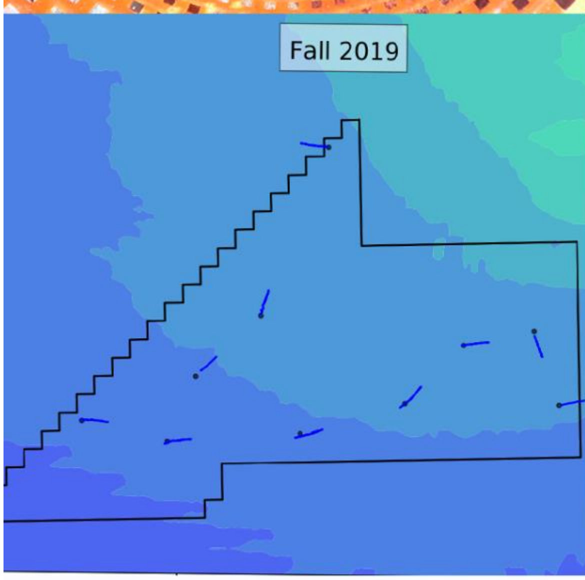
Vineyard Wind
Demersal Trawl Survey



522 Lease Area

Quarterly Report
Fall 2019 (October - December)

VINEYARD WIND DEMERSAL TRAWL SURVEY

Fall 2019 Seasonal Report

522 Lease Area

May 2020

Prepared for Vineyard Wind, LLC

Prepared by:

Pingguo He and Chris Rillahan

University of Massachusetts Dartmouth
School for Marine Science and Technology

Vineyard Wind Demersal Trawl Survey Fall 2019 Seasonal Report

522 Lease Area

Progress Report #3

October 1 – December 31, 2019

Project title:	Vineyard Wind Demersal Trawl Survey Fall 2019 Seasonal Report – 522 Lease Area
Project leaders:	Pingguo He and Christopher Rillahan University of Massachusetts Dartmouth School for Marine Science and Technology 836 S. Rodney French Blvd., New Bedford, MA 02744 Tel. (508) 910-6323, Fax. (508) 999-8197 Email: phe@umassd.edu
Submitted to:	Vineyard Wind LLC 700 Pleasant St, New Bedford, MA 02740
Report by:	Christopher Rillahan and Pingguo He
Date:	May 7, 2020

You may cite this report as:
Rillahan, C., He, P. (2020). Vineyard Wind Demersal Trawl Survey Fall 2019 Seasonal Report – 522 Lease Area. Progress report #3. University of Massachusetts Dartmouth - SMAST, New Bedford, MA. SMAST-CE-REP-2020-084. 44 pp.

SMAST-CE-REP-2020-084

Table of Contents

List of Tables

List of Figures

1. Introduction

In 2019, Vineyard Wind LLC leased a 516 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 Lease 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 "501 North Study Area") and within the southern portion of Lease Area OCS-A 0501 (the "501 South Study Area"); these studies are reported separately.

The Bureau of Ocean Energy Management (BOEM) has statutory obligations under the National Environmental Policy Act (NEPA) to evaluate 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 LLC, 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 has on the ecosystem within an everchanging 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 a vessel along the seafloor 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 trawls are a general tool for assessing the biological communities along the seafloor and are widely used by institutions worldwide for ecological monitoring. Since they are actively towed behind a vessel, they are less biased by fish activity and behavior like passive fishing gear (i.e. gillnets, longlines, traps, etc.), which rely 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 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 (NMFS) annual spring and fall trawl survey, the annual NEAMAP spring and fall trawl survey, and state trawl surveys including the Massachusetts Division of Marine Fisheries (MADMF) trawl survey.

The primary goal of this survey was to provide data related to fish abundance, distribution, and population structure in and around Vineyard Wind's 522 Lease Area. The data will serve as a baseline to be used in a future analysis under the BACI framework. This progress report documents survey methodology, survey effort, and data collected during the fall of 2019.

2. Methodology

The methodology for the survey was adapted from the Atlantic States Marine Fisheries Commission's (ASMFC) NEAMAP nearshore trawl survey. Initiated in 2006, NEAMAP conducts annual spring and fall trawl surveys from Cape Hatteras to Cape Cod. The NEAMAP protocol has gone through extensive peer review and is currently implemented near the Lease Area using a commercial fishing vessel (Bonzek et al., 2008). The current NEAMAP protocol samples at a resolution of ~100 sq. kilometers, 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 windfarm 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 (Vineyard Wind's 501N 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).

Tow locations within the Vineyard Wind 522 Lease Area were selected using a systematic random sampling design. The 522 Lease Area (536 km^2) was sub-divided into 10 sub-areas (each ~53.6 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 survey area. The starting location within each 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 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 survey area. To ensure the retention of small individuals, a 1" mesh size knotless liner was used within a 12 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. Wingspread was targeted between 13.0 and 14.0 meters (acceptable range: 11.7 – 15.4 m). Door spread was targeted between 32.0 and 33.0 meters (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^{o} 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, RI. The F/V Heather Lynn is a commercial fishing vessel currently operating in the industry. One trip to the survey area was made (November 20 – 23, 2019), 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 spring and summer surveys indicating that the 4:1 ratio constrained the horizontal spreading of the net increasing the headline height. Trawl warp was set to 100 fathoms (183 m.) for tows in 20 to 27 fathoms (36 to 50 m) and 125 fathoms (229 m) in depths between 28 and 30 fathoms (51 to 55 m). Compared to the spring and summer surveys, the trawl warp was increased in shallower tows (20-23 fm) to simplify operations by reducing the number of trawl warp groupings. To further increase the headline height, the chain attaching the bottom bridle to the footrope was shortened by ~25 cm. This was intended to shift the towing force lower in the net reducing the force on the upper bridle and allowing the headline to rise.

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. Efforts were made to process all animals; however, during large catches sub-sampling was used for some abundant species. One of two sub-sampling strategies was employed during a tow: straight sub-sampling by weight, or discard by count.

> Straight sub-sampling by weight: When catch diversity was relatively low (5-10 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 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. This was the predominate sub-sampling strategy employed during this survey.
>
> Discard by count: The discard by count method was used when a large catch of large bodied fish was caught. For this method a sub-sample of the species (30-50 individuals) was collected to calculate a mean individual weight. The remaining individuals were counted and discarded. The aggregated weight for the species is the total number multiplied by the average individual weight. This method was employed to quantify the catch of spiny dogfish during large tows.

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 n of squid eggs was documented. All data was 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 Lease Area (Figure 2, Table 1). Tow duration averaged 19.2 ± 1.5 minutes (mean ± one standard deviation). Tow distance averaged 0.9 ± 0.1 nautical miles giving an average tow speed of 2.9 ± 0.2 knots. Due to the heavy volume of spiny dogfish, and concerns over the integrity of the net, one tow was shortened to 15 minutes. This is acceptable under the NEAMAP protocol.

The seafloor in the 522 Lease Area follows a north to south depth gradient with the shallowest tow along the north edge (~40 m). Depth increased to a maximum of 60 meters along the southwestern boundary. Bottom water temperature varied from 10.1°C to 14.4°C. The bottom water temperature did not appear to correlate with depth (Table 2).

The trawl geometry data indicated that the trawl took about 2 to 3 minutes to open and stabilize. Once open, readings were stable through the duration of the tow. Door spread averaged 35.8 ± 1.4 m (range: 33.8 – 37.7 m). On average, door spread was within the acceptable range however one tow was 30 cm higher than the acceptable range. While this door spread measurement was higher than the acceptable tolerance limit, we do not believe this affected the catch because the wing spread measurement was within the appropriate range indicating that the net had the appropriate geometry. Wing spread averaged 14.1 ± 0.4 m (range: 13.5 – 14.6 m). All wingspread measurements were within the acceptable tolerance limits. Headline height averaged 4.6 ± 0.3 m (range: 4.2 – 5.1 m). Headline height was targeted to be between 5.0 and 5.5 m with acceptable deviations between 4.5 and 6.1 m. While wing spread data indicated the net was within acceptable tolerances, during two tows the headline height was lower than desired. We do not believe this significantly impacted the representation of species in the catch composition. The majority of species are demersal and are well represented in the catch. Additionally, this survey caught a significant volume of herring and other pelagic species in the 501N and 501S study area, which traditionally require a high vertical opening in the net. As a result, we believe that the survey results are representative of the fish community in the area, however additional testing and measurement are required to achieve the headline height to within the acceptable range.

3.2 Catch Data

In the 522 Lease Area, a total of 27 species were caught over the duration of the survey (Table 3). Catch volume ranged from 40.1 kg/tow to 496.5 kg/tow with an average of 229.2 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, scup, butterfish, winter skate, and spiny dogfish) accounted for 85% of the total catch weight. Adding the next five most abundant species (red hake, silver hake, northern sea robin, longfin squid, and summer flounder) would encompass 96% 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 accounting for 30% of the total catch weight. Little skates ranged in size from 10 to 33 cm (disk width) with a unimodal size distribution peaking at 27 cm (Figure 8). Little skates were observed in every tow at an average catch rate of 69.1 ± 19.1 kg/tow (mean ± SE, range: 12.4 – 199.7 kg/tow). Little skate were caught throughout the 522 Lease Area (Figure 9).

Scup (*Stenotomus chrysops*) was the second most abundant species observed. Scup ranged in length from 10 to 28 cm with a narrow unimodal peak at 23 cm (Figure 10). Scup were observed in 7 of the 10 tows at an average catch rate of 64.8 ± 28.9 kg/tow (range: 0 – 202.7 kg/tow). Scup were caught throughout the 522 Lease Area with the highest catches observed in the deeper water to the southwest (Figure 11).

Butterfish (*Peprilus triacanthus*) was the third most abundant species observed. Butterfish ranged in length from 5 to 20 cm with a narrow unimodal peak at 8 cm (Figure 12). Butterfish were observed in every tow at an average catch rate of 24.2 ± 15.9 kg/tow (range: 0.7 – 166.3 kg/tow). Butterfish were caught throughout the 522 Lease Area with the highest catch observed on the eastern side of the area (Figure 13).

Winter skate (*Leucoraja ocellata*) was the fourth most abundant species. Winter skates ranged in size from 30 to 53 cm (disk width; Figure 14). Winter skates were observed in every tow at an average catch rate of 18.3 ± 7.9 kg/tow (range: 0.4 – 84.3 kg/tow). The catch of winter skate appeared to correlate with depth with the catch increasing along the depth gradient (Figure 15).

Spiny dogfish (*Squalus acanthias*) was the fifth most abundant species. Individuals ranged in size from 44 to 80 cm with a unimodal distribution peaking at 66 cm (Figure 16). Dogfish were observed in 7 of the 10 tows. Catch rates averaged 17.3 ± 9.3 kg/tow (range: 0 – 87.2 kg/tow). Similar to winter skate, the catch of spiny dogfish increase along the depth gradient with higher catches in deeper water (Figure 17).

Red hake were caught in 8 of the 10 tows with individuals ranging in size from 17 to 37 cm. Red hake had a wide size distribution with most individuals between 18 and 28 cm (Figure 18). The average catch of red hake was 10.8 ± 8.7 kg/tow (range: 0 – 88.7 kg/tow). Red hake were observed throughout the 522 Lease Area with the highest catch observed along the northern edge (Figure 19).

Silver hake (*Merluccius bilinearis*), also commonly referred to as whiting, were observed in every tow. Silver hake ranged in length from 4 to 42 cm with a unimodal peak at 25 cm (Figure 20). Silver hake had an average catch rate of 4.9 ± 3.0 kg/tow (range: 0.5 – 31.3 kg/tow). Silver hake were caught throughout the 522 Lease Area with the highest catch observed along the northern edge (Figure 21).

Northern sea robin (*Prionotus carolinus*) were observed in 5 of the 10 tows. Sea robins ranged in length from 10 to 35 cm with a peaks at 20 and 27 cm (Figure 22). The average catch rate of sea robins was 4.6 ± 2.3 kg/tow (range: 0 – 20.9 kg/tow). The catch of sea robins appeared to increase along the depth gradient with higher catches in deeper water (Figure 23).

Other federally regulated commercial species frequently observed included Atlantic longfin squid (*Doryteuthis pealeii*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus*) and monkfish ((*Lophius americanus*). Longfin squid were observed in every tow. Squid were mostly small. Individuals ranged in size from 3 to 24 cm mantle length with a peak of abundance at 5 cm (Figure 24). Longfin squid were caught at an average rate of 3.2 ± 1.4 kg/tow (range: 0.4 – 14.7 kg/tow). The catch was distributed throughout the 522 Lease Area (Figure 25). No squid eggs were observed during the survey.

Summer flounder were observed in 9 of the 10 tows. Thirty-eight summer flounder were caught ranging in size from 25 to 76 cm. (Figure 26). The average catch rate was 3.0 ± 1.2 kg/tow (range:

0 – 12.3 kg/tow). Summer flounder were observed throughout the 522 Lease Area with increased catch to the southwest (Figure 27).

Windowpane flounder were observed in every tow. Individuals ranged in size from 19 to 31 cm (Figure 28). Catch rates averaged 1.7 ± 0.5 kg/tow (range: 0.5 – 4.7 kg/tow). Windowpane flounder were observed throughout the 522 Lease Area with increased catch to the southwest (Figure 29).

Monkfish were observed in 3 of the 10 tows. Eight individuals were caught ranging in size from 36 to 54 cm (Figure 30). The catch rate averaged 1.1 ± 0.6 kg/tow (range: 0 – 5.3 kg/tow). Monkfish were observed throughout the 522 Lease Area with increased catch to the southwest (Figure 31).

Less common recreational and commercial species observed included 10 bluefish (*Pomatomus saltatrix*, size range: 36 – 47 cm), 4 Atlantic sea scallops (*Placopecten magellanicus*), 3 weakfish (*Cynoscion regalis*, size range: 36 - 40 cm) and 3 Atlantic cod (*Gadus morhua*, size range: 43 - 54 cm).

4. Acknowledgements

We would like to thank the owner (Stephen Follett), captain (Kevin Jones) and crew (Mark Bolster, Andrew Follett, Ryan Roache and Matt Manchester) of the F/V Heather Lynn for their help sorting, processing and measuring the catch. Additionally, we would like to thank Susan Inglis (SMAST), Mike Coute (SMAST), Natalie Hernandez (A.I.S.), Trevor Coble (A.I.S.), and Ashley Jones (A.I.S.) 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	Tow Area	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)
51	522	11/21/2019	Clear	11-15	NE	1.25-2.5	14:26	N 40º 48.972	W 70º 14.482	24	14:46	N 40º 48.732	W 70º 13.211	23	100
52	522	11/21/2019	Clear	11-15	NE	1.25-2.5	15:40	N 40º 43.552	W 70º 16.076	26	16:00	N 40º 42.711	W 70º 16.456	25	100
53	522	11/21/2019	Clear	11-15	S	1.25-2.5	16:26	N 40º 41.169	W 70º 18.567	27	16:41	N 40º 40.671	W 70º 19.295	27	125
54	522	11/22/2019	Mostly Cloudy	11-15	SW	1.25-2.5	6:53	N 40º 39.519	W 70º 01.137	26	7:13	N 40º 39.372	W 70º 02.196	26	100
55	522	11/22/2019	Mostly Cloudy	16-20	SW	1.25-2.5	7:39	N 40º 41.119	W 70º 03.117	25	7:59	N 40º 41.871	W 70º 03.442	24	100
56	522	11/22/2019	Partly Cloudy	16-20	SW	1.25-2.5	8:26	N 40º 41.656	W 70º 05.656	25	8:46	N 40º 41.553	W 70º 06.924	25	125
57	522	11/22/2019	Partly Cloudy	16-20	SW	1.25-2.5	9:22	N 40º 40.059	W 70º 08.866	25	9:42	N 40º 39.316	W 70º 09.847	26	125
58	522	11/22/2019	Mostly Cloudy	16-20	SW	1.25-2.5	10:22	N 40º 38.531	W 70º 13.559	27	10:42	N 40º 38.248	W 70º 14.834	28	125
59	522	11/22/2019	Mostly Cloudy	21-26	SW	1.25-2.5	11:29	N 40º 38.211	W 70º 19.775	29	11:49	N 40º 38.033	W 70º 21.005	30	125
60	522	11/22/2019	Mostly Cloudy	21-26	SW	2.5-4.0	12:28	N 40º 38.823	W 70º 23.739	30	12:48	N 40º 38.909	W 70º 24.005	30	125

Table 2: Tow parameters for each survey tow.

Tow Number	Tow Area	Tow Duration (min.)	Tow Speed (knots)	Tow Distance (nm.)	Bottom Temperature (^{o}C)	Headline Height (m.)	Wing Spread (m.)	Spread Door (m.)
51	522	19.6	3.0	1.0	10.1	4.7	13.6	34.5
52	522	19.9	3.0	1.0	13.6	4.8	13.5	33.8
53	522	15.0	3.2	0.8	14.4	4.2	14.5	36.9
54	522	19.7	2.6	0.8	11.0	4.9	14.0	35.4
55	522	19.4	2.8	0.9	11.3	5.1	13.8	33.8
56	522	19.6	3.0	1.0	11.9	4.3	14.6	37.7
57	522	20.0	3.0	1.0	11.9	4.7	13.9	35.2
58	522	19.5	2.9	0.9	12.6	4.5	14.4	36.6
59	522	19.6	3.0	1.0	12.6	4.5	14.6	37.2
60	522	20.1	3.0	1.0	13.7	4.5	14.6	36.7
Summary Statistics								
	Minimum	15.0	2.6	0.8	10.1	4.2	13.5	33.8
	Maximum	20.1	3.2	1.0	14.4	5.1	14.6	37.7
	Average	19.2	2.9	0.9	12.3	4.6	14.1	35.8
	St. Dev	1.5	0.2	0.1	1.3	0.3	0.4	1.4

Table 3: Total and average catch weights observed in the 522 Lease Area.

Species Name	Scientific Name	Total Weight (Kg)	Catch/Tow (Kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Skate, Little	*Leucoraja erinacea*	690.7	69.1	19.1	30.1	10
Scup	*Stenotomus chrysops*	648.0	92.6	28.9	28.3	7
Butterfish	*Peprilus triacanthus*	241.6	24.2	15.9	10.5	10
Skate, Winter	*Leucoraja ocellata*	182.5	18.3	7.9	8.0	10
Dogfish, Spiny	*Squalus acanthias*	173.1	24.7	9.3	7.6	7
Hake, Red	*Urophycis chuss*	108.2	13.5	8.7	4.7	8
Hake, Silver	*Merluccius bilinearis*	48.5	4.9	3.0	2.1	10
Sea Robin, Northern	*Prionotus carolinus*	46.0	7.7	2.3	2.0	5
Squid, Atlantic Longfin	*Doryteuthis pealeii*	32.3	3.2	1.4	1.4	10
Flounder, Summer (Fluke)	*Paralichthys dentatus*	30.3	3.4	1.2	1.3	9
Flounder, Windowpane	*Scophthalmus aquosus*	17.3	1.7	0.5	0.8	10
Flounder, Fourspot	*Hippoglossina oblonga*	14.8	2.5	0.6	0.6	6
Sculpin, Longhorn	*Myoxocephalus octodecemspinosus*	12.9	2.6	0.6	0.6	5
Monkfish	*Lophius americanus*	10.7	3.6	0.6	0.5	3
Bluefish	*Pomatomus saltatrix*	9.8	2.0	0.4	0.4	5
Hake, Spotted	*Urophycis regius*	9.1	3.0	0.7	0.4	3
Skate, Barndoor	*Dipturus laevis*	7.4	3.7	0.5	0.3	2
Atlantic Cod	*Gadus morhua*	3.8	1.9	0.3	0.2	2
Weakfish	*Cynoscion regalis*	1.8	1.8	0.2	0.1	1
Sea Scallop	*Placopecten magellanicus*	0.8	0.3	0.1	0.0	3
Crab, Rock	*Cancer sp.*	0.7	0.2	0.0	0.0	3
Eel, Conger	*Conger oceanicus*	0.5	0.5	0.1	0.0	1
Clam, Surf	*Spisula solidissima*	0.5	0.5	0.1	0.0	1
Shad, American	*Alosa sapidissima*	0.1	0.1	0.0	0.0	1
Cutlassfish, Atlantic	*Truchiurus lepturus*	0.1	0.1	0.0	0.0	1
Flounder, Gulfstream	*Citharichthys arctifrons*	0.1	0.1	0.0	0.0	2
Alewife	*Alosa pseudoharengus*	0.1	0.1	0.0	0.0	1
Total		2291.7				

*SEM is an acronym for Standard Error of the Mean

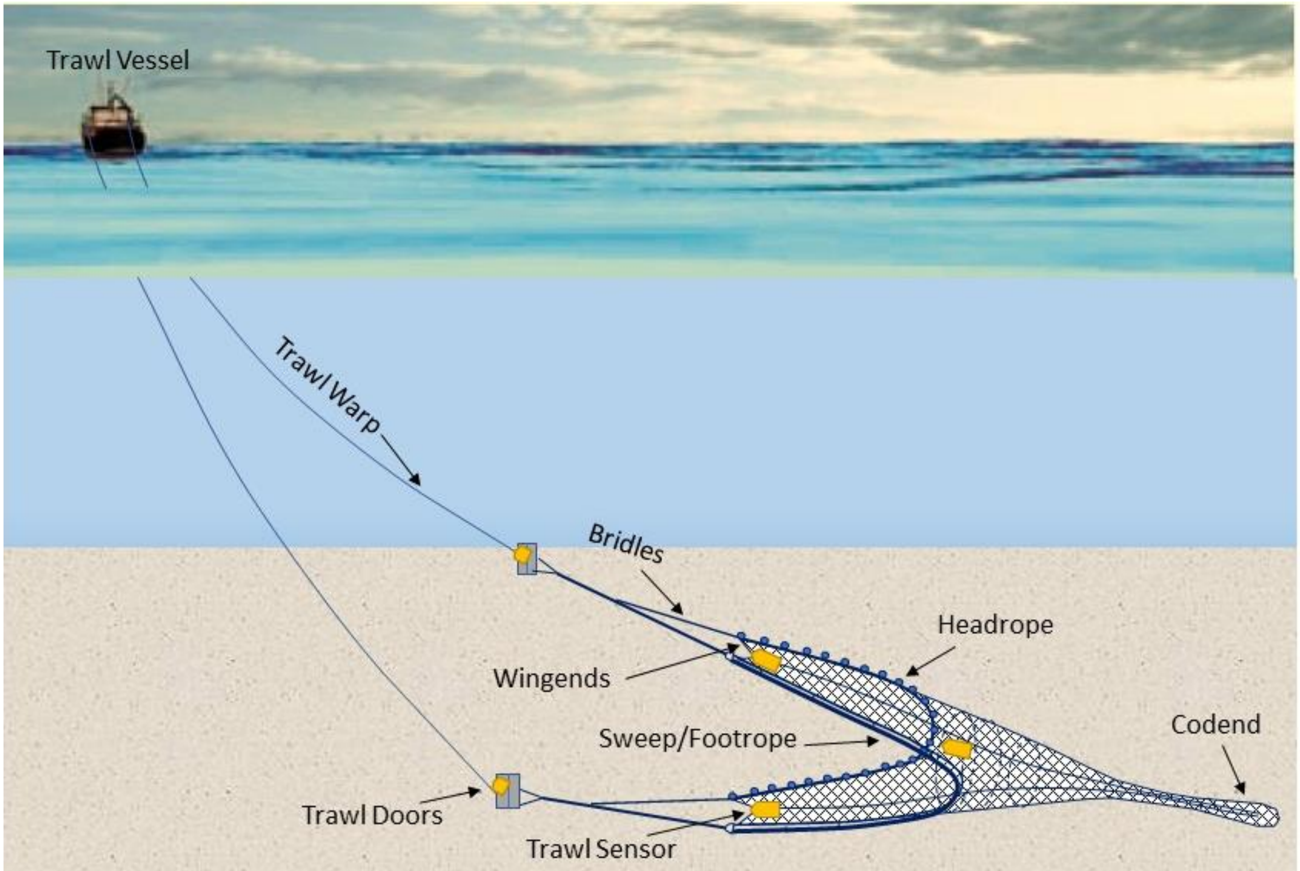


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

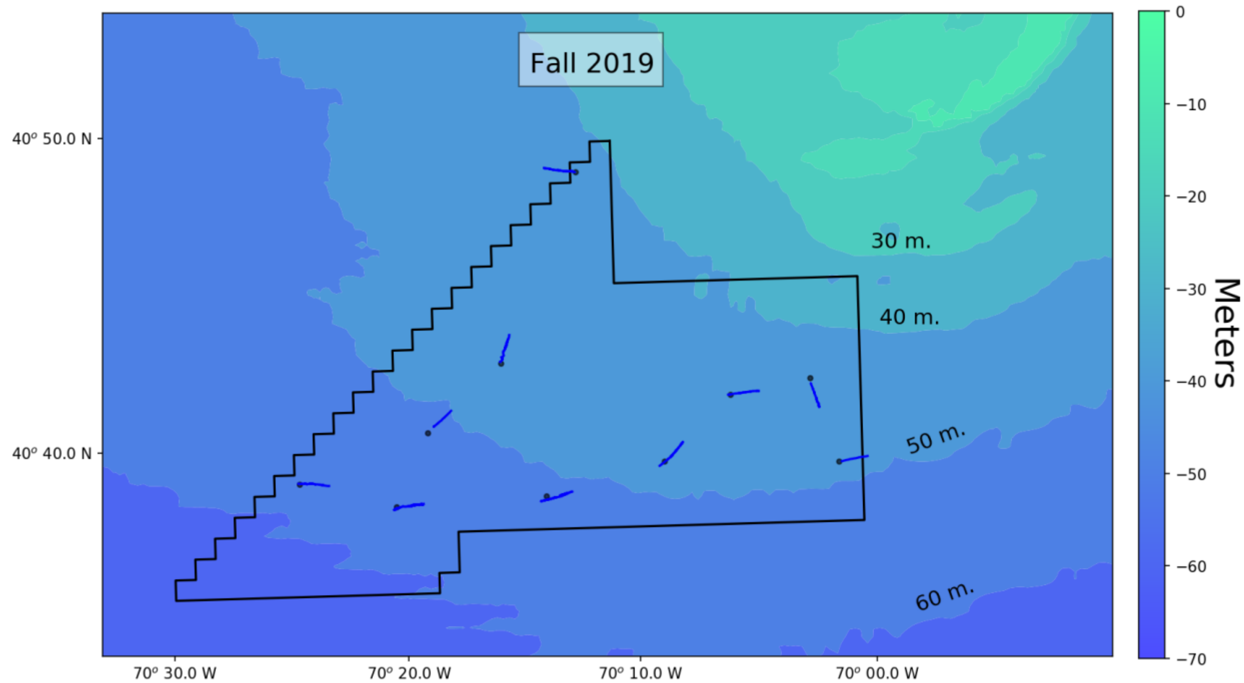


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Lease Area.

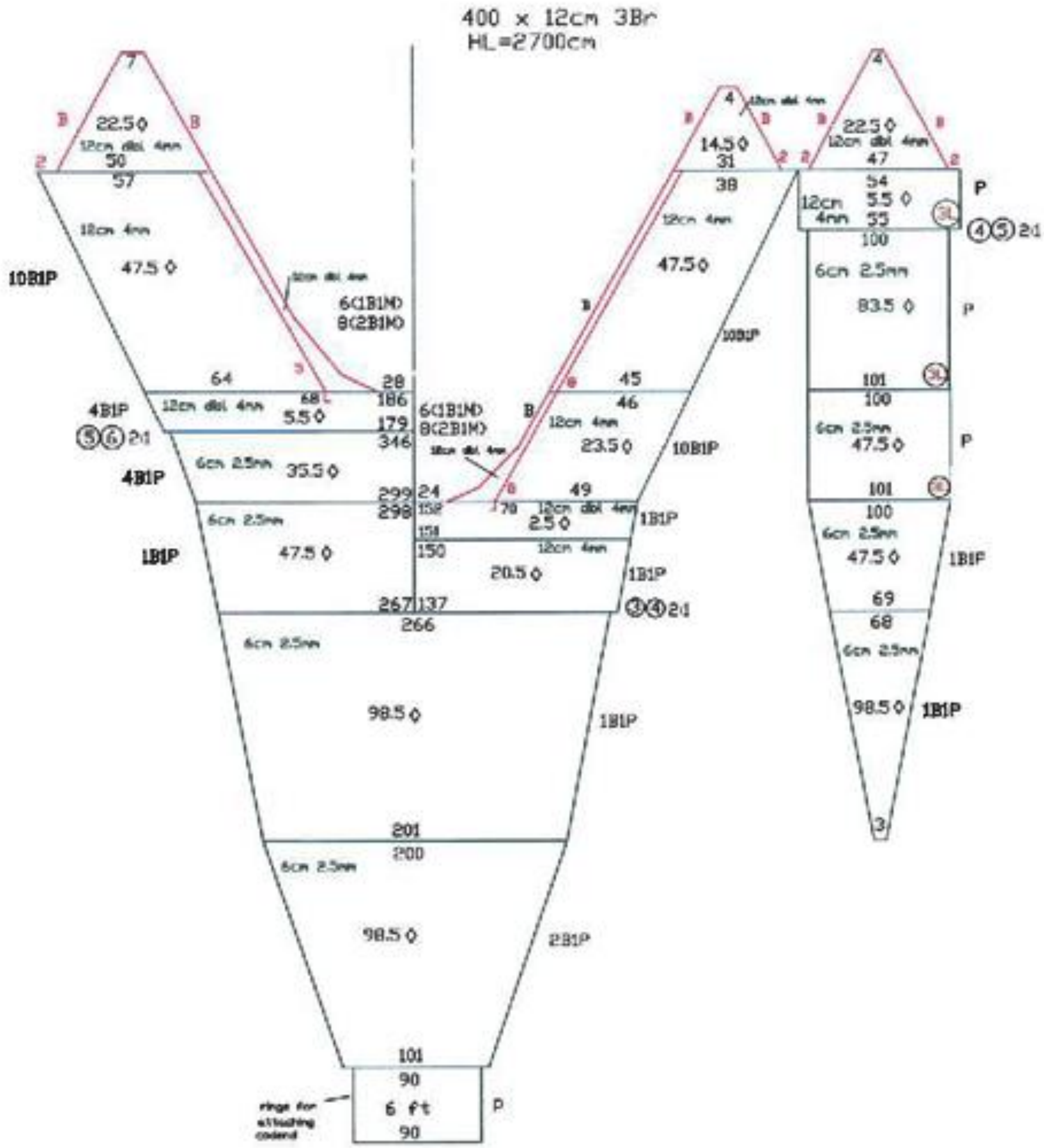


Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al. 2008)

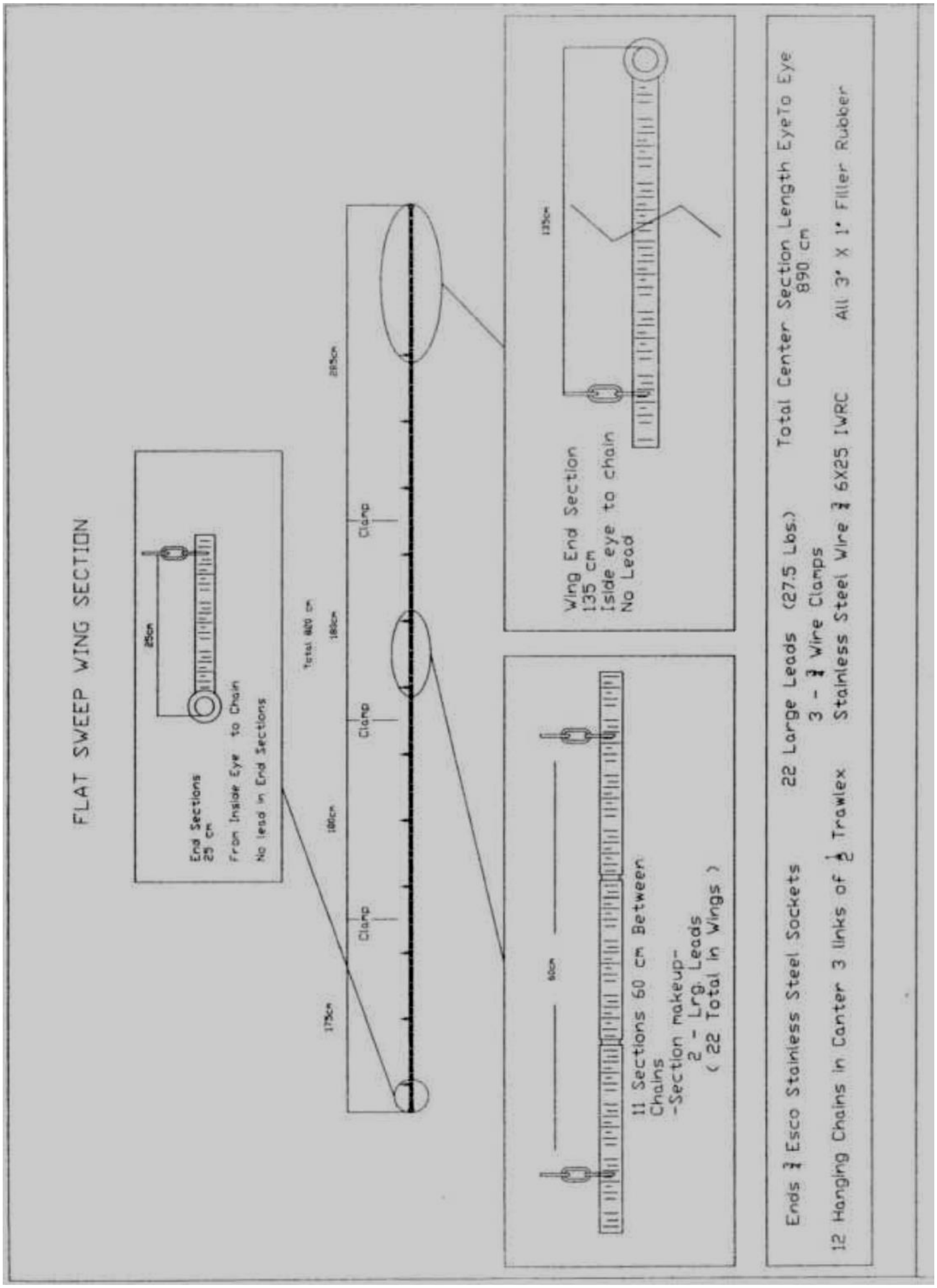


Figure 4: Sweep diagram for the survey trawl (Bonzek et al. 2008).

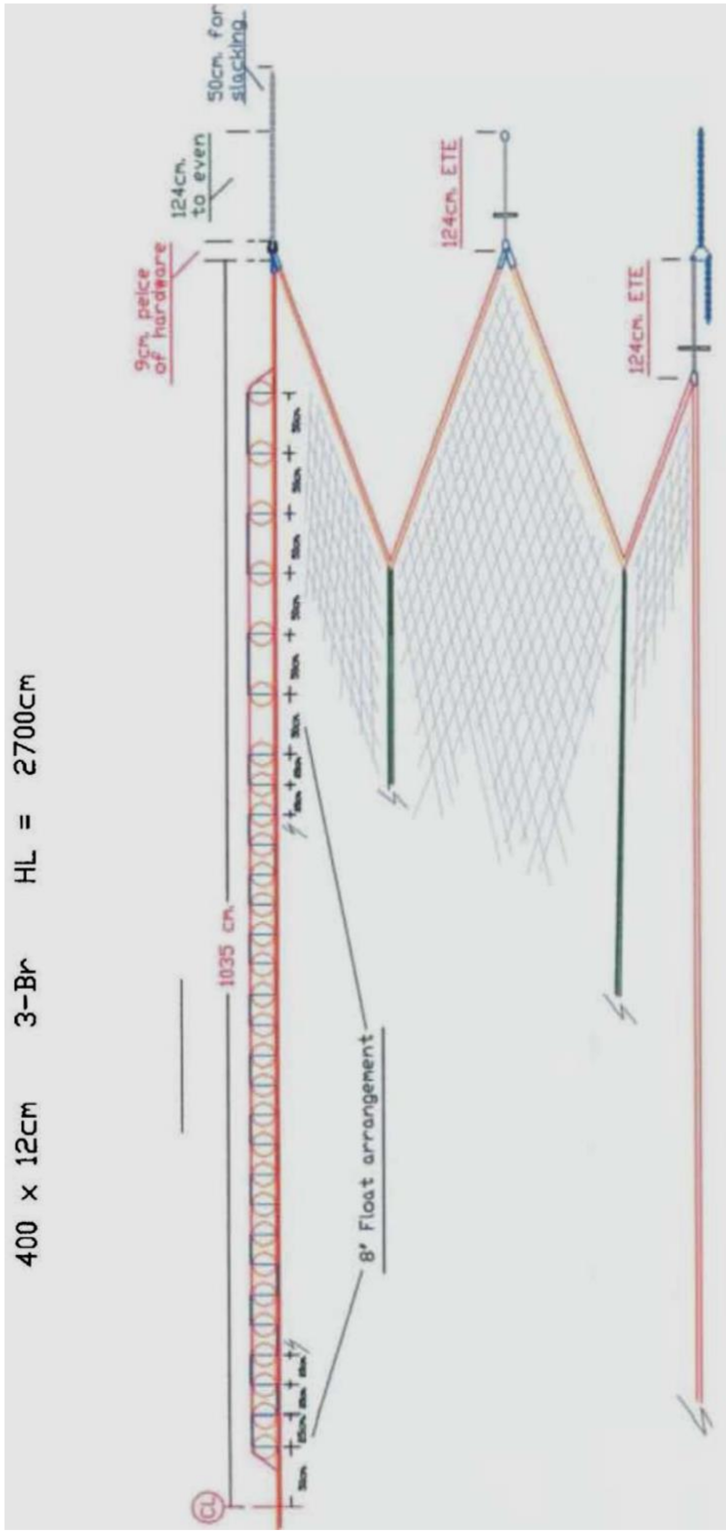


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al. 2008)

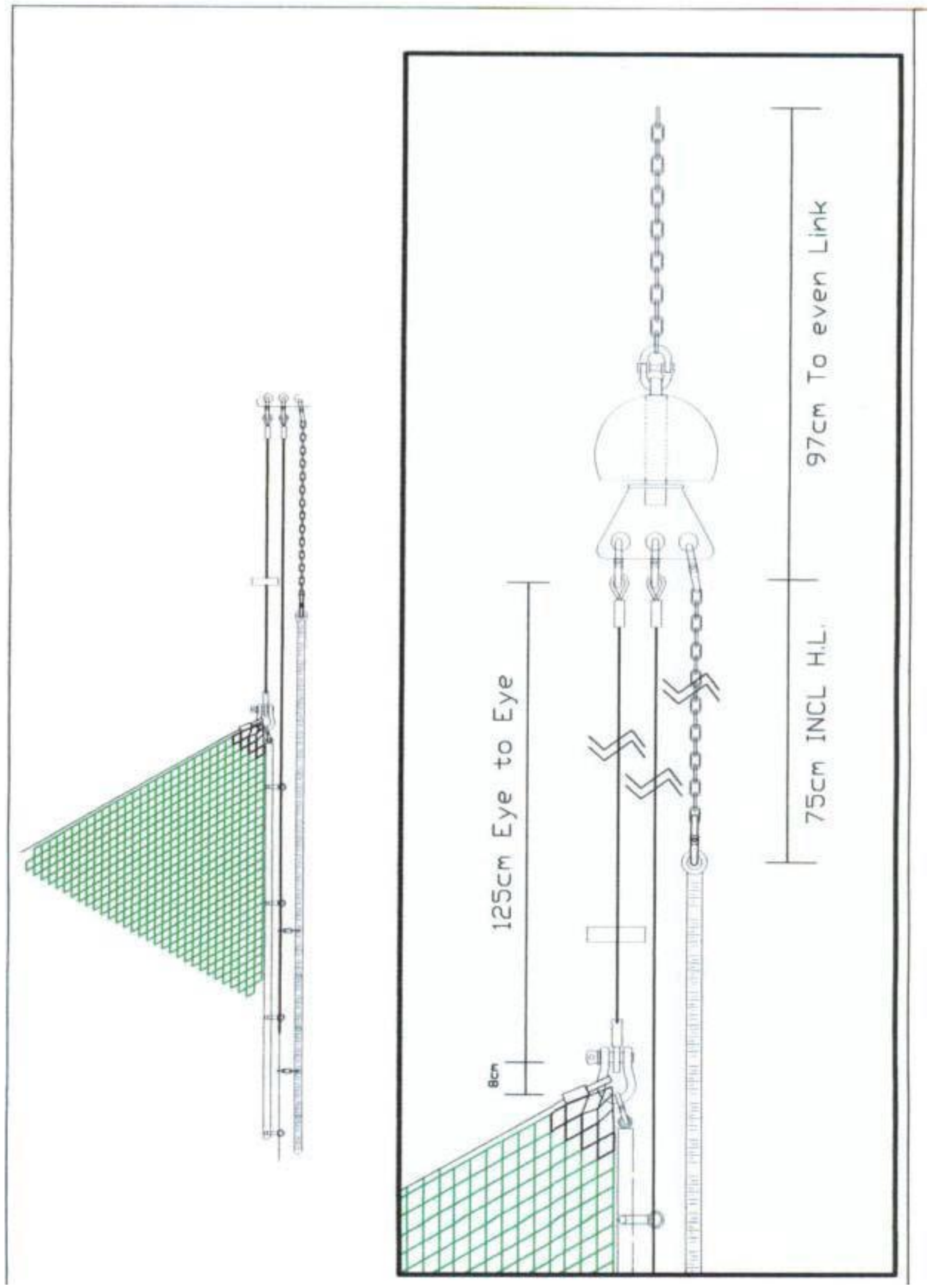


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al. 2008).

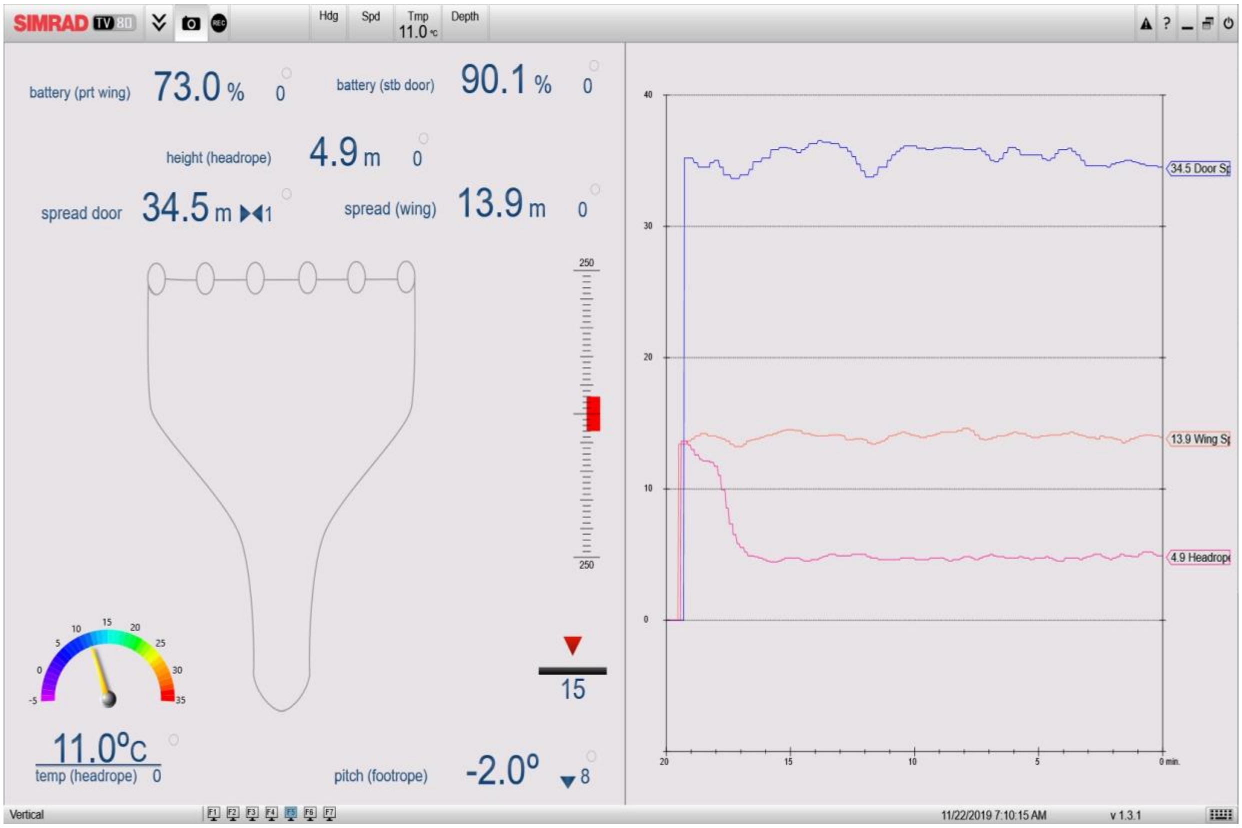
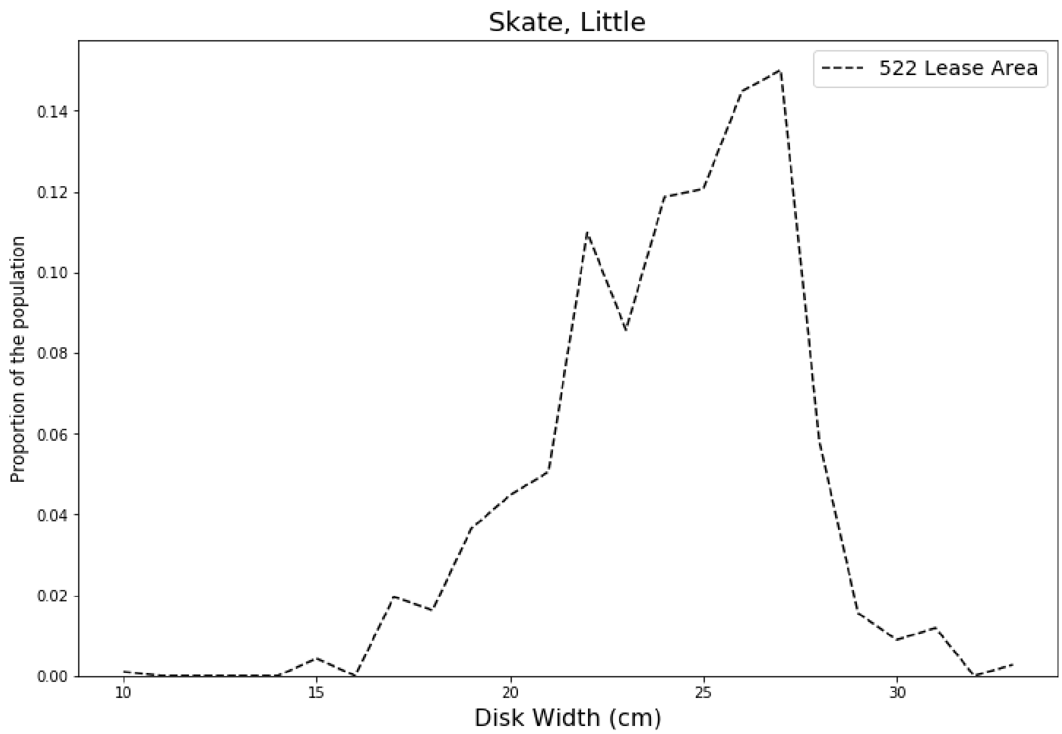


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.



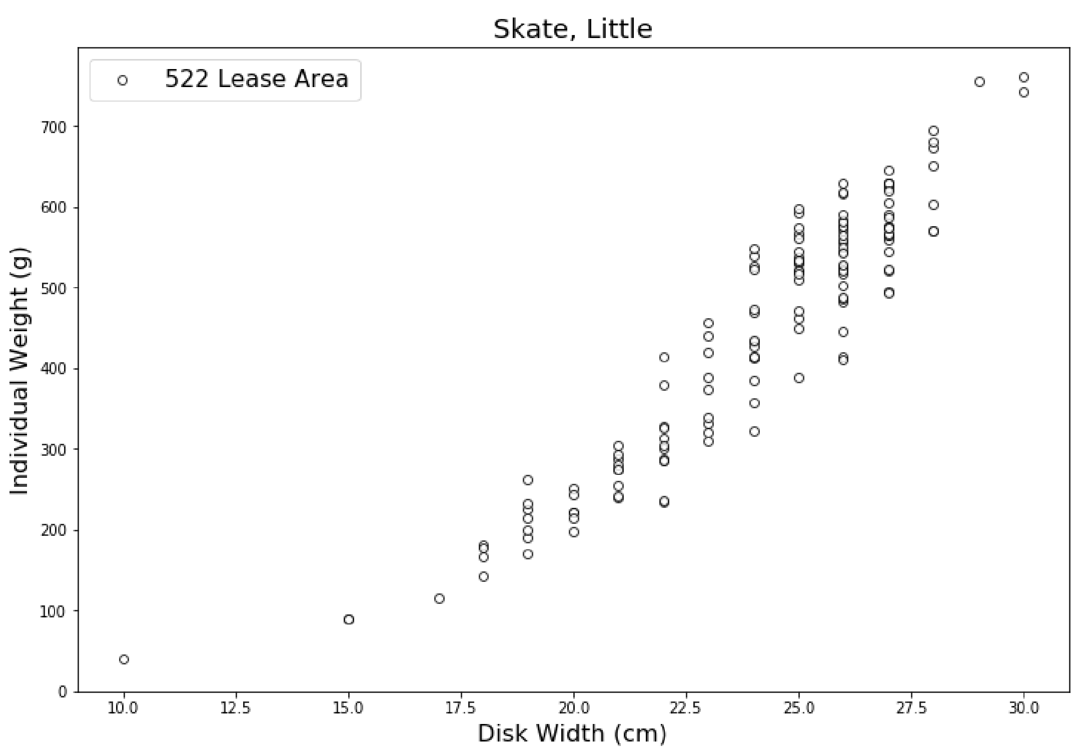


Figure 8: Population structure of little skate in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

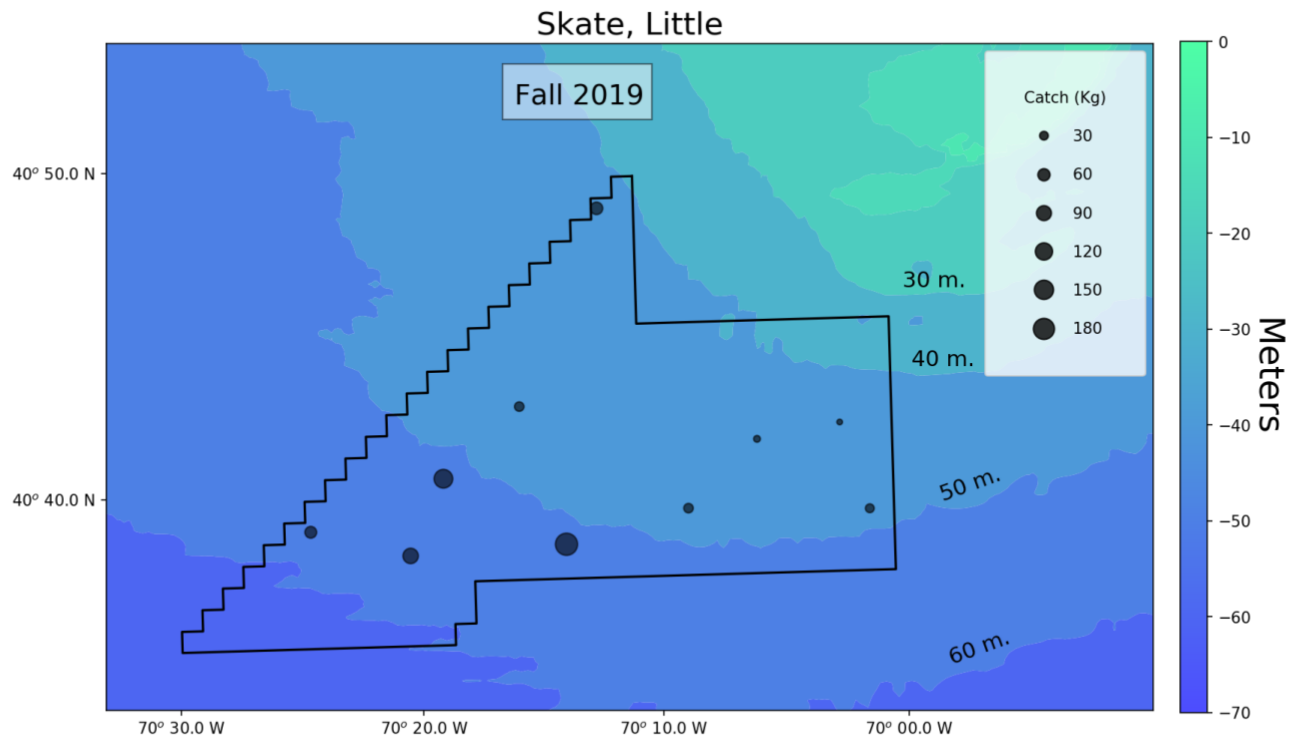
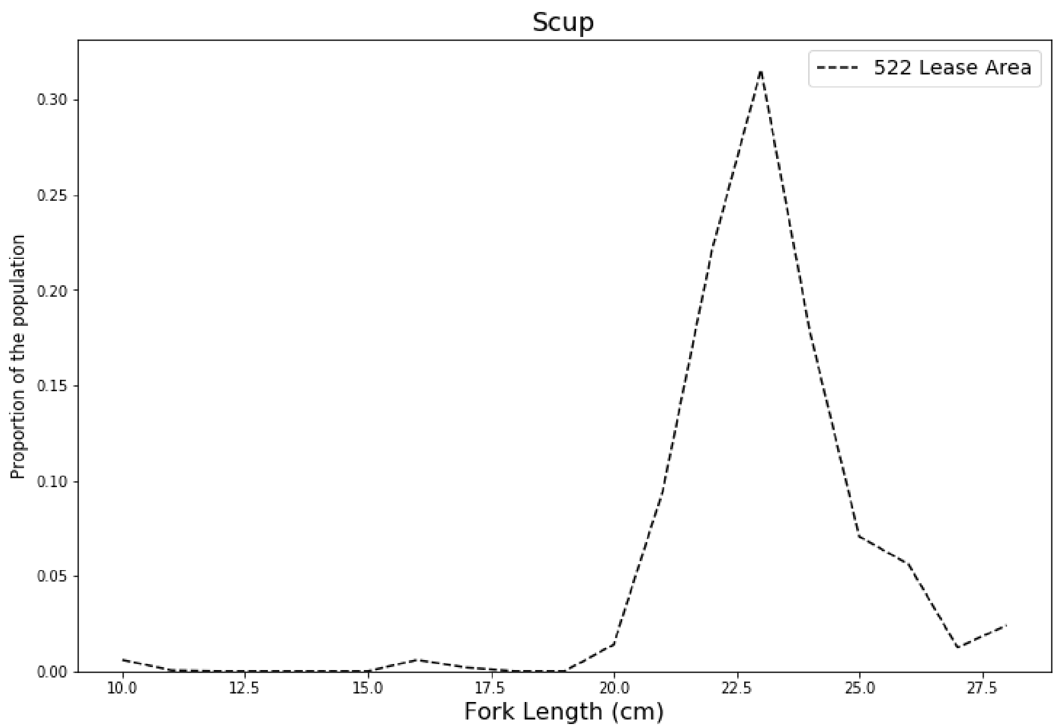


Figure 9: Distribution of the catch of little skate in the 522 Lease Area.



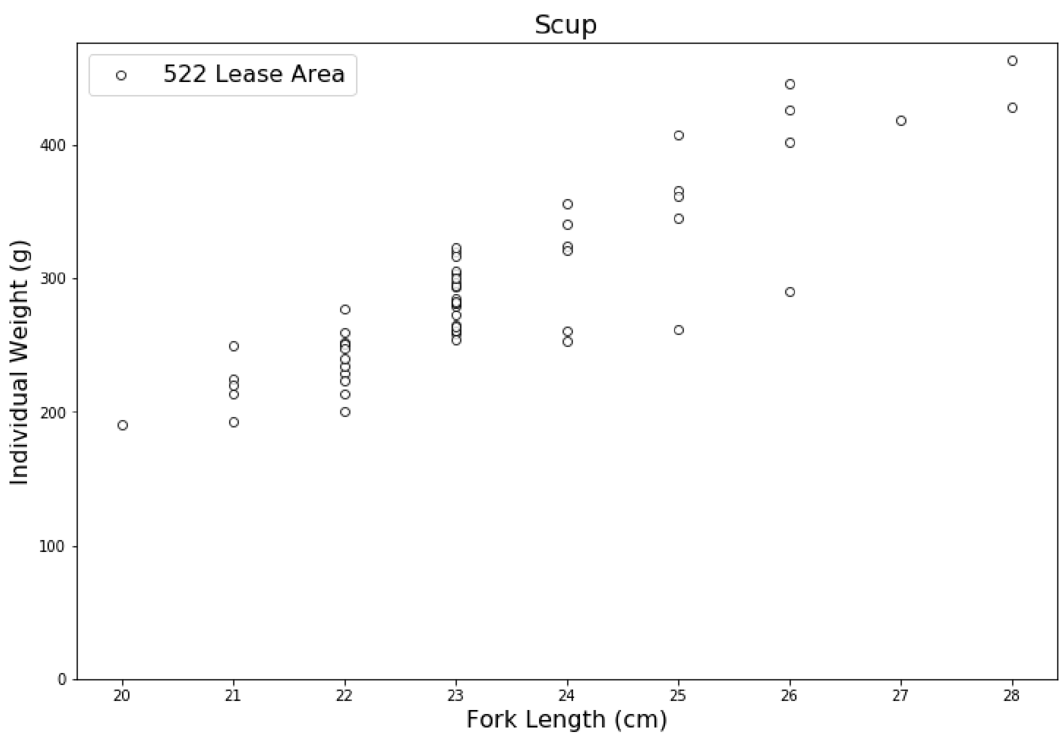


Figure 10: Population structure of scup in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

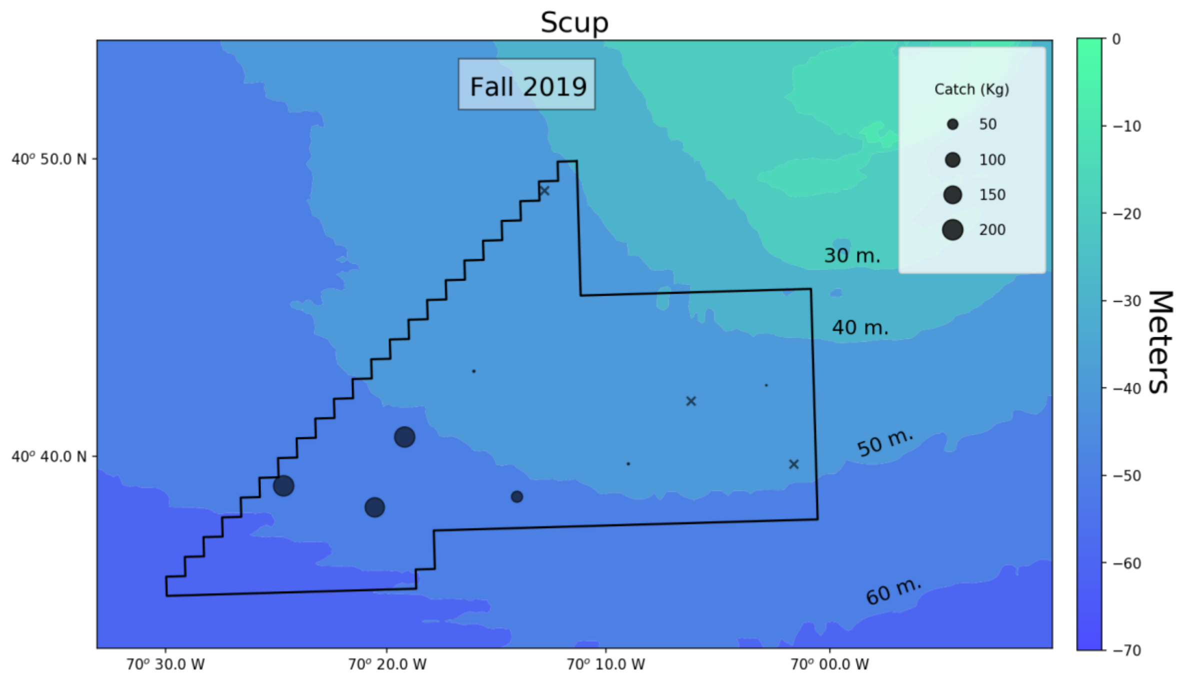
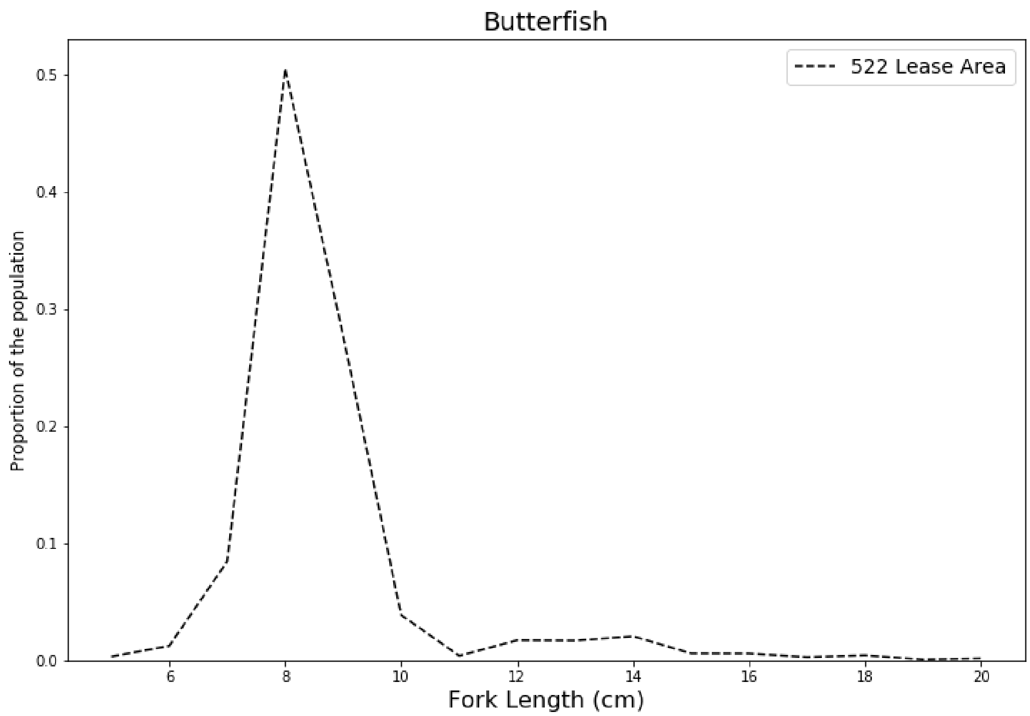


Figure 11: Distribution of the catch of scup in the 522 Lease Area. Tows with zero catch are denoted with an X.



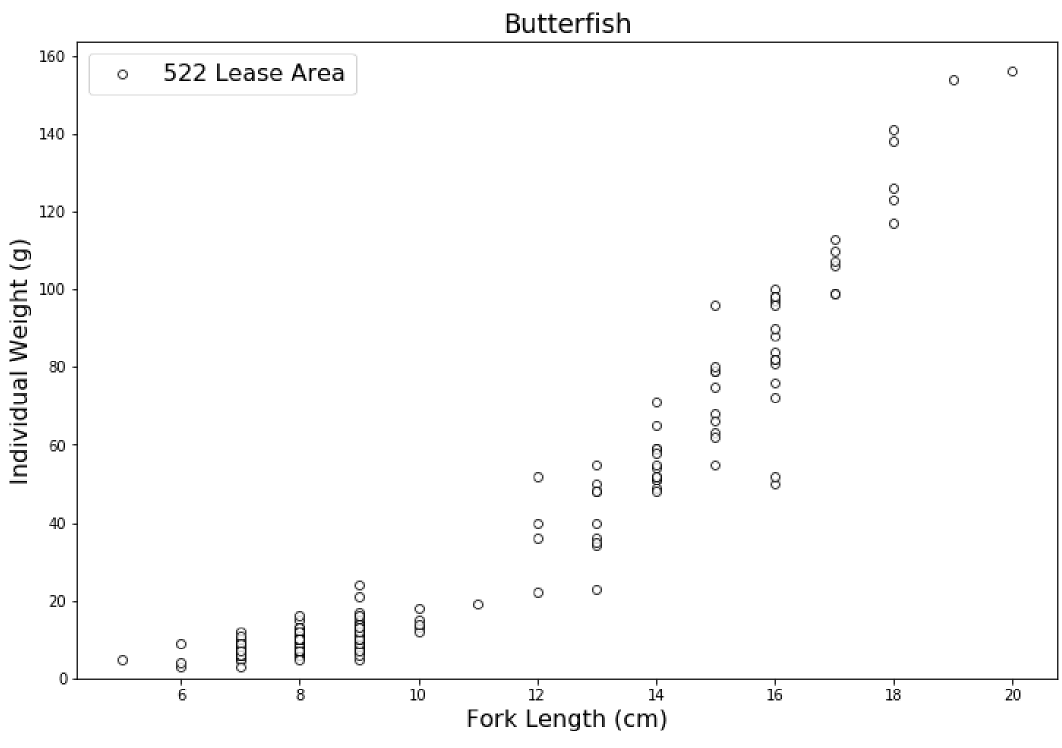


Figure 12: Population structure of butterfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

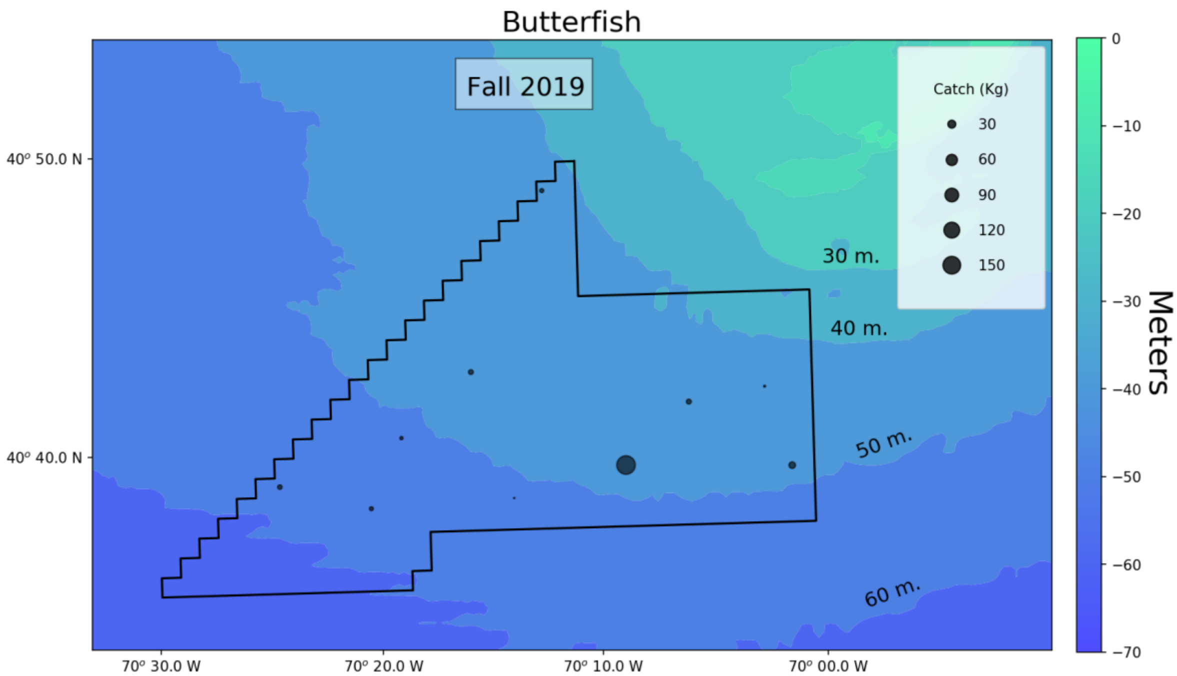
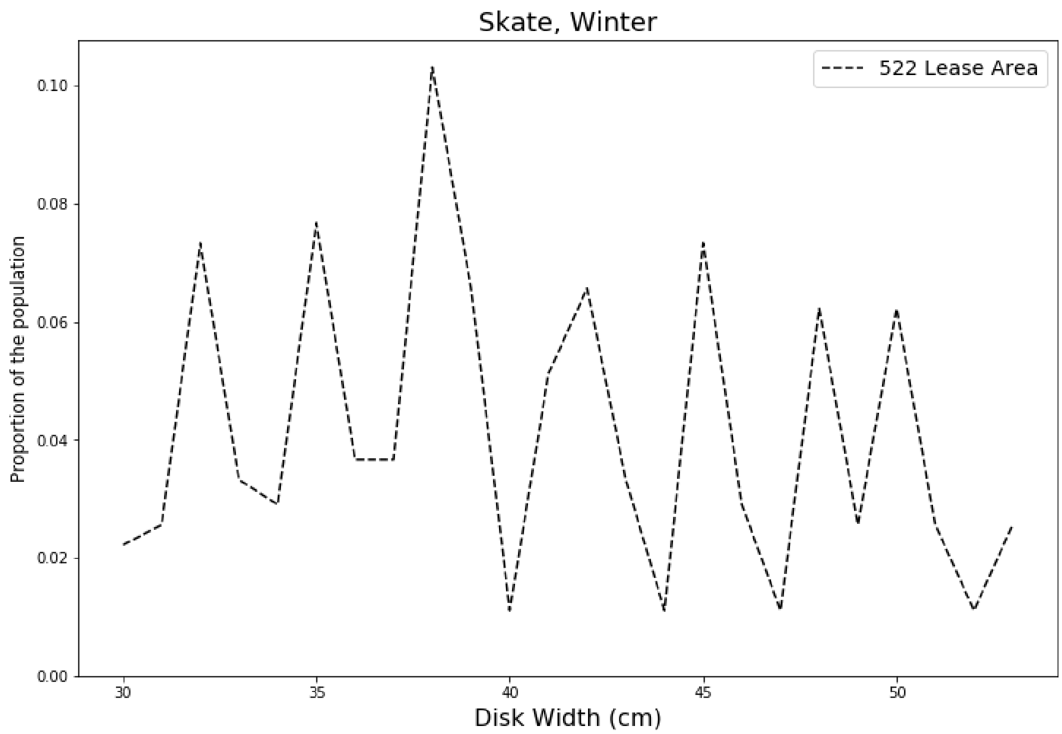


Figure 13: Distribution of the catch of butterfish in the 522 Lease Area.



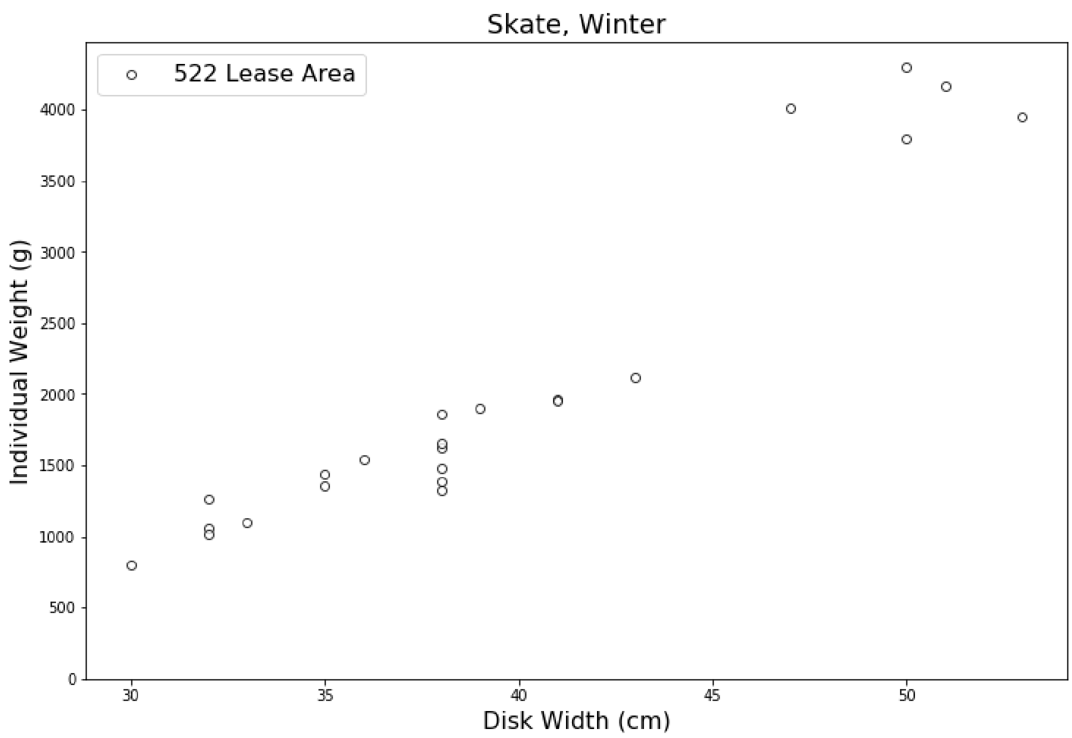


Figure 14: Population structure of winter skate in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

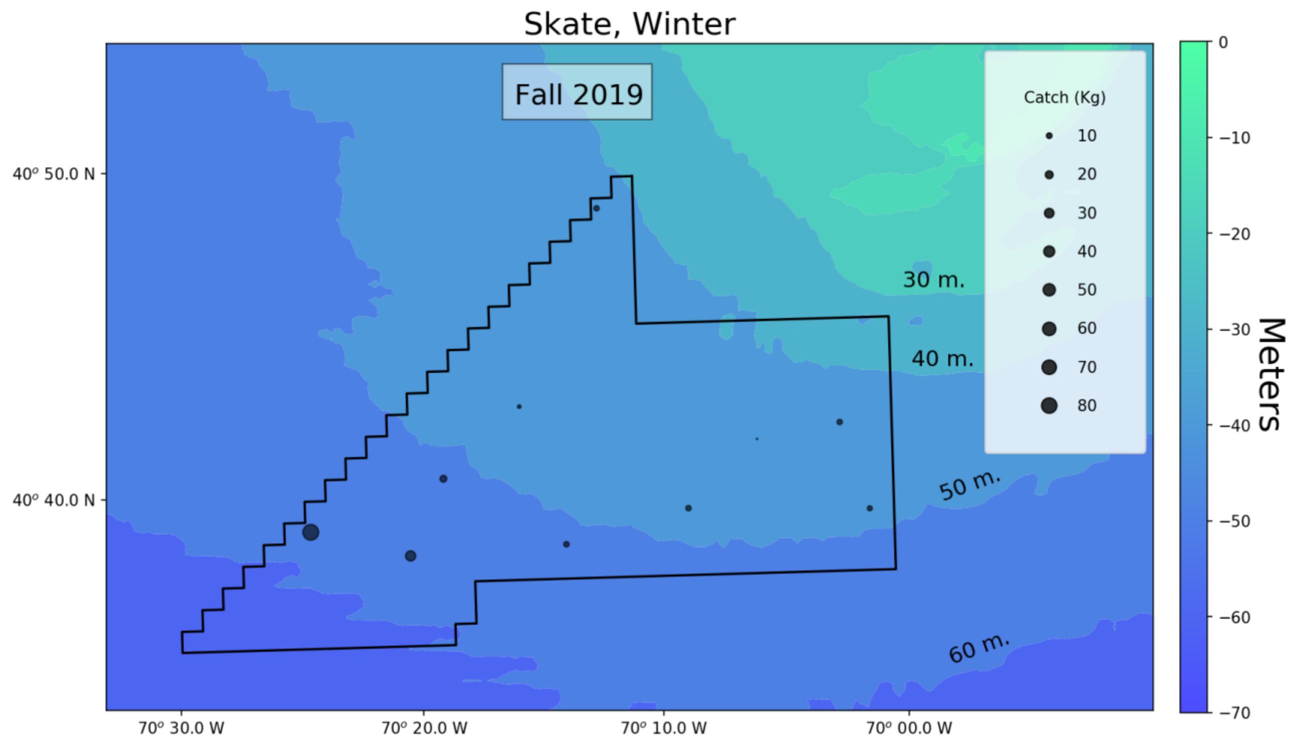
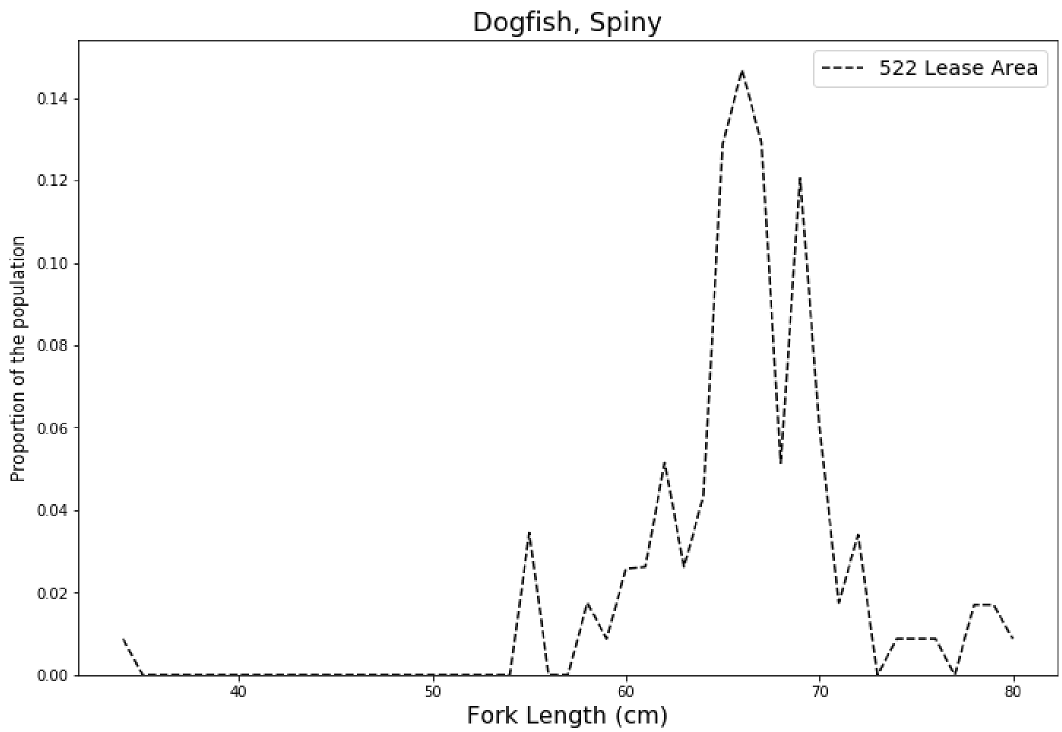


Figure 15: Distribution of the catch of winter skate in the 522 Lease Area.



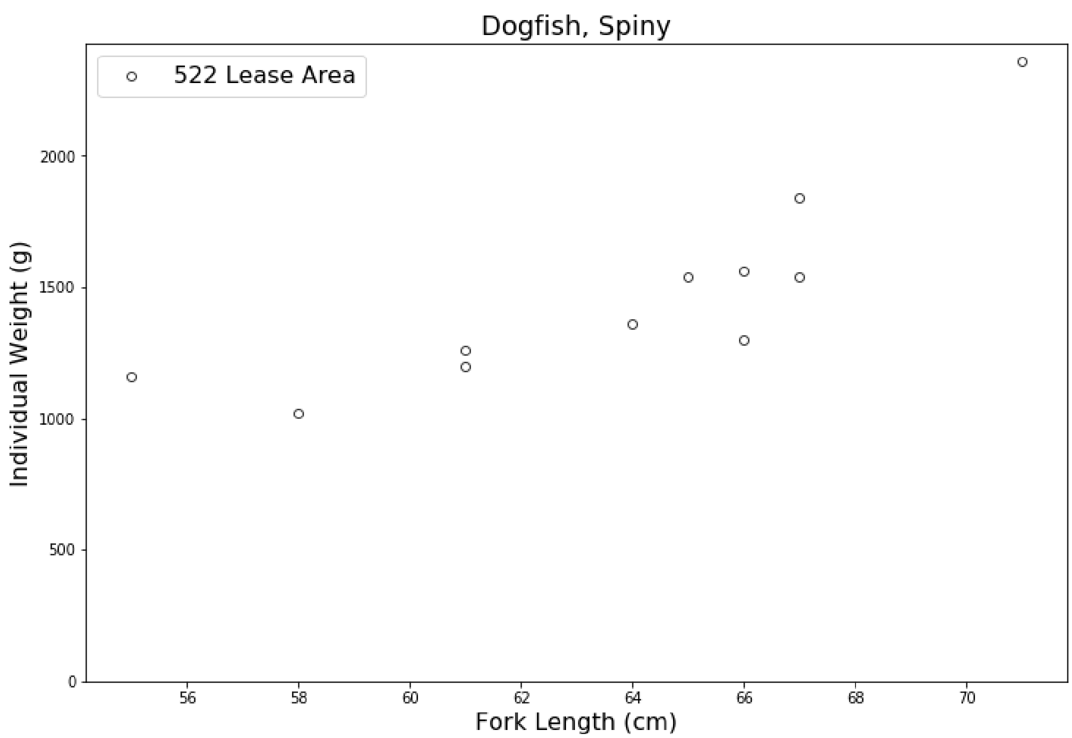


Figure 16: Population structure of spiny dogfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

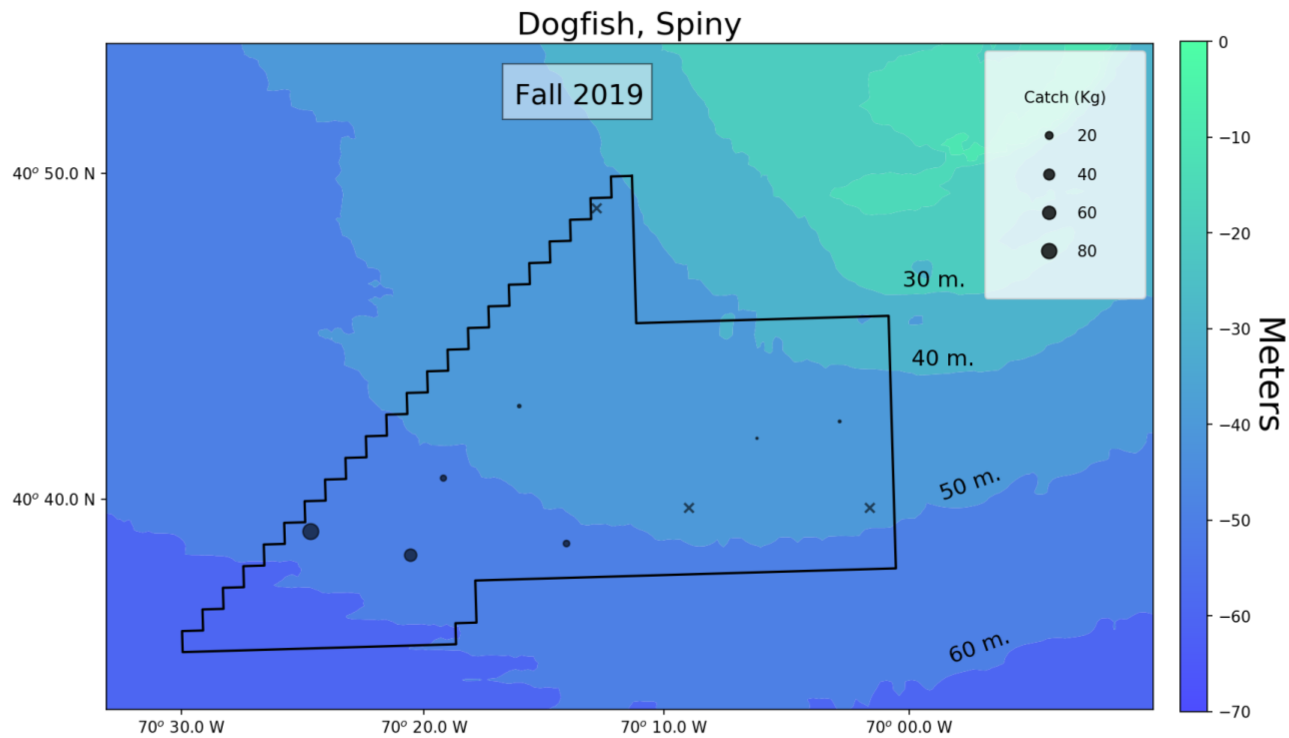
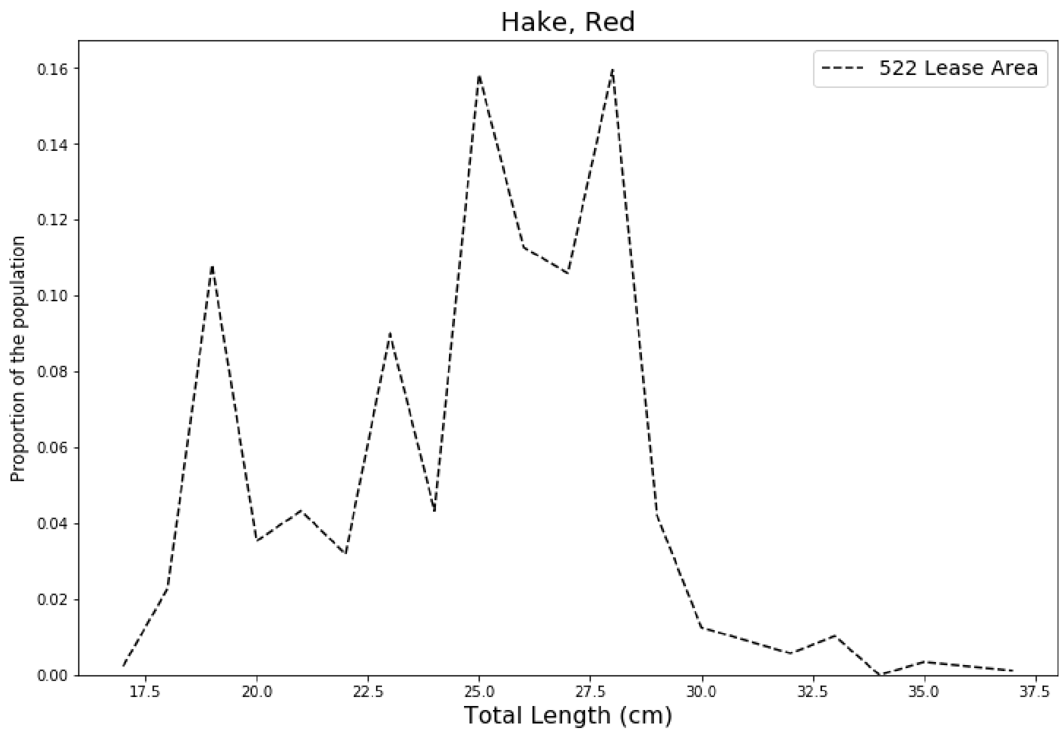


Figure 17: Distribution of the catch of spiny dogfish in the 522 Lease Area. Tows with zero catch are denoted with an X.



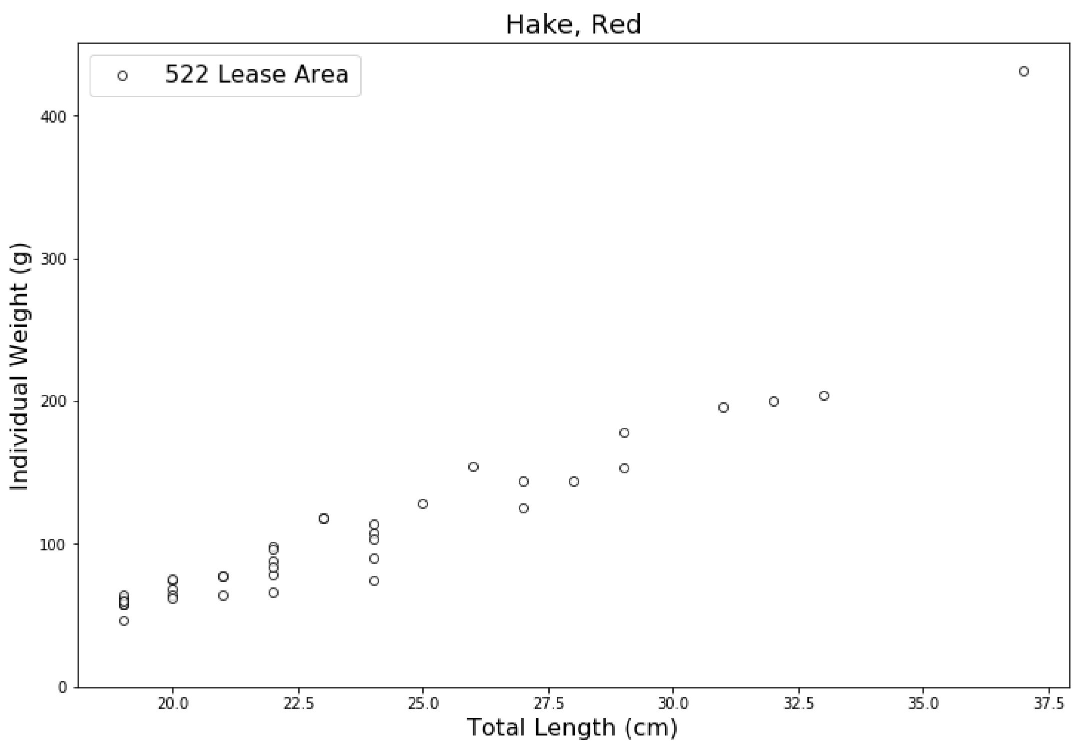


Figure 18: Population structure of red hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

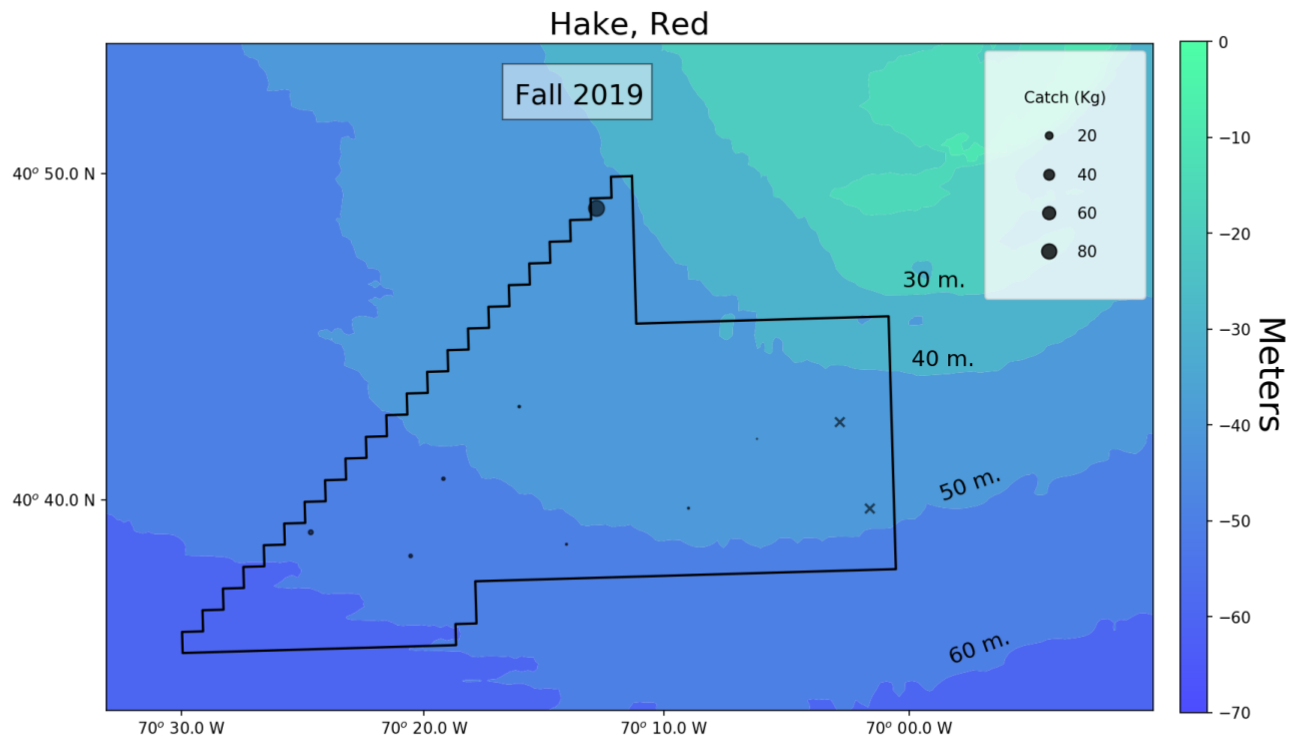


Figure 19: Distribution of the catch of red hake in the 522 Lease Area. Tows with zero catch are denoted with an X.

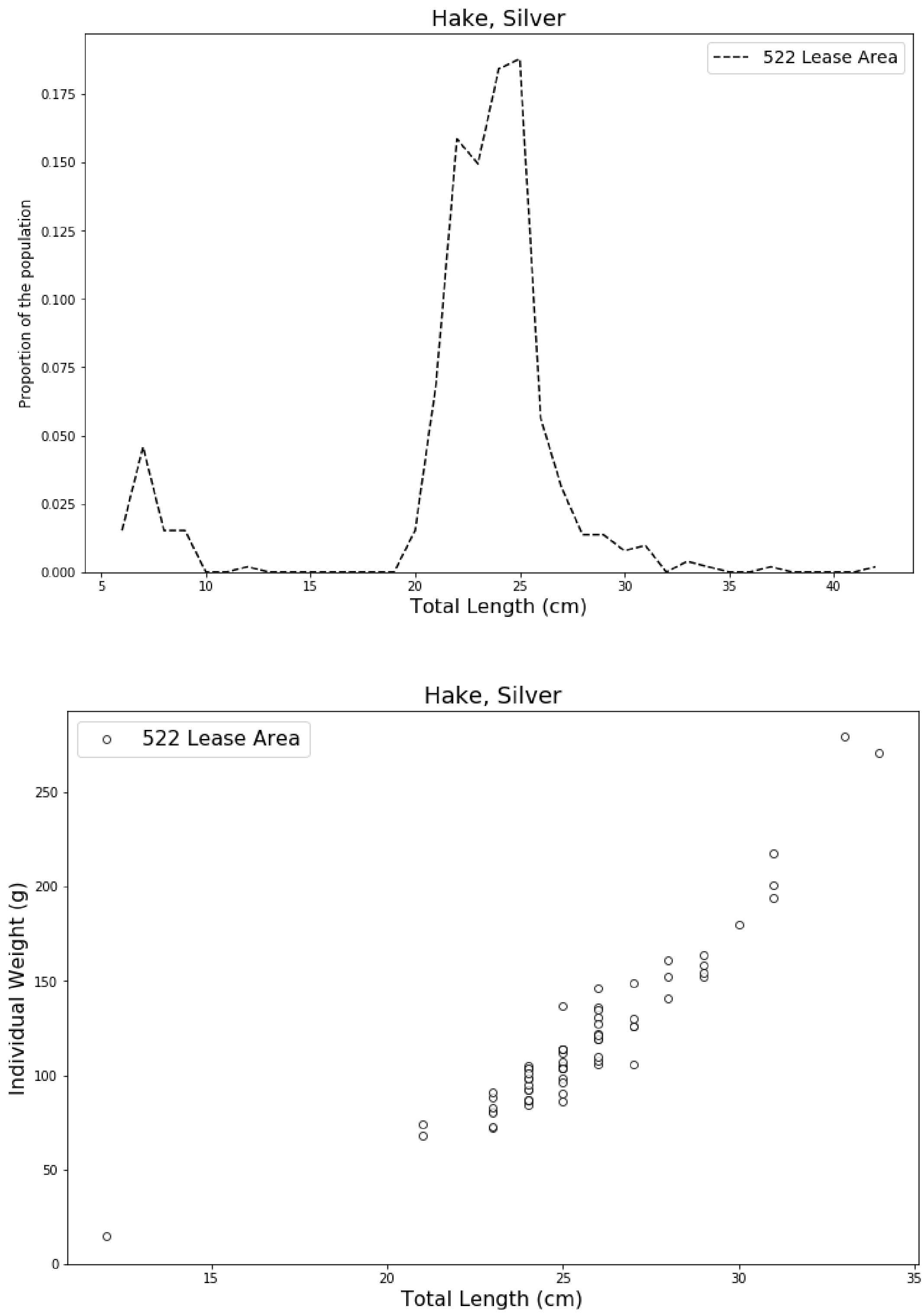


Figure 20: Population structure of silver hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

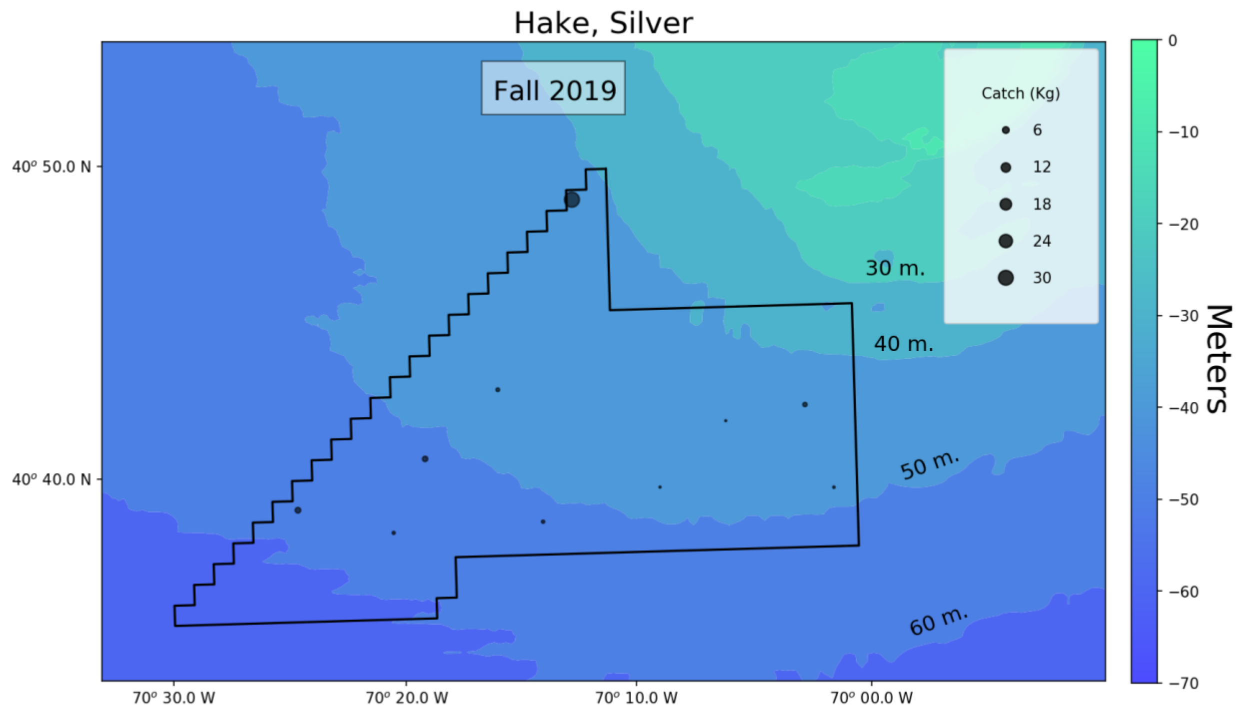
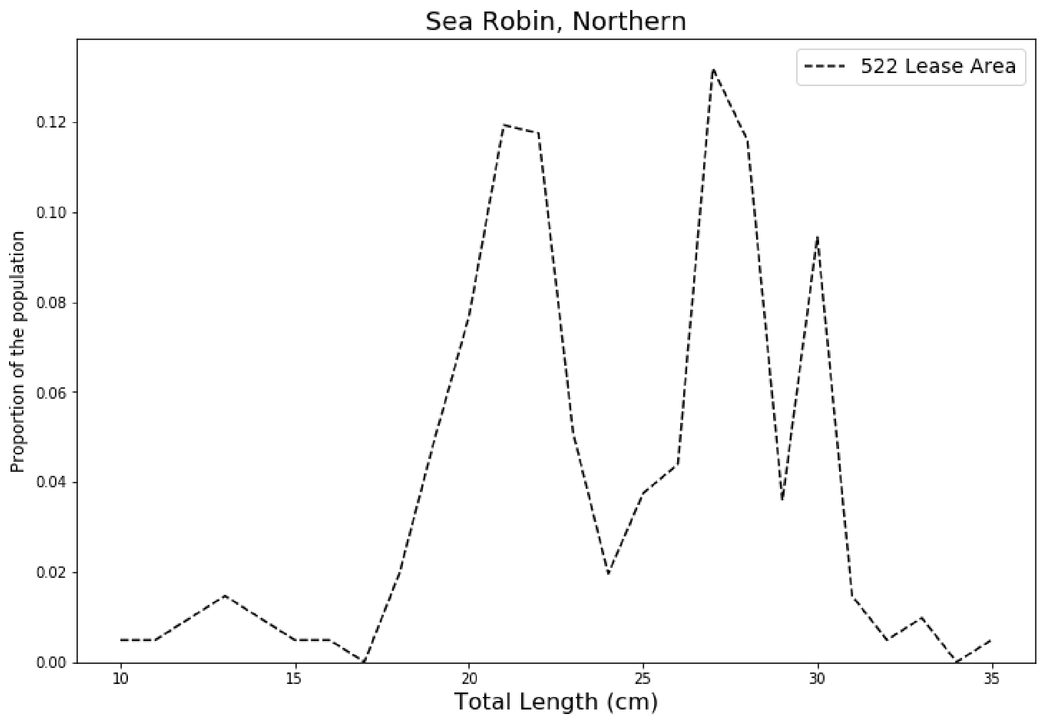


Figure 21: Distribution of the catch of silver hake in the 522 Lease Area.



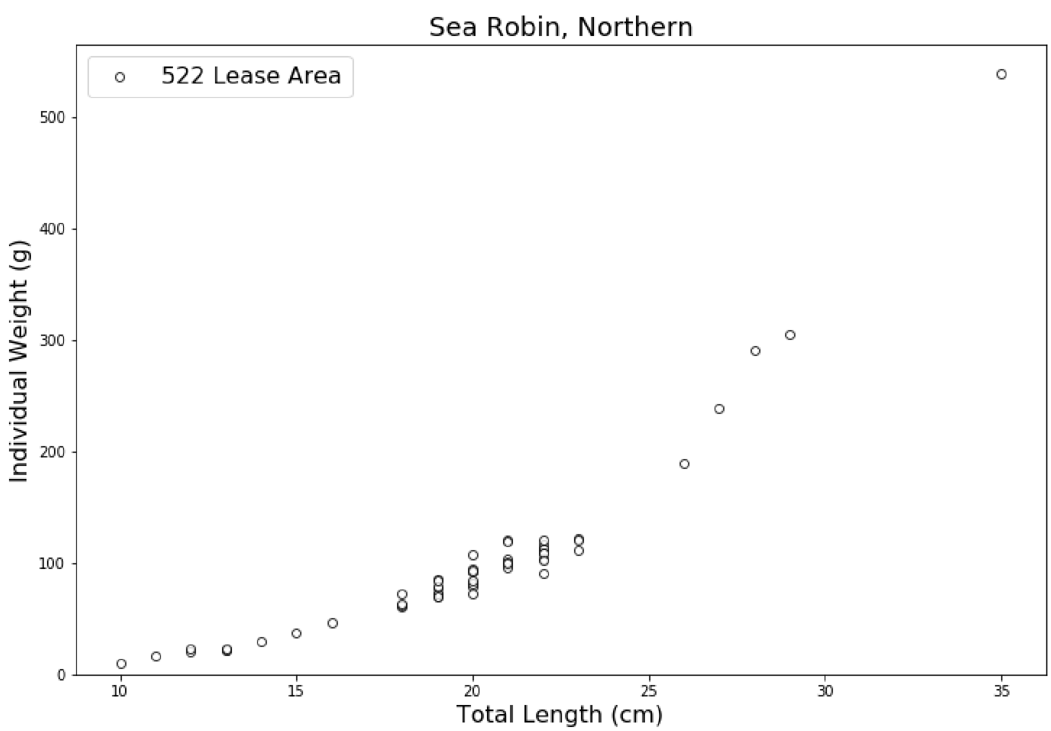


Figure 22: Population structure of northern sea robin in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

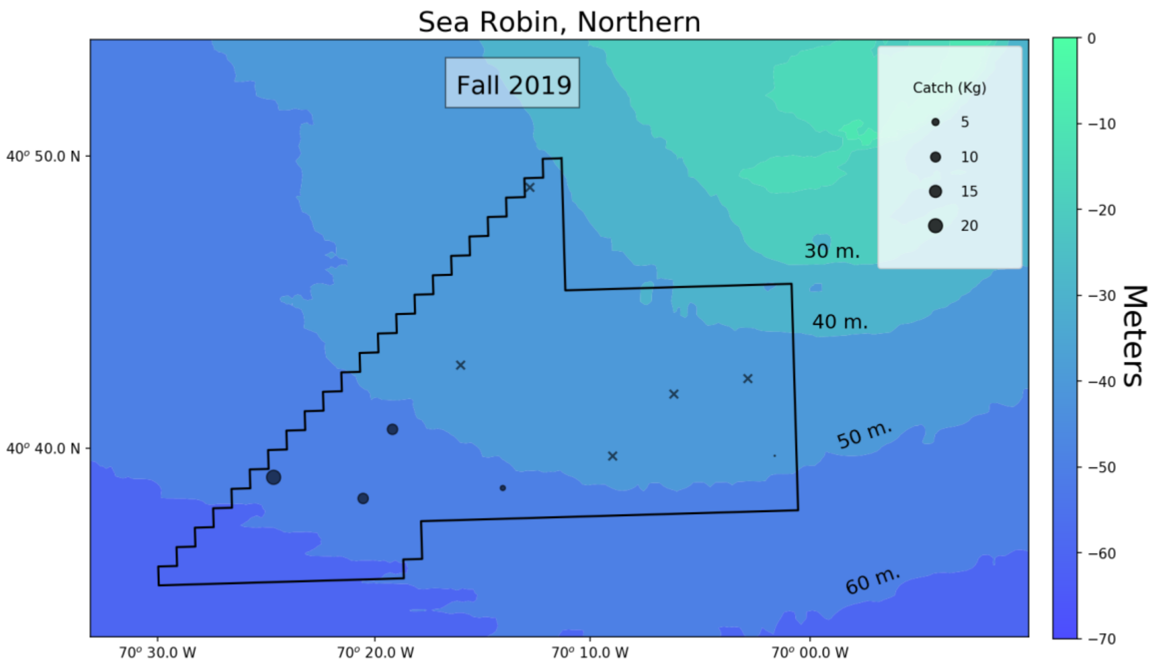
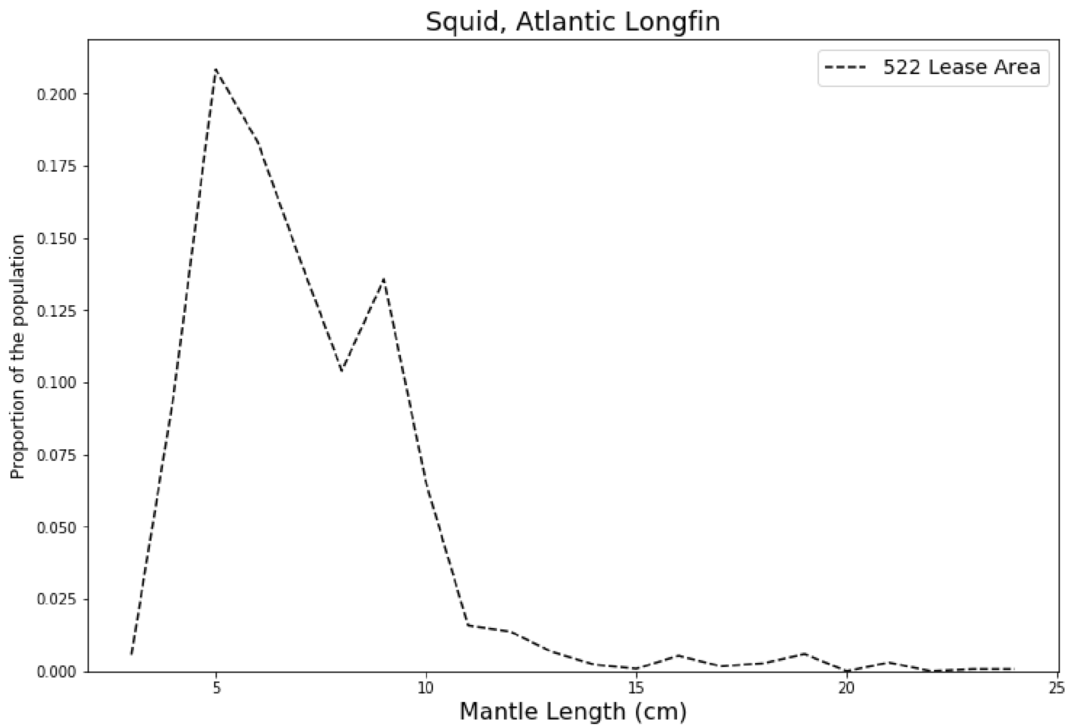


Figure 23: Distribution of the catch of northern sea robin in the 522 Lease Area. Tows with zero catch are denoted with an X.



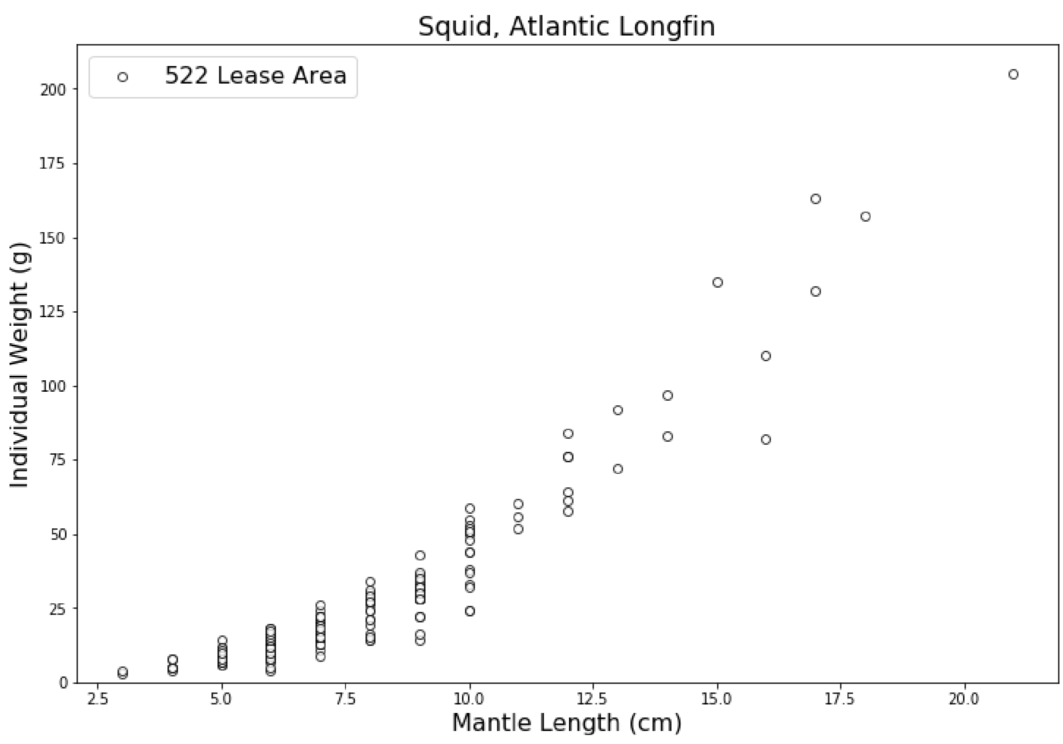


Figure 24: Population structure of longfin squid in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

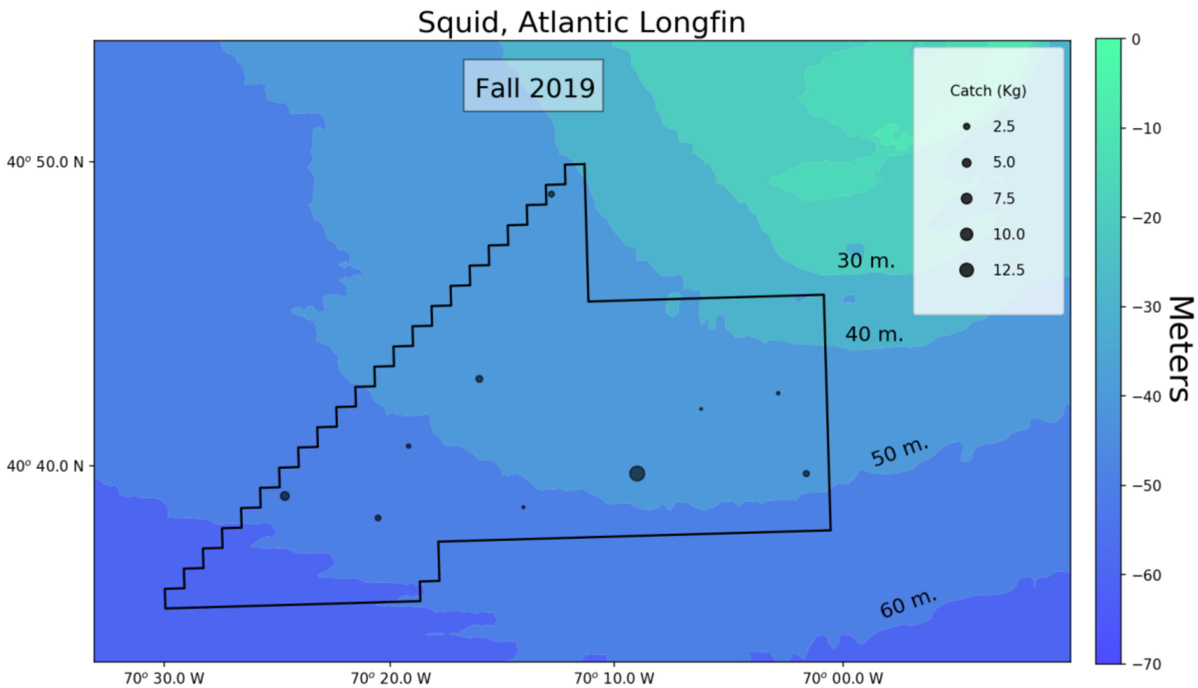
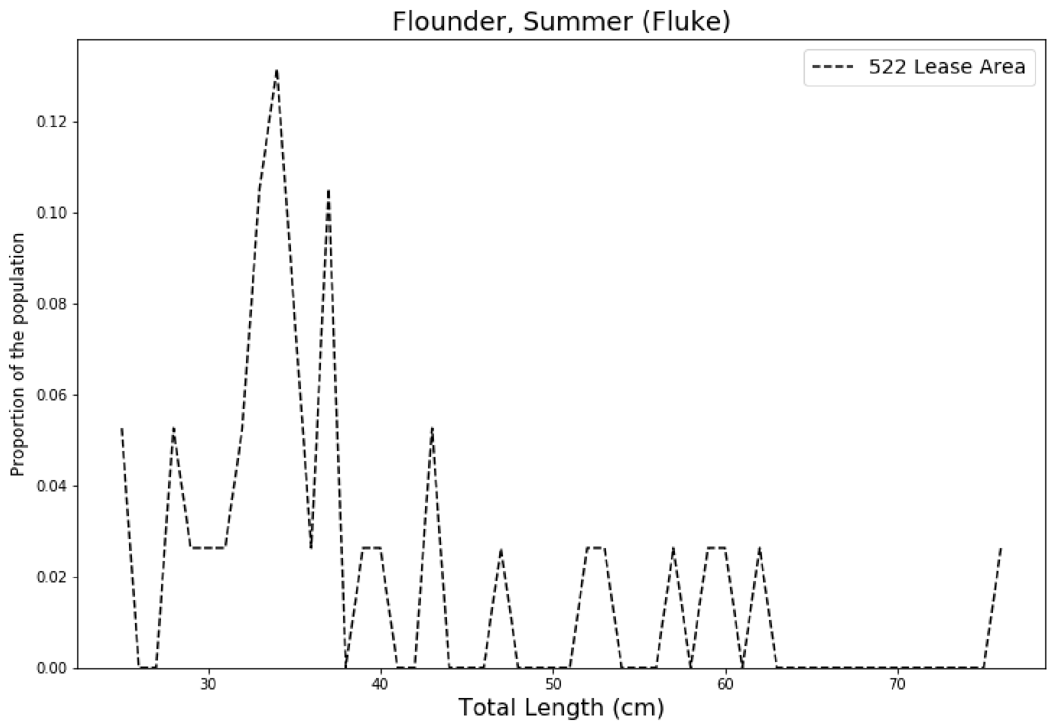


Figure 25: Distribution of the catch of longfin squid in the 522 Lease Area.



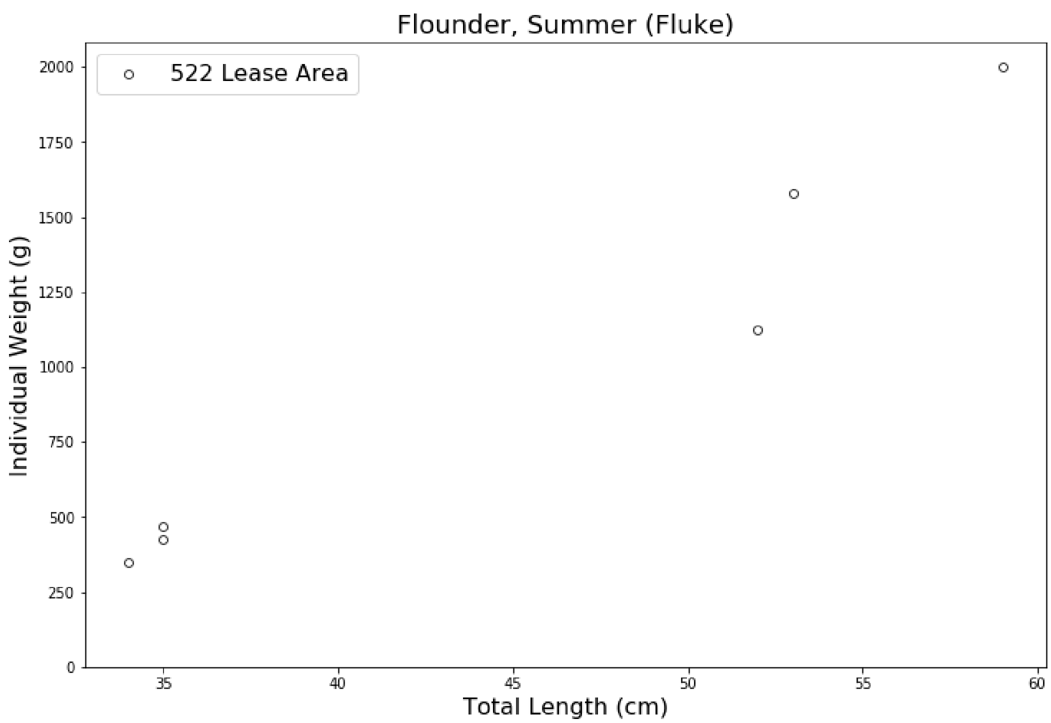


Figure 26: Population structure of summer flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

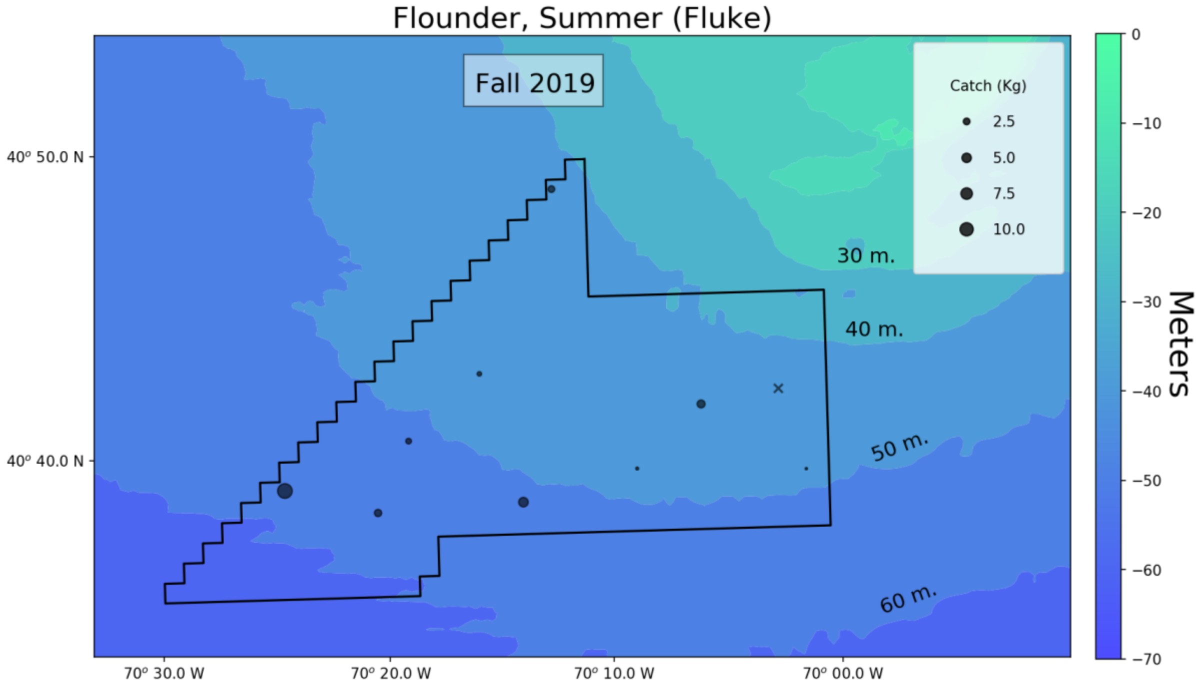


Figure 27: Distribution of the catch of summer flounder in the 522 Lease Area. Tows with zero catch are denoted with an X.

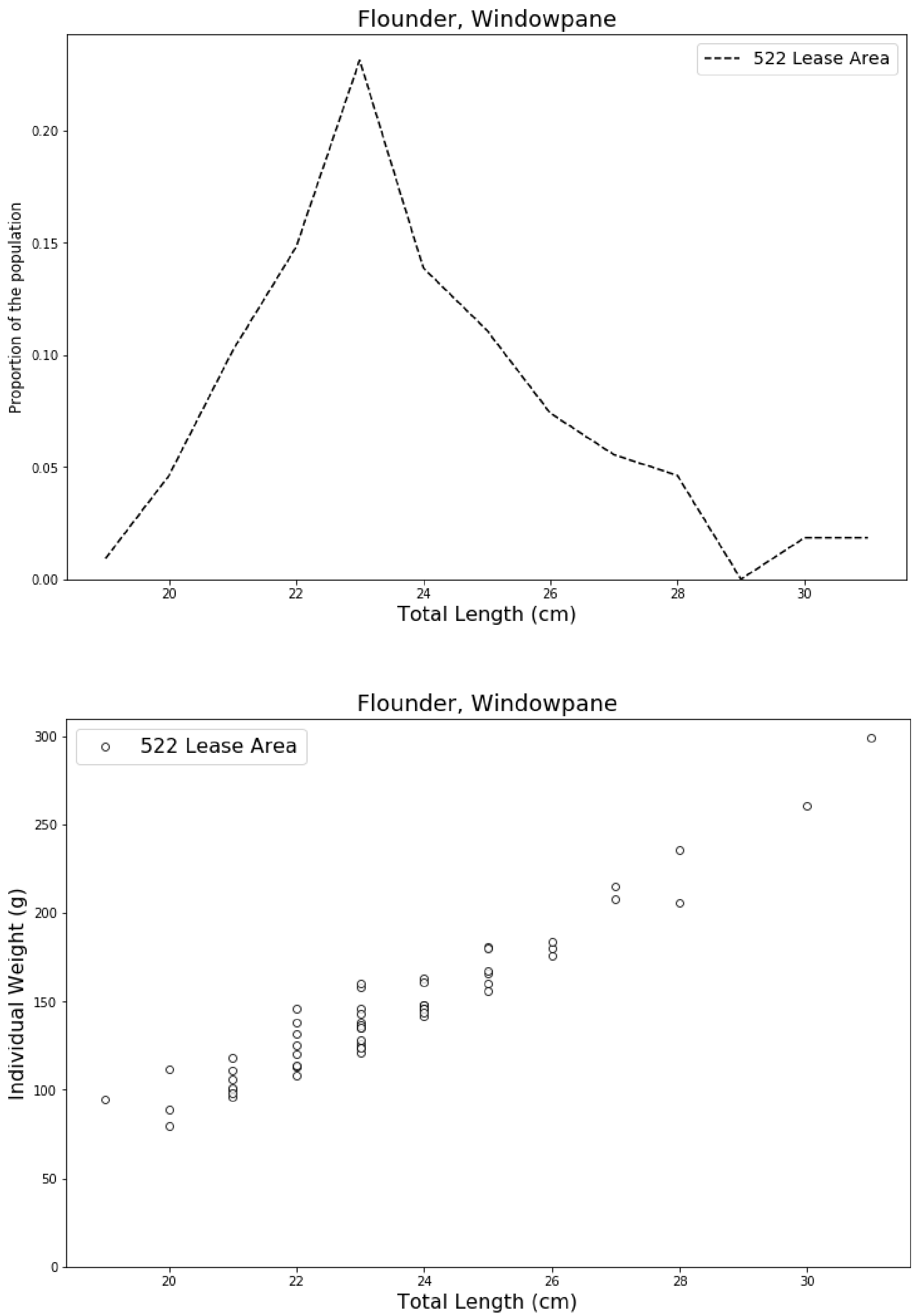


Figure 28: Population structure of windowpane flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

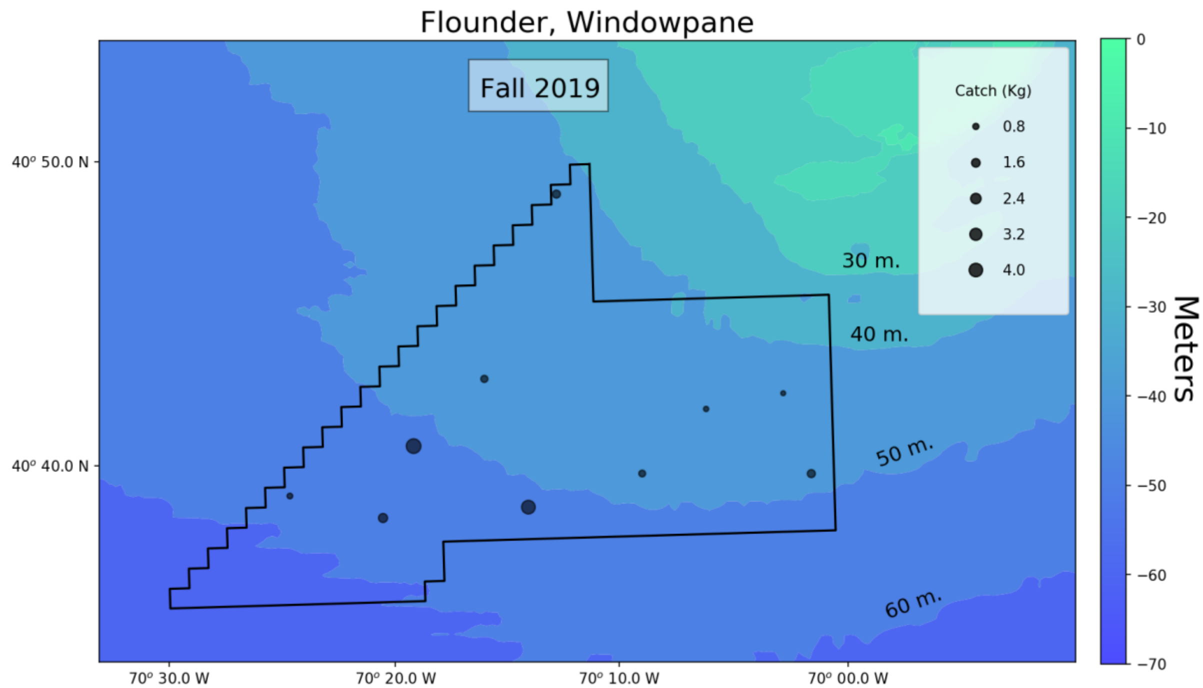


Figure 29: Distribution of the catch of windowpane flounder in the 522 Lease Area.

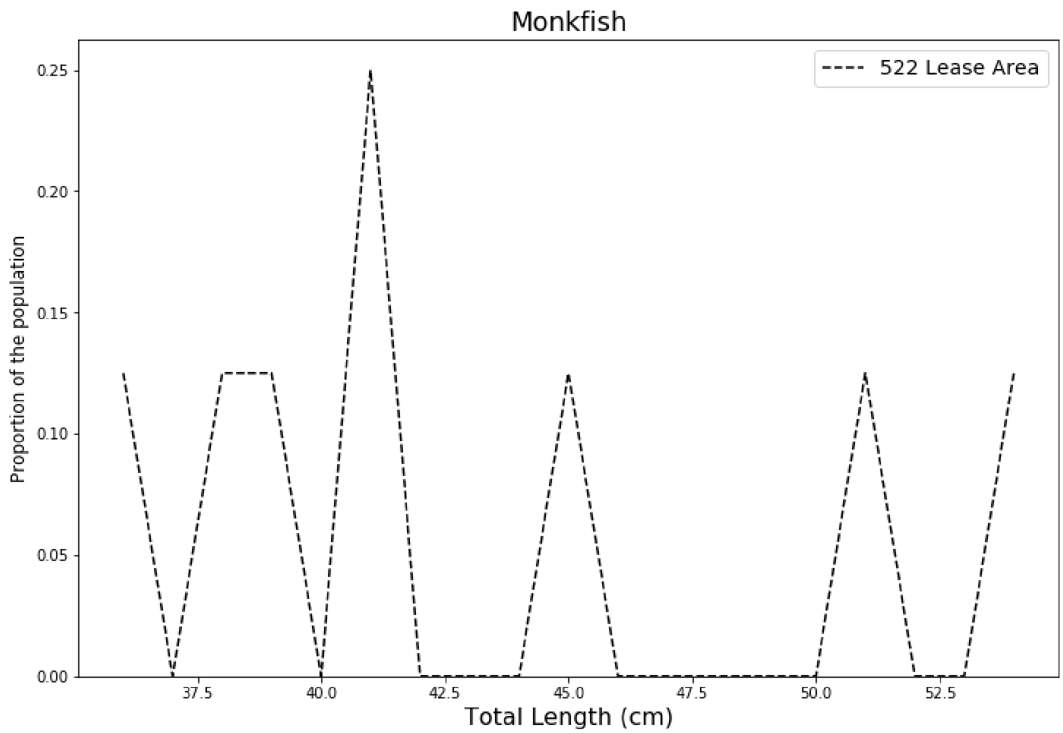


Figure 30: Population structure of monkfish in the 522 Lease Area as determined by the length-frequency data.

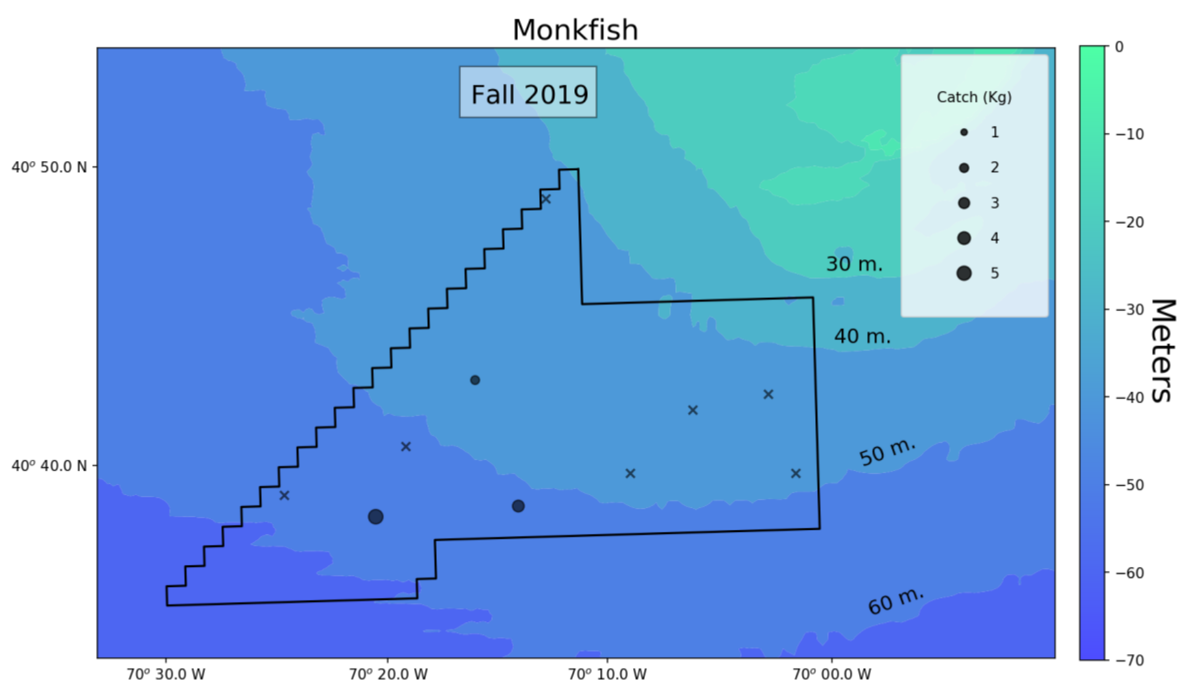


Figure 31: Distribution of the catch of monkfish in the 522 Lease Area. Tows with zero catch are denoted with an X.