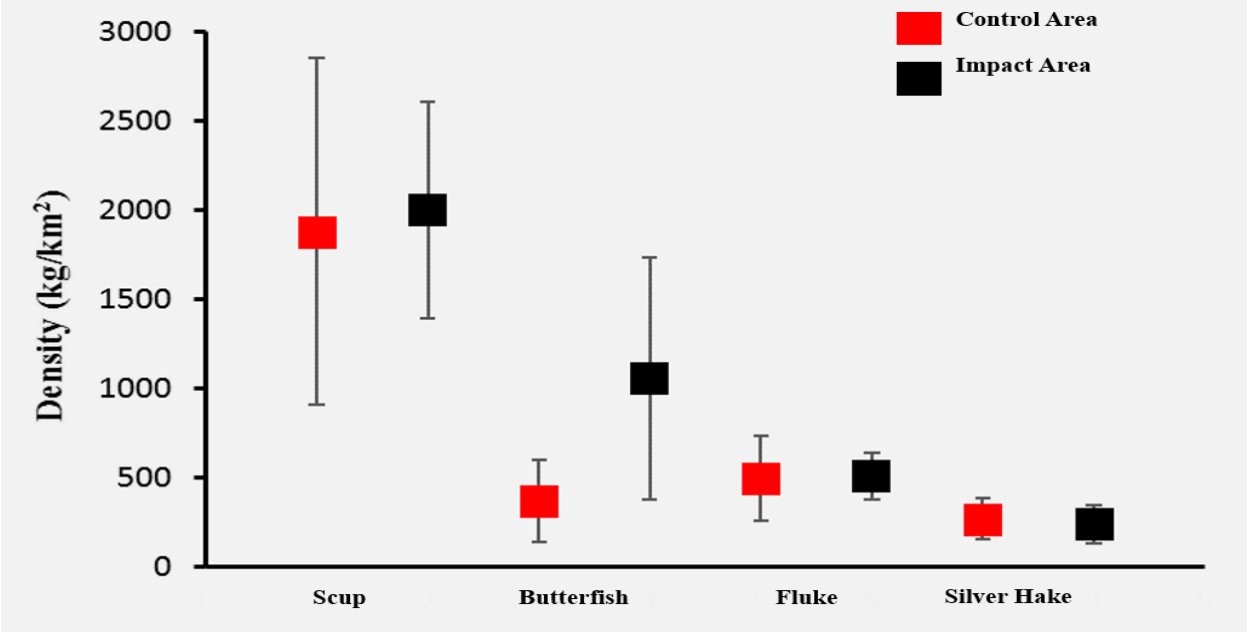

Figure A24. Mean density (kg/km^2) and standard error of scup, butterfish, fluke, and silver hake in control and development (Impact) areas.

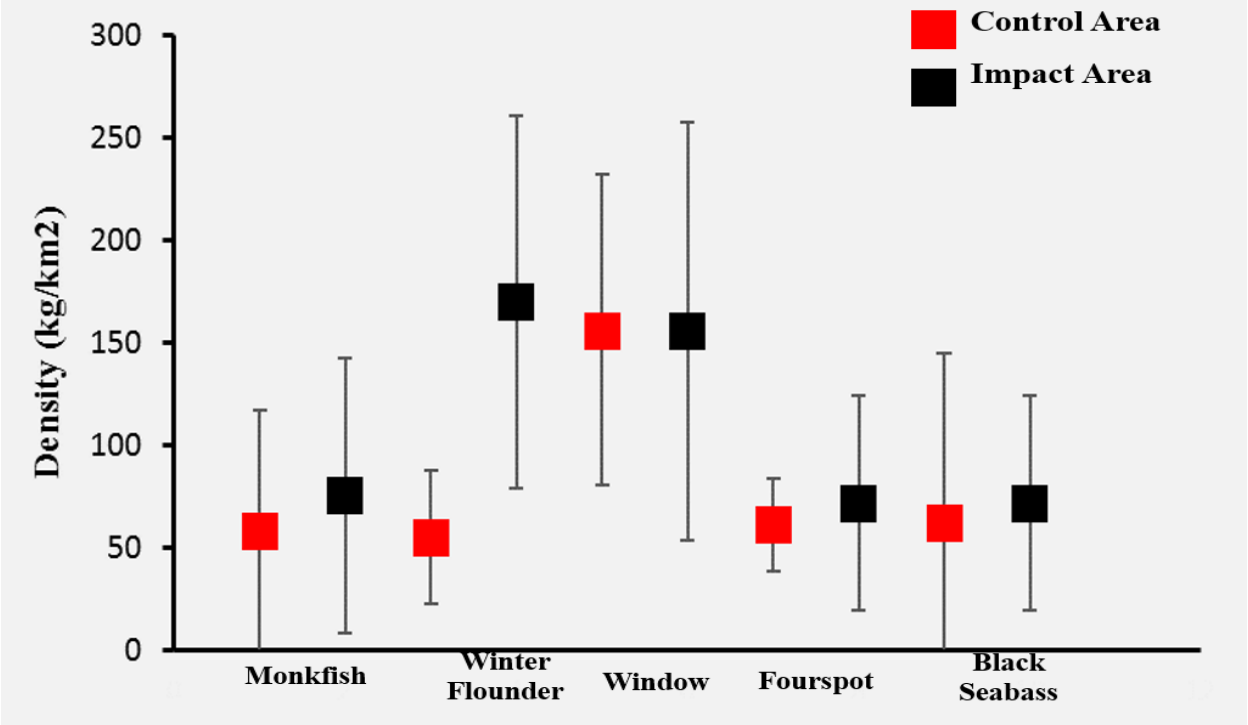

Figure A25. Mean density (kg/km^2) and standard error of monkfish, winter flounder, windowpane flounder, fourspot flounder, and black seabass in control and impact areas.

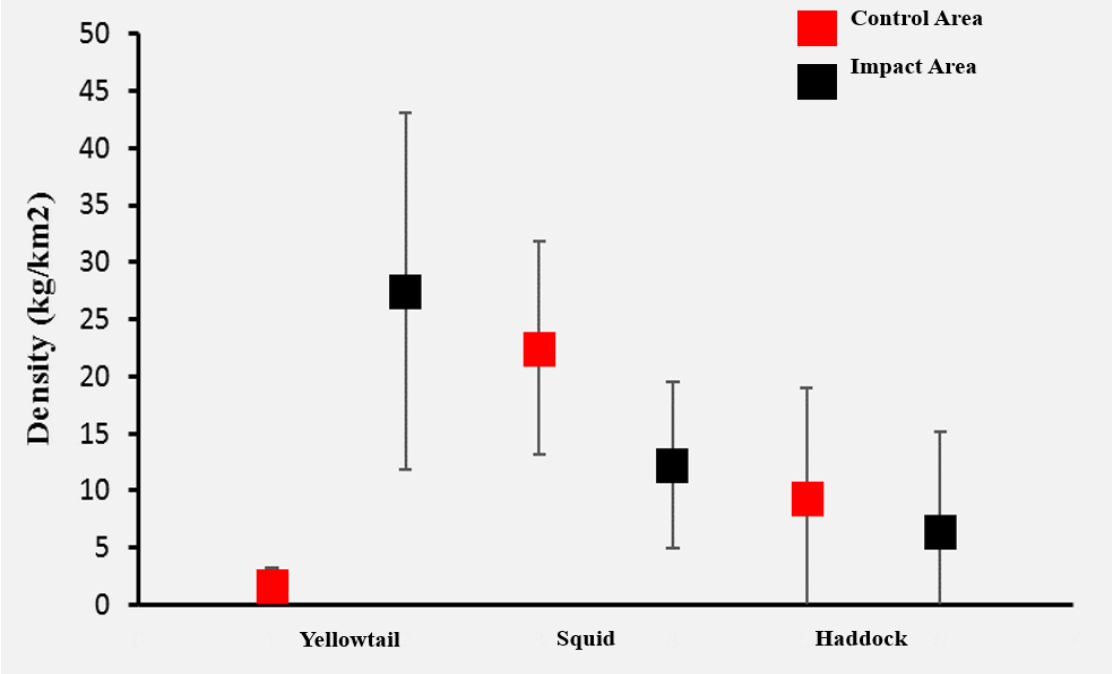

Figure A26. Mean density (kg/km^2) and standard error of yellowtail, squid and haddock in control and development (Impact) areas.

References

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2. Krebs, Charles J. *Ecological methodology*. New York: Harper & Row, 1989.