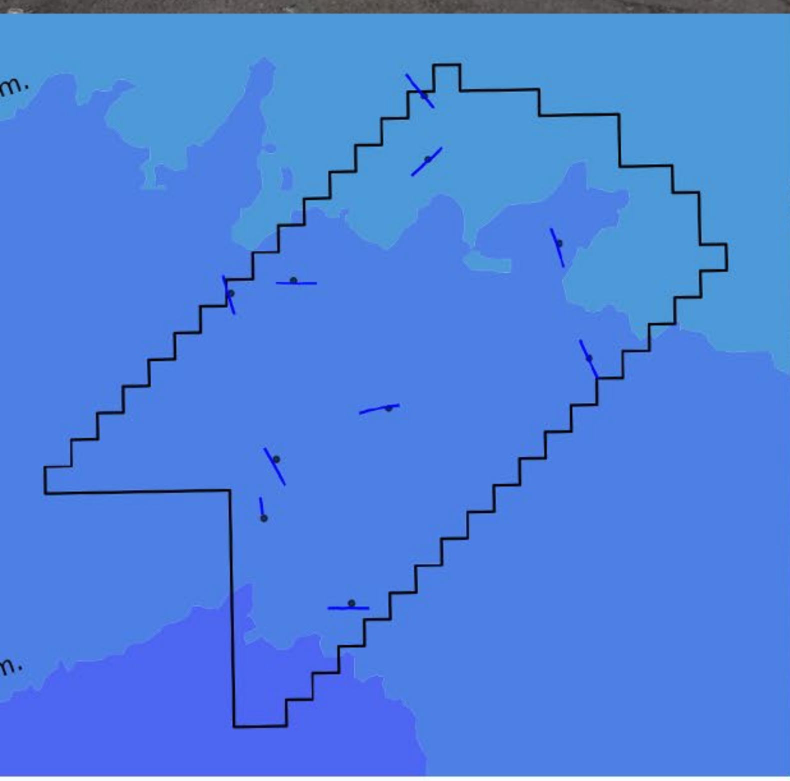
New England Wind Demersal Trawl Survey


Quarterly Report

534 Study Area

Winter 2022 (January - March)

NEW ENGLAND WIND DEMERSAL TRAWL SURVEY

Winter 2022 Seasonal Report

534 Study Area

March 2022

Prepared for Avangrid Renewables, LLC

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Progress Report #10

January 1 – March 31, 2022

Project title:	New England Wind Demersal Trawl Survey Winter 2022 Seasonal Report – 534 Study Area
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1. Introduction

In 2015, Vineyard Wind LLC, a joint venture between Avangrid Renewables LLC (Avangrid) and Copenhagen Infrastructure Partners, leased a 675-square-kilometer (km^2) area for renewable energy development on the Outer Continental Shelf, Lease Area OCS-A 0501, which is located approximately 14 miles south of Martha's Vineyard off the south coast of Massachusetts. In June 2021, the Bureau of Ocean Energy Management (BOEM) segregated Lease Area OCS-A 0501 into two lease areas – OCS-A 0501 and OCS-A 0534. Lease Area OCS-A 0501 is assigned to an entity identified as Vineyard Wind 1 and OCS-A 0534 is assigned to Park City Wind LLC, a wholly owned subsidiary of Avangrid Renewables, LLC ("Avangrid"). Fisheries surveys are occurring within these areas – referred to as the "VW1 Study Area and "534 Study Area," respectively.[1] The latter is the focus of this report. The VW1 Study Area fisheries surveys are reported separately.

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, Avangrid, 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

[1] The VW1 Study Area 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 is referred to as the 501S Study Area in SMAST fisheries survey reports compiled prior to the lease area segregation. Park City Wind LLC became the sole holder of the OCS-A 0534 lease in late 2021.

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.

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 534 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 0534 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 the 522 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). The results of the power analysis will be available in the annual report.

The 534 Study Area increased from 369 km^2 in the 2020/2021 survey season to 411 km^2 during the current survey year due to a decrease in the VW1 Study Area (Figure 2). Tow locations within the 534 Study Area were selected using a spatially balanced sampling design. The 534 Study Area (411 km^2) was sub-divided into 10 sub-areas (each ~41.1 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 534 Study Area. The starting location within each sub-area was then randomly selected (Figure 3).

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 4). 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 5). 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 534 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 6 and 7 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 the 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 8).

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 January 31 and February 4, 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. The 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 measured using a 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.

<u>Straight subsampling by weight:</u> 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 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 534 Study Area (Figure 3, Table 1). Tow duration averaged 20.0 ± 0.1 minutes (mean ± one standard deviation). The tow distance averaged 0.96 ± 0.02 nautical miles (nmi) giving an average tow speed of 2.9 ± 0.06 knots.

The seafloor in the 534 Study Area follows a northeast to southwest depth gradient with the shallowest tow along the northeastern edge (~48 m). Depth increased to a maximum of 60 m along the southwestern boundary. Bottom water temperatures were relatively consistent at 4.3 ± 0.4°C (39.7 ± 0.7°F, Table 2). The winter 2022 survey was comparable to the winter 2020 and 2021 surveys where bottom water temperatures averaged 4.5 ± 0.2°C and 4.2 ± 0.4°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 37.5 ± 0.9 m (range: 36.0 – 38.3 m). Wing spread averaged 14.7 ± 0.6 m (range: 13.1 – 15.0 m). Headline height averaged 4.6 ± 0.2 m (range: 4.3 – 4.9 m).

3.2 Catch Data

In the 534 Study Area, a total of 26 species were caught over the duration of the survey (Table 3). Catch volume ranged from 12.6 to 122.2 kilograms per tow (kg/tow) with an average of 40.3 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, alewife, blueback herring, and Atlantic mackerel) accounted for 83.2% 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 534 Study Area, accounting for 36.2% of the total catch weight. Individuals ranged in length from 12 to 32 cm (disk width) with a unimodal size distribution consisting of a peak at 26 cm (Figure 9). Little skate were observed in all 10 tows. Catch rates averaged 14.6 ± 4.1 kg/tow (mean ± Standard Error of the Mean [SEM], range: 1.2 – 39.6 kg/tow). Little skate were observed throughout the 534 Study Area (Figure 10).

Atlantic herring (*Clupea harengus*) was the second most abundant species, accounting for 21.7% of the total catch weight. Individuals ranged in length from 18 to 24 cm with a unimodal size distribution consisting of a peak at 20 cm (Figure 11). Atlantic herring were observed in all 10 tows at an average catch rate of 8.7 ± 5.0 kg/tow (range: 0.6 – 52.3 kg/tow). Atlantic herring were caught throughout the 534 Study Area (Figure 12).

Alewife (*Alosa pseudoharengus*) was the third most abundant species observed. Individuals ranged in length from 13 to 29 cm with a unimodal size distribution peaking at 20 cm (Figure 13). Alewife were observed in all 10 tows. Catch rates averaged 5.3 ± 1.4 kg/tow (range: 0.6 – 14.1 kg/tow). Alewife were observed throughout the 534 Study Area with the catch increasing with depth (Figure 14).

Blueback herring (*Alosa aestivalis*) were observed in all 10 tows in the 534 Study Area. Individuals ranged in length from 13 to 27 cm with a unimodal peak at 21 cm (Figure 15). The average catch rate of blueback herring was 2.6 ± 1.4 kg/tow (range: 0.2 – 14.9 kg/tow). Blueback herring were caught throughout the 534 Study Area (Figure 16).

Atlantic mackerel (*Scomber scombrus*) were observed in all 10 tows in the 534 Study Area. Individuals ranged in length from 18 to 35 cm with a unimodal peak at 30 cm (Figure 17). The average catch rate of Atlantic mackerel was 2.2 ± 0.6 kg/tow (range: 0.4 – 6.5 kg/tow). Atlantic mackerel were caught throughout the 534 Study Area (Figure 18).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was a frequently observed species in the 534 Study Area. Individuals ranged in length from 8 to 33 cm. Silver hake had a unimodal size distribution consisting of a peak at 12 cm (Figure 19). Silver hake were observed in all 10 tows at an average catch rate of 1.8 ± 0.6 kg/tow (range: 0.3 – 6.6 kg/tow). The catch of silver hake was distributed across the 534 Study Area (Figure 20).

Atlantic cod (*Gadus morhua*) were commonly observed in the 534 Study Area. Individuals ranged in length from 43 to 58 cm with a broad size distribution (Figure 21). Atlantic cod were observed in five of the 10 tows with an average catch rate of 1.3 ± 0.6 kg/tow (range: 0 – 6.1 kg/tow). Atlantic cod were primarily caught in the northern half of the 534 Study Area (Figure 22).

Longhorn sculpin (*Myoxocephalus octodecimspinosus*) were commonly caught in the 534 Study Area. Individuals ranged in length from 9 to 33 cm with a wide size distribution (Figure 23). Longhorn sculpin were observed in eight of the 10 tows at an average catch rate of 0.7 ± 0.2 kg/tow (range: 0 – 1.9 kg/tow). Longhorn sculpin were observed throughout the 534 Study Area with higher catches observed in the northern half of the 534 Study Area (Figure 24).

Windowpane flounder (*Scophthalmus aquosus*) is a federally regulated commercial flatfish species found in the 534 Study Area. Individuals ranged in length from 9 to 30 cm with a wide size distribution (Figure 25). Windowpane flounder were observed in eight of the 10 tows at an average catch rate of 0.4 ± 0.1 kg/tow (range: 0 – 1.0 kg/tow). Windowpane flounder were sporadically caught throughout the 534 Study Area (Figure 26).

Less common recreational and commercial species observed included four individuals of summer flounder (*Paralichthys dentatus*, lengths: 28, 28, 31, 34 cm), three individuals of Atlantic sea scallop (*Placopecten magellanicus*), one individual winter flounder (*Pleuronectes americanus*), one individual American lobster (*Homarus americanus*), one individual haddock (*Melanogrammus aeglefinus*, length: 36 cm), and one individual black sea bass (*Centropristis striata*, length: 13 cm).

One porbeagle shark (*Lamna nasus*) was caught. The animal was estimated to be ~2.5 m long (fork length). The shark was immediately returned to the sea and was observed to swim away.

4. Acknowledgments

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

BOEM (U.S. Department of the Interior, Bureau of Ocean Energy Management). 2013. Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.

Bonzek, C. F., Gartland, J., Johnson, R. A., & Lange Jr, J. D. (2008). NEAMAP Near Shore Trawl Survey: Peer Review Documentation. *A report to the Atlantic States Marine Fisheries Commission by the Virginia Institute of Marine Science, Gloucester Point, Virginia*.

Stokesbury, K.D.E. and Lowery, T. (2018). 2018 Vineyard Wind Groundfish Bottom Trawl Survey: Final Report.

Underwood, A. J. (1991). Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. *Marine and Freshwater Research*, *42*(5), 569-587.

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

Tow Number	Date	Sky Condition	Wind State (Knots)	Wind Directio n	Sea State (m.)	Start Time	Start Latitude	Start Longitude	Start Depth (fm)	End Time	End Latitude	End Longitude	End Depth (fm)	Bottom Temp. (°C)	Trawl Warp (fm)
1	2/3/2022	Obscured	1-2	SW	0.5-1.25	7:06	N 40° 57.005	W 70° 34.641	29	7:26	N 40° 56.090	W 70° 34.242	28	3.7	125
2	2/3/2022	Obscured	1-2	SW	0.5-1.25	8:04	N 40° 54.251	W 70° 33.684	29	8:24	N 40° 53.357	W 70° 33.126	30	4.4	125
3	2/3/2022	Obscured	1-2	SW	0.5-1.25	9:22	N 40° 52.676	W 70° 39.662	29	9:42	N 40° 52.477	W 70° 40.815	29	3.9	120
4	2/3/2022	Mostly Cloudy	1-2	SW	0.5-1.25	10:39	N 40° 47.673	W 70° 40.5662	32	10:59	N 40° 47.673	W 70° 41.833	32	4.4	125
5	2/3/2022	Partly Cloudy	1-2	SW	0.5-1.25	11:35	N 40° 49.422	W 70° 43.857	32	11:55	N 40° 50.371	W 70° 44.053	30	4.3	125
6	2/3/2022	Partly Cloudy	1-2	SW	0.5-1.25	12:31	N 40° 50.713	W 70° 43.273	30	12:51	N 40° 51.590	W 70° 43.918	30	3.9	120
7	2/3/2022	Mostly Cloudy	1-2	SW	0.5-1.25	13:33	N 40° 54.862	W 70° 44.894	29	13:53	N 40° 55.829	W 70° 45.296	29	5.0	120
8	2/3/2022	Mostly Cloudy	1-2	SW	0.5-1.25	14:23	N 40° 55.681	W 70° 43.556	29	14:43	N 40° 55.668	W 70° 42.301	31	5.0	120
9	2/3/2022	Obscured	1-2	SW	0.5-1.25	15:26	N 40° 58.332	W 70° 39.146	27	15:46	N 40° 58.993	W 70° 38.220	26	4.5	100
10	2/3/2022	Obscured	1-2	SW	0.5-1.25	16:10	N 40° 59.999	W 70° 38.484	26	16:30	N 41° 00.790	W 70° 39.349	26	4.4	100

Table 2: Tow parameters for each survey tow.

Tow Number	Tow Duration (min)	Tow Distance (nmi)	Tow Speed (knots)	Start Depth (fm)	Bottom Temp. (°C)	Trawl Warp (fm)	Headline Height (m)	Wing Spread (m)	Spread Door (m)
1	20.1	0.9	2.8	29	3.7	125	4.5	15.0	38.1
2	20.0	1.0	3.0	29	4.4	125	4.3	15.0	
3	20.1	0.9	2.8	29	3.9	120	4.6	14.9	37.7
4	20.0	1.0	2.9	32	4.4	125	4.9	14.7	37.6
5	20.0	1.0	2.9	32	4.3	125	4.5	15.0	38.3
6	20.0	1.0	2.9	30	3.9	120	4.4	15.0	38.3
7	19.8	1.0	2.9	29	5.0	120	4.4	15.0	38.0
8	20.0	0.9	2.8	29	5.0	120	4.6	14.7	37.2
9	20.0	1.0	2.9	27	4.5	100	4.8	13.1	36.0
10	20.3	1.0	3.0	26	4.4	100	4.8	14.5	36.2
Summary Statistics									
Minimum	19.8	0.9	2.8	26	3.7	100	4.3	13.1	36.0
Maximum	20.3	1.0	3.0	32	5.0	125	4.9	15.0	38.3
Average	20.0	1.0	2.9	29	4.3	118	4.6	14.7	37.5
St. Dev	0.1	0.02	0.1	1.9	0.4	9.8	0.2	0.6	0.9

Table 3: Total and average catch weights from 10 tows within the 534 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*	146.1	14.6	4.1	36.2	10
Herring, Atlantic	*Clupea harengus*	87.4	8.7	5.0	21.7	10
Alewife	*Alosa pseudoharengus*	53.1	5.3	1.4	13.2	10
Herring, Blueback	*Alosa aestivalis*	26.4	2.6	1.4	6.5	10
Mackerel, Atlantic	*Scomber scombrus*	22.5	2.2	0.6	5.6	10
Hake, Silver (Whiting)	*Merluccius bilinearis*	17.6	1.8	0.6	4.4	10
Atlantic Cod	*Gadus morhua*	13.8	1.4	0.6	3.4	5
Dogfish, Spiny	*Squalus acanthias*	11.8	1.2	0.8	2.9	2
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	6.9	0.7	0.2	1.7	8
Flounder, Windowpane	*Scophtalmus aquosus*	4.3	0.4	0.1	1.1	8
Shad, American	*Alosa sapidissima*	3.5	0.4	0.1	0.9	8
Hake, Red	*Urophycis chuss*	1.6	0.2	0.1	0.4	6
Skate, Winter	*Leucoraja ocellata*	1.5	0.1	0.1	0.4	2
Flounder, Summer (Fluke)	*Paralichthys dentatus*	1.0	0.1	0.1	0.2	3
Flounder, Winter	*Pleuronectes americanus*	0.8	0.1	0.1	0.2	1
Hake, Spotted	*Urophycis regia*	0.6	0.1	0.1	0.2	1
Flounder, Gulfstream	*Citharichthys arctifrons*	0.6	0.1	0.0	0.1	4
Menhaden, Atlantic	*Brevoortia tyrannus*	0.5	0.1	0.1	0.1	1
Lobster, American	*Homarus americanus*	0.5	0.1	0.1	0.1	1
Flounder, Fourspot	*Paralichthys oblongus*	0.4	0.04	0.02	0.1	3
Scup	*Stenotomus chrysops*	0.4	0.04	0.03	0.1	2
Sea Scallop	*Placopecten magellanicus*	0.4	0.04	0.02	0.1	3
Skate, Barndoor	*Dipturus laevis*	0.3	0.03	0.03	0.1	1
Haddock	*Melanogrammus aeglefinus*	0.3	0.03	0.03	0.1	1
Black Sea bass	*Centropristis striata*	0.03	0.00	0.00	0.01	1
Shark, Porbeagle	*Lamna nasus*	NA				1
Total		403.3				

*SEM - Standard Error of the Mean

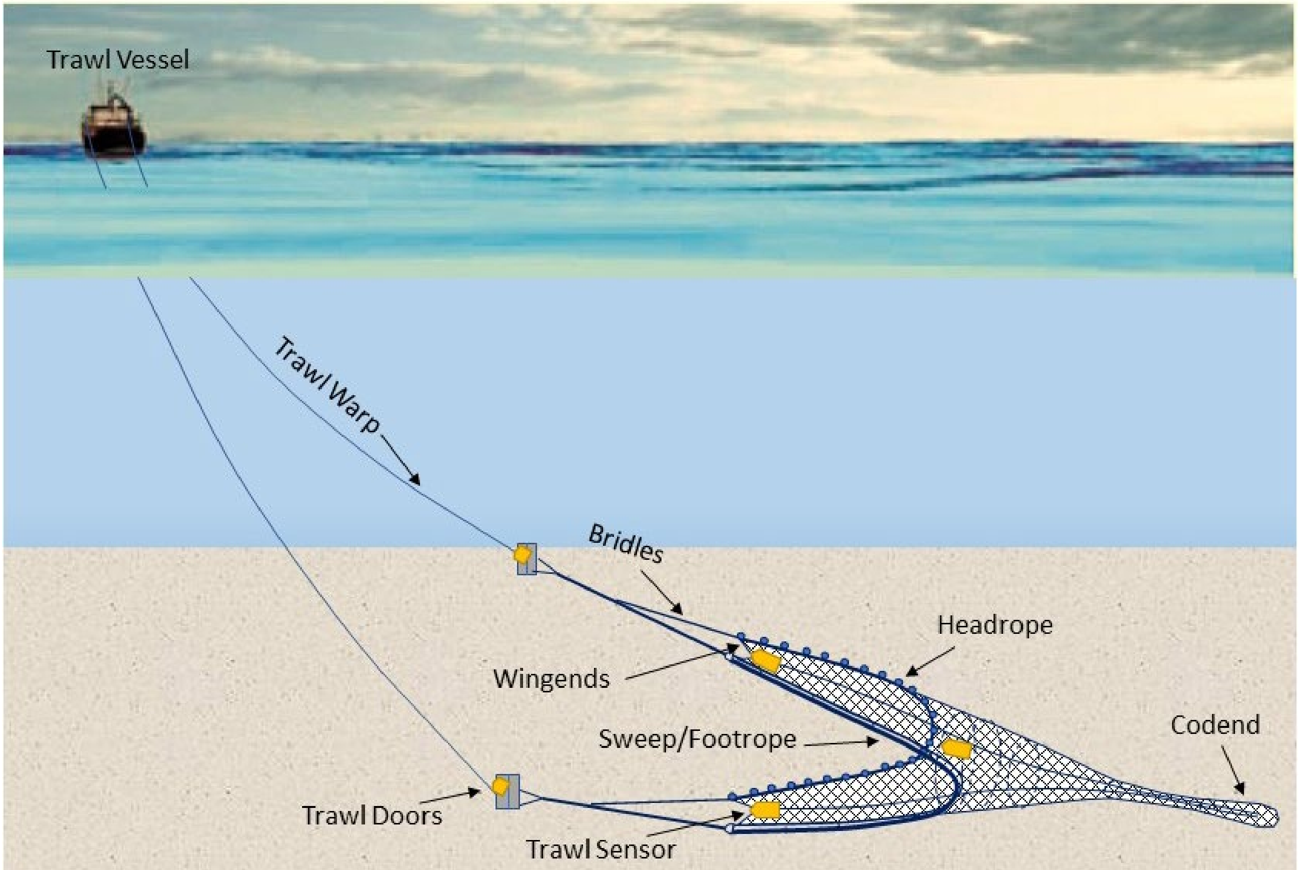


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate Simrad PX trawl geometry sensors.

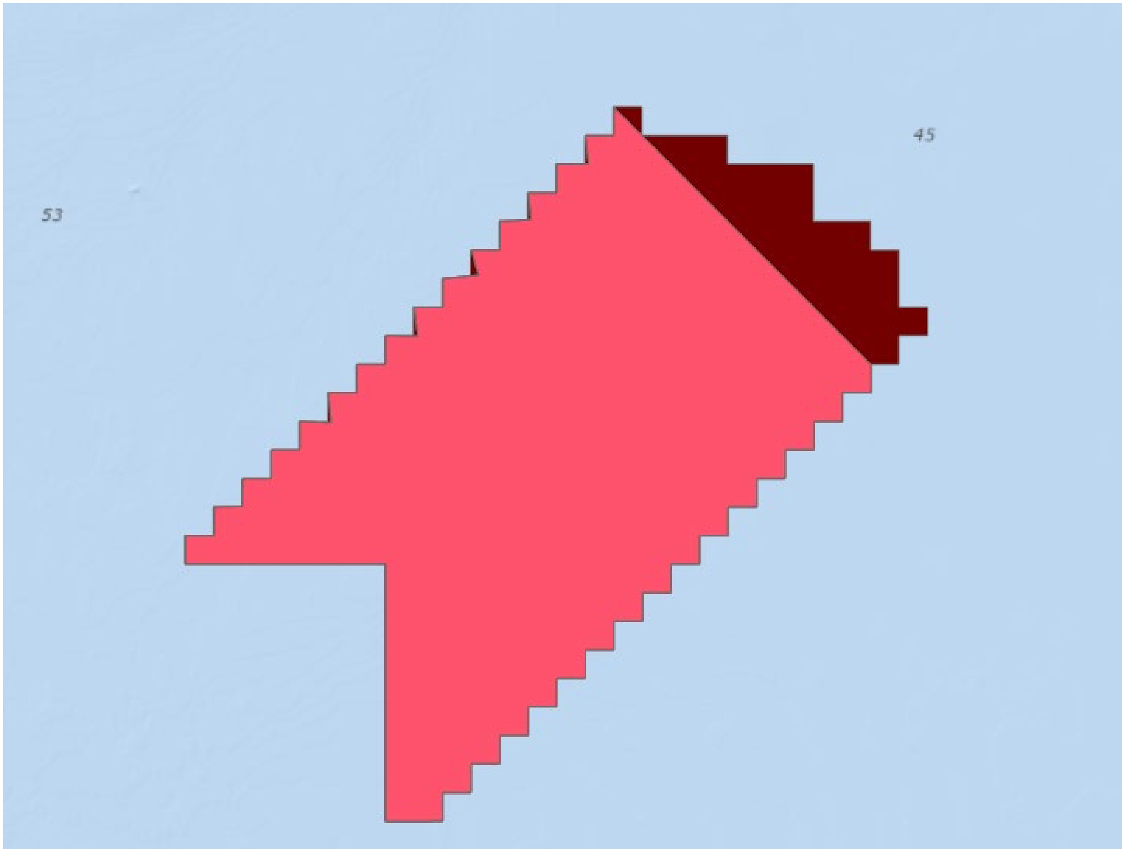


Figure 2: Boundary refinement of the 534 Study Area. The 534 Study Area was increased from 369 km^2 (light red) in 2020/2021 to 411 km^2 during 2021/2022 survey year to include the area in dark red.

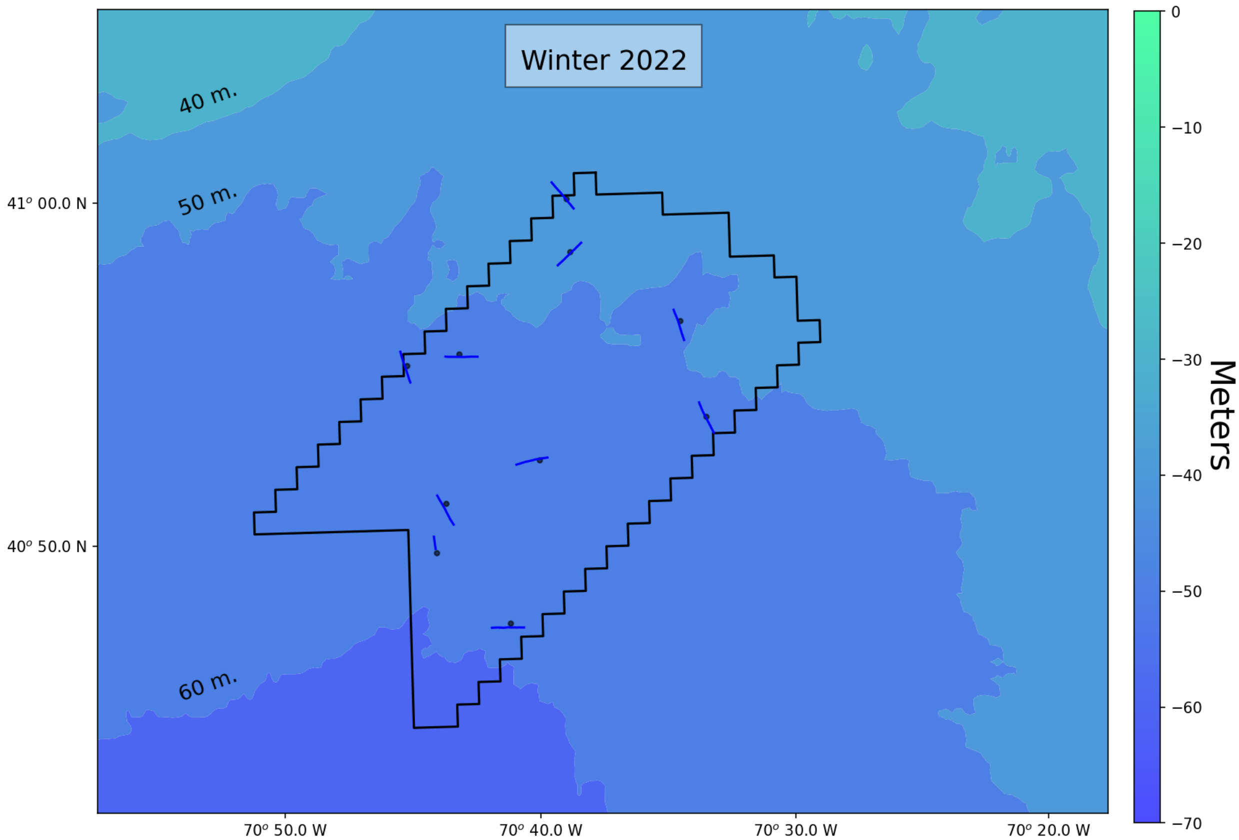


Figure 3: Tow locations (black dots) and trawl tracks (blue lines) from the 534 Study Area.

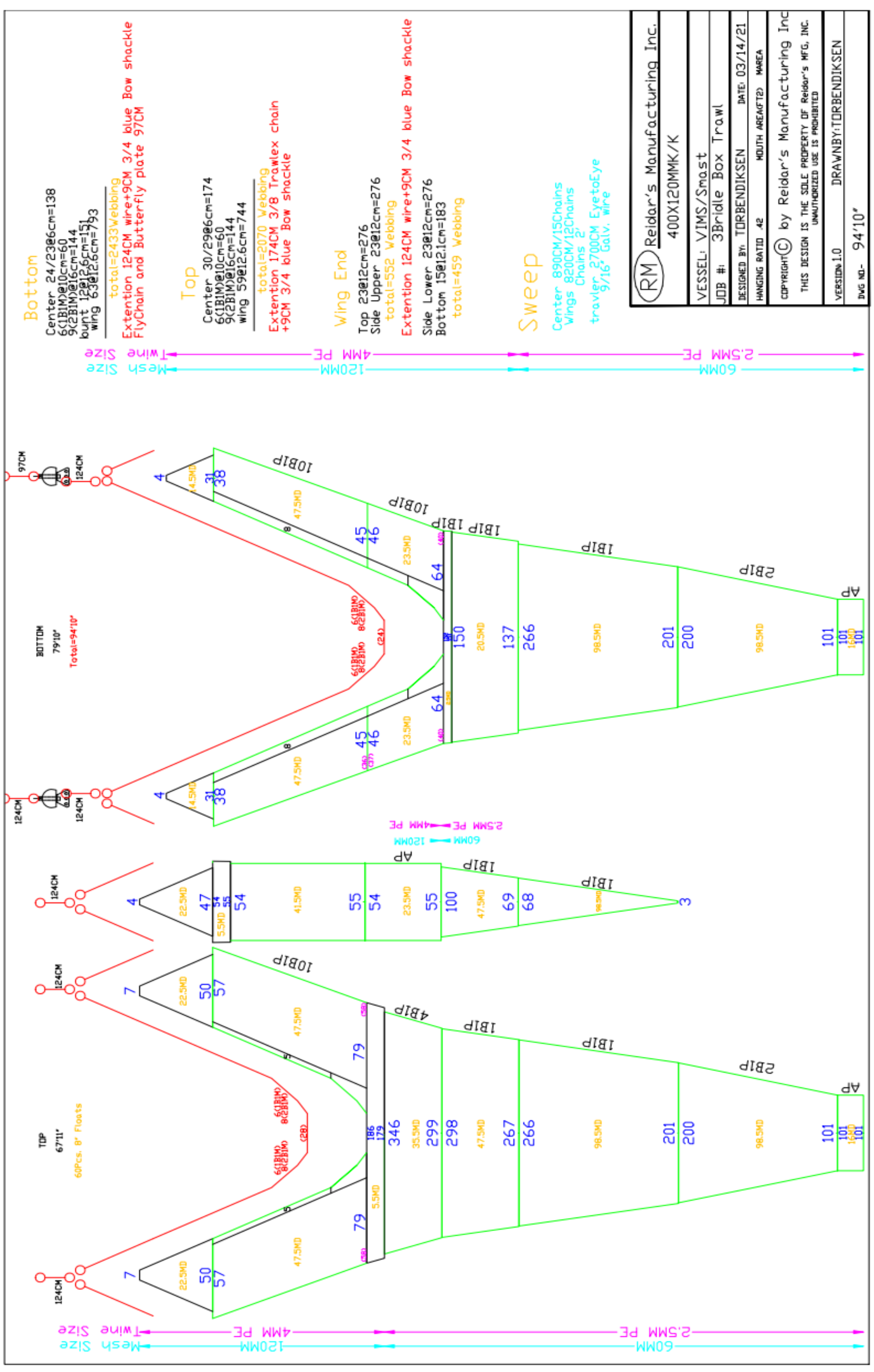


Figure 4: Schematic net plan for the NEAMAP trawl (Courtesy of Reidar's Manufacturing Inc.).

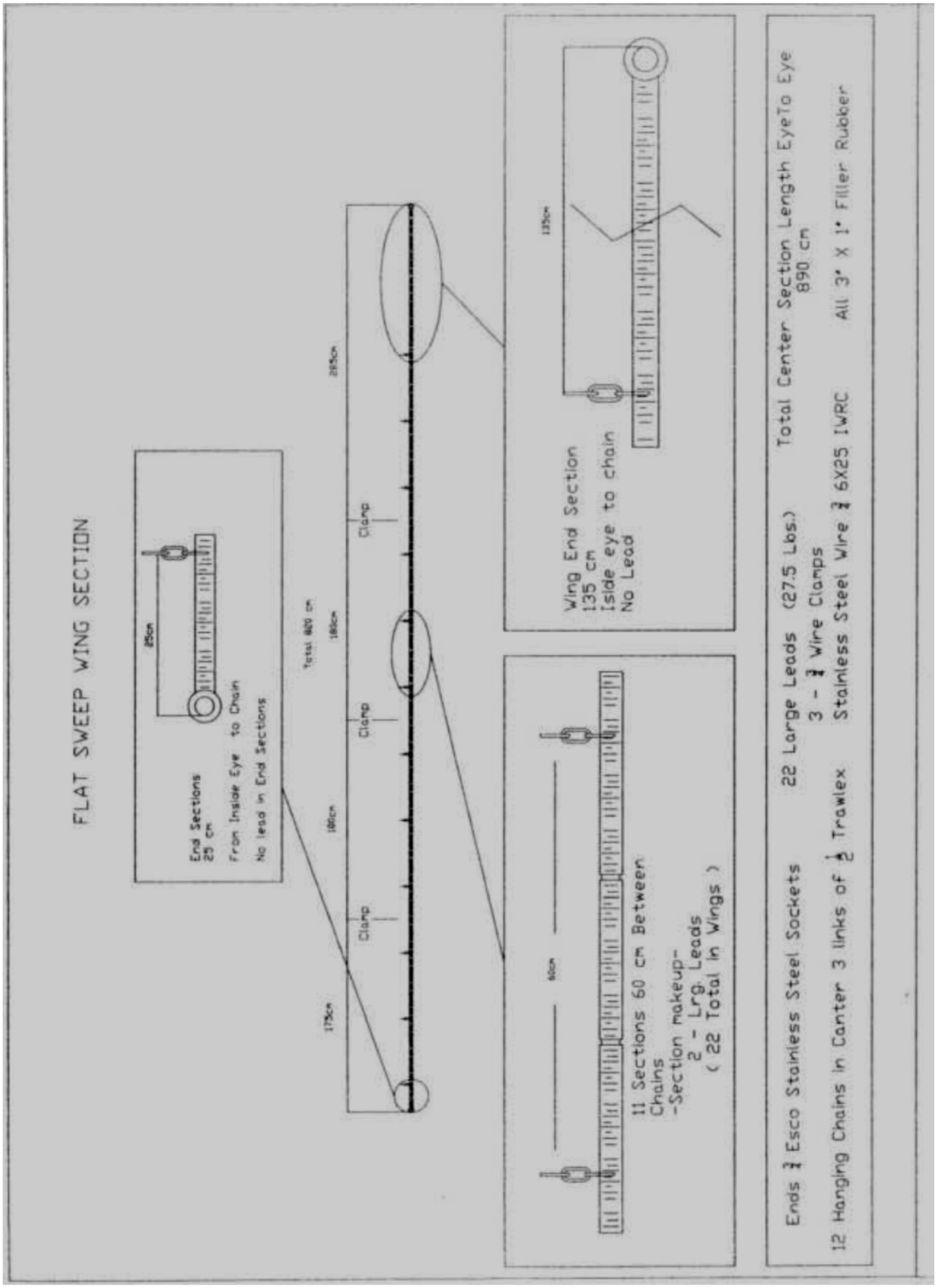


Figure 5: Sweep diagram for the survey trawl (Bonzek et al., 2008).

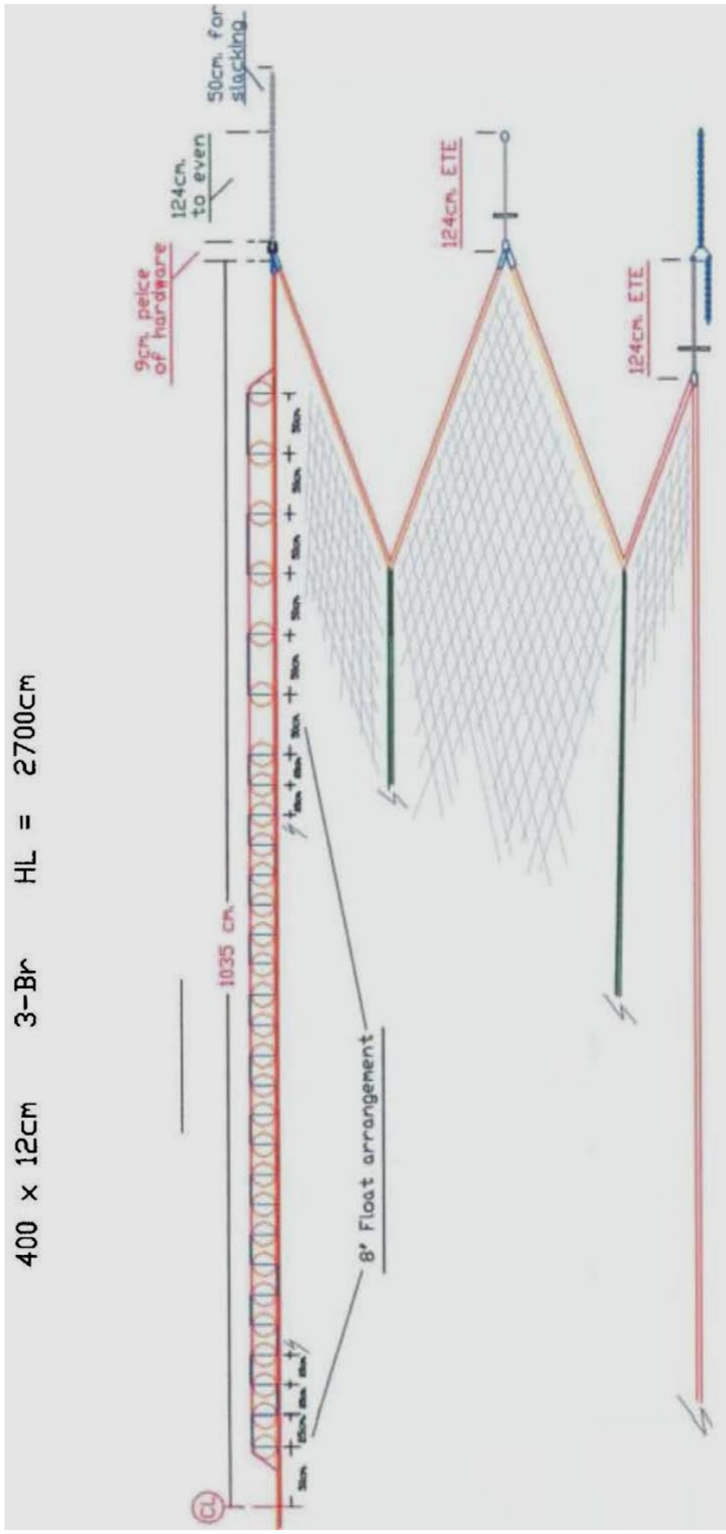


Figure 6: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008).

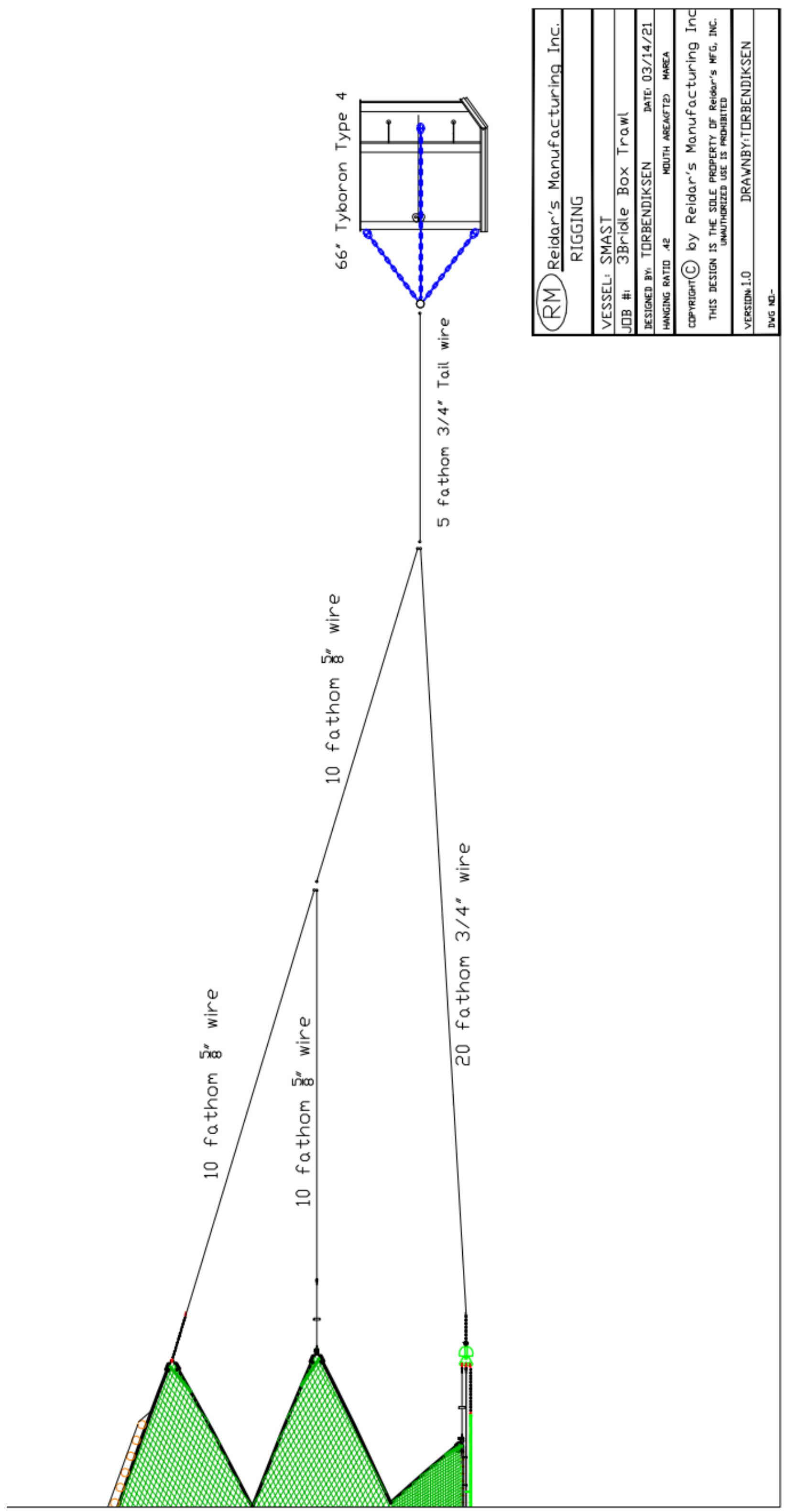


Figure 7: Bridle and door rigging schematic for the survey trawl (Courtesy of Reidar's Manufacturing Inc.).

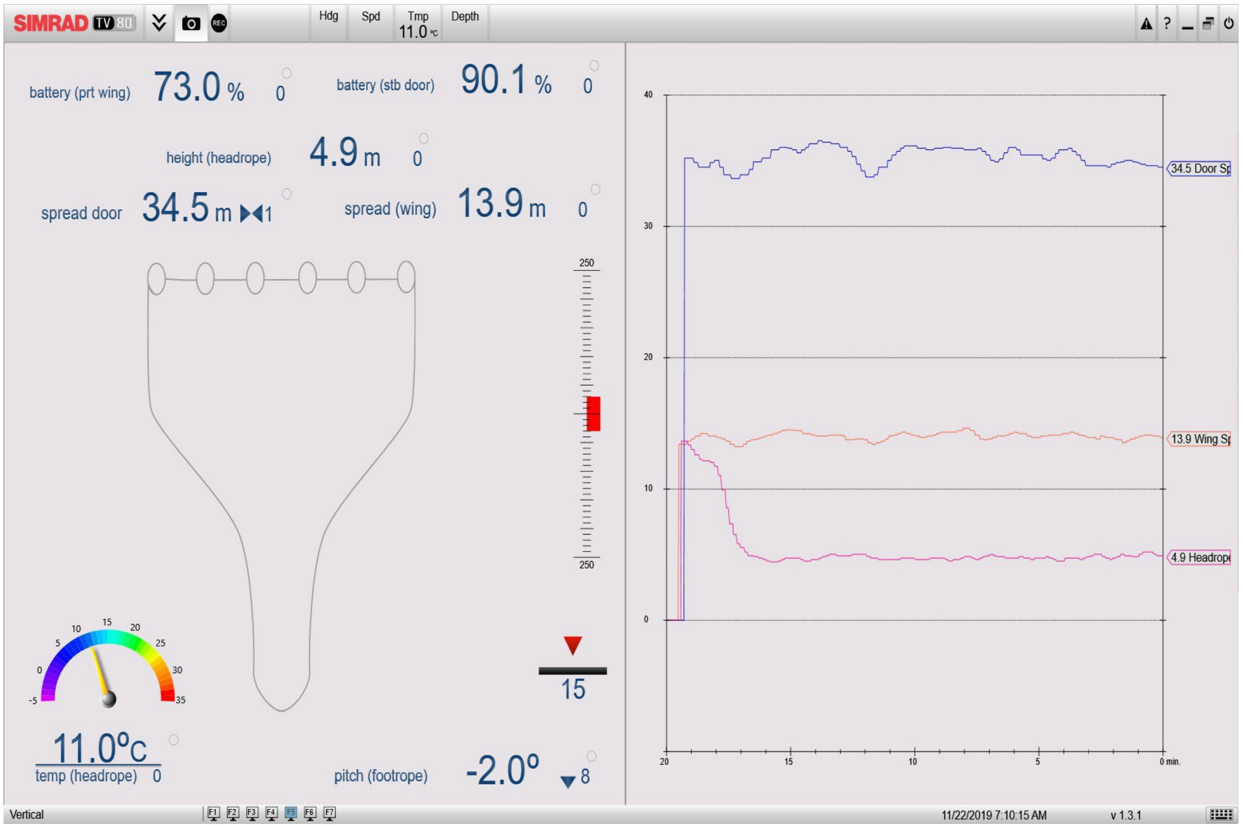
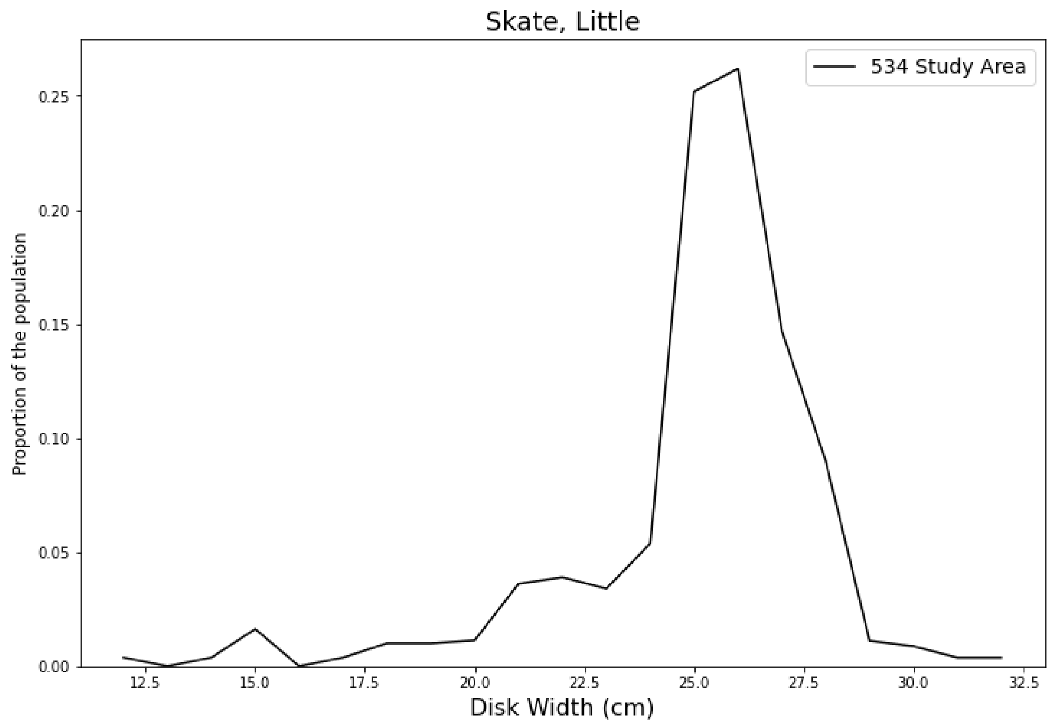


Figure 8: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.



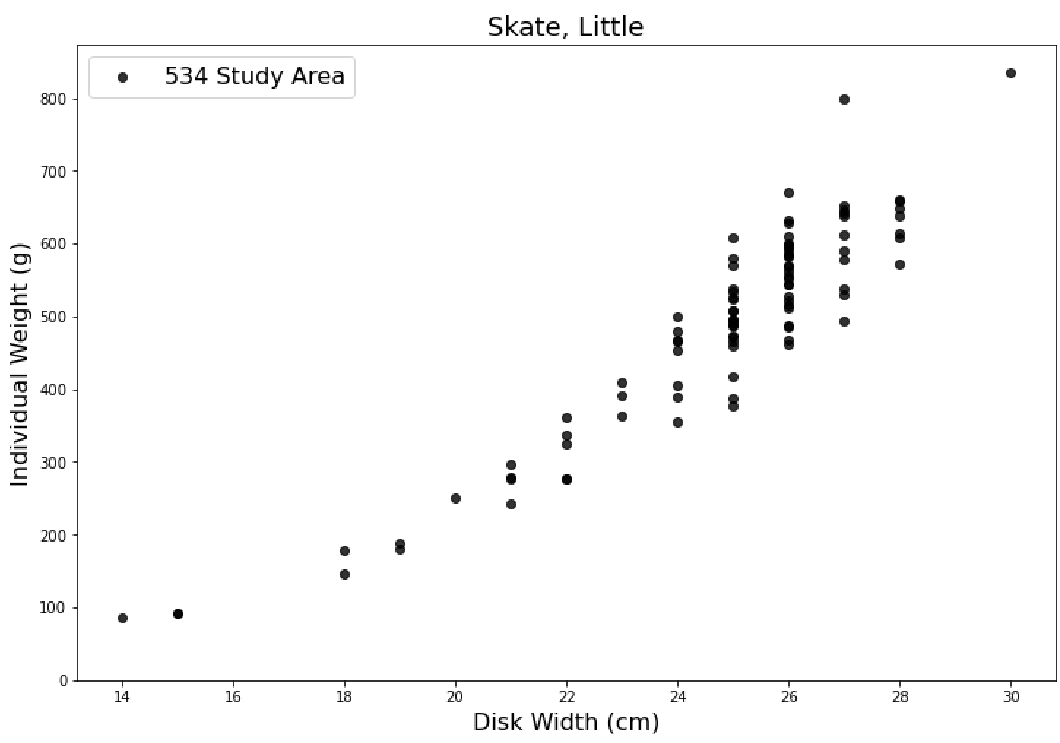


Figure 9: Population structure of little skate in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

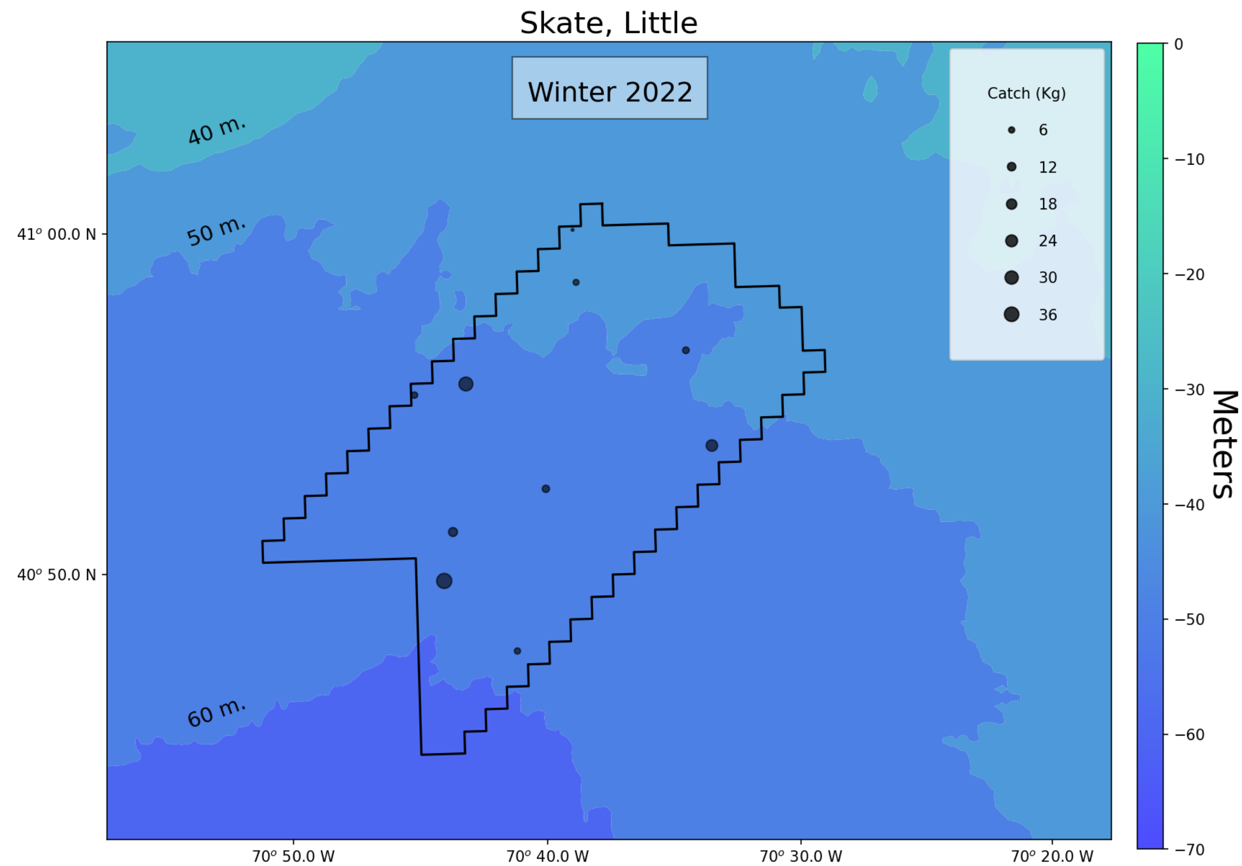
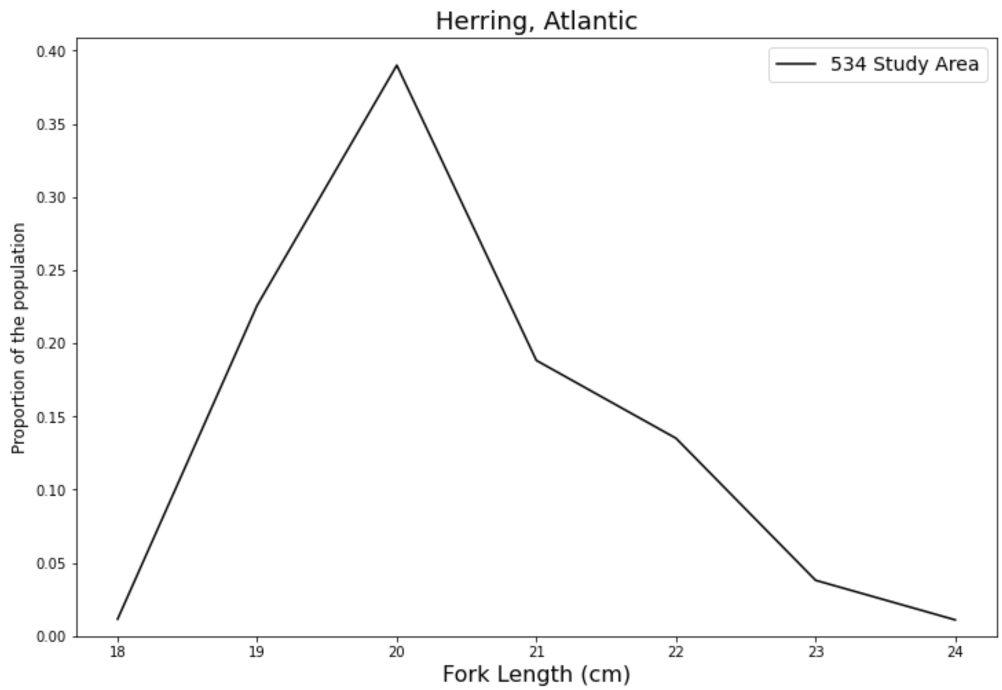


Figure 10: Distribution of the catch of little skate in the 534 Study Area.



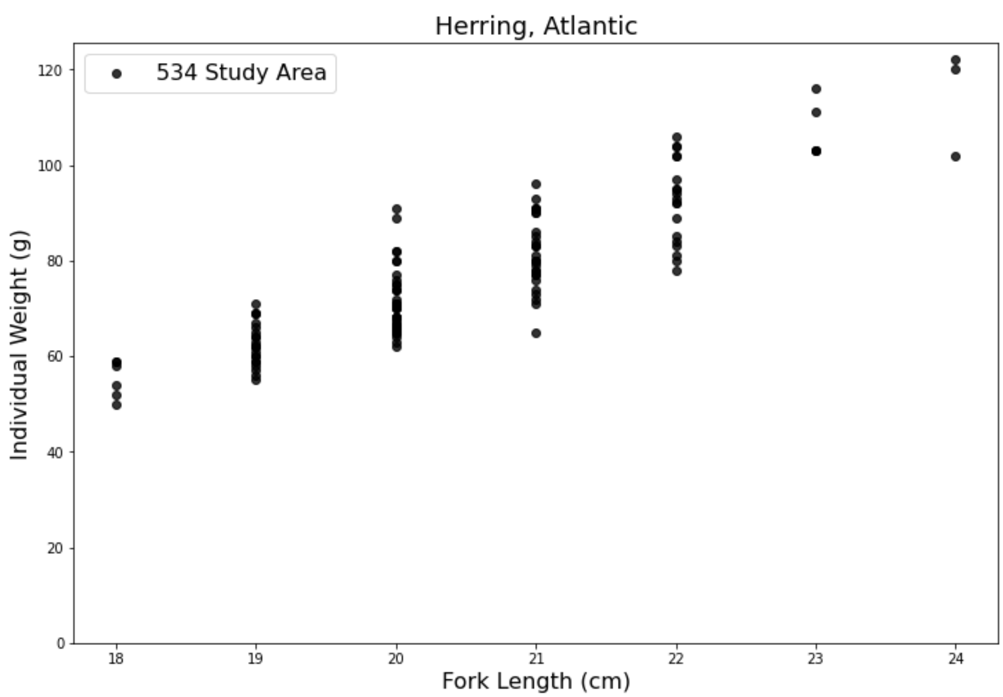


Figure 11: Population structure of Atlantic herring in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

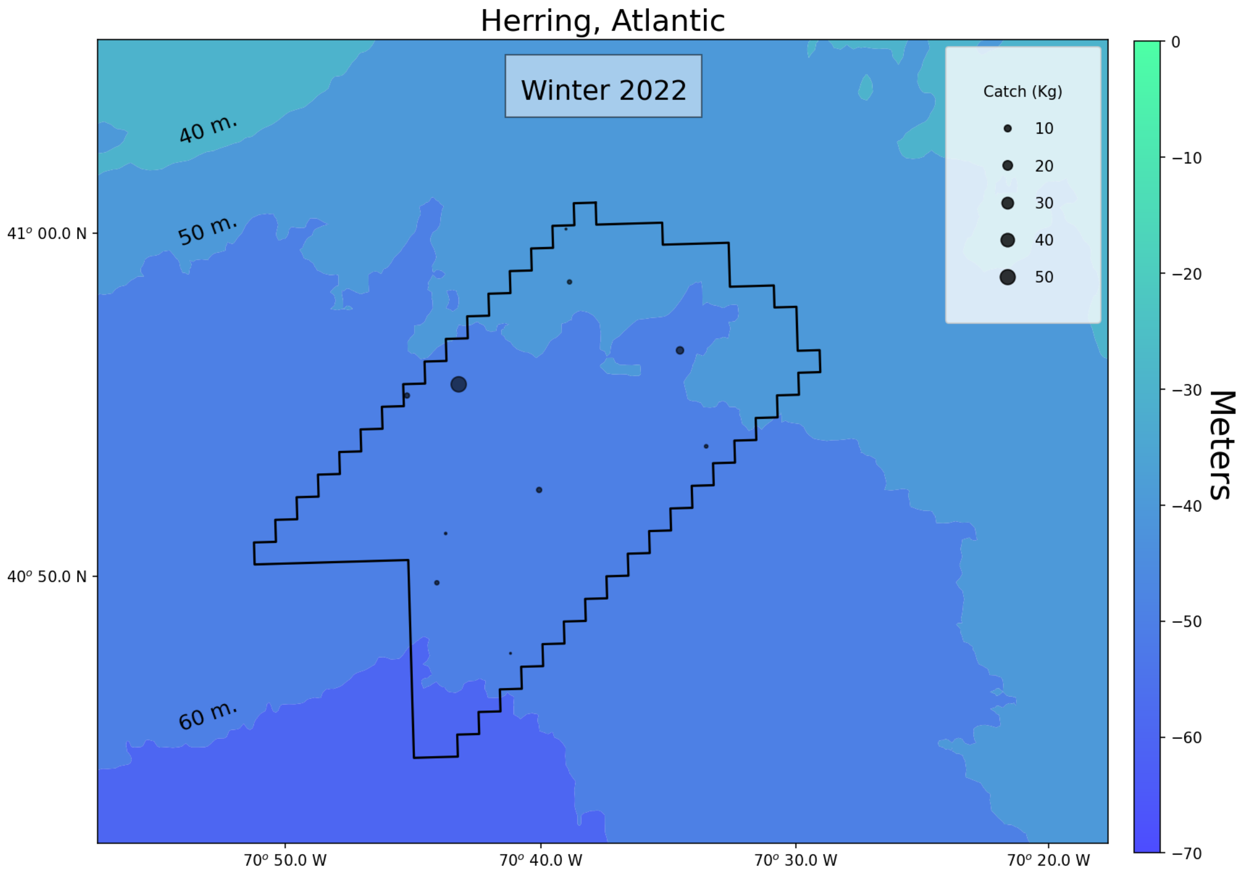
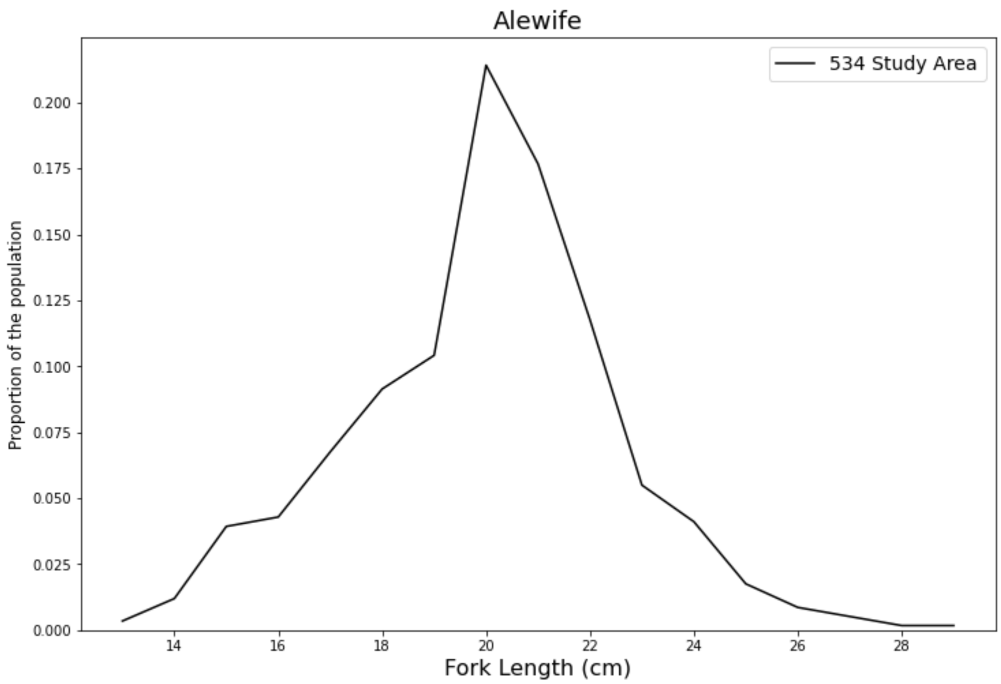


Figure 12: Distribution of the catch of Atlantic herring in the 534 Study Area. Tows with zero catch are denoted with an x.



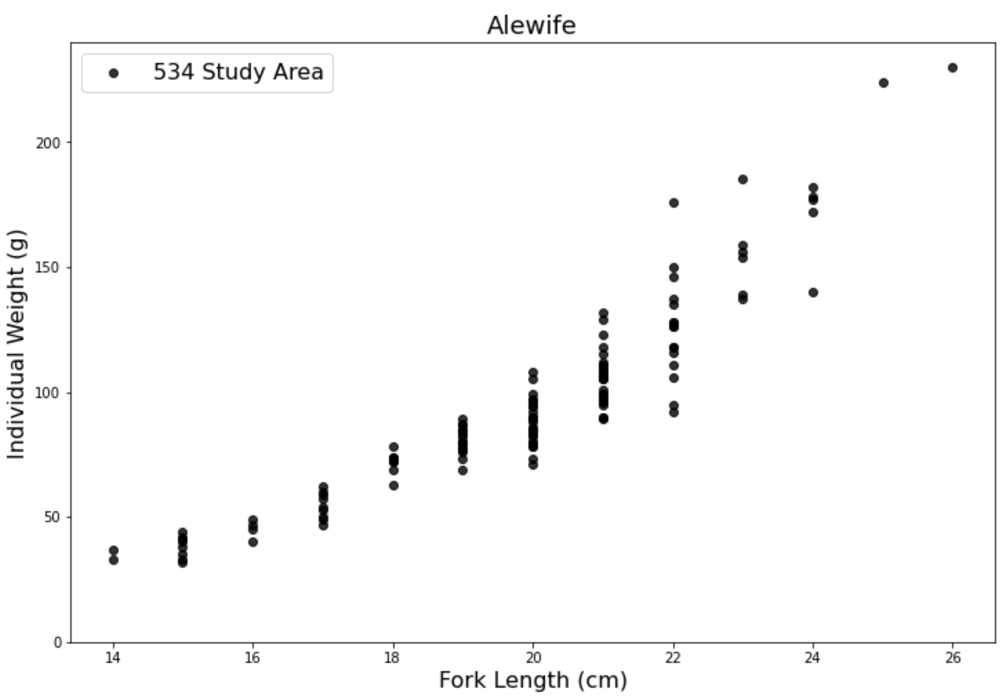


Figure 13: Population structure of alewife in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

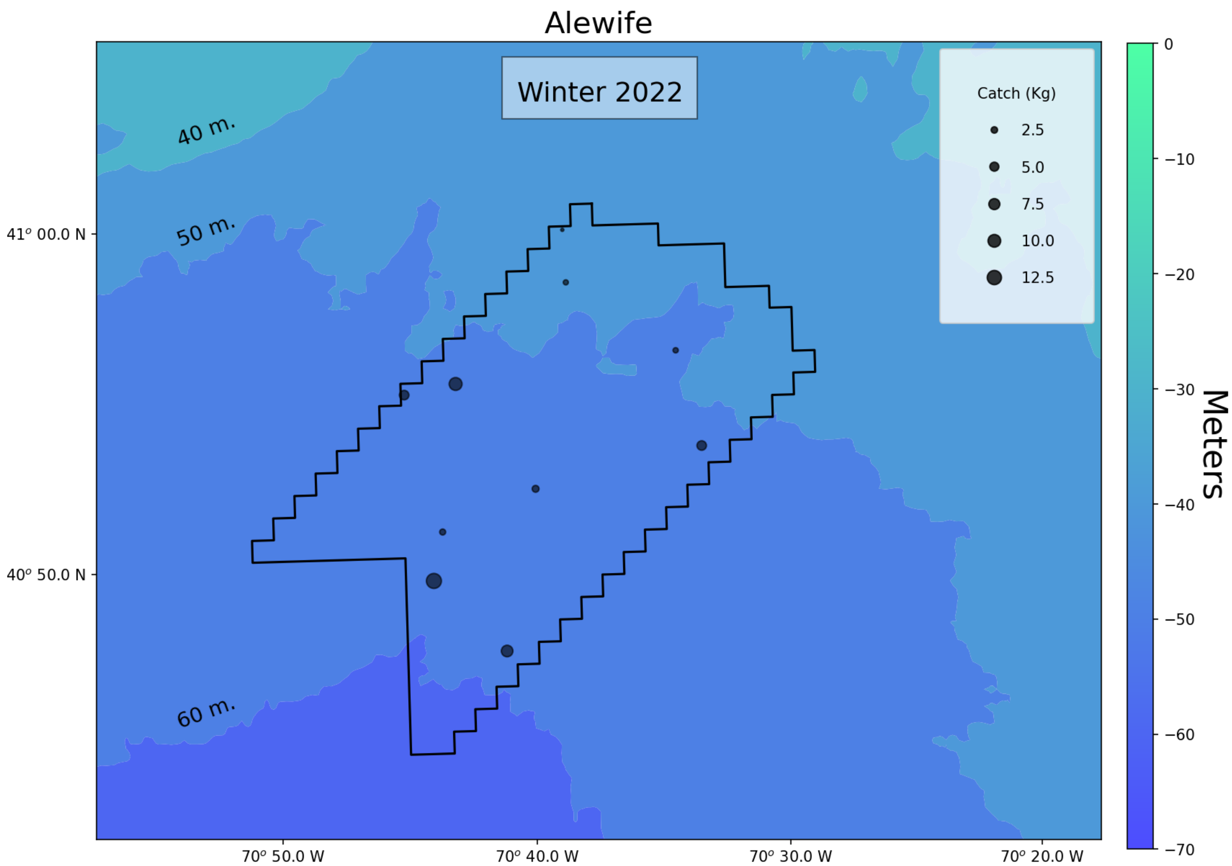
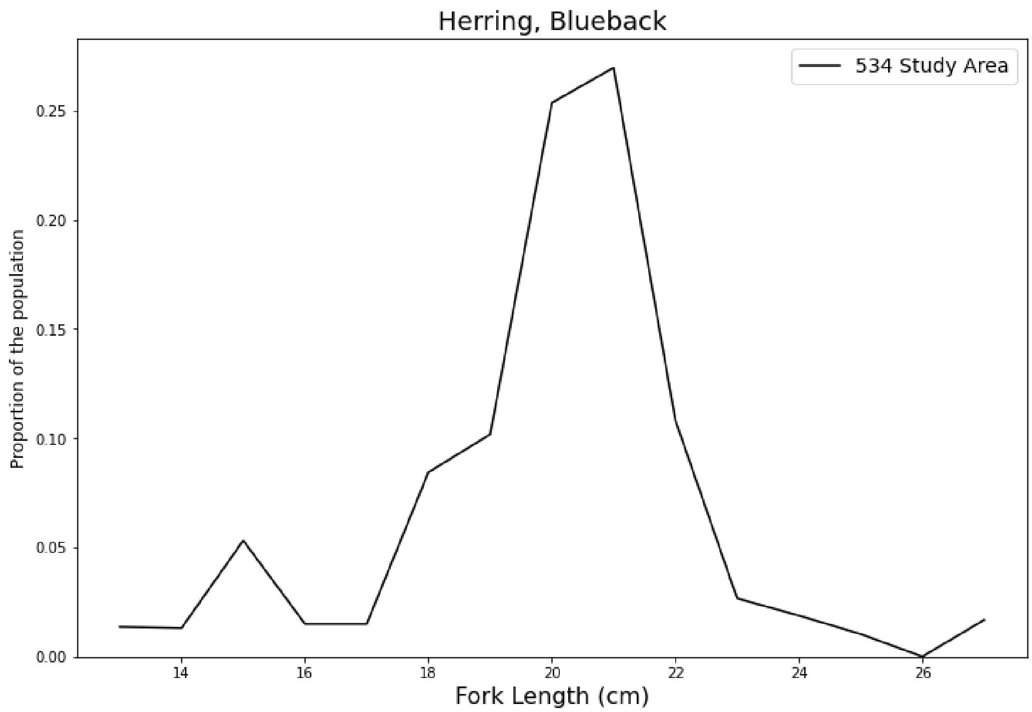


Figure 14: Distribution of the catch of alewife in the 534 Study Area.



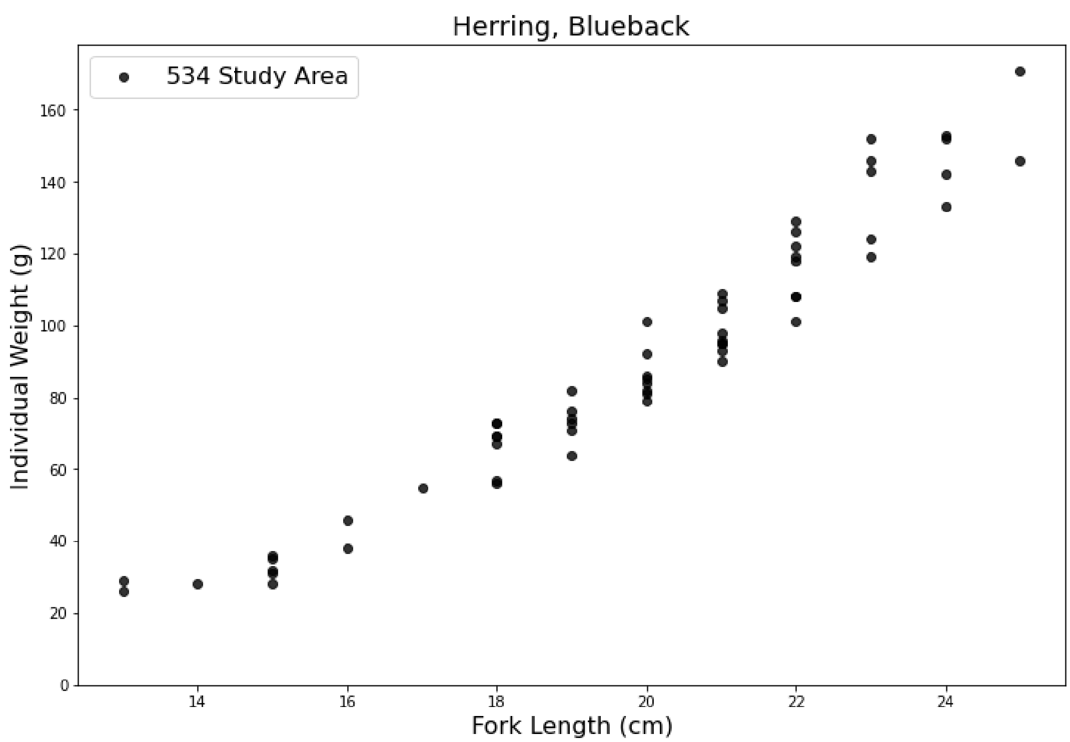


Figure 15: Population structure of blueback herring in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

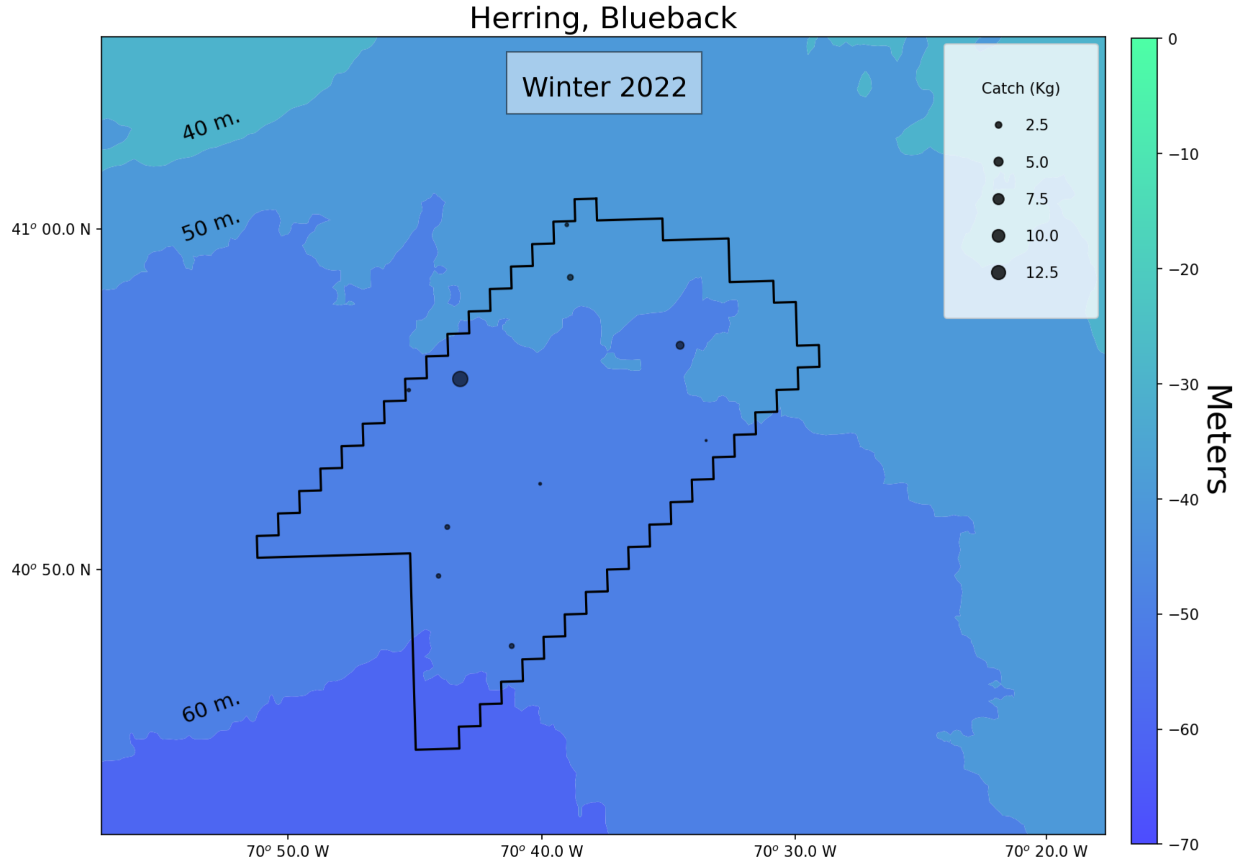
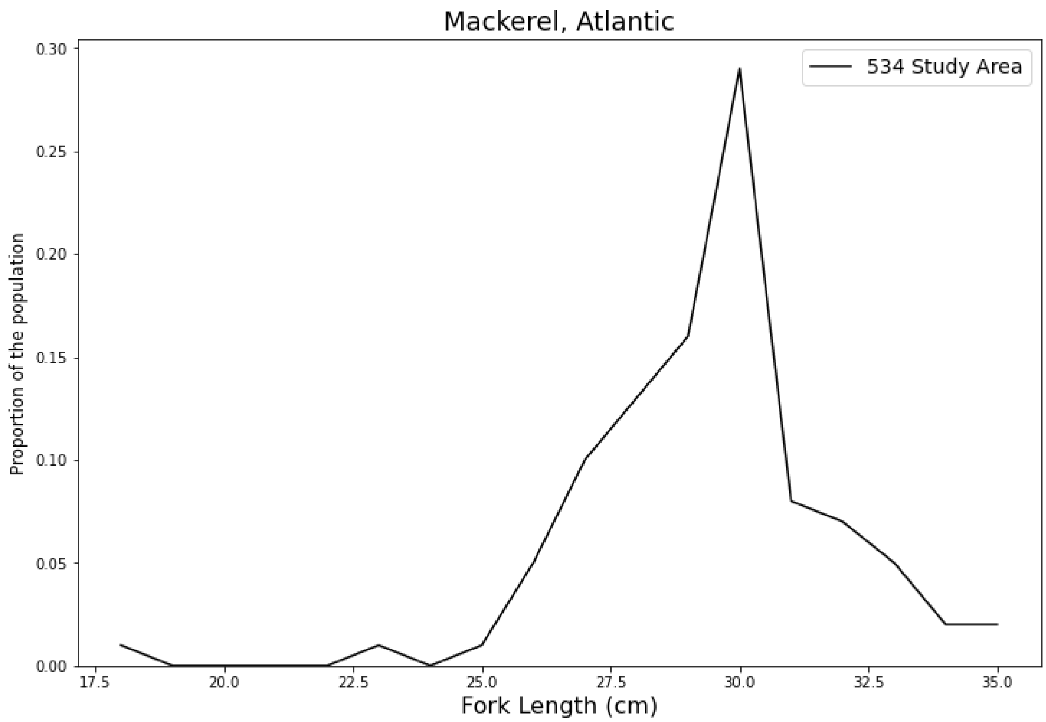


Figure 16: Distribution of the catch of blueback herring in the 534 Study Area.



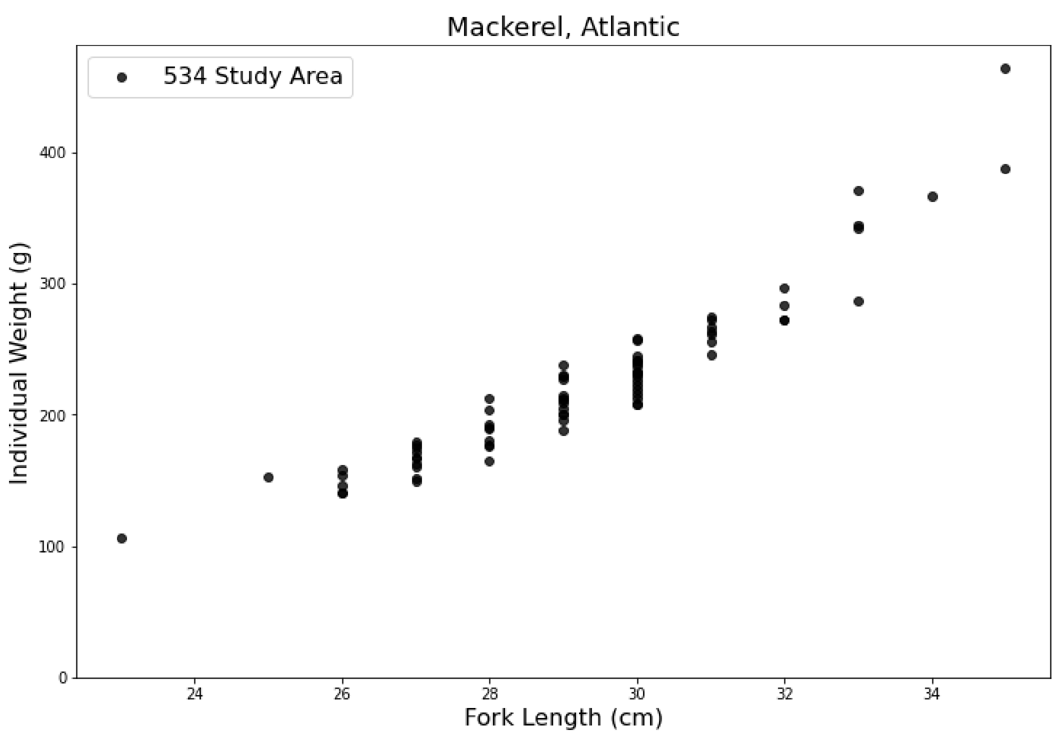


Figure 17: Population structure of Atlantic mackerel in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

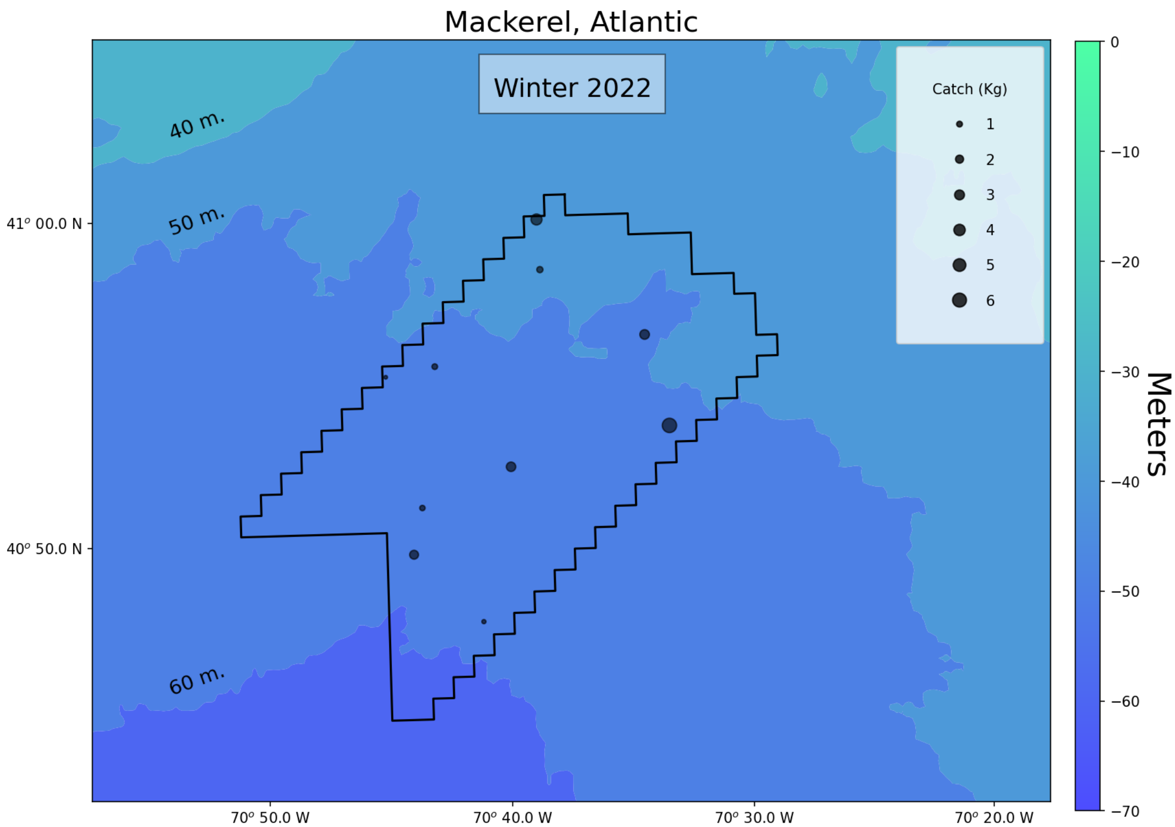
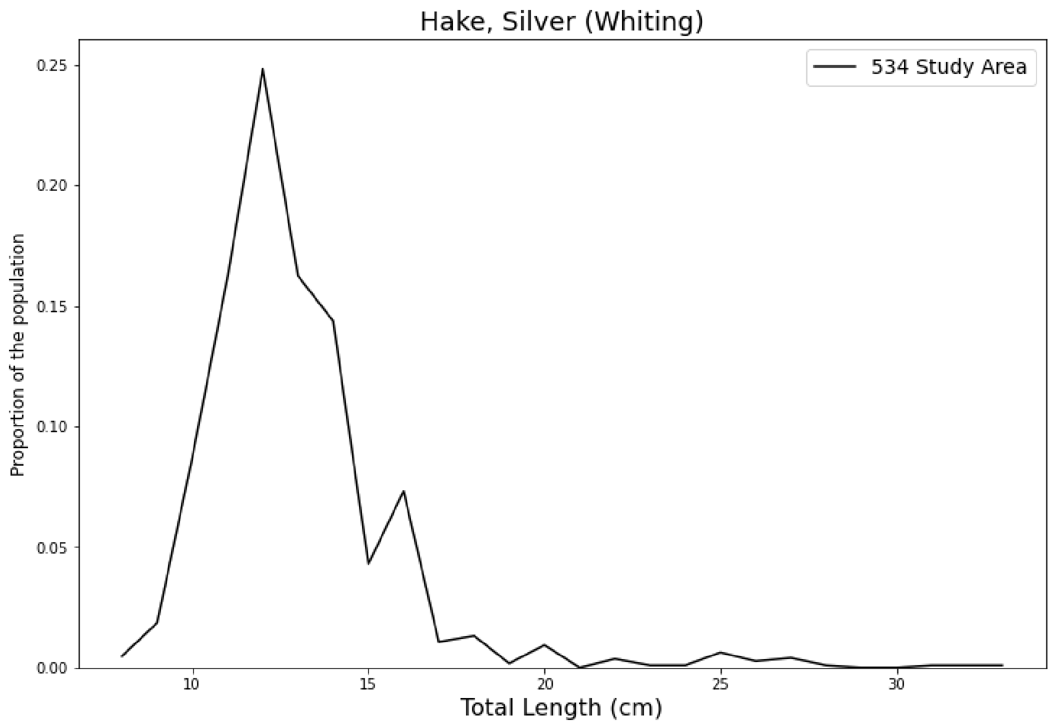


Figure 18: Distribution of the catch of Atlantic mackerel in the 534 Study Area.



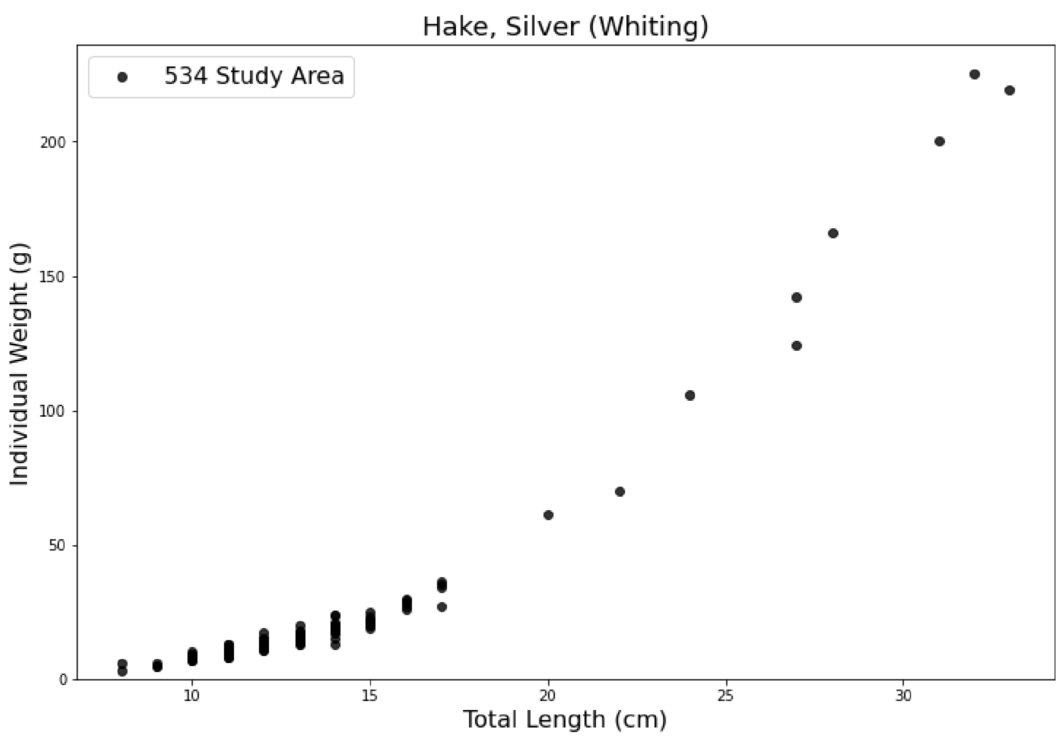


Figure 19: Population structure of silver hake in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

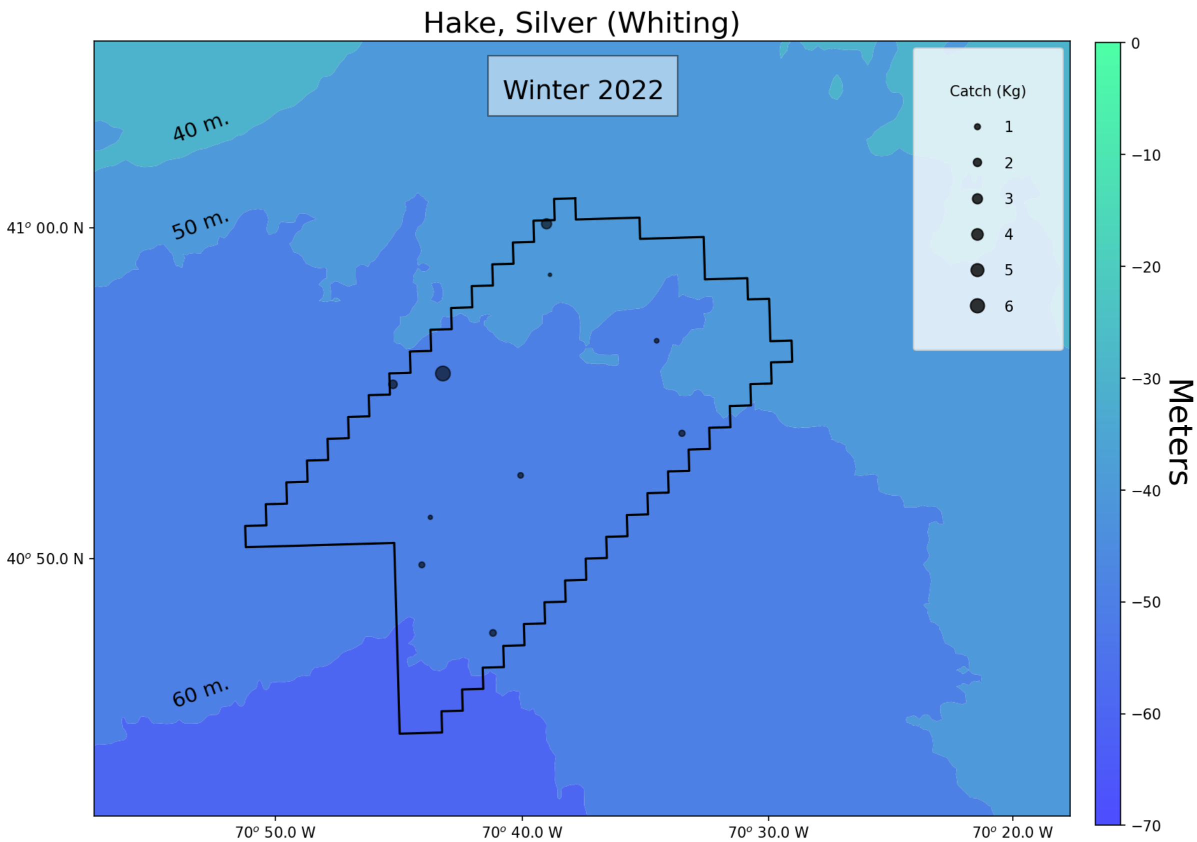
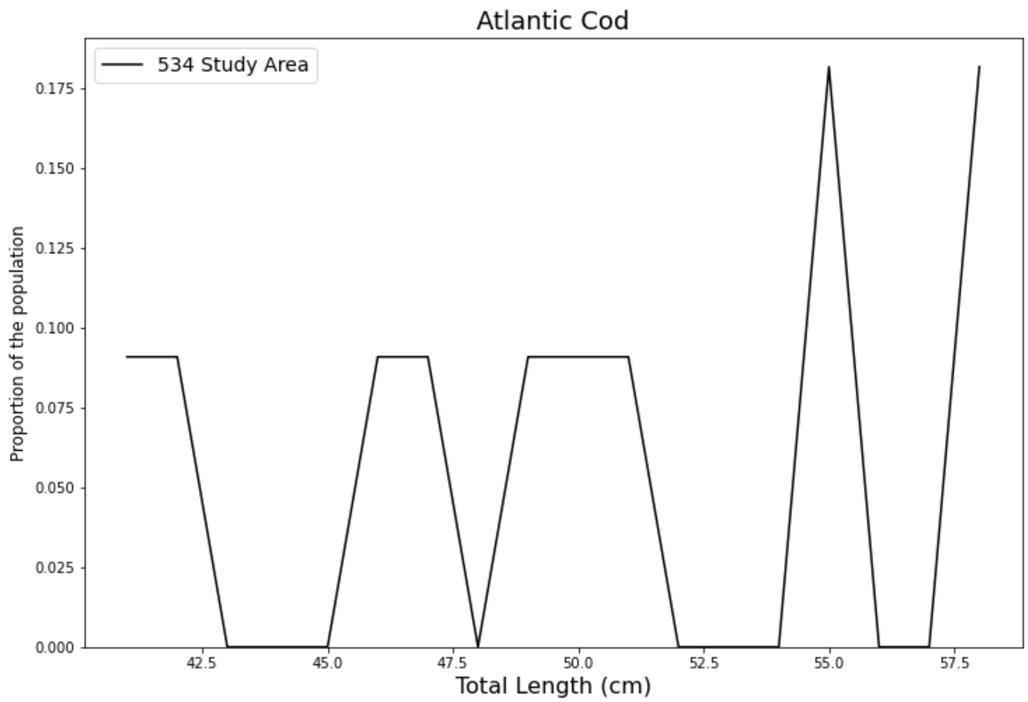


Figure 20: Distribution of the catch of silver hake in the 534 Study Area.



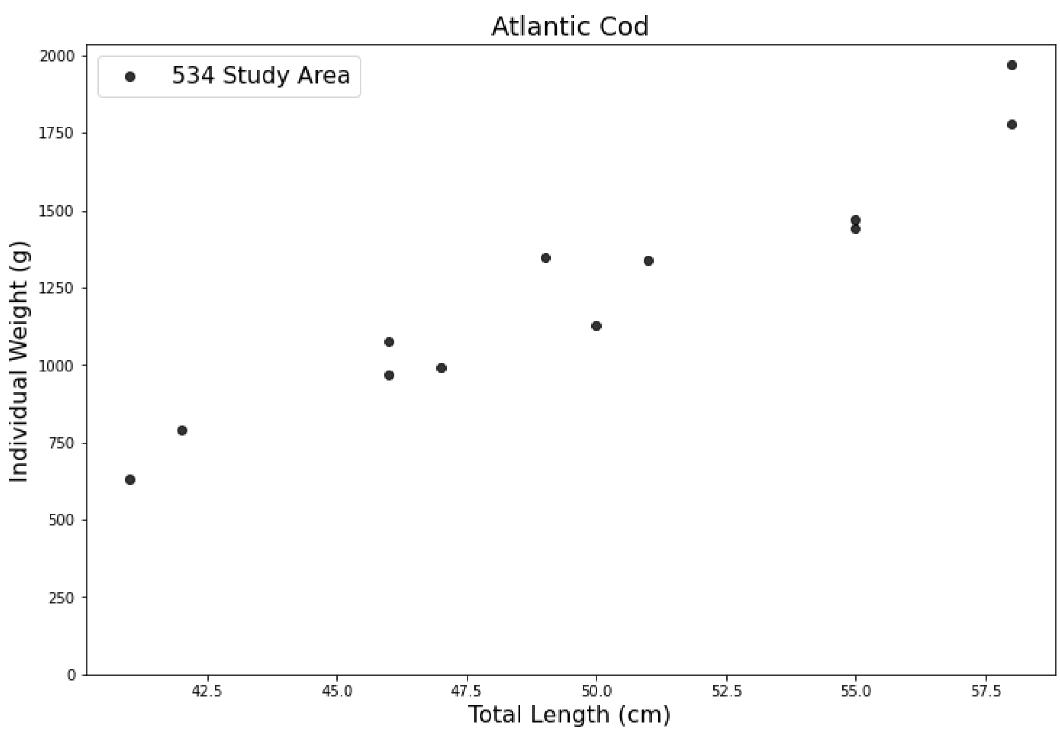


Figure 21: Population structure of Atlantic cod in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

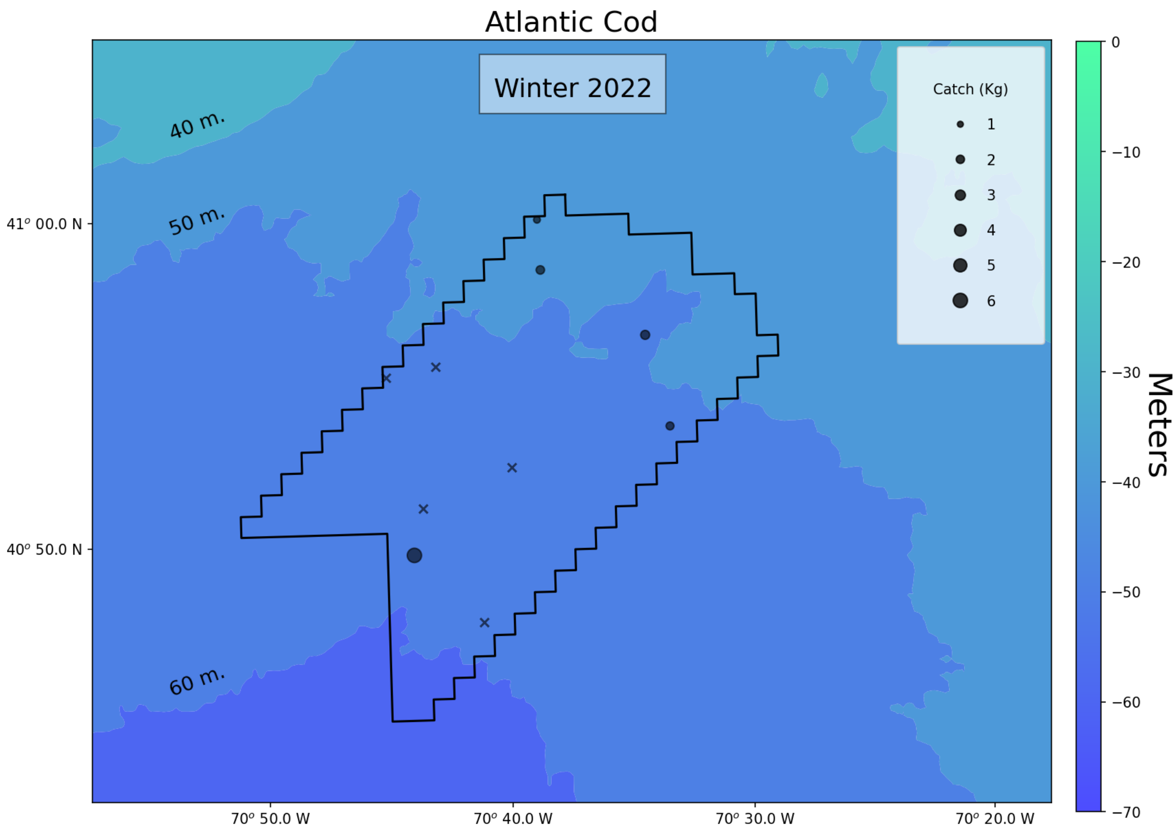
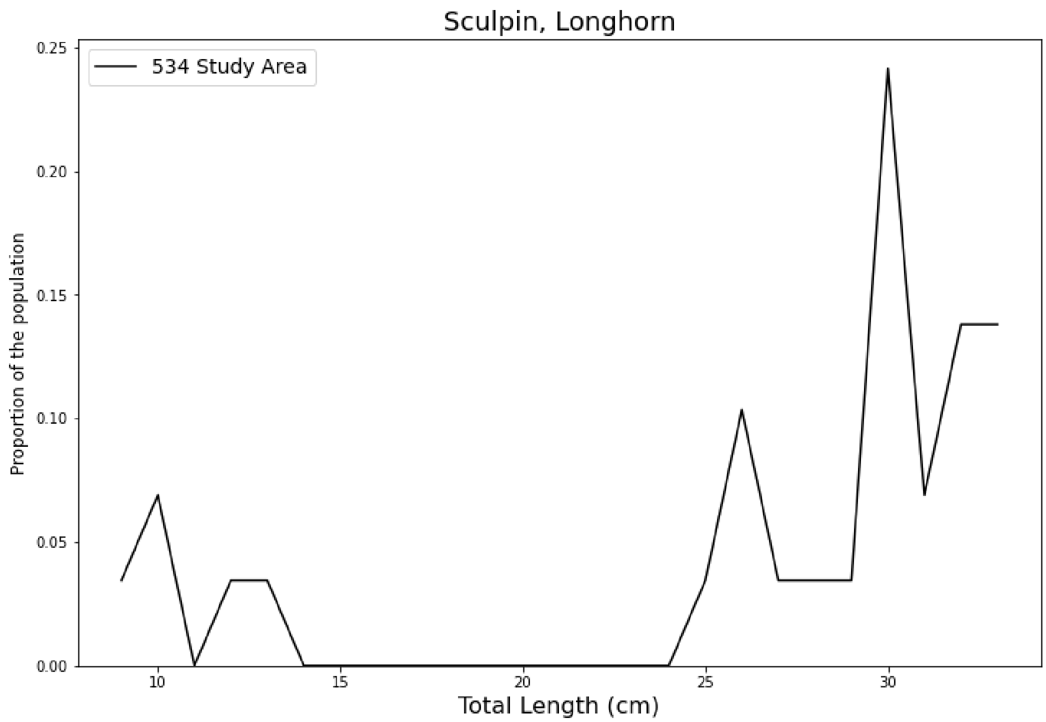


Figure 22: Distribution of the catch of Atlantic cod in the 534 Study Area. Tows with zero catch are denoted with an x.



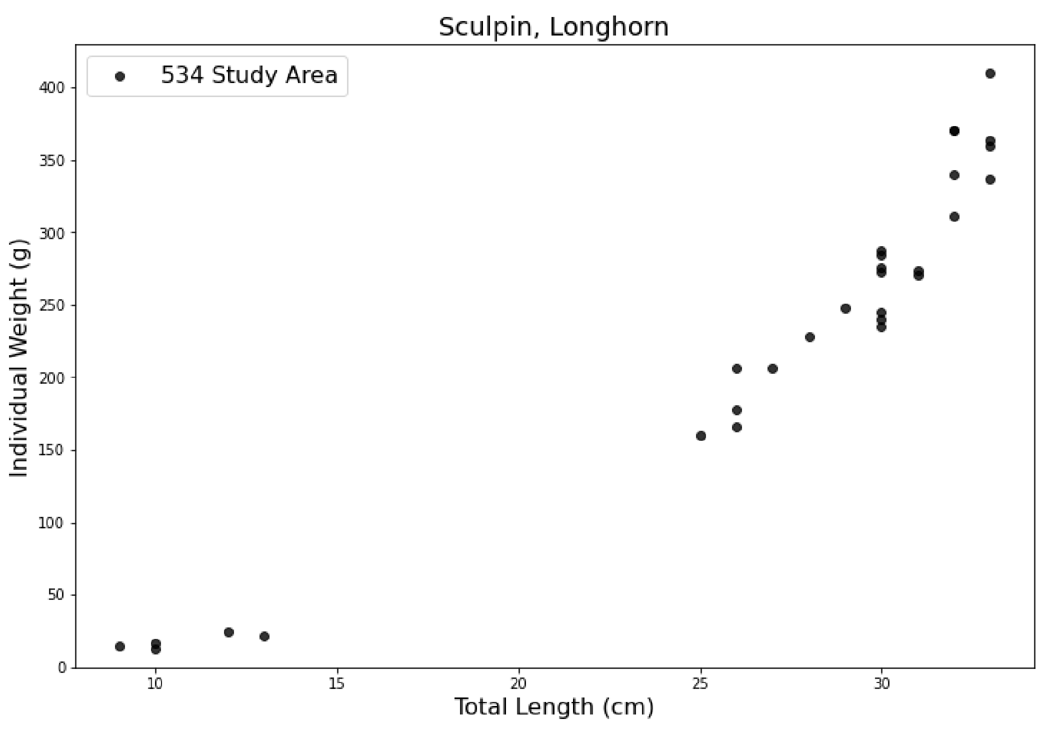


Figure 23: Population structure of longhorn sculpin in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

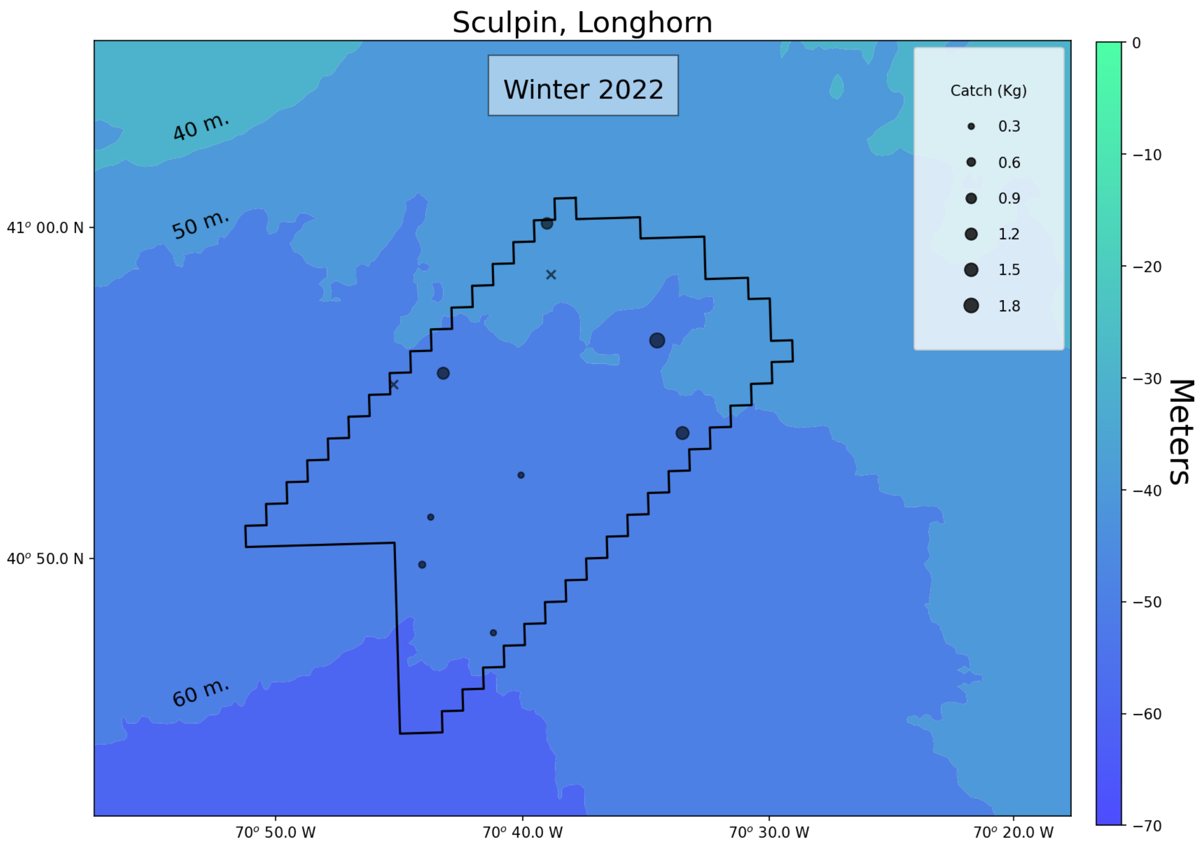


Figure 24: Distribution of the catch of longhorn sculpin in the 534 Study Area. Tows with zero catch are denoted with an x.

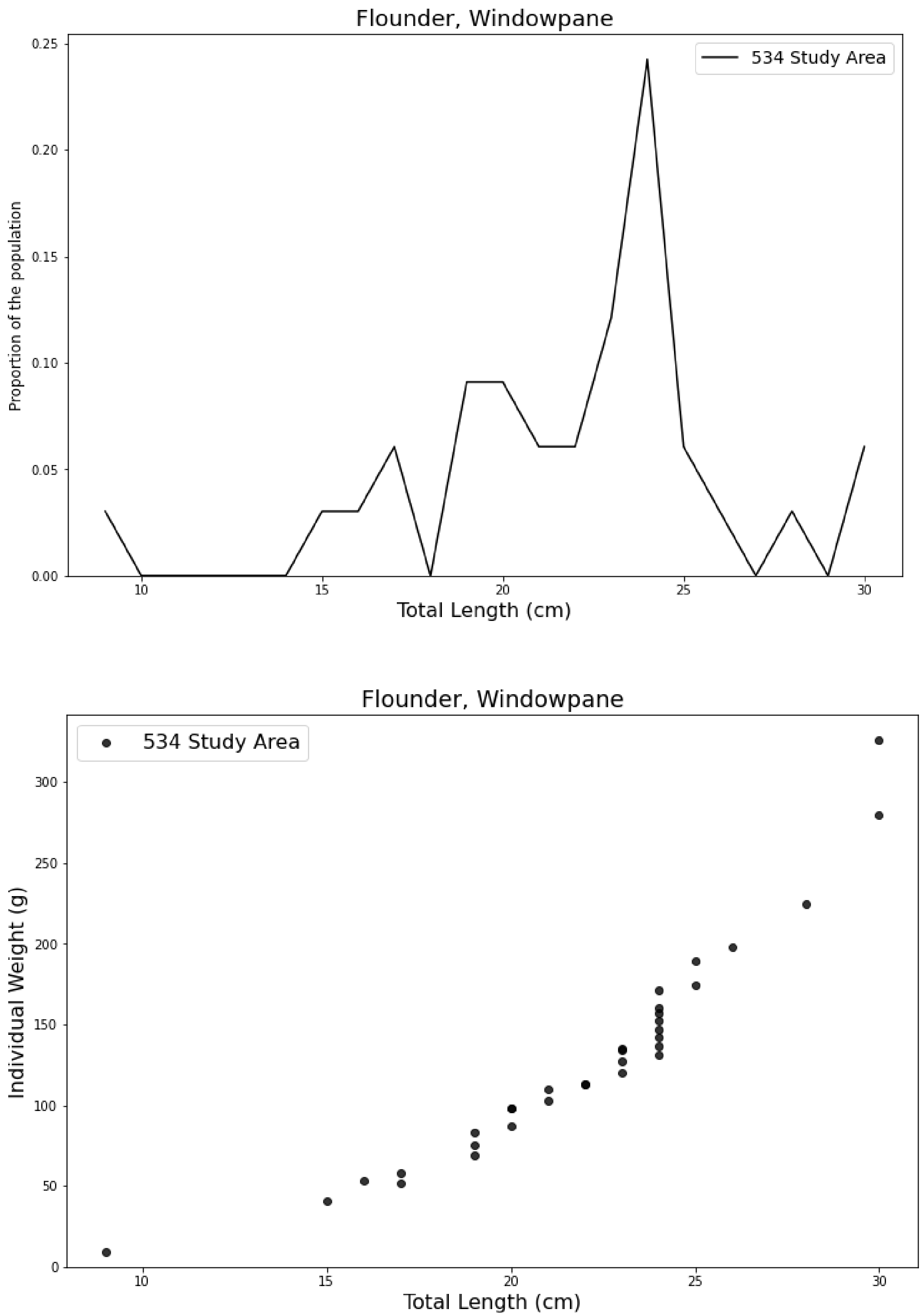


Figure 25: Population structure of windowpane flounder in the 534 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

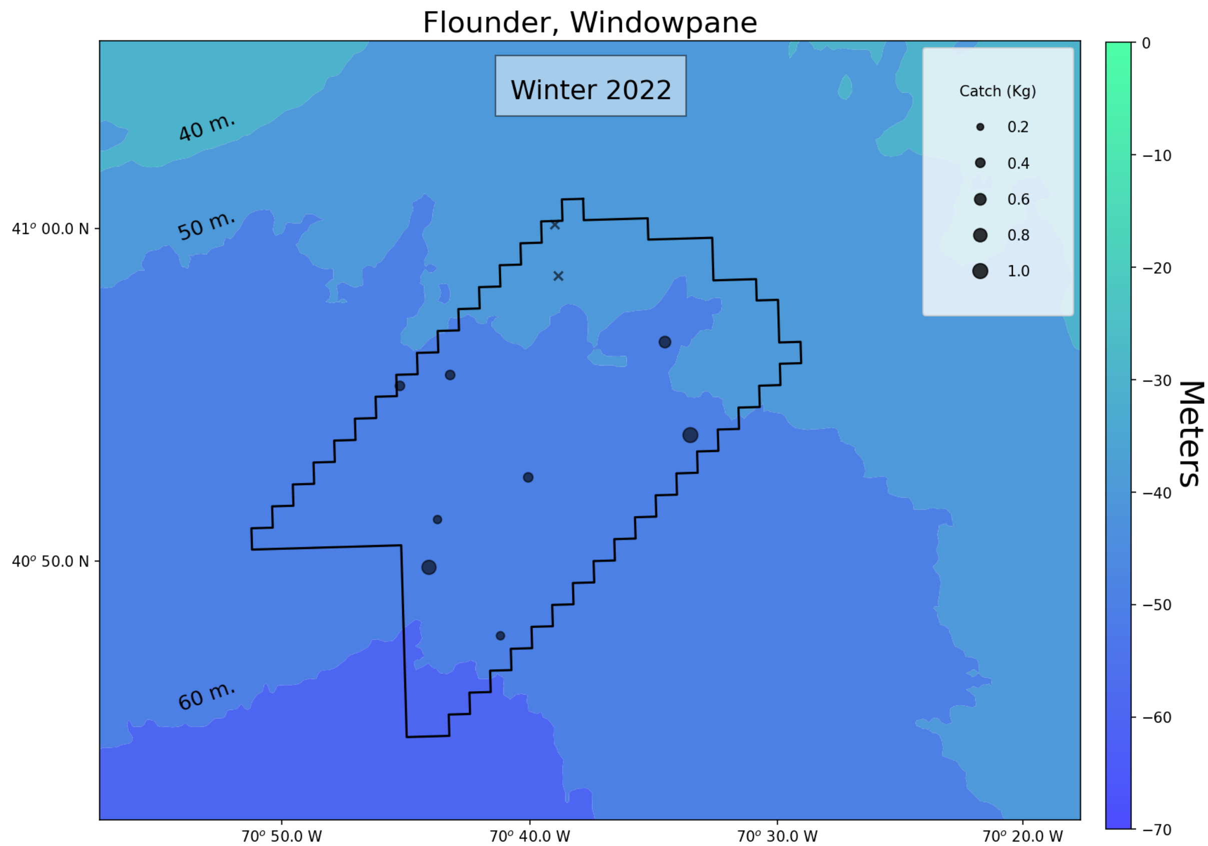


Figure 26: Distribution of the catch of windowpane flounder in the 534 Study Area. Tows with zero catch are denoted with an x.