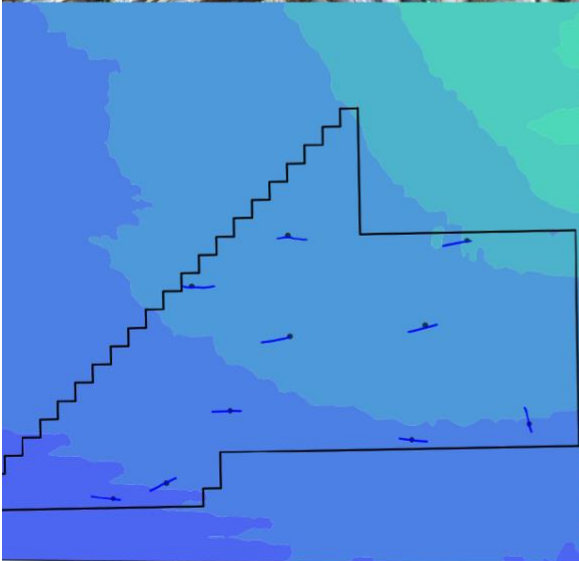




Vineyard Wind Demersal Trawl Survey



522 Lease Area

Quarterly Report
Summer 2019 (July - September)

VINEYARD WIND DEMERSAL TRAWL SURVEY

Summer 2019 Seasonal Report

522 Lease Area

March 2020

Prepared for Vineyard Wind, LLC



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Vineyard Wind Demersal Trawl Survey Summer 2019 Seasonal Report

522 Lease Area

Progress Report #2

July 1 – September 30, 2019

Project title: Vineyard Wind Demersal Trawl Survey Summer 2019 Seasonal Report – 522 Lease Area

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Date: March 19, 2020

This progress report may contain unpublished designs, experimental methods and data. It is intended for the funding organization evaluating the progress of the project and is not intended for wider distribution. This report should not be on the internet without access restriction.

You may cite this report as:

Rillahan, C., He, P. (2020). Vineyard Wind Demersal Trawl Survey Summer 2019 Seasonal Report – 522 Lease Area. Progress report #2. University of Massachusetts Dartmouth - SMAST, New Bedford, MA. SMAST-CE-REP-2020-081. 36 pp.

SMAST-CE-REP-2020-081

Table of Contents

| | |
|--|-----|
| List of Tables | ii |
| List of Figures | iii |
| 1. Introduction | 1 |
| 2. Methodology | 2 |
| 2.1 Survey Design..... | 3 |
| 2.2 Trawl Net..... | 3 |
| 2.3 Trawl Geometry and Acoustic Monitoring Equipment..... | 4 |
| 2.4 Survey Operations | 4 |
| 2.5 Catch Processing | 6 |
| 3. Results..... | 6 |
| 3.1 Operational Data, Environmental Data and Trawl Performance | 6 |
| 3.2 Catch Data..... | 7 |
| 4. Acknowledgements | 9 |
| 5. References | 9 |

List of Tables

| | |
|--|----|
| Table 1: Operational and environmental conditions for each survey tow..... | 10 |
| Table 2: Tow parameters for each survey tow. | 11 |
| Table 3: Total and average catch weights observed with the 522 Lease Area..... | 12 |

List of Figures

| | |
|--|----|
| Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors..... | 13 |
| Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Lease Area. | 14 |
| Figure 3: Schematic net plan for the NEAMAP trawl (Bonsek et al. 2008)..... | 15 |
| Figure 4: Sweep diagram for the survey trawl (Bonsek et al. 2008)..... | 16 |
| Figure 5: Headrope and rigging plan for the survey trawl (Bonsek et al. 2008)..... | 17 |
| Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonsek et al. 2008). | 18 |
| Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters. | 19 |
| Figure 8: Population structure of red hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom). | 20 |
| Figure 9: Distribution of the catch of red hake in the 522 Lease Area. Tows with zero catch are denoted with an X. | 21 |
| Figure 10: Population structure of scup in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom). | 22 |
| Figure 11: Distribution of the catch of scup in the 522 Lease Area. Tows with zero catch are denoted with an X. | 23 |
| Figure 12: Distribution of the catch of little skate in the 522 Lease Area. | 24 |
| Figure 13: Population structure of butterfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom). | 25 |
| Figure 14: Distribution of the catch of butterfish in the 522 Lease Area. | 26 |
| Figure 15: Population structure of silver hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom)..... | 27 |
| Figure 16: Distribution of the catch of silver hake in the 522 Lease Area..... | 28 |
| Figure 17: Population structure of longfin squid in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom)..... | 29 |
| Figure 18: Distribution of the catch of longfin squid in the 522 Lease Area. | 30 |
| Figure 19: Distribution of the catch of smooth dogfish in the 522 Lease Area. Tows with zero catch are denoted with an X. | 30 |
| Figure 20: Population structure of fourspot flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom)..... | 31 |
| Figure 21: Distribution of the catch of fourspot flounder in the 522 Lease Area. Tows with zero catch are denoted with an X. | 32 |
| Figure 22: Population structure of monkfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom). | 33 |
| Figure 23: Distribution of the catch of monkfish in the 522 Lease Area. Tows with zero catch are denoted with an X. | 34 |
| Figure 24: Population structure of summer flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom)..... | 35 |
| Figure 25: Population structure of windowpane flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom). | 36 |

1. Introduction

In 2019, Vineyard Wind LLC leased a 516 km² 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 Before-After-Control-Impact (BACI) framework. This progress report documents survey methodology, survey effort, and data collected during Summer 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, which 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).

Two locations within the Vineyard Wind 522 Lease Area were selected using a systematic random sampling design. The 522 Lease Area (536 km²) was sub-divided into 10 sub-areas (each ~53.6 km²), 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 Bonsek 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 ($\pm 10\%$) 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 newly acquired Simrad PX net mensuration system (Kongsberg Group, Kongsberg, Norway) was used to monitor the net geometry. This system was a significant improvement from the system used in the spring survey (Notus Trawl Master) in which problems were encountered with faulty sensors. 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 (Figure 1). The headline sensor also measured bottom 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, RI. The F/V Heather Lynn is a commercial fishing vessel currently operating in the industry. One seven-day trip to the survey area were made (August 25 – 31, 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 reduced from 5:1, used in the spring survey, to 4:1. This decision was based on the net geometry data obtained from the spring survey indicating that the headline height was too low. The goal was to constrain the horizontal spread of the net, reducing the wingspread which should increase the headline height. Trawl warp was set to 100 fathoms (183 m) for tows in 20 to 25 fathoms (37 to 46 m), 120 fathoms (220 m) in depths between 26 and 28 fathoms (48 to 51 m) and 125 fathoms (229 m) in depths between 29 and 32 fathoms (53 to 59 m). Additionally, the towing points on the trawl doors were moved to the forwardmost position to further reduce the wingspread and increase the headline height. Positioning the towing points forward reduces the angle of attack of the doors decreasing the horizontal spreading force.

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.

The straight subsampling by weight strategy 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 dogfish, skates, crabs, lobsters, and some non-commercial species. For these species, aggregated weight and counts were collected. Any observation of squid eggs was documented. All data 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 19.7 ± 0.2 minutes (mean \pm one standard deviation). Tow distance averaged 1.0 ± 0.1 nautical miles giving an average tow speed of 3.1 ± 0.2 knots

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 followed a similar gradient with warmer water observed during shallow tows (15.0°C at 40 m) and colder water observed during deeper tows (10.9°C at 60 m) (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 36.4 ± 3.3 m (range: 29.1 – 39.4 m). On average, door spread was within the acceptable range however five tows were slightly higher (~1 meter) than the acceptable range. These tows were all conducted in deeper water which required additional trawl warp. The additional trawl warp allowed the doors to spread. While the door spread measurements are higher than the acceptable tolerance limits, we do not believe this affected the catch because the wing spread measurements are within the appropriate range indicating that the net had the appropriate geometry. Wing spread averaged 14.4 ± 0.5 m (range: 13.4 – 15.3 m). All wingspread measurements were within the acceptable tolerance limits. Headline height averaged 4.1 ± 0.1 m (range: 3.9 – 4.3 m) (Table 2). 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 some 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 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 28 species were caught over the duration of the survey (Table 3). Catch volume ranged from 69.2 kg/tow to 780.5 kg/tow with an average of 371.7 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (red hake, scup, little skate, butterfish, and silver hake) accounted for 92% of the total catch weight. Adding the next five most abundant species (longfin squid, smooth dogfish, fourspot flounder, monkfish, and alewife) would encompass 98% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Red hake (*Urophycis chuss*) was the predominate species observed accounting for 27% of the total weight. Red hake ranged in length from 17 – 36 cm with a unimodal peak at 28 cm. (Figure

8). Catch rates averaged 99.0 ± 31.8 kg/tow (mean \pm SE) ranging from 0 to 298.5 kg/tow. Red hake were caught throughout the 522 lease area with higher catches in deeper water (Figure 9).

Scup (*Stenotomus chrysops*) was the second most abundant species. Scup ranged in length from 19 to 33 cm with a unimodal size distribution consisting of a peak at 22 cm (Figure 10). Scup were caught in 6 of the 10 tows with higher catches observed in the northern section of the lease area (Figure 11). Catch rates averaged 77.2 ± 39.1 kg/tow (range: 0 to 321.9 kg/tow).

Little skate (*Leucoraja erinaca*), butterfish (*Peprilus triacanthus*), silver hake (*Merluccius bilinearis*), and longfin squid (*Doryteuthis pealeii*) were the third, fourth, fifth, and sixth most abundant species, respectively, with each caught in every tow. Little skates were distributed throughout the lease area at an average catch rate of 66.8 ± 13.5 kg/tow (range: 23.2 – 142.1 kg/tow, Figure 12). Butterfish had a unimodal distribution ranging from 8 to 17 with a peak between 12 and 13 cm (Figure 13). Catch rates averaged 52.7 ± 17.2 kg/tow (range: 8.4 - 163.5 kg/tow). Butterfish were dispersed throughout the 522 Lease Area (Figure 14). Silver hake, also commonly referred to as whiting, ranged in length from 16 to 44 cm with a bimodal size distribution consisting of peaks at 21 and 25 cm (Figure 15). Catch rates averaged 48.2 ± 9.8 kg/tow (range: 7.4 kg/tow - 105.3 kg/tow). Silver hake were observed to be distributed throughout the study area with the catch increasing with depth (Figure 16). Finally, longfin squid were primarily small, ranging in size from 3 to 22 cm mantle length with a peak of abundance at 5 cm (Figure 17). Longfin squid were caught at an average rate of 7.0 ± 1.9 kg/tow (range: 0.8 - 17.4 kg/tow). The catch was distributed throughout the lease area (Figure 18). No squid mops were observed during the survey.

Additional common species included smooth dogfish (*Mustelus canis*), fourspot flounder (*Hippoglossina oblonga*), and monkfish (*Lophius americanus*). Smooth dogfish were caught in 7 of the 10 tows at an average catch rate of 4.3 ± 1.5 kg/tow (range: 0 – 14.4 kg/tow, Figure 19). Fourspot flounder were caught in 9 out of the 10 tows. Individuals ranged from 18 to 37 cm (Figure 20). The catch rate of fourspot flounder averaged 3.4 ± 1.1 kg/tow (range: 0 – 9.1 kg/tow) and were dispersed throughout the survey area (Figure 21). Monkfish has a wide size distribution ranging from 32 to 65 cm (Figure 22). The catch rate averaged 2.9 ± 1.1 kg/tow (range: 0 – 9.6 kg/tow, Figure 23).

Other commercially important species observed were summer flounder (*Paralichthys dentatus*), haddock (*Melanogrammus aeglefinus*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), American lobster (*Homarus americanus*), yellowtail flounder (*Limanda ferruginea*), black sea bass (*Centropristis striata*), cusk (*Brosme brosme*), and Atlantic sea scallop (*Placopecten magellanicus*).

Thirteen summer flounder were caught with individuals ranging from 44 to 65 cm (Figure 24). Thirteen windowpane flounder were also caught with individuals ranging from 24 to 32 cm (Figure 25). The other commercially important catches included 6 lobsters, 5 haddock, 5 winter flounder, 4 yellowtail, 2 cusk, 1 black sea bass and 1 scallop.

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 Kate Donnellan (A.I.S.), Susan Inglis (SMAST), Mike Coute (SMAST) and Travis Lowery (SMAST) for their help with data collection at sea.

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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) |
|------------|----------|-----------|---------------|--------------------|----------------|----------------|------------|----------------|-----------------|------------------|----------|--------------|---------------|----------------|-----------------|
| 1 | 522 | 8/28/2019 | Rain | 11-15 | SE | 0.5-1.25 | 13:31 | N 40° 35.723 | W 70° 24.360 | 32 | 13:51 | N 40° 35.593 | W 70° 23.066 | 33 | 125 |
| 2 | 522 | 8/28/2019 | Rain | 7-10 | SE | 0.5-1.25 | 15:02 | N 40° 35.928 | W 70° 21.603 | 33 | 15:22 | N 40° 36.377 | W 70° 20.426 | 32 | 125 |
| 3 | 522 | 8/28/2019 | Rain | 7-10 | SE | 0.5-1.25 | 16:17 | N 40° 38.771 | W 70° 18.644 | 29 | 16:37 | N 40° 38.792 | W 70° 17.340 | 29 | 125 |
| 4 | 522 | 8/28/2019 | Overcast | 7-10 | SE | 0.5-1.25 | 17:38 | N 40° 41.546 | W 70° 14.575 | 25 | 17:58 | N 40° 41.271 | W 70° 16.313 | 26 | 125 |
| 5 | 522 | 8/29/2019 | Rain | 11-15 | SE | 1.25-2.5 | 7:15 | N 40° 38.557 | W 70° 03.803 | 27 | 7:35 | N 40° 37.991 | W 70° 03.540 | 28 | 120 |
| 6 | 522 | 8/29/2019 | Overcast | 7-10 | SE | 1.25-2.5 | 8:33 | N 40° 37.675 | W 70° 08.547 | 28 | 8:53 | N 40° 37.781 | W 70° 09.800 | 27 | 120 |
| 7 | 522 | 8/29/2019 | Overcast | 7-10 | SE | 1.25-2.5 | 9:44 | N 40° 41.638 | W 70° 09.323 | 25 | 10:04 | N 40° 41.896 | W 70° 08.006 | 24 | 100 |
| 8 | 522 | 8/29/2019 | Obscured | 7-10 | SE | 1.25-2.5 | 10:49 | N 40° 44.884 | W 70° 06.414 | 21 | 11:09 | N 40° 44.719 | W 70° 07.687 | 21 | 100 |
| 9 | 522 | 8/29/2019 | Overcast | 11-15 | SE | 1.25-2.5 | 12:08 | N 40° 44.960 | W 70° 14.222 | 24 | 12:28 | N 40° 45.022 | W 70° 15.548 | 24 | 120 |
| 10 | 522 | 8/29/2019 | Overcast | 16-20 | SE | 1.25-2.5 | 13:26 | N 40° 43.296 | W 70° 18.604 | 25 | 13:46 | N 40° 43.288 | W 70° 20.048 | 26 | 120 |

Table 2: Tow parameters for each survey tow.

| Tow Number | Tow Area | Tow Duration (min.) | Tow Speed (Knots) | Tow Distance (nautical miles) | Bottom Temp. (°C) | Headrope Height (m) | Wing spread (m) | Door Spread (m) |
|---------------------------|----------|---------------------|-------------------|-------------------------------|-------------------|---------------------|-----------------|-----------------|
| 1 | 522 | 20.2 | 3.0 | 1.01 | 11.1 | 4.1 | 14.6 | 38.7 |
| 2 | 522 | 19.8 | 3.1 | 1.01 | 10.9 | 4.1 | 14.5 | 38.3 |
| 3 | 522 | 19.4 | 3.1 | 1.00 | 11.2 | 4.2 | 14.3 | 33.1 |
| 4 | 522 | 19.6 | 3.0 | 0.98 | 11.2 | 3.9 | 14.6 | 38.9 |
| 5 | 522 | 19.4 | 2.8 | 0.92 | 13.0 | 4.1 | 15.3 | 39.4 |
| 6 | 522 | 19.6 | 3.0 | 0.97 | 11.6 | 4.0 | 14.5 | 38.6 |
| 7 | 522 | 19.7 | 3.3 | 1.07 | 13.8 | 4.1 | 14.0 | 36.8 |
| 8 | 522 | 20.0 | 3.0 | 1.01 | 15.0 | 4.3 | 13.4 | 34.9 |
| 9 | 522 | 19.8 | 3.2 | 1.05 | 14.0 | 4.0 | 13.7 | 35.9 |
| 10 | 522 | 19.7 | 3.4 | 1.12 | 13.2 | 3.9 | 14.9 | 29.1 |
| Summary Statistics | | | | | | | | |
| | Minimum | 19.4 | 2.8 | 0.9 | 10.9 | 3.9 | 13.4 | 29.1 |
| | Maximum | 20.2 | 3.4 | 1.1 | 15.0 | 4.3 | 15.3 | 39.4 |
| | Mean | 19.7 | 3.1 | 1.0 | 12.5 | 4.1 | 14.4 | 36.4 |
| | St. Dev. | 0.2 | 0.2 | 0.1 | 1.5 | 0.1 | 0.5 | 3.3 |

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

| Species Name | Scientific Name | Total Weight (Kg) | Catch/Tow (Kg) | | % of Total Catch | Tows with Species Present |
|--------------------------|--------------------------------------|-------------------|----------------|------|------------------|---------------------------|
| | | | Mean | SEM* | | |
| Hake, Red | <i>Urophycis chuss</i> | 990.0 | 99.0 | 31.8 | 26.6 | 8 |
| Scup | <i>Stenotomus chrysops</i> | 771.8 | 77.2 | 39.1 | 20.8 | 6 |
| Skate, Little | <i>Leucoraja erinacea</i> | 668.2 | 66.8 | 13.5 | 18.0 | 10 |
| Butterfish | <i>Peprilus triacanthus</i> | 526.5 | 52.7 | 17.2 | 14.2 | 10 |
| Hake, Silver | <i>Merluccius bilinearis</i> | 482.0 | 48.2 | 9.8 | 13.0 | 10 |
| Squid, Atlantic Longfin | <i>Doryteuthis pealeii</i> | 70.4 | 7.0 | 1.9 | 1.9 | 10 |
| Dogfish, Smooth | <i>Mustelus canis</i> | 42.5 | 4.3 | 1.5 | 1.1 | 7 |
| Flounder, Fourspot | <i>Hippoglossina oblonga</i> | 34.1 | 3.4 | 1.1 | 0.9 | 9 |
| Monkfish | <i>Lophius americanus</i> | 29.0 | 2.9 | 1.1 | 0.8 | 7 |
| Alewife | <i>Alosa pseudoharengus</i> | 21.0 | 2.1 | 1.1 | 0.6 | 5 |
| Flounder, Summer (Fluke) | <i>Paralichthys dentatus</i> | 20.8 | 2.1 | 1.2 | 0.6 | 5 |
| Skate, Barndoor | <i>Dipturus laevis</i> | 16.0 | 1.6 | 0.6 | 0.4 | 8 |
| Sea Robin, Northern | <i>Prionotus carolinus</i> | 10.9 | 1.1 | 1.1 | 0.3 | 5 |
| Crab, Rock | <i>Cancer sp.</i> | 10.6 | 1.1 | 0.4 | 0.3 | 7 |
| Haddock | <i>Melanogrammus aeglefinus</i> | 7.9 | 0.8 | 0.5 | 0.2 | 3 |
| Dogfish, Spiny | <i>Squalus acanthias</i> | 4.8 | 0.5 | 0.4 | 0.1 | 3 |
| Flounder, Windowpane | <i>Scophthalmus aquosus</i> | 3.2 | 0.3 | 0.3 | 0.1 | 2 |
| Flounder, Winter | <i>Pseudopleuronectes americanus</i> | 2.4 | 0.2 | 0.2 | 0.1 | 3 |
| Flounder, Gulfstream | <i>Citharichthys arctifrons</i> | 2.2 | 0.2 | 0.1 | 0.1 | 7 |
| Lobster, American | <i>Homarus americanus</i> | 1.3 | 0.1 | 0.1 | 0.0 | 3 |
| Flounder, Yellowtail | <i>Limanda ferruginea</i> | 0.4 | 0.04 | 0.03 | 0.0 | 2 |
| Black Sea bass | <i>Centropristis striata</i> | 0.4 | 0.04 | | 0.0 | 1 |
| Menhaden, Atlantic | <i>Brevoortia tyrannus</i> | 0.4 | 0.04 | | 0.0 | 1 |
| Hake, Spotted | <i>Urophycis regius</i> | 0.3 | 0.03 | 0.02 | 0.0 | 2 |
| Cusk | <i>Brosme brosme</i> | 0.2 | 0.02 | 0.01 | 0.0 | 2 |
| Mackerel, Atlantic | <i>Scomber scombrus</i> | 0.1 | 0.01 | | 0.0 | 1 |
| Sea Scallop | <i>Placopecten magellanicus</i> | 0.1 | 0.01 | | 0.0 | 1 |
| Ocean Pout | <i>Zoarces americanus</i> | 0.0 | 0.00 | | 0.0 | 1 |
| Total | | 3717.4 | | | | |

*SEM is an acronym for Standard Error of the Mean

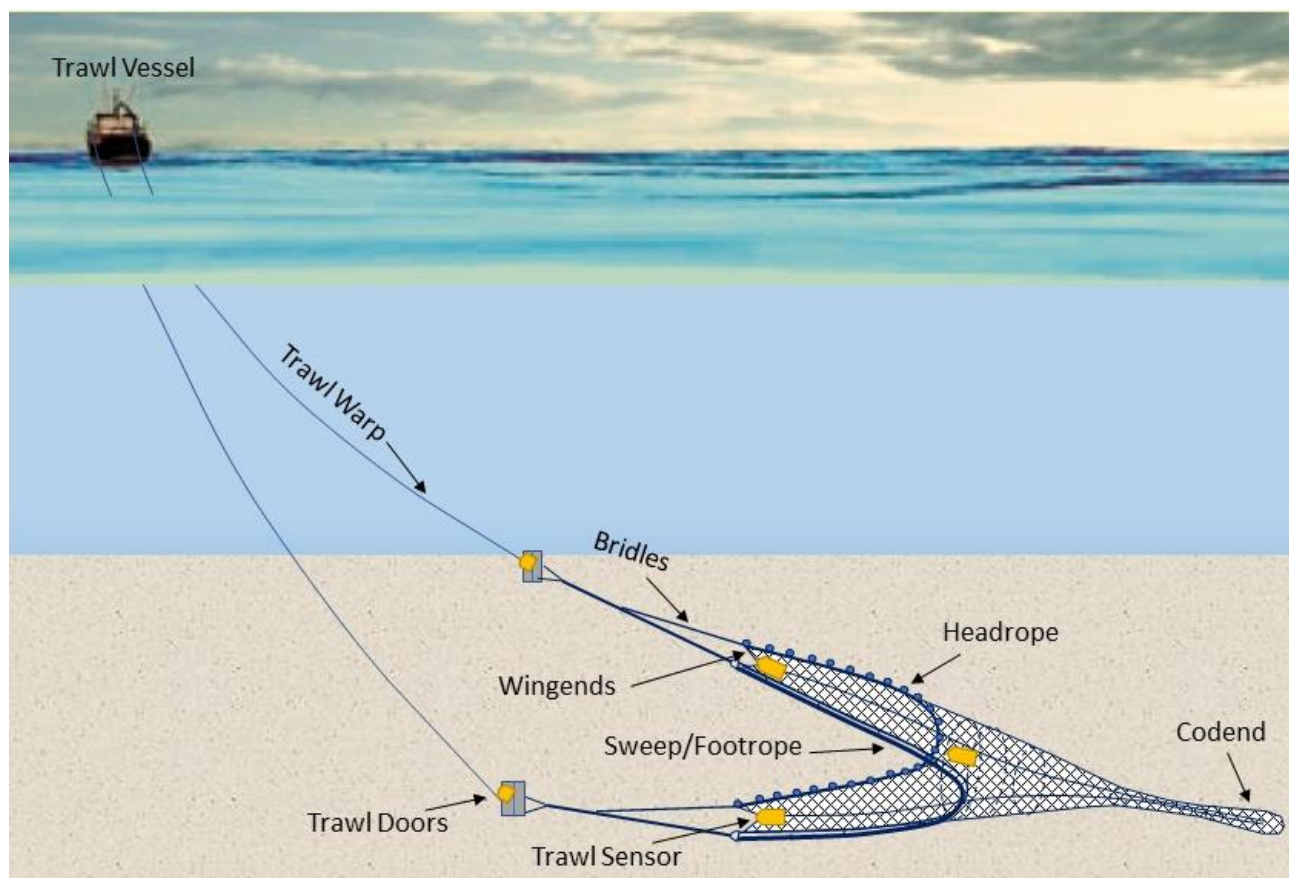


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

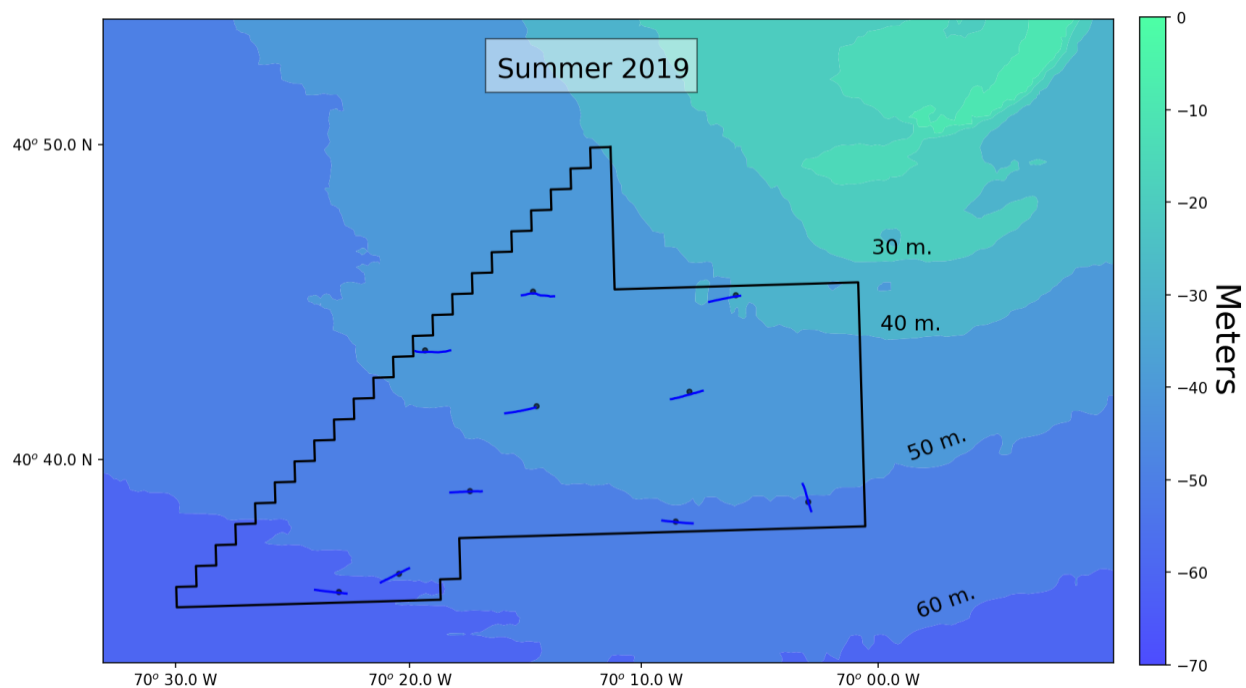


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 522 Lease Area.

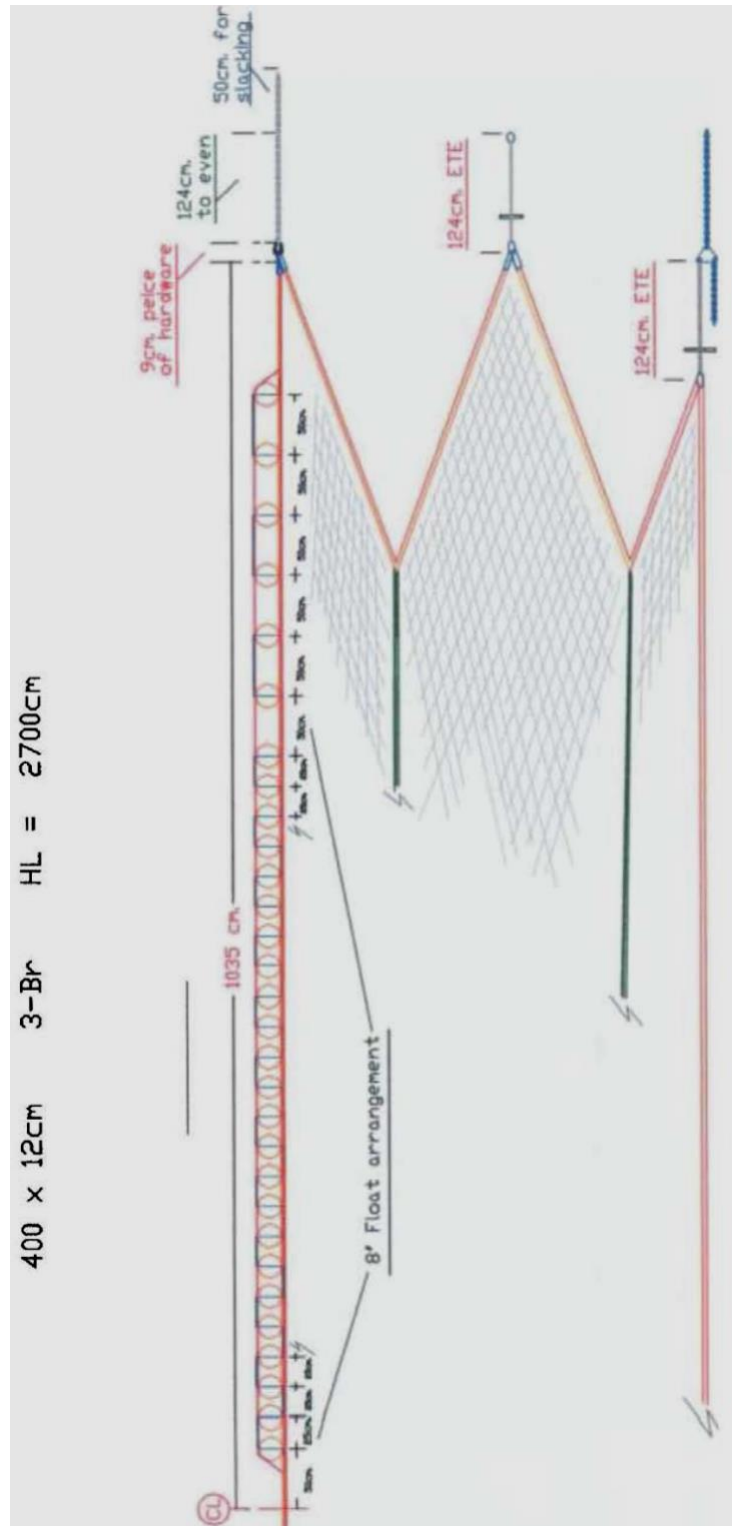


Figure 5: Headrope and rigging plan for the survey trawl (Bonsek et al. 2008)

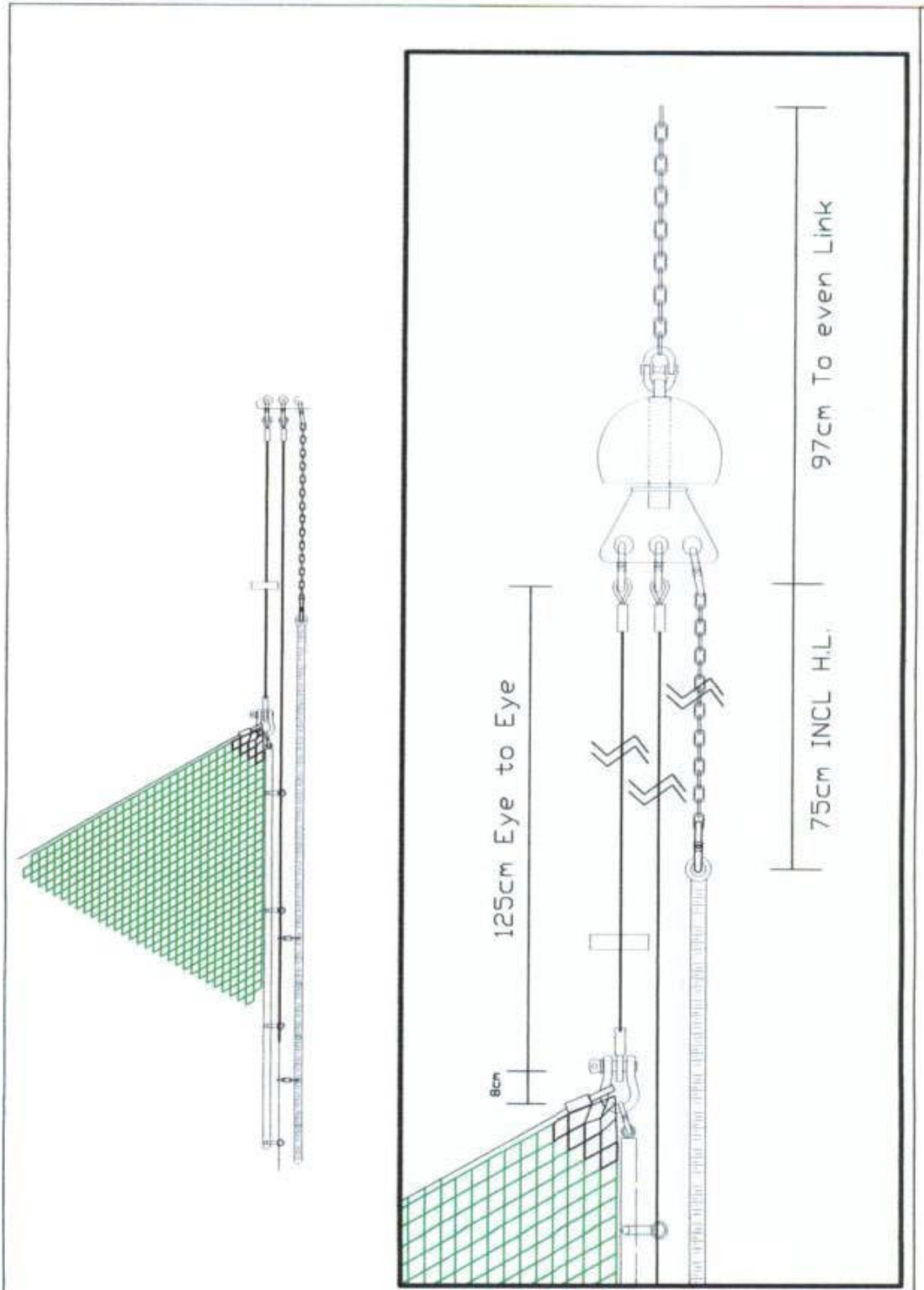


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonsek et al. 2008).



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

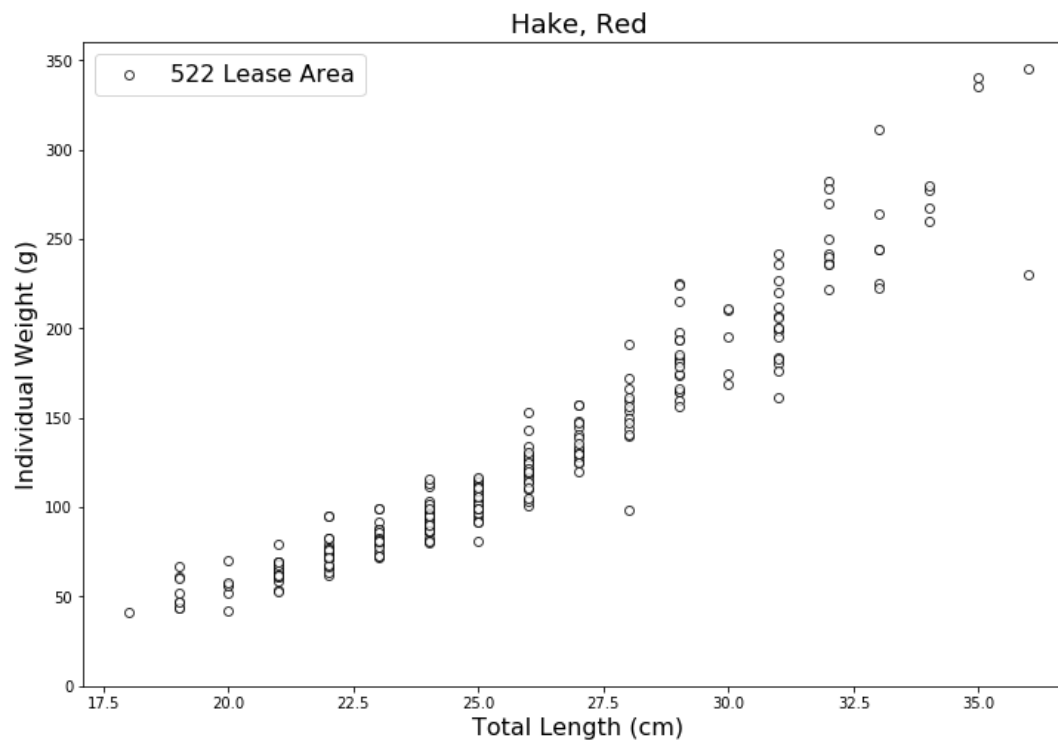
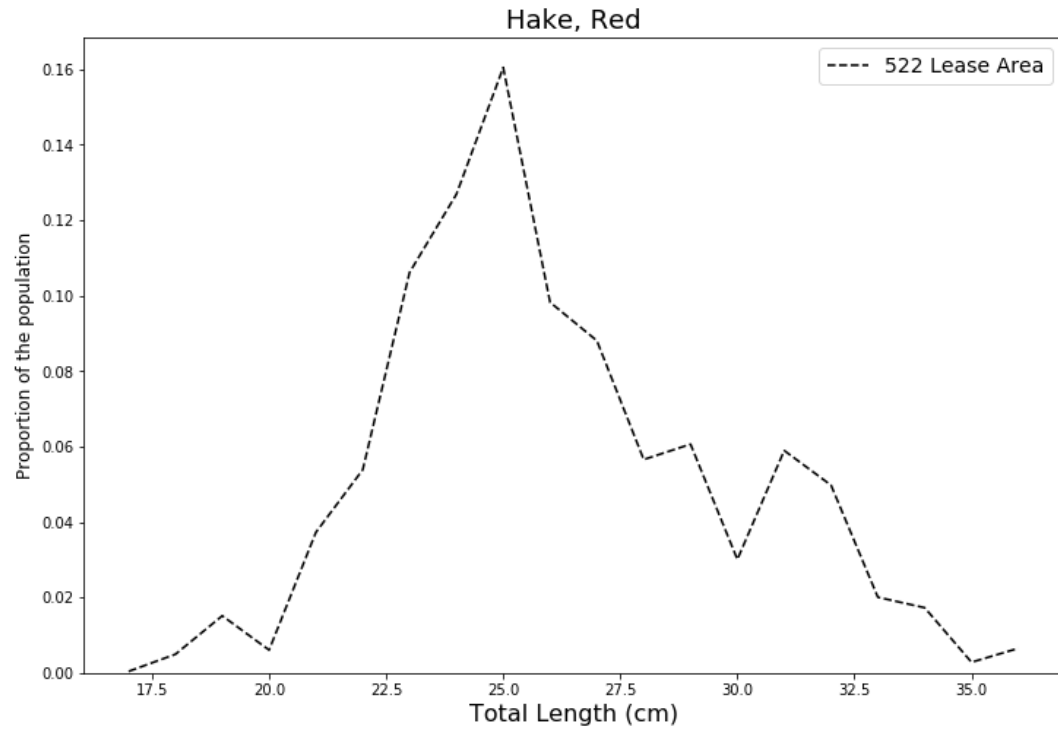


Figure 8: Population structure of red hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

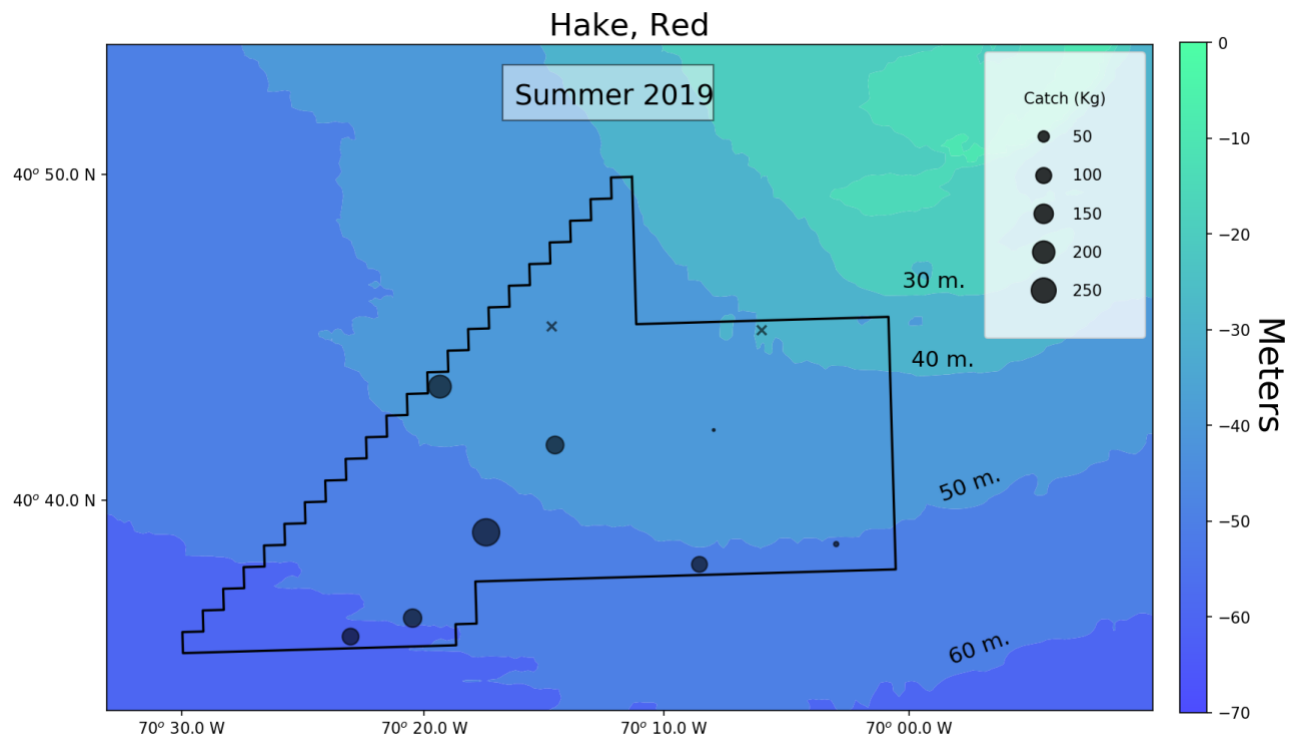


Figure 9: Distribution of the catch of red hake in the 522 Lease Area. Tows with zero catch are denoted with an X.

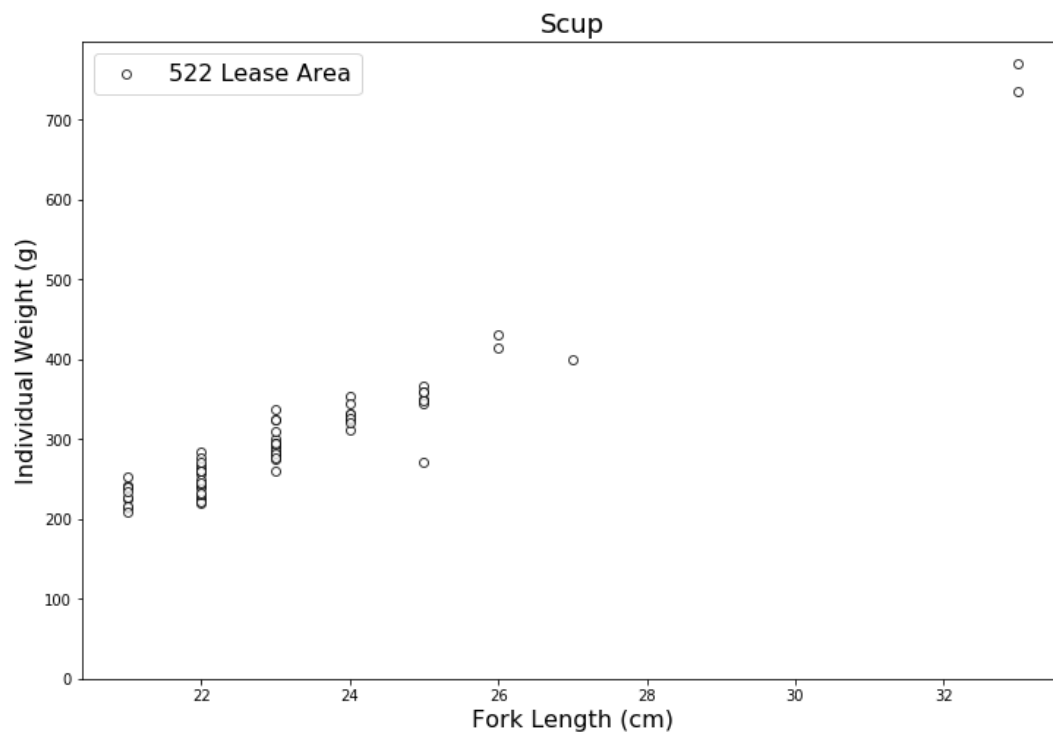
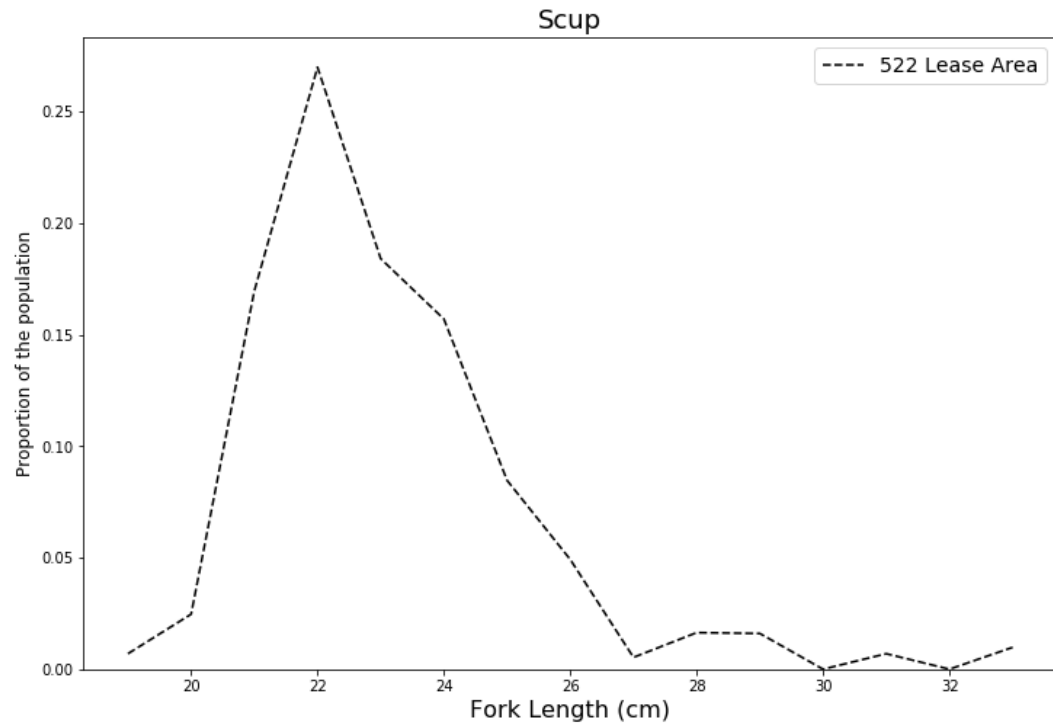


Figure 10: Population structure of scup in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

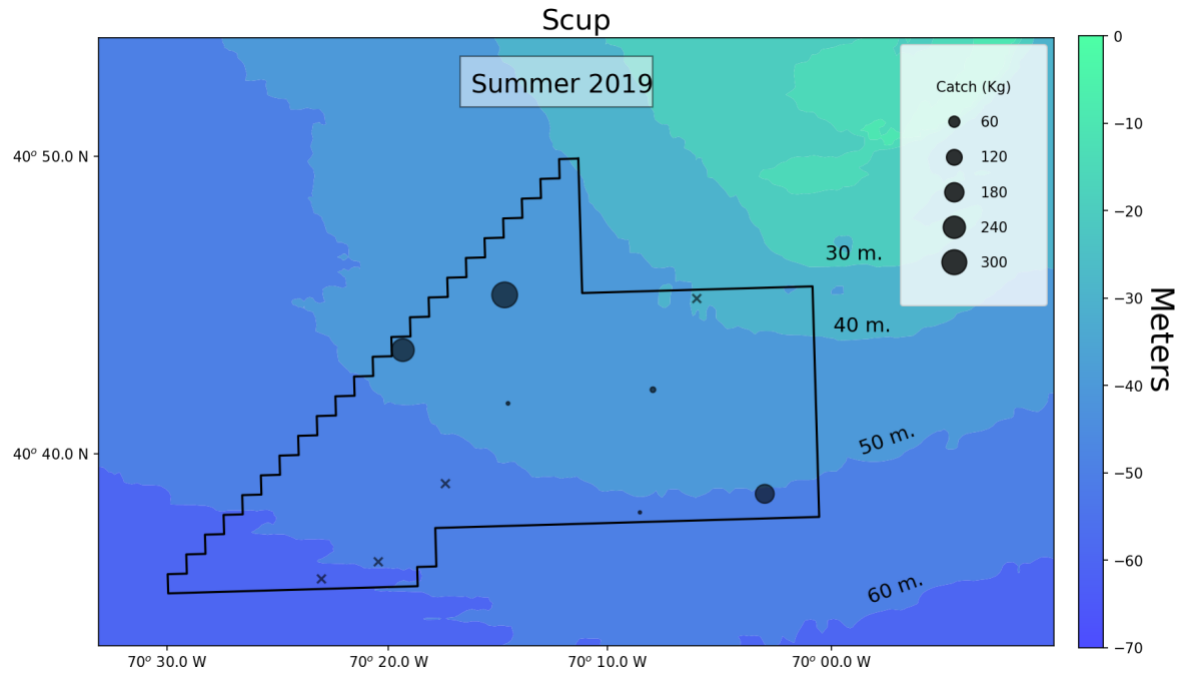


Figure 11: Distribution of the catch of scup in the 522 Lease Area. Tows with zero catch are denoted with an X.

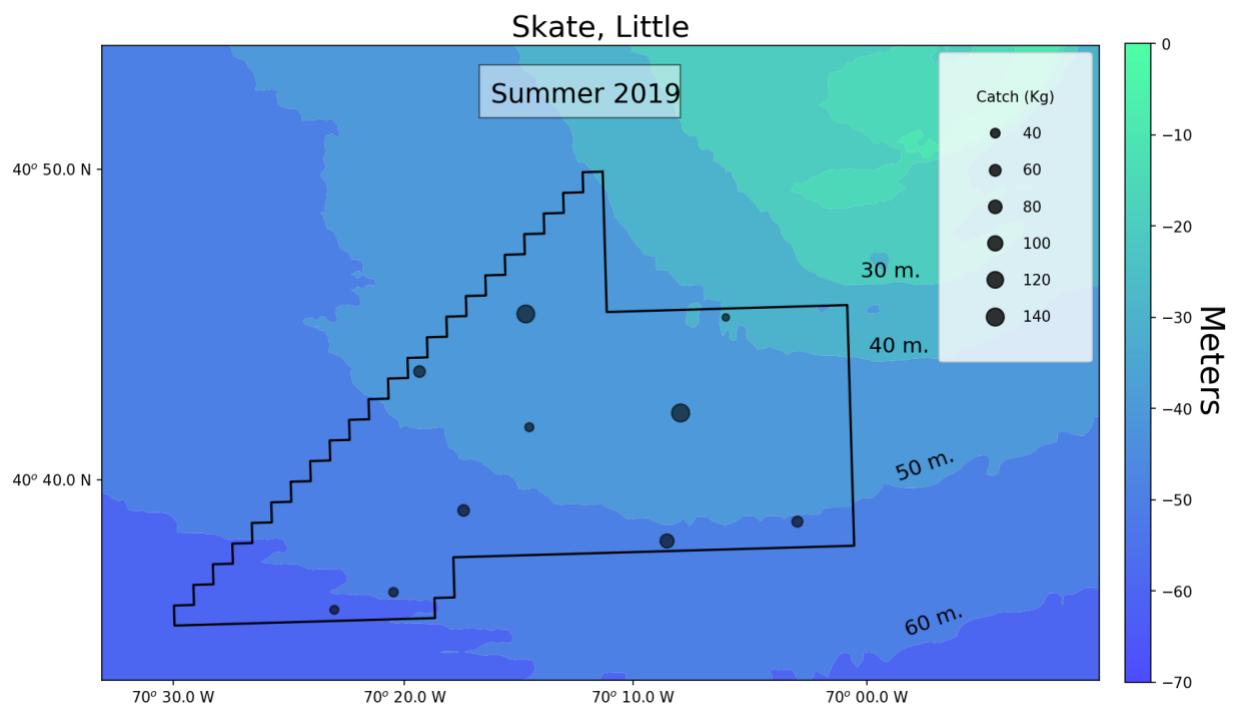


Figure 12: Distribution of the catch of little skate in the 522 Lease Area.

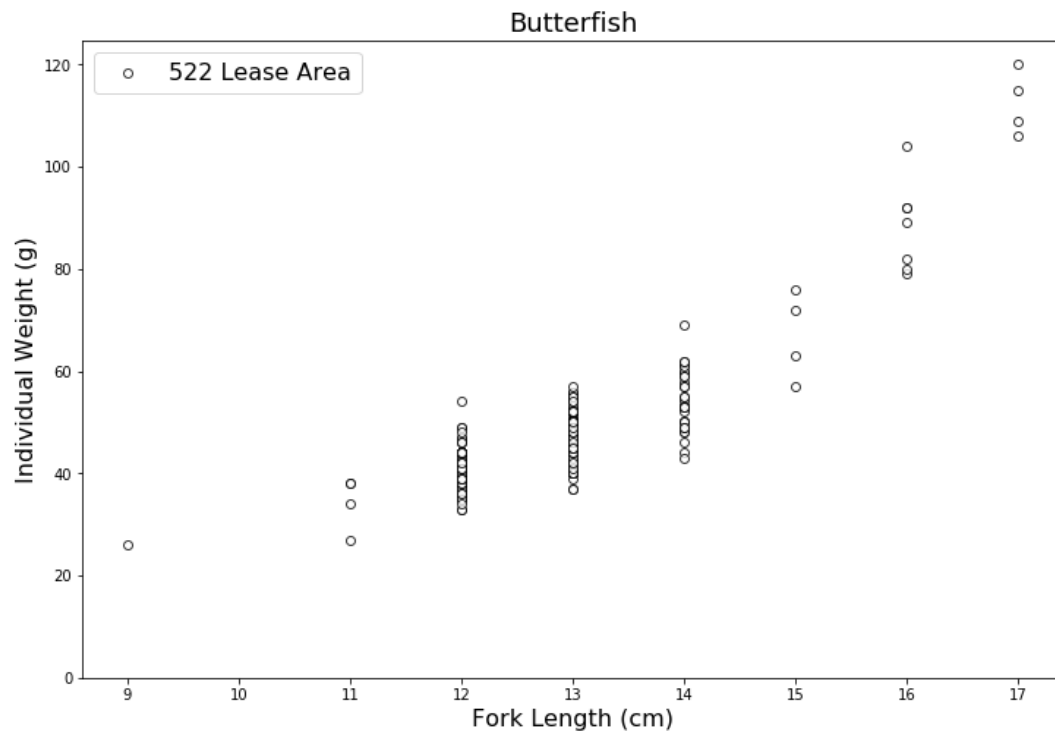
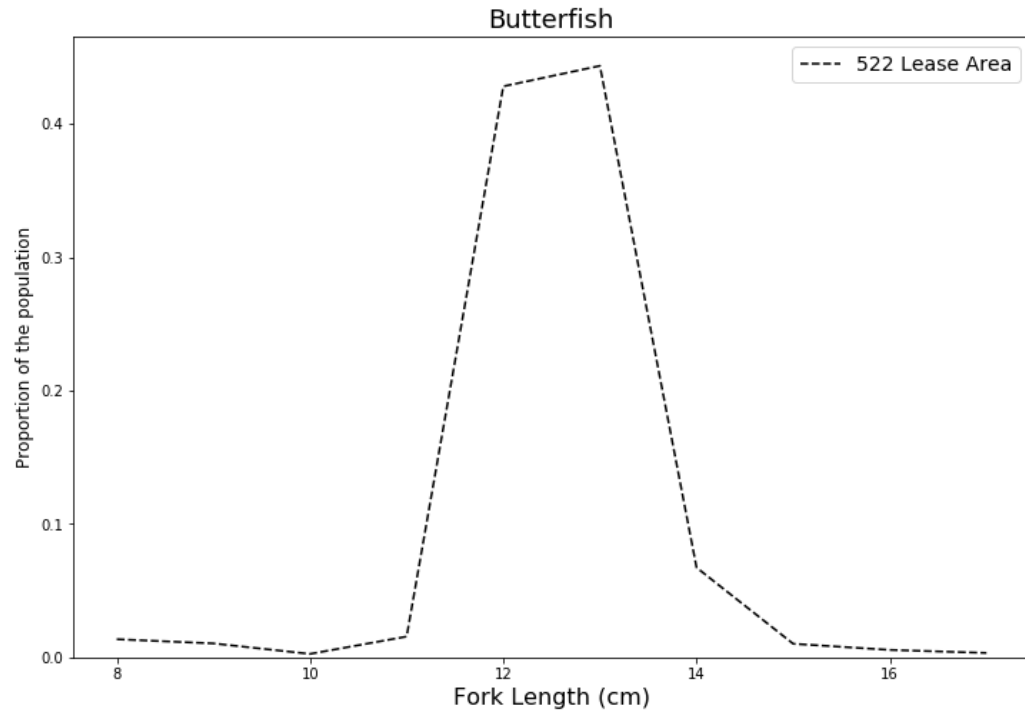


Figure 13: Population structure of butterfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

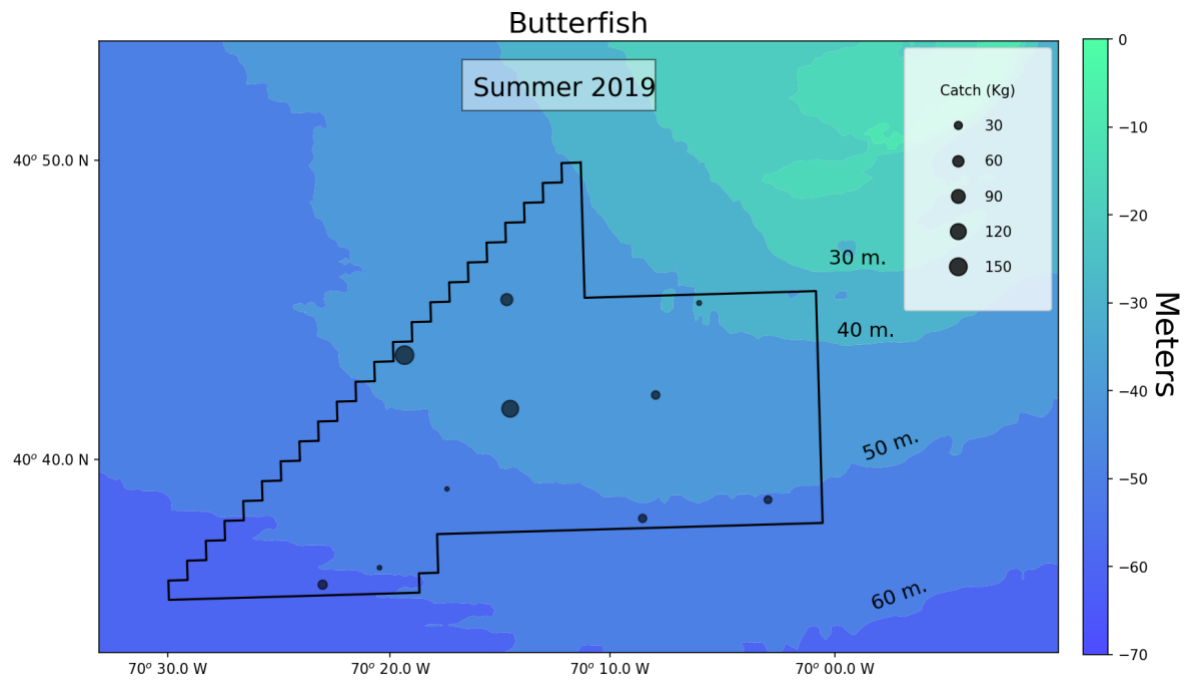


Figure 14: Distribution of the catch of butterfish in the 522 Lease Area.

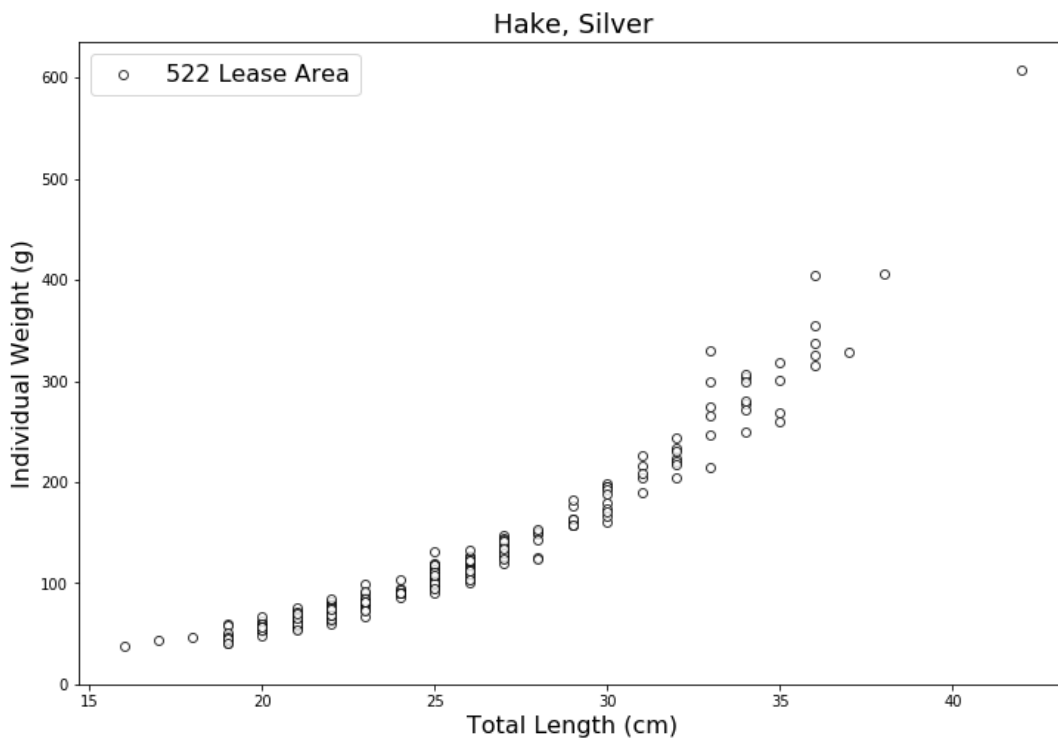
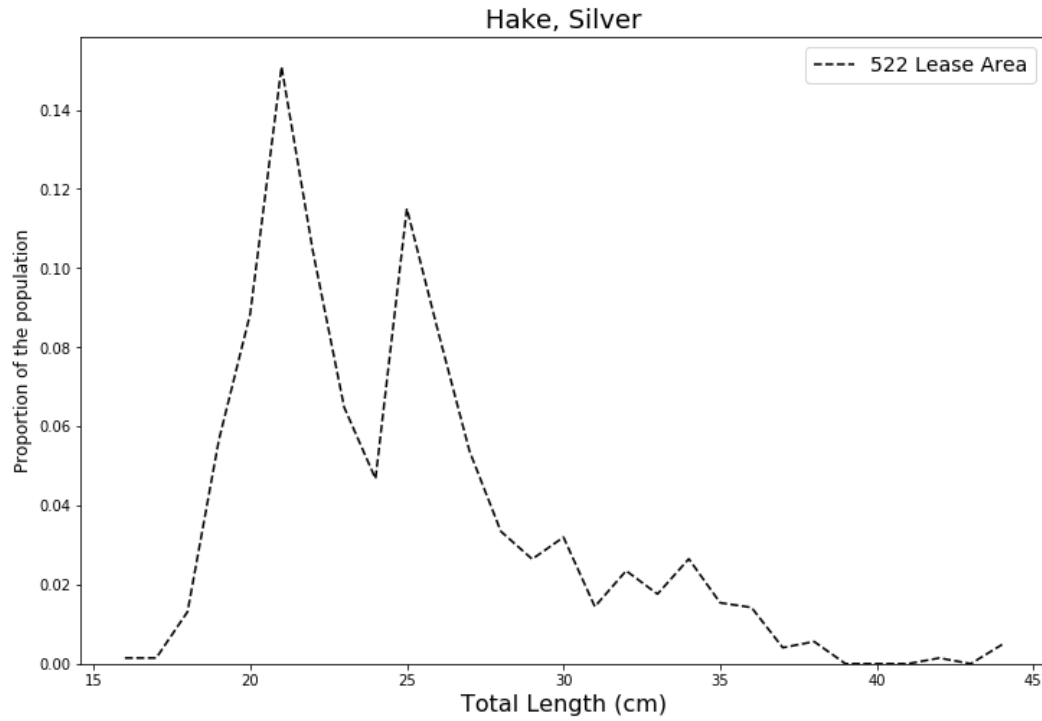


Figure 15: Population structure of silver hake in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

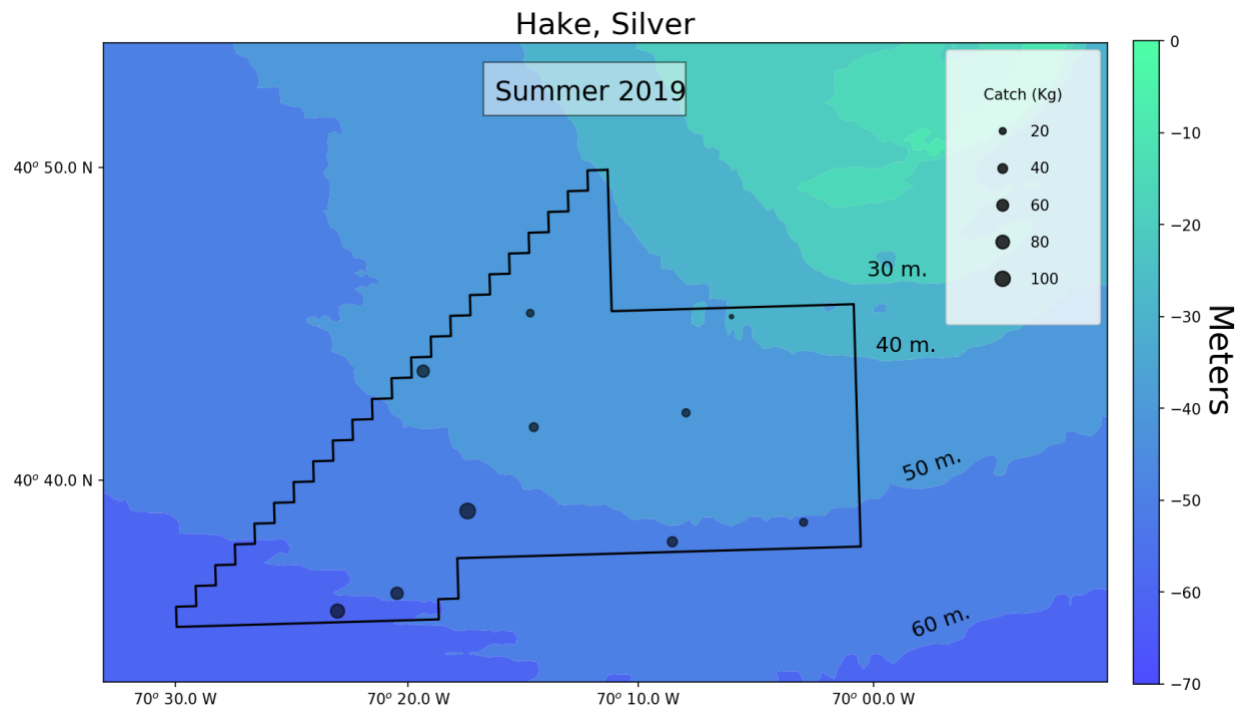


Figure 16: Distribution of the catch of silver hake in the 522 Lease Area.

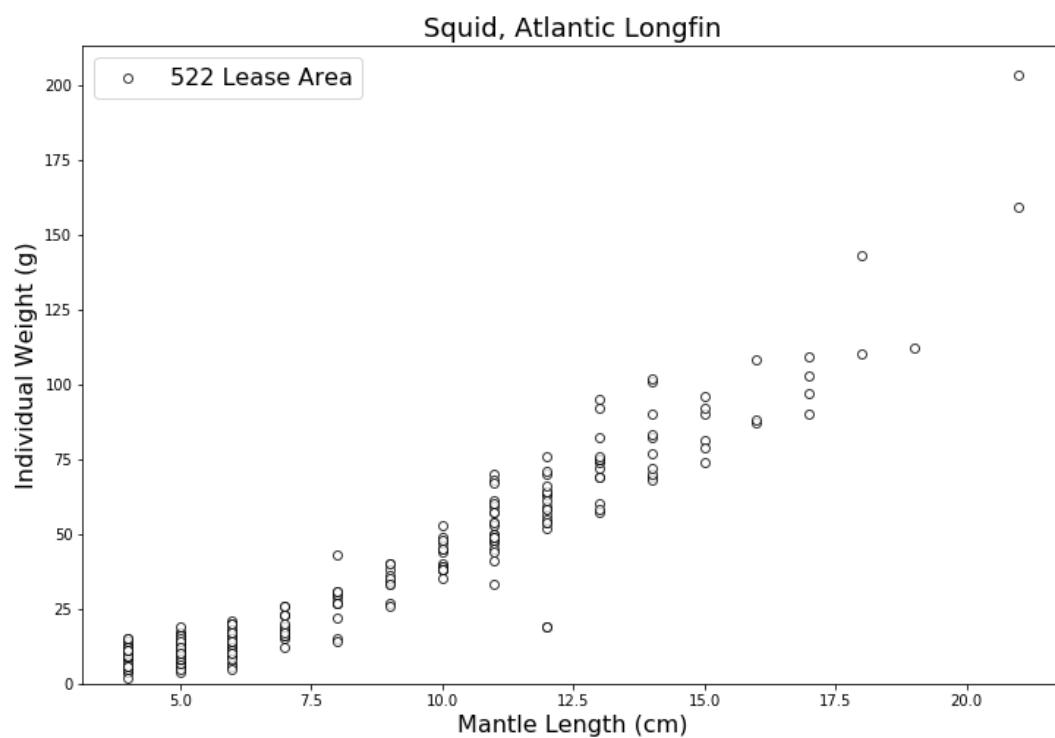
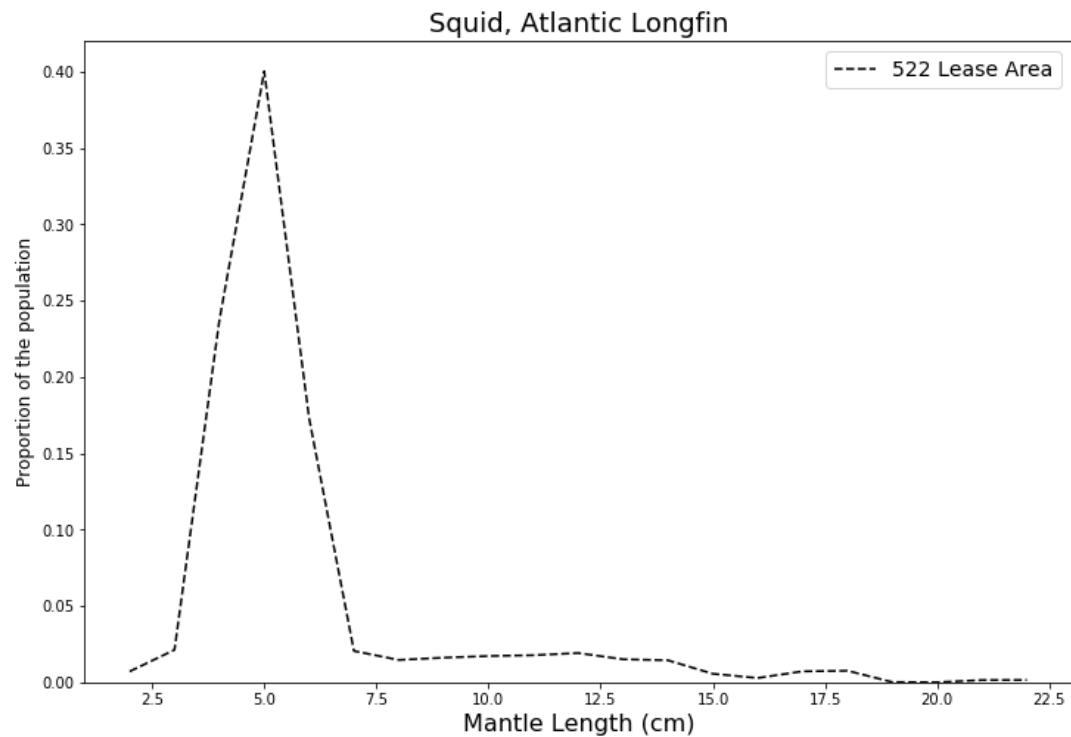


Figure 17: Population structure of longfin squid in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

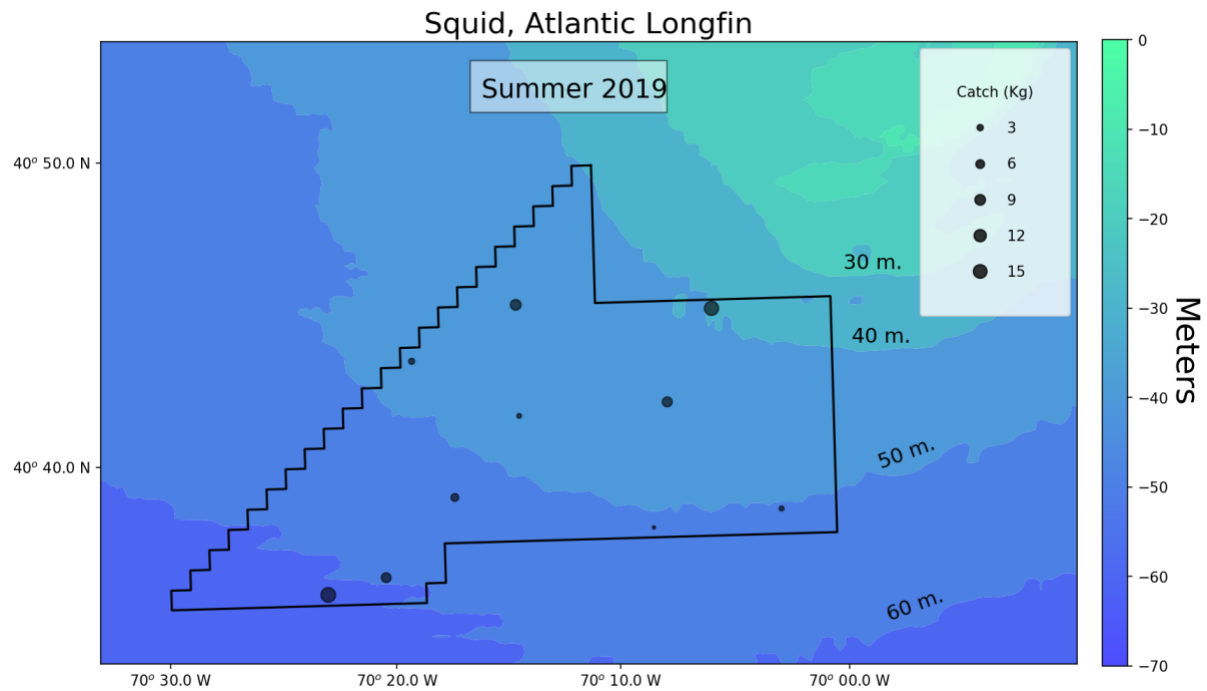


Figure 18: Distribution of the catch of longfin squid in the 522 Lease Area.

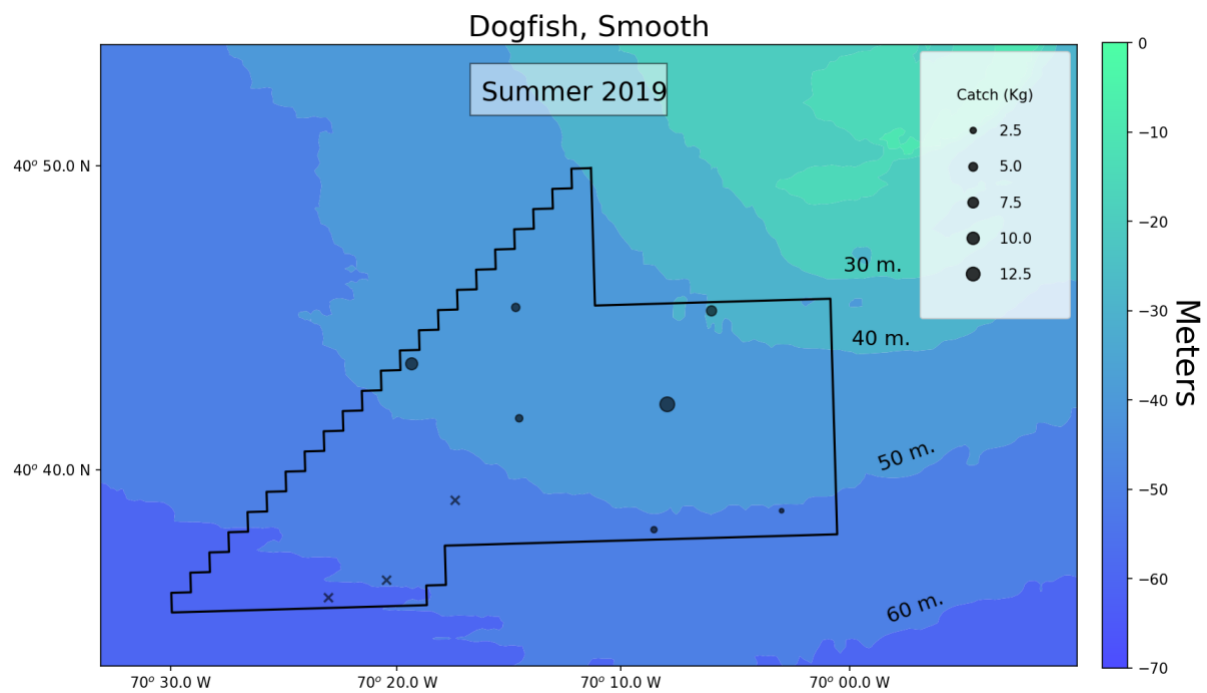


Figure 19: Distribution of the catch of smooth dogfish in the 522 Lease Area. Tows with zero catch are denoted with an X.

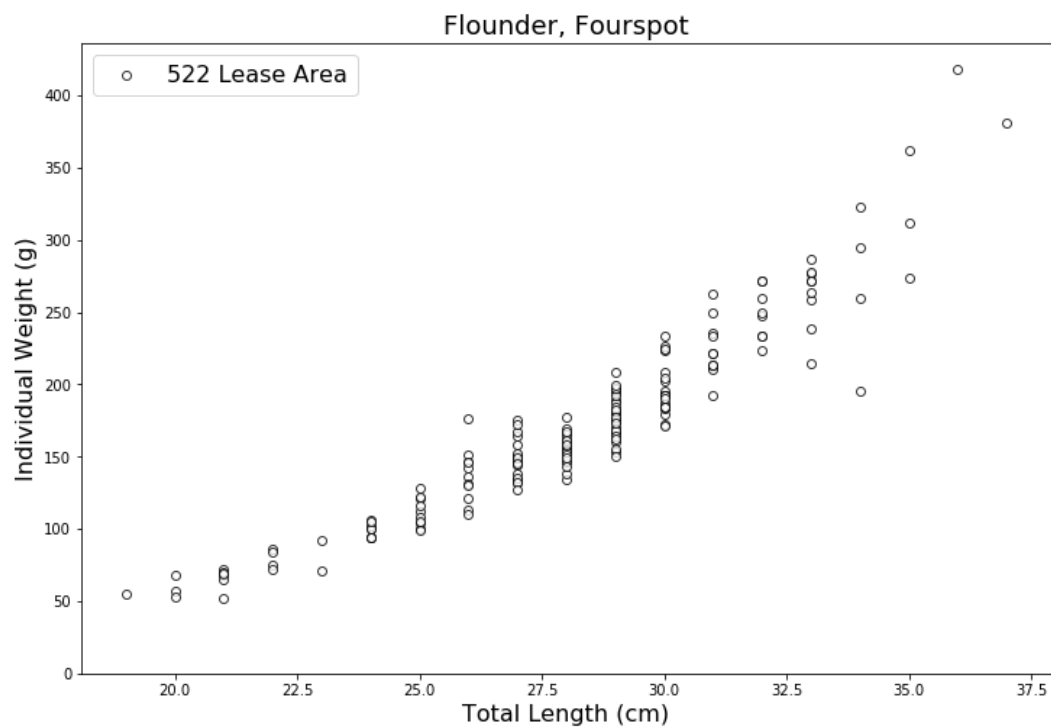
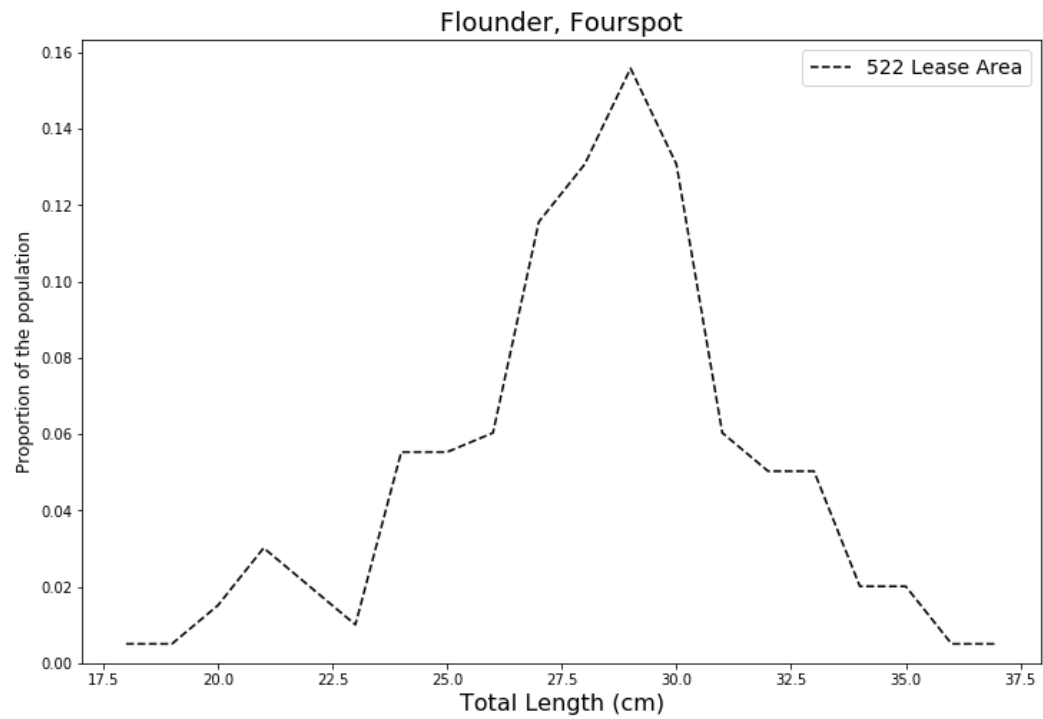


Figure 20: Population structure of fourspot flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

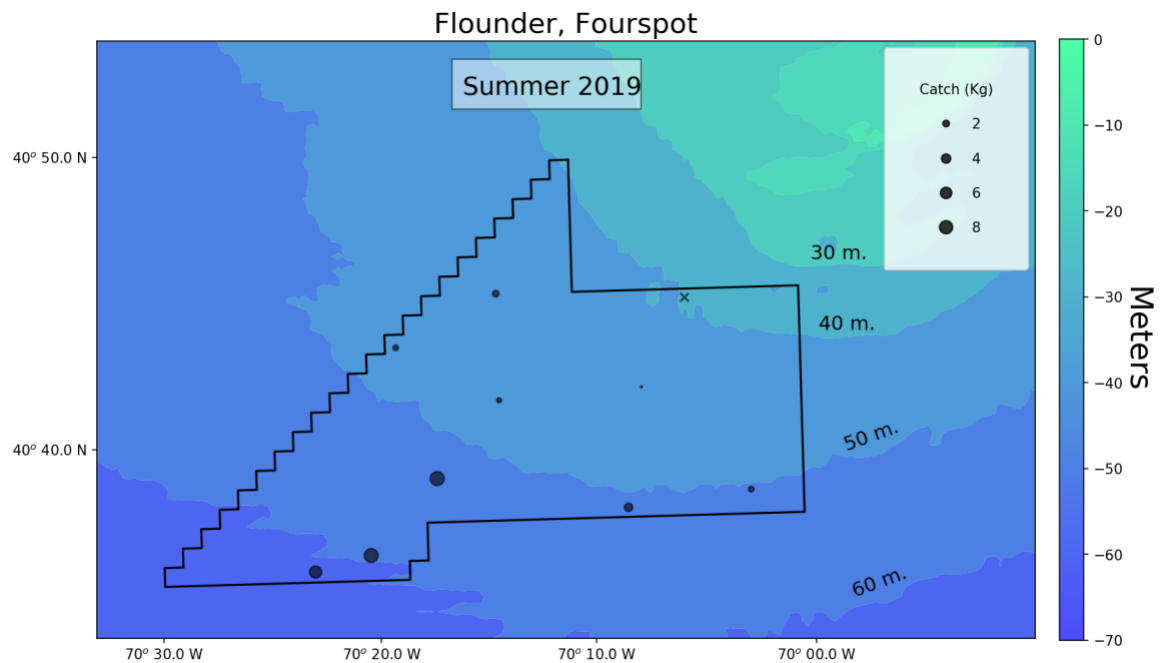


Figure 21: Distribution of the catch of fourspot flounder in the 522 Lease Area. Tows with zero catch are denoted with an X.

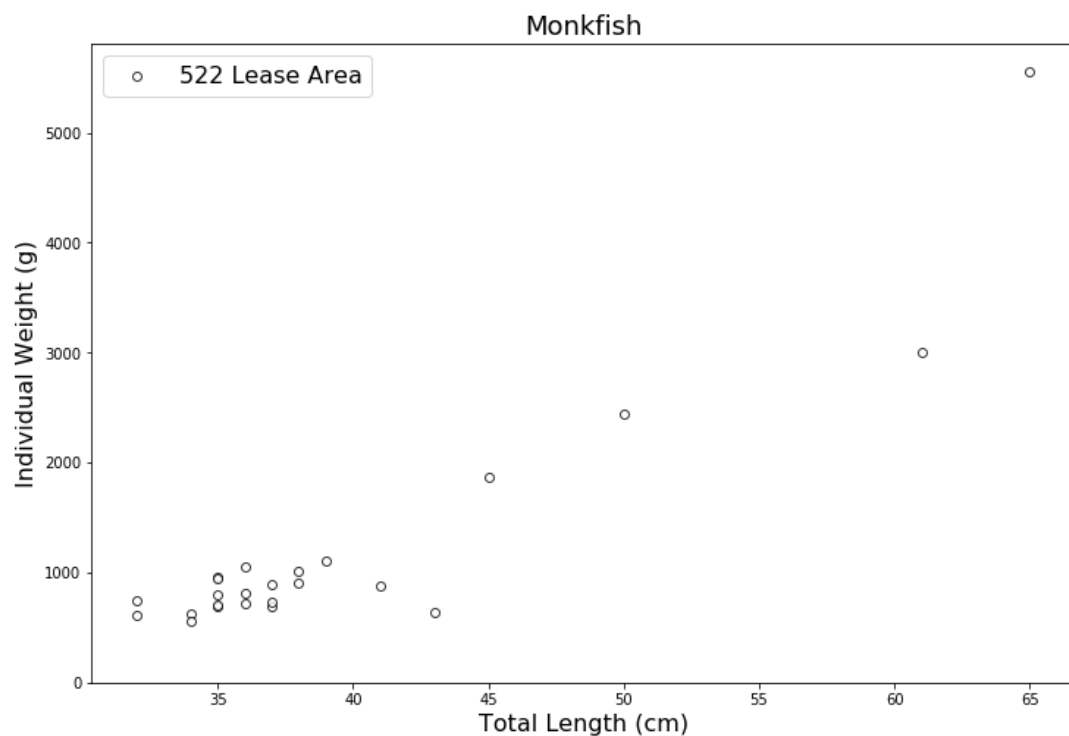
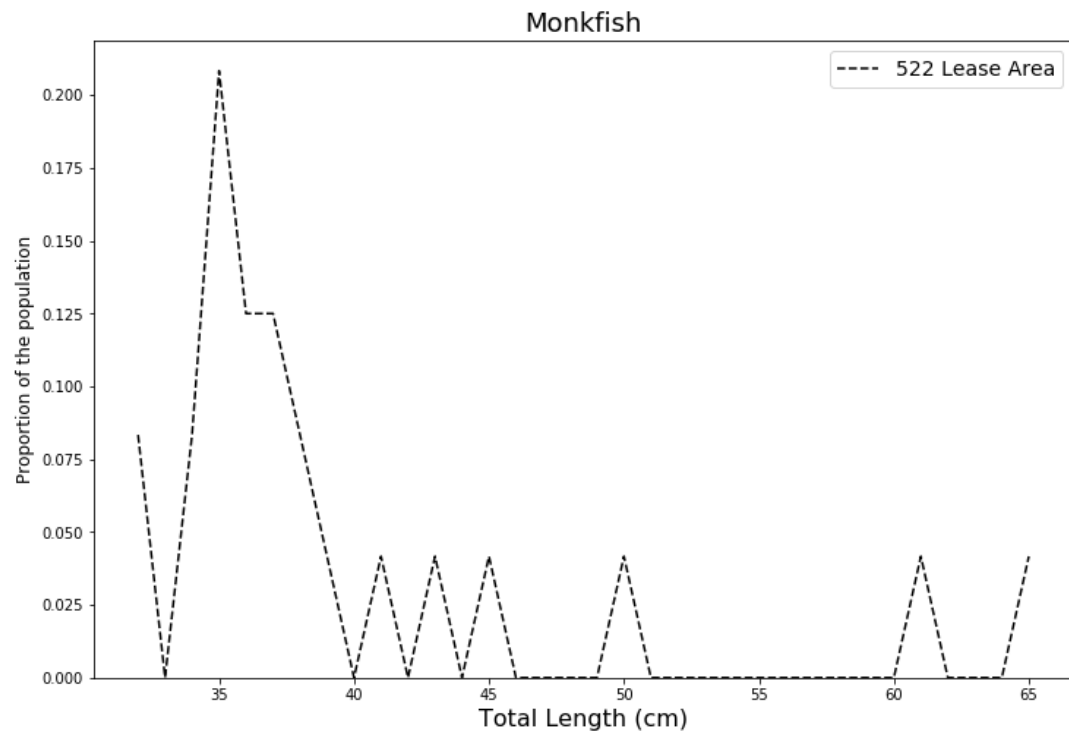


Figure 22: Population structure of monkfish in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

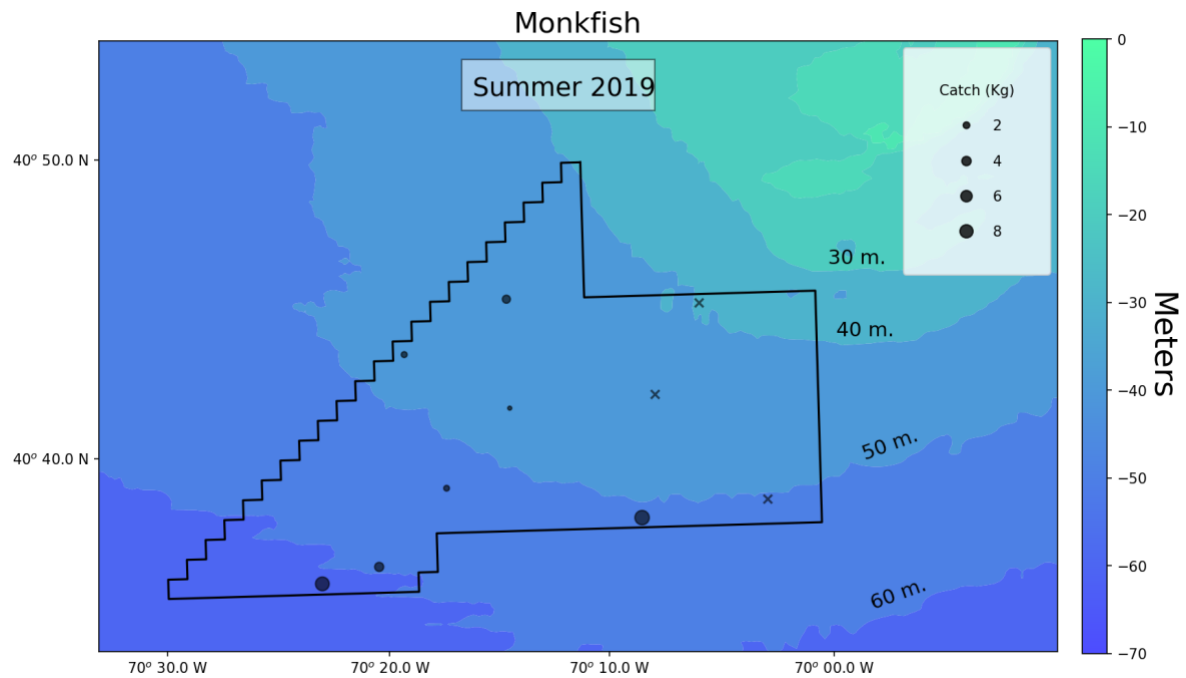


Figure 23: Distribution of the catch of monkfish in the 522 Lease Area. Tows with zero catch are denoted with an X.

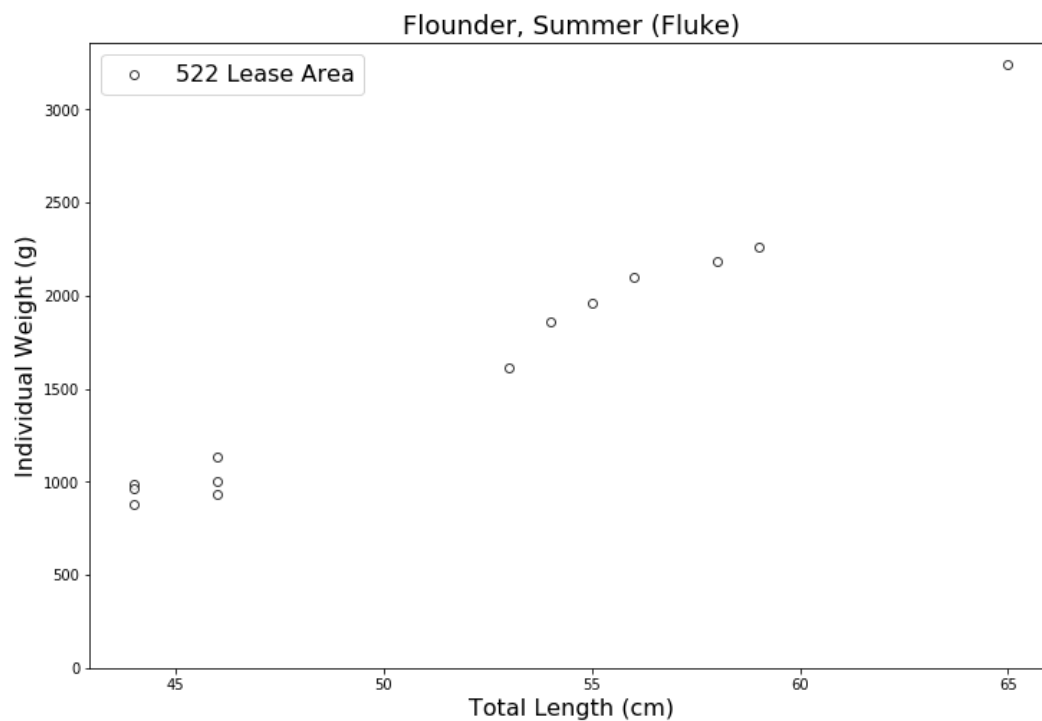
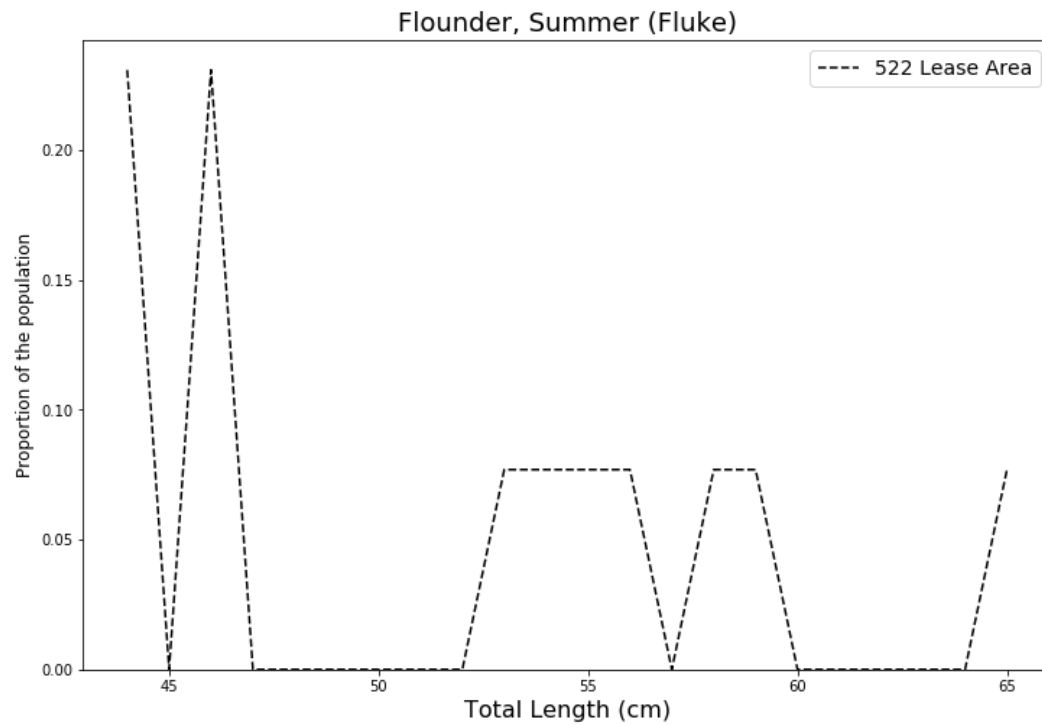


Figure 24: Population structure of summer flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

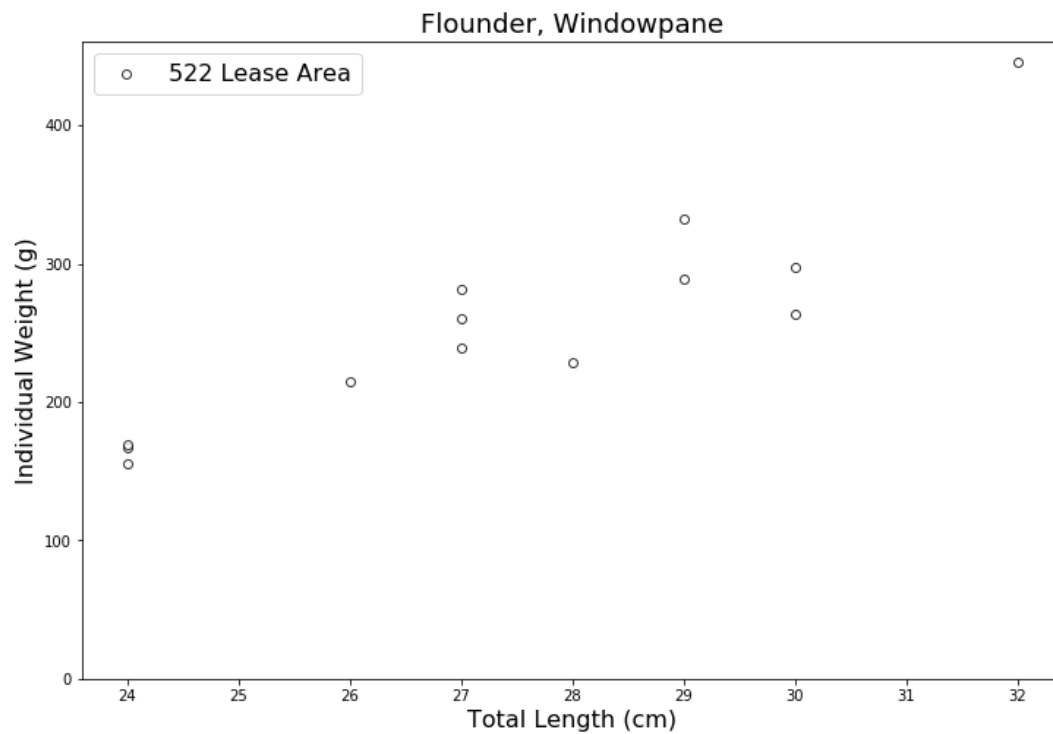
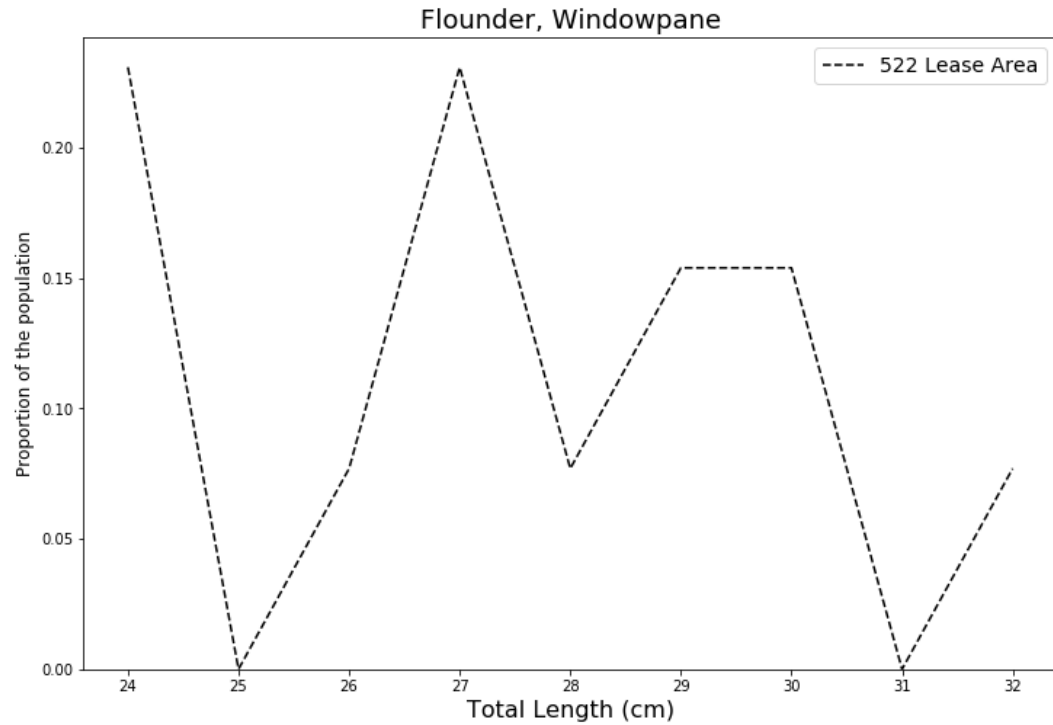


Figure 25: Population structure of windowpane flounder in the 522 Lease Area as determined by the length-frequency data (top) and length-weight relationships (bottom).