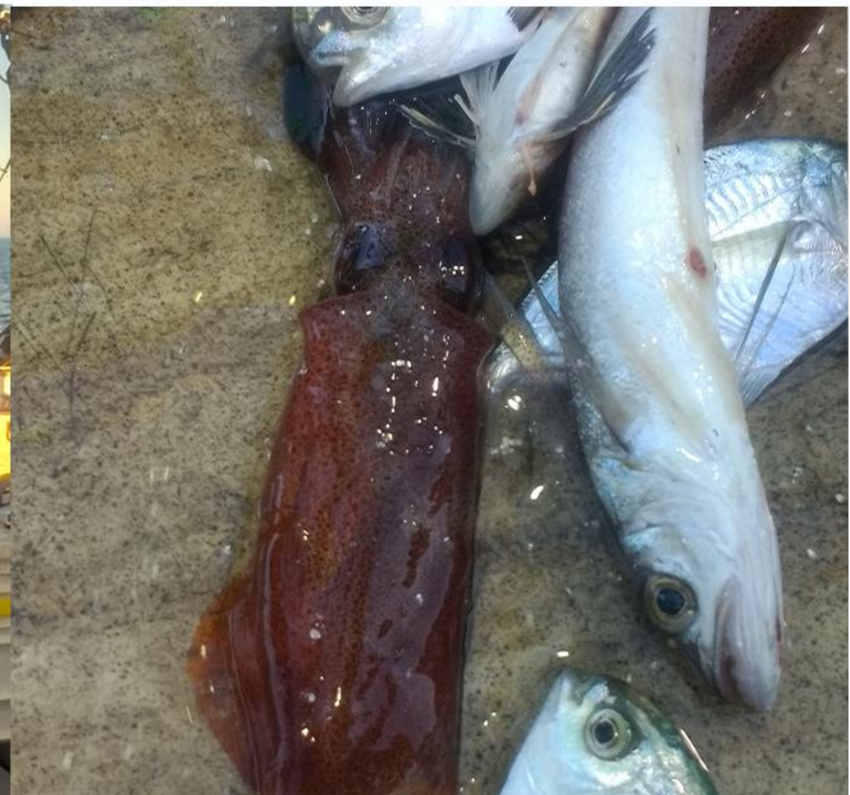
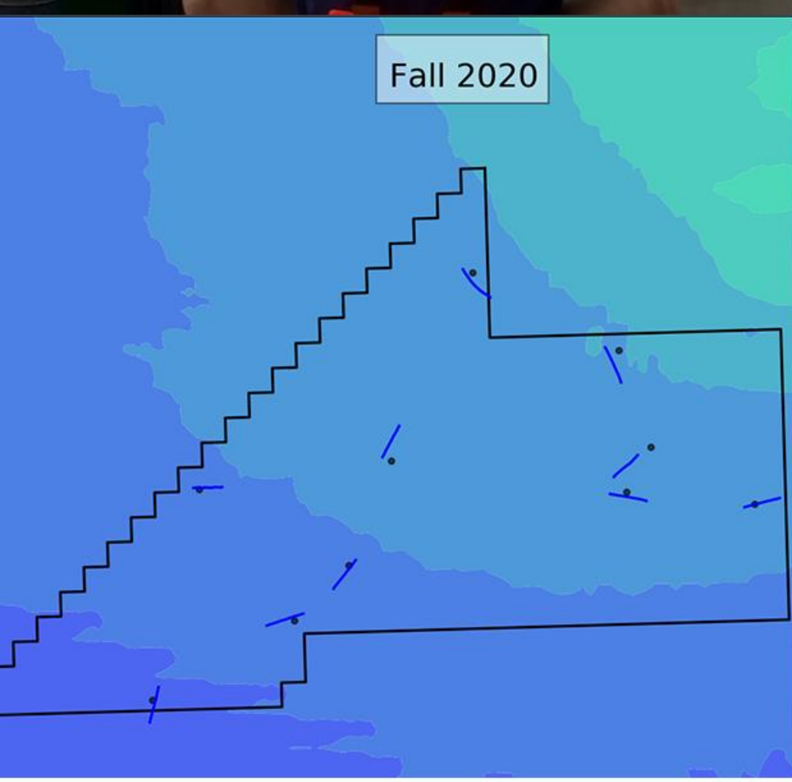
Vineyard Wind Demersal Trawl Survey





Quarterly Report

522 Lease Area

Fall 2020 (October - December)

VINEYARD WIND DEMERSAL TRAWL SURVEY

Fall 2020 Seasonal Report

522 Study Area

October 2020

Prepared for Vineyard Wind, LLC

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School for Marine Science and Technology

Vineyard Wind Demersal Trawl Survey Fall 2020 Seasonal Report

522 Study Area

Progress Report #6

October 1 – December 31, 2020

Project title: Vineyard Wind Demersal Trawl Survey Fall 2020 Seasonal Report – 522 Study Area

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SMAST-CE-REP-2020-096

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

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).

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 ~53.6 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 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 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 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 (November 18 – 23, 2020).

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. 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 (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 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 predominant 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 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 19.6 ± 1.5 minutes (mean ± one standard deviation). Tow distance averaged 1.0 ± 0.08 nautical miles (nmi) giving an average tow speed of 3.0 ± 0.2 knots.

The seafloor in the 522 Study 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 m along the southwestern boundary. Bottom water temperatures were relatively uniform throughout the 522 Study Area. Bottom water temperatures averaged 13.1 ± 0.7°C (range: 12.4 – 14.0°C, Table 2).

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 33.6 ± 1.5 m (range: 31.1 – 35.6 m). Wing spread averaged 13.6 ± 0.4 m (range: 13.1 – 14.2 m). Headline height averaged 5.1 ± 0.2 m (range: 4.7 – 5.3 m). All trawl parameters were within the acceptable tolerance limits.

3.2 Catch Data

In the 522 Study Area, a total of 28 species were caught over the duration of the survey (Table 3). Catch volume ranged from 36.5 kilograms per tow (kg/tow) to 3,824.6 kg/tow with an average of 608.4 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (spiny dogfish, scup, little skate, silver hake, and winter skate) accounted for 92.5% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Spiny dogfish (*Squalus acanthias*) was the predominant species observed, accounting for 63.8% of the total catch weight. Individuals ranged in length from 55 to 78 cm with a unimodal distribution peaking at 67 cm (Figure 8). Dogfish were observed in seven of the 10 tows. The catch rate averaged 378.6 ± 367.0 kg/tow (mean ± Standard Error of the Mean [SEM], range: 0 – 3,680.9 kg/tow). The catch of spiny dogfish appeared to follow the depth gradient with the highest catches observed in the southwestern corner of the 522 Study Area (Figure 9).

Scup (*Stenotomus chysops*) was the second most abundant species, accounting for 14% of the total catch weight. Individuals ranged in length from 7 to 29 cm with a narrow unimodal size distribution consisting of a peak at 22 cm (Figure 10). Scup were observed in five of the 10 tows at an average catch rate of 91.3 ± 43.7 kg/tow (range: 0 – 378.5 kg/tow). Similar to spiny dogfish, scup appeared to follow the depth gradient with the highest catches observed in the southwestern corner of the 522 Study Area (Figure 11).

Little skate (*Leucoraja erinacea*) was the third most abundant species observed, accounting for 8.4% of the total catch weight. Individuals ranged in length from 12 to 31 cm with a unimodal size distribution consisting of a peak at 26 cm (Figure 12). Little skate were observed in all 10 tows. Catch rates averaged 53.1 ± 12.4 kg/tow (range: 6.7 – 105.6 kg/tow). Little skate were observed throughout the 522 Study Area (Figure 13).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was regularly caught in the 522 Study Area. Individuals ranged in length from 12 to 35 cm. Silver hake had a narrow unimodal size distribution consisting of a peak at 23 cm (Figure 14) and were observed in all 10 tows at an average catch rate of 26.8 ± 6.9 kg/tow (range: 3.9 – 68.4 kg/tow). The catch of silver hake was distributed across the 522 Study Area (Figure 15).

Winter skate (*Leucoraja ocellata*) was commonly caught in the 522 Study Area. Individuals ranged in size from 25 to 56 cm (Figure 16). Winter skate were observed in nine of the 10 tows at an average catch rate of 12.0 ± 3.9 kg/tow (range: 0 – 33.5 kg/tow). The catch of winter skate appeared to follow the depth gradient in the 522 Study Area with catch increasing with depth (Figure 17).

Butterfish (*Peprilus triacanthus*) ranged in length from 5 to 17 cm with a unimodal size distribution consisting of a peak at 8 cm (Figure 18). Butterfish were observed in all 10 tows at an average catch rate of 11.9 ± 3.0 kg/tow (range: 2.7 – 31.5 kg/tow). Butterfish were caught throughout the 522 Study Area with the highest catches observed in the northeastern corner (Figure 19).

Northern sea robin (*Prionotus carolinus*) was observed in seven of the 10 tows in the 522 Study Area. Individuals ranged in length from 11 to 30 cm with a majority of individuals between 20 and 28 cm (Figure 20). The average catch rate of northern sea robins was 10.2 ± 5.3 kg/tow (range: 0 – 51.6 kg/tow). Northern sea robins were caught throughout the 522 Study Area with higher catches observed in the southwestern corner of the development area (Figure 21).

Red hake (*Urophycis chuss*) was one of the dominant species in the 2019/2020 survey year. During this fall survey, the catch of red hake was common but at low abundances. Individuals ranged in length from 18 to 46 cm with a unimodal size distribution peaking at 24 cm (Figure 22). Red hake were observed in five of the 10 tows at an average catch rate of 5.1 ± 2.5 kg/tow (range: 0 – 23.1 kg/tow). Red hake were primarily observed in the deeper tows in the southwestern corner of the 522 Study Area (Figure 23).

Spotted hake (*Urophycis regia*), a congener of red hake, was observed in eight of the 10 tows. Individuals ranged in length from 17 to 40 cm with a unimodal size distribution peaking at 20 cm (Figure 24). Spotted hake had an average catch rate of 4.9 ± 2.2 kg/tow (range: 0 – 23.2 kg/tow). Spotted hake were caught throughout the 522 Study Area (Figure 25).

Windowpane flounder (*Scophtalmus aquosus*) is a federally regulated commercial flatfish species found in the 522 Study Area. Individuals ranged in length from 18 to 31 cm with a unimodal size distribution peaking at 22 cm (Figure 26). Windowpane flounder were observed in nine of the 10 tows at an average catch rate of 2.4 ± 0.5 kg/tow (range: 0 – 5.2 kg/tow). Windowpane flounder were caught throughout the 522 Study Area (Figure 27).

Atlantic longfin squid (*Dorytheuthis pealei*) is a commercially important species commonly referred to as loligo squid. Individuals ranged in length from 2 to 27 cm (mantle length) with a unimodal size distribution peaking at 10 cm (Figure 28). Atlantic longfin squid were observed in all 10 tows at an average catch rate of 2.3 ± 0.5 kg/tow (range: 1.1 – 5.6 kg/tow). Atlantic longfin squid were caught throughout the 522 Study Area (Figure 29). No squid “mops” were observed during this survey.

Summer flounder (*Paralichthys dentatus*) is a commercially important flatfish species commonly referred to as fluke. Individuals ranged in length from 26 to 65 cm with a broad size distribution (Figure 30). Summer flounder were observed in eight of the 10 tows at an average catch rate of 1.5 ± 0.4 kg/tow (range: 0 – 4.0 kg/tow). The catch of summer flounder was scattered around the 522 Study Area (Figure 31).

Fourspot flounder (*Paralichthys oblongus*) ranged in length from 17 to 38 cm with a wide size distribution (Figure 32). Fourspot flounder were observed in eight of the 10 tows at an average catch rate of 1.2 ± 0.3 kg/tow (range: 0 – 2.3 kg/tow). Fourspot flounder were caught throughout the 522 Study Area (Figure 33).

Black sea bass (*Centropristis striata*) is another commercially important species commonly observed in the 522 Study Area. Individuals ranged in length from 9 to 37 cm with a peak in the size distribution at 28 cm (Figure 34). Black sea bass were observed in eight of the 10 tows at an average catch rate of 0.6 ± 0.2 kg/tow (range: 0 – 1.4 kg/tow). Black sea bass were caught throughout the 522 Study Area with higher catches observed in the southwestern corner (Figure 35).

Less common recreational and commercial species observed included 11 bluefish (*Pomotomus saltatrix*, size range: 38 – 49 cm), five weakfish (*Cynoscion regalis*, size range: 32 – 45 cm), three monkfish (*Lophius americanus*, 50, 50, 66 cm), one Atlantic Sea scallop (*Placopecten* magellanicus), and one northern kingfish (*Menticirrchus saxatilis*, 25 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 Altan Ernesti (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	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	11/21/2020	Clear	7-10	W	0.5-1.25	11:46	N 40° 41.253	W 70° 22.127	28	12:01	N 40° 41.261	W 70° 21.129	28	100
2	11/21/2020	Partly Cloudy	7-10	W	0.5-1.25	13:06	N 40° 35.939	W 70° 23.455	32	13:26	N 40° 35.988	W 70° 23.771	33	125
3	11/21/2020	Partly Cloudy	7-10	W	0.5-1.25	14:30	N 40° 37.544	W 70° 19.614	31	14:50	N 40° 37.846	W 70° 18.345	30	125
4	11/21/2020	Partly Cloudy	3-6	W	0.5-1.25	15:44	N 40° 38.516	W 70° 17.253	29	16:04	N 40° 39.270	W 70° 16.461	28	100
5	11/22/2020	Overcast	16-20	NE	1.25-2.5	6:32	N 40° 40.738	W 70° 01.578	25	6:52	N 40° 40.515	W 70° 02.792	25	100
6	11/22/2020	Mostly Cloudy	16-20	NE	1.25-2.5	7:36	N 40° 40.730	W 70° 06.256	24	7:56	N 40° 40.927	W 70° 07.503	25	100
7	11/22/2020	Partly Cloudy	16-20	NE	1.25-2.5	8:27	N 40° 41.391	W 70° 07.352	25	8:47	N 40° 41.947	W 70° 06.525	24	100
8	11/22/2020	Mostly Cloudy	16-20	NE	1.25-2.5	9:19	N 40° 43.924	W 70° 07.063	23	9:39	N 40° 44.859	W 70° 07.598	21	100
9	11/22/2020	Mostly Cloudy	16-20	NE	1.25-2.5	10:13	N 40° 46.252	W 70° 11.629	23	10:33	N 40° 46.069	W 70° 12.556	23	100
10	11/22/2020	Mostly Cloudy	16-20	NE	1.25-2.5	11:24	N 40° 42.820	W 70° 14.893	25	11:44	N 40° 42.015	W 70° 15.473	25	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. (^{o}C)	Headline Height (m.)	Wing Spread (m.)	Spread Door (m.)
1	15.5	0.8	3.1	28	14.0	5.0	13.8	34.4
2	20.5	1.0	2.9	32		4.7	14.0	35.6
3	20.1	1.0	3.1	31	13.9	4.7	13.9	35.3
4	20.0	1.0	2.9	29	13.9	5.0	13.4	32.9
5	20.0	1.0	2.9	25	12.6	5.3	13.5	33.0
6	20.0	1.0	3.0	24	12.5	5.3	13.1	32.3
7	19.8	0.9	2.7	25	12.4	5.1	14.2	35.2
8	20.3	1.0	3.1	23		5.2	13.5	32.3
9	19.8	1.1	3.3	23	12.9	5.3	13.1	31.1
10	20.1	0.9	2.8	25	12.8	4.9	13.9	34.0
Summary Statistics								
Minimum	15.5	0.8	2.7	23	12.4	4.7	13.1	31.1
Maximum	20.5	1.1	3.3	32	14.0	5.3	14.2	35.6
Average	19.6	1.0	3.0	26.5	13.1	5.1	13.6	33.6
St. Dev	1.5	0.08	0.2	3.3	0.7	0.2	0.4	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)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Dogfish, Spiny	*Squalus acanthias*	3873.8	378.6	367.0	63.8	7
Scup	*Stenotomus chrysops*	852.9	91.3	43.7	14.0	5
Skate, Little	*Leucoraja erinacea*	511.6	53.1	12.4	8.4	10
Hake, Silver (Whiting)	*Merluccius bilinearis*	260.1	26.8	6.9	4.3	10
Skate, Winter	*Leucoraja ocellata*	118.4	12.0	3.9	1.9	9
Butterfish	*Peprilus triacanthus*	117.9	11.9	3.0	1.9	10
Northern Sea Robin	*Prionotus carolinus*	99.2	10.2	5.3	1.6	7
Hake, Red	*Urophycis chuss*	49.0	5.1	2.5	0.8	5
Hake, Spotted	*Urophycis regia*	48.7	4.9	2.2	0.8	8
Flounder, Windowpane	*Scophtalmus aquosus*	22.9	2.4	0.5	0.4	9
Squid, Atlantic Longfin	*Dorytheuthis pealei*	22.7	2.3	0.5	0.4	10
Herring, Atlantic	*Clupea harengus*	19.3	1.9	1.7	0.3	2
Flounder, Summer (Fluke)	*Paralichthys dentatus*	14.6	1.5	0.4	0.2	8
Bluefish	*Pomatomus saltatrix*	13.6	1.4	1.4	0.2	1
Flounder, Fourspot	*Paralichthys oblongus*	11.5	1.2	0.3	0.2	8
Monkfish	*Lophius americanus*	9.9	1.0	0.6	0.2	3
Black Sea bass	*Centropristis striata*	5.3	0.6	0.2	0.1	8
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	5.0	0.5	0.2	0.1	5
Skate, Barndoor	*Dipturus laevis*	4.0	0.4	0.1	0.1	7
Hake, White	*Urophycis tenuis*	3.2	0.3	0.3	0.1	1
Shad, American	*Alosa sapidissima*	2.9	0.3	0.2	0.0	4
Weakfish	*Cynoscion regalis*	2.8	0.3	0.2	0.0	3
Crab, Rock	*Cancer irroratus*	1.9	0.2	0.1	0.0	5
Flounder, Gulfstream	*Citharichthys arctifrons*	1.4	0.1	0.1	0.0	4
Eel, Conger	*Conger oceanicus*	0.6	0.1	0.1	0.0	1
Kingfish, Northern	*Menticirrhus saxatilis*	0.4	0.04	0.04	0.0	1
Sea Scallop	*Placopecten magellanicus*	0.1	0.01	0.01	0.0	1
Alewife	*Alosa pseudoharengus*	0.1	0.01	0.01	0.0	1
Total		6073.9				

*SEM is an acronym for Standard Error of the Mean

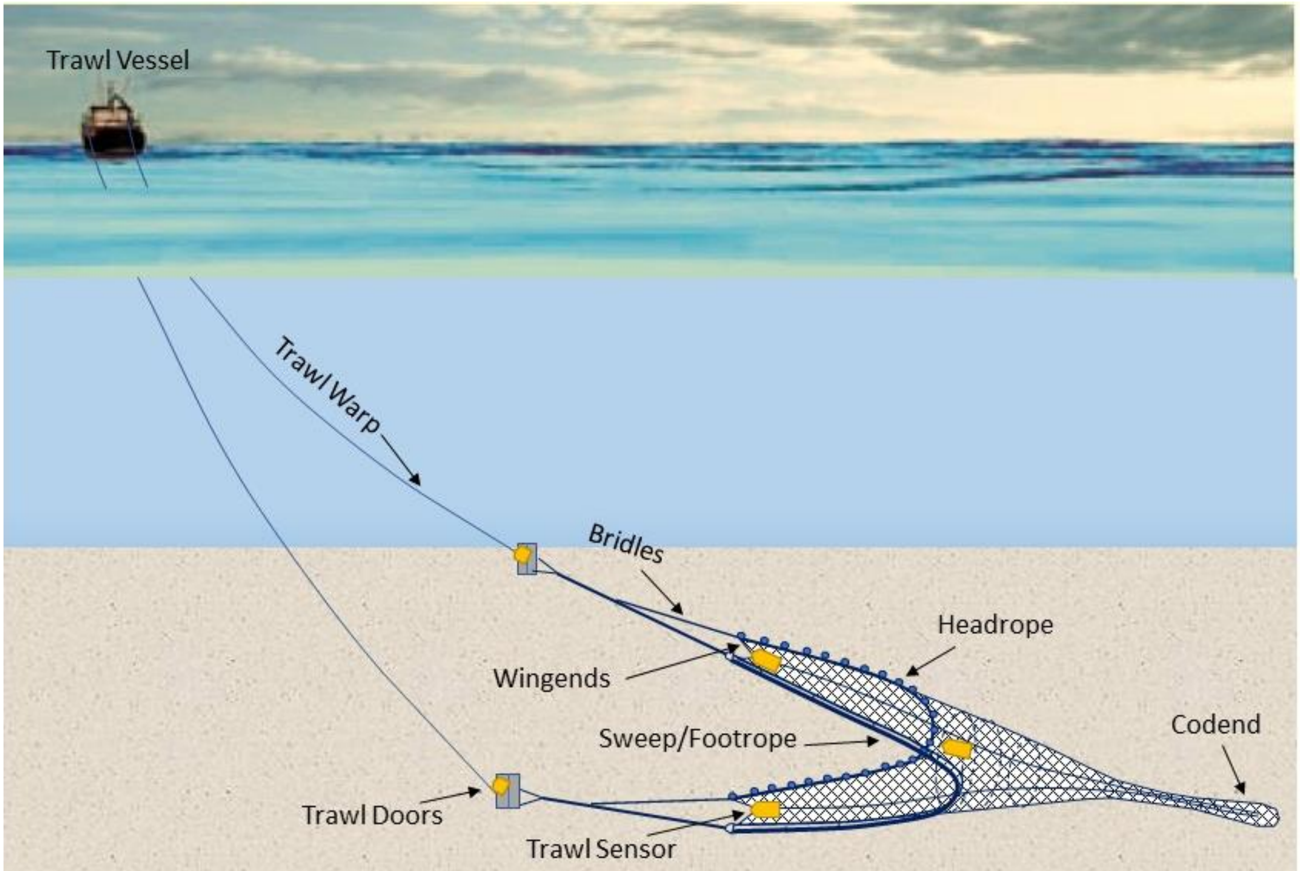


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

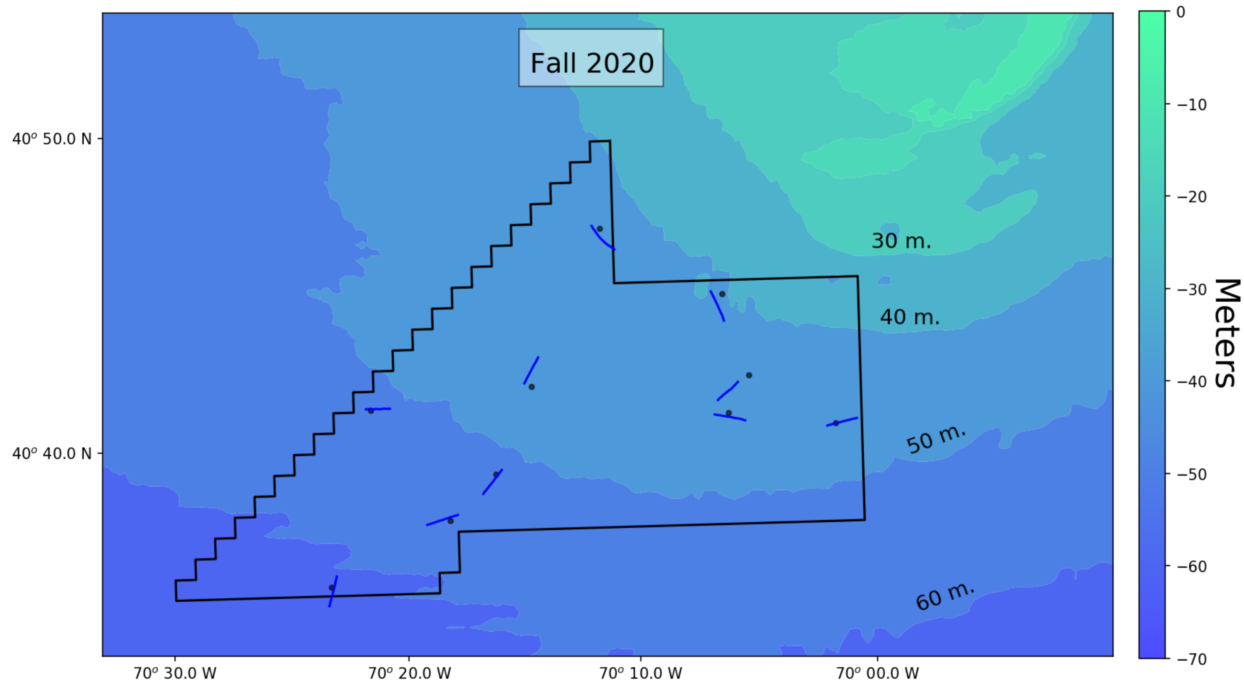


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Study Area.

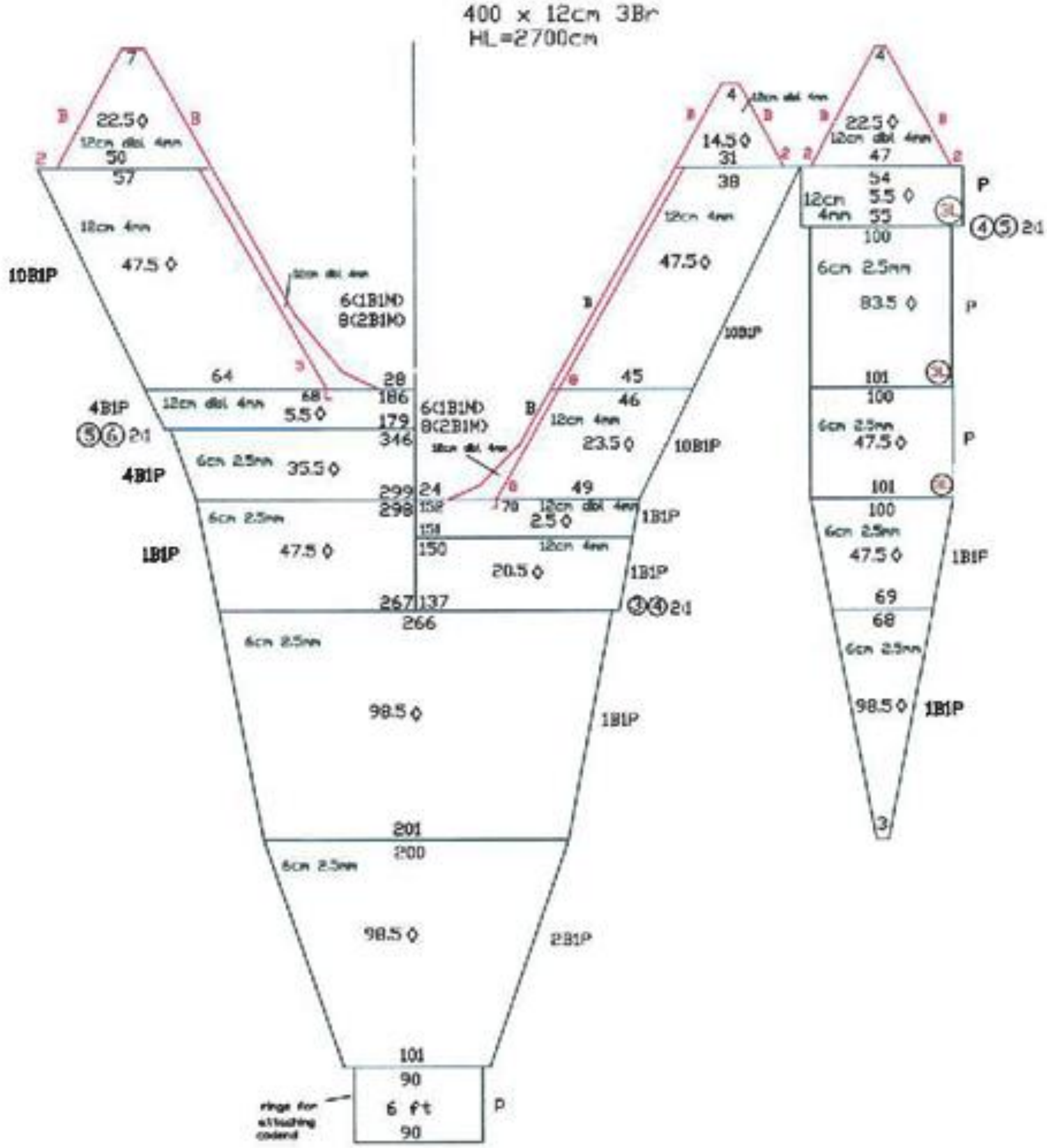


Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al., 2008)

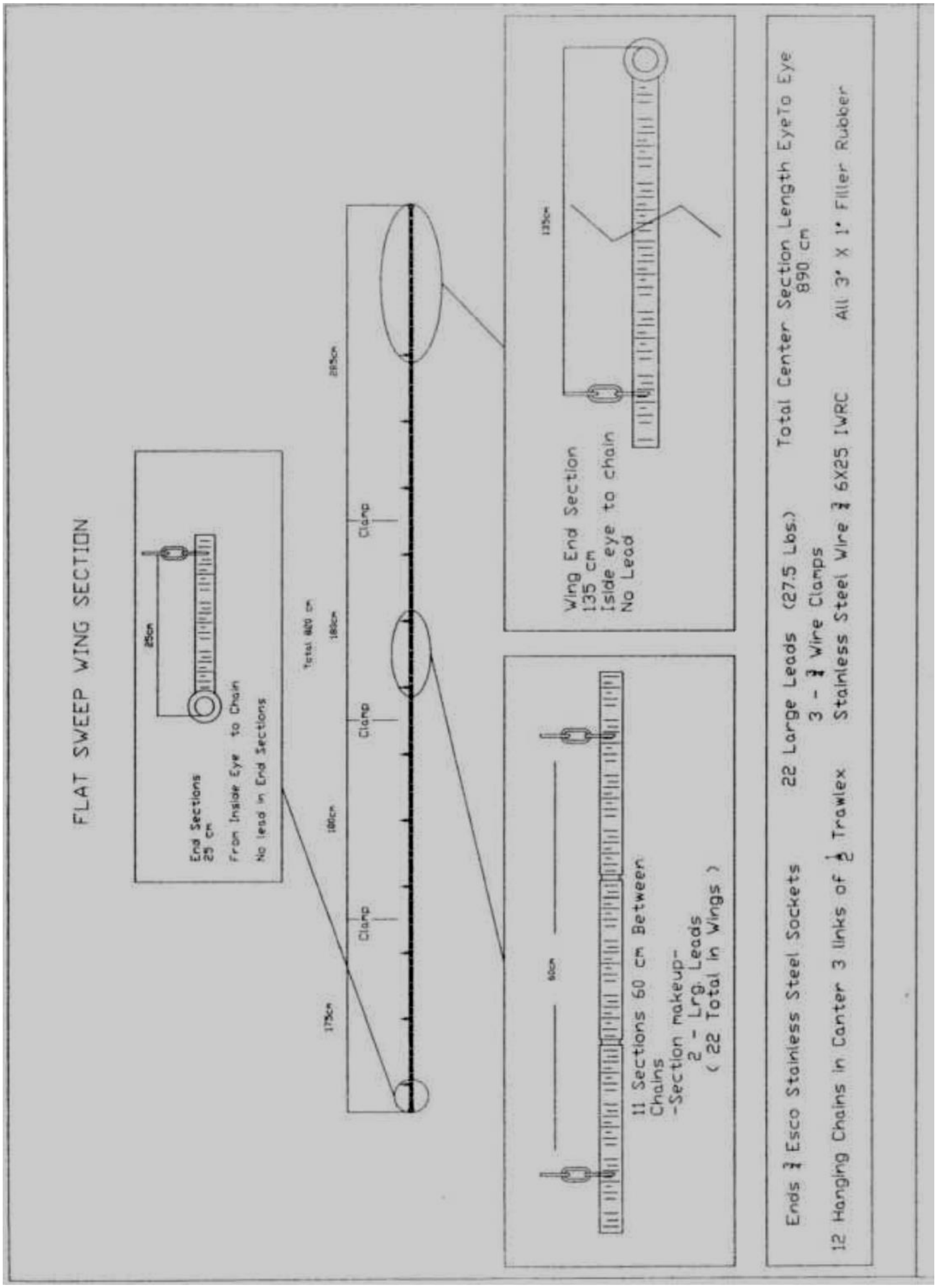


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

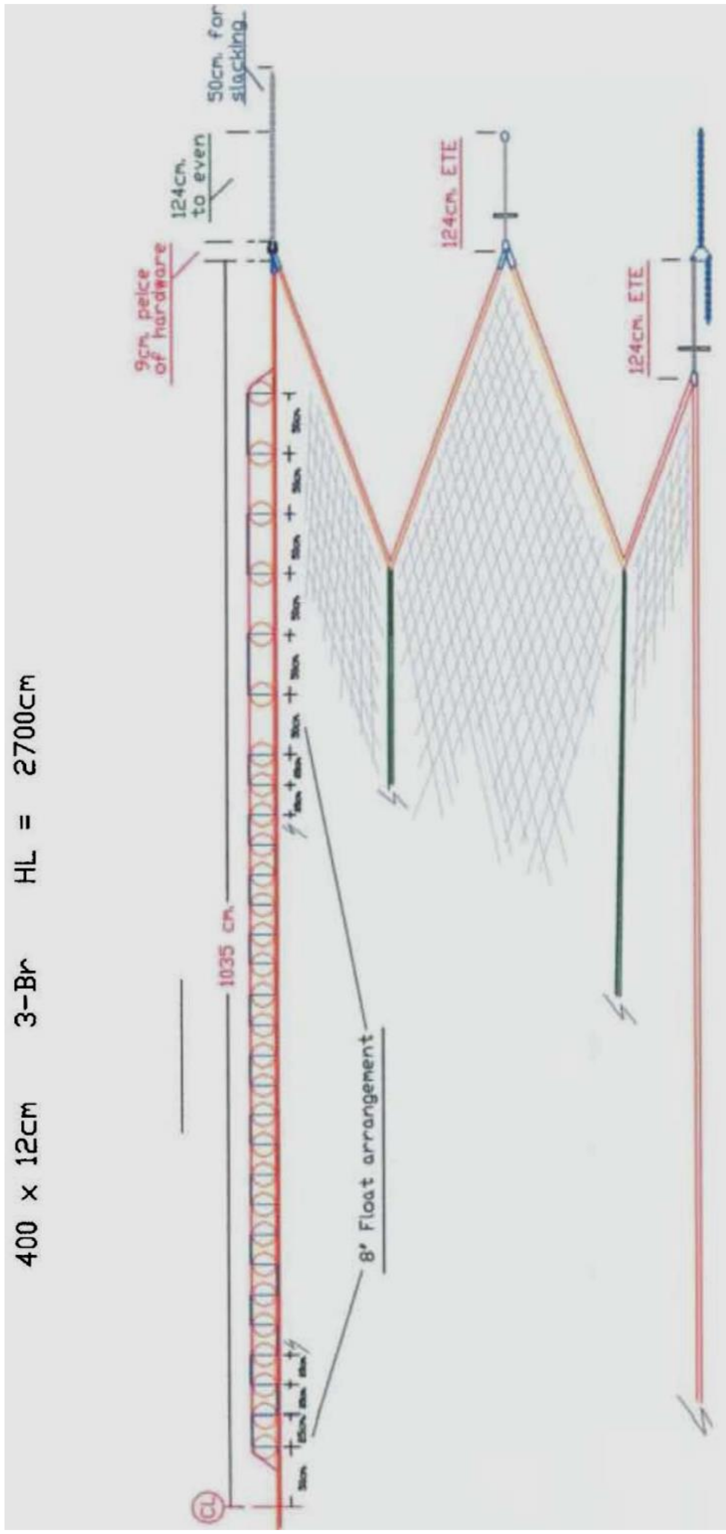


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008)

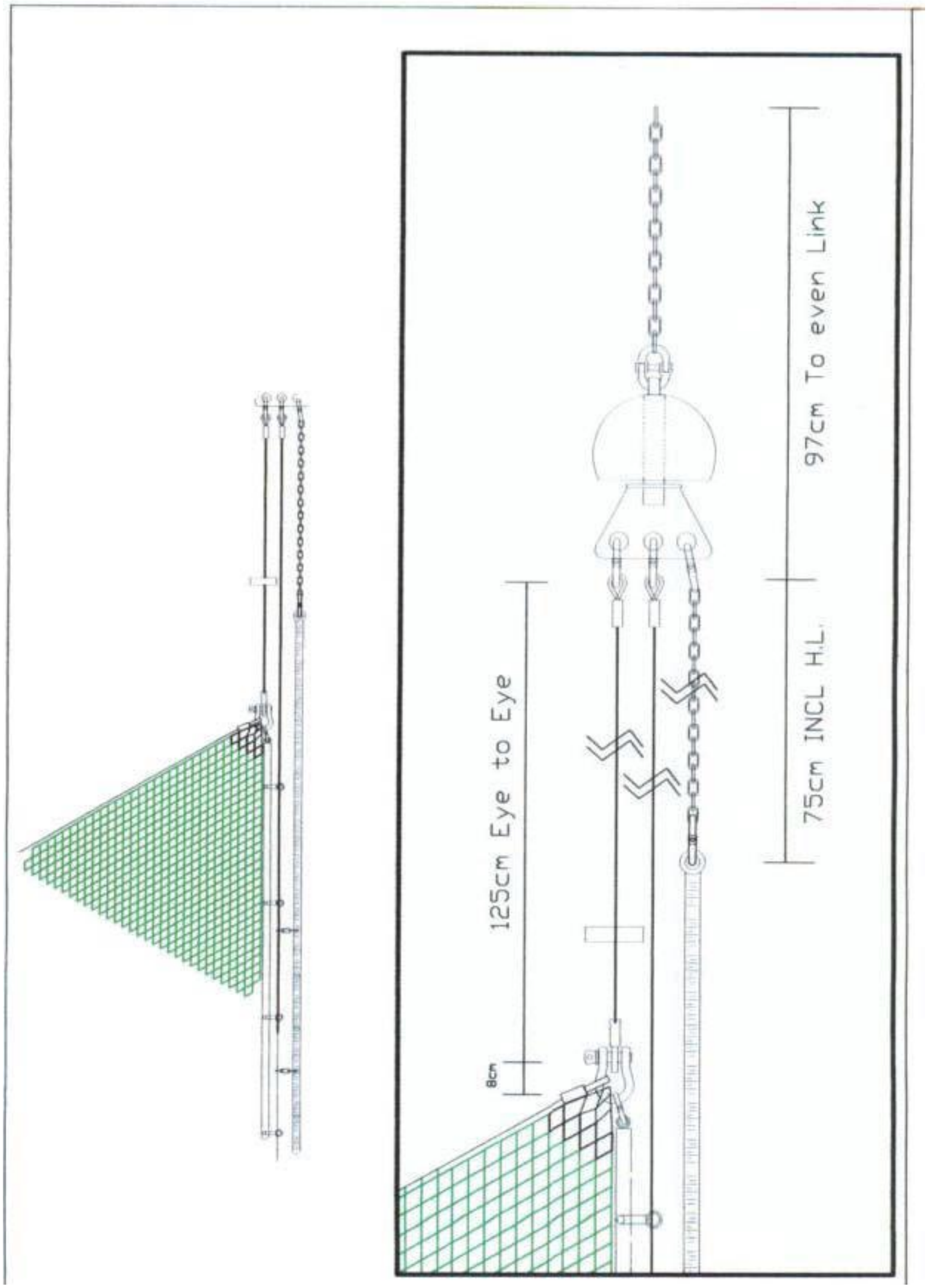


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al., 2008).

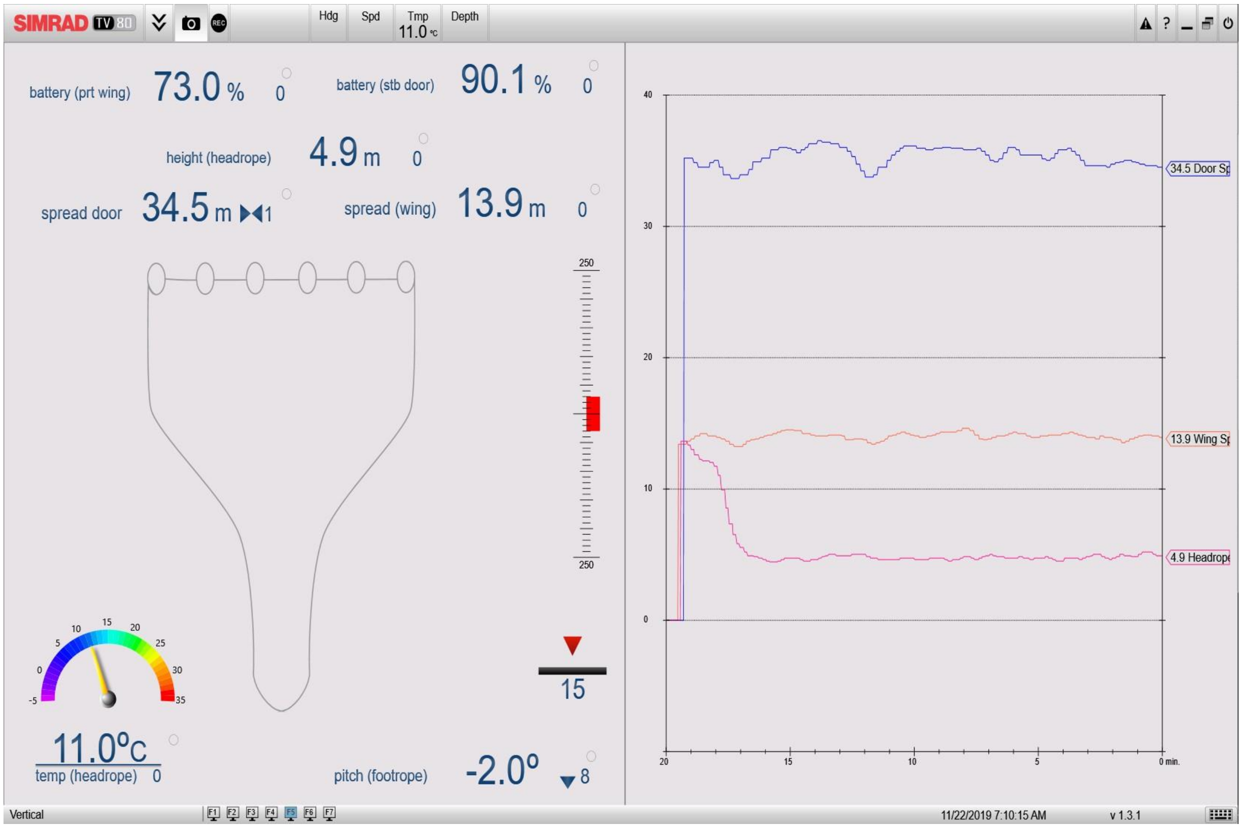


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.

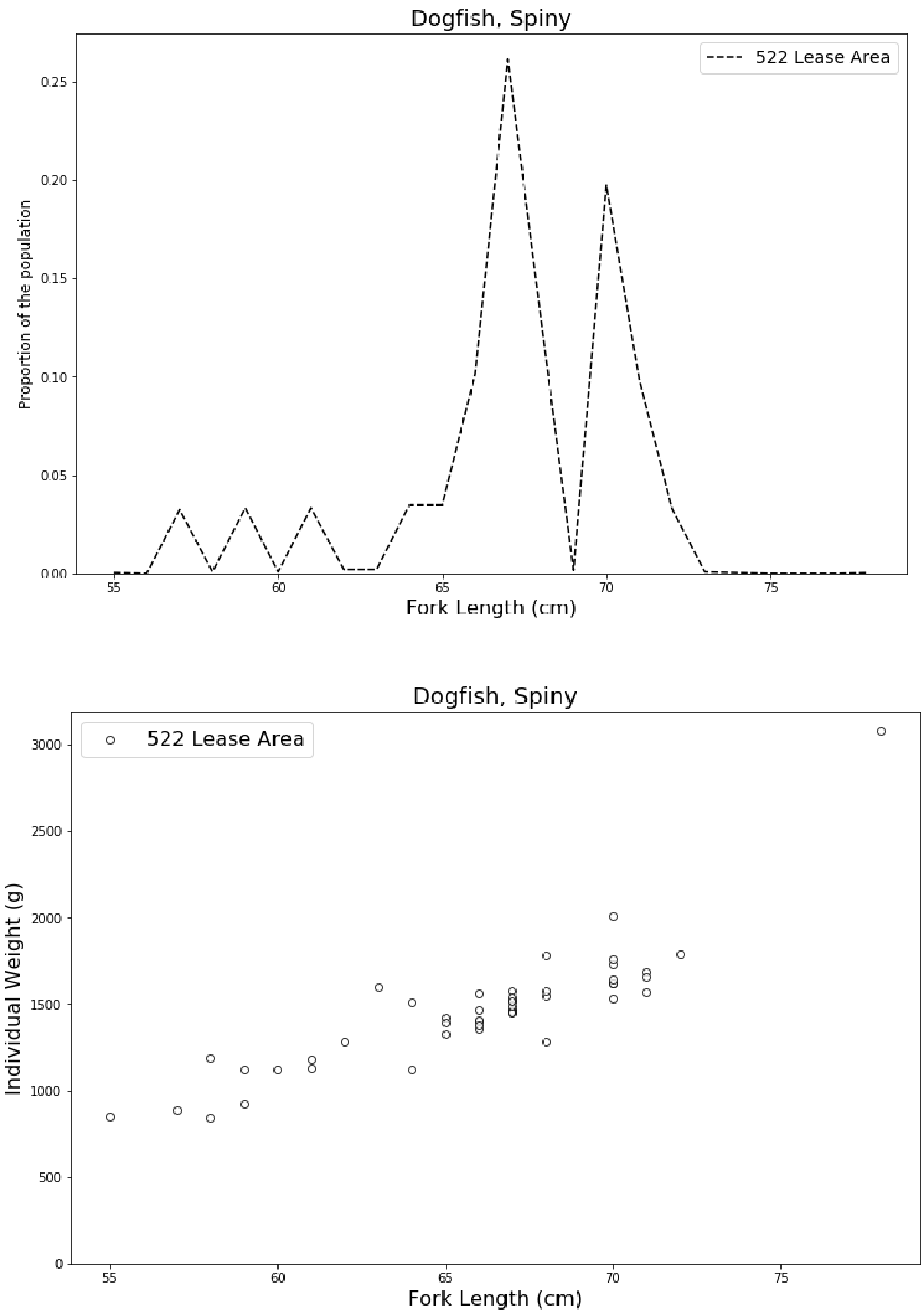


Figure 8: Population structure of spiny dogfish in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

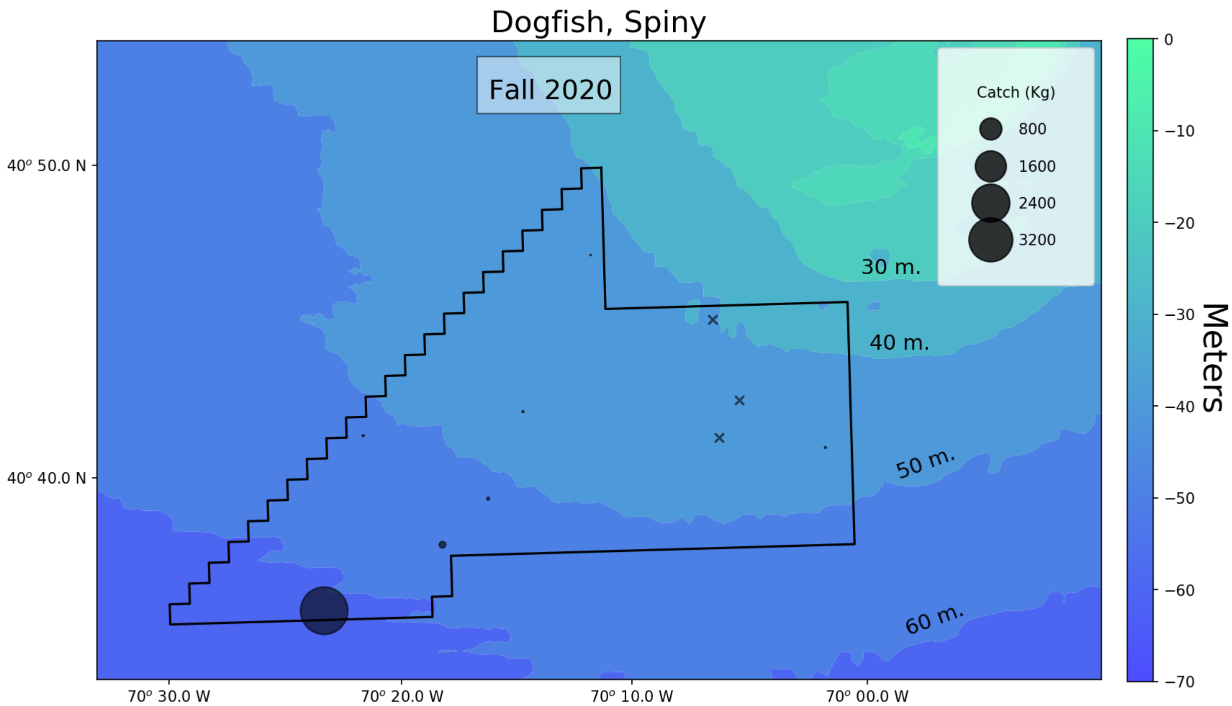


Figure 9: Distribution of the catch of spiny dogfish in the 522 Study Area. Tows with zero catch are denoted with an x.

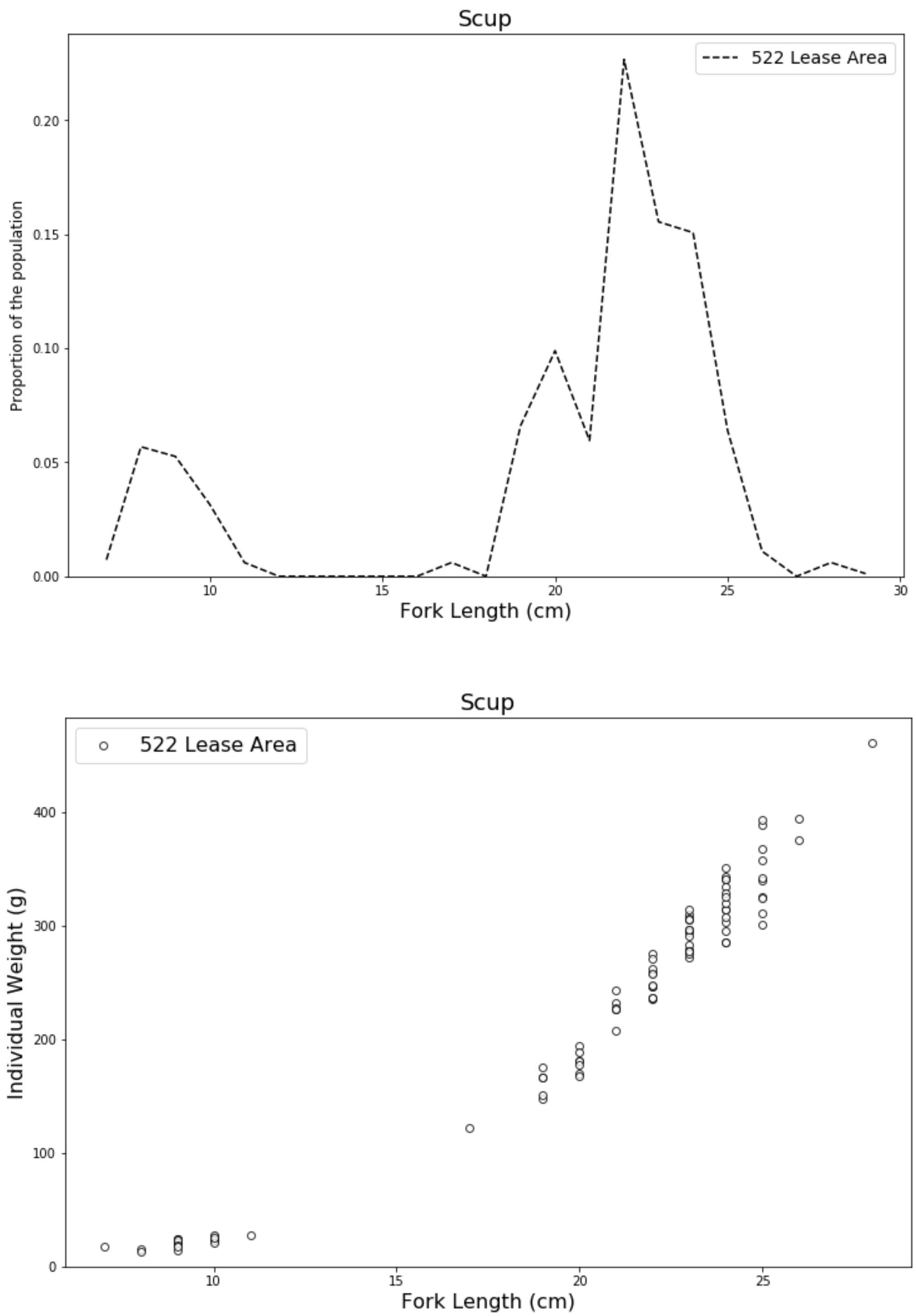


Figure 10: Population structure of scup in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

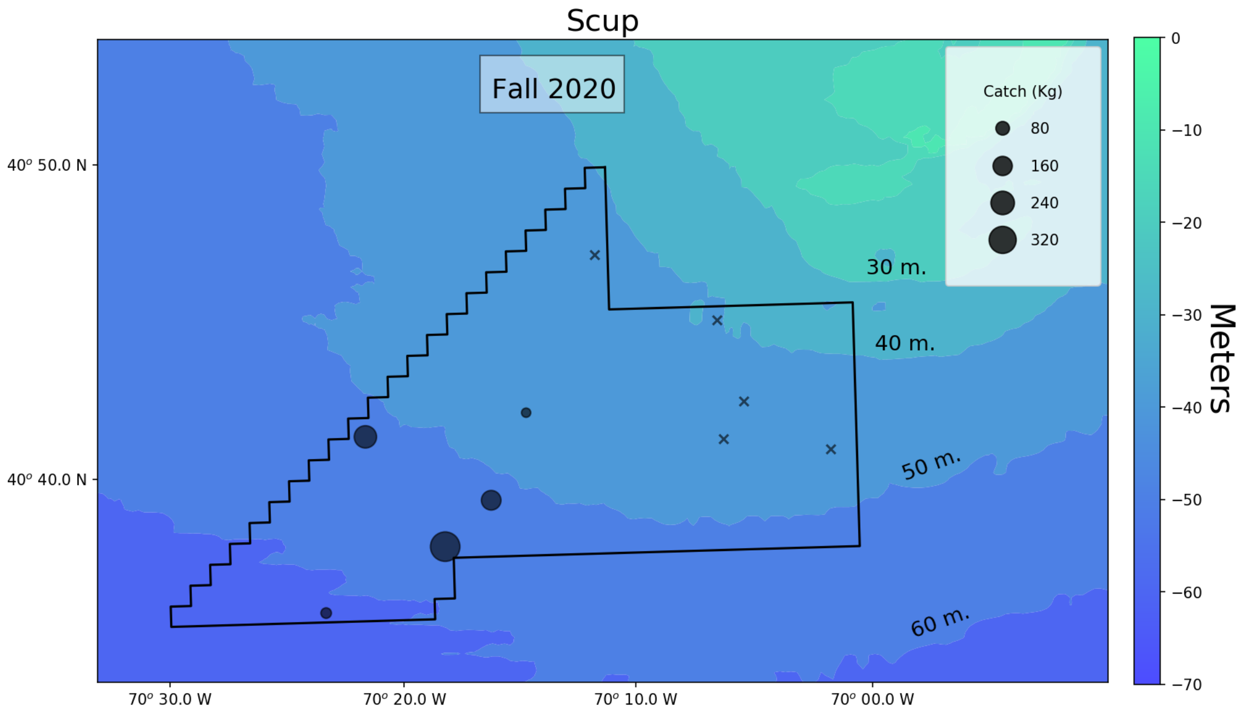


Figure 11: Distribution of the catch of scup in the 522 Study Area. Tows with zero catch are denoted with an x.

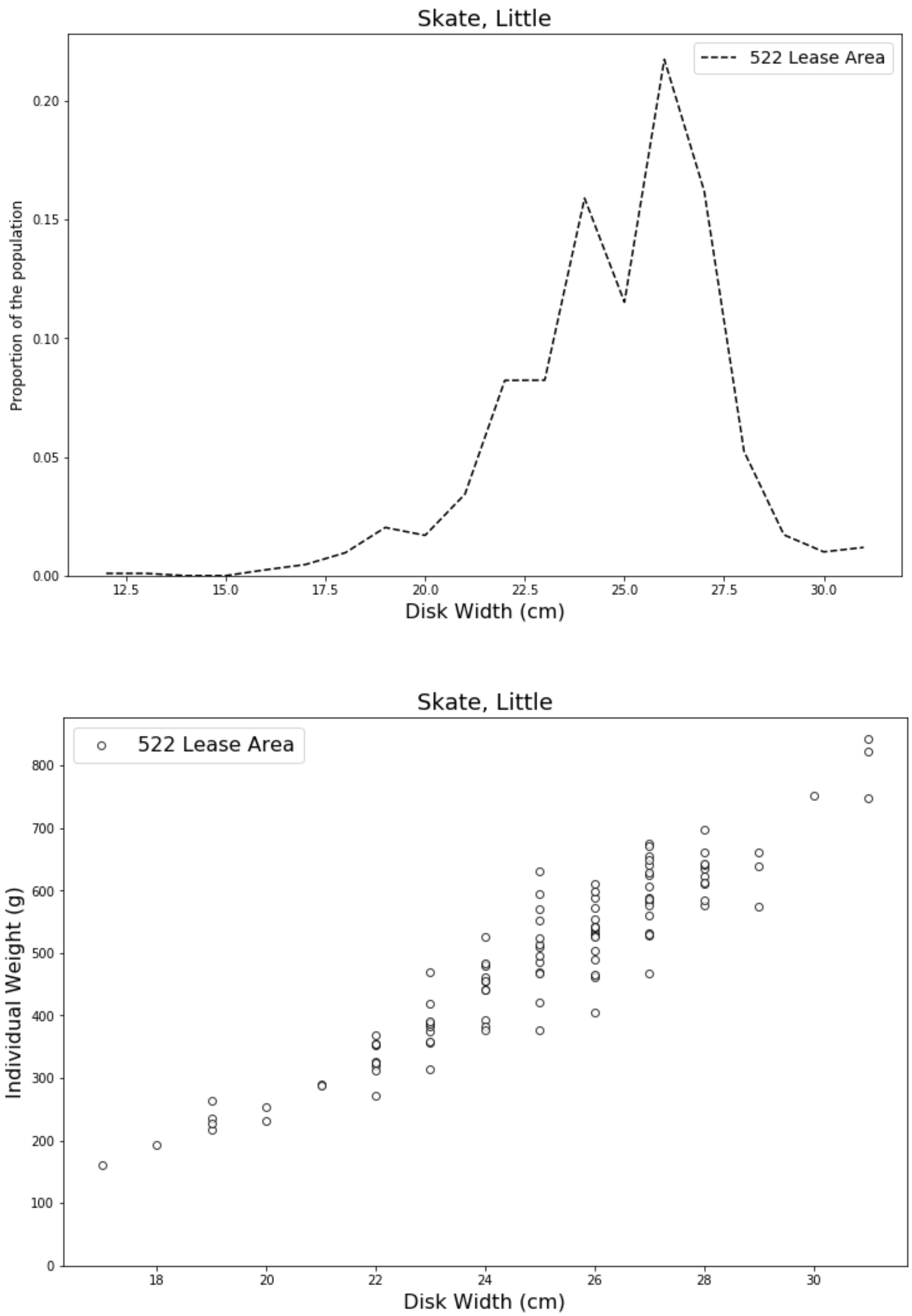


Figure 12: Population structure of little skate in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

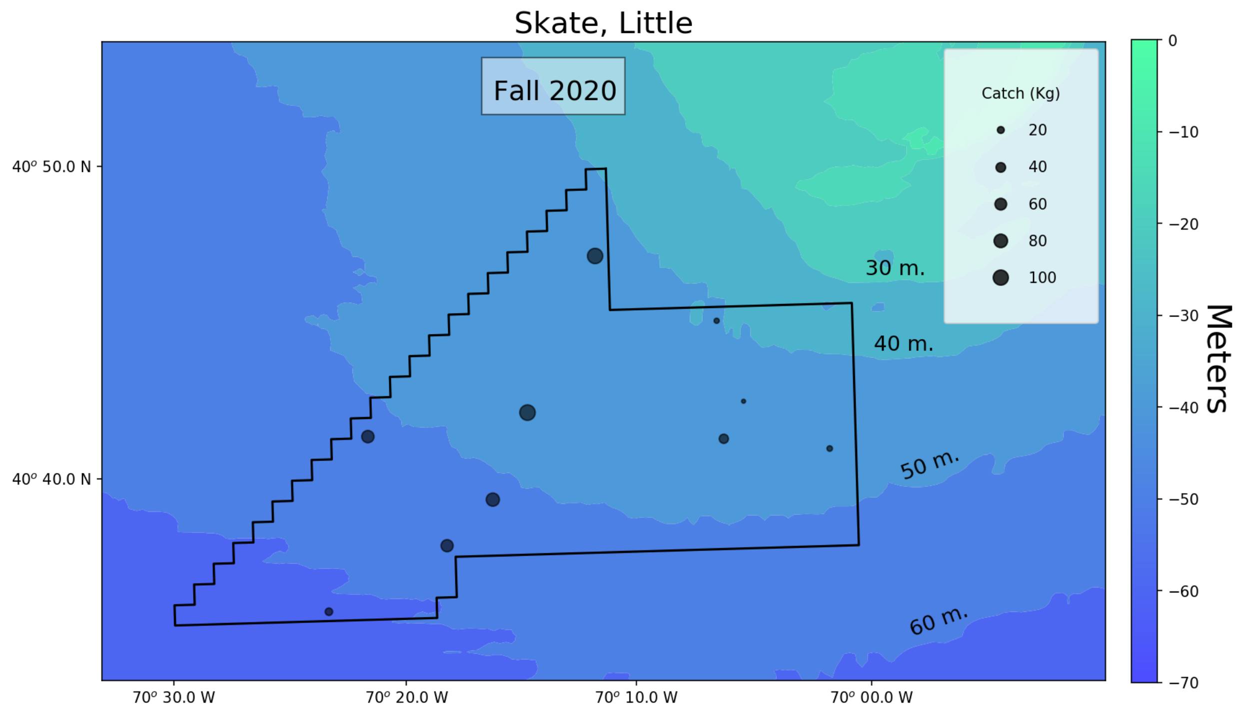


Figure 13: Distribution of the catch of little skate in the 522 Study Area.

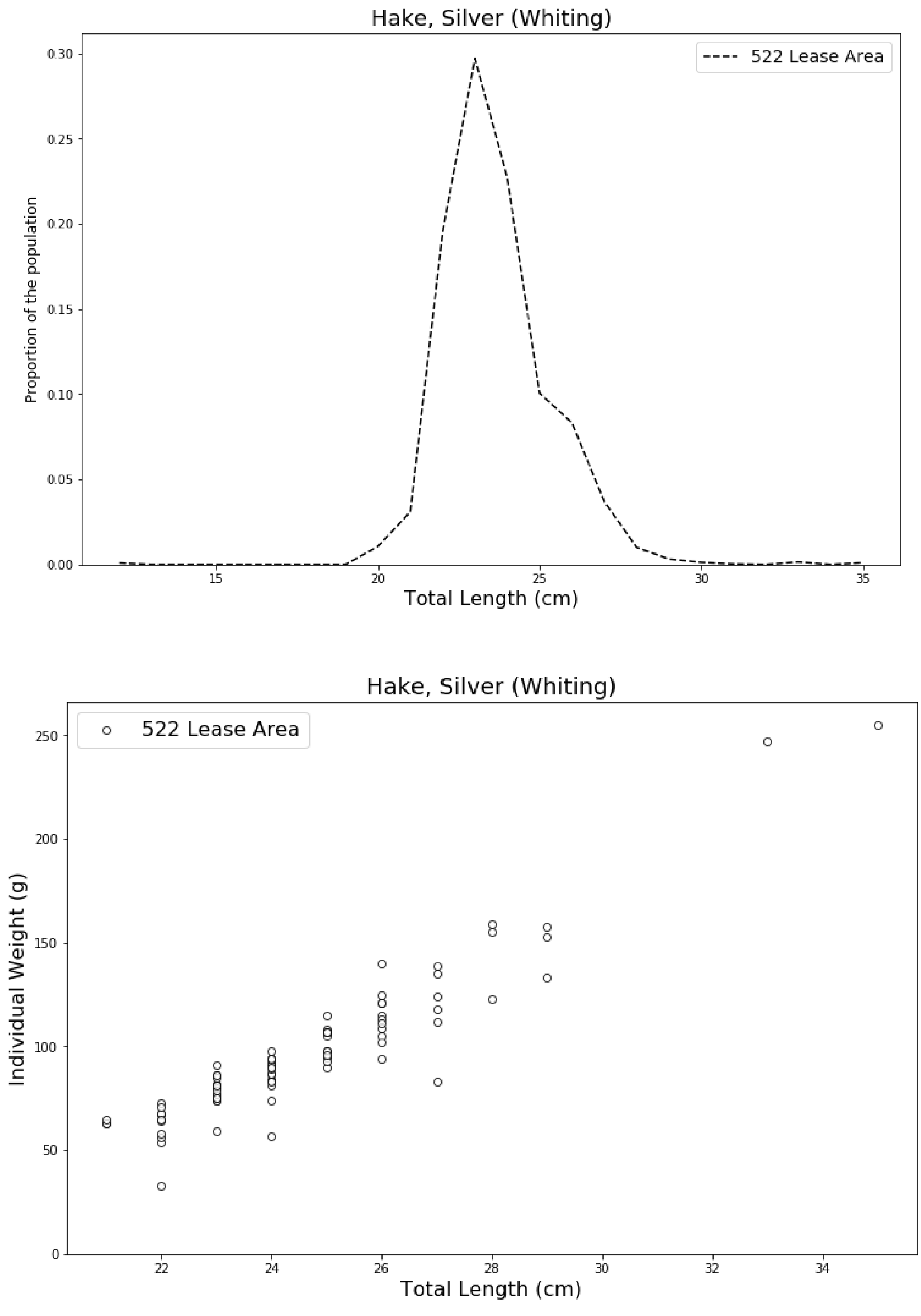


Figure 14: Population structure of silver hake in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

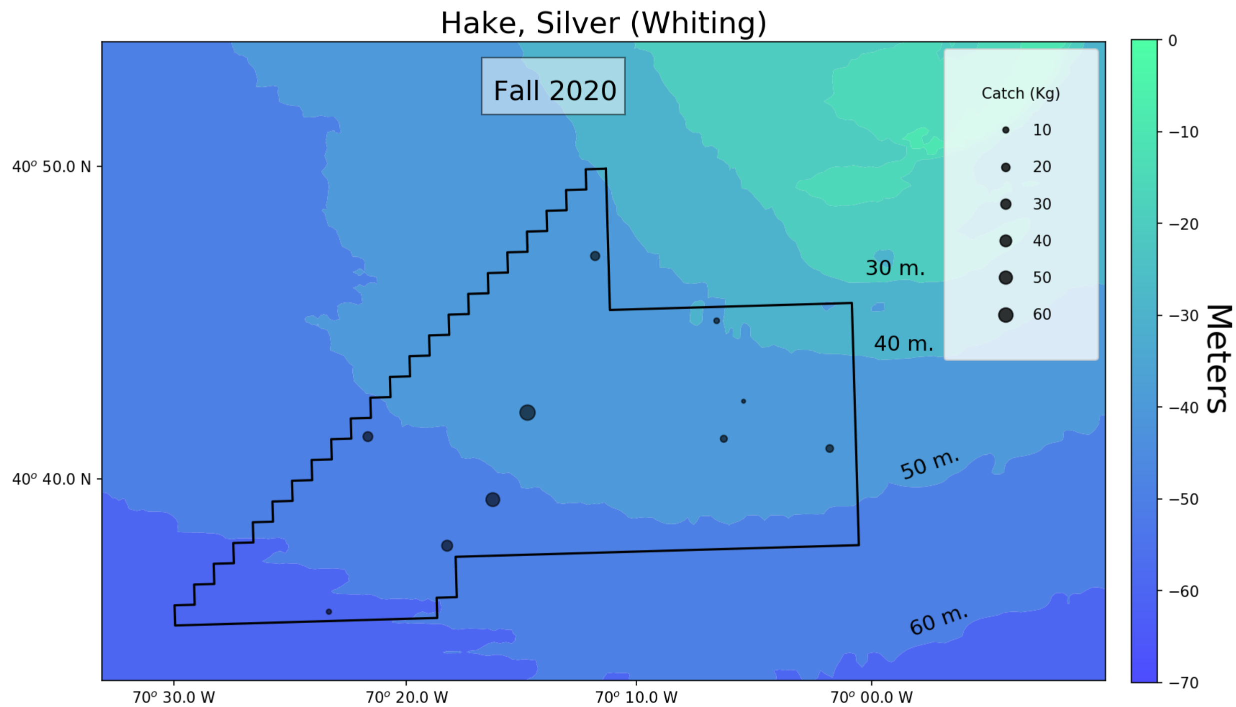
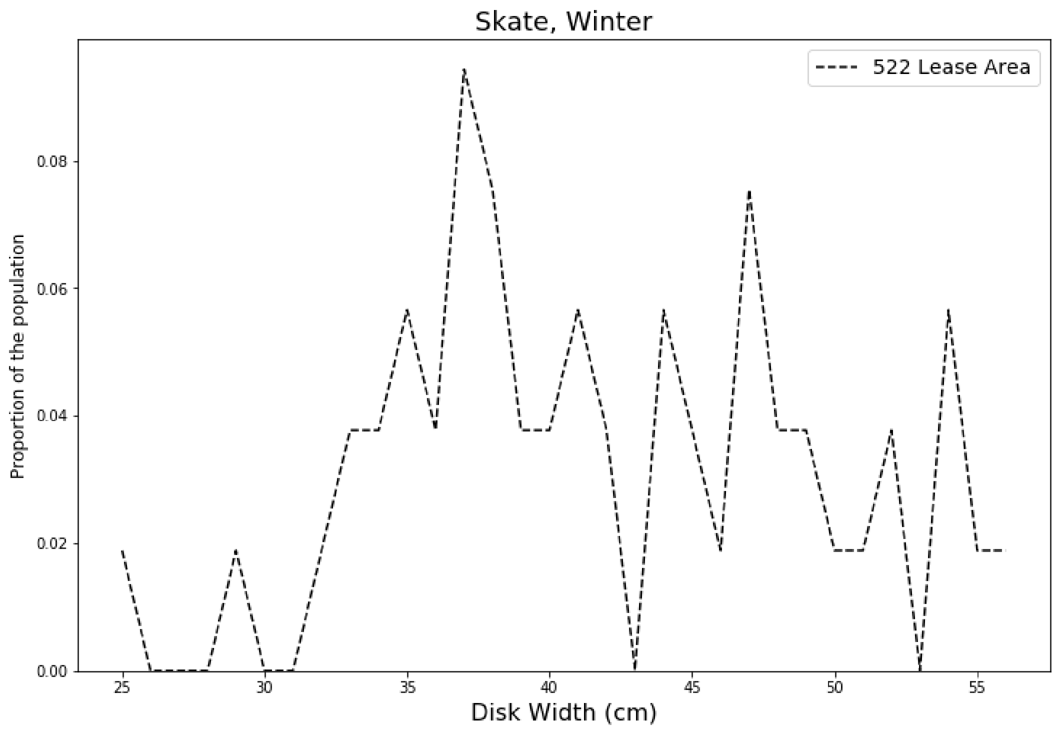


Figure 15: Distribution of the catch of silver hake in the 522 Study Area.



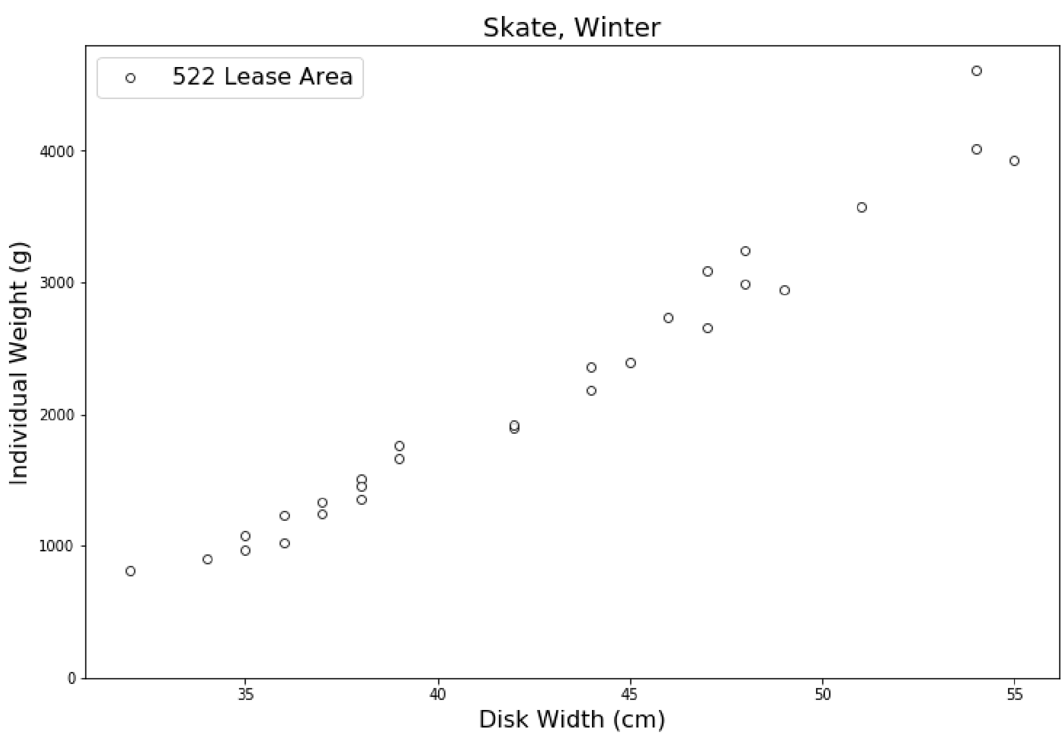


Figure 16: Population structure of winter skate in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

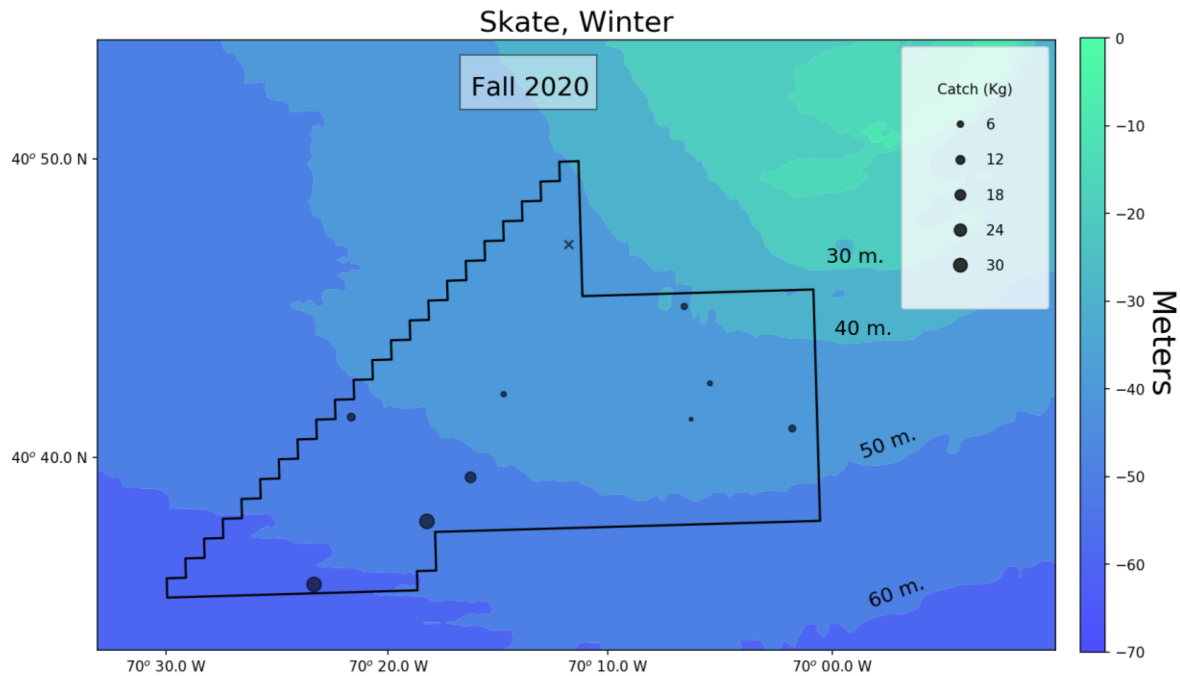
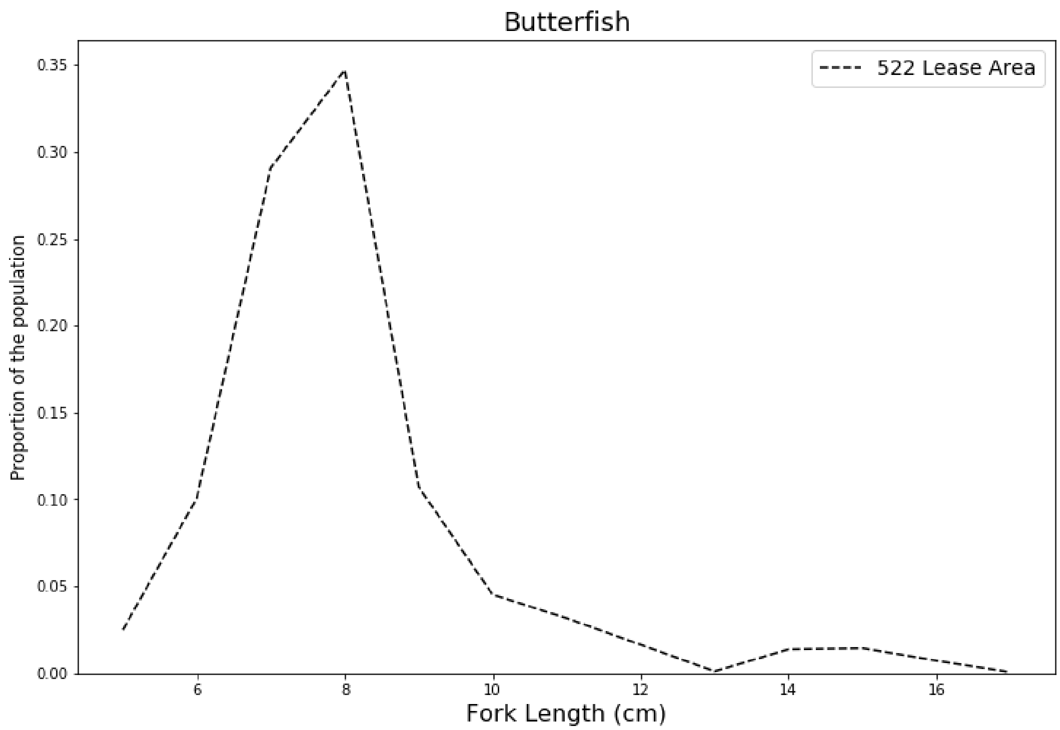


Figure 17: Distribution of the catch of winter skate in the 522 Study Area. Tows with zero catch are denoted with an x.



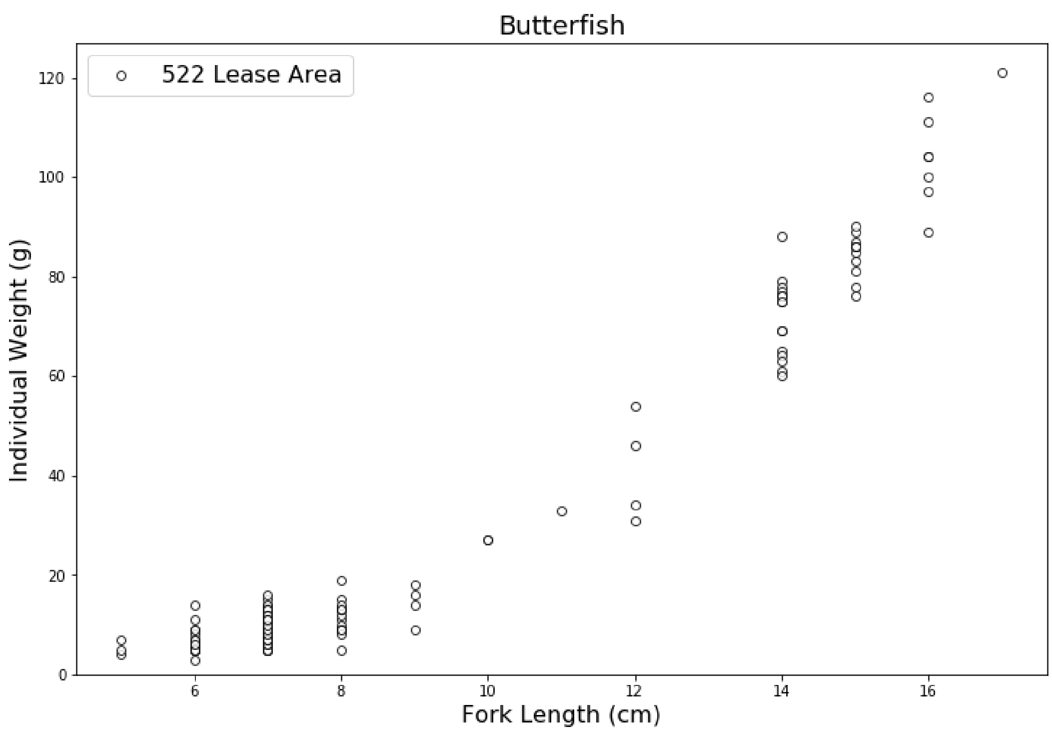


Figure 18: Population structure of butterfish in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

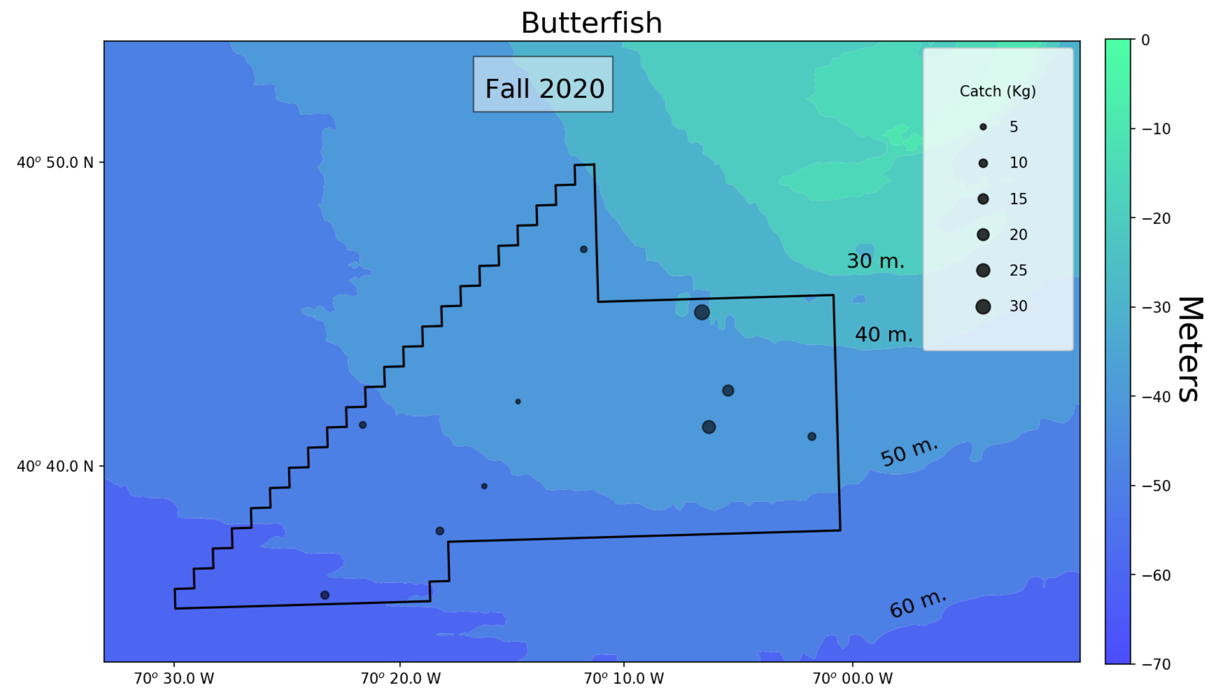
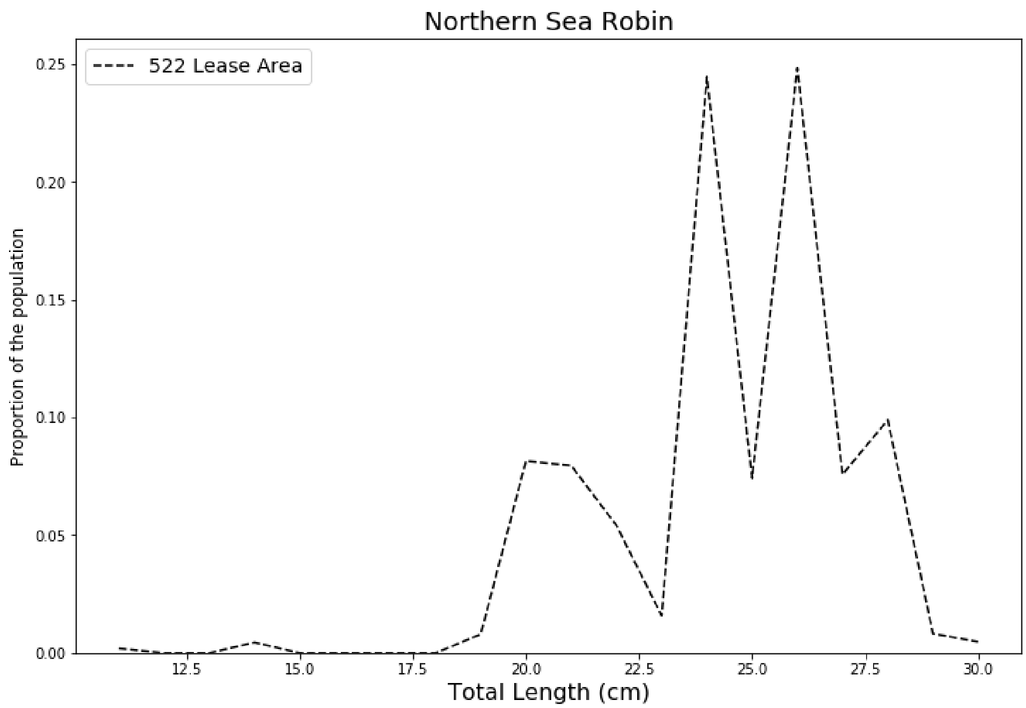


Figure 19: Distribution of the catch of butterfish in the 522 Study Area.



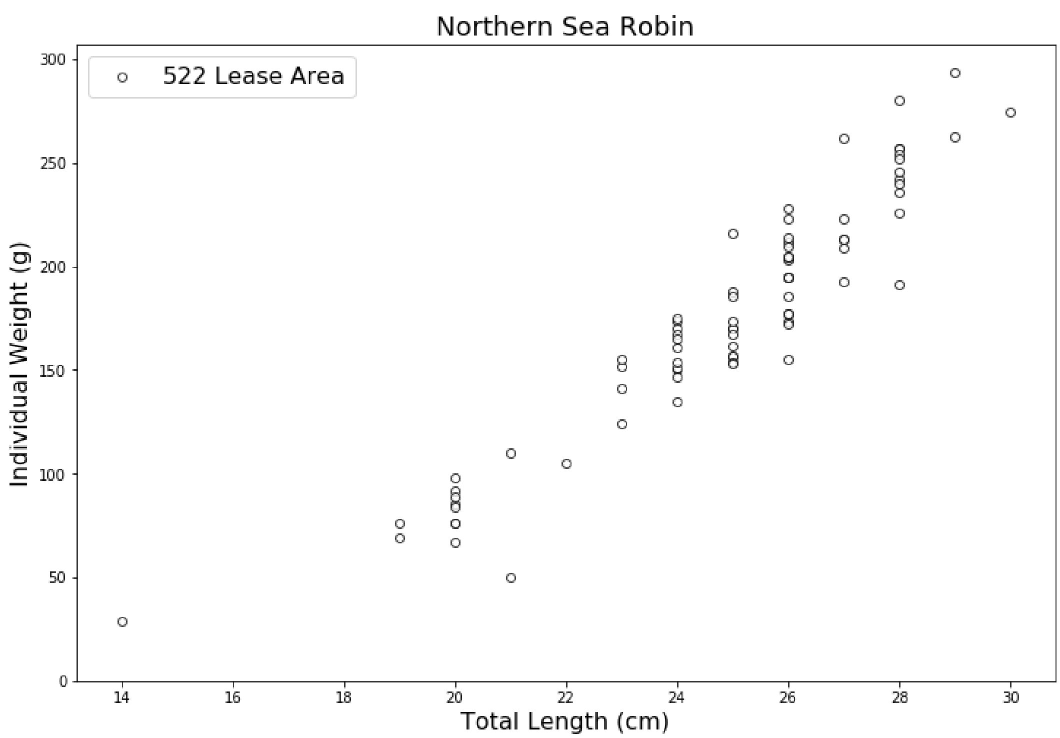


Figure 20: Population structure of northern sea robin in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

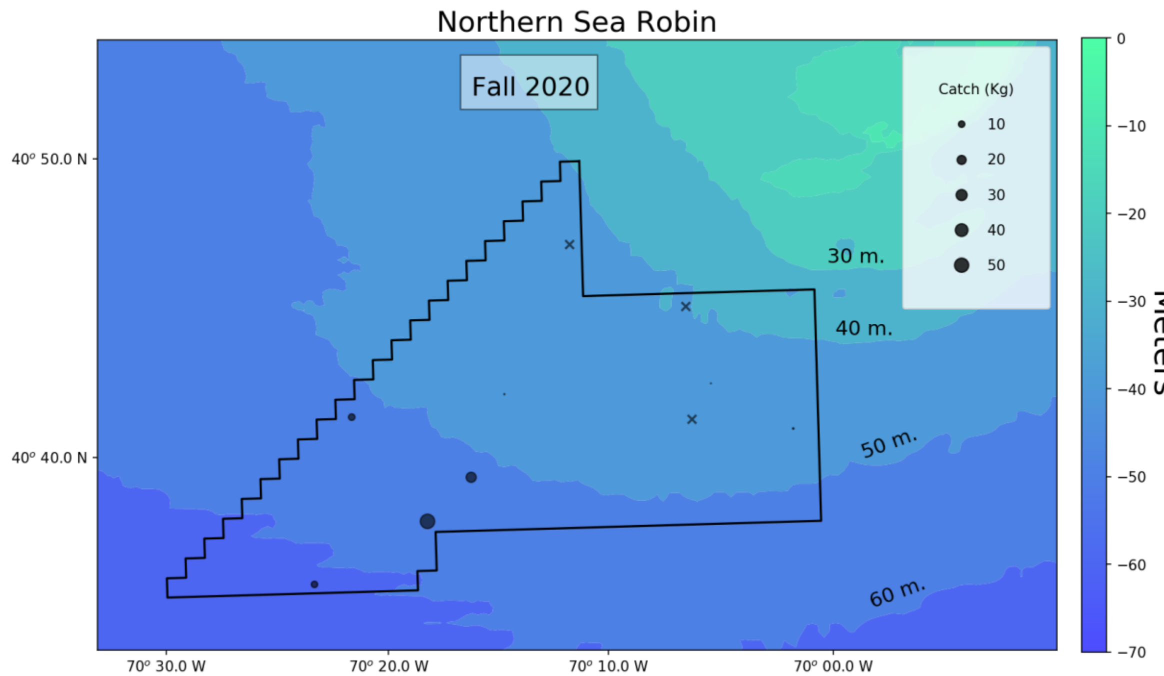
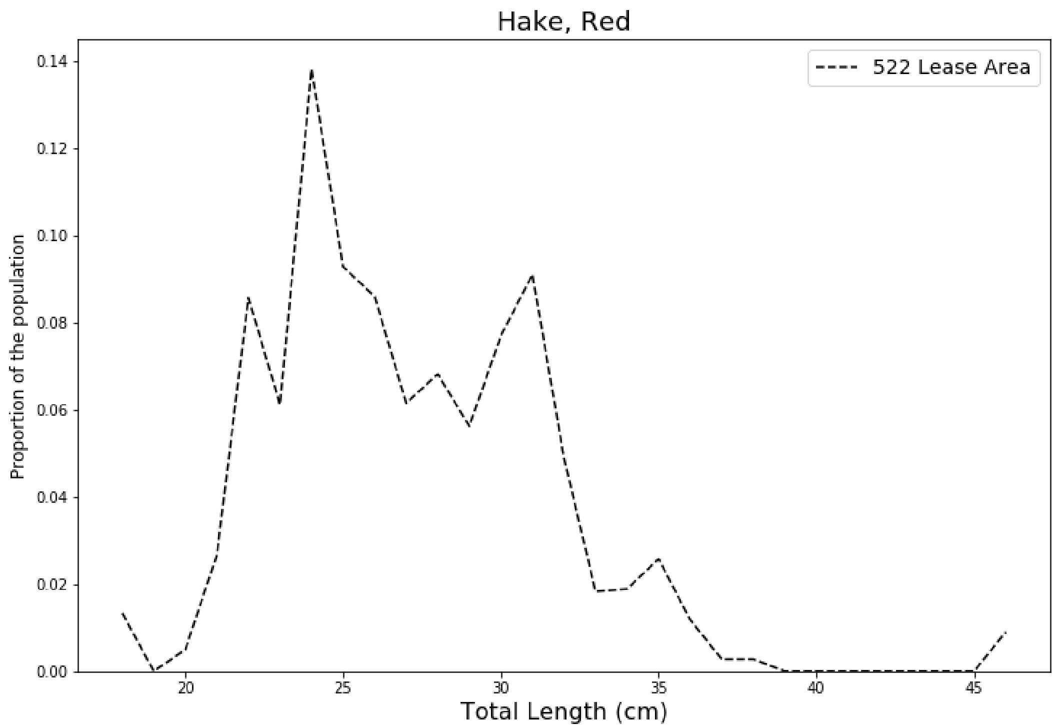


Figure 21: Distribution of the catch of northern sea robin in the 522 Study Area. Tows with zero catch are denoted with an x.



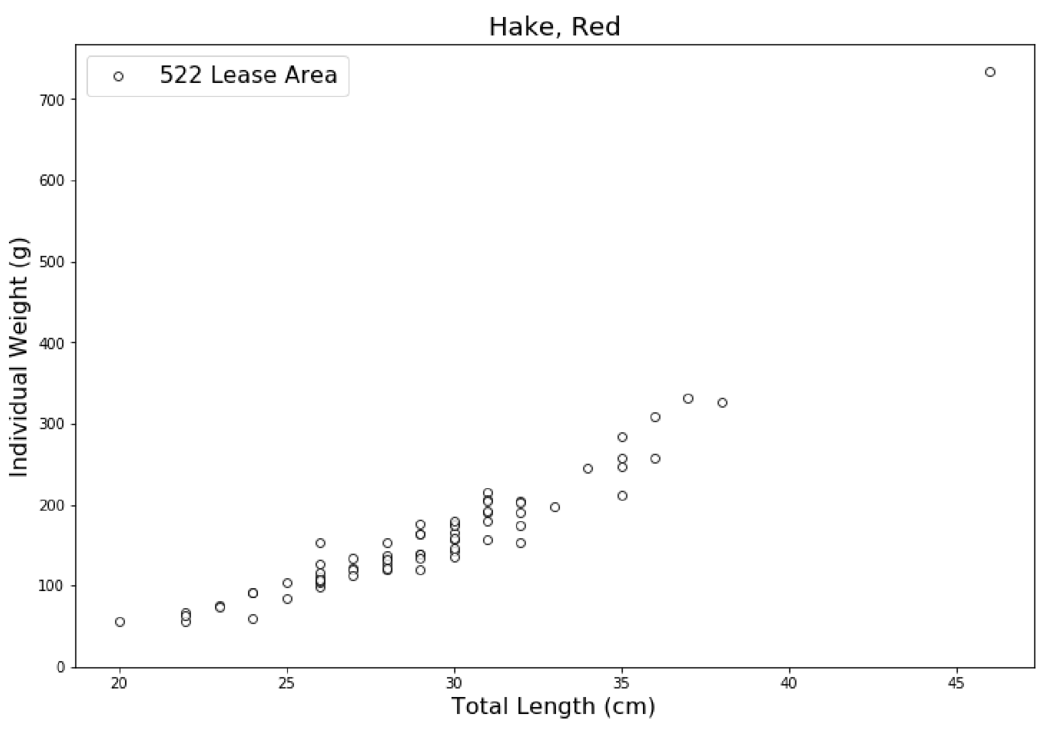


Figure 22: Population structure of red hake in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

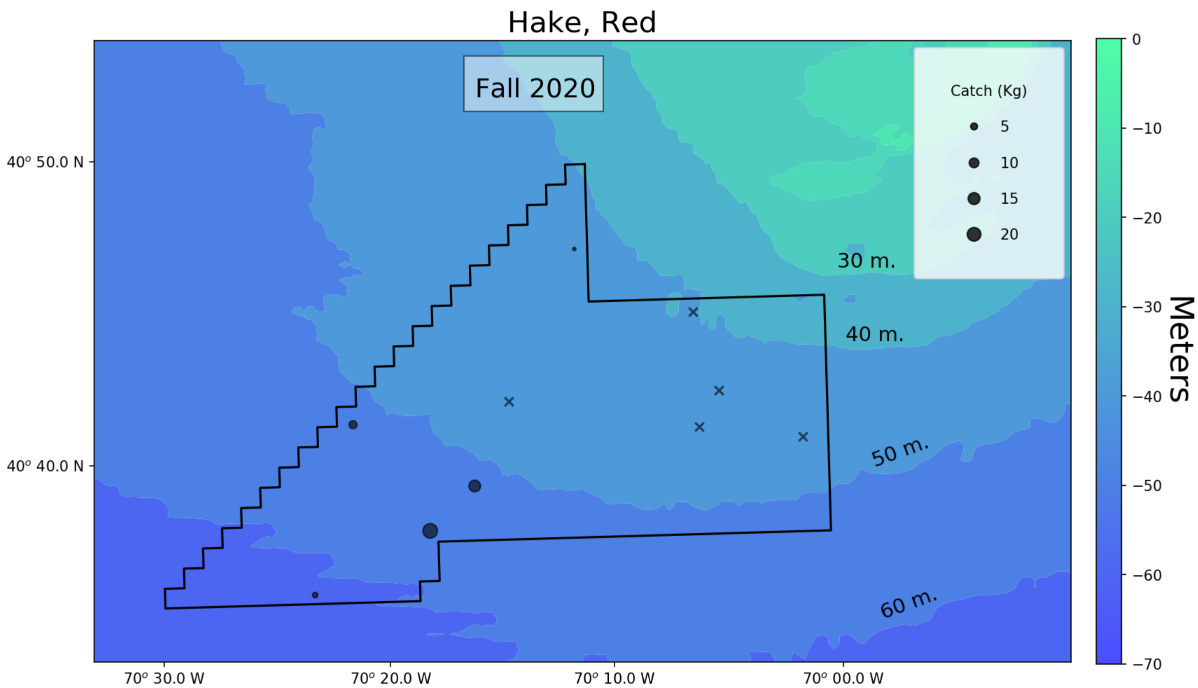
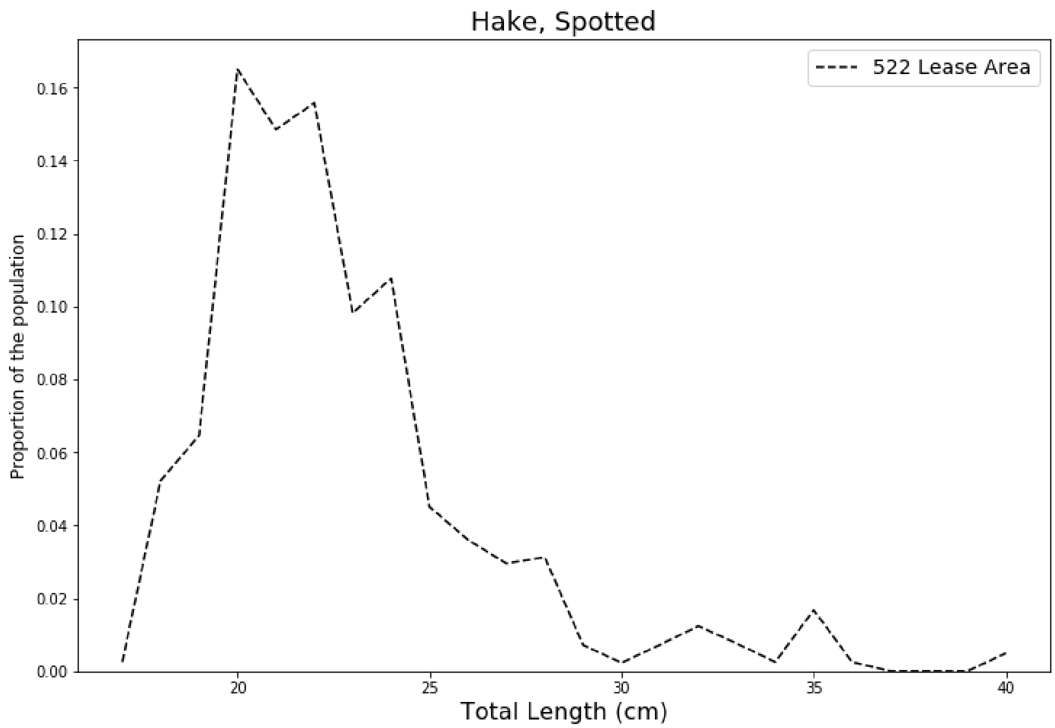


Figure 23: Distribution of the catch of red hake in the 522 Study Area. Tows with zero catch are denoted with an x.



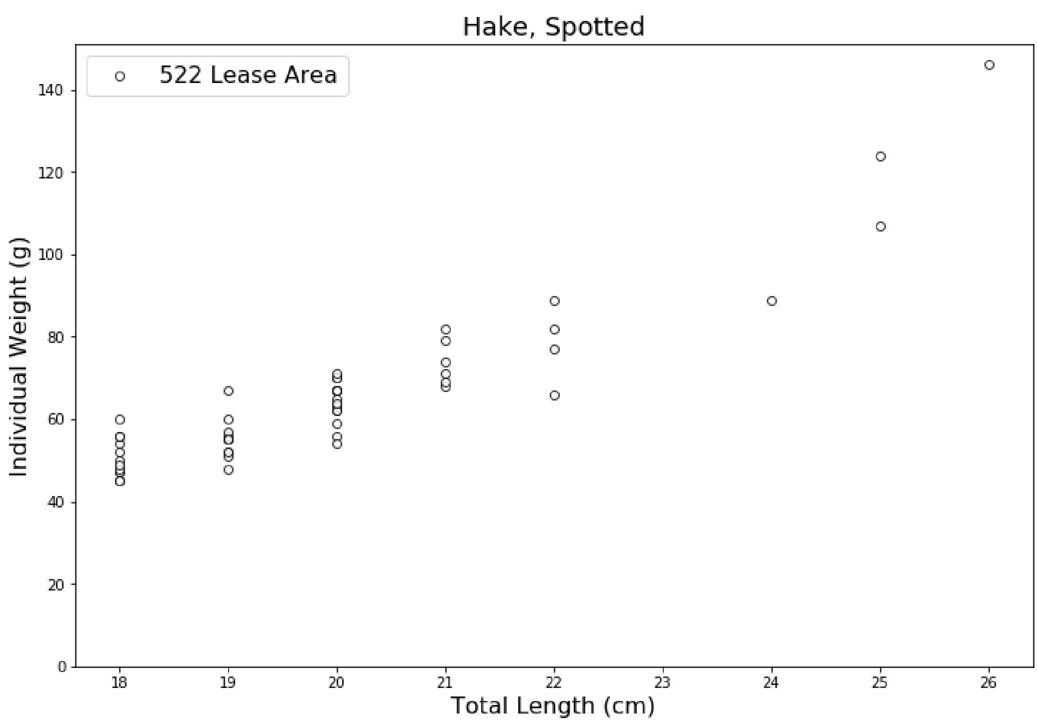


Figure 24: Population structure of spotted hake in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

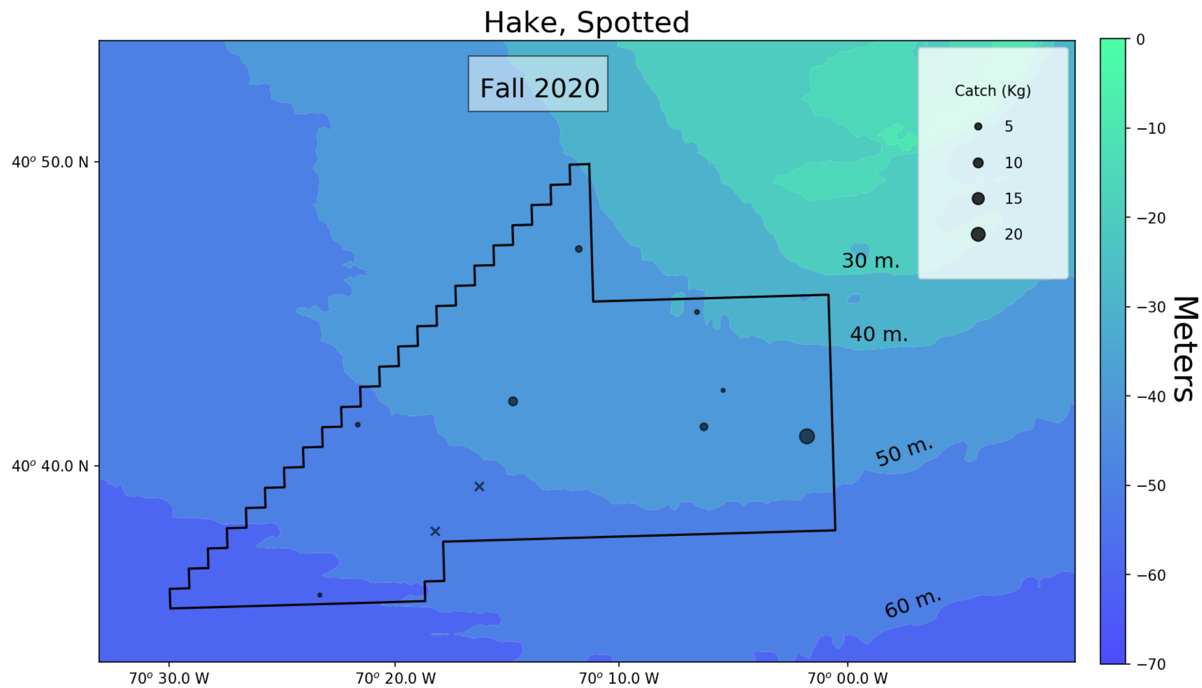
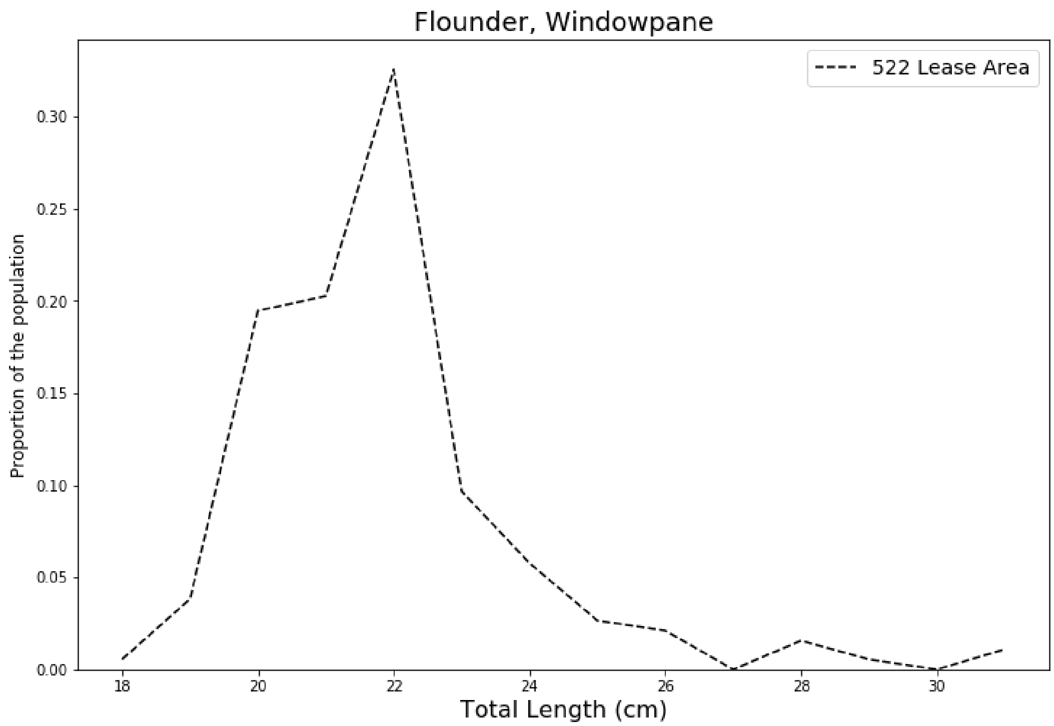


Figure 25: Distribution of the catch of spotted hake in the 522 Study Area. Tows with zero catch are denoted with an x.



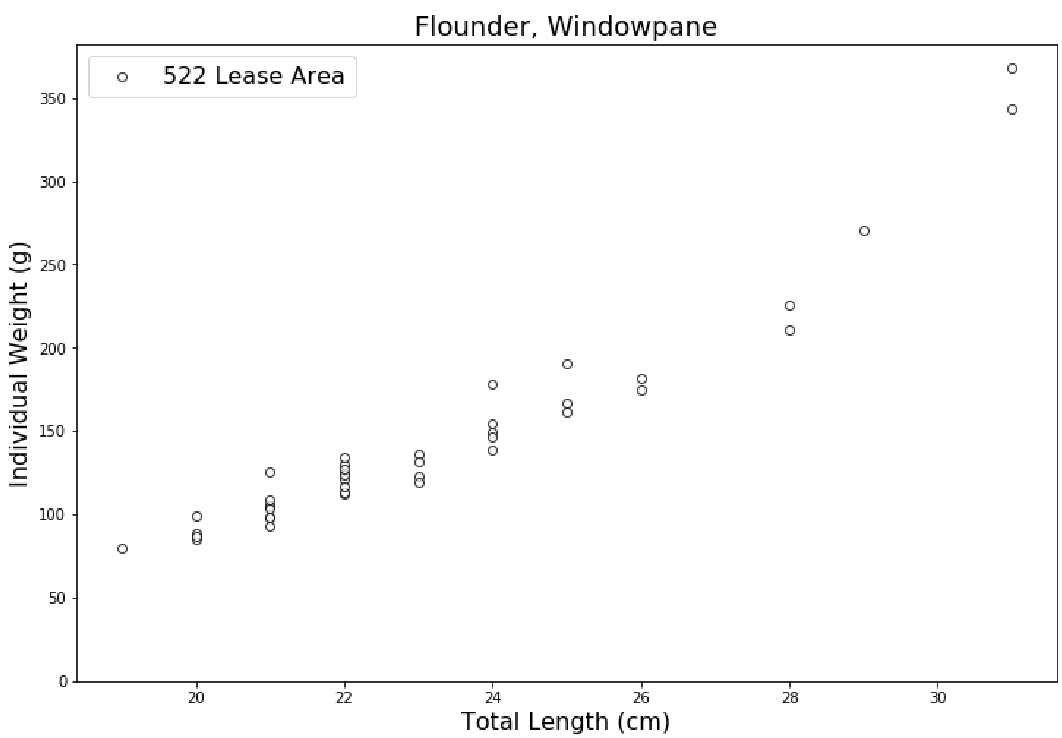


Figure 26: Population structure of windowpane flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

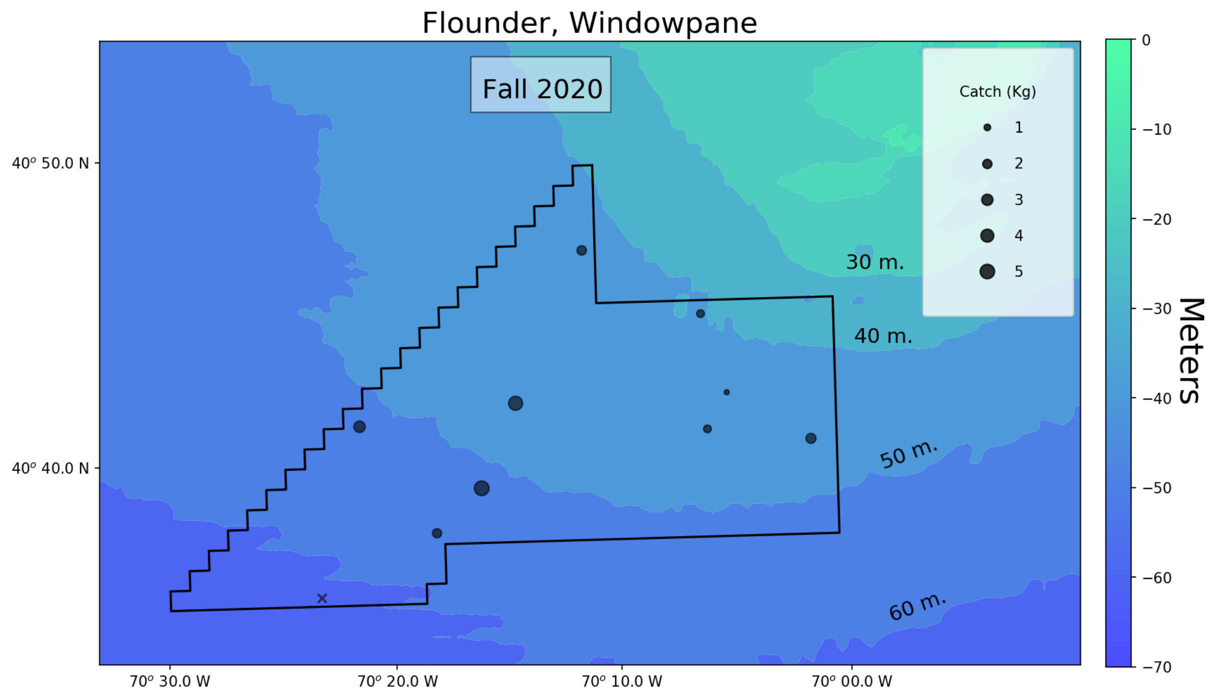
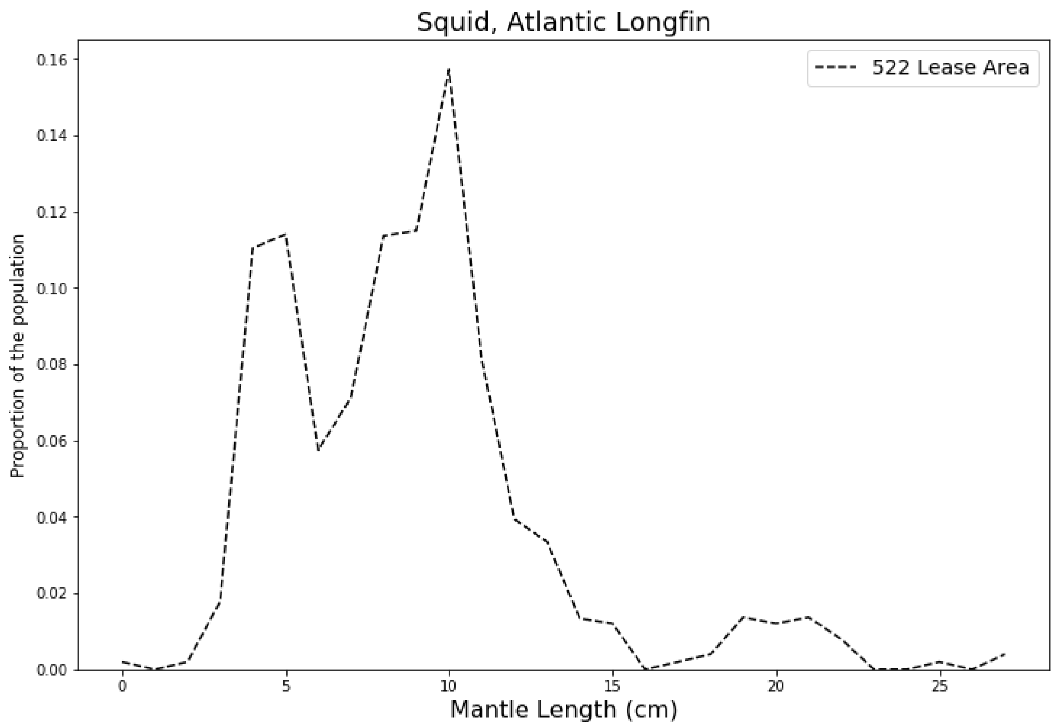


Figure 27: Distribution of the catch of windowpane flounder in the 522 Study Area. Tows with zero catch are denoted with an x.



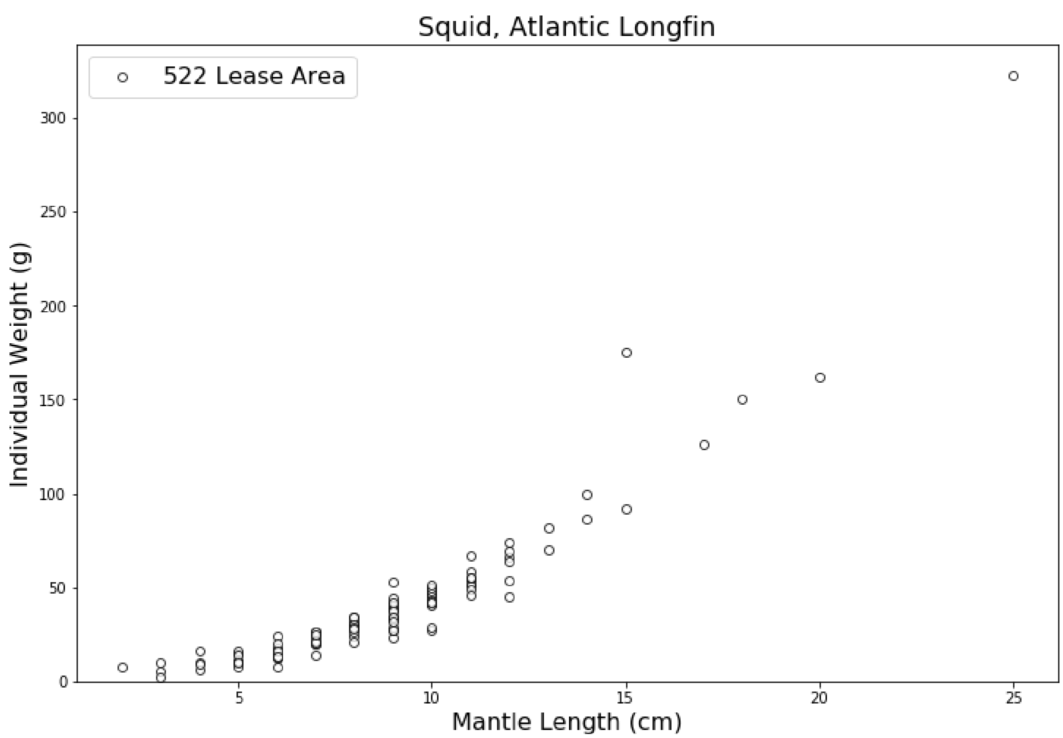


Figure 28: Population structure of Atlantic longfin squid in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

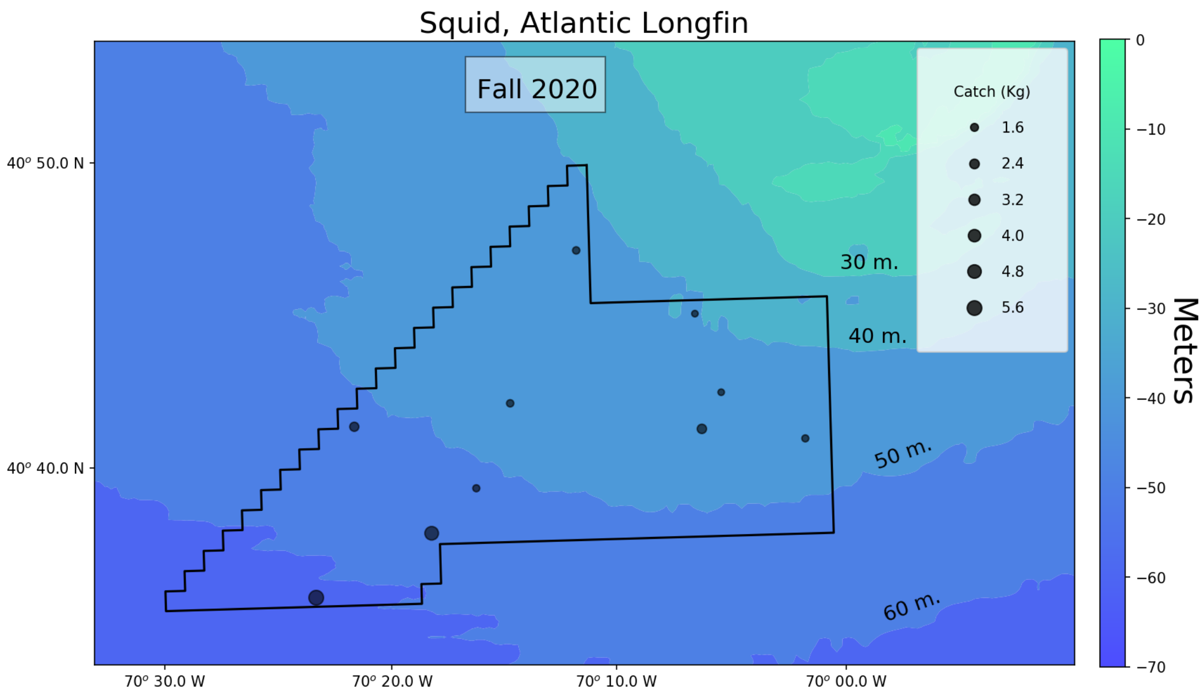


Figure 29: Distribution of the catch of Atlantic longfin squid in the 522 Study Area.

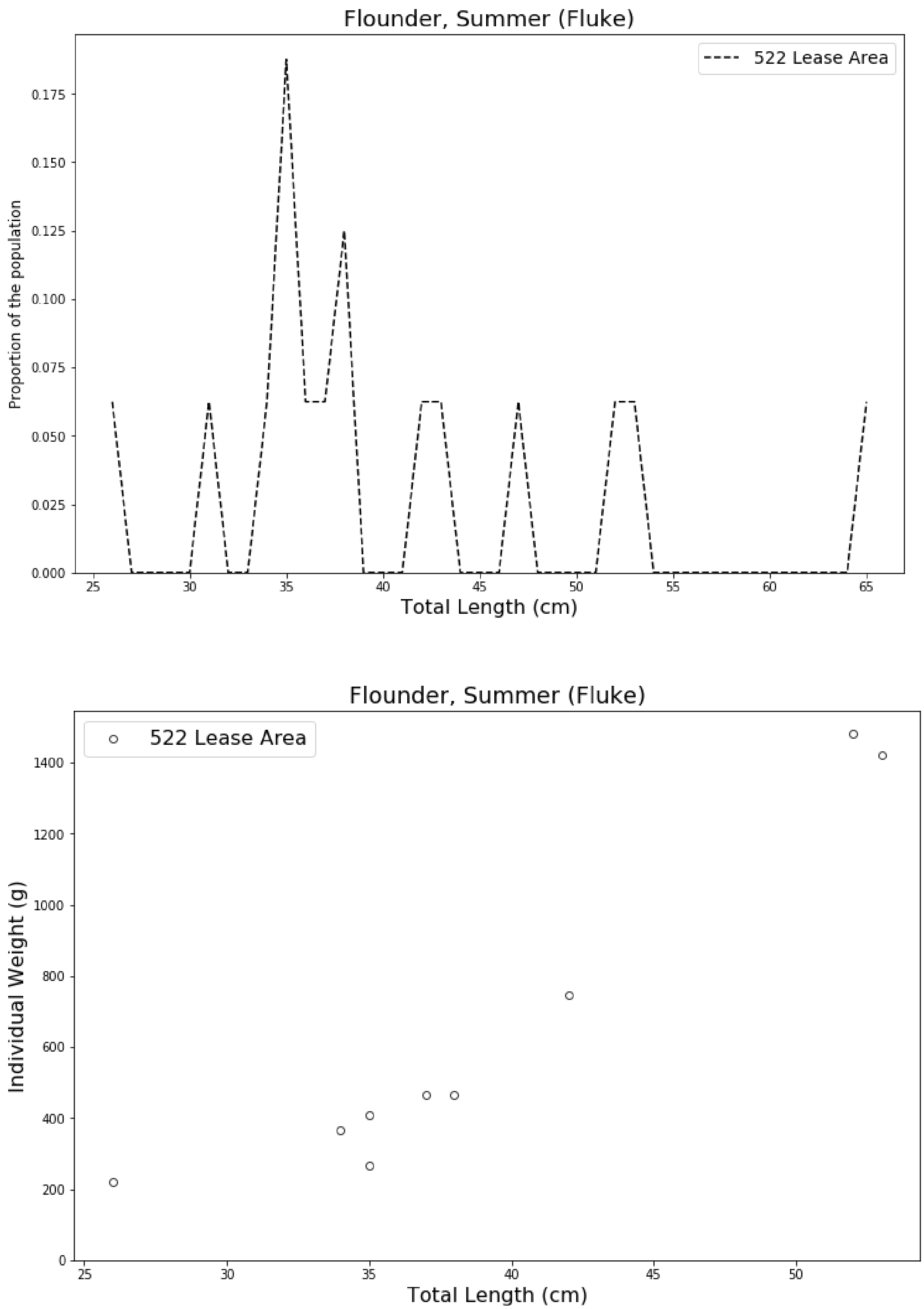


Figure 30: Population structure of summer flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

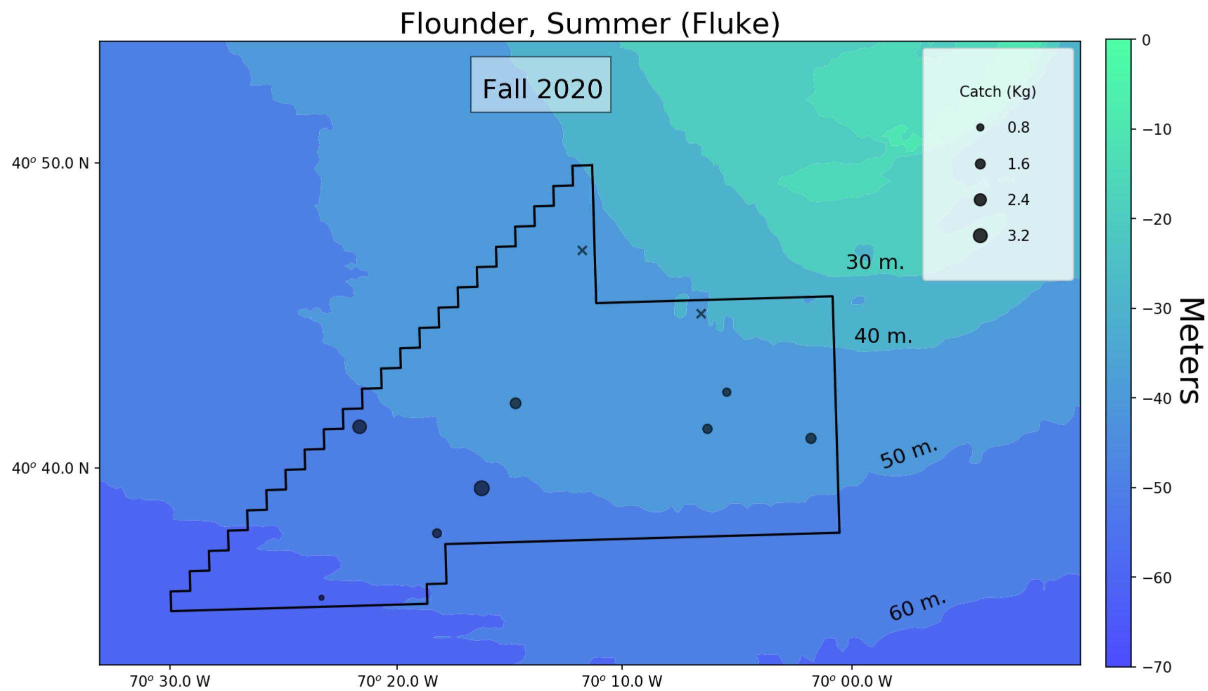
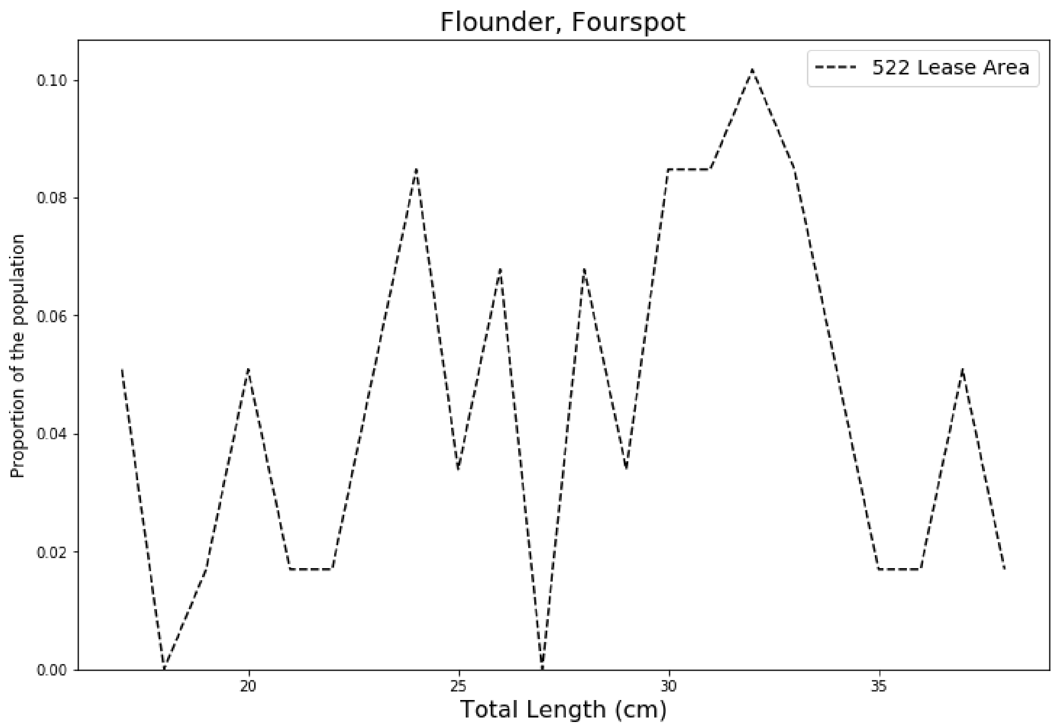


Figure 31: Distribution of the catch of summer flounder in the 522 Study Area. Tows with zero catch are denoted with an x.



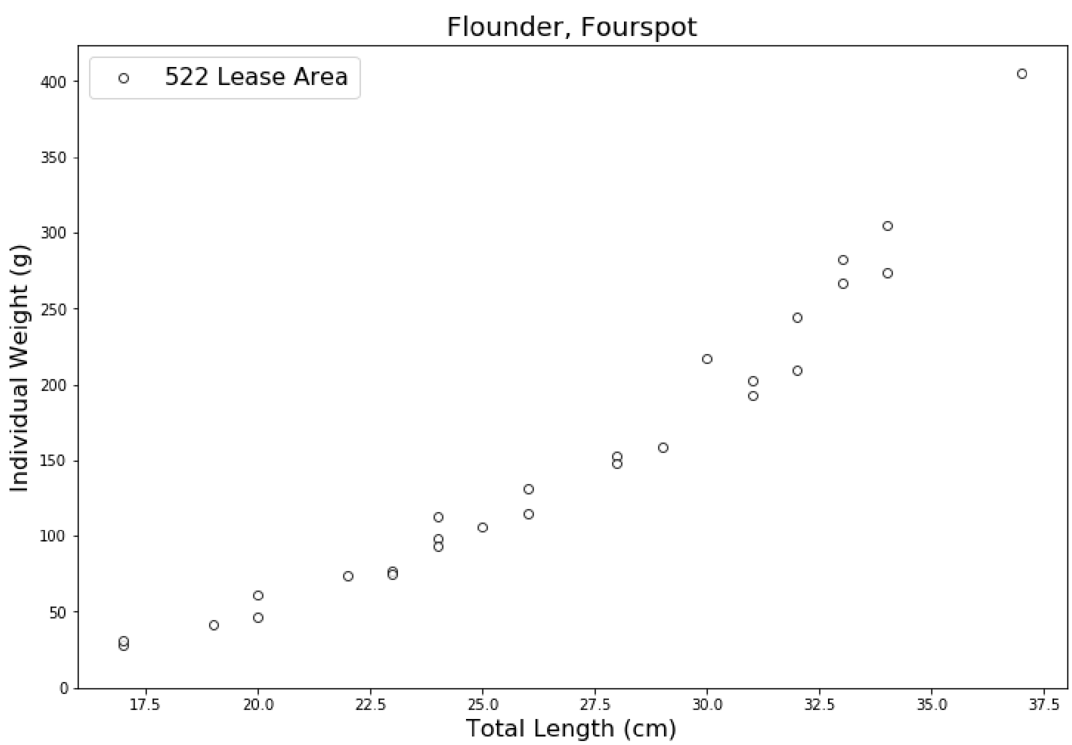


Figure 32: Population structure of fourspot flounder in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

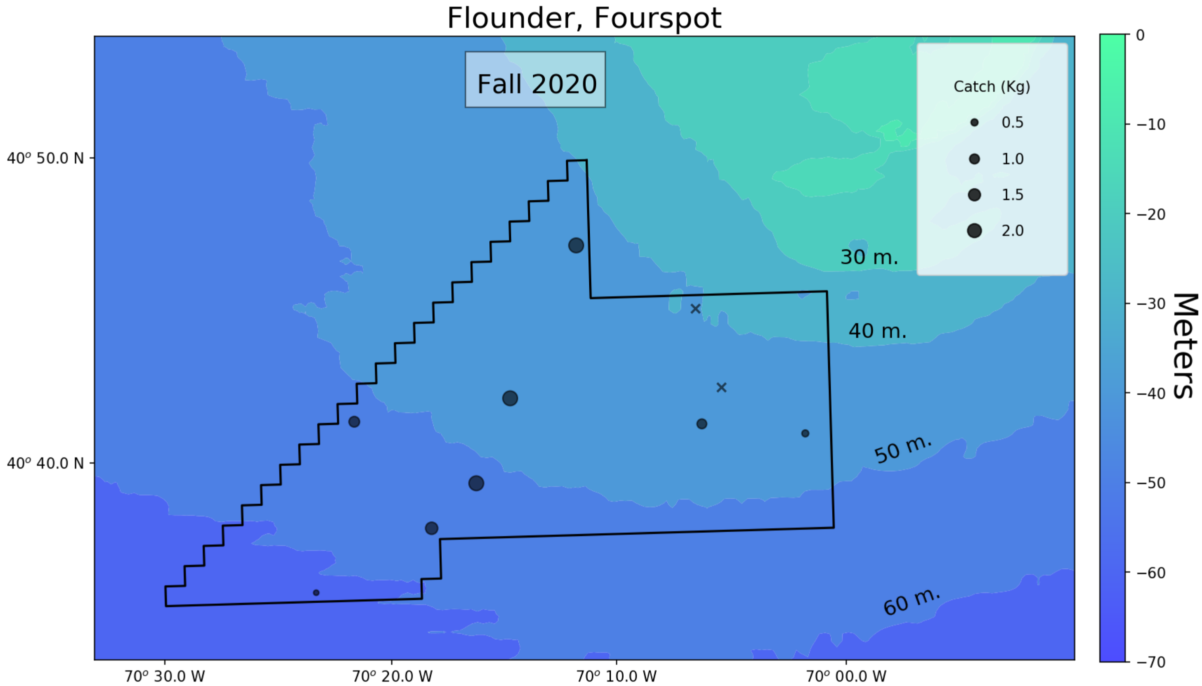
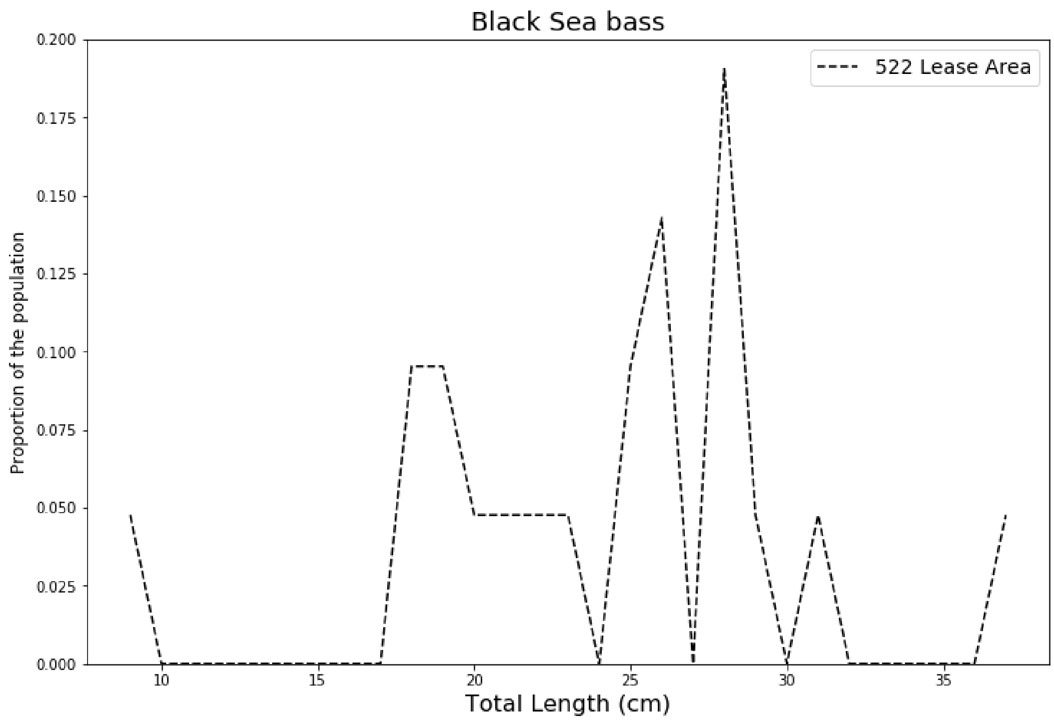


Figure 33: Distribution of the catch of fourspot flounder in the 522 Study Area. Tows with zero catch are denoted with an x.



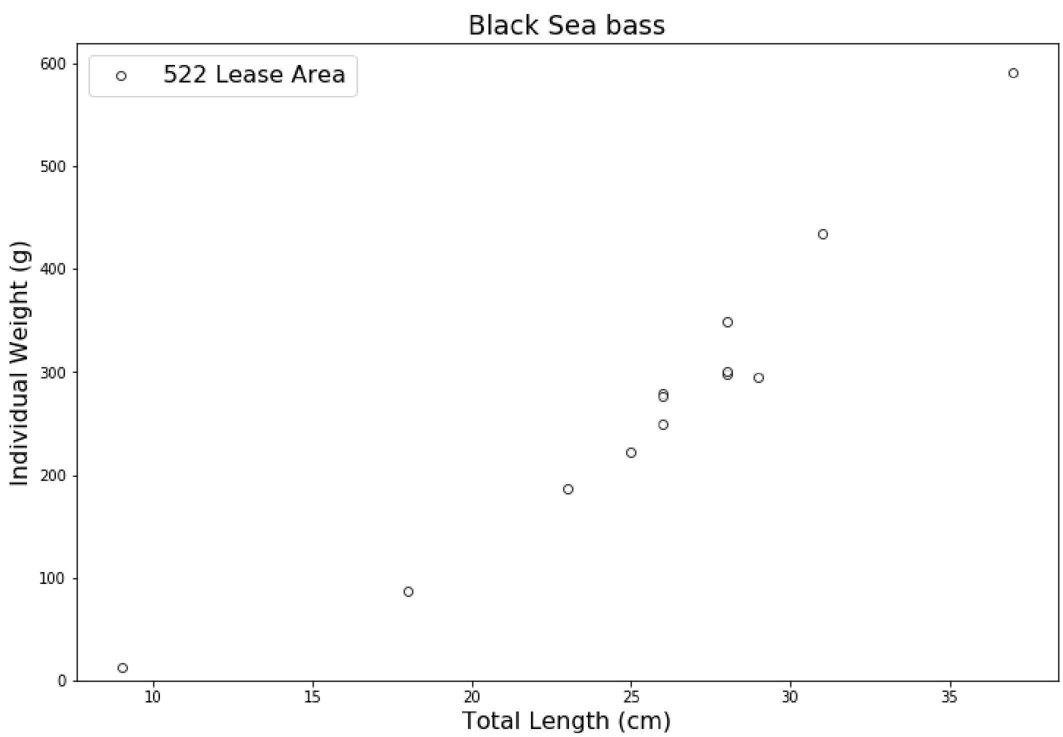


Figure 34: Population structure of black sea bass in the 522 Study Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

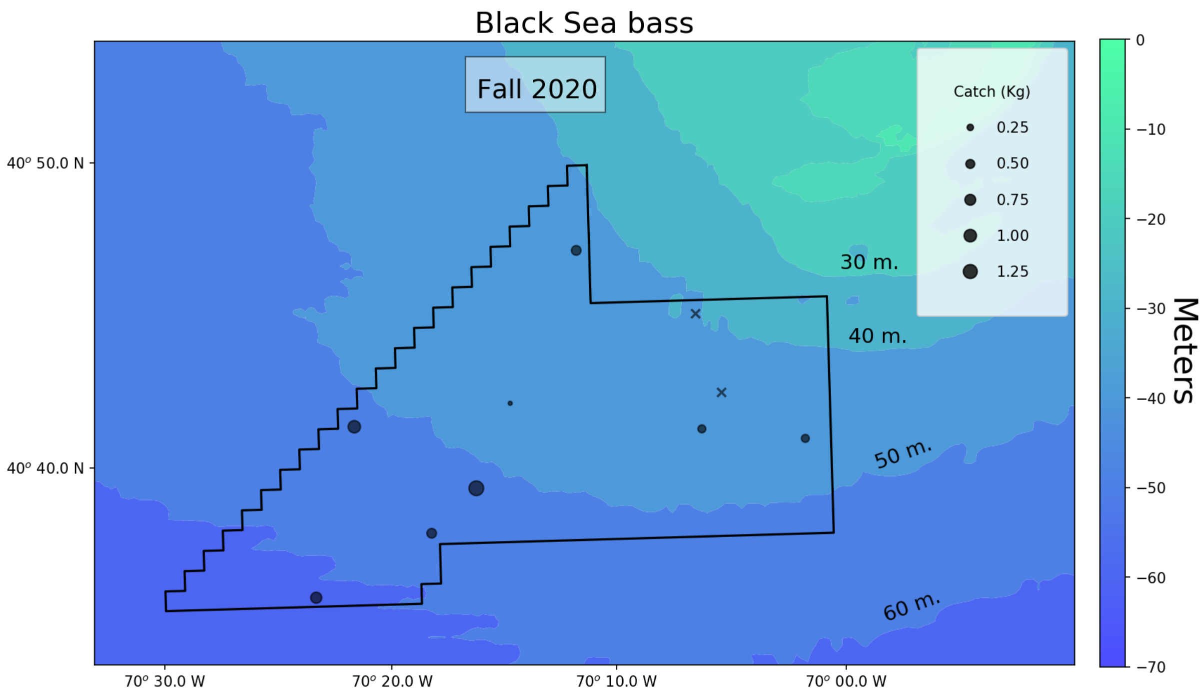


Figure 35: Distribution of the catch of black sea bass in the 522 Study Area. Tows with zero catch are denoted with an x.