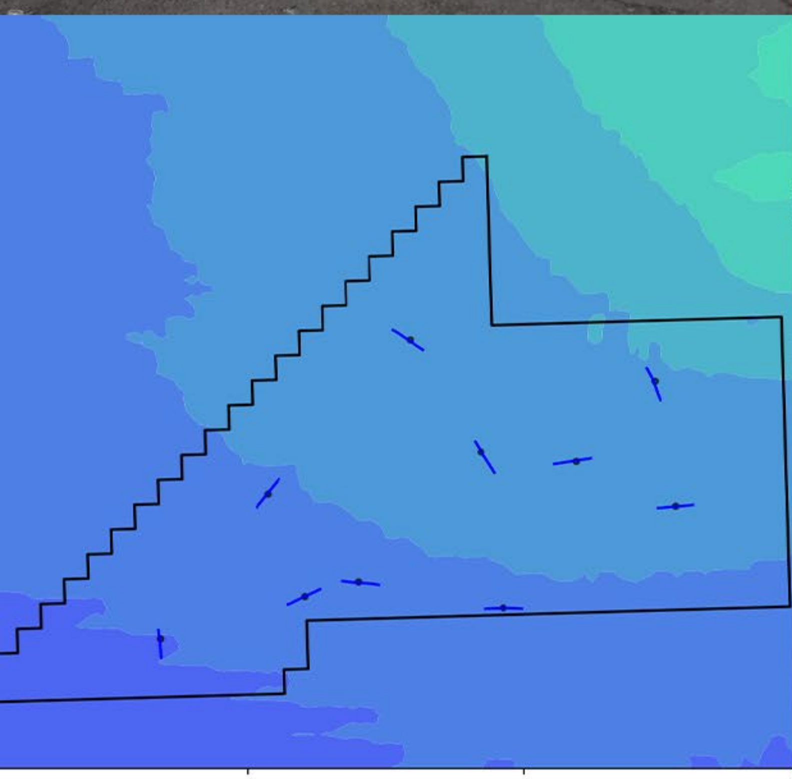
Vineyard Wind Demersal Trawl Survey



Quarterly Report

Winter 2022 (January - March)

522 Study Area

VINEYARD WIND DEMERSAL TRAWL SURVEY

Winter 2022 Seasonal Report

522 Study Area

March 2022

Prepared for Vineyard Wind LLC

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School for Marine Science and Technology

Vineyard Wind Demersal Trawl Survey
Winter 2022 Seasonal Report

522 Study Area

Progress Report #10

January 1 – March 31, 2022

Project title:	Vineyard Wind Demersal Trawl Survey Winter 2022 Seasonal Report – 522 Study Area
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Date:	March 31, 2022

You may cite this report as:
Rillahan, C., He, P. (2022). Vineyard Wind Demersal Trawl Survey Winter 2022 Seasonal Report – 522 Study Area. Progress report #10. University of Massachusetts Dartmouth – SMAST, New Bedford, MA. SMAST-CE-REP-2022-111. 37 pp.

SMAST-CE-REP-2022-111

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1. Introduction

In 2019, Vineyard Wind LLC (Vineyard Wind) leased a 536 square kilometer (km^2) area for renewable energy development on the Outer Continental Shelf, Lease Area OCS-A 0522, located south of Nantucket, Massachusetts. Vineyard Wind is conducting fisheries surveys within Lease Area OCS-A 0522 (the "522 Study Area"), which is the focus of this report. Vineyard Wind is also conducting fisheries studies within Lease Area OCS-A 0501 (the "VW1 Study Area") and within Lease Area OCS-A 0534 (the "534 Study Area"); these studies are reported separately.[1]

The Bureau of Ocean Energy Management (BOEM) has statutory obligations under the National Environmental Policy Act to evaluate the environmental, social, and economic impacts of a potential project. Additionally, BOEM has statutory obligations under the Outer Continental Shelf Lands Act to ensure any on-lease activities "protect the environment, conserve natural resources, prevent interference with reasonable use of the U.S. Exclusive Economic Zone, and consider the use of the sea as a fishery."

To address the potential impacts, Vineyard Wind, in collaboration with the University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST), has developed a monitoring plan to assess the potential environmental impacts of offshore wind development on marine fish and invertebrate communities. The impact of such developments will be evaluated using the Before-After-Control-Impact (BACI) framework. This framework is commonly used to assess the environmental impact of an activity (i.e., wind farm development and operation). Under this framework, monitoring will occur prior to development (Before), and then during construction and operation (After). During these periods, changes in the ecosystem will be compared between the development site (Impact) and a control site (Control) to assess if there is any impact due to the development of wind farms. The control site will be in the general vicinity with similar characteristics to the study areas (i.e., depth, habitat type, seabed characteristics, etc.). The goal of the monitoring plan is to assess the impact that wind farm construction and operation may have on the ecosystem within an ever-changing ocean.

[1] The Bureau of Ocean Energy Management (BOEM) segregated Lease Area OCS-A 0501 into two lease areas – OCS-A 0501 and OCS-A 0534 – in June 2021. The VW1 Study Area, which is located in the area designated as Lease Area OCS-A 0501, is referred to as the "501N Study Area" in SMAST fisheries survey reports compiled prior to the lease area segregation. Similarly, the 534 Study Area, which is located area designated as Lease Area OCS-A 0534, is referred to as the 501S Study Area in SMAST fisheries survey reports compiled prior to the lease area segregation.

The current monitoring plan incorporates multiple surveys utilizing a range of survey methods to assess different facets of the regional marine ecosystem. The trawl survey is one component of the overall survey plan. A demersal otter trawl, further referred to as a trawl, is a net that is towed behind a vessel along the seafloor and expanded horizontally by a pair of otter boards or trawl doors (Figure 1). Trawls tend to be relatively indiscriminate in the fish and invertebrates they collect; hence, bottom trawls are a generally accepted tool for assessing the biological communities along the seafloor and are widely used by institutions worldwide for ecosystem monitoring. Since they are actively towed behind a vessel, they are less biased by fish activity and behavior than passive fishing gear (i.e., gillnets, longlines, traps, etc.), which relies on animals moving to the gear. As such, state and federal fisheries management agencies heavily rely on trawl surveys to evaluate ecosystem changes and to assess the abundance of fishery resources. The current trawl survey closely emulates the Northeast Area Monitoring and Assessment Program (NEAMAP) survey protocol. In doing so, the goal was to ensure compatibility with other regional surveys, including the National Marine Fisheries Service annual spring and fall trawl surveys, the annual NEAMAP spring and fall trawl surveys, and state trawl surveys including the Massachusetts Division of Marine Fisheries trawl survey. The NEAMAP survey protocol has also been adopted by trawl surveys conducted in other offshore wind development areas in the northeast US by other institutions. The bottom trawl survey is complemented by the drop camera survey in the same area, also carried out by SMAST (reported separately).

The primary goal of this survey was to provide data related to fish abundance, distribution, and population structure in and around the 522 Study Area. The data will serve as a baseline to be used in a future analysis under the BACI framework. The reports for the first two years of monitoring from spring 2019 to spring 2021 have been submitted to the sponsoring organization. This progress report documents the survey methodology, survey effort, and data collected during the winter of 2022.

2. Methodology

The methodology for the survey was adapted from the Atlantic States Marine Fisheries Commission's NEAMAP nearshore trawl survey. Initiated in 2006, NEAMAP conducts annual spring and fall trawl surveys from Cape Hatteras to Cape Cod. The NEAMAP survey protocol has gone through extensive peer review and is currently implemented near Lease Area OCS-A 0522 using a commercial fishing vessel (Bonzek et al., 2008). The current NEAMAP protocol samples at a resolution of ~100 km^2, which is inadequate to provide scientific information related to potential changes on a smaller scale. Adapting existing methods with increased resolution (see Section 2.1) will enable the survey to fulfill the primary goal of evaluating the impact of wind farm development while improving the consistency between survey platforms. This should facilitate easier sharing and integration of the data with state and federal agencies and allow the data from this survey to be incorporated into existing datasets to enhance our understanding of the region's ecosystem dynamics. Additionally, the methodology is consistent with other ongoing surveys of nearby study areas (i.e., the VW1 Study Area and 534 Study Area).

2.1 Survey Design

The current survey is designed to provide baseline data on catch rates, population structure, and community composition for a future environmental assessment. Data collected during this survey will be used to understand the population dynamics of the area while providing data related to the spatial and temporal variability of local fish communities. A power analysis of this data will ensure that an adequate sampling resolution is used when conducting a future environmental assessment using the BACI framework as recommended by BOEM (BOEM, 2013).

Tow locations within the 522 Study Area were selected using a spatially balanced sampling design. The 522 Study Area (536 km^2) was sub-divided into 10 sub-areas (each ~53.5 km^2), and one trawl tow was made in each of the 10 sub-areas. This was designed to ensure adequate spatial coverage throughout the 522 Study Area. The starting location within each sub-area was then randomly selected (Figure 2).

2.2 Trawl Net

To ensure standardization and compatibility between these surveys and ongoing regional surveys, and to take advantage of the well-established survey protocol, the otter trawl used in this survey has an identical design to the trawl used for the NEAMAP surveys, including otter boards, ground cables, and sweeps. This trawl was designed by the Mid-Atlantic and New England Fisheries Management Council's Trawl Advisory Panel (NTAP). As a result, the net design has been accepted by management authorities, the scientific community, and the commercial fishing industry in the region.

The survey trawl is a three-bridle, four-seam bottom trawl (Figure 3). This net style allows for a high vertical opening (~5 meters [m]) relative to the size of the net and consistent trawl geometry.

These features make it a suitable net to sample a wide diversity of species with varying life history characteristics (i.e., demersal, pelagic, benthic, etc.). To effectively capture benthic organisms, a "flat sweep" was used (Figure 4). A "flat sweep" contains tightly packed rubber disks and lead weights, which ensures close contact with the substrate and minimizes the escape of fish under the net. This is permissible due to the soft bottom (i.e., sand, mud) in the 522 Study Area. To ensure the retention of small individuals, a 1" mesh size knotless liner was used within a 12-centimeter (cm) diamond mesh codend. Thyboron Type IV 66" trawl doors were used to horizontally open the net. The trawl doors were connected to the trawl by a series of steel wire bridles (see Figures 5 and 6 for a diagram of the trawl's rigging during the surveys). For a detailed description of the trawl design, see Bonzek et al. (2008).

2.3 Trawl Geometry and Acoustic Monitoring Equipment

To ensure standardization between tows, the net geometry was required to be within pre-specified tolerances (±10%) for each of the geometry metrics (door spread, wing spread, and headline height). These metrics were developed by the NTAP and are part of the operational criteria in the NEAMAP survey protocol. Headline height was targeted to be between 5.0 and 5.5 m with acceptable deviations between 4.5 and 6.1 m. Wing spread was targeted between 13.0 and 14.0 m (acceptable range: 11.7 – 15.4 m). Door spread was targeted between 32.0 and 33.0 m (acceptable range: 28.8 – 37.4 m).

The Simrad PX net mensuration system (Kongsberg Group, Kongsberg, Norway) was used to monitor the net geometry (Figure 1). Two sensors were placed in the doors, one in each, to measure the distance between the doors, referred to as door spread. Two sensors placed on the center wingends measured the horizontal spread of the net, commonly referred to as the wing spread. A sensor with a sonar transducer was placed on the top of the net (headrope) to measure the vertical net opening, referred to as headline height. The headline sensor also measured bottom water temperature. To ensure the net was on the bottom, a sensor was placed behind the footrope in the belly of the net. That sensor was equipped with a tilt sensor which reported the angle of the net belly. An angle around 0° indicated the net was on the seafloor. A towed hydrophone was placed over the side of the vessel to receive the acoustic signals from the net sensors. A processing unit, located in the wheelhouse and running the TV80 software, was used to monitor and log the data during tows (Figure 7).

2.4 Survey Operations

The survey was conducted on the F/V *Heather Lynn*, an 84' stern trawler operating out of Point Judith, Rhode Island. The F/V *Heather Lynn* is a commercial fishing vessel currently operating in the industry. One trip to the 522 Study Area between February 5 and 9, 2022 was made during which all planned tows were completed.

Tows were only conducted during daylight hours. All tows started at least 30 minutes after sunrise and ended 30 minutes before sunset. This was intended to reduce the variability commonly observed during crepuscular periods. Tow duration was 20 minutes at a target tow speed of 3.0 knots (range: 2.8 – 3.2 knots). Timing of the tow duration was initiated when the wire drums were locked and ended at the beginning of the haulback (i.e., net retrieval). The trawl was towed behind the fishing vessel from steel wires, commonly referred to as trawl warp. The trawl warp ratio (trawl warp: seafloor depth) was set to ~4:1. This decision was based on the net geometry data obtained from the 2019 surveys indicating that the 4:1 ratio constrained the horizontal spreading of the net increasing the headline height.

In addition to monitoring the net geometry to ensure acceptable performance (as described in Section 2.3 above), the following environmental and operational data were collected:

- Cloud cover (i.e., clear, partly cloudy, overcast, fog, etc.)
- Wind speed (Beaufort scale)
- Wind direction
- Sea state (Douglas Sea Scale)
- Start and end position (Latitude and Longitude)
- Start and end depth
- Tow speed
- Bottom temperature

Tow paths and tow speed were continuously logged using the OpenCPN charting software (opencpn.org) running on a computer with a USB GPS unit (GlobalSat BU-353-S4).

2.5 Catch Processing

The catch from each tow was sorted by species. Aggregated weight from each species was weighed on a motion-compensated scale (M1100, Marel Corp., Gardabaer, Iceland). Individual fish length (to the nearest centimeter) and weight (to the nearest gram) were collected. Length data were collected using a digital measuring board (DCS-5, Big Fin Scientific LLC, Austin, Texas) and individual weights were obtained from the motion-compensated digital scale (M1100, Marel Corp., Gardabaer, Iceland). An Android tablet (Samsung Active Tab 2) running DCSLinkStream (Big Fin Scientific LLC, Austin, Texas) served as the data collection platform.

Efforts were made to process all animals; however, during large catches, sub-sampling was used for some abundant species. Only one sub-sampling strategy was employed over the duration of the survey: straight sub-sampling by weight and discard by count.

Straight subsampling by weight: When catch diversity was relatively low (five to 10 species), straight sub-sampling was used. In this method, the catch was sorted by species. An aggregated species weight was measured and then a sub-sample (50 – 100 individuals) was collected for individual length and weight measurements. The ratio of the sub-sample weight to the total species weight was then used to extrapolate the length-frequency estimates. This was the predominant sub-sampling strategy.

Lengths were collected during every tow. Individual fish weights were collected during every tow for low abundance species (<20 individuals/tow) or during alternating tows for abundant common species (>20 individuals/tow). The result from each tow was a measurement of aggregated weight, length-frequency curves, and length-weight curves for each species except crabs, lobsters, and some non-commercial species. For these species, aggregated weight and counts were collected. Any observation of squid eggs was documented. All data were manually recorded and entered into a Microsoft Access database.

3. Results

3.1 Operational Data, Environmental Data, and Trawl Performance

Ten tows were successfully completed in the 522 Study Area (Figure 2, Table 1). Tow duration averaged 20.0 ± 0.2 minutes (mean ± one standard deviation). Tow distance averaged 1.0 ± 0.02 nautical miles (nmi) giving an average tow speed of 2.9 ± 0.04 knots.

The seafloor in the 522 Study Area follows a north to south depth gradient with the shallowest tow along the northern edge (~40 m). Depth increased to a maximum of 60 m along the southwestern boundary. Bottom water temperatures were relatively consistent at 4.7 ± 0.3°C (40.5 ± 0.5°F, Table 2). The winter 2022 survey was comparable to the winter 2020 and 2021 surveys where bottom water temperatures averaged 5.1 ± 0.2°C and 4.7 ± 0.5°C, respectively.

The trawl geometry data indicated that the trawl took about two to three minutes to open and stabilize. Once open, readings were stable throughout the duration of the tow. Door spread averaged 36.5 ± 1.7 m (range: 33.3 – 38.6 m). Wing spread averaged 14.3 ± 0.4 m (range: 13.5 – 14.8 m). Headline height averaged 4.7 ± 0.3 m (range: 4.5 – 5.3 m). All tows were in the acceptable range for all the trawl parameters.

3.2 Catch Data

In the 522 Study Area, a total of 24 species were caught over the duration of the survey (Table 3). Catch volume ranged from 0.7 to 136.4 kilograms per tow (kg/tow) with an average of 70.1 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (little skate, Atlantic herring, spiny dogfish, alewife, and longhorn sculpin) accounted for 90.9% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Little skate (*Leucoraja erinacea*) was the most abundant species observed in the 522 Study Area, accounting for 38.8% of the total catch weight. Individuals ranged in size from 15 to 30 cm (disk width) with a unimodal size distribution consisting of a peak at 26 cm (Figure 8). Little skate were observed in all 10 tows. Catch rates averaged 27.2 ± 9.1 kg/tow (mean ± Standard Error of the Mean [SEM], range: 0.2 – 74.6 kg/tow). Little skate were observed to follow a gradient throughout the 522 Study Area with the highest catches in the southwest and lowest catches in the northeast (Figure 9).

Atlantic herring (*Clupea harengus*) was the second most abundant species, accounting for 27.3% of the total catch weight. Atlantic herring ranged in length from 18 to 25 cm with a unimodal size distribution consisting of a peak at 21 cm (Figure 10). Atlantic herring were observed in nine of the 10 tows at an average catch rate of 19.1 ± 8.9 kg/tow (range: 0 – 91.6 kg/tow). Atlantic herring were caught throughout the 522 Study Area (Figure 11).

Spiny dogfish (*Squalus acanthias*) was the third most abundant species observed in the 522 Study Area. Individuals ranged in length from 20 to 78 cm with a wide unimodal size distribution peaking at 66 cm (Figure 12). Spiny dogfish were observed in 5 of the 10 tows. Catch rates averaged 12.9 ± 6.4 kg/tow (0 – 61.9 kg/tow). Spiny dogfish were observed in the southern half of the 522 Study Area in deeper waters (Figure 13).

Alewife (*Alosa pseudoharengus*) was the fourth most abundant species observed. Individuals ranged in length from 14 to 24 cm with a unimodal size distribution peaking at 20 cm (Figure 14). Alewife were observed in eight of the 10 tows. Catch rates averaged 2.4 ± 1.4 kg/tow (range: 0 – 14.6 kg/tow). Alewife were observed throughout the 522 Study Area with higher catches in the western half of the 522 Study Area (Figure 15).

Longhorn sculpin (*Myoxocephalus octodecimspinosus*) was commonly caught in the 522 Study Area. Individuals ranged in length from 23 to 36 cm with a wide size distribution (Figure 16). Longhorn sculpin were observed in seven of the 10 tows at an average catch rate of 2.1 ± 0.6 kg/tow (range: 0 – 5.1 kg/tow). Longhorn sculpin were observed throughout the 522 Study Area with higher catches observed in the western half of the study area (Figure 17).

Atlantic cod (*Gadus morhua*) were commonly observed in the 522 Study Area. Individuals ranged in length from 36 to 53 cm with a broad size distribution (Figure 18). Atlantic cod were observed in six of the 10 tows with an average catch rate of 1.5 ± 0.6 kg/tow (range: 0 – 5.0 kg/tow). Atlantic Cod were primarily observed in the western half of the 522 Study Area (Figure 19).

Blueback herring (*Alosa aestivalis*) were commonly observed in the 522 Study Area. Individuals ranged in length from 14 to 24 cm with a unimodal peak at 21 cm (Figure 20). The average catch rate of blueback herring was 1.0 ± 0.8 kg/tow (range: 0 – 8.0 kg/tow). Blueback herring were only caught in the western half of the 522 Study Area (Figure 21).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was a frequently observed species in the 522 Study Area. Individuals ranged in length from 8 to 29 cm. Silver hake had a unimodal size distribution consisting of a peak at 11 cm (Figure 22). Silver hake were observed in seven of the 10 tows at an average catch rate of 0.6 ± 0.4 kg/tow (range: 0 – 3.6 kg/tow). The highest catches of silver hake were observed in the southwestern corner of the 522 Study Area (Figure 23).

Windowpane flounder (*Scophtalmus aquosus*) is a federally regulated commercial flatfish species found in the 522 Study Area. Individuals ranged in length from 13 to 30 cm with a wide size distribution (Figure 24). Windowpane flounder were observed in nine of the 10 tows at an average catch rate of 0.5 ± 0.2 kg/tow (range: 0 – 1.7 kg/tow). Windowpane flounder were caught throughout the 522 Study Area with the highest catches observed in the southwestern corner of the 522 Study Area (Figure 25).

Less common recreational and commercial species observed included one individual summer flounder (*Paralichthys dentatus*, 26 cm), one individual haddock (*Melanogrammus aeglefinus*, 26 cm), and one individual monkfish (*Lophius americanus*).

4. Acknowledgements

We would like to thank the owner (Paul Farnham), captain (Mike Gallagher), and crew (Matt Manchester, Scott Riley, and Barry Klapp) of the F/V *Heather Lynn* for their help sorting, processing, and measuring the catch. Additionally, we would like to thank Mike Coute, Keith Hankowsky, and David Gauld in our Fish Behavior and Conservation Engineering lab for their help with data collection at sea.

5. References

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Table 1: Operational and environmental conditions for each survey tow.

Tow Number	Date	Sky Condition	Wind State (Knots)	Wind Direction	Sea State (m.)	Start Time	Start Latitude	Start Longitude	Start Depth (fm)	End Time	End Latitude	End Longitude	End Depth (fm)	Bottom Temp. (ºC)	Trawl Warp (fm)
1	2/7/2022	Mostly Cloudy	7-10	E	0.5-1.25	7:09	N 40º 45.079	W 70º 15.120	25	7:29	N 40º 44.544	W 70º 14.097	24	5.5	100
2	2/7/2022	Partly Cloudy	7-10	E	0.5-1.25	8:12	N 40º 42.037	W 70º 12.281	25	8:32	N 40º 41.127	W 70º 11.642	25	5.6	100
3	2/7/2022	Mostly Cloudy	7-10	E	0.5-1.25	9:06	N 40º 41.417	W 70º 09.527	25	9:26	N 40º 41.558	W 70º 08.197	25	5.8	100
4	2/7/2022	Mostly Cloudy	7-10	E	0.5-1.25	10:10	N 40º 44.947	W 70º 06.193	23	10:30	N 40º 43.100	W 70º 05.745	24	5.6	100
5	2/7/2022	Partly Cloudy	7-10	E	0.5-1.25	11:15	N 40º 40.258	W 70º 04.660	25	11:35	N 40º 40.189	W 70º 05.882	25	6.0	100
6	2/7/2022	Mostly Cloudy	11-15	E	0.5-1.25	12:33	N 40º 37.545	W 70º 10.750	29	12:53	N 40º 37.556	W 70º 12.003	29	6.1	125
7	2/7/2022	Partly Cloudy	11-15	E	0.5-1.25	13:29	N 40º 38.245	W 70º 15.792	29	13:49	N 40º 38.355	W 70º 17.033	30	6.0	125
8	2/7/2022	Partly Cloudy	11-15	SE	1.25-2.5	14:25	N 40º 38.151	W 70º 17.849	30	14:45	N 40º 37.753	W 70º 18.968	31	6.2	125
9	2/7/2022	Partly Cloudy	11-15	SE	1.25-2.5	15:39	N 40º 35.966	W 70º 23.404	33	15:59	N 40º 37.125	W 70º 23.563	33	6.0	150
10	2/7/2022	Mostly Cloudy	11-15	SE	1.25-2.5	16:51	N 40º 40.366	W 70º 20.023	28	17:11	N 40º 41.111	W 70º 19.043	27	5.9	120

Table 2: Tow parameters for each survey tow.

Tow Number	Tow Duration (min)	Tow Distance (nmi)	Tow Speed (knots)	Start Depth (fm)	Bottom Temp. (^{o}C)	Trawl Warp (fm)	Headline Height (m)	Wing Spread (m)	Spread Door (m)
1	20.0	1.0	2.9	25	5.5	100	4.7	14.4	36.8
2	20.0	1.0	2.9	25	5.6	100	4.8	14.0	36.4
3	20.5	1.0	2.9	25	5.8	100	5.3	14.2	36.2
4	19.5	0.9	2.8	23	5.6	100	4.6	14.2	33.3
5	20.0	0.9	2.8	25	6.0	100	5.1	13.5	34.3
6	20.0	1.0	2.9	29	6.1	125	4.6	14.4	37.2
7	20.0	1.0	3.0	29	6.0	125	4.5	14.6	37.7
8	20.0	0.9	2.8	30	6.2	125	4.6	14.6	
9	20.0	1.0	2.9	33	6.0	150	4.5	14.8	38.6
10	20.0	0.9	2.8	28	5.9	120	4.5	14.7	38.1
Summary Statistics									
Minimum	19.5	0.9	2.8	23	5.5	100	4.5	13.5	33.3
Maximum	20.5	1.0	3.0	33	6.2	150	5.3	14.8	38.6
Average	20.0	1.0	2.9	27	5.9	115	4.7	14.3	36.5
St. Dev	0.2	0.02	0.04	3.1	0.2	17.2	0.3	0.4	1.7

Table 3: Total and average catch weights for 10 tows within the 522 Study Area.

Species Name	Scientific Name	Total Weight (kg)	Catch/Tow (kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Skate, Little	*Leucoraja erinacea*	272.1	27.2	9.1	38.8	10
Herring, Atlantic	*Clupea harengus*	191.5	19.1	8.9	27.3	9
Dogfish, Spiny	*Squalus acanthias*	128.9	12.9	6.4	18.4	5
Alewife	*Alosa pseudoharengus*	24.1	2.4	1.4	3.4	8
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	21.0	2.1	0.6	3.0	7
Atlantic Cod	*Gadus morhua*	15.8	1.6	0.6	2.3	6
Herring, Blueback	*Alosa aestivalis*	10.3	1.0	0.8	1.5	5
Shad, American	*Alosa sapidissima*	6.6	0.7	0.2	0.9	6
Skate, Winter	*Leucoraja ocellata*	6.1	0.6	0.4	0.9	2
Hake, Silver (Whiting)	*Merluccius bilinearis*	5.8	0.6	0.4	0.8	7
Flounder, Windowpane	*Scophtalmus aquosus*	4.5	0.5	0.2	0.6	9
Hake, Red	*Urophycis chuss*	3.2	0.3	0.1	0.5	6
Crab, Rock	*Cancer irroratus*	2.4	0.2	0.2	0.3	1
Sea Raven	*Hemitripterus americanus*	2.1	0.2	0.1	0.3	2
Hake, Spotted	*Urophycis regia*	1.9	0.2	0.1	0.3	6
Butterfish	*Peprilus triacanthus*	1.9	0.2	0.0	0.3	9
Mackerel, Atlantic	*Scomber scombrus*	1.6	0.2	0.1	0.2	3
Ocean Pout	*Zoarces americanus*	0.7	0.1	0.1	0.1	1
Squid, Atlantic Longfin	*Dorytheuthis pealei*	0.5	0.05	0.02	0.1	4
Flounder, Summer (Fluke)	*Paralichthys dentatus*	0.2	0.02	0.02	0.03	1
Haddock	*Melanogrammus aeglefinus*	0.2	0.02	0.02	0.03	1
Skate, Barndoor	*Dipturus laevis*	0.1	0.01	0.01	0.01	1
Flounder, Fourspot	*Paralichthys oblongus*	0.1	0.01	0.01	0.01	1
Monkfish	*Lophius americanus*	0.1	0.01	0.01	0.01	1
Total		701.7				

*SEM - for Standard Error of the Mean

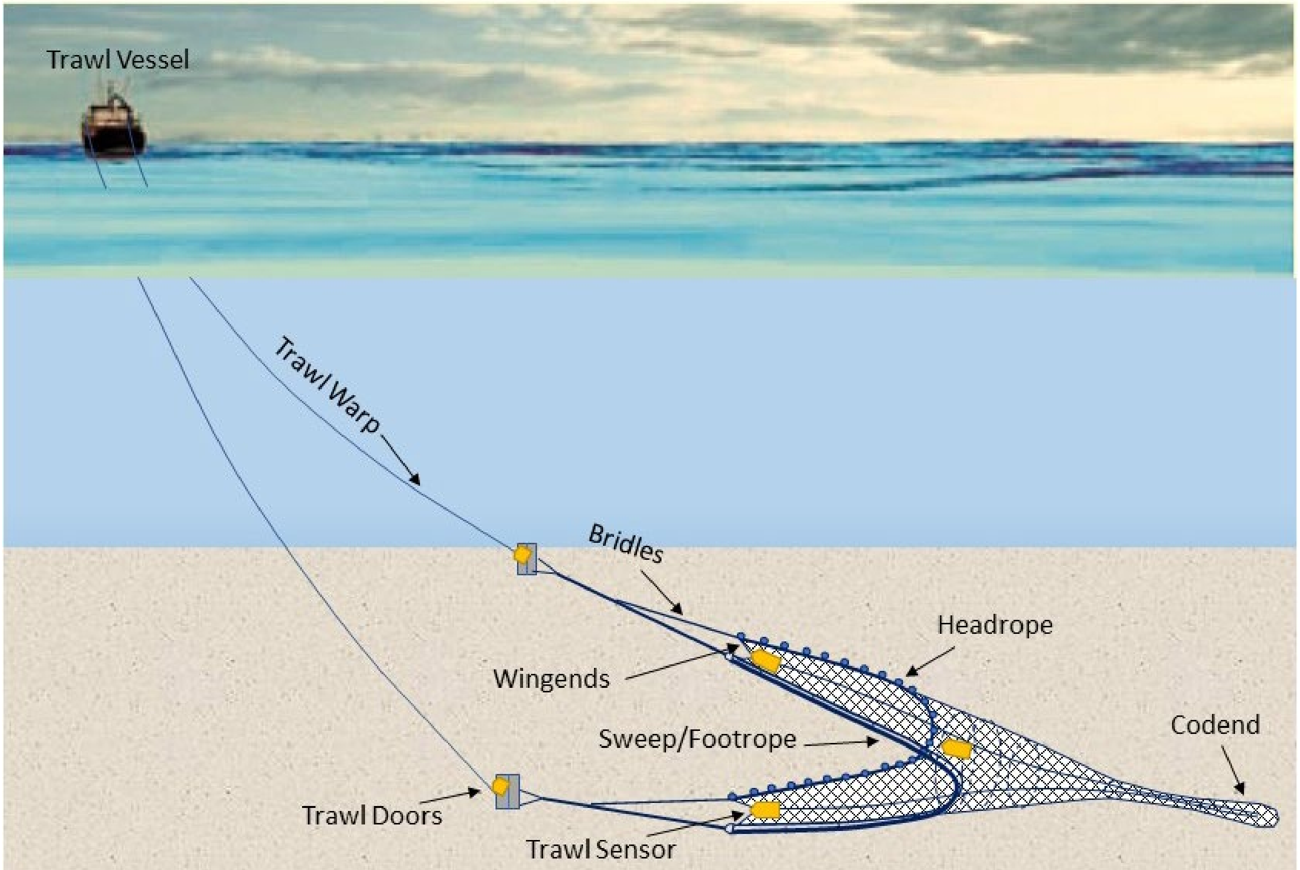


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate Simrad PX trawl geometry sensors.

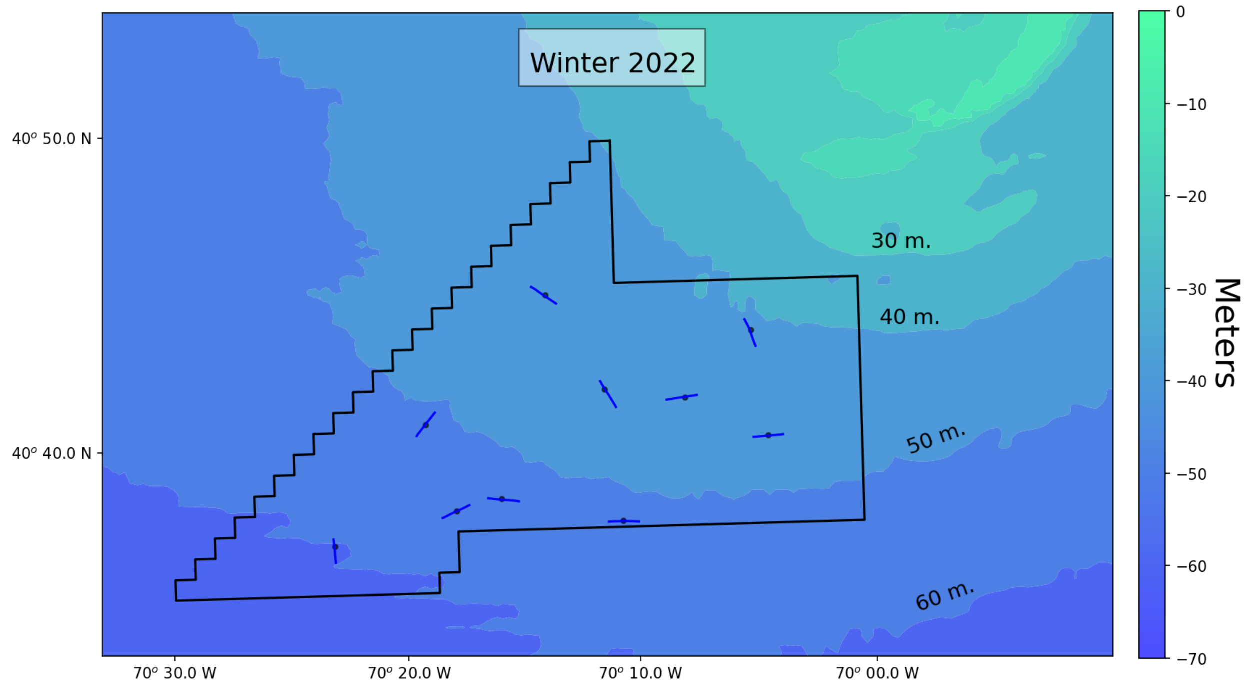


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Study Area.

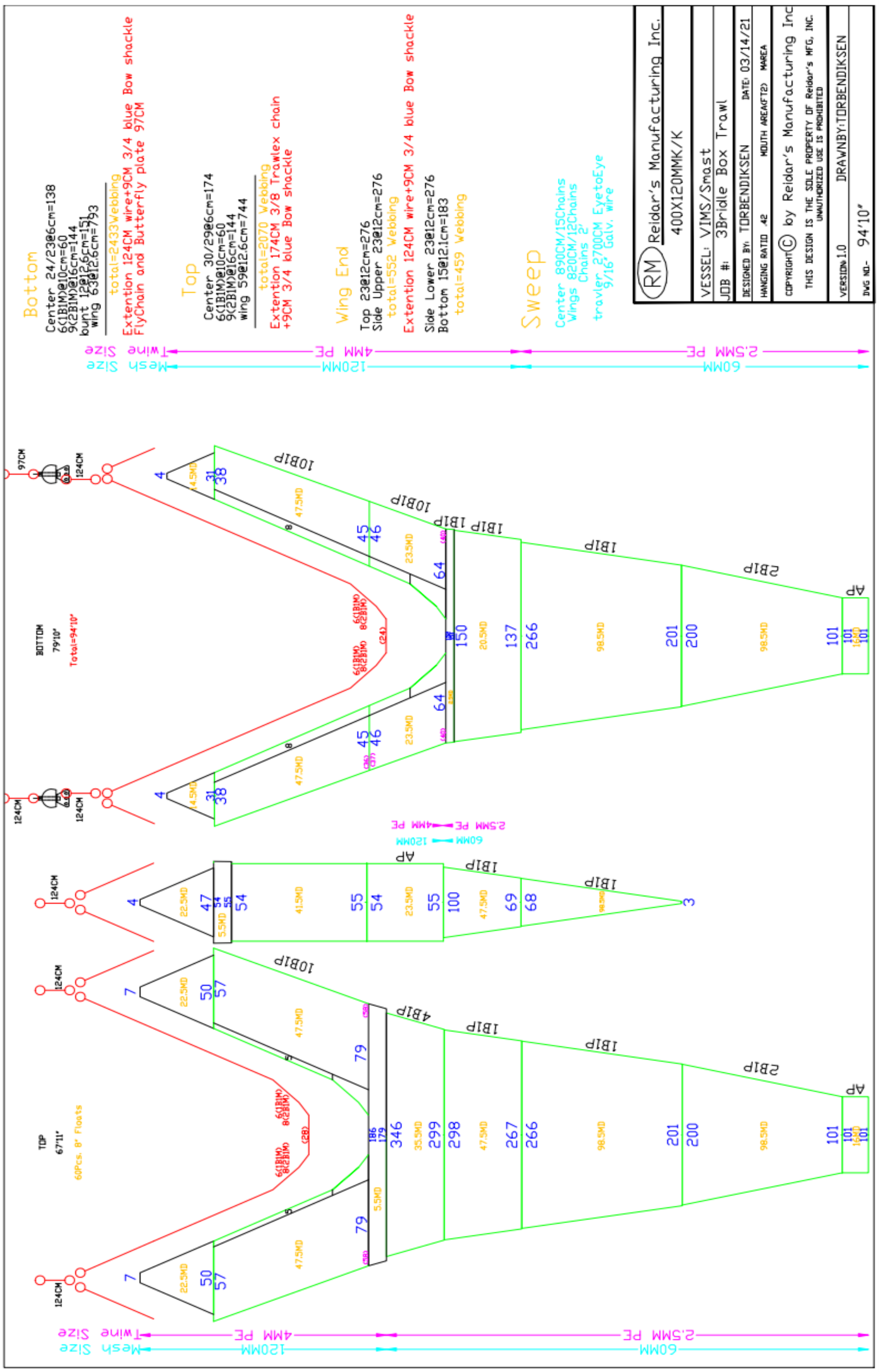


Figure 3: Schematic net plan for the NEAMAP trawl (Courtesy of Reidar's Manufacturing Inc.).

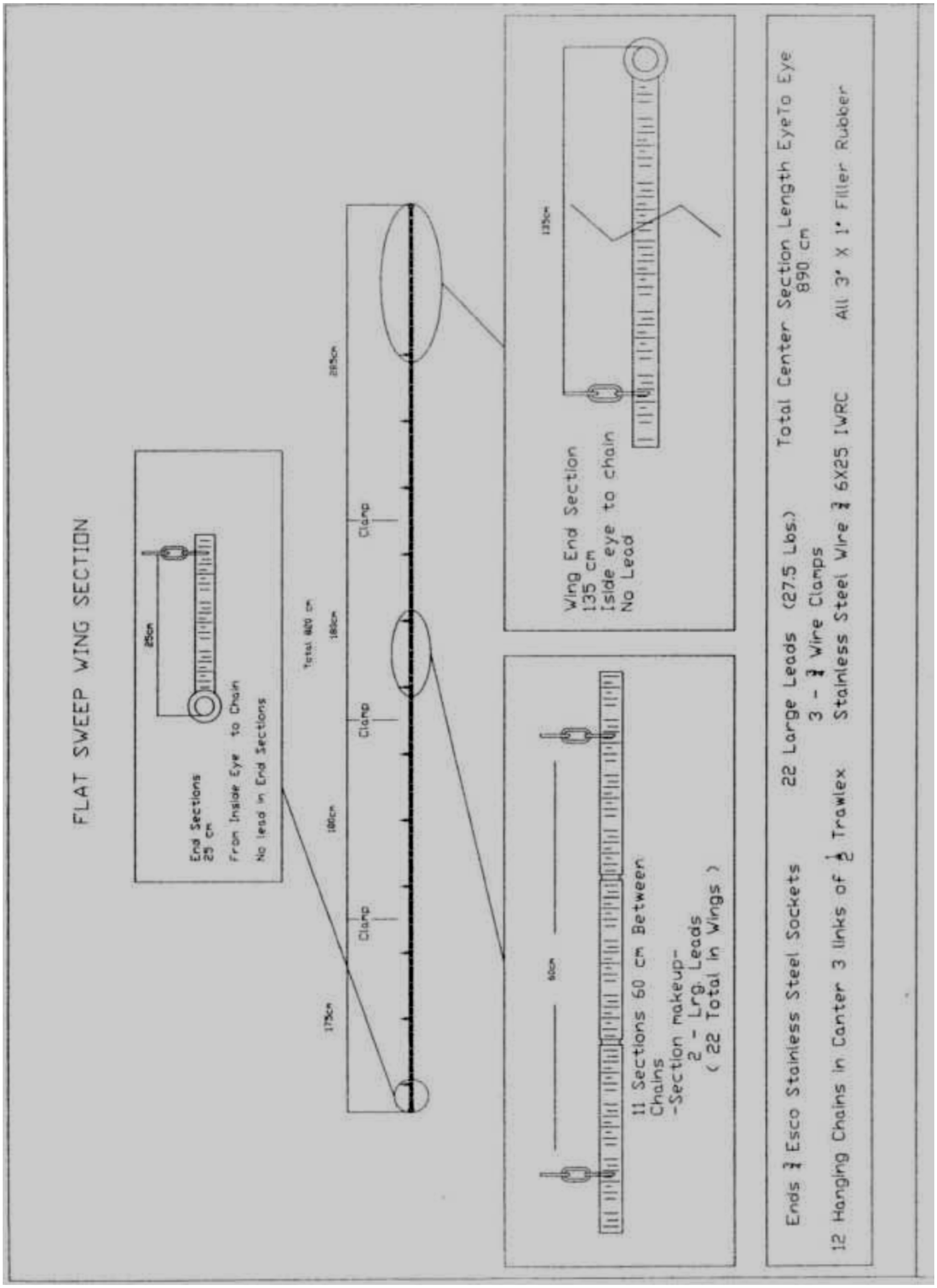


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

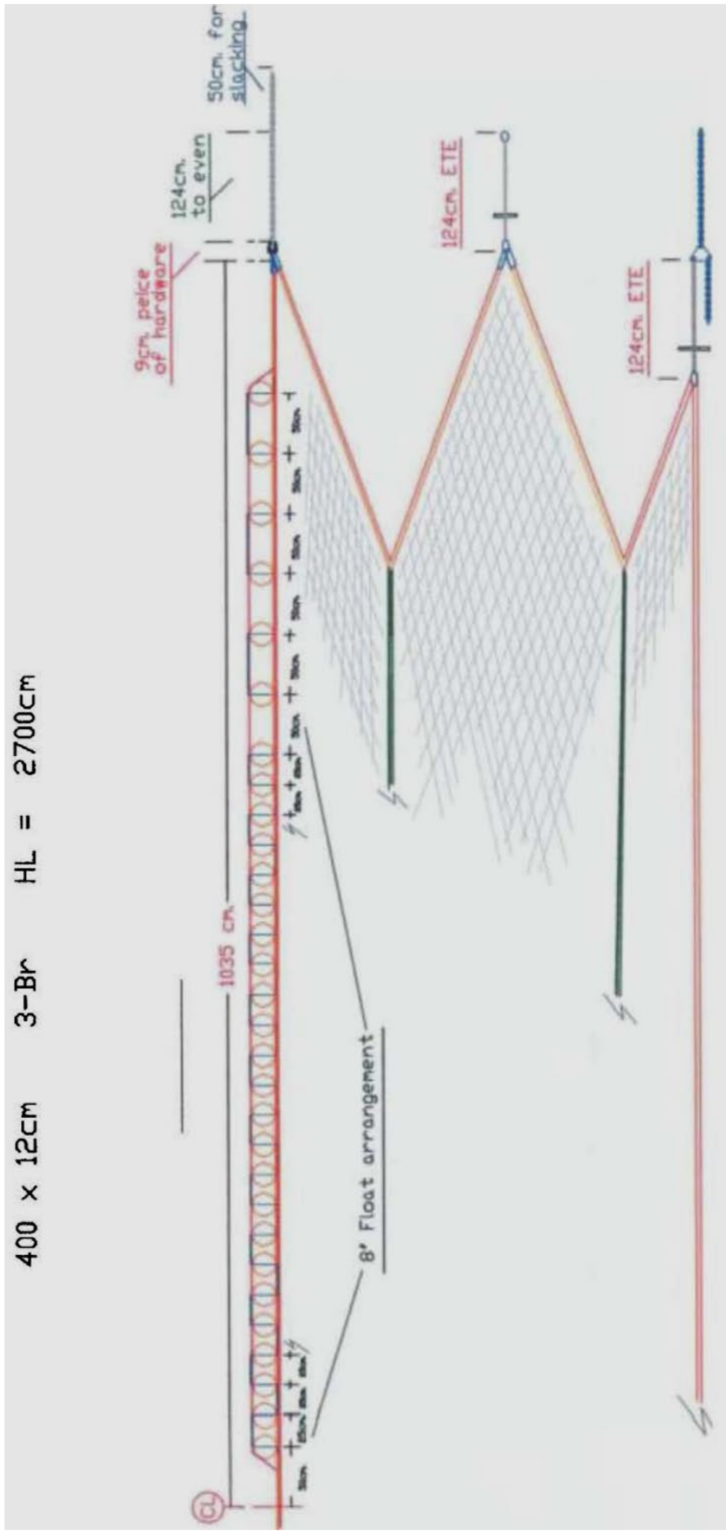


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008)

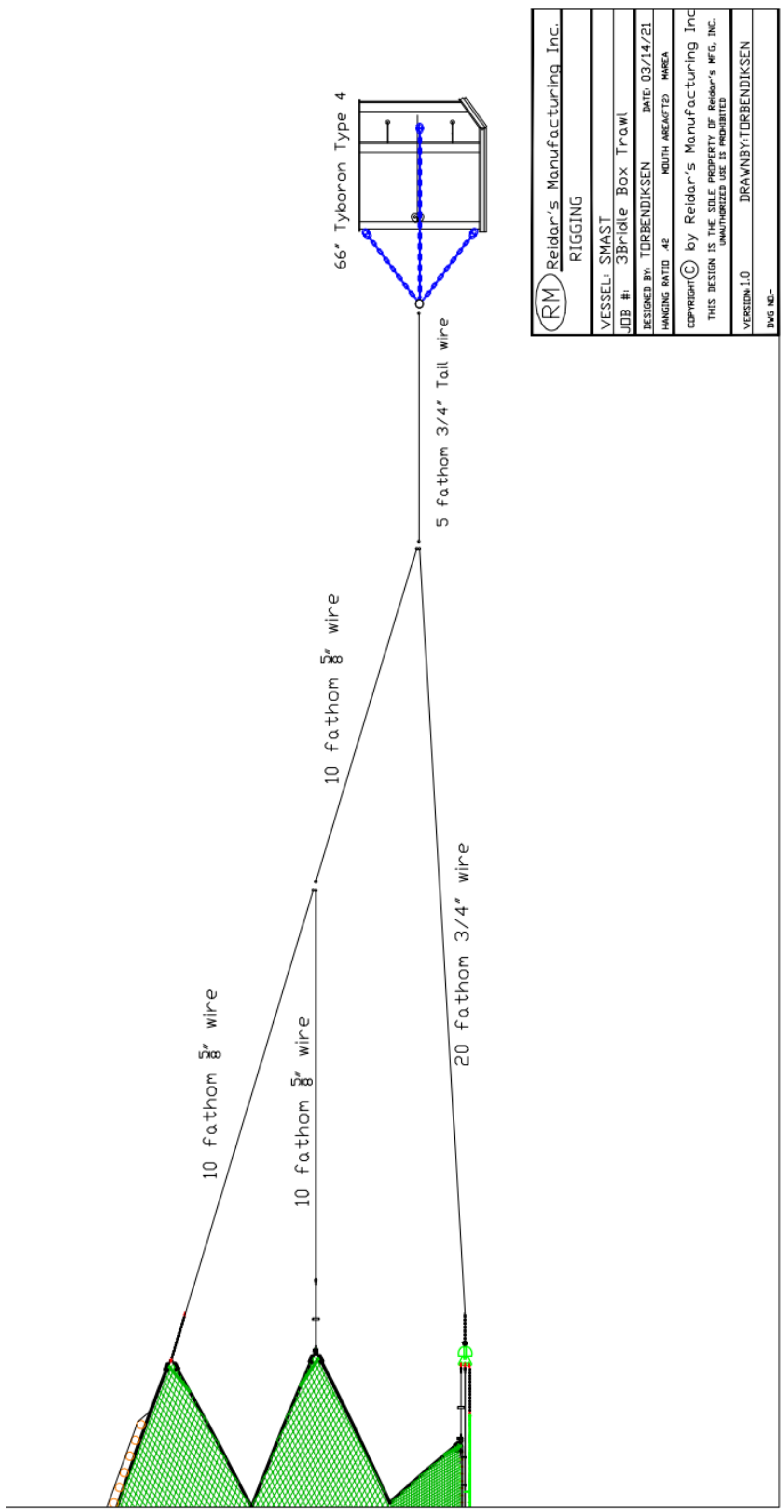


Figure 6: Bridle and door rigging schematic for the survey trawl (Courtesy of Reidar's Manufacturing Inc.).

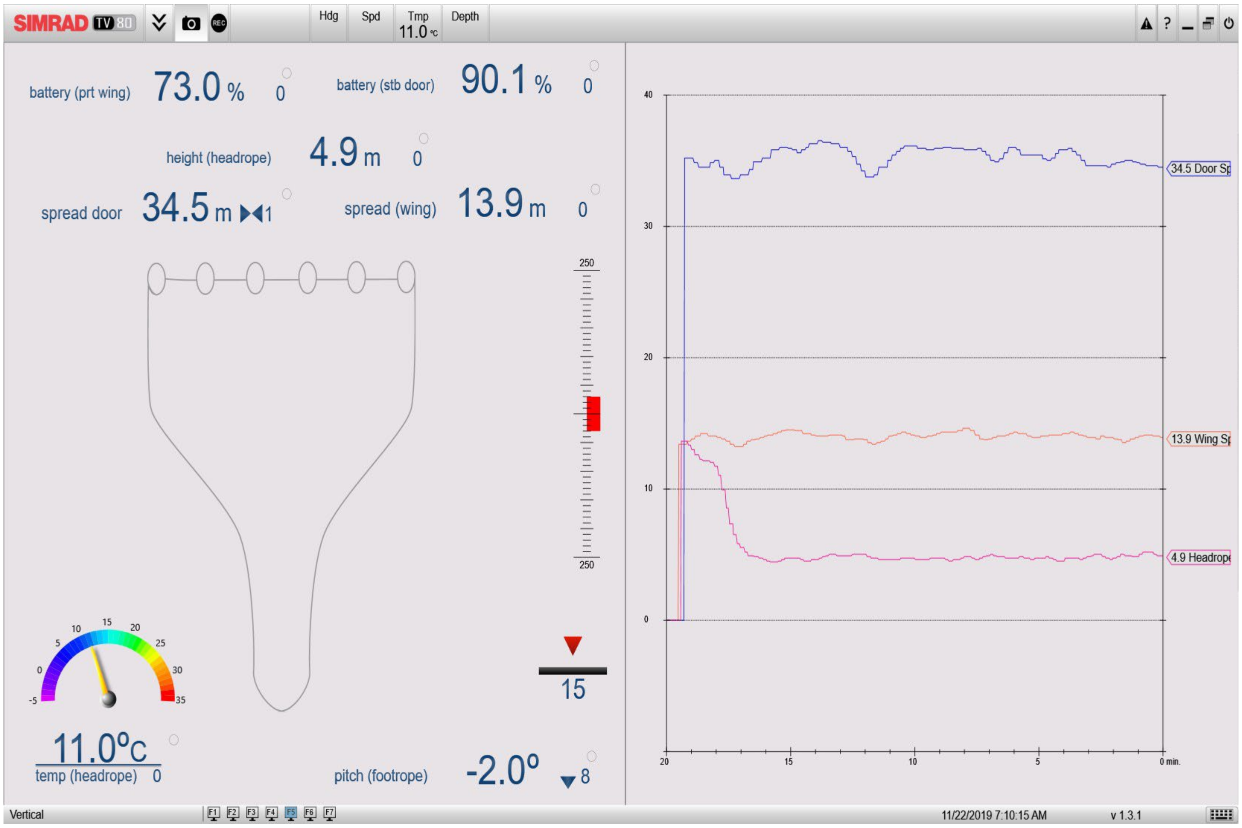
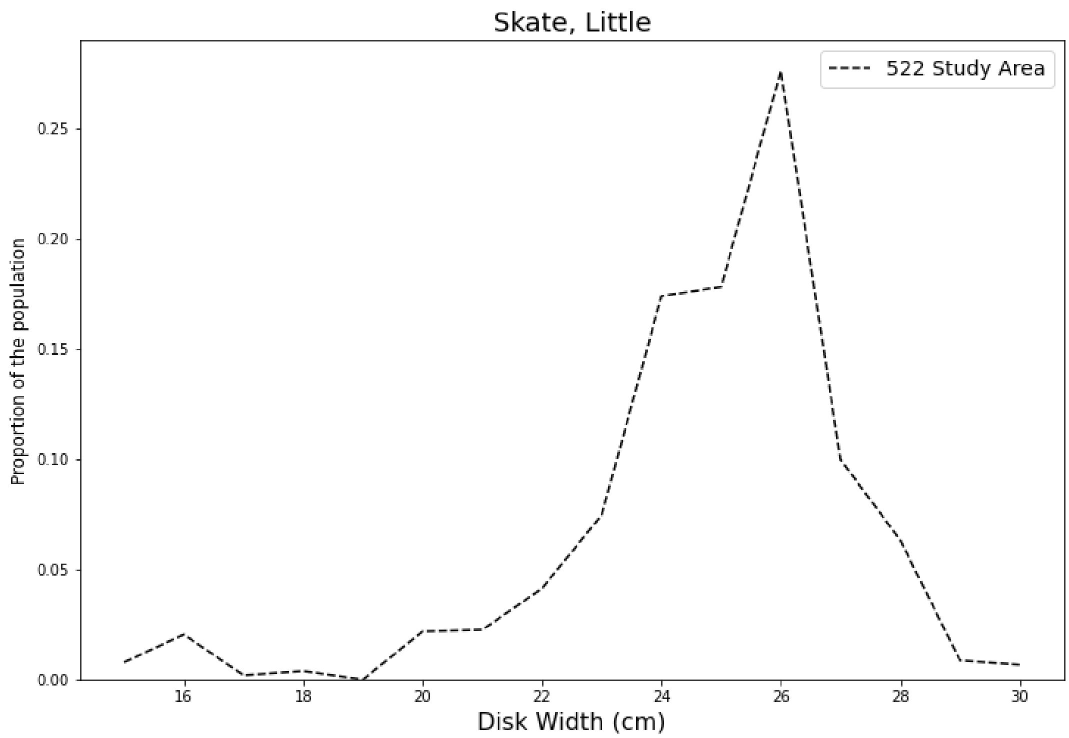


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.



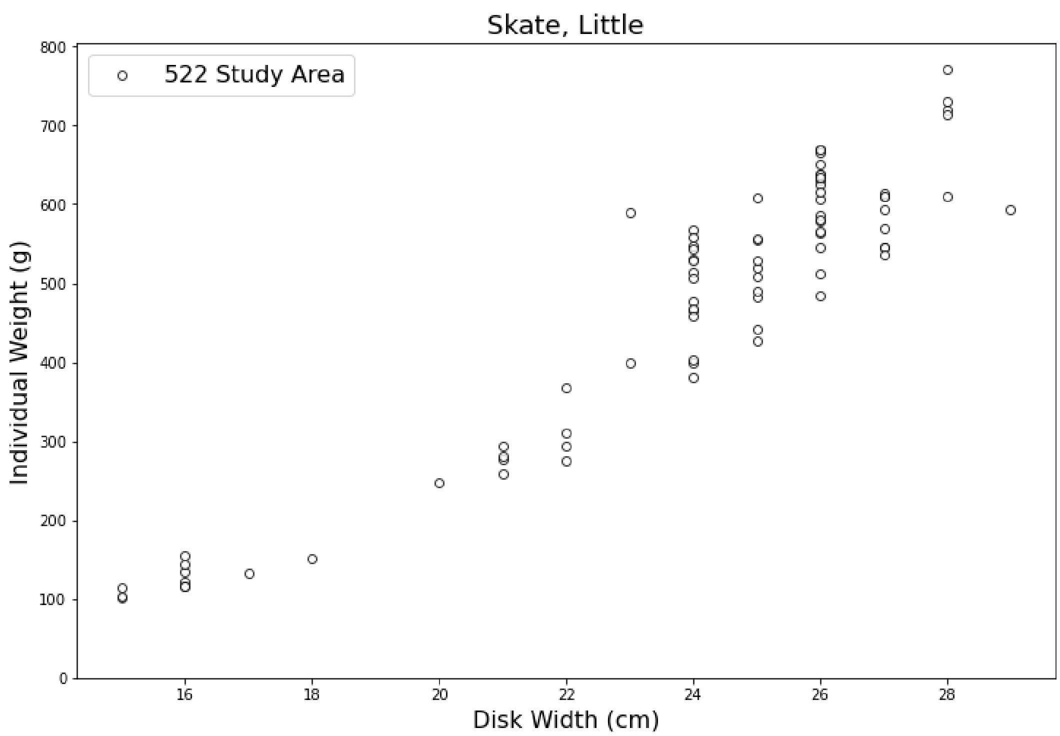


Figure 8: Population structure of little skate in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

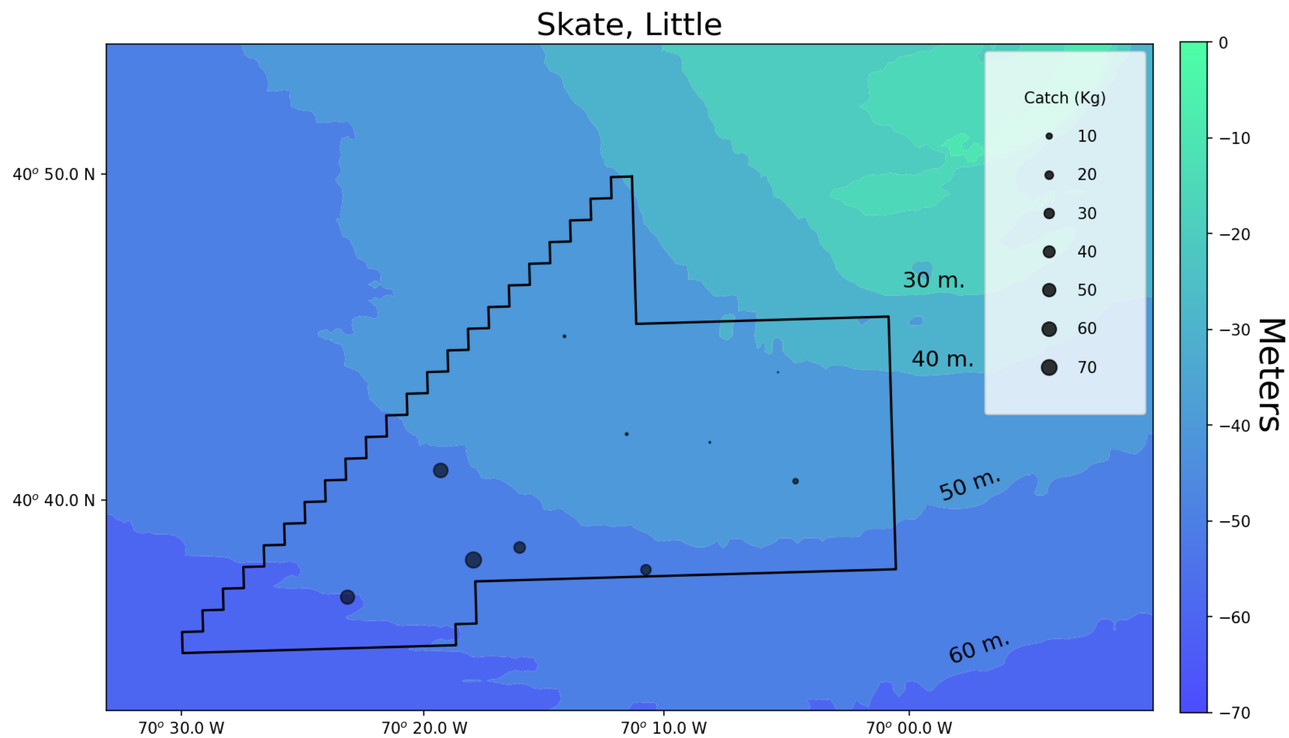
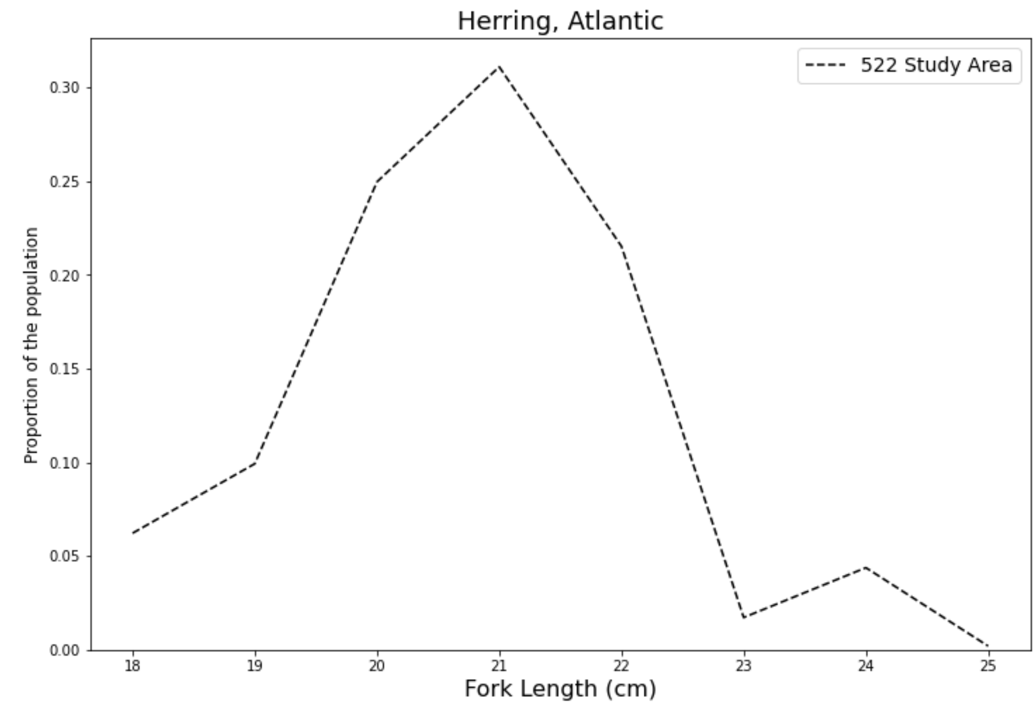


Figure 9: Distribution of the catch of little skate in the 522 Study Area.



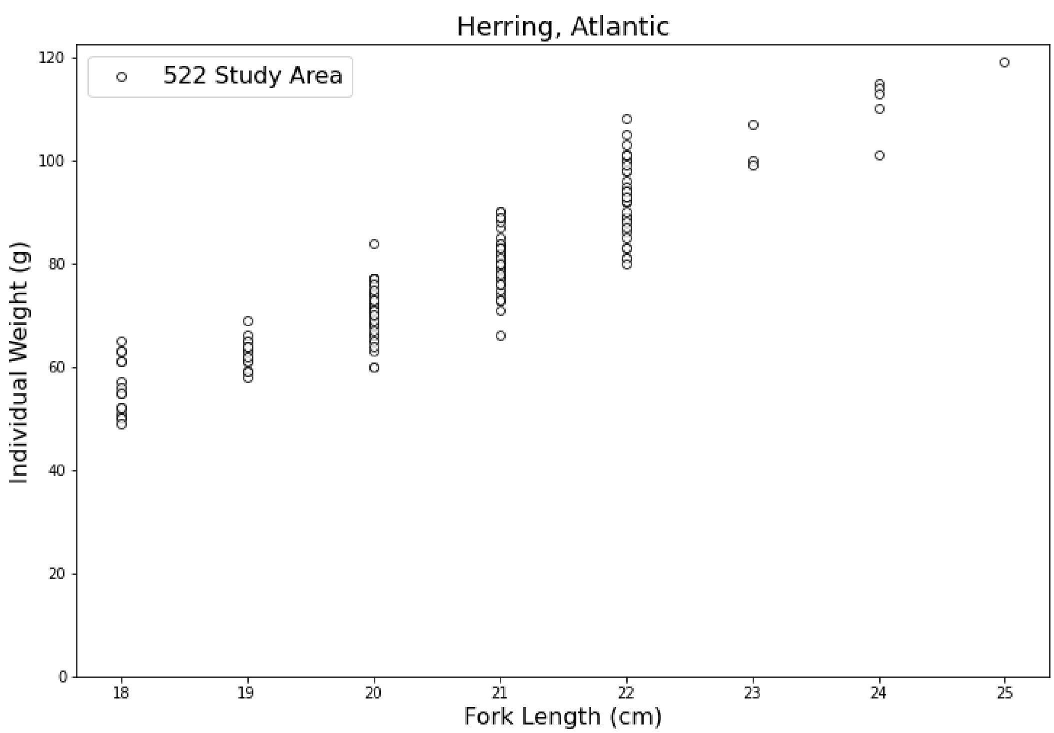


Figure 10: Population structure of Atlantic herring in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

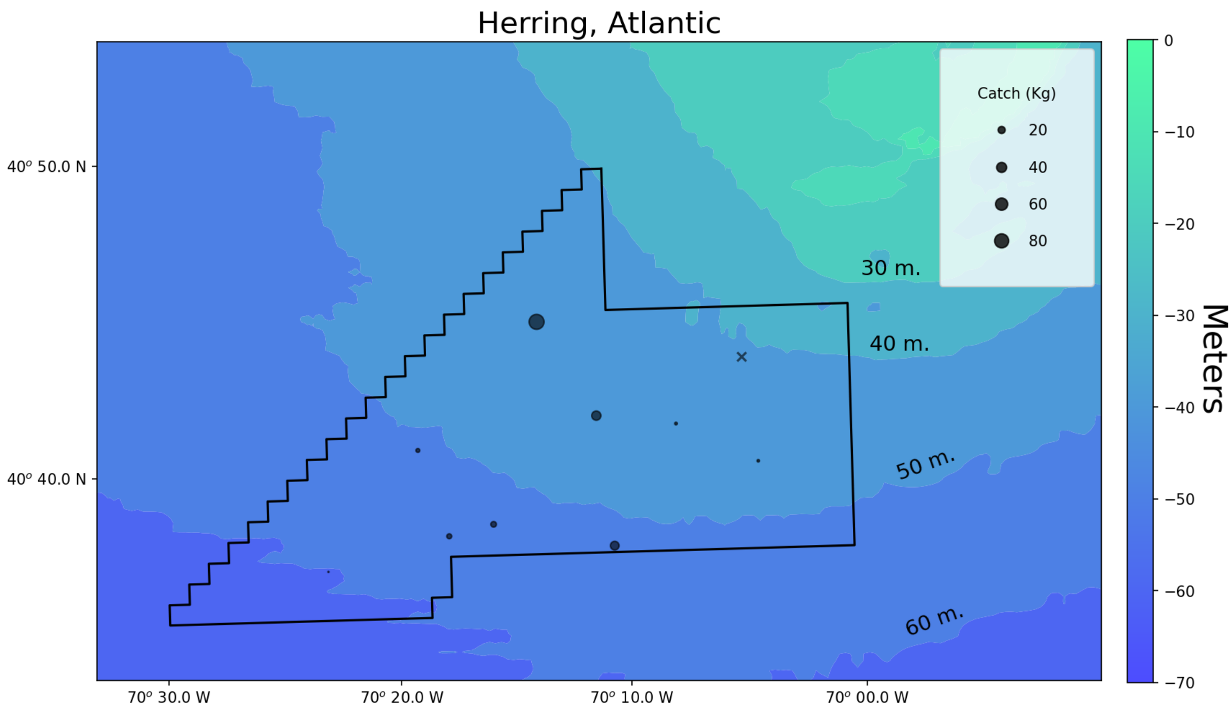
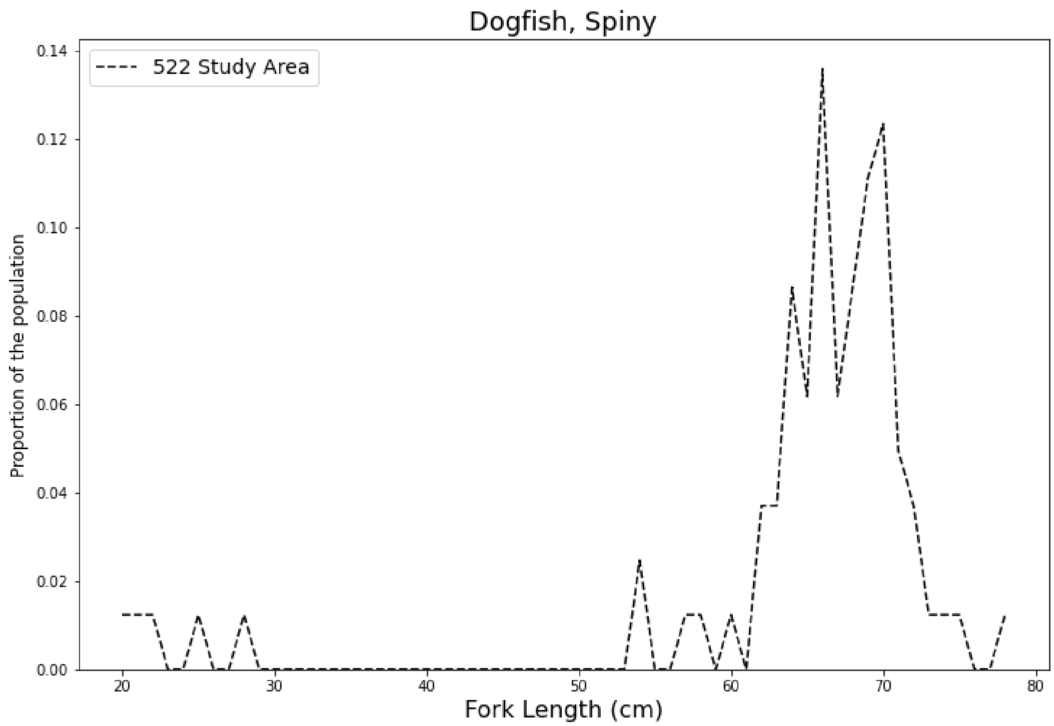


Figure 11: Distribution of the catch of Atlantic herring in the 522 Study Area. Tows with zero catch are denoted with an x.



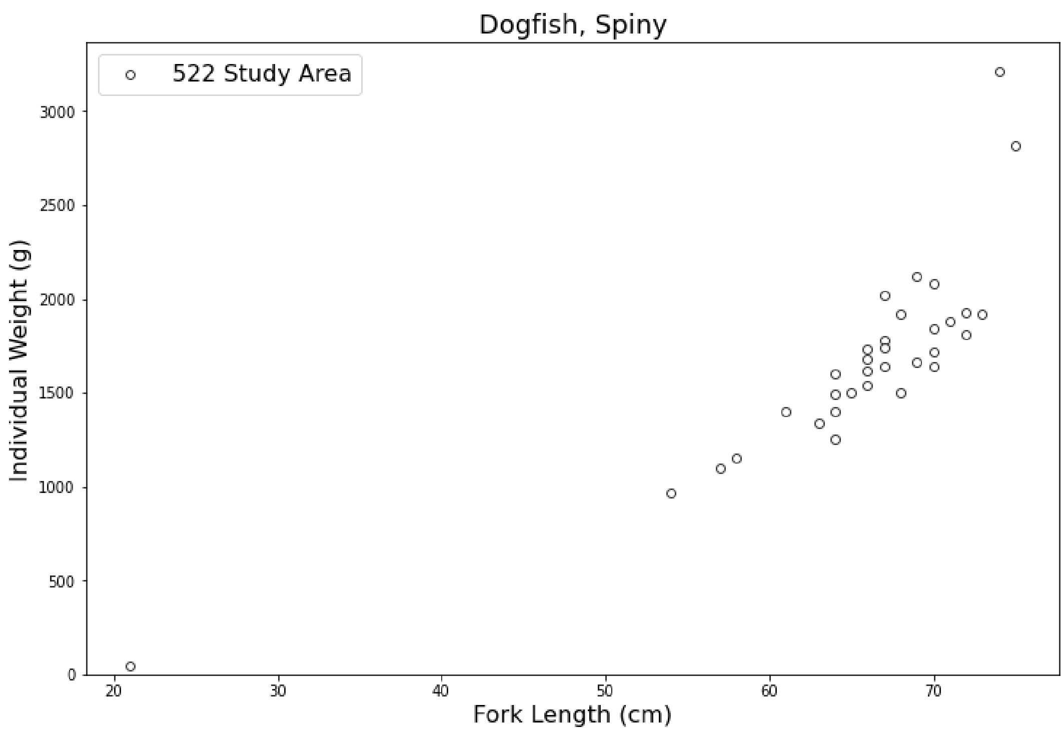


Figure 12: Population structure of spiny dogfish in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

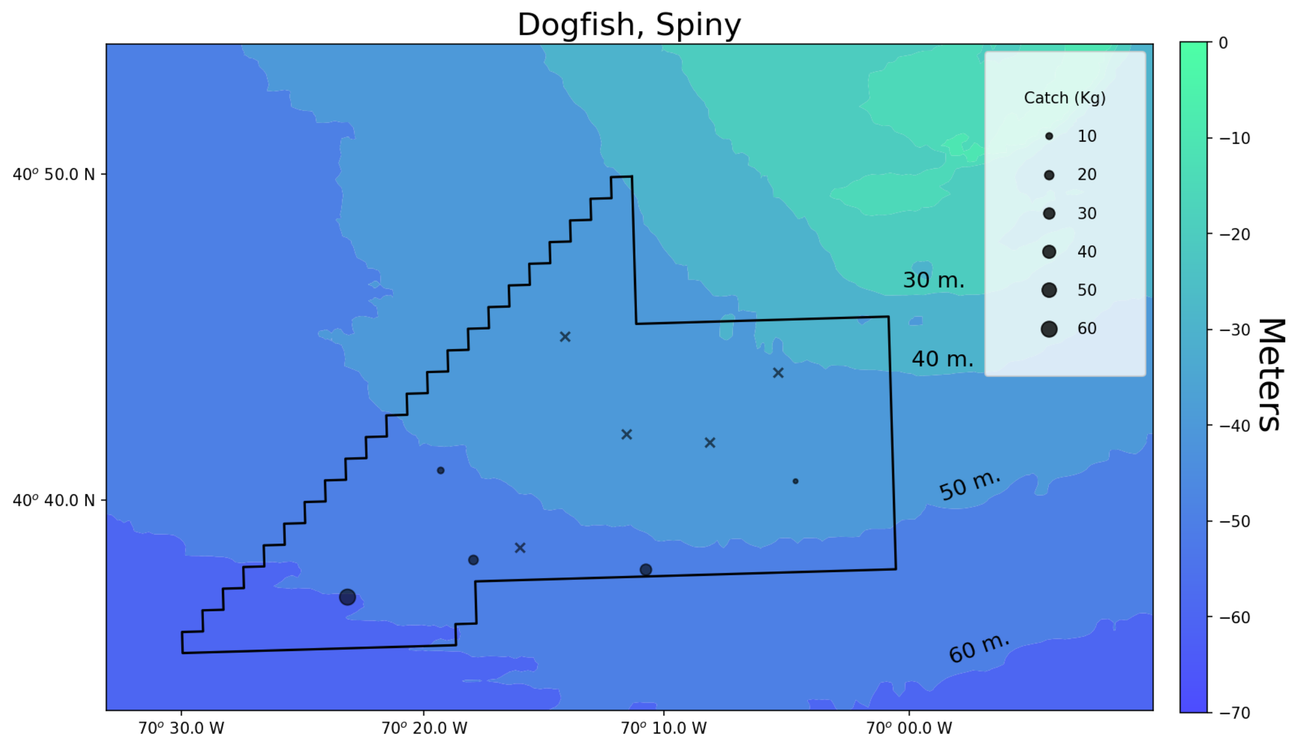


Figure 13: Distribution of the catch of spiny dogfish in the 522 Study Area. Tows with zero catch are denoted with an x.

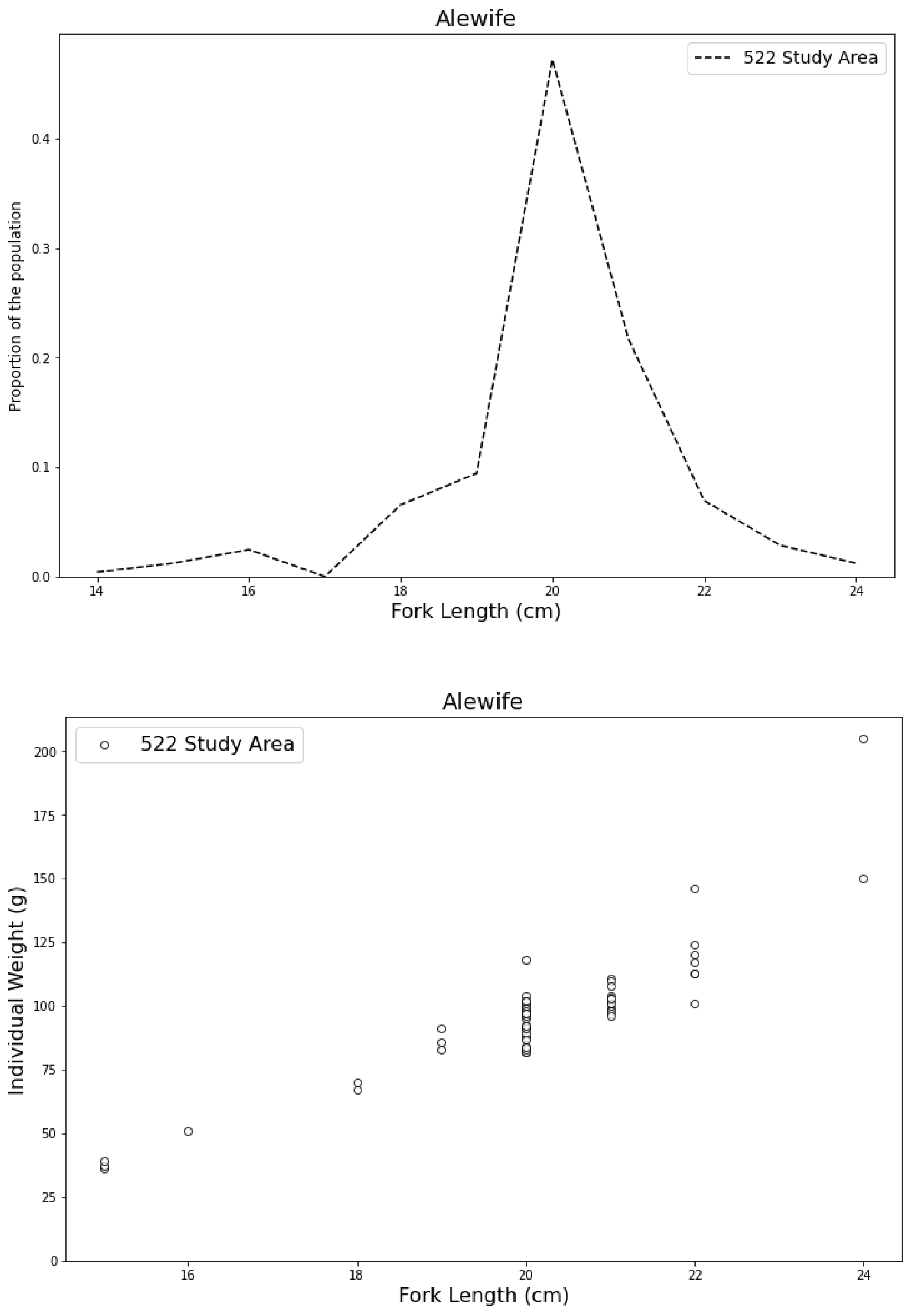


Figure 14: Population structure of alewife in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

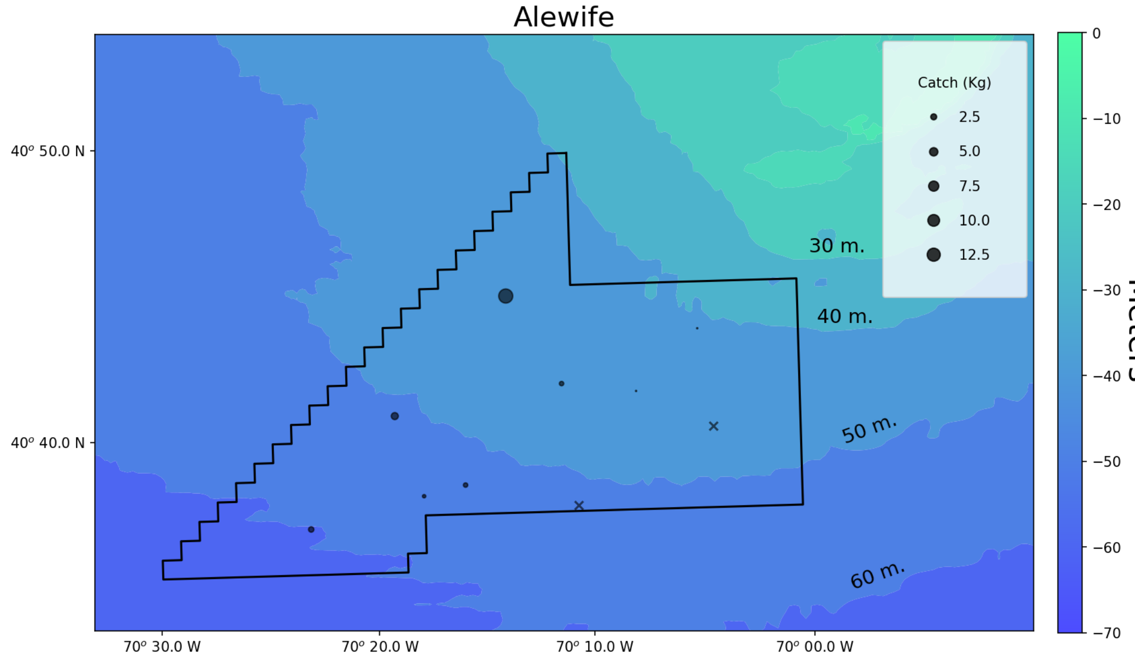
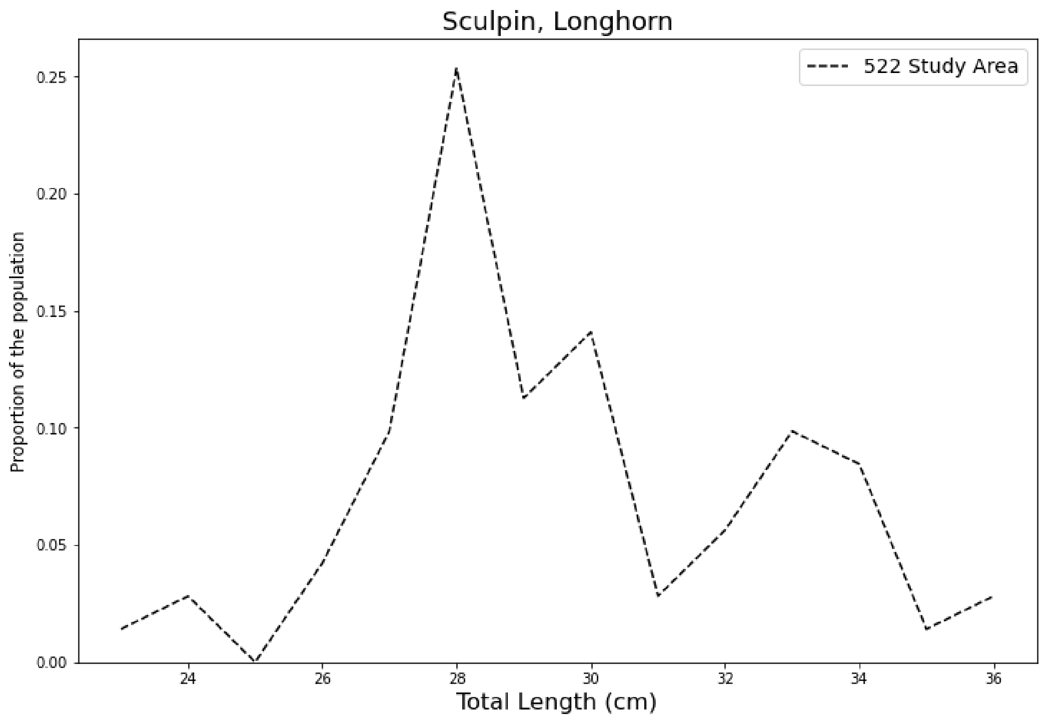


Figure 15: Distribution of the catch of alewife in the 522 Study Area. Tows with zero catch are denoted with an x.



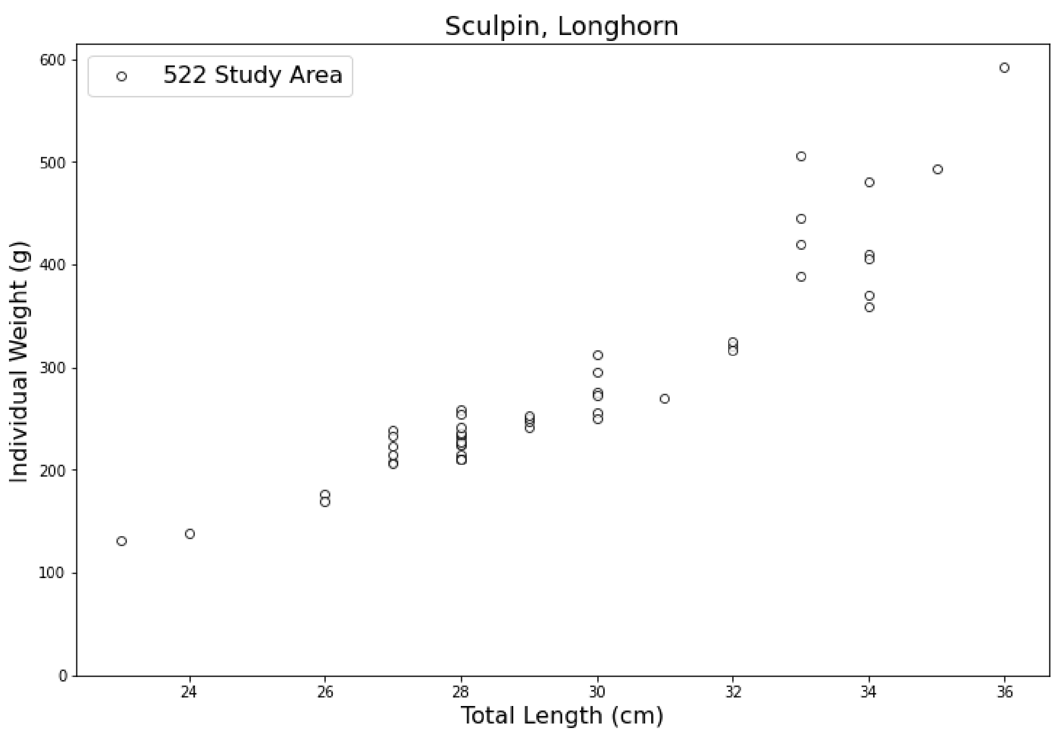


Figure 16: Population structure of longhorn sculpin in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

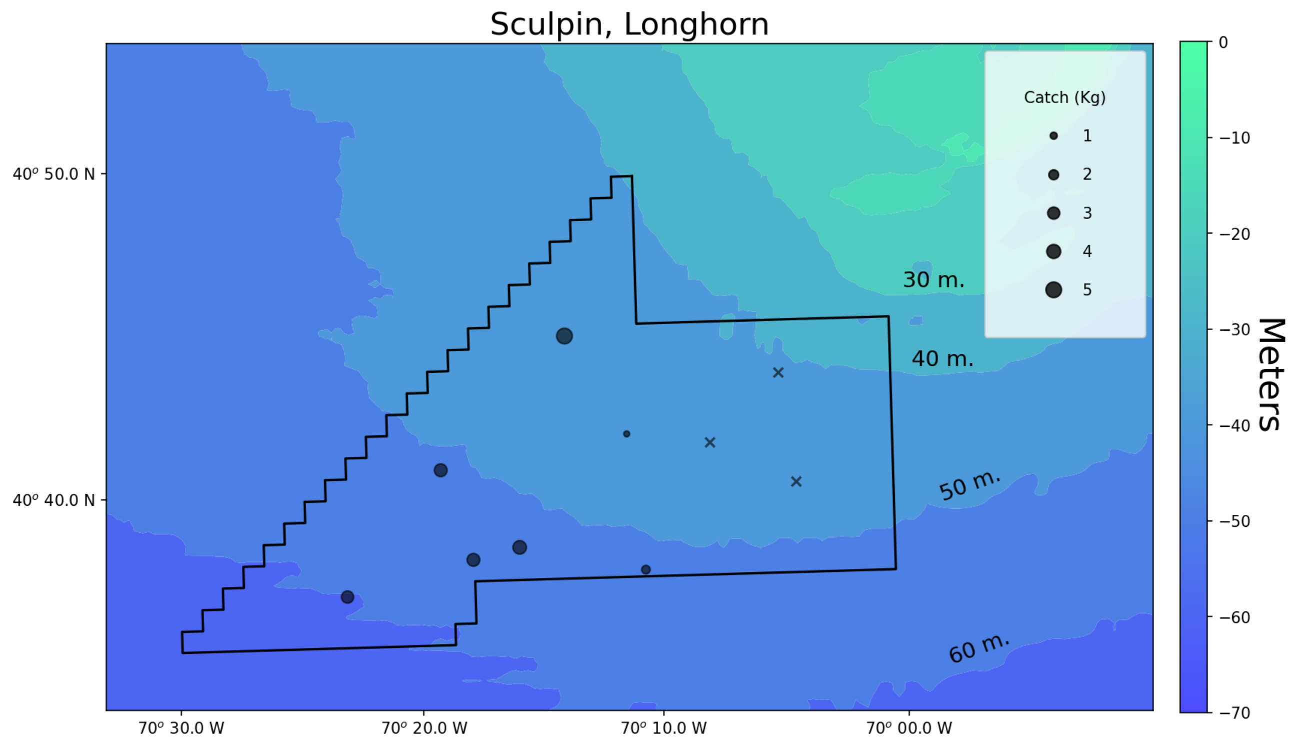
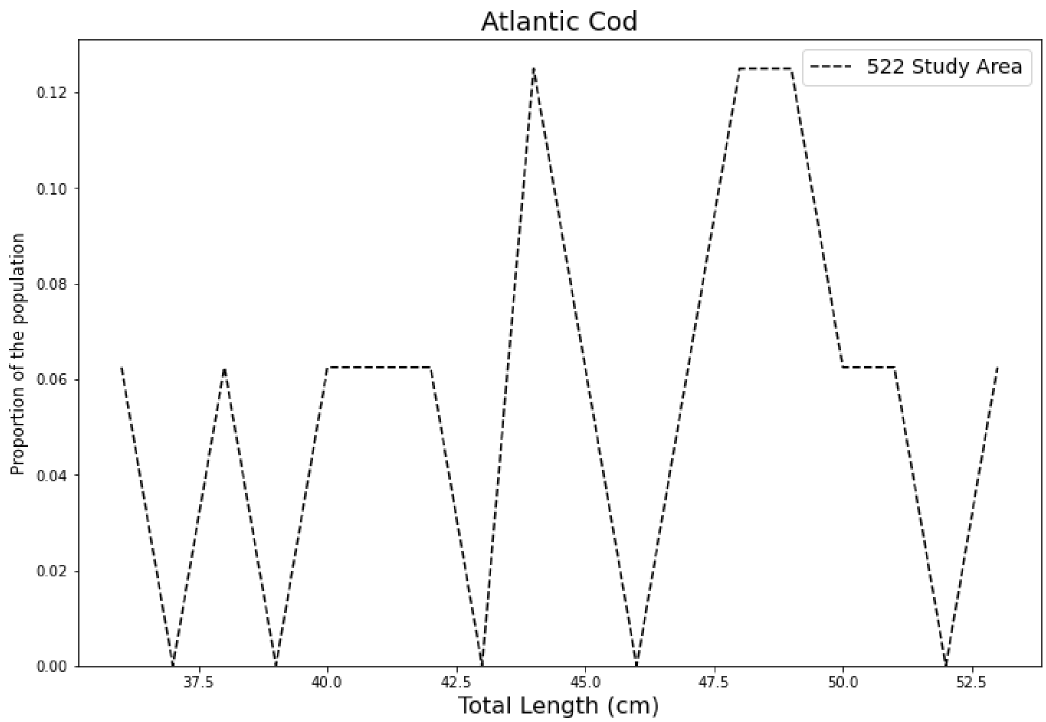


Figure 17: Distribution of the catch of longhorn sculpin in the 522 Study Area. Tows with zero catch are denoted with an x.



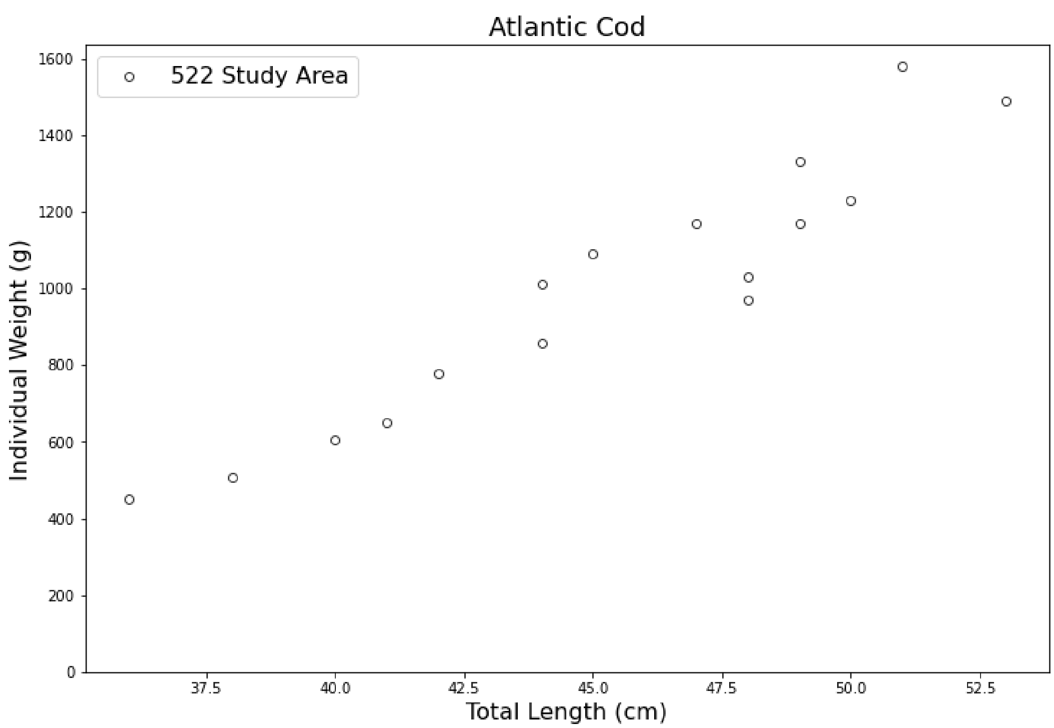


Figure 18: Population structure of Atlantic cod in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

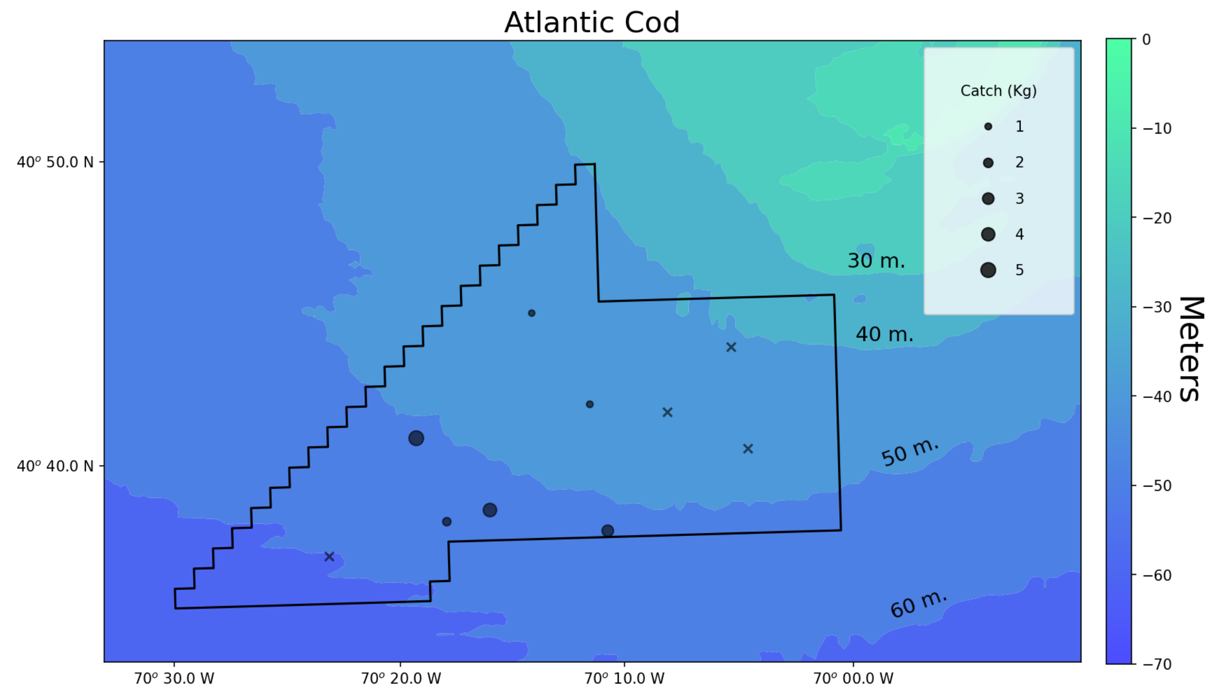
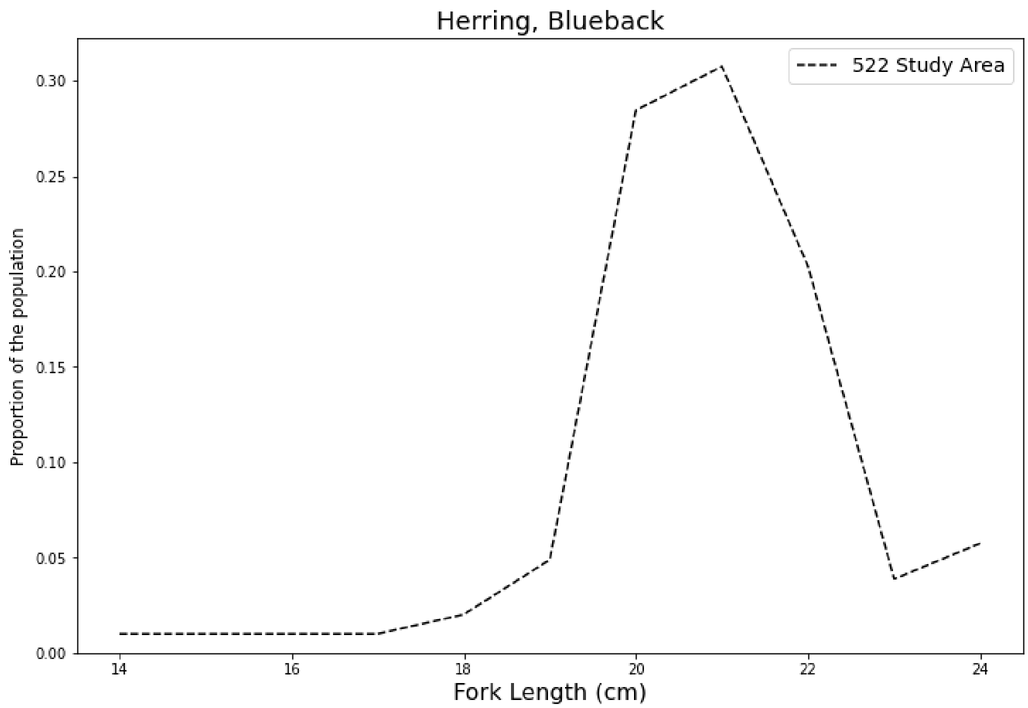


Figure 19: Distribution of the catch of Atlantic cod in the 522 Study Area. Tows with zero catch are denoted with an x.



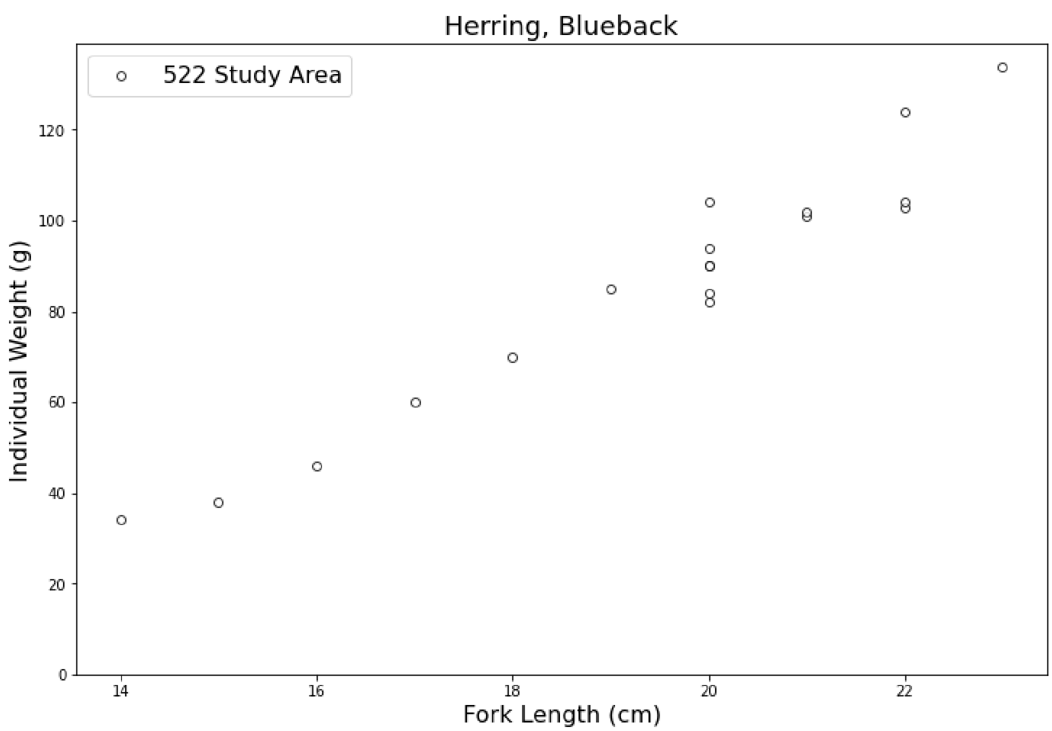


Figure 20: Population structure of blueback herring in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

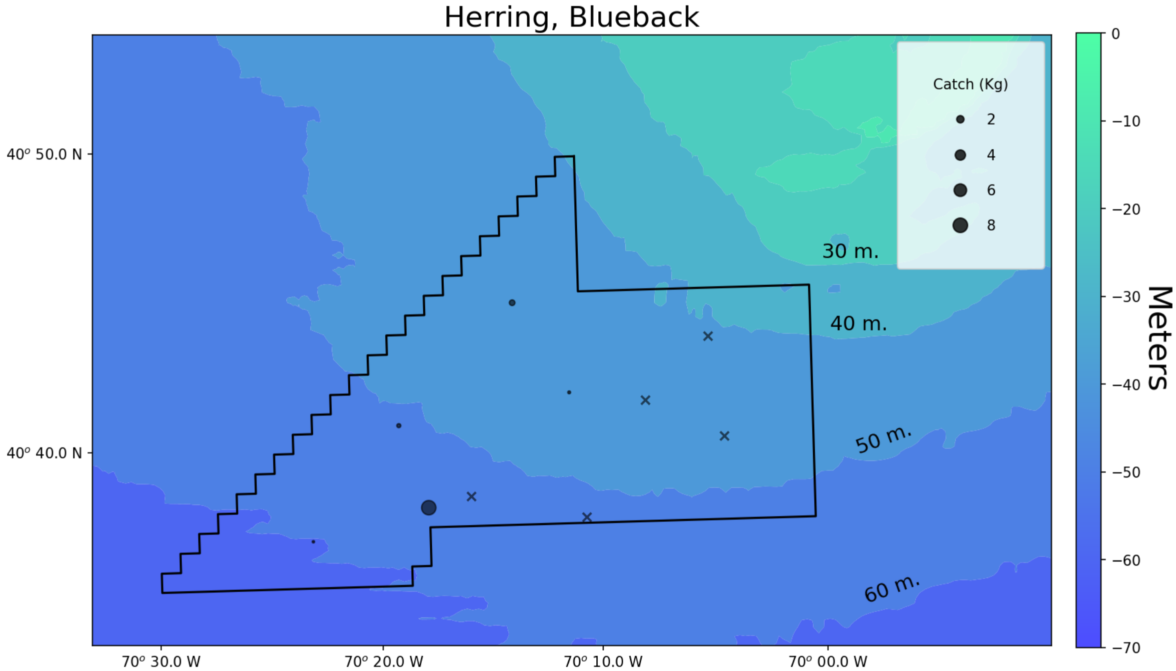
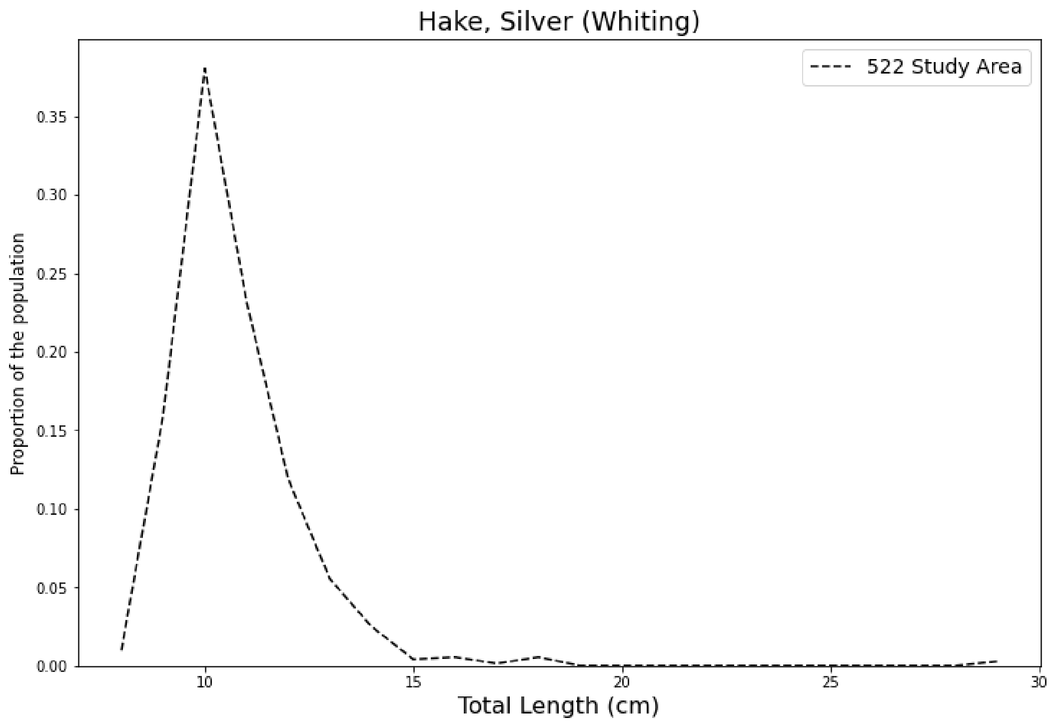


Figure 21: Distribution of the catch of blueback herring in the 522 Study Area. Tows with zero catch are denoted with an x.



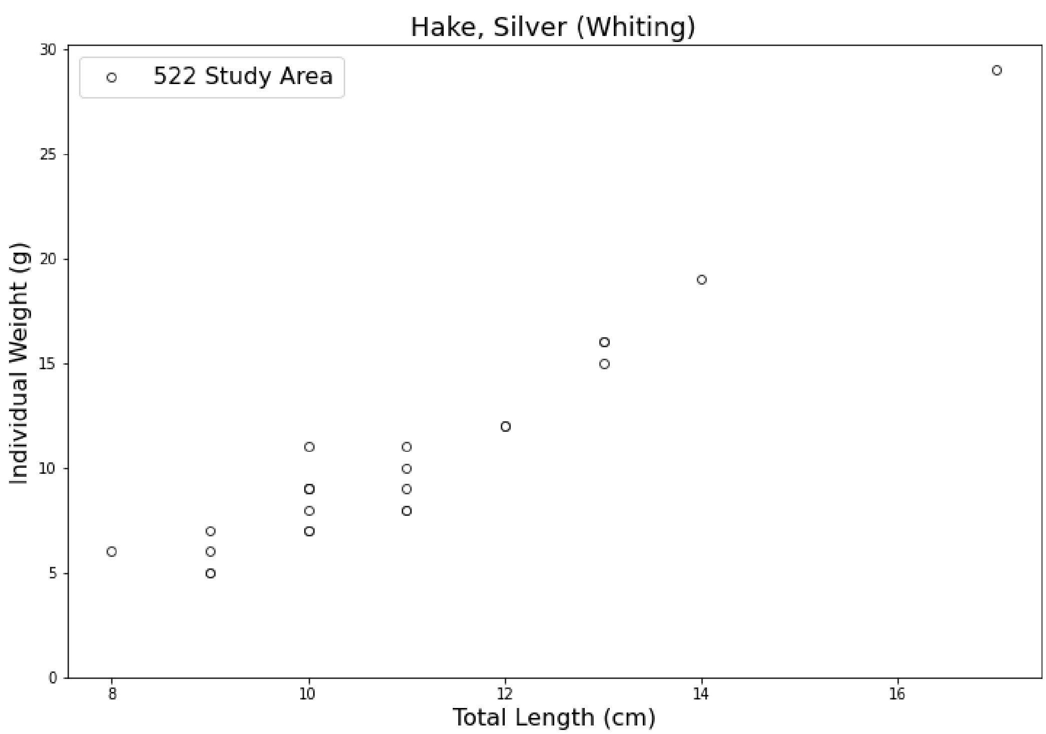


Figure 22: Population structure of silver hake in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

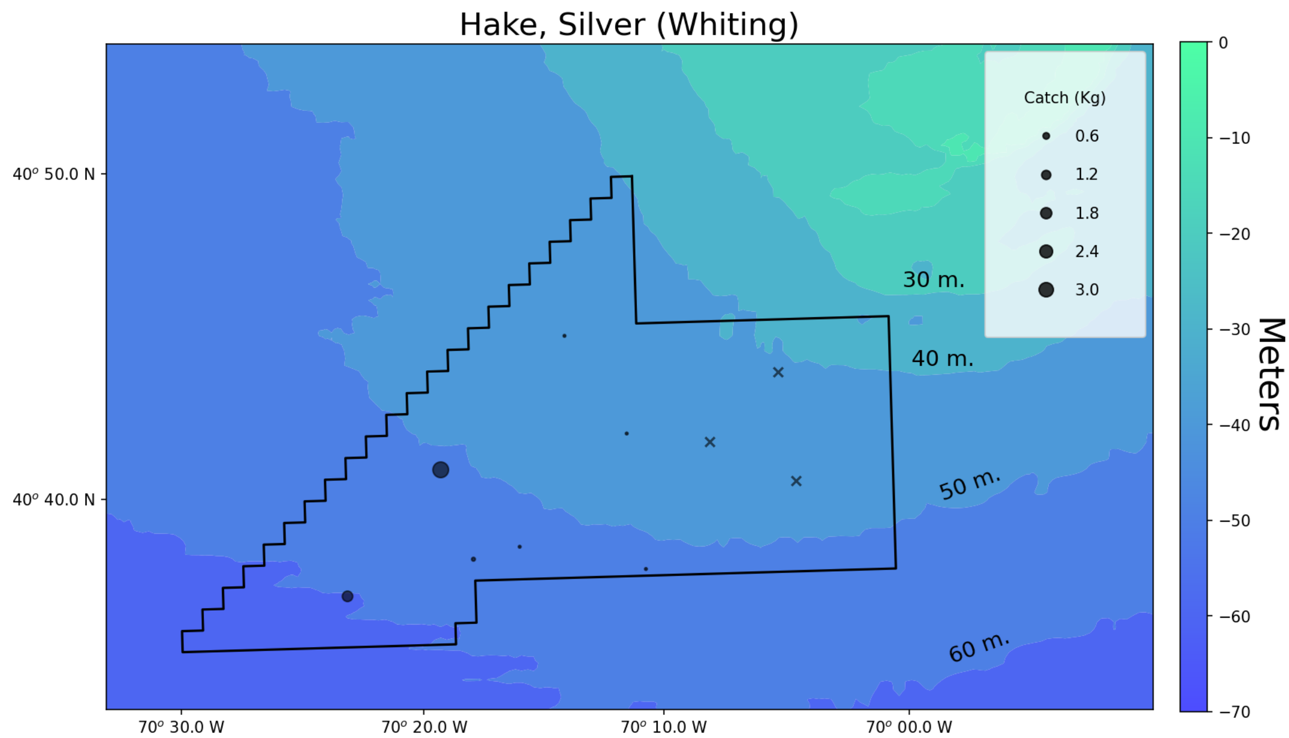
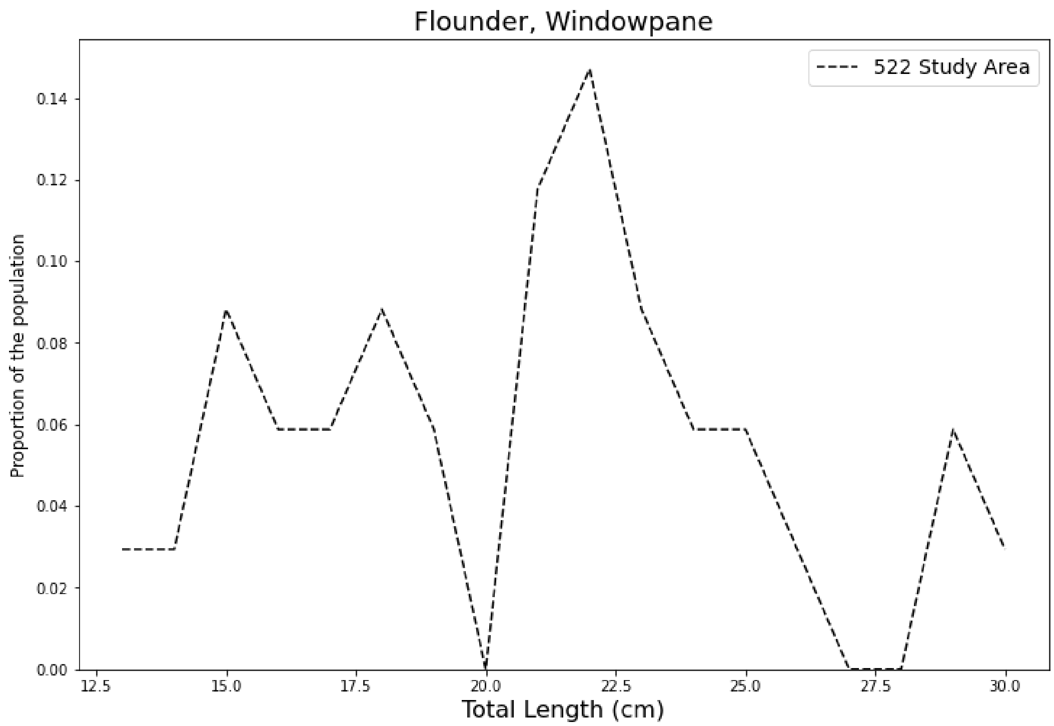


Figure 23: Distribution of the catch of silver hake in the 522 Study Area. Tows with zero catch are denoted with an x.



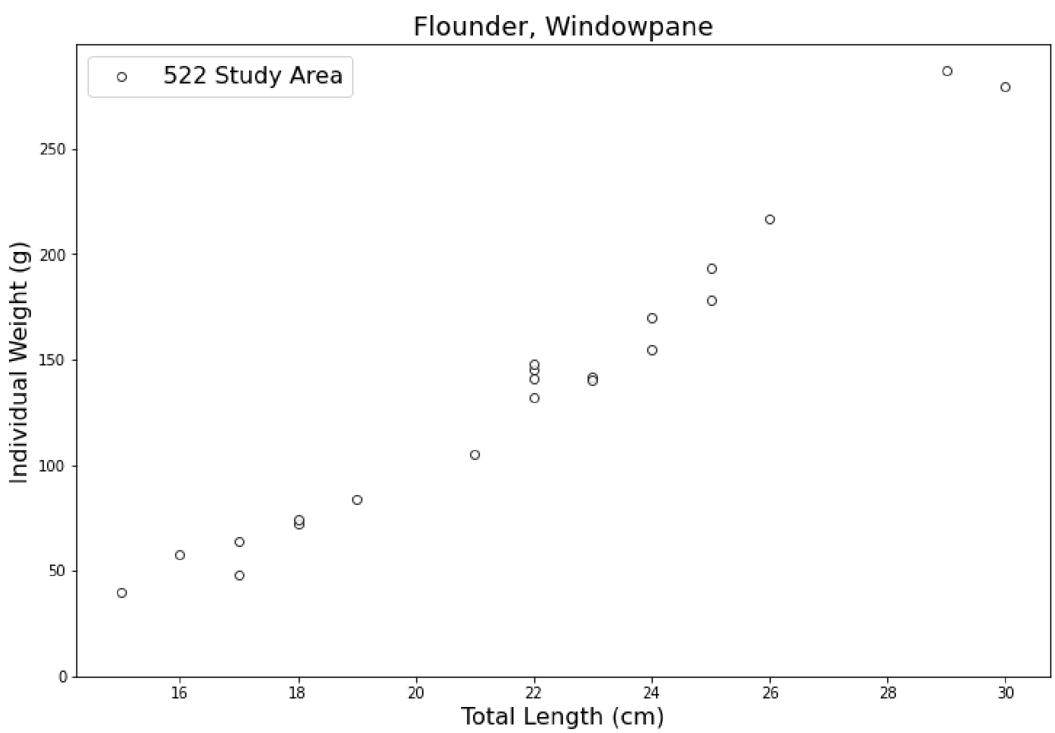


Figure 24: Population structure of windowpane flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

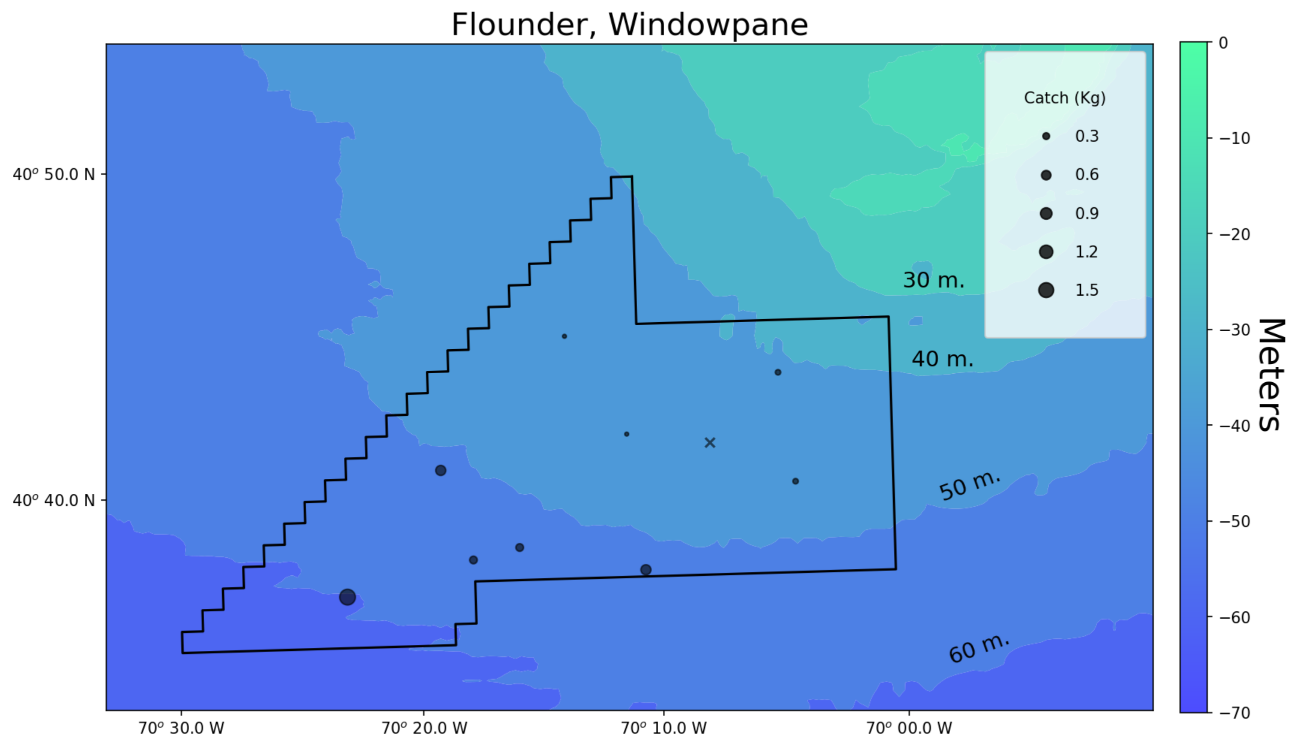


Figure 25: Distribution of the catch of windowpane flounder in the 522 Study Area. Tows with zero catch are denoted with an x.