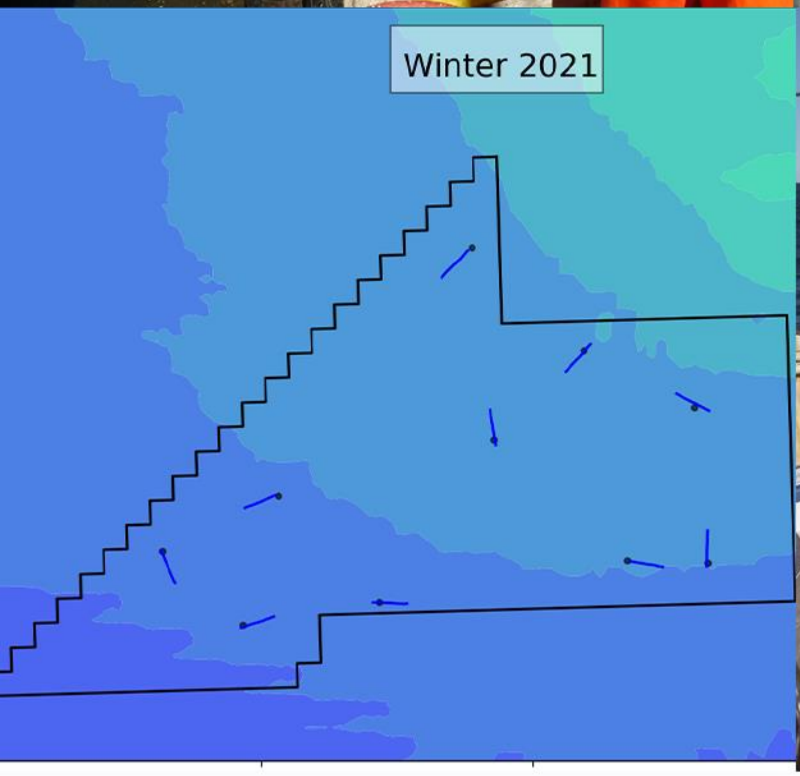
# Vineyard Wind Demersal Trawl Survey




# Quarterly Report

## Winter 2021 (January - March)

## 522 Lease Area

# VINEYARD WIND DEMERSAL TRAWL SURVEY

## Winter 2021 Seasonal Report

## 522 Study Area

**March 2021**

**Prepared for Vineyard Wind, LLC**

Prepared by: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**University of Massachusetts Dartmouth**
**School for Marine Science and Technology**

# Vineyard Wind Demersal Trawl Survey Winter 2021 Seasonal Report

# 522 Study Area

**<u>Progress Report #7</u>**
January 1 – March 31, 2021

| | |
|---|---|
| Project title: | Vineyard Wind Demersal Trawl Survey Winter 2021 Seasonal Report – 522 Study Area |
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**SMAST-CE-REP-2021-099**

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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 the northern portion of Lease Area OCS-A 0501 (the "501N Study Area") and within the southern portion of Lease Area OCS-A 0501 (the "501S Study Area"); these studies are reported separately.[1]

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 the proposed development on marine fish and invertebrate communities. The impact of the development 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). The control site will be in the general vicinity with similar characteristics to the impact 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 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 ecology. 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

[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 501S Study Area is now located in the area designated as Lease Area OCS-A 0534 and referred to as the 501S Study Area in SMAST fisheries survey reports published prior to 2022.

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 bottom trawl survey is complemented by the drop camera survey and lobster trap survey, both are also carried out by SMAST.

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 previous six seasons of surveys – conducted from spring 2019 to fall 2020 – have been submitted to the sponsoring organization. This progress report documents survey methodology, survey effort, and data collected during the winter of 2021.

# 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 501N Study Area and 501S Study Area).

## 2.1 Survey Design

The current survey is designed to provide baseline data on catch rates, population structure, and community structure 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.

Tow locations within the 522 Study Area were selected using a systematic random 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 (i.e., 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 headline height of the trawl has been below the targeted level during all previous surveys. To increase the vertical opening of the net, eight additional floats were attached to the headline. Two strings of four floats were placed 2 m from the center of the headline, one on the starboard side of the net and the other on the port side of the net.

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 that 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 was made during which all planned tows were completed (February 9 – 16, 2021).

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. The straight sub-sampling by weight was the only sub-sampling strategy used during this survey. In this method, the catch was sorted by species. An aggregated species weight was measured and then a sub-sample (50 – 100 individuals) was made 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.

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 the survey data were uploaded and stored in 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 20.1 ± 0.1 minutes (mean ± one standard deviation). Tow distance averaged 1.0 ± 0.04 nautical miles (nmi) giving an average tow speed of 2.9 ± 0.1 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 temperature was relatively consistent, varying from

4.2°C to 5.4°C with warmer water associated with deeper tows (Table 2). The bottom water temperature averaged 4.7 ± 0.5°C.

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 34.6 ± 1.5 m (range: 32.2 – 37.2 m). Wing spread averaged 14.0 ± 0.5 m (range: 13.4 – 14.9 m). Headline height averaged 5.0 ± 0.3 m (range: 4.5 – 5.6 m). All trawl parameters were within the acceptable tolerance limits.

## 3.2 Catch Data

In the 522 Study Area, a total of 21 species were caught over the duration of the survey (Table 3). Catch volume ranged from 3.5 kilograms per tow (kg/tow) to 145.6 kg/tow with an average of 59.7 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, Atlantic mackerel, longhorn sculpin, and silver hake) accounted for 91.9% 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 predominant species observed, accounting for 62.5% of the total catch weight. Individuals ranged in size from 8 to 30 cm (disk width) with a unimodal distribution peaking at 26 cm (Figure 8). Little skate were observed in all 10 tows. Catch rates averaged 37.3 ± 14.4 kg/tow (mean ± Standard Error of the Mean [SEM], range: 0.4 – 119.6 kg/tow). Little skate were observed throughout the 522 Study Area; however, the catch appeared to be correlated with depth as higher catch rates were observed in deeper waters (Figure 9).

Atlantic herring (*Clupea harengus*) was the second most abundant species observed, accounting for 21.5% of the total catch weight. Individuals ranged in length from 16 to 23 cm with a unimodal size distribution peaking at 20 cm (Figure 10). Atlantic herring were observed in nine of the 10 tows. Catch rates averaged 12.9 ± 4.7 kg/tow (range: 0 – 37.1 kg/tow). Atlantic herring were observed throughout the 522 Study Area (Figure 11).

Atlantic mackerel (*Scombrus scombrus*) was the third most abundant species observed in the 522 Study Area. Individuals ranged in length from 18 to 27 cm (Figure 12). Mackerel were observed in six of the 10 tows. Catch rates averaged 2.0 ± 01.3 kg/tow (range: 0 – 12.9 kg/tow). Mackerel were primarily observed in the southern half of the 522 Study Area (Figure 13).

Longhorn sculpin (*Myoxocephalus octodecimspinosus*) was frequently observed in the 522 Study Area. Individuals ranged in length from 21 to 35 cm with a wide, dispersed size distribution (Figure 14). Longhorn culpin were observed in nine of the 10 tows at an average catch rate of 1.6 ± 0.4 kg/tow (range: 0 – 4.5 kg/tow). Longhorn culpin were caught throughout the 522 Study Area (Figure 15).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was caught in the 522 Study Area. Individuals ranged in length from 10 to 28 cm with a unimodal size distribution consisting of a peak at 23 cm (Figure 16). Silver hake were observed in eight of the 10 tows at an average catch rate of 1.1 ± 0.4 kg/tow (range: 0 – 3.8 kg/tow). The catch of silver hake appeared to be correlated with depth as higher catches were observed in the deeper waters in the southwestern portion of the 522 Study Area (Figure 17).

Twelve Atlantic cod (*Gadus morhua*) were caught in the 522 Study Area. Individuals ranged in length from 21 to 62 cm (Figure 18). Atlantic cod were observed in eight of the 10 tows at an average catch rate of 0.9 ± 0.3 kg/tow (range: 0 – 3.3 kg/tow). Atlantic cod were caught throughout the 522 Study Area (Figure 19).

Windowpane flounder (*Scophtalmus aquosus*) was one of the few flatfish species observed in the 522 Study Area. Individuals ranged in length from 21 to 32 cm (Figure 20). Windowpane flounder were observed in seven of the 10 tows at an average catch rate of 0.3 ± 0.1 kg/tow (range: 0 – 1.0 kg/tow). Windowpane flounder were caught throughout the 522 Study Area (Figure 21).

Fourspot flounder (*Paralichthys oblongus*) were observed in four of the 10 tows in the 522 Study Area. Individuals ranged in length from 28 to 40 cm (Figure 22). The average catch rate of fourspot flounder was 0.2 ± 0.1 kg/tow (range: 0 – 0.8 kg/tow). Fourspot flounder were only caught in the southwestern corner of the 522 Study Area (Figure 23).

Less common recreational and commercial species observed included one Atlantic sea scallop (*Placopecten* magellanicus), one summer flounder (*Paralichthys dentatus*, 27 cm), and one monkfish (*Lophius americanus*, 53 cm).

## 4. Acknowledgments

We would like to thank the owner (Stephen Follett), captain (Kevin Jones), and crew (Mark Bolster, Andrew Follett, and Matt Manchester) of the F/V *Heather Lynn* for their help sorting, processing, and measuring the catch. Additionally, we would like to thank Mike Coute (SMAST), Keith Hankowsky (SMAST), and Harrison Tobi (SMAST) 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 Direction | Sea State (m.) | Start Time | Start Latitude | Start Longitude | Start Depth (fm) | End Time | End Latitude | End Longitude | End Depth (fm) | Trawl Warp (fm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2/13/2021 | Clear | 11-15 | N | 0.5-1.25 | 6:46 | N 40° 46.453 | W 70° 13.749 | 24 | 7:06 | N 40° 47.164 | W 70° 12.827 | 24 | 95 |
| 2 | 2/13/2021 | Partly Cloudy | 11-15 | N | 0.5-1.25 | 7:55 | N 40° 42.816 | W 70° 12.099 | 25 | 8:15 | N 40° 41.875 | W 70° 11.919 | 25 | 100 |
| 3 | 2/13/2021 | Mostly Cloudy | 11-15 | N | 0.5-1.25 | 8:51 | N 40° 43.843 | W 70° 09.352 | 24 | 9:11 | N 40° 44.567 | W 70° 08.469 | 22 | 95 |
| 4 | 2/13/2021 | Mostly Cloudy | 7-10 | N | 0.5-1.25 | 9:43 | N 40° 43.185 | W 70° 05.407 | 23 | 10:03 | N 40° 42.707 | W 70° 04.272 | 23 | 95 |
| 5 | 2/13/2021 | Overcast | 11-15 | N | 0.5-1.25 | 10:40 | N 40° 39.507 | W 70° 04.382 | 26 | 11:00 | N 40° 38.488 | W 70° 04.439 | 28 | 120 |
| 6 | 2/13/2021 | Overcast | 11-15 | N | 0.5-1.25 | 11:29 | N 40° 38.477 | W 70° 06.033 | 27 | 11:49 | N 40° 38.647 | W 70° 07.205 | 27 | 120 |
| 7 | 2/13/2021 | Overcast | 11-15 | N | 0.5-1.25 | 12:54 | N 40° 57.588 | W 70° 15.203 | 29 | 13:14 | N 40° 37.633 | W 70° 16.404 | 30 | 125 |
| 8 | 2/13/2021 | Overcast | 11-15 | N | 0.5-1.25 | 13:47 | N 40° 37.288 | W 70° 19.968 | 31 | 14:07 | N 40° 37.994 | W 70° 21.112 | 32 | 125 |
| 9 | 2/13/2021 | Overcast | 11-15 | N | 1.25-2.5 | 14:56 | N 40° 38.224 | W 70° 23.467 | 31 | 15:16 | N 40° 39.098 | W 70° 23.952 | 31 | 125 |
| 10 | 2/13/2021 | Overcast | 16-20 | NE | 1.25-2.5 | 15:58 | N 40° 40.250 | W 70° 20.948 | 29 | 16:18 | N 40° 40.588 | W 70° 19.852 | 28 | 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. ($^{0}$C) | Headline Height (m.) | Wing Spread (m.) | Spread Door (m.) |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.2 | 1.0 | 3.0 | 24.0 | 4.2 | 5.1 | 13.4 | 33.3 |
| 2 | 20.0 | 1.0 | 2.9 | 25.0 | 4.3 | 5.6 | 13.5 | 33.5 |
| 3 | 20.0 | 1.0 | 3.0 | 24.0 | 4.2 | 5.4 | 13.4 | 32.2 |
| 4 | 20.0 | 1.0 | 3.0 | 23.0 | 4.3 | 5.2 | 13.7 | 33.4 |
| 5 | 20.0 | 1.0 | 2.9 | 26.0 | 4.7 | 4.8 | 14.2 | 35.8 |
| 6 | 20.4 | 0.9 | 2.7 | 27.0 | 4.8 | 4.7 | 14.6 | 35.7 |
| 7 | 20.1 | 0.9 | 2.8 | 29.0 | 5.3 | 4.9 | 14.3 | 35.2 |
| 8 | 20.2 | 0.9 | 2.8 | 31.0 | 5.4 | 5.2 | 13.8 | 34.1 |
| 9 | 20.0 | 0.9 | 2.8 | 31.0 | 5.3 | 4.7 | 14.4 | 35.3 |
| 10 | 19.9 | 0.9 | 2.7 | 29.0 | 4.9 | 4.5 | 14.9 | 37.2 |
| Summary Statistics | | | | | | | | |
| Minimum | 19.9 | 0.9 | 2.7 | 23.0 | 4.2 | 4.5 | 13.4 | 32.2 |
| Maximum | 20.4 | 1.0 | 3.0 | 31.0 | 5.4 | 5.6 | 14.9 | 37.2 |
| Average | 20.1 | 1.0 | 2.9 | 26.9 | 4.7 | 5.0 | 14.0 | 34.6 |
| St. Dev | 0.1 | 0.04 | 0.1 | 3.0 | 0.5 | 0.3 | 0.5 | 1.5 |

**Table 3: Total and average catch weights observed within the 522 Study Area.**

| Species Name | Scientific Name | Total Weight (Kg) | Catch/Tow (Kg) Mean | Catch/Tow (Kg) SEM* | % of Total Catch | Tows with Species Present |
|---|---|---|---|---|---|---|
| Skate, Little | *Leucoraja erinacea* | 374.3 | 37.3 | 14.4 | 62.5 | 10 |
| Herring, Atlantic | *Clupea harengus* | 129.1 | 12.9 | 4.7 | 21.5 | 9 |
| Mackeral, Atlantic | *Scomber scombrus* | 20.3 | 2.0 | 1.3 | 3.4 | 6 |
| Sculpin, Longhorn | *Myoxocephalus octodecimspinosus* | 15.8 | 1.6 | 0.4 | 2.6 | 9 |
| Hake, Silver (Whiting) | *Merluccius bilinearis* | 11.1 | 1.1 | 0.4 | 1.9 | 8 |
| Skate, Winter | *Leucoraja ocellata* | 10.2 | 1.0 | 0.5 | 1.7 | 4 |
| Dogfish, Spiny | *Squalus acanthias* | 10.2 | 1.0 | 0.8 | 1.7 | 2 |
| Atlantic Cod | *Gadus morhua* | 8.8 | 0.9 | 0.3 | 1.5 | 8 |
| Shad, American | *Alosa sapidissima* | 2.8 | 0.3 | 0.2 | 0.5 | 4 |
| Crab, Cancer | *Cancer sp.* | 2.6 | 0.3 | 0.1 | 0.4 | 4 |
| Flounder, Windowpane | *Scophtalmus aquosus* | 2.6 | 0.3 | 0.1 | 0.4 | 7 |
| Monkfish | *Lophius americanus* | 2.4 | 0.2 | 0.2 | 0.4 | 1 |
| Sea Raven | *Hemitripterus americanus* | 2.3 | 0.2 | 0.1 | 0.4 | 3 |
| Flounder, Fourspot | *Paralichthys oblongus* | 2.2 | 0.2 | 0.1 | 0.4 | 4 |
| Hake, Spotted | *Urophycis regia* | 1.5 | 0.1 | 0.1 | 0.3 | 7 |
| Skate, Barndoor | *Dipturus laevis* | 1.4 | 0.1 | 0.1 | 0.2 | 3 |
| Alewife | *Alosa pseudoharengus* | 0.8 | 0.1 | 0.0 | 0.1 | 3 |
| Sea Scallop | *Placopecten magellanicus* | 0.5 | 0.05 | 0.05 | 0.1 | 1 |
| Flounder, Summer (Fluke) | *Paralichthys dentatus* | 0.2 | 0.02 | 0.02 | 0.0 | 1 |
| Ocean Pout | *Macrozoarces americanus* | 0.1 | 0.01 | 0.01 | 0.02 | 1 |
| Hake, Red | *Urophycis chuss* | 0.1 | 0.01 | 0.01 | 0.02 | 1 |
| **Total** | | **599.3** | | | | |

*SEM is an acronym for Standard Error of the Mean

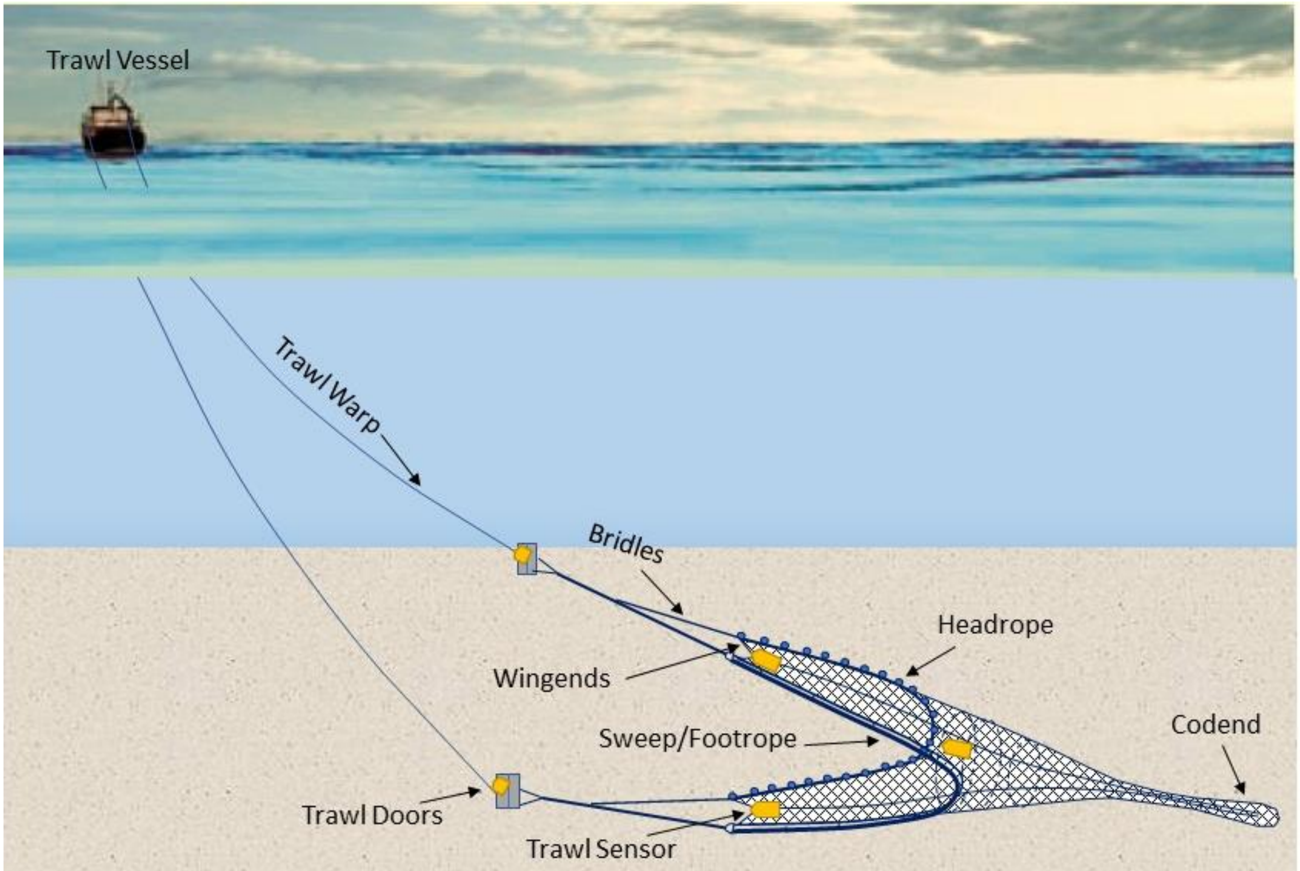



**Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.**

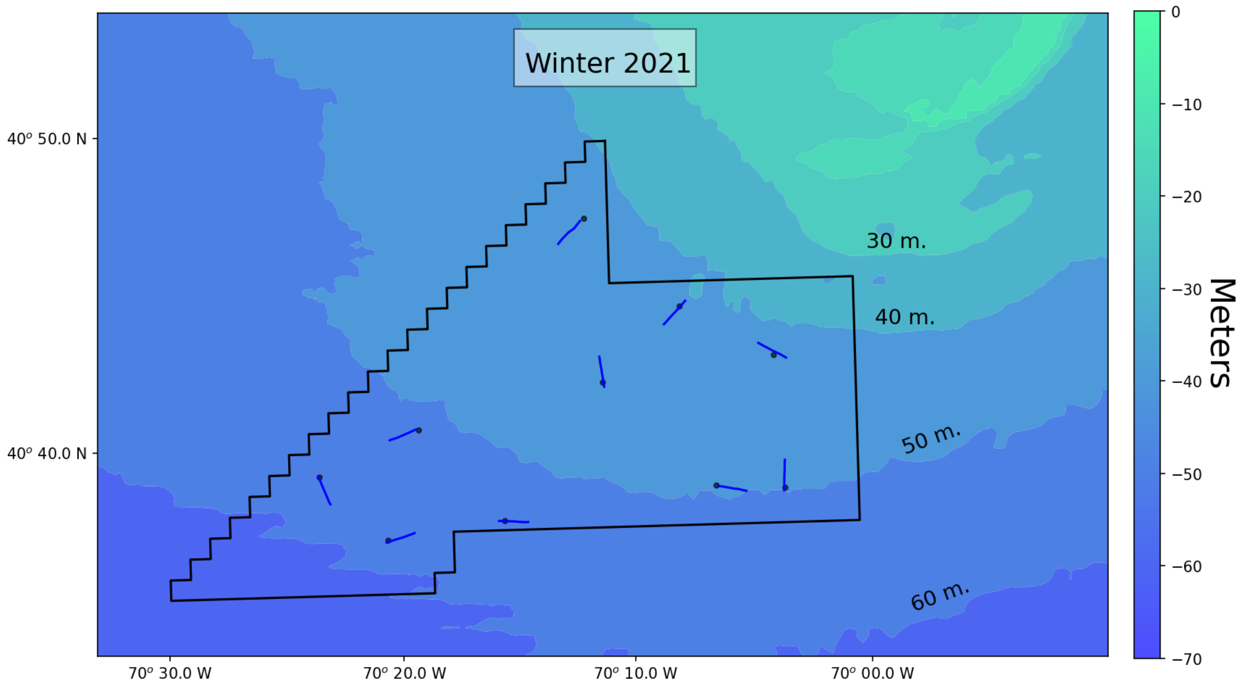



**Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Study Area.**

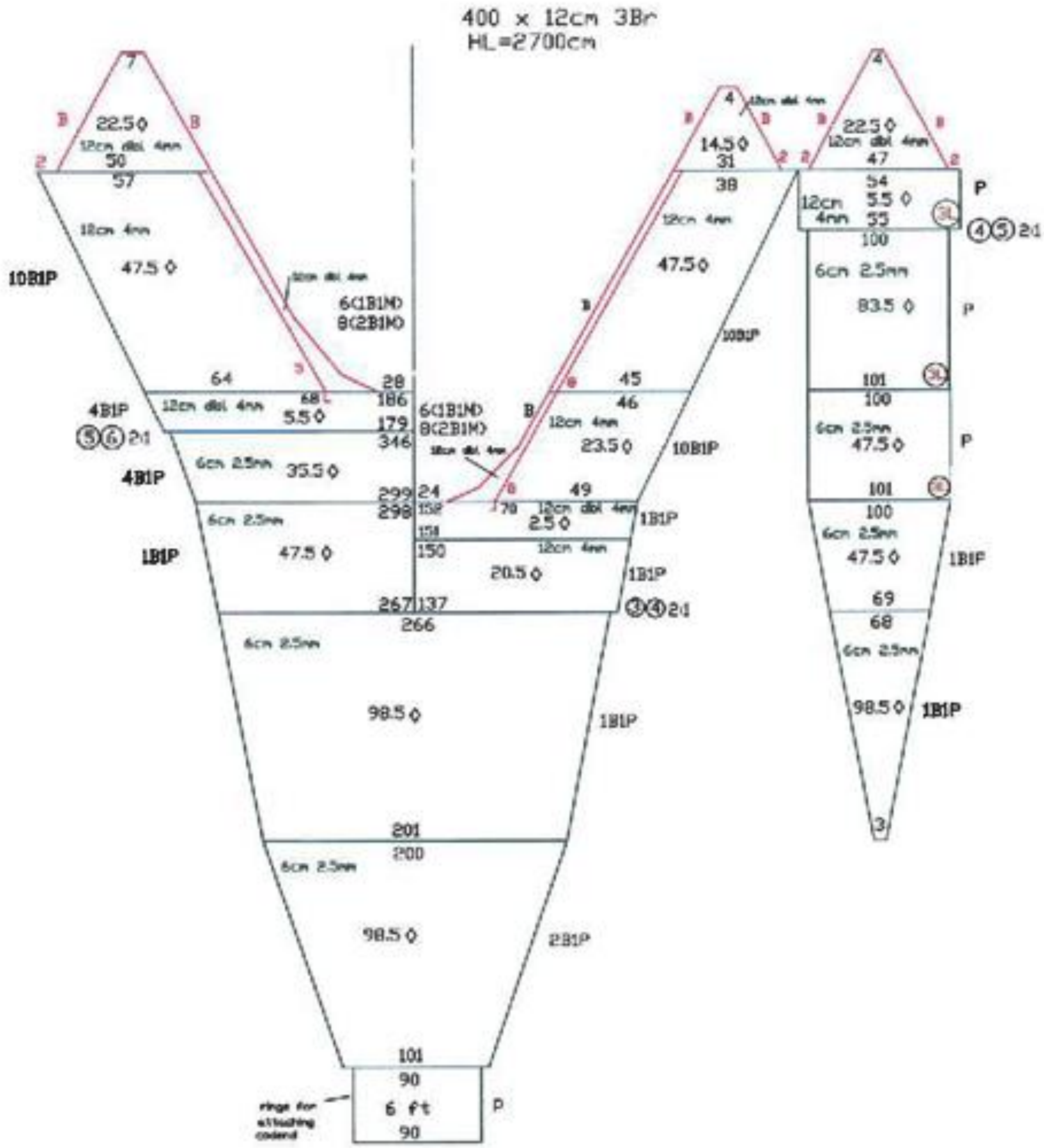



**Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al., 2008)**

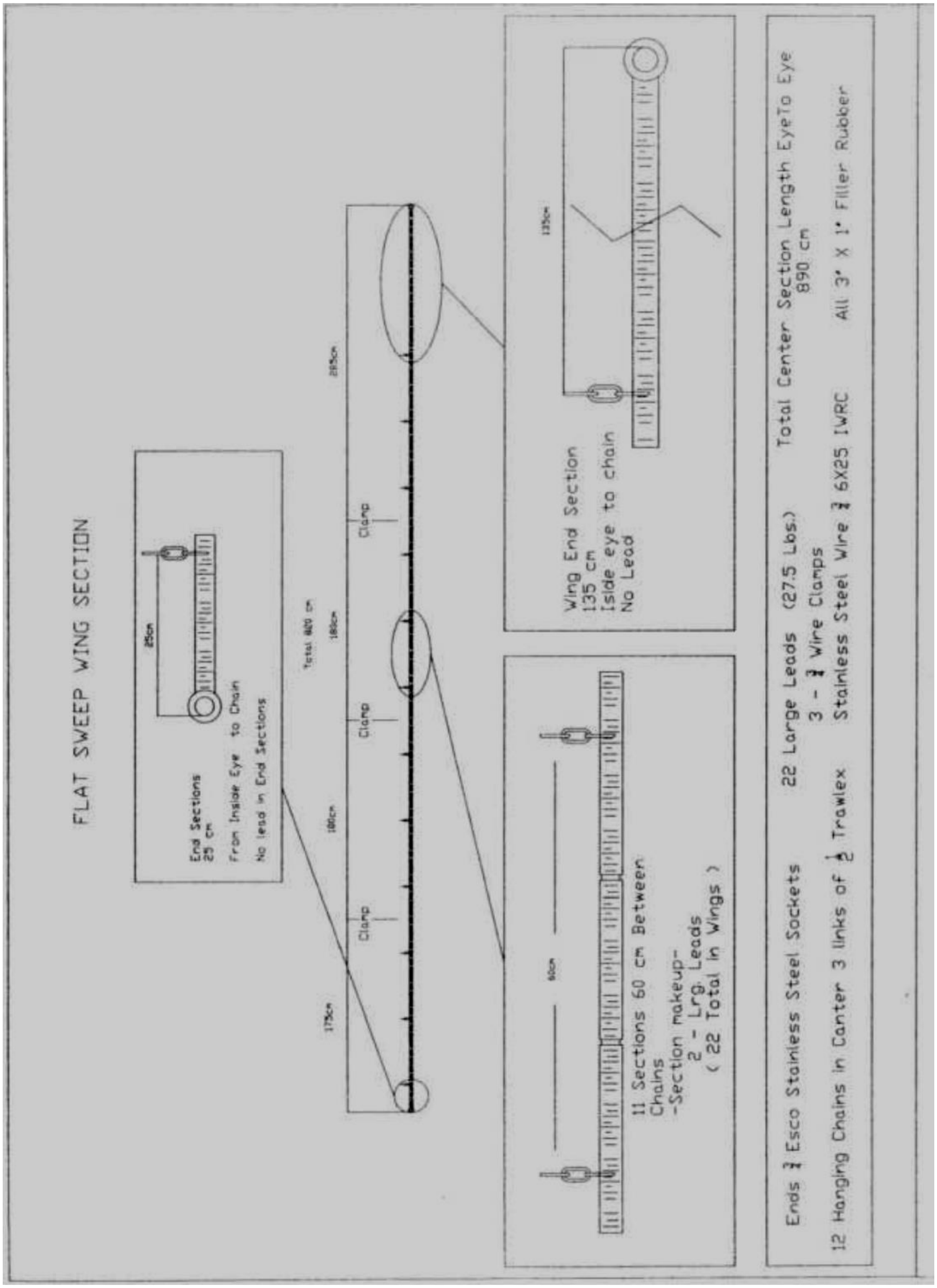



**Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).**

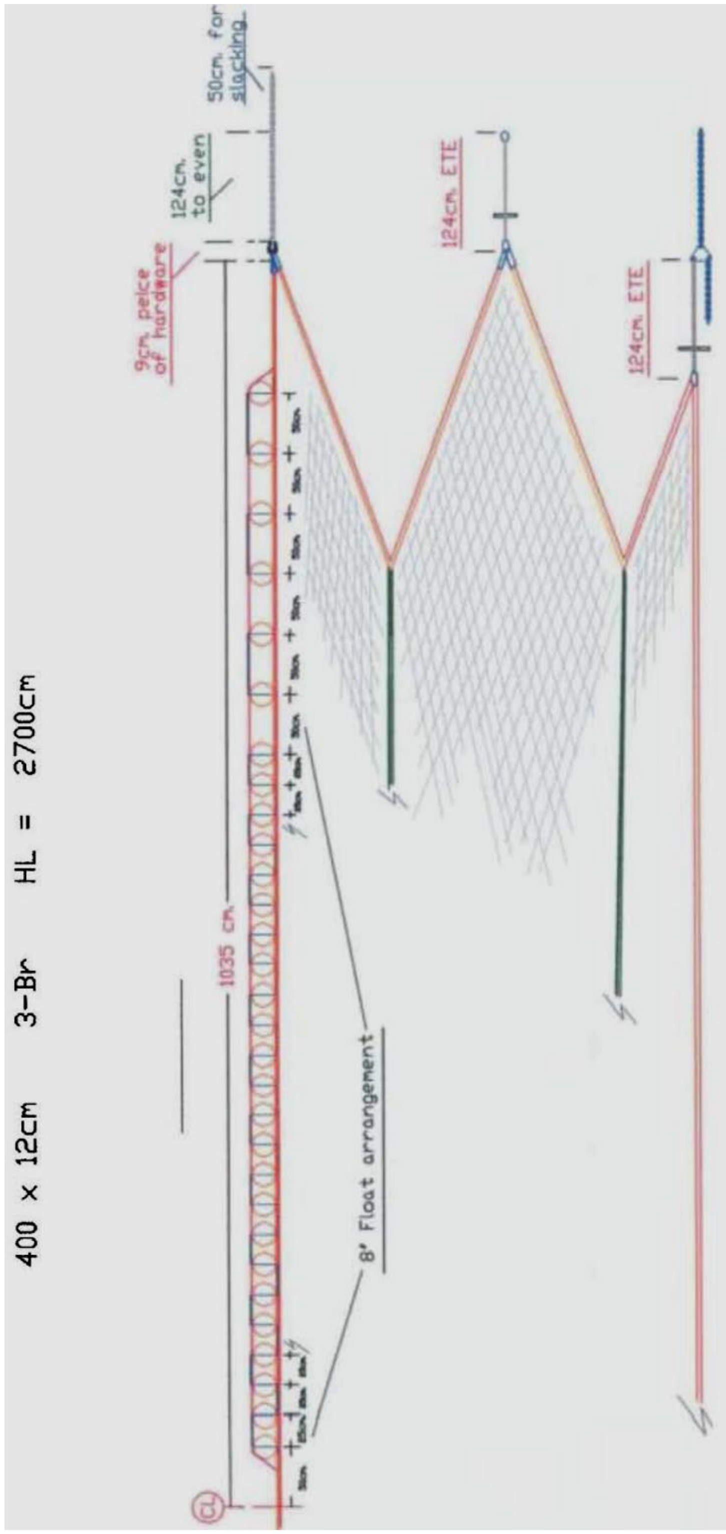



**Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008)**

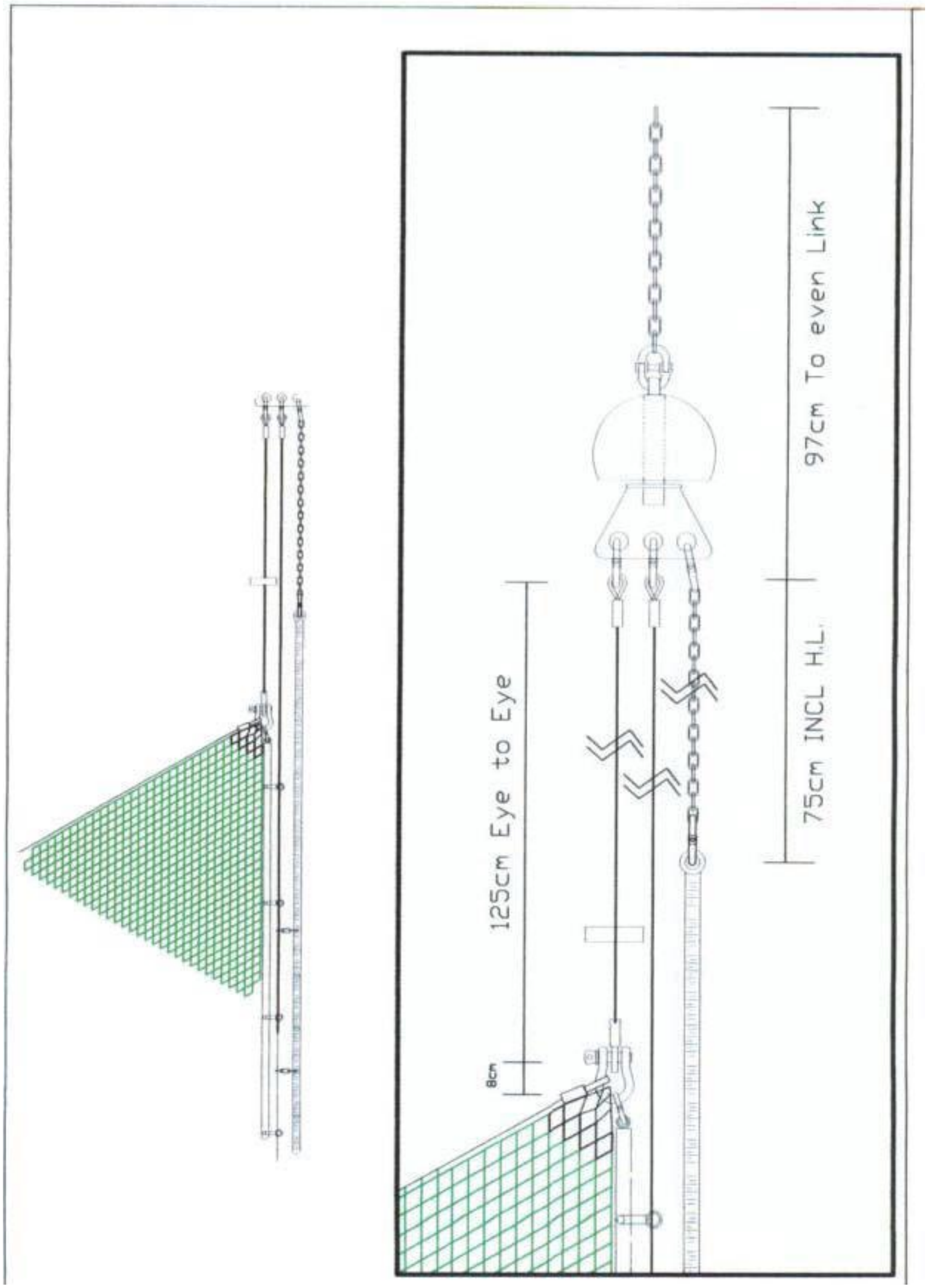



**Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al., 2008).**

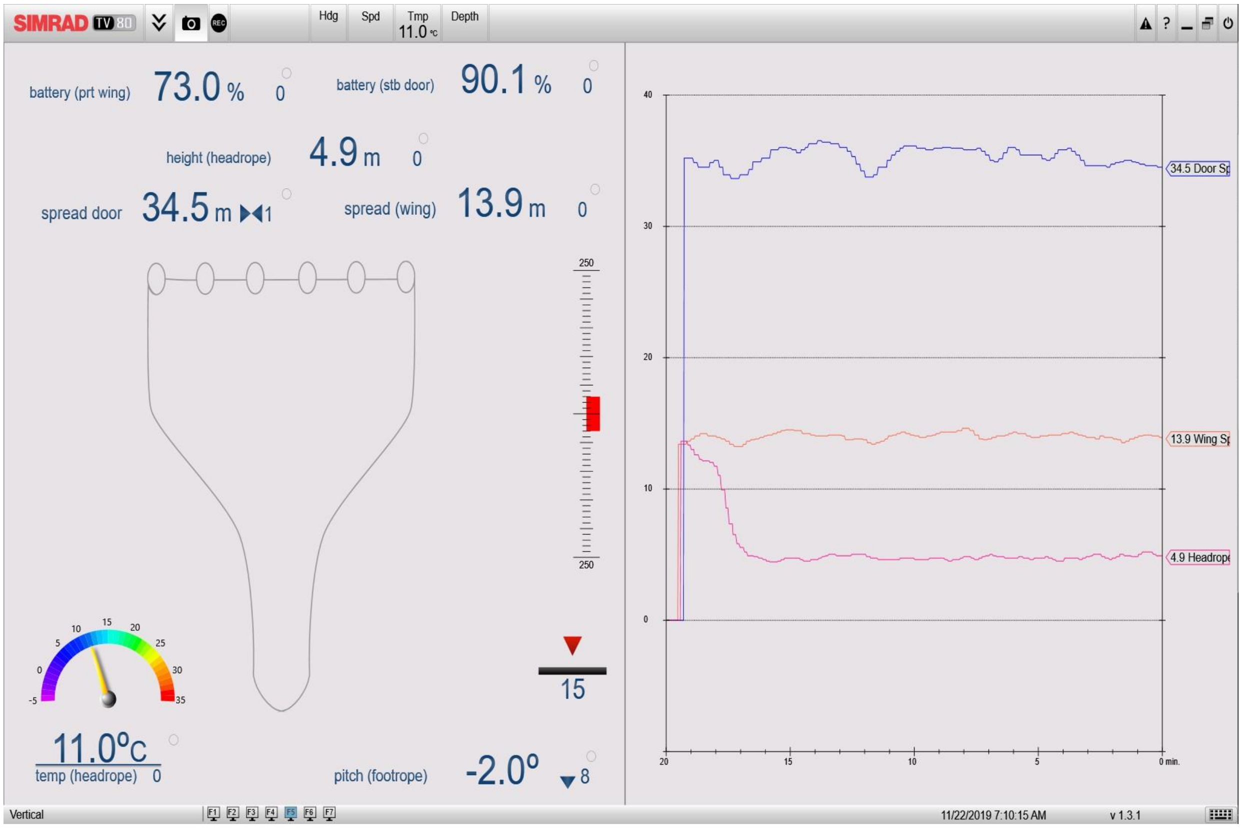
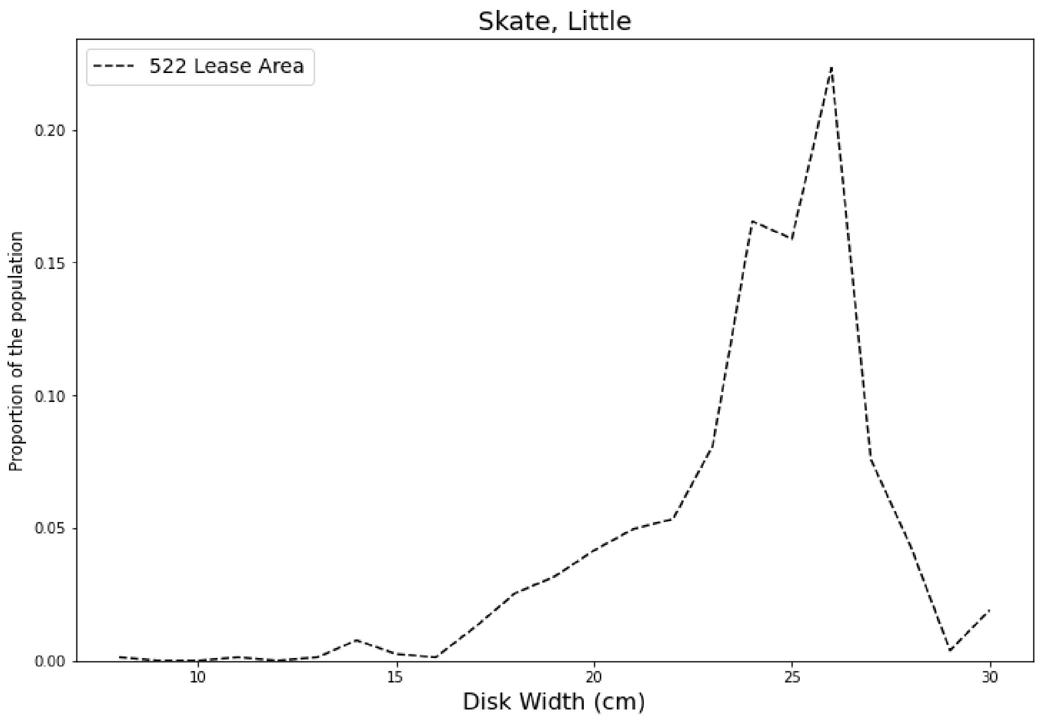



**Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.**



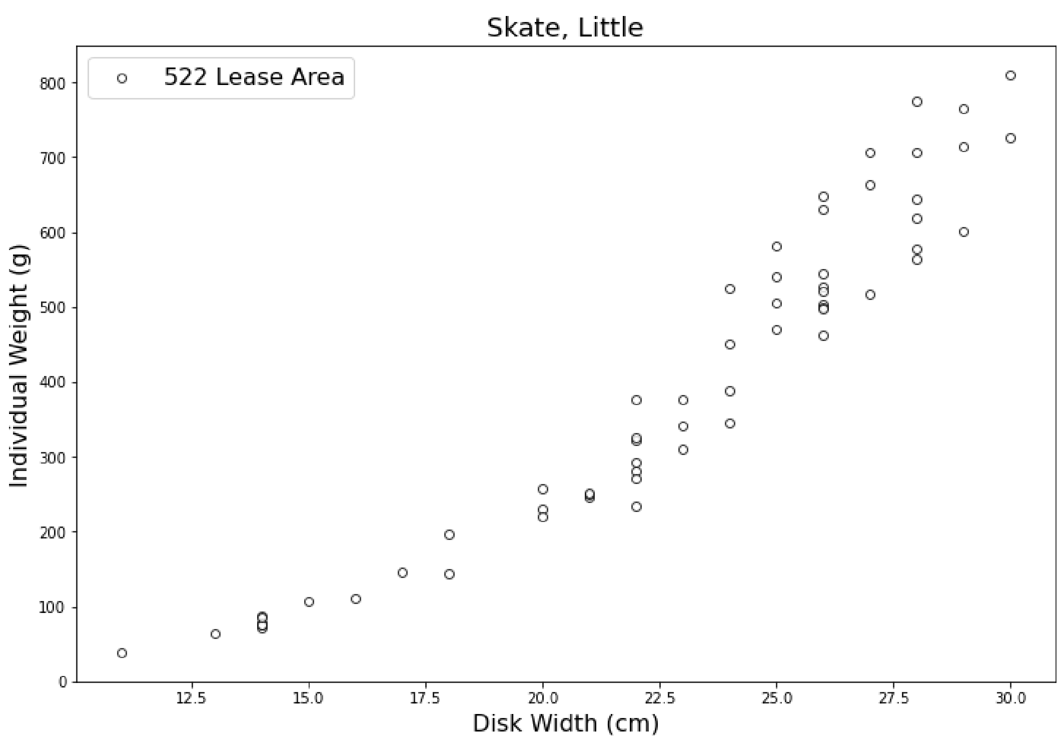




**Figure 8: Population structure of little skate in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

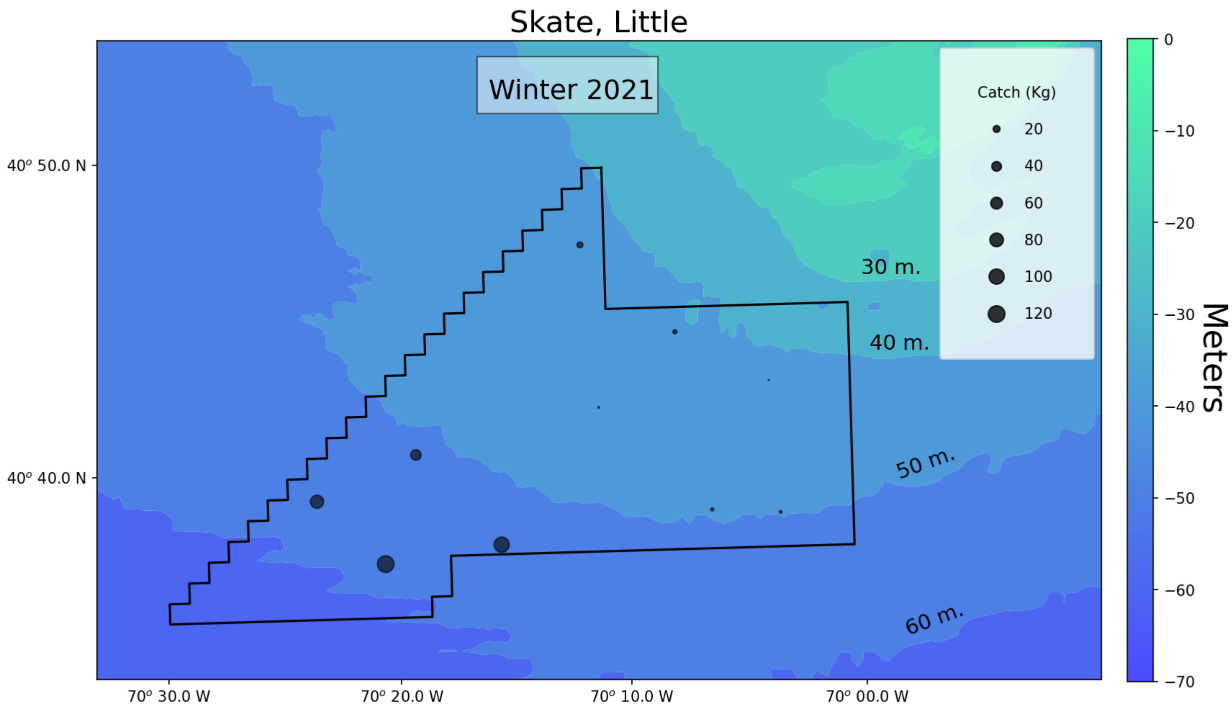
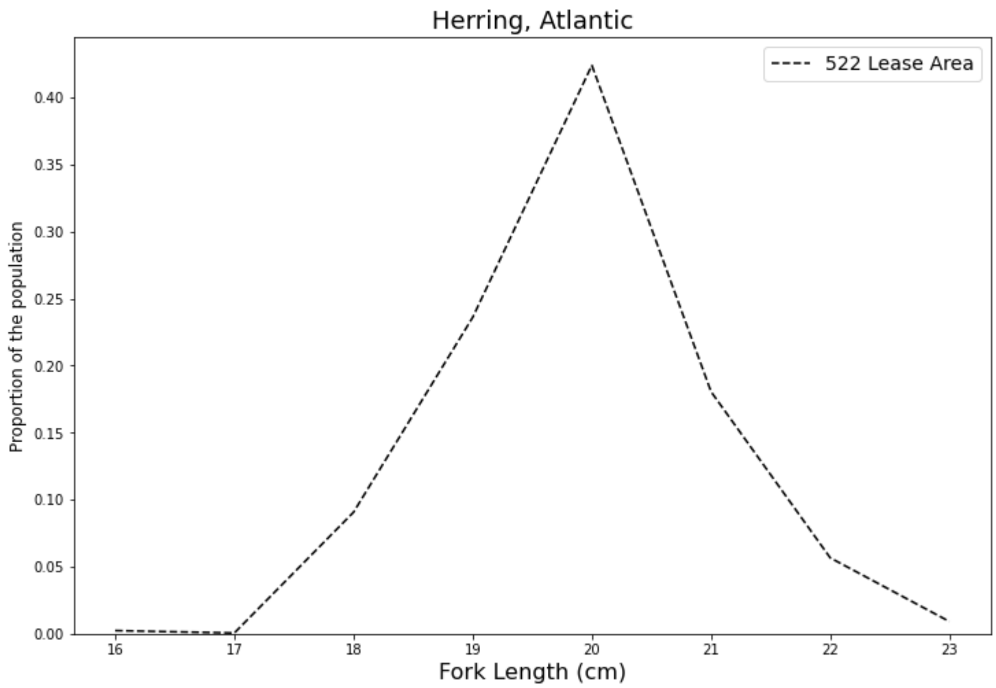



**Figure 9: Distribution of the catch of little skate in the 522 Study Area.**



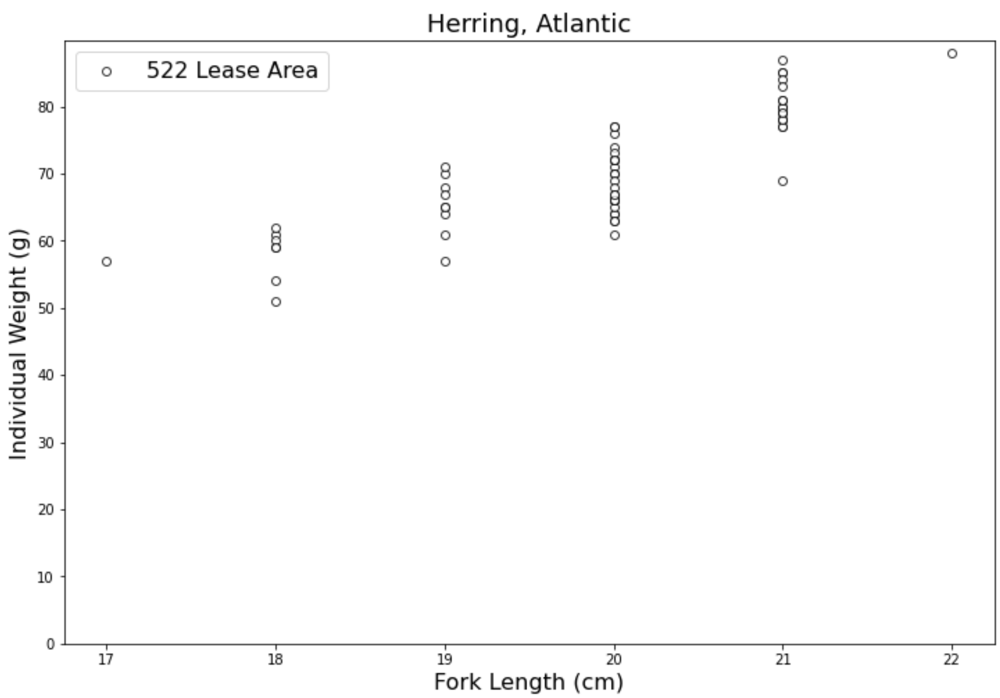




**Figure 10: Population structure of Atlantic herring in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

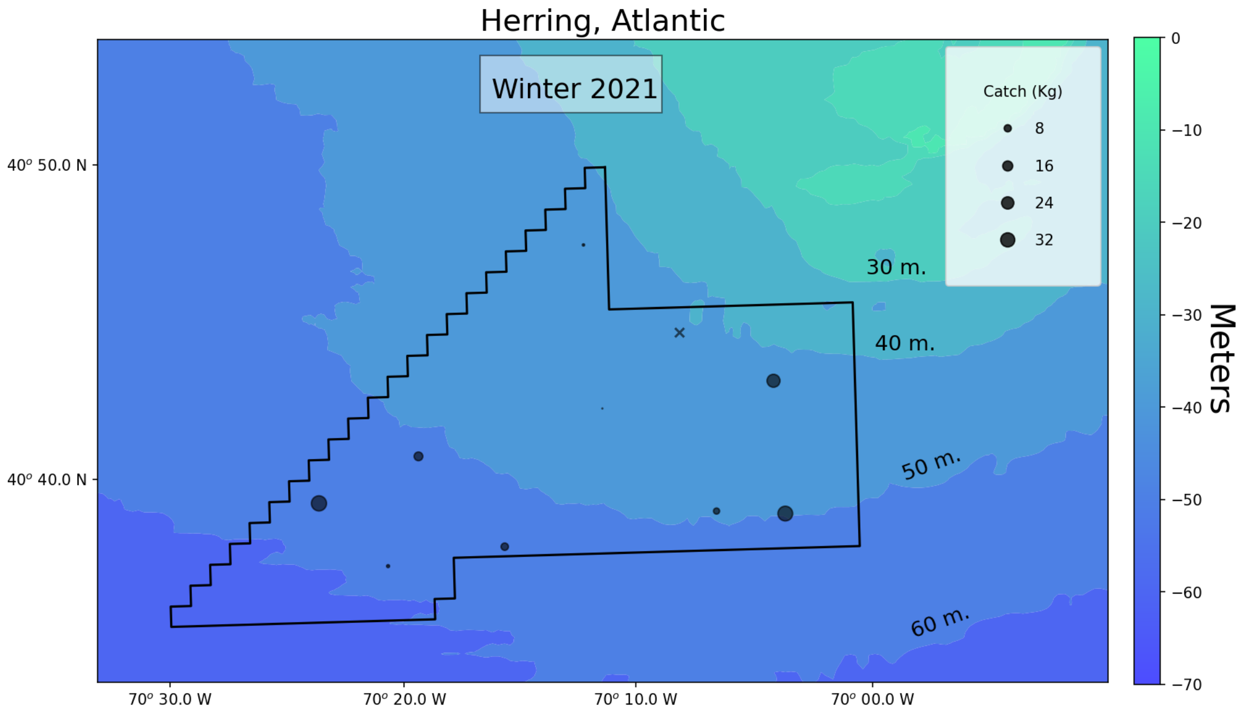
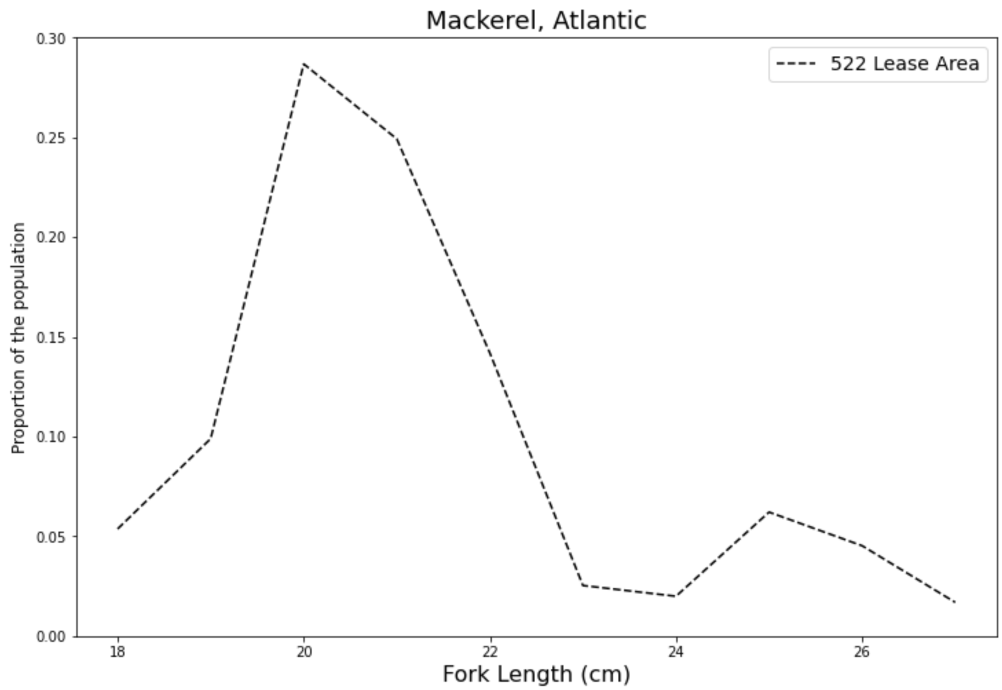



**Figure 11: Distribution of the catch of Atlantic herring in the 522 Study Area. Tows with zero catch are denoted with an x.**



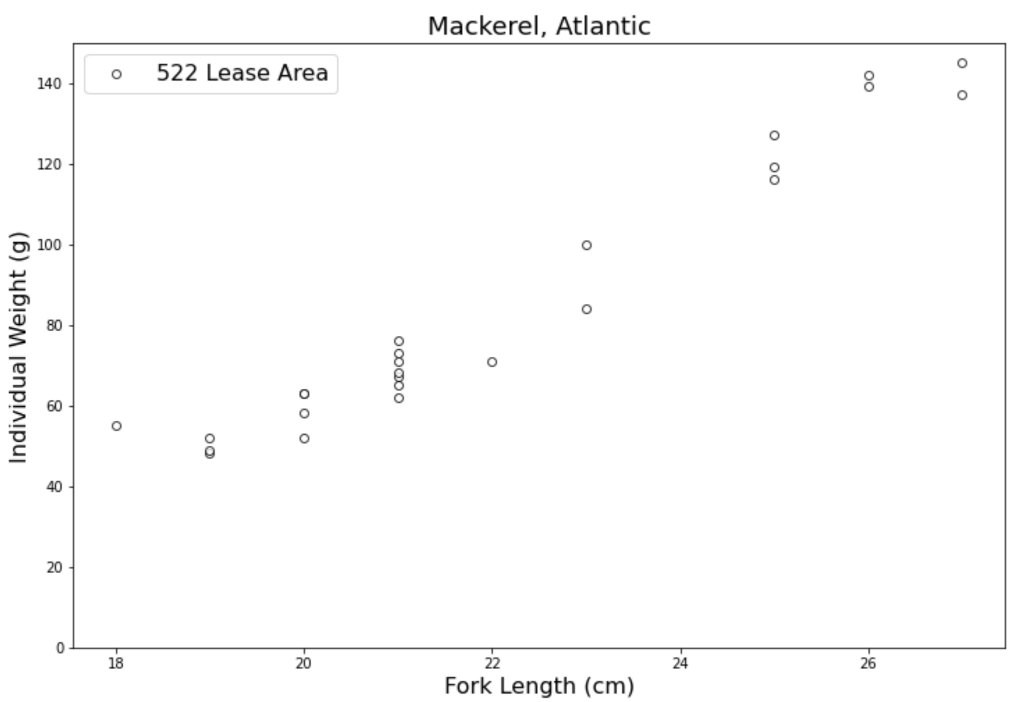




**Figure 12: Population structure of Atlantic mackerel in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

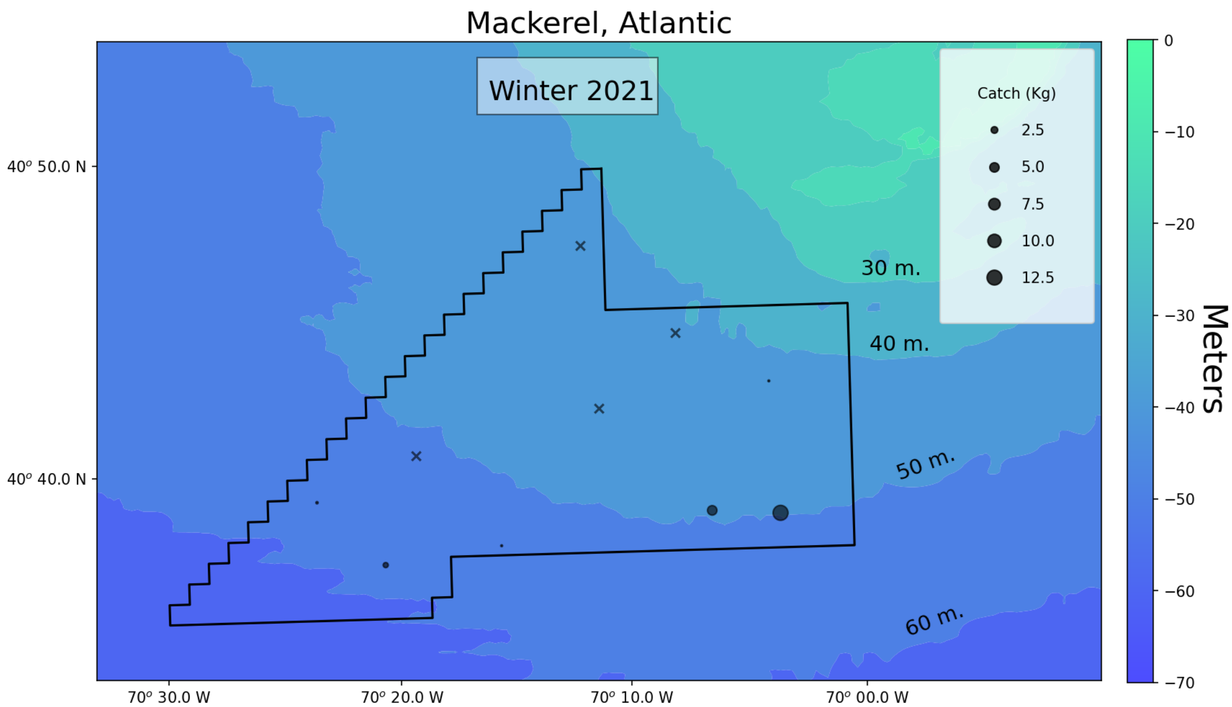



**Figure 13: Distribution of the catch of Atlantic mackerel in the 522 Study Area. Tows with zero catch are denoted with an x.**

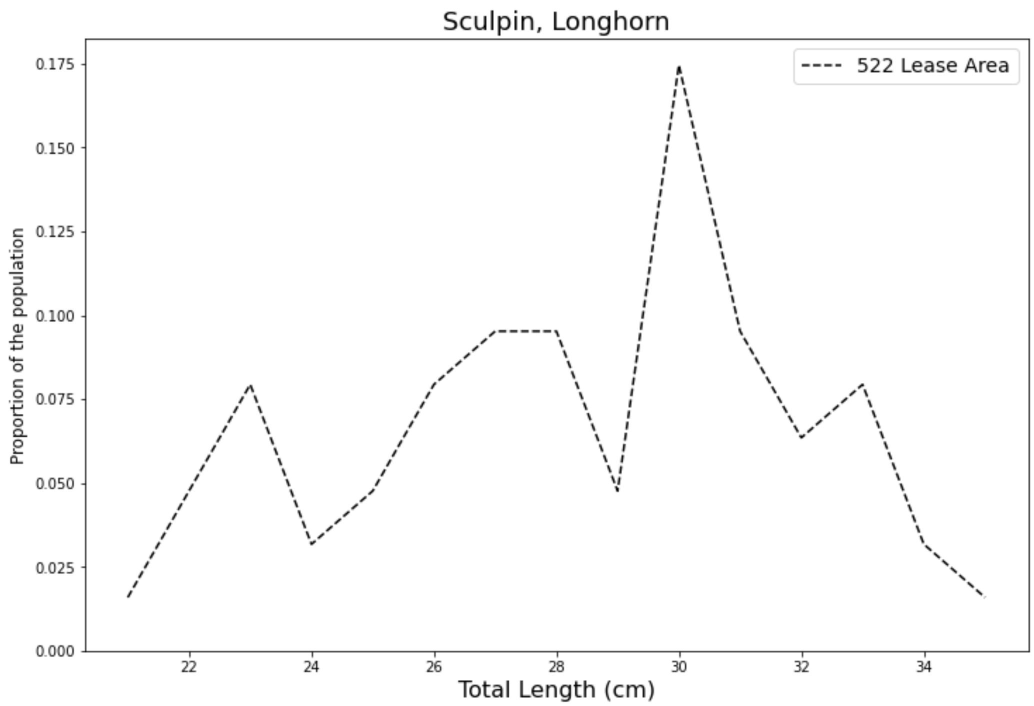




**Figure 14: Population structure of longhorn sculpin in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

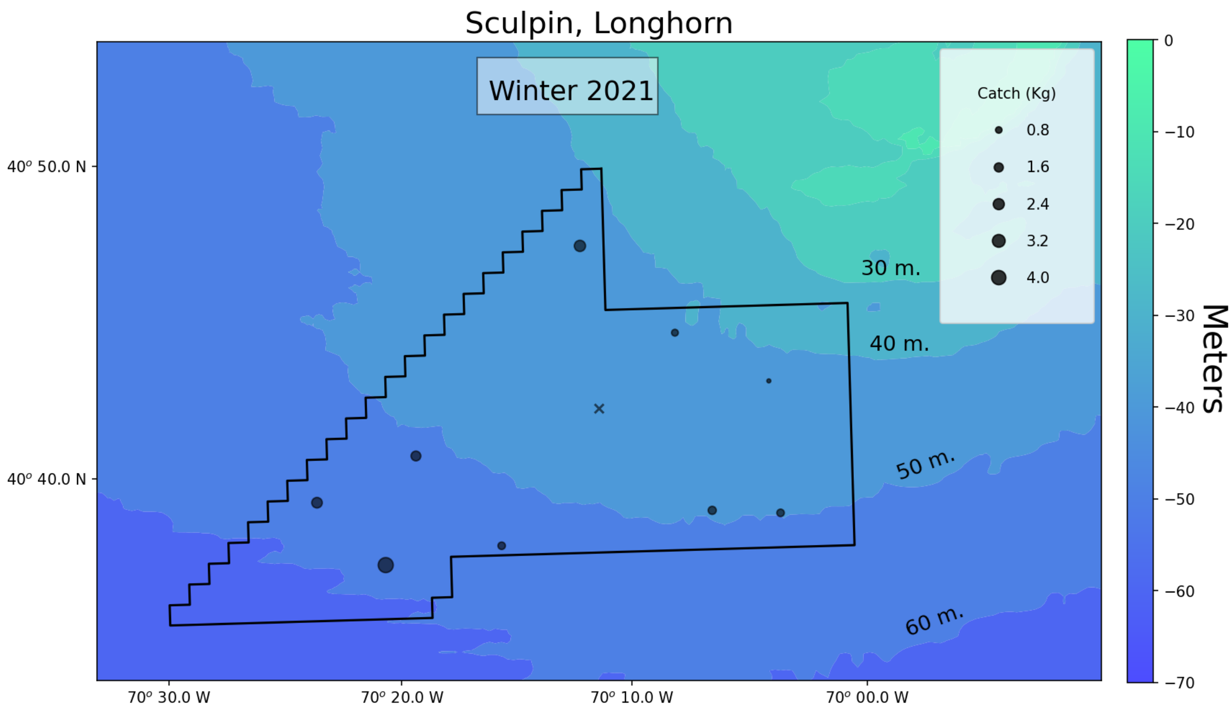
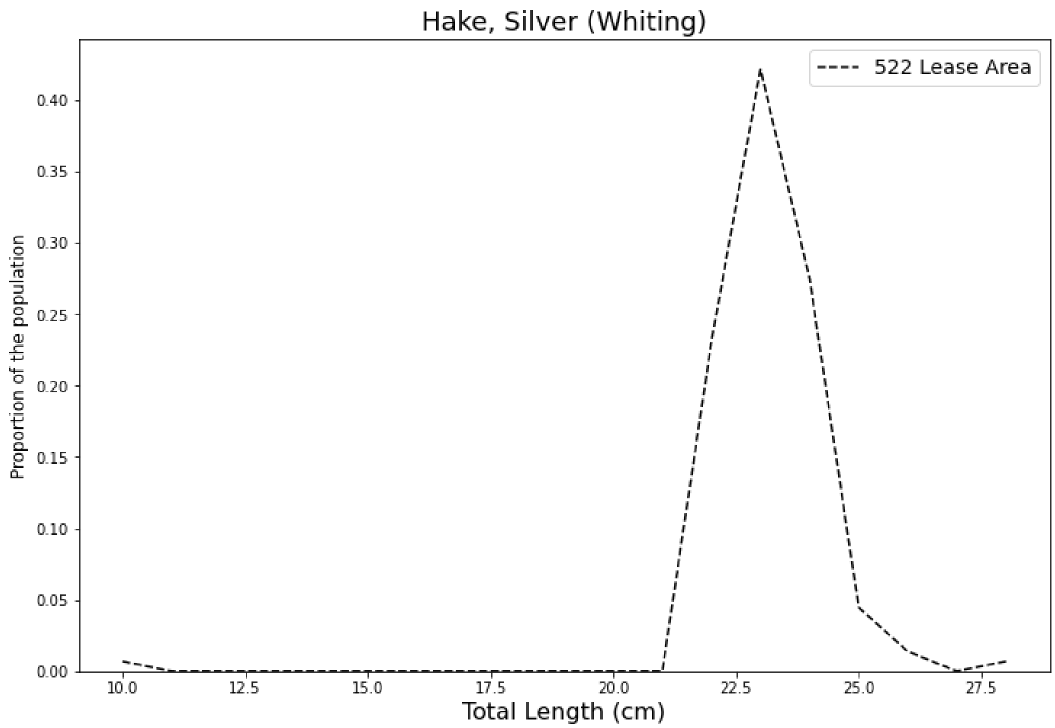



**Figure 15: Distribution of the catch of longhorn sculpin in the 522 Study Area. Tows with zero catch are denoted with an x.**



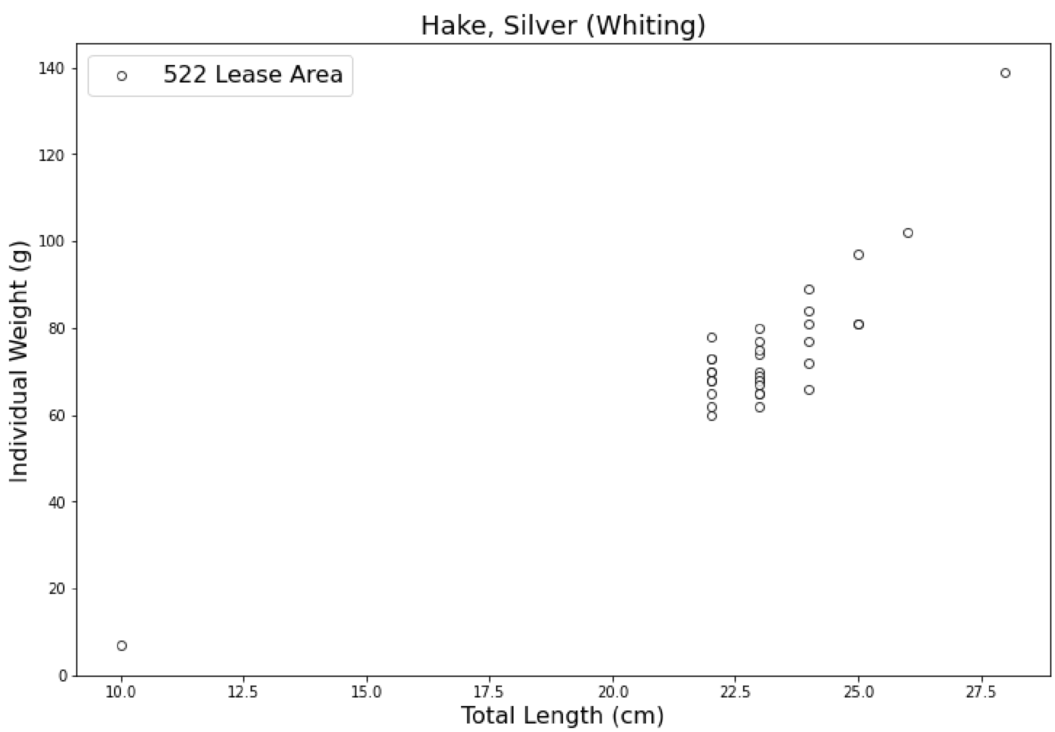




**Figure 16: Population structure of silver hake in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

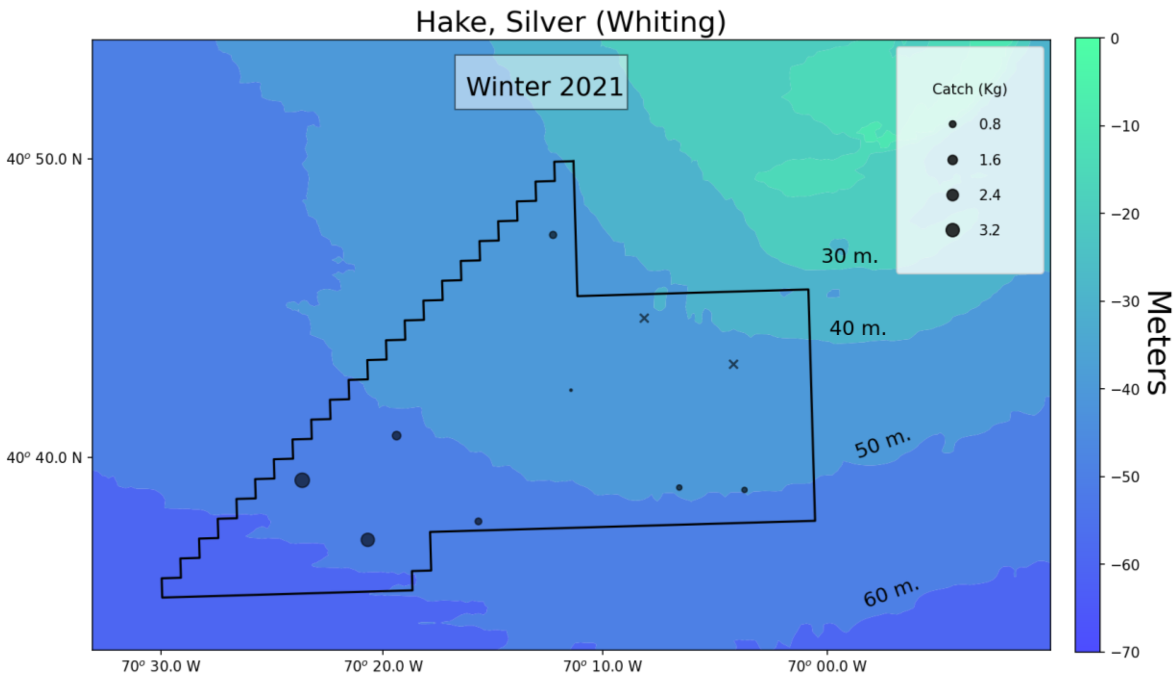
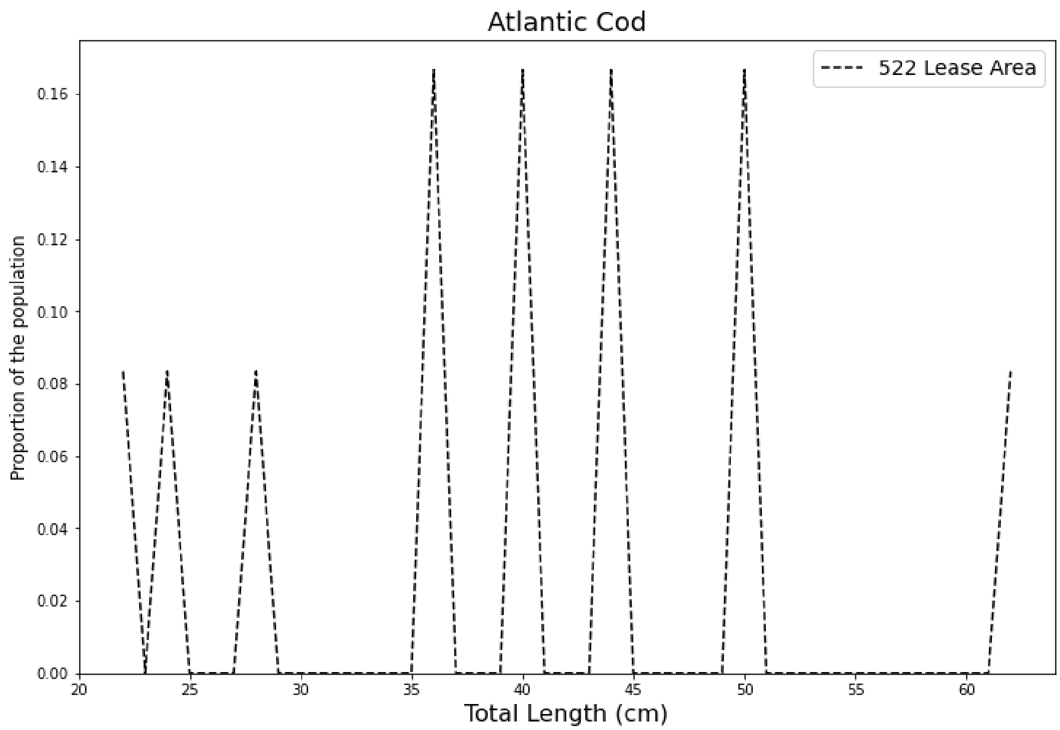



**Figure 17: Distribution of the catch of silver hake in the 522 Study Area. Tows with zero catch are denoted with an x.**



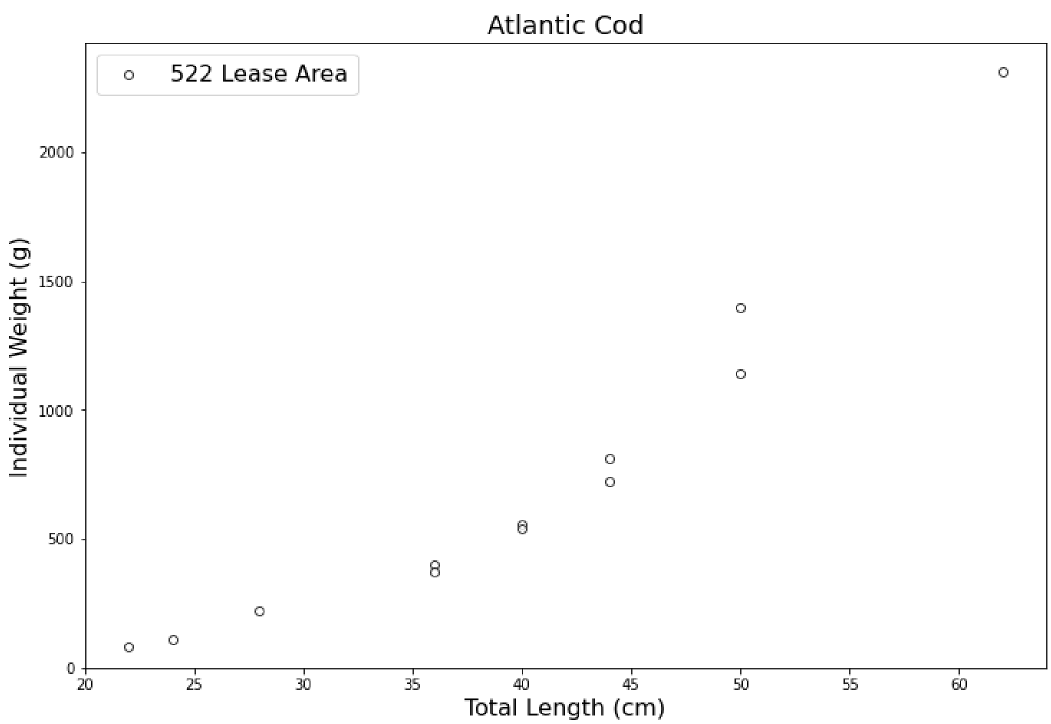




**Figure 18: Population structure of Atlantic cod in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

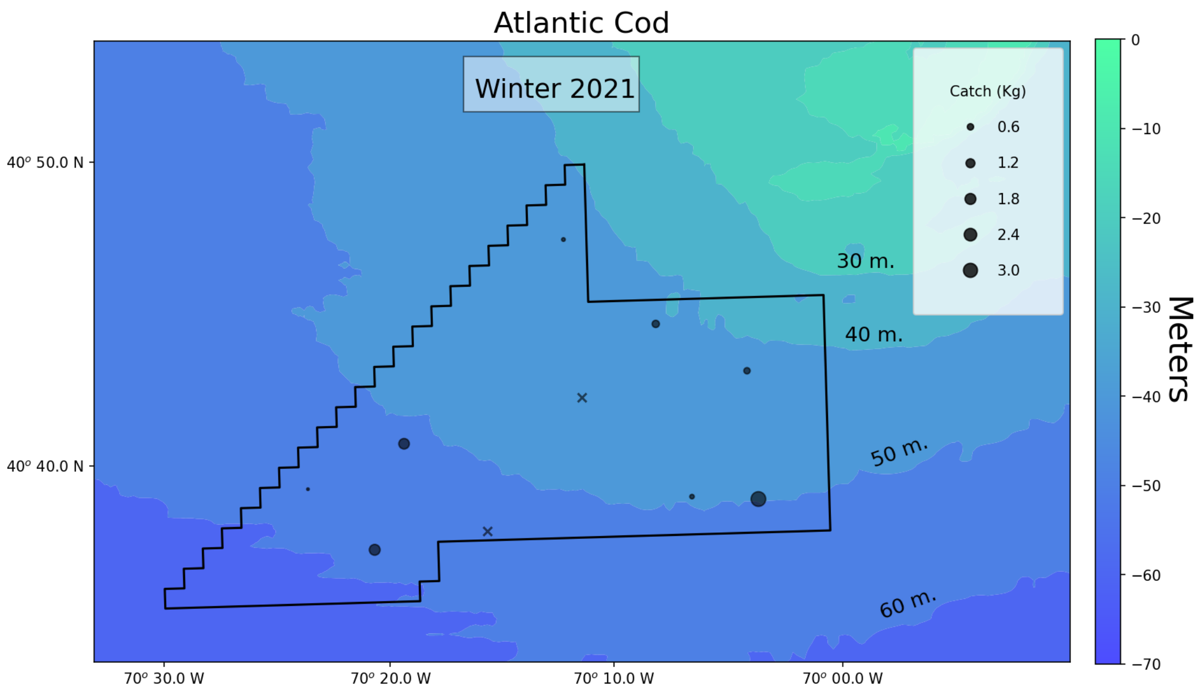



**Figure 19: Distribution of the catch of Atlantic cod in the 522 Study Area. Tows with zero catch are denoted with an x.**

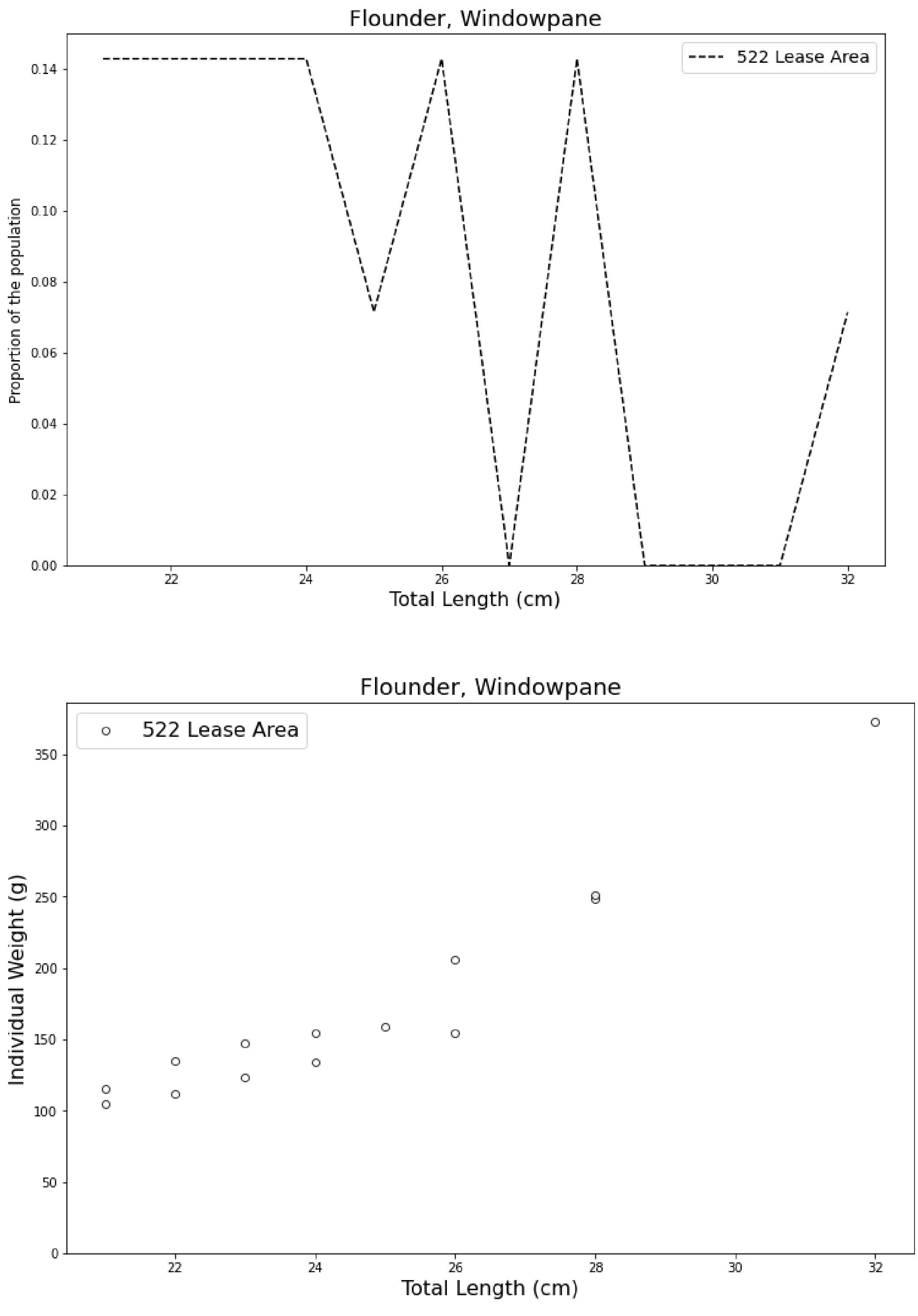



**Figure 20: Population structure of windowpane flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

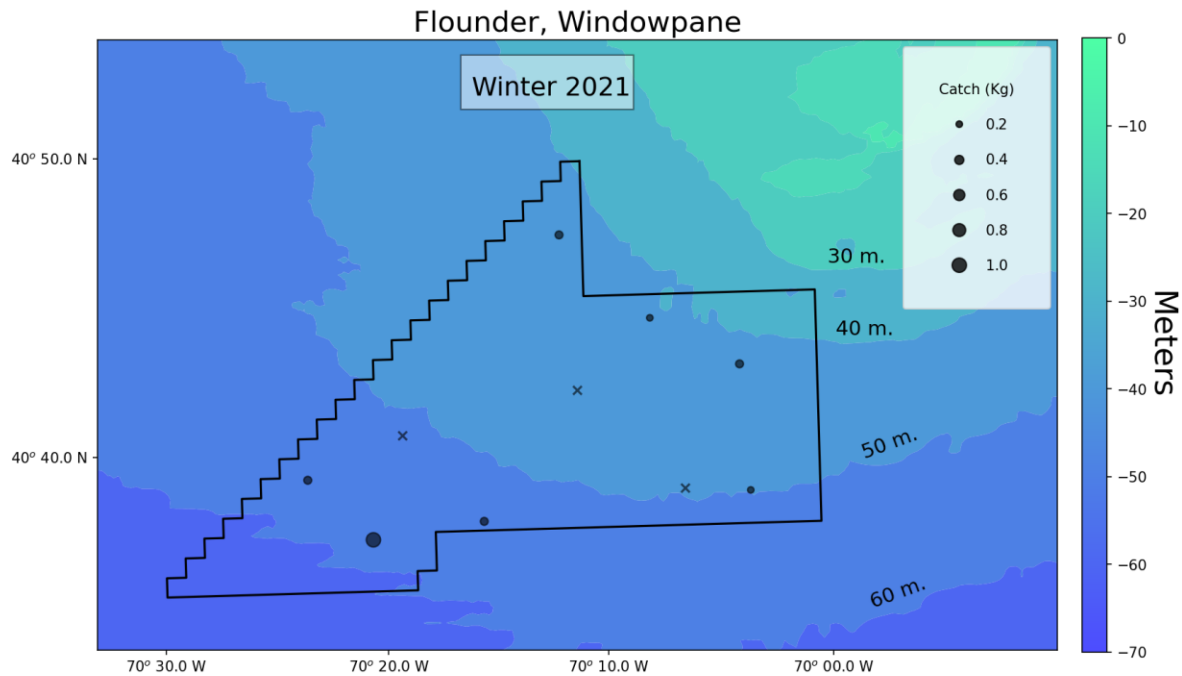
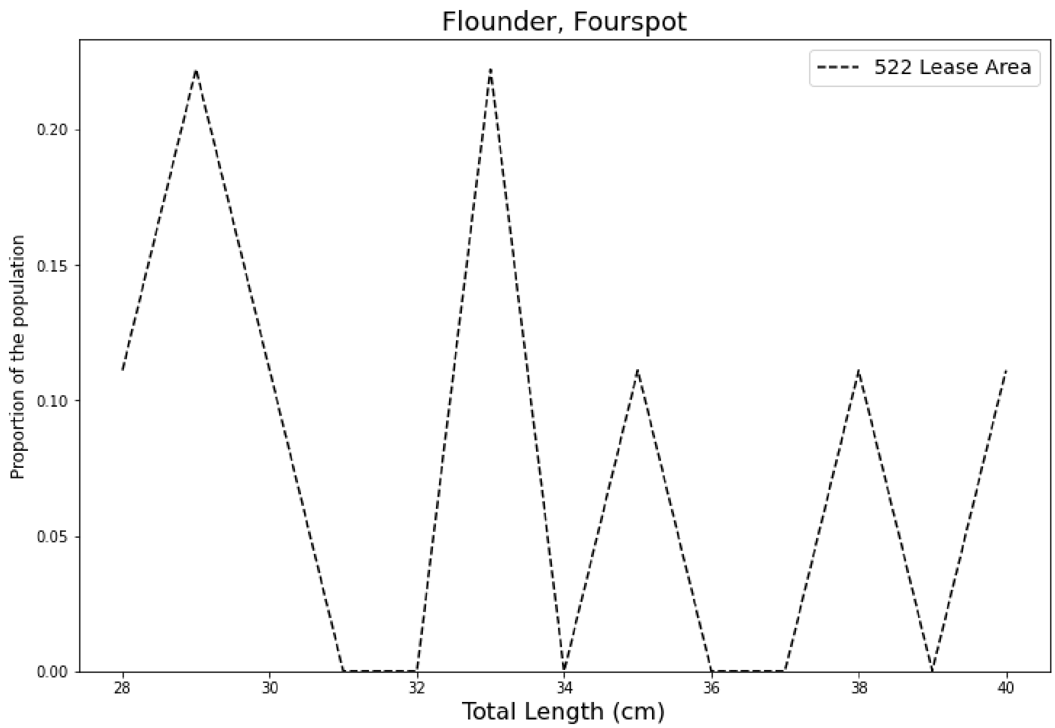



**Figure 21: Distribution of the catch of windowpane flounder in the 522 Study Area. Tows with zero catch are denoted with an x.**



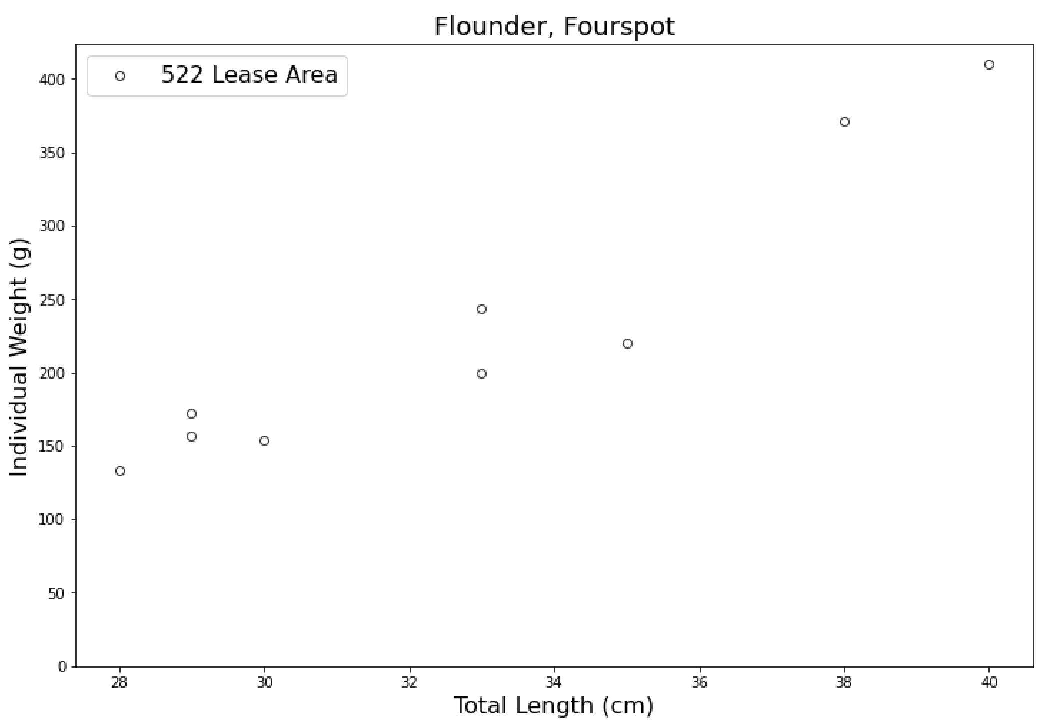




**Figure 22: Population structure of fourspot flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

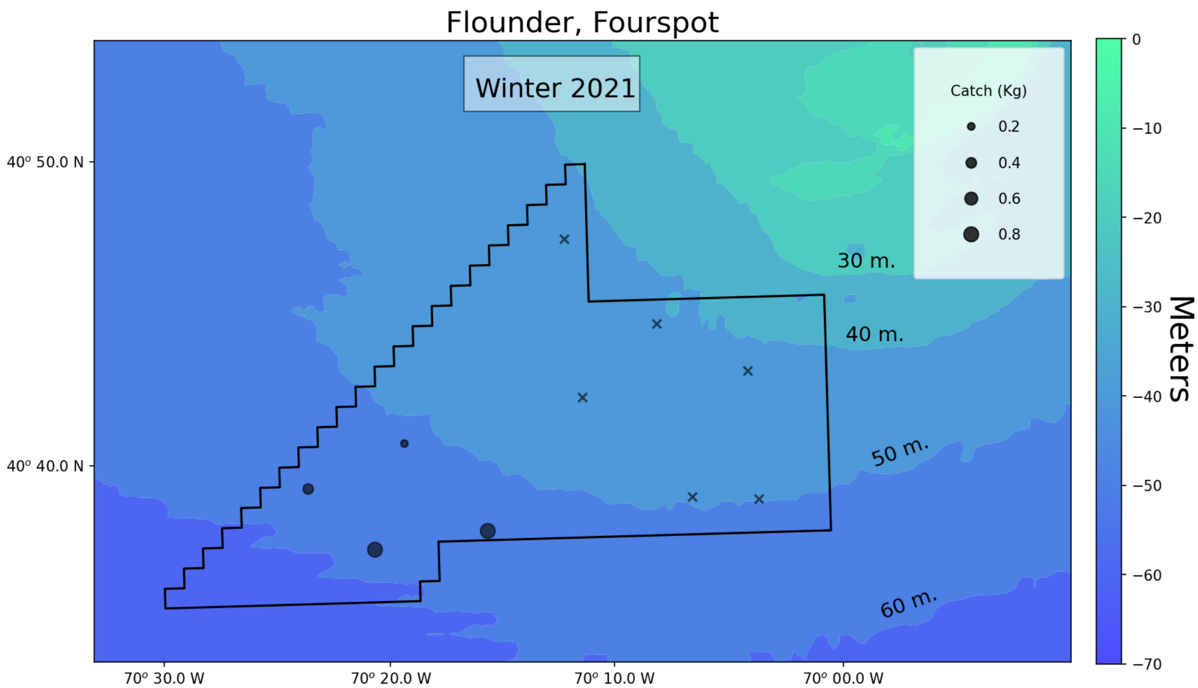



**Figure 23: Distribution of the catch of fourspot flounder in the 522 Study Area. Tows with zero catch are denoted with an x.**