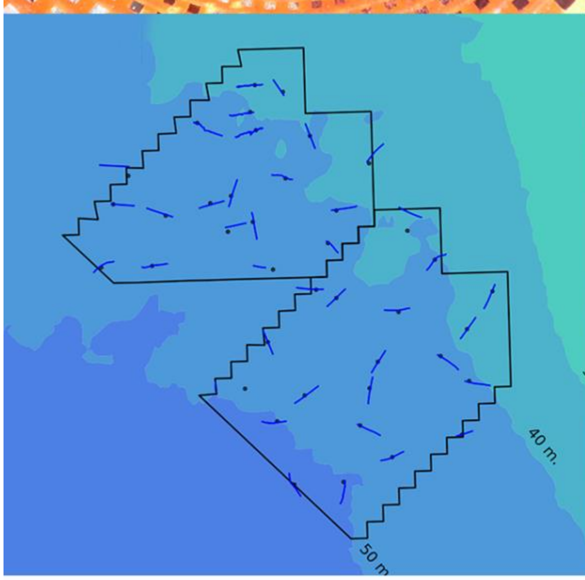
VINEYARD WIND

Vineyard Wind Demersal Trawl Survey





Quarterly Report

501 North Study Area

Fall 2019 (October - December)

VINEYARD WIND DEMERSAL TRAWL SURVEY

Fall 2019 Seasonal Report

501 North Study 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

501 North Study Area

Progress Report #3

October 1 – December 31, 2019

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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
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1. Introduction

In 2015, Vineyard Wind LLC leased a 675 km^2 area for renewable energy development on the Outer Continental Shelf, Lease Area OCS-A 0501, located approximately 14 miles south of Martha's Vineyard off the south coast of Massachusetts. Vineyard Wind is developing the northern portion of Lease Area OCS-A 0501 and fisheries studies are being conducted in a 250 km^2 area referred to as the "501 North (501N) Study Area," which is the focus of this report. Vineyard Wind is also conducting fisheries studies within the southern portion of Lease Area OCS-A 0501 (the "501 South Study Area") and within Lease Area OCS-A 0522; 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 501N Study 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, 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 501S Study Area and 522 Lease 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 using the BACI framework as recommended by BOEM (BOEM, 2013). Tow locations within the Vineyard Wind 501N Study Area were selected using a systematic random sampling design. The 501N Study Area (249.3 km^2) was sub-divided into 20 sub-areas (each ~12.5 km^2), and one trawl tow was made in each of the 20 sub-areas. This was designed to ensure adequate spatial coverage throughout the survey area. The starting location within each area were randomly selected (Figure 2).

An area located to the east of the 501N Study Area was established as a control region (306 km^2). The selected region has similar depth contours, bottom types, and benthic habitats to the 501N Study Area. An additional 20 tows were completed in the Control Area. Tow locations were selected in the same manner as the 501N Study Area, using the systematic random sampling design.

The selection of 20 tows in each area was based on a preliminary power analysis conducted using catch data from a scoping survey (Stokesbury and Lowery, 2018). The results indicated that 20 tows within the 501N Study Area and a similar number in the Control Area would allow for a 95% chance of detecting a 25% change in the population of the most abundant species (i.e. scup, butterfish, silver hake, and summer flounder). When distributing the survey effort, randomly selecting multiple tow locations across the Study Area and Control Area accounts for spatial variations in fish populations. Alternatively, multiple tows could be sampled from a single tow track, which would assume that the tow track is representative of the larger ecosystem. The distributed approach, applied here, assumed that the catch characteristics across each area represents the ecosystem. Additionally, surveying each site seasonally accounts for temporal variations in fish populations. Accounting for spatial and temporal variations in fish assemblages reduces the assumptions of the population dynamics while increasing the power to detect changes due to the impacting activities. This methodology is commonly referred to in the scientific literature as the “beyond-BACI” approach (Underwood, 1991)

The survey will have a sampling density of 1 station per 12.5 km^2 (3.6 sq. nautical miles) in the 501N Study Area and 1 station per 15.3 km^2 (4.5 sq. nautical miles) in the Control Area. As previously mentioned, the NEAMAP nearshore survey samples at a density of one station per ~100 km^2 (30 sq. nautical miles).

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. Two trips to the survey area were made (Trip 1: November 5 - 11, 2019; Trip 2: November 13 – 16, 2019), during which all planned tows were completed.

Surveys were alternated daily between the Control Area and 501N Study Area. 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 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

Twenty tows were successfully completed in both the 501N Study Area and the Control Area (Figure 2, Table 1). Operational parameters were similar between these two areas (Table 2). Tow durations averaged 18.8 ± 2.8 minutes (mean ± one standard deviation) in the 501N Study Area and 19.6 ± 1.1 minutes in the Control Area. Due to the heavy volume of spiny dogfish, and concerns over the integrity of the net, three tows were shortened in the 501N Study Area to 15 minutes. This is allowed under the NEAMAP protocol. One tow was shortened to 10 minutes over concerns that we would not be able to get the catch onboard the vessel. The tow was still conducted to ensure that the area of high abundance was still sampled.

Tow distances averaged 0.9 ± 0.2 nautical miles in the 501N Study Area giving an average tow speed of 3.0 ± 0.2 knots. Similarly tow distance averaged 1.0 ± 0.1 nautical miles in the Control Area giving an average tow speed of 3.0 ± 0.1 knots.

The seafloor in both areas follows a northeast to southwest depth gradient with the shallowest tow along the northeast edge (~35 meters). Depth increased to a maximum of 50 meters along the southwest boundary. Bottom water temperature tended to vary across the tows. Warmer water (~16°C) was observed in both shallow (38 meters) and deep tows (51 meters). Similarly, cold water tows (12-13°C) were observed between 38 and 50 meters (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 34.8 ± 0.7 m (range: 33.4 – 36.0 m.) for tows in the 501N Study Area and 35.2 ± 0.8 (range: 33.2 – 36.0 m.) in the Control Area. The doorspread was within the acceptable tolerance limits for all tows. Wing spread averaged 13.5 ± 0.4 m for tows in the 501N Study Area (range: 13.0 – 14.4 m) and 13.7 ± 0.3 m for tows in the Control Area (range: 13.1 – 14.6 m). All tows were within the acceptable tolerance limits for wingspread. Headline height averaged 4.4 ± 0.3 m for tows in the Study Area (range: 4.0 – 5.1 m) and 4.3 ± 0.3 m for tows in the Control Area (range: 4.0 – 5.0). Headline height was targeted to be between 5.0 and 5.5 m with acceptable deviations between 4.5 and 6.1 m. The changes made to the trawl in the summer and fall surveys have increased the average headline height by ~0.2-0.3 m. While wing spread data indicated the net was within acceptable tolerances, during some tows the headline height is still lower than desired. Most of the tows require an additional 0.1-0.3 m to be within the acceptable range. While additional improvements are needed, 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 (Table 3). As a result, we believe that the survey results are representative of the fish community in the area, however additional testing is being conducted to increase the headline height to within the acceptable range.

3.2 Catch Data

3.2.1 501N Study Area

In the 501N Study Area, a total of 30 species were caught over the duration of the survey (Table 3). Catch volume ranged from 197.8 kg/tow to 4279.4 kg/tow with an average of 1171.5 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. Spiny dogfish accounted for 74% of the total catch weight. The six most abundant species (spiny dogfish, little skate, scup, silver hake, winter skate and red hake) accounted for 98% 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 predominate species observed accounting for 74% of the total catch weight. Individuals ranged in size from 46 to 86 cm with a unimodal distribution peaking at 66 cm (Figure 8). Dogfish were observed in 19 of the 20 tows. Catch rates averaged 860.7 ± 258.6 kg/tow (mean ± SEM, range: 0 – 4161.7 kg/tow). Spiny dogfish were observed throughout the 501N Study Area with the highest catches observed in the northwest (Figure 9).

Little skate (*Leucoraja erinacea*) was the second most abundant species. Little skates ranged in size from 12 to 37 cm (disk width) with a unimodal size distribution peaking at 25 cm (Figure 10). Little skates were observed in every tow at an average catch rate of 118.4 ± 14.0 kg/tow (range: 17.6 – 249.8 kg/tow). Little skates were caught throughout the 501N Study Area (Figure 11).

Scup (*Stenotomus chrysops*), was the third most abundant species observed. Scup ranged in length from 7 to 31 cm with a narrow unimodal peak at 22 cm (Figure 12). Scup were observed in every tow at an average catch rate of 63.9 ± 13.2 kg/tow (range: 0.6 – 275.2 kg/tow). Scup were caught throughout the 501N Study Area (Figure 13).

Silver hake (*Merluccius bilinearis*), also commonly referred to as whiting, was the fourth most abundant species observed. Silver hake ranged in length from 6 to 46 cm. Silver hake had a bimodal size distribution consisting of a small peak at 9 cm and a large peak at 22 cm (Figure 14). Silver hake were observed in every tow at an average catch rate of 47.5 ± 10.7 kg/tow (range: 5.9 – 234.0 kg/tow). Silver hake were caught throughout the 501N Study Area (Figure 15).

Winter skate (*Leucoraja* ocellata), red hake (*Urophycis chuss*) and butterfish (*Peprilus triacanthus*) were the fifth, sixth and seventh most abundant species, respectively, each accounting for 1-2% of the total catch weight. Winter skates were observed in 17 of the 20 tows. Winter skates had a wide size distribution ranging from 16 to 61 cm (disk width; Figure 16). Catch rates averaged 25.9 ± 5.2 kg/tow (range: 0 – 80.1 kg/tow). Winter skates were observed throughout the 501N Study Area with higher catches observed to the south in deeper water (Figure 17).

Red hake were caught in every tow with individuals ranging in size from 16 to 42 cm. Red hake had a unimodal size distribution peaking at 24 to 26 cm (Figure 18). The average catch of red hake was 24.9 ± 5.0 kg/tow (range: 4.2 – 104.8 kg/tow). Red hake were observed throughout the 501N Study Area (Figure 19).

Similarly, butterfish were caught in every tow. Individuals ranging in size from 2 to 20 cm. Butterfish had a bimodal size distribution with peaks at 5 and 15 cm (Figure 20). The average catch of butterfish was 7.0 ± 1.2 kg/tow (range: 0.3 – 19.3 kg/tow). Butterfish were observed throughout the 501N Study Area (Figure 21).

Northern sea robin (*Prionotus carolinus*), Atlantic longfin squid (*Doryteuthis pealeii*) and fourspot flounder (*Hippoglossina oblonga*) were frequently observed at low densities. Northern sea robins were caught in 16 of the 20 tows. Individuals ranging in size from 9 to 33 cm with a unimodal size distribution peaking at 21 cm (Figure 22). The catch rate averaged 3.5 ± 1.0 kg/tow (range: 0 – 15.6 kg/tow) and was distributed throughout the 501N Study Area (Figure 23).

Longfin squid were caught in 19 of the 20 tows. Individuals ranging in size from 3 to 26 cm with a unimodal size distribution peaking at 9 cm (Figure 24). The catch rate averaged 3.0 ± 0.4 kg/tow (range: 0 – 6.3 kg/tow) and was distributed throughout the 501N Study Area (Figure 25). No squid eggs were observed during the survey.

Caught in every tow, fourspot flounder had a wide size distribution ranging from 6 to 39 cm (Figure 26). The catch rate of fourspot flounder averaged 2.3 ± 0.3 kg/tow (range: 0.6 – 5.4 kg/tow) and was distributed throughout the 501N Study Area (Figure 27).

Other commonly observed commercially regulated species included monkfish ((*Lophius americanus*), windowpane flounder (*Scophthalmus aquosus*), winter flounder ((*Pseudopleuronectes americanus*) and summer flounder (*Paralichthys dentatus*). Monkfish had a wide size distribution (31 - 70 cm) with most individuals between 35 and 46 cm (Figure 28). The catch rate averaged 2.3 ± 0.6 kg/tow (range: 0 – 9.0 kg/tow). Monkfish were observed throughout the 501N Study Area (Figure 29).

Windowpane flounder ranged in size from 13 to 33 cm (Figure 30). Catch rates averaged 2.1 ± 0.4 kg/tow (range: 0 – 5.5 kg/tow, Figure 31). Winter flounder ranged in size from 22 to 42 cm (Figure 32). Catch rates averaged 1.9 ± 0.5 kg/tow (range: 0 – 8.2 kg/tow, Figure 33). Summer flounder ranged in size from 30 to 93 cm. (Figure 34). The average catch rate was 1.5 ± 0.4 kg/tow (range: 0 – 6.2 kg/tow, Figure 35).

Less common recreational and commercial species observed included 27 Atlantic sea scallops (*Placopecten* magellanicus), 16 bluefish (*Pomatomus saltatrix*, size rage: 33 – 51 cm), 15 black sea bass (*Centropristis striata*, size range: 10 – 22 cm), 13 yellowtail flounder (*Limanda ferruginea*, size range: 24 – 30 cm), 12 weakfish (*Cynoscion regalis*, size range: 25 – 39 cm), 4 American plaice (*Hippoglossoides platessoides*, size range: 22 – 30 cm*)*, 1 Atlantic cod (*Gadus morhua*, size: 69 cm) and 1 northern kingfish (*Menticirrhus saxatilis*, size: 20 cm).

3.2.2 Control Area

In the Control Area, a total of 30 species were caught over the duration of the survey (Table 4). Catch volume ranged from 107.4 kg/tow to 4420.6 kg/tow with an average of 955.2 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The six most abundant species (spiny dogfish, little skate, scup, red hake, silver hake and winter skate) accounted for 95% of the total catch weight. The species assemblage and catch rates were similar between the Control Area and 501N Study Area. Data collected from this area included the catch of both adults and juveniles of most species observed.

Spiny dogfish was the predominate species observed accounting for 51% of the total catch weight. Individuals ranged in size from 38 to 83 cm with a unimodal distribution peaking at 66 cm (Figure 8). Dogfish were observed in all 20 tows. Catch rates averaged 483.7 ± 236.3 kg/tow (range: 7.3 – 4117.8 kg/tow). Spiny dogfish were observed throughout the Control Area (Figure 9).

Little skate was the second most abundant species. Little skates ranged in size from 13 to 38 cm (disk width) with a unimodal size distribution peaking at 27 cm (Figure 10). Little skates were observed in every tow at an average catch rate of 151.3 ± 20.5 kg/tow (range: 16.2 – 365.9 kg/tow). Little skate were caught throughout the Control Area (Figure 11).

Scup was the third most abundant species observed. Scup ranged in length from 9 to 43 cm with a narrow unimodal peak at 23 cm (Figure 12). Scup were observed in every tow at an average catch rate of 110.5 ± 18.1 kg/tow (range: 10.2 – 279.2 kg/tow). Scup were caught throughout the Control Area (Figure 13).

Red hake was the fourth most abundant species observed. Red hake were caught in every tow with individuals ranging in size from 15 to 47 cm. Red hake had a unimodal size distribution peaking at 26 cm (Figure 18). The average catch of red hake was 67.8 ± 25.4 kg/tow (range: 0.7 – 435 kg/tow). Red hake were observed throughout the Control Area with the highest catches in the northwest corner (Figure 19).

Silver hake was the fifth most abundant species observed. Silver hake ranged in length from 6 to 48 cm. Silver hake had a unimodal size distribution consisting of a peak at 23 cm (Figure 14). Silver hake were observed in every tow with an average catch rate of 48.1 ± 10.0 kg/tow (range: 4.5 – 185.6 kg/tow). Silver hake were caught throughout the Control Area with the highest catches in the northwest corner (Figure 15).

Northern sea robins were caught in 18 of the 20 tows. Individuals ranged in size from 9 to 43 cm with a unimodal size distribution peaking at 26 cm (Figure 22). Their catch rate averaged 27.4 ± 17.3 kg/tow (range: 0 – 340.8 kg/tow) with one tow containing 340.8 kg. Northern sea robin were distributed throughout the Control Area with higher catches in the south (Figure 23).

Butterfish, monkfish, fourspot flounder, windowpane founder, and longfin squid were frequently observed but at low densities. Butterfish were caught in every tow. Individuals ranging in size from 2 to 20 cm. Butterfish had a bimodal size distribution peaking at 7 and 15 cm (Figure 20). The average catch of butterfish was 5.5 ± 1.3 kg/tow (range: 0.5 – 24.5 kg/tow). Butterfish were observed throughout the Control Area (Figure 21).

Monkfish were observed in 16 of the 20 tows. Monkfish had a wide size distribution (35 - 74 cm) with most individuals between 35 and 47 cm (Figure 28). The catch rate averaged 5.3 ± 1.2 kg/tow (range: 0 – 19.0 kg/tow). Monkfish were observed throughout the Control Area (Figure 29).

Fourspot flounder and windowpane flounder were both observed in every tow. Fourspot flounder had a wide size distribution ranging from 10 to 41 cm (Figure 26). The catch rate of fourspot flounder averaged 3.6 ± 0.8 kg/tow (range: 0.4 – 11.4 kg/tow) and was distributed throughout the Control Area (Figure 27). Windowpane flounder ranged in size from 19 to 32 cm (Figure 30). Catch rates averaged 2.6 ± 0.5 kg/tow (range: 0.5 – 9.4 kg/tow, Figure 31).

Longfin squid were caught in 18 of the 20 tows. Individuals ranged in size from 4 to 25 cm with a unimodal size distribution peak between 8 and 11 cm (Figure 24). The catch rate averaged 2.3 ± 0.8 kg/tow (range: 0 – 17.1 kg/tow) and was distributed throughout the Control Area (Figure 25). No squid eggs were observed during the survey.

Finally, 30 summer flounder were caught ranging in size from 33 to 68 cm. (Figure 34). The average catch rate was 1.7 ± 0.5 kg/tow (range: 0 – 9.4 kg/tow, Figure 35).

Less common recreational and commercial species observed included 28 bluefish (size range: 35 – 50 cm), 13 Atlantic sea scallops, 8 weakfish (size range: 32 – 50 cm), 7 black sea bass (size range: 15 – 21 cm), 3 winter flounder (size range: 41 – 44 cm; Figure 32, 33) and 1 yellowtail flounder (size: 28 cm).

4. Acknowledgements

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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	**501N**	11/6/2019	Clear	16-20	N	0.5-1.25	7:27	N 41° 04.919	W 70° 30.109	22	7:47	N 41° 05.459	W 70° 31.573	22	100
2	**501N**	11/6/2019	Clear	16 -20	N	0.5-1.25	8:43	N 41° 04.865	W 70° 29.346	21	9:03	N 41° 05.199	W 70° 28.973	22	100
3	**501N**	11/6/2019	Clear	16-20	N	0.5-1.25	10:09	N 41° 05.724	W 70° 29.661	22	10:29	N 41° 05.825	W 70° 28.445	21	100
4	**501N**	11/6/2019	Clear	7-10	N	0.5-1.25	11:27	N 41° 06.845	W 70° 29.275	21	11:47	N 41° 06.923	W 70° 27.967	21	100
5	**501N**	11/6/2019	Clear	7-10	N	0.5-1.25	13:08	N 41° 07.084	W 70° 29.372	21	13:23	N 41° 06.923	W 70° 27.967	21	100
6	**501N**	11/6/2019	Clear	7-10	N	0.5-1.25	14:39	N 41° 05.321	W 70° 25.724	21	14:59	N 41° 04.380	W 70° 25.254	22	100
7	**501N**	11/6/2019	Clear	7-10	N	0.5-1.25	16:11	N 41° 03.155	W 70° 26.493	22	16:27	N 41° 03.344	W 70° 27.513	23	100
8	**Control**	11/7/2019	Partly Cloudy	3-6	W	0.5-1.25	6:27	N 40° 53.106	W 70° 17.270	23	6:42	N 40° 52.916	W 70° 18.077	24	100
9	**Control**	11/7/2019	Partly Cloudy	3-6	W	0.5-1.25	7:25	N 40° 54.902	W 70° 26.493	21	7:45	N 40° 55.067	W 70° 17.591	21	100
10	**Control**	11/7/2019	Mostly Cloudy	11-15	W	0.5-1.25	8:24	N 40° 55.562	W 70° 17.967	21	8:44	N 40° 56.139	W 70° 19.001	22	100
11	**Control**	11/7/2019	Mostly Cloudy	16-20	SW	0.5-1.25	9:48	N 40° 56.788	W 70° 17.780	21	10:08	N 40° 57.594	W 70° 17.006	20	100
12	**Control**	11/7/2019	Mostly Cloudy	16-20	SW	0.5-1.25	10:23	N 40° 57.967	W 70° 16.573	20	10:43	N 40° 58.885	W 70° 15.976	19	100
13	**Control**	11/7/2019	Overcast	16-20	SW	0.5-1.25	11:44	N 40° 57.997	W 70° 20.477	23	12:04	N 40° 57.945	W 70° 21.738	23	100
14	**Control**	11/7/2019	Overcast	16-20	SW	0.5-1.25	13:22	N 40° 59.521	W 70° 19.477	23	13:42	N 41° 00.109	W 70° 18.514	21	100
15	**Control**	11/7/2019	Overcast	21-26	SW	1.25-2.5	14:54	N 41° 01.594	W 70° 19.782	22	15:14	N 41° 01.995	W 70° 20.903	21	100
16	**501N**	11/7/2019	Overcast	21-26	SW	1.25-2.5	15:56	N 41° 02.058	W 70° 23.155	21	16:16	N 41° 01.916	W 70° 24.430	22	100
17	**501N**	11/9/2019	Partly Cloudy	11-15	N	1.25-2.5	6:37	N 41° 03.806	W 70° 36.392	24	6:57	N 41° 03.735	W 70° 34.978	23	100
18	**501N**	11/9/2019	Partly Cloudy	7-10	N	1.25-2.5	7:57	N 41° 02.186	W 70° 34.756	24	8:17	N 41° 02.268	W 70° 35.911	24	100
19	**501N**	11/9/2019	Partly Cloudy	7-10	N	0.5-1.25	9:06	N 41° 02.076	W 70° 34.031	24	9:26	N 41° 01.730	W 70° 32.735	25	100
20	**501N**	11/9/2019	Partly Cloudy	7-10	N	0.5-1.25	10:12	N 41° 02.073	W 70° 31.301	25	10:32	N 41° 02.335	W 70° 30.046	24	100
21	**501N**	11/9/2019	Partly Cloudy	7-10	N	0.5-1.25	11:17	N 41° 02.136	W 70° 29.778	24	11:39	N 41° 03.161	W 70° 29.339	24	100
22	**501N**	11/9/2019	Clear	7-10	N	0.5-1.25	12:33	N 41° 01.446	W 70° 28.585	22	12:53	N 41° 00.815	W 70° 28.351	23	100
23	**501N**	11/9/2019	Clear	3-6	N	0.1-0.5	13:57	N 41° 01.446	W 70° 28.941	23	14:12	N 41° 01.290	W 70° 29.962	24	100
24	**501N**	11/9/2019	Clear	3-6	N	0.1-0.5	15:12	N 40° 59.757	W 70° 28.507	24	15:22	N 40° 59.685	W 70° 27.928	24	100
25	**Control**	11/10/2019	Partly Cloudy	11-15	SW	0.5-1.25	6:26	N 40° 52.323	W 70° 20.477	25	6:46	N 40° 51.944	W 70° 22.023	26	100
26	**Control**	11/10/2019	Mostly Cloudy	11-15	SW	0.5-1.25	7:29	N 40° 53.001	W 70° 22.090	25	7:49	N 40° 53.438	W 70° 23.222	25	100
27	**Control**	11/10/2019	Mostly Cloudy	11-15	SW	0.5-1.25	8:35	N 40° 54.274	W 70° 22.652	24	8:55	N 40° 55.291	W 70° 22.403	23	100
28	**Control**	11/10/2019	Overcast	11-15	SW	0.5-1.25	9:53	N 40° 55.494	W 70° 22.440	23	10:13	N 40° 56.330	W 70° 21.727	23	100
29	**Control**	11/10/2019	Overcast	11-15	SW	0.5-1.25	11:16	N 40° 54.882	W 70° 25.409	25	11:36	N 40° 54.305	W 70° 26.467	25	100
30	**Control**	11/10/2019	Mostly Cloudy	7-10	SW	0.5-1.25	12:28	N 40° 56.278	W 70° 27.602	25	12:48	N 40° 57.181	W 70° 28.080	24	100
31	**Control**	11/10/2019	Partly Cloudy	11-15	SW	0.5-1.25	13:40	N 40° 58.132	W 70° 24.699	23	14:00	N 40° 58.793	W 70° 23.744	22	100
32	**Control**	11/10/2019	Partly Cloudy	16-20	SW	0.5-1.25	14:59	N 40° 58.797	W 70° 24.955	24	15:19	N 40° 58.872	W 70° 26.302	23	100
33	**501N**	11/14/2019	Mostly Cloudy	3-6	W	0.1-0.5	6:59	N 41° 00.267	W 70° 24.166	23	7:19	N 41° 00.689	W 70° 24.744	23	100
34	**501N**	11/14/2019	Mostly Cloudy	7-10	W	0.1-0.5	8:21	N 41° 04.495	W 70° 21.707	22	8:41	N 41° 03.818	W 70° 22.552	21	100
35	**501N**	11/14/2019	Overcast	7-10	W	0.5-1.25	11:26	N 40° 55.739	W 70° 36.392	26	11:46	N 40° 54.818	W 70° 30.578	27	100
36	**Control**	11/14/2019	Mostly Cloudy	11-15	W	0.5-1.25	12:51	N 40° 53.637	W 70° 28.309	27	13:11	N 40° 53.594	W 70° 26.943	26	100
37	**Control**	11/14/2019	Overcast	11-15	W	0.5-1.25	14:12	N 40° 51.510	W 70° 26.808	28	14:32	N 40° 50.629	W 70° 26.234	28	125
38	**Control**	11/14/2019	Overcast	16-20	W	0.5-1.25	15:48	N 40° 50.324	W 70° 24.153	27	16:08	N 40° 57.206	W 70° 23.908	27	100
39	**Control**	11/15/2019	Overcast	11-15	W	1.25-2.5	6:57	N 40° 59.750	W 70° 34.310	26	7:17	N 40° 59.876	W 70° 33.033	27	100
40	**501N**	11/15/2019	Rain	11-15	W	1.25-2.5	8:22	N 40° 59.984	W 70° 35.858	27	8:42	N 40° 59.570	W 70° 36.868	26	100

Table 2: Tow parameters for each survey tow.

Tow Number	Tow Area	Tow Duration (min.)	Tow Speed (knots)	Tow Distance (nm.)	Bottom Temperature (°C)	Headline Height (m.)	Wing Spread (m.)	Spread Door (m.)
1	501N	20.1	3.0	1.0	14.6	4.7		36.0
2	501N	21.3	3.1	1.1	15.0	4.2	14.4	35.6
3	501N	19.5	3.3	1.1	14.9	4.2	13.9	35.0
4	501N	19.7	3.0	1.0	15.0	4.1		34.7
5	501N	13.9	3.2	0.7	14.8	4.2		34.9
6	501N	20.1	3.1	1.0	14.8	4.0		35.3
7	501N	16.3	3.0	0.8	14.4	4.4		35.6
8	Control	15.0	2.9	0.7	16.1	4.7	14.0	34.6
9	Control	19.7	3.0	1.0	16.2	4.2		35.7
10	Control	19.7	3.0	1.0	16.2	4.1		35.9
11	Control	19.3	3.1	1.0	15.3	4.6		35.2
12	Control	20.5	3.0	1.0	14.8	4.0		35.8
13	Control	19.8	3.0	1.0	15.0	4.6	13.1	33.2
14	Control	20.0	3.0	1.0	14.3	4.1	13.5	34.9
15	Control	19.8	2.9	1.0	14.2	4.2	13.6	35.1
16	501N	19.9	3.0	1.0	14.3	4.4	13.7	35.7
17	501N	20.7	3.3	1.1	15.8	4.1	13.6	35.1
18	501N	19.4	2.7	0.9	15.8	4.5	13.1	33.5
19	501N	19.5	3.2	1.0	16.0	4.6	13.2	
20	501N	19.5	3.1	1.0	16.1	4.7	13.3	34.4
21	501N	21.7	3.0	1.1	16.3	4.2	13.2	34.2
22	501N	20.0	3.2	1.1	15.8	4.2	13.4	34.9
23	501N	15.0	3.2	0.8	15.8	4.1	13.5	35.2
24	501N	10.2	2.7	0.5	14.0	4.3	13.0	33.4
25	Control	20.0	2.9	1.0	16.1	4.6	13.7	35.8
26	Control	20.1	2.9	1.0	16.3	5.0	13.7	35.5
27	Control	20.1	3.1	1.0	16.2	4.1	13.6	35.5
28	Control	19.6	3.1	1.0	15.9	4.0	13.7	35.8
29	Control	20.8	3.2	1.1	16.4	4.2	13.8	35.8
30	Control	19.3	3.1	1.0	16.0	4.1	13.6	35.4
31	Control	19.6	3.0	1.0	13.7	4.4	13.5	34.8
32	Control	19.5	3.2	1.0	13.8	4.3	13.8	35.9
33	501N	19.6	2.9	0.6	12.9	4.4	13.9	34.3
34	501N	20.0	2.9	1.0	12.8	4.7		34.3
35	501N	20.0	3.1	1.0	14.3	5.1	13.5	33.9
36	Control	19.8	3.1	1.0	15.5	4.4	14.6	34.6
37	Control	19.6	3.2	1.0	16.3	4.6	14.0	36.0
38	Control	19.6	2.9	1.0	15.7	4.2	13.9	33.9
39	Control	19.4	3.2	1.0	13.6	4.8	13.7	34.2
40	501N	19.6	2.8	0.9	13.6	4.6	13.7	34.4
Summary Statistics								
Control	Minimum	15.0	2.9	0.7	13.6	4.0	13.1	33.2
	Maximum	20.8	3.2	1.1	16.4	5.0	14.6	36.0
	Average	19.6	3.0	1.0	15.4	4.4	13.7	35.2
	St. Dev	1.1	0.1	0.1	1.0	0.3	0.3	0.8
501N	Minimum	10.2	2.7	0.5	12.8	4.0	13.0	33.4
	Maximum	21.7	3.3	1.1	16.3	5.1	14.4	36.0
	Average	18.8	3.0	0.9	14.9	4.4	13.5	34.8
	St. Dev.	2.8	0.2	0.2	1.0	0.3	0.4	0.7

Table 3: Total and average catch weights observed within the 501N 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*	17213.1	860.7	258.9	73.7	19
Skate, Little	*Leucoraja erinacea*	2367.3	118.4	14.0	10.1	20
Scup	*Stenotomus chrysops*	1278.6	63.9	13.2	5.5	20
Hake, Silver	*Merluccius bilinearis*	949.8	47.5	10.7	4.1	20
Skate, Winter	*Leucoraja ocellata*	518.6	25.9	5.2	2.2	17
Hake, Red	*Urophycis chuss*	498.1	24.9	5.0	2.1	20
Butterfish	*Peprilus triacanthus*	140.8	7.0	1.2	0.6	20
Sea Robin, Northern	*Prionotus carolinus*	69.4	3.5	1.0	0.3	16
Squid, Atlantic Longfin	*Doryteuthis pealeii*	59.3	3.0	0.4	0.3	19
Flounder, Fourspot	*Hippoglossina oblonga*	45.4	2.3	0.3	0.2	20
Monkfish	*Lophius americanus*	45.2	2.3	0.6	0.2	13
Flounder, Windowpane	*Scophthalmus aquosus*	42.5	2.1	0.4	0.2	17
Flounder, Winter	*Pseudopleuronectes americanus*	37.1	1.9	0.5	0.2	15
Flounder, Summer (Fluke)	*Paralichthys dentatus*	30.9	1.5	0.4	0.1	13
Bluefish	*Pomatomus saltatrix*	14.2	0.7	0.2	0.1	9
Alewife	*Alosa pseudoharengus*	10.4	0.5	0.2	0.0	9
Weakfish	*Cynoscion regalis*	4.5	0.2	0.1	0.0	7
Sea Scallop	*Placopecten magellanicus*	4.1	0.2	0.1	0.0	9
Atlantic Cod	*Gadus morhua*	3.5	0.2	0.2	0.0	1
Crab, Rock	*Cancer sp.*	3.0	0.1	0.1	0.0	6
Skate, Barndoor	*Dipturus laevis*	2.2	0.1	0.1	0.0	4
Flounder, Yellowtail	*Limanda ferruginea*	1.5	0.1	0.0	0.0	7
Black Sea bass	*Centropristis striata*	1.4	0.1	0.0	0.0	7
Shad, American	*Alosa sapidissima*	1.3	0.1	0.0	0.0	4
Flounder, American Plaice	*Hippoglossoides platessoides*	0.5	0.0	0.0	0.0	1
Sculpin, Longhorn	*Myoxocephalus octodecemspinosus*	0.3	0.0	0.0	0.0	1
Mackerel, Atlantic	*Scomber scombrus*	0.3	0.0	0.0	0.0	1
Herring, Atlantic	*Clupea harengus*	0.1	0.0	0.0	0.0	1
Flounder, Gulfstream	*Citharichthys arctifrons*	0.1	0.0	0.0	0.0	1
Kingfish, Northern	*Menticirrhus saxatilis*	0.1	0.0	0.0	0.0	1
Total		23343.6				

*SEM is an acronym for Standard Error of the Mean

Table 4: Total and average catch weights observed within the Control Area.

Species Name	Scientific Name	Total Weight (Kg)	Catch/Tow (Kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Dogfish, Spiny	*Squalus acanthias*	9673.8	483.7	236.3	50.6	20
Skate, Little	*Leucoraja erinacea*	3026.8	151.3	20.5	15.8	20
Scup	*Stenotomus chrysops*	2209.9	110.5	18.1	11.6	20
Hake, Red	*Urophycis chuss*	1356.6	67.8	25.4	7.1	20
Hake, Silver	*Merluccius bilinearis*	962.0	48.1	10.0	5.0	20
Skate, Winter	*Leucoraja ocellata*	822.0	41.1	10.6	4.3	18
Sea Robin, Northern	*Prionotus carolinus*	547.6	27.4	17.3	2.9	18
Butterfish	*Peprilus triacanthus*	110.9	5.5	1.3	0.6	20
Monkfish	*Lophius americanus*	105.5	5.3	1.2	0.6	16
Flounder, Fourspot	*Hippoglossina oblonga*	72.0	3.6	0.8	0.4	20
Flounder, Windowpane	*Scophthalmus aquosus*	52.8	2.6	0.5	0.3	20
Squid, Atlantic Longfin	*Doryteuthis pealeii*	46.3	2.3	0.8	0.2	18
Flounder, Summer (Fluke)	*Paralichthys dentatus*	34.1	1.7	0.5	0.2	14
Bluefish	*Pomatomus saltatrix*	27.2	1.4	0.4	0.1	13
Alewife	*Alosa pseudoharengus*	21.1	1.1	0.3	0.1	13
Skate, Barndoor	*Dipturus laevis*	8.0	0.4	0.2	0.0	6
Menhaden, Atlantic	*Brevoortia tyrannus*	6.1	0.3	0.3	0.0	1
Crab, Rock	*Cancer sp.*	6.1	0.3	0.1	0.0	10
Weakfish	*Cynoscion regalis*	4.3	0.2	0.1	0.0	6
Sea Scallop	*Placopecten magellanicus*	3.4	0.2	0.1	0.0	6
Flounder, Winter	*Pseudopleuronectes americanus*	3.2	0.2	0.1	0.0	3
Flounder, Gulfstream	*Citharichthys arctifrons*	1.3	0.1	0.0	0.0	5
Conger Eel	*Conger oceanicus*	1.2	0.1	0.1	0.0	1
Mackerel, Atlantic	*Scomber scombrus*	0.7	0.0	0.0	0.0	3
Black Sea bass	*Centropristis striata*	0.7	0.0	0.0	0.0	4
Cutlassfish, Atlantic	*Truchiurus lepturus*	0.3	0.0	0.0	0.0	1
Shad, American	*Alosa sapidissima*	0.2	0.0	0.0	0.0	1
Flounder, Yellowtail	*Limanda ferruginea*	0.2	0.0	0.0	0.0	1
Herring, Atlantic	*Clupea harengus*	0.1	0.0	0.0	0.0	1
Snail, Moonshell	*Euspira heros*	0.1	0.0	0.0	0.0	1
Total		19103.99				

*SEM is an acronym for Standard Error of the Mean

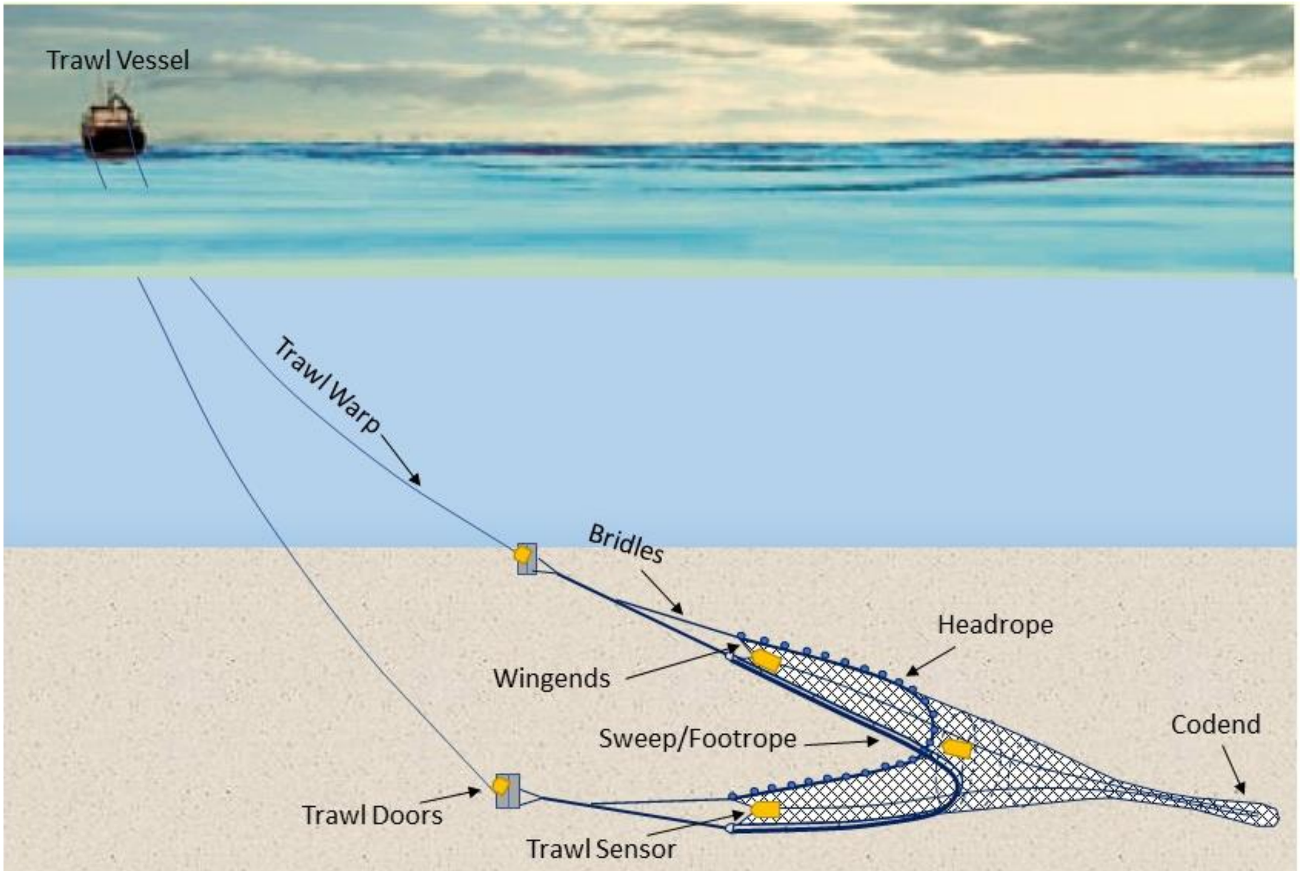


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

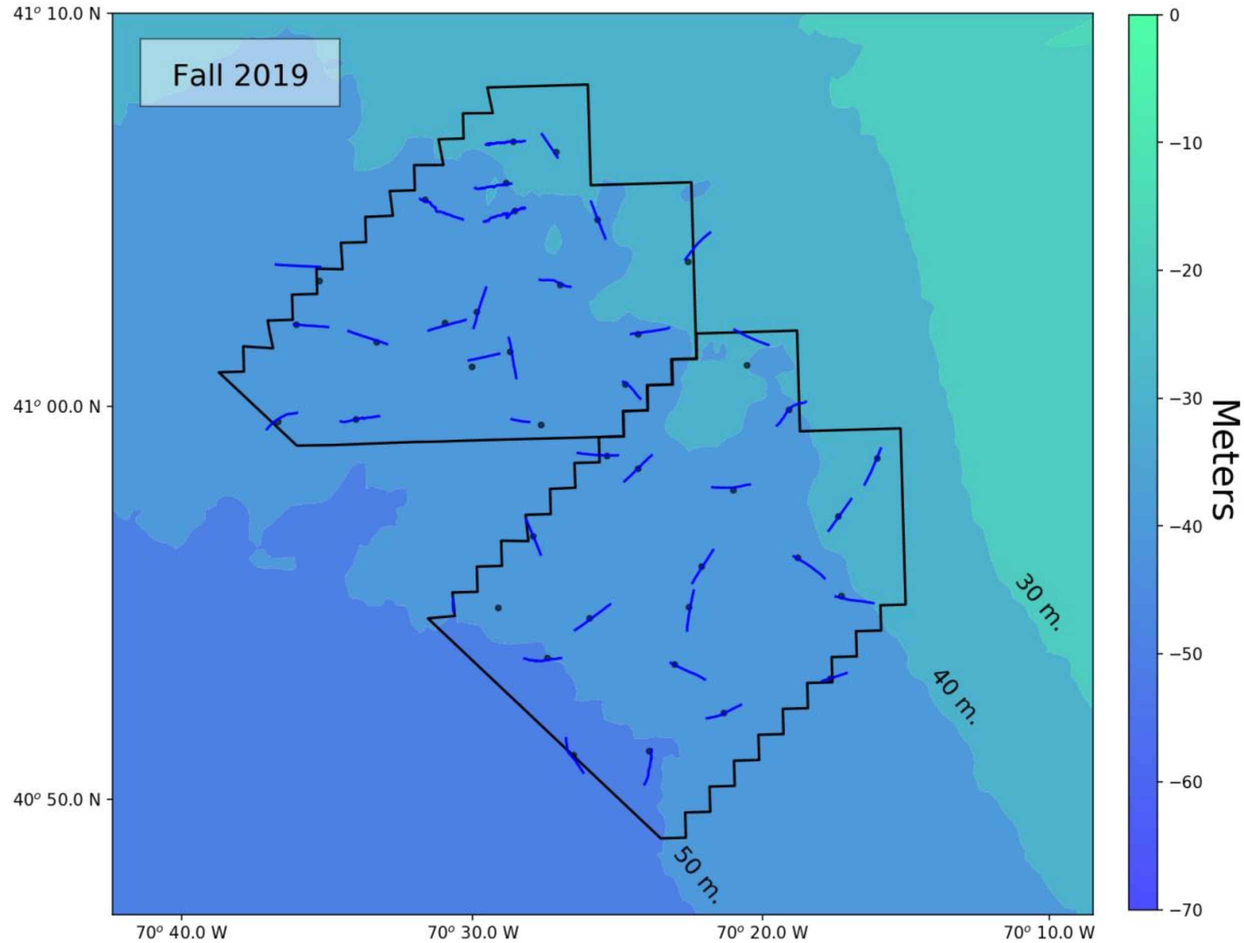


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 501N Study Area (left) and the Control Area (right)

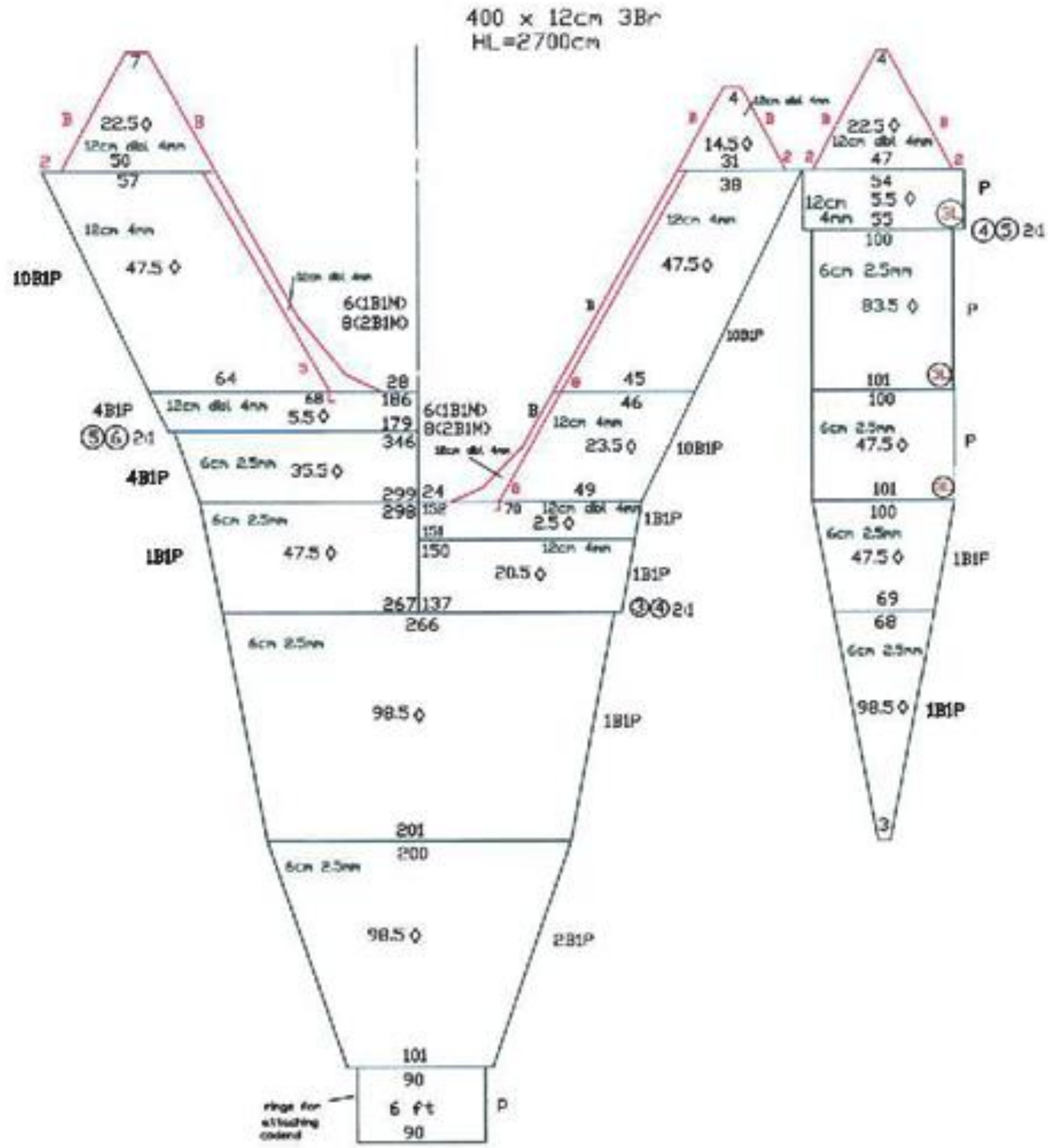


Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al. 2008).

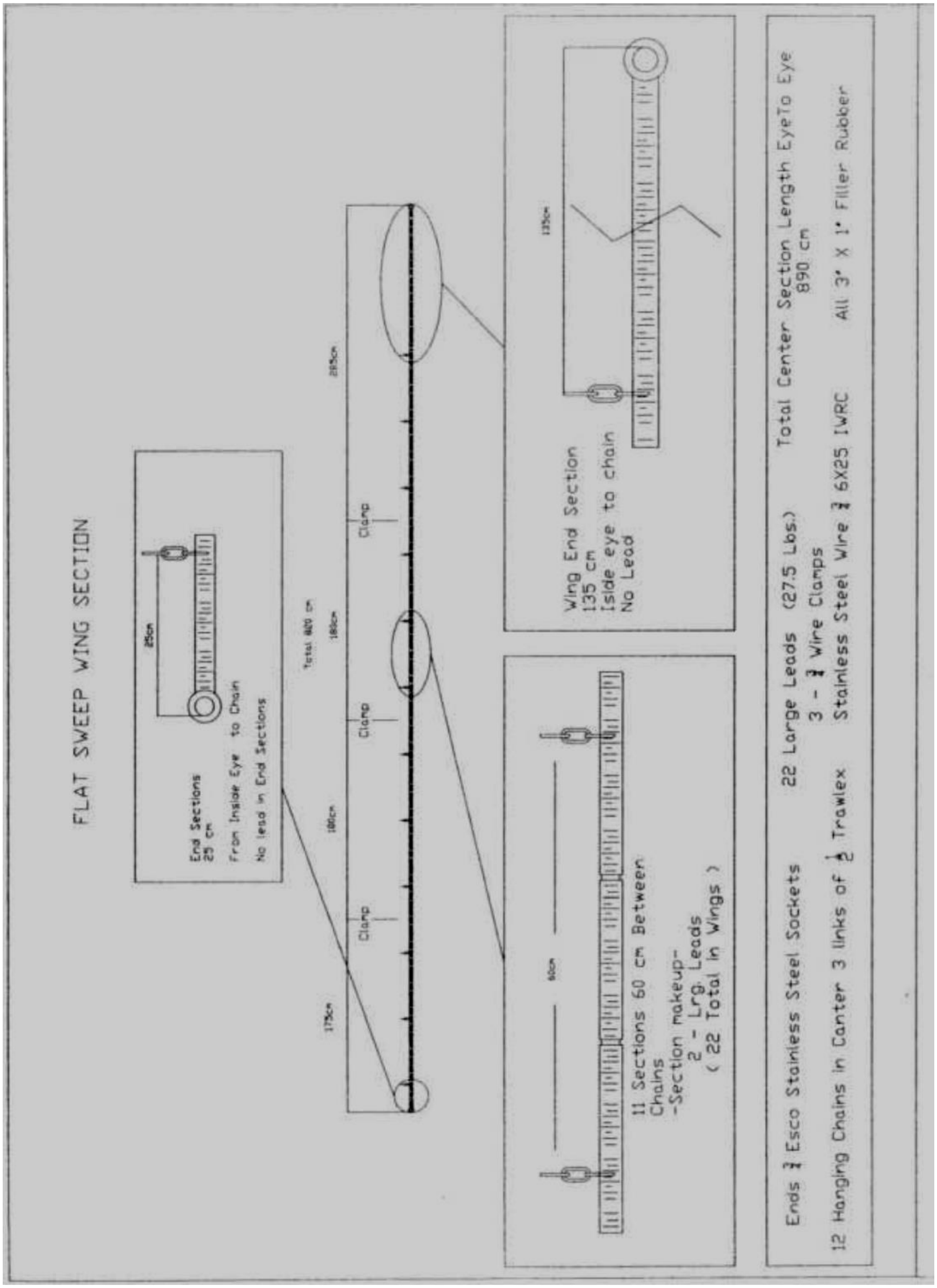


Figure 4: Sweep diagram for the survey trawl (Bonzek et al. 2008).

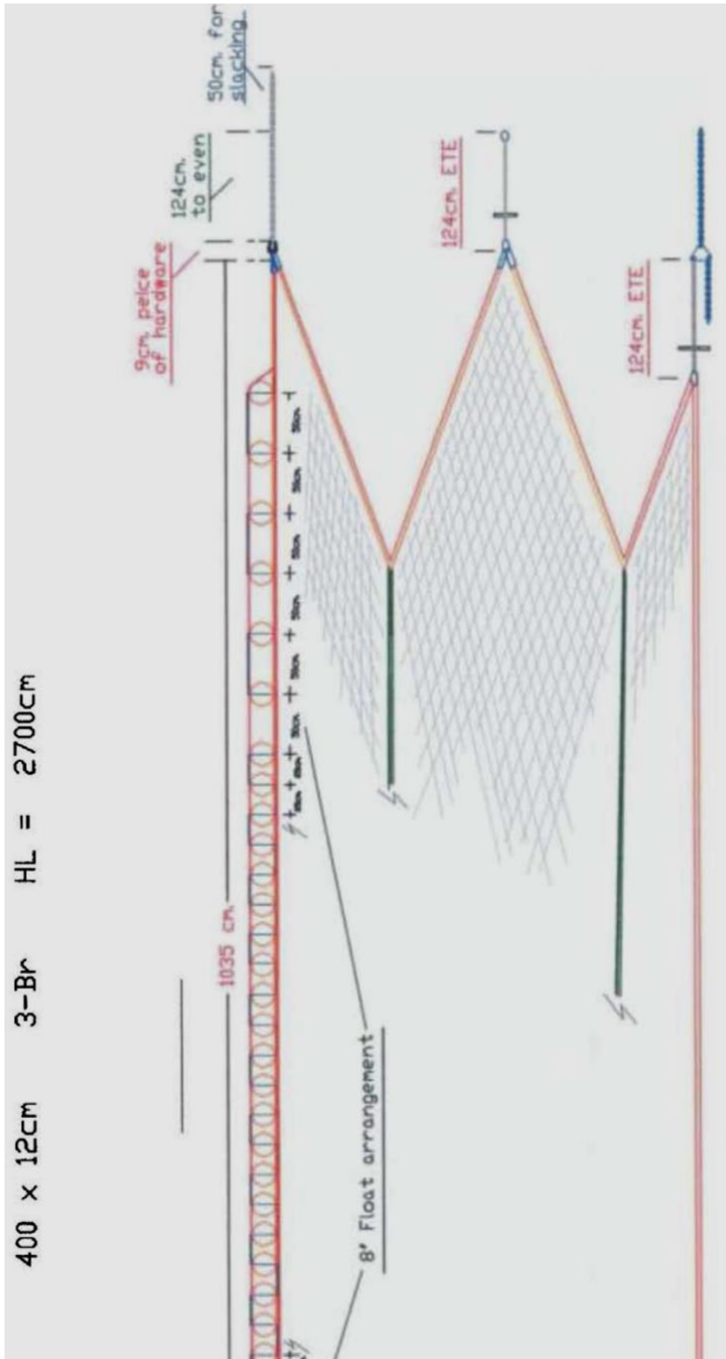


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al. 2008).

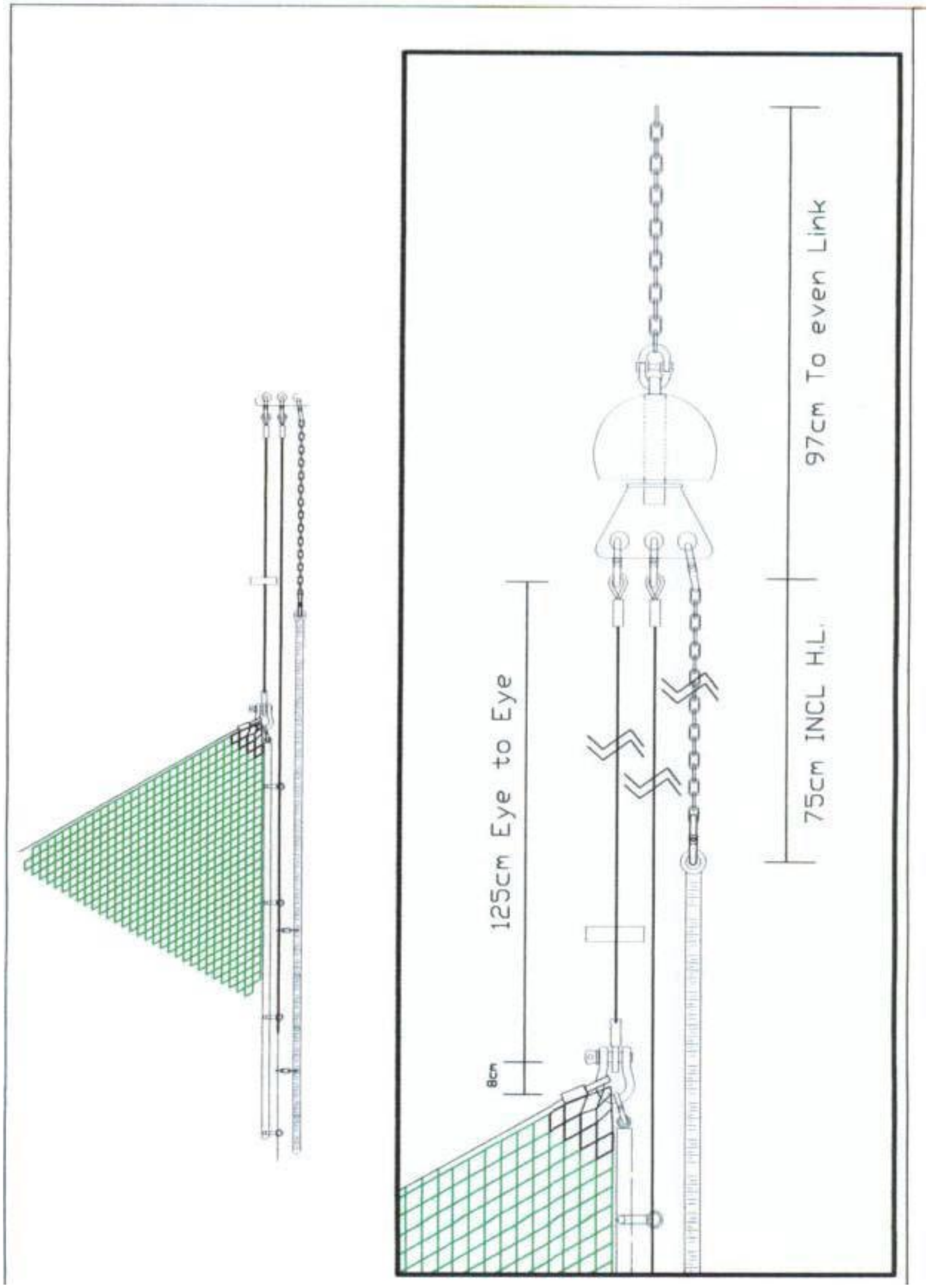


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al. 2008).

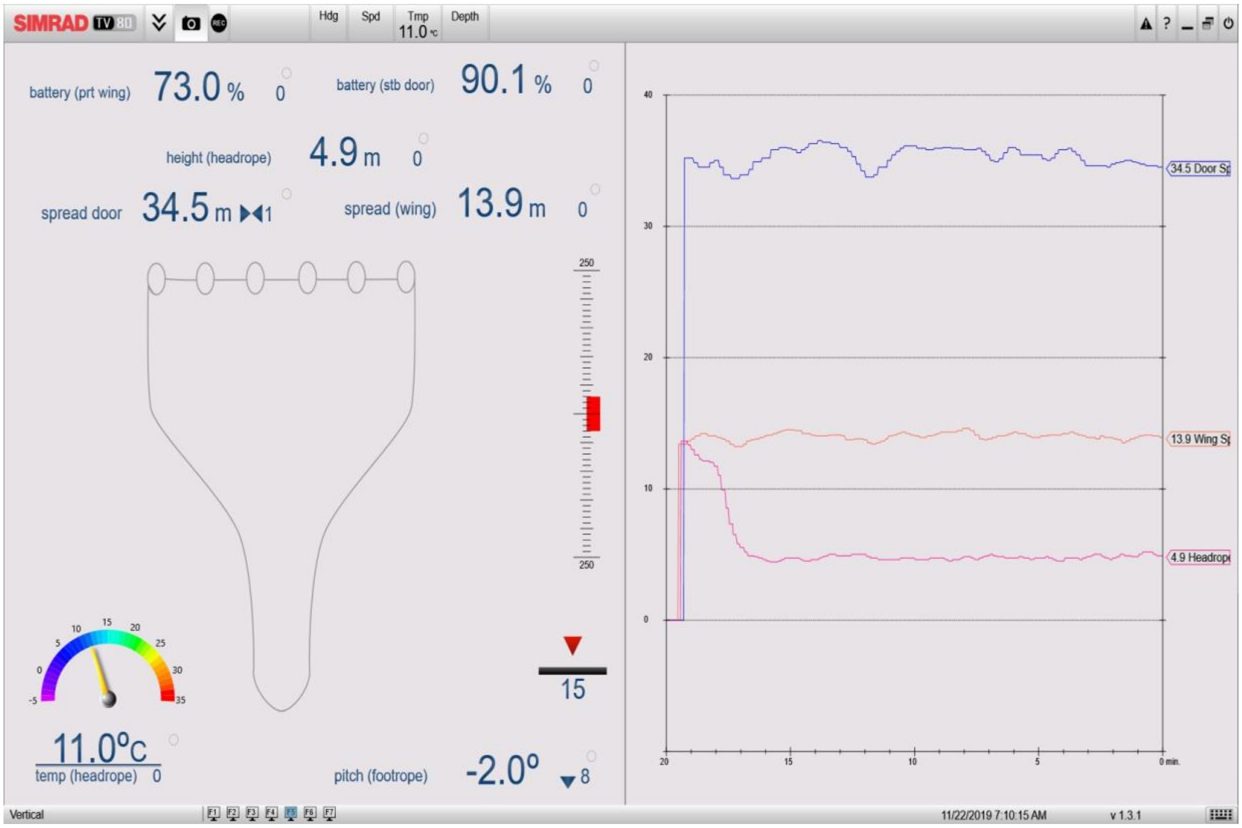
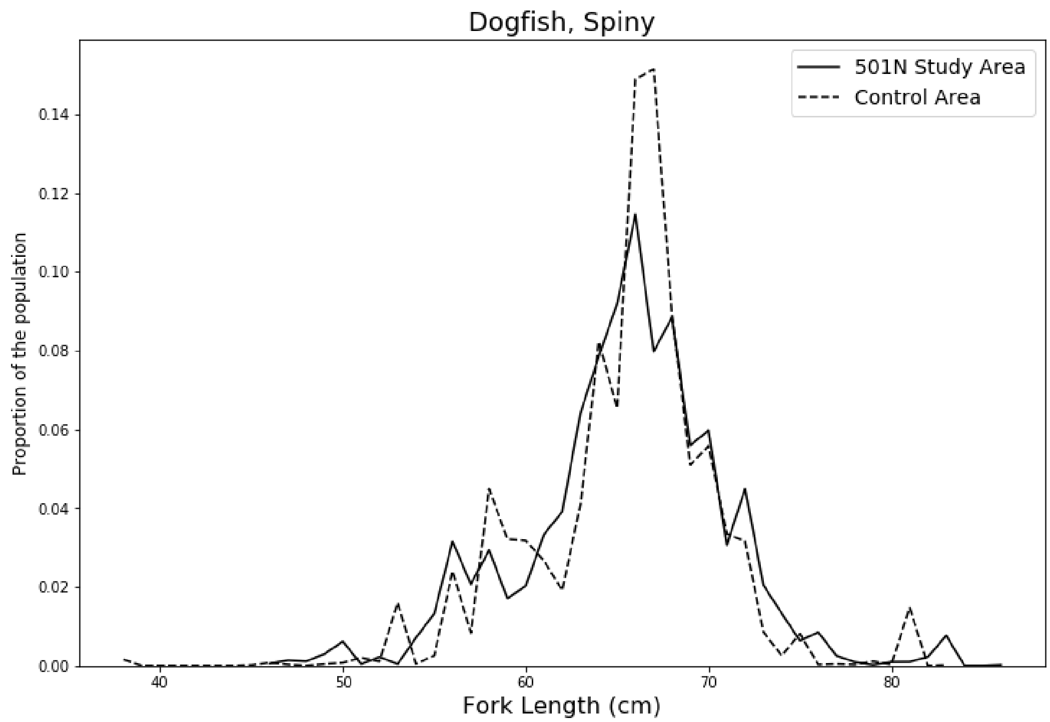


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.



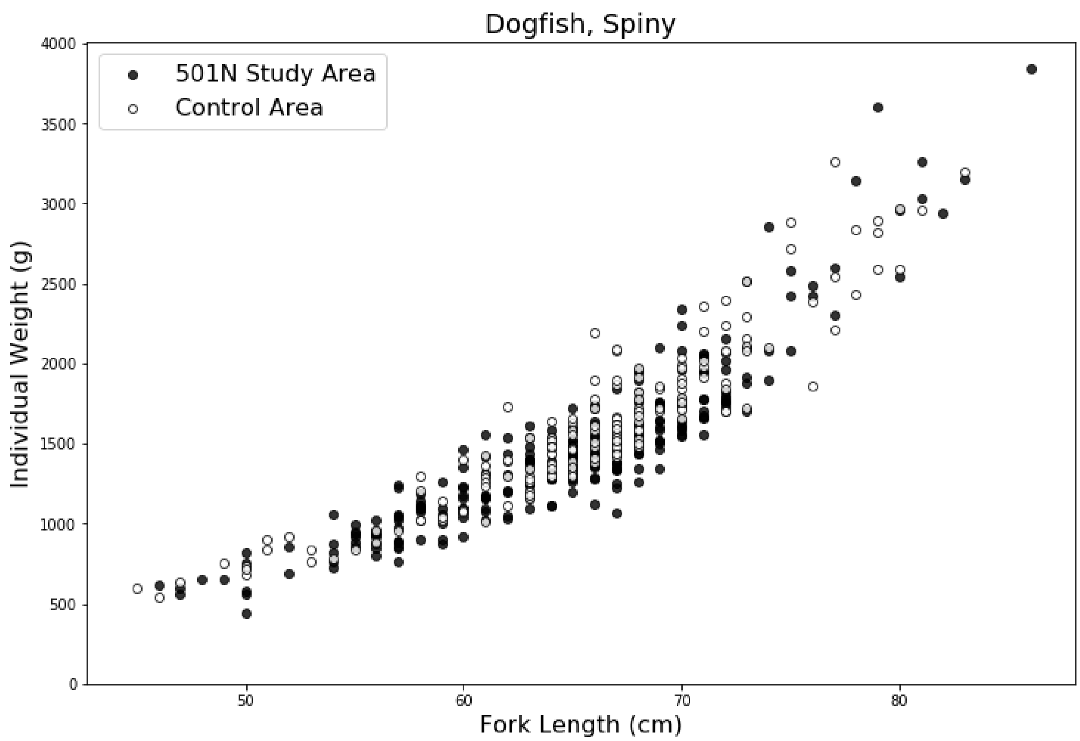


Figure 8: Population structure of spiny dogfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

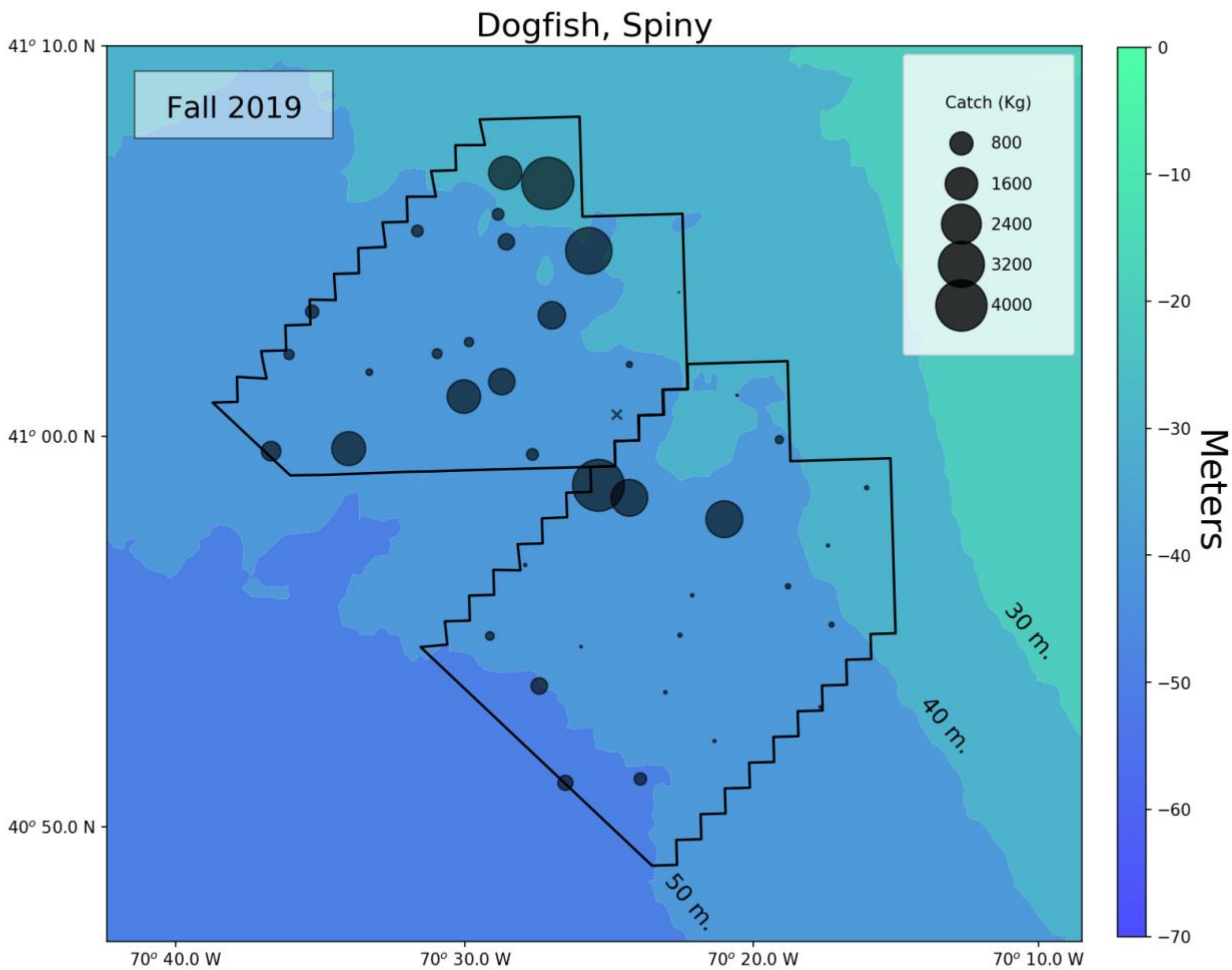
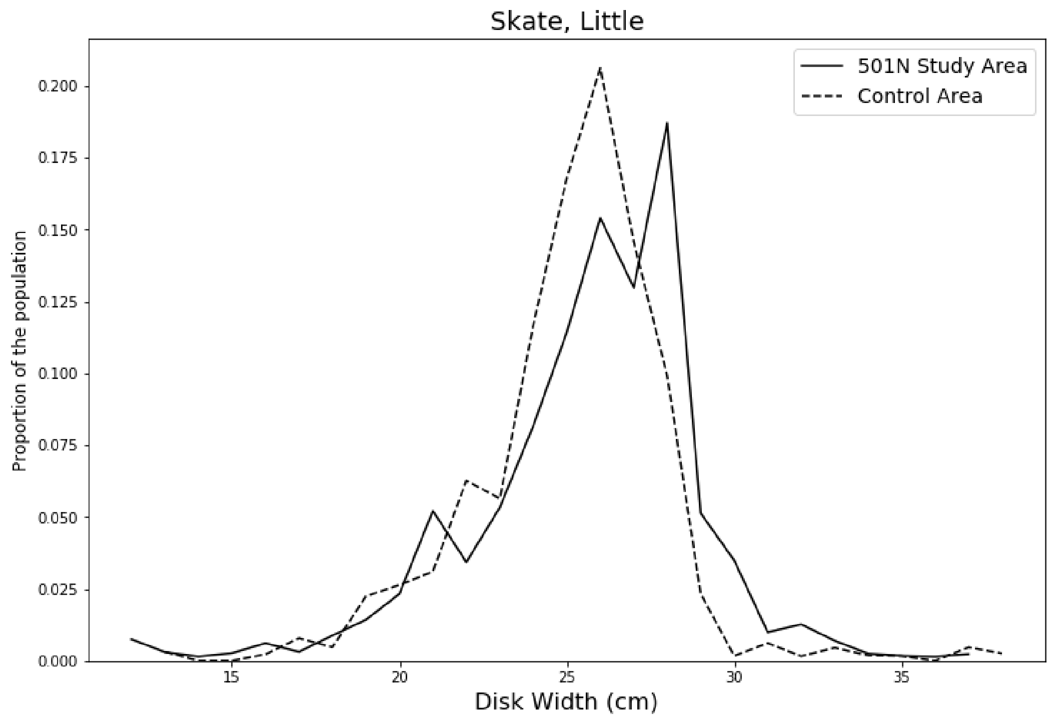


Figure 9: Distribution of the catch of spiny dogfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



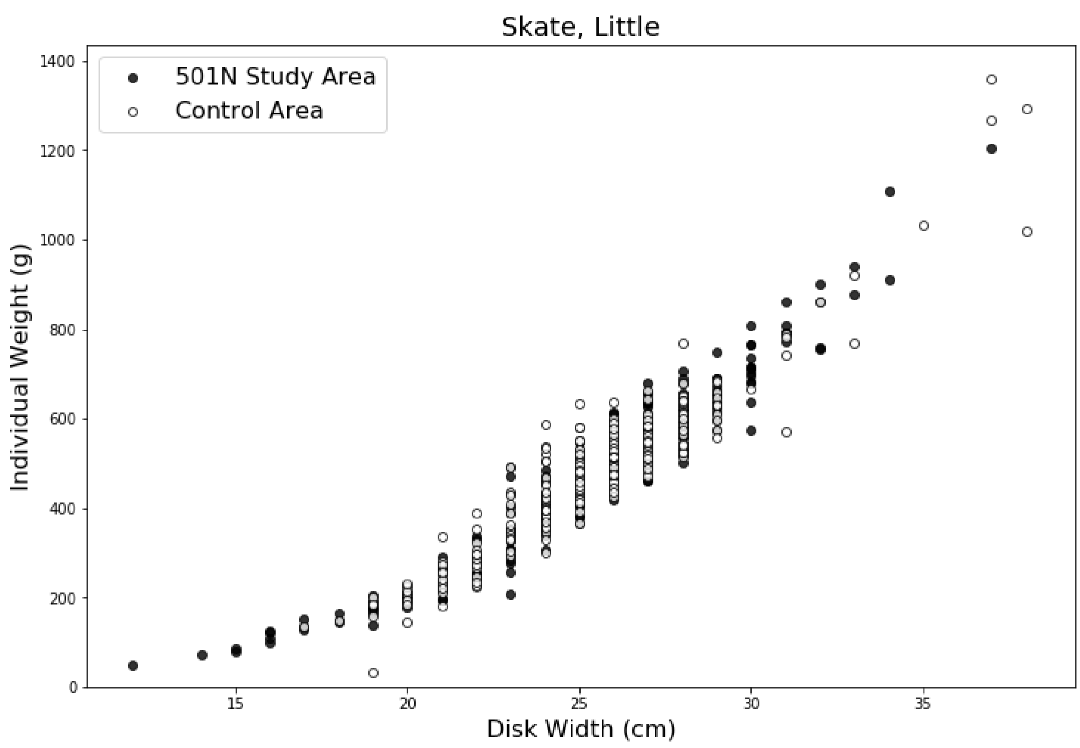


Figure 10: Population structure of little skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

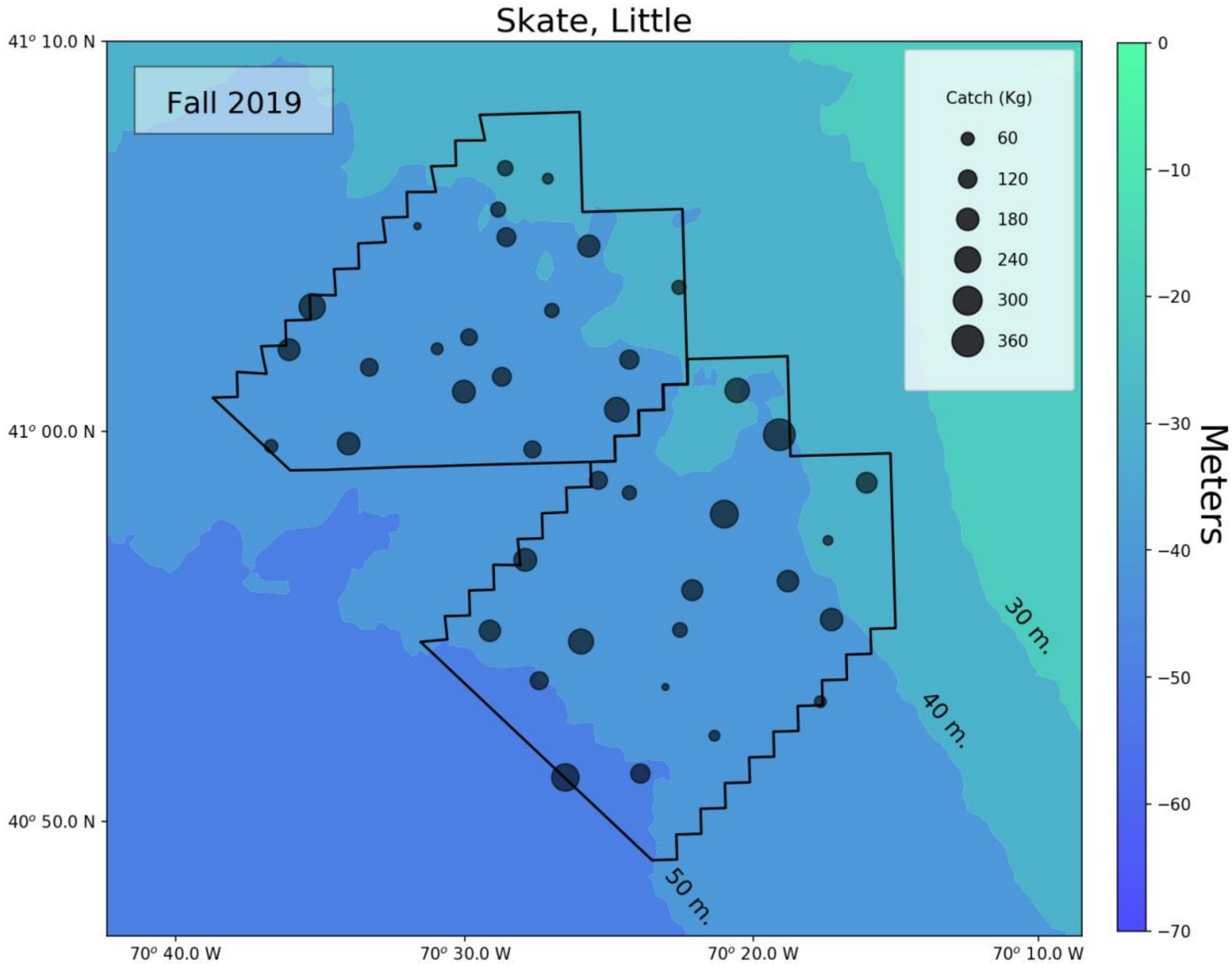
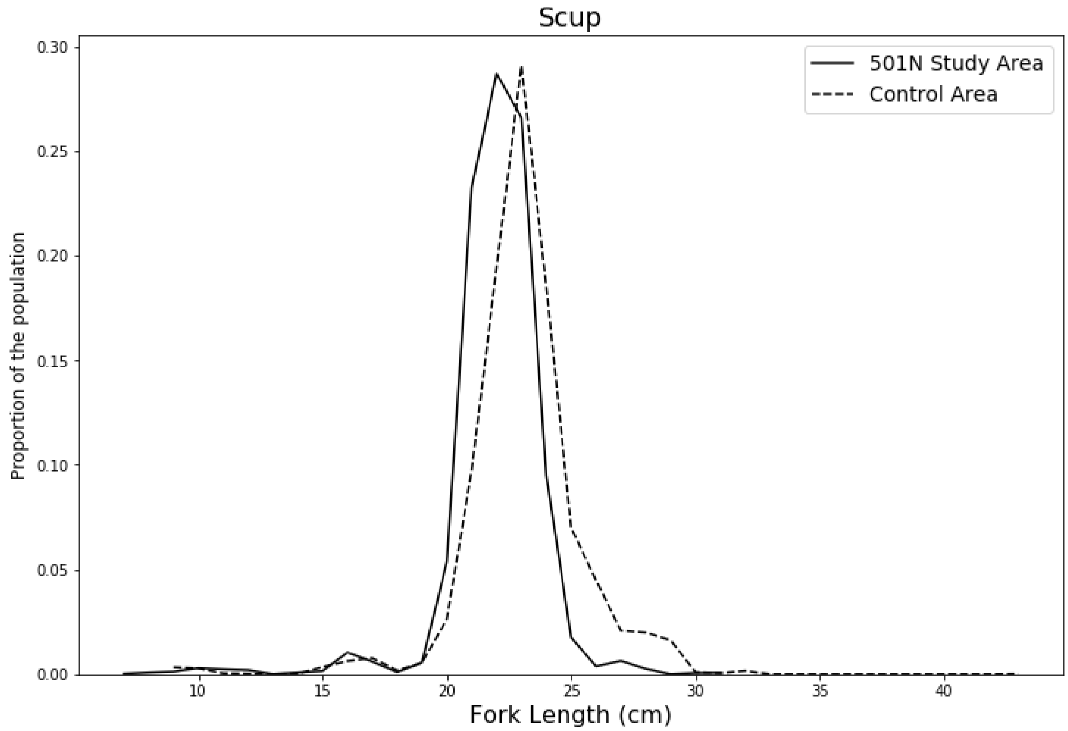


Figure 11: Distribution of the catch of little skate in the 501N Study Area (left) and Control Area (right).



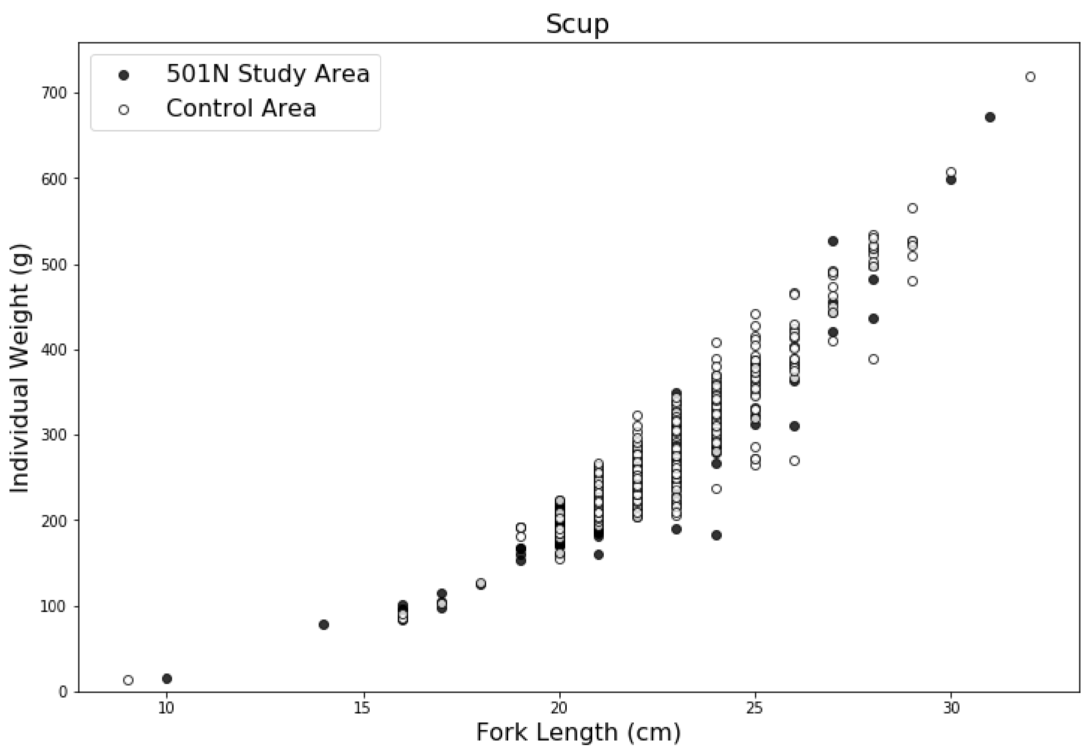


Figure 12: Population structure of scup in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

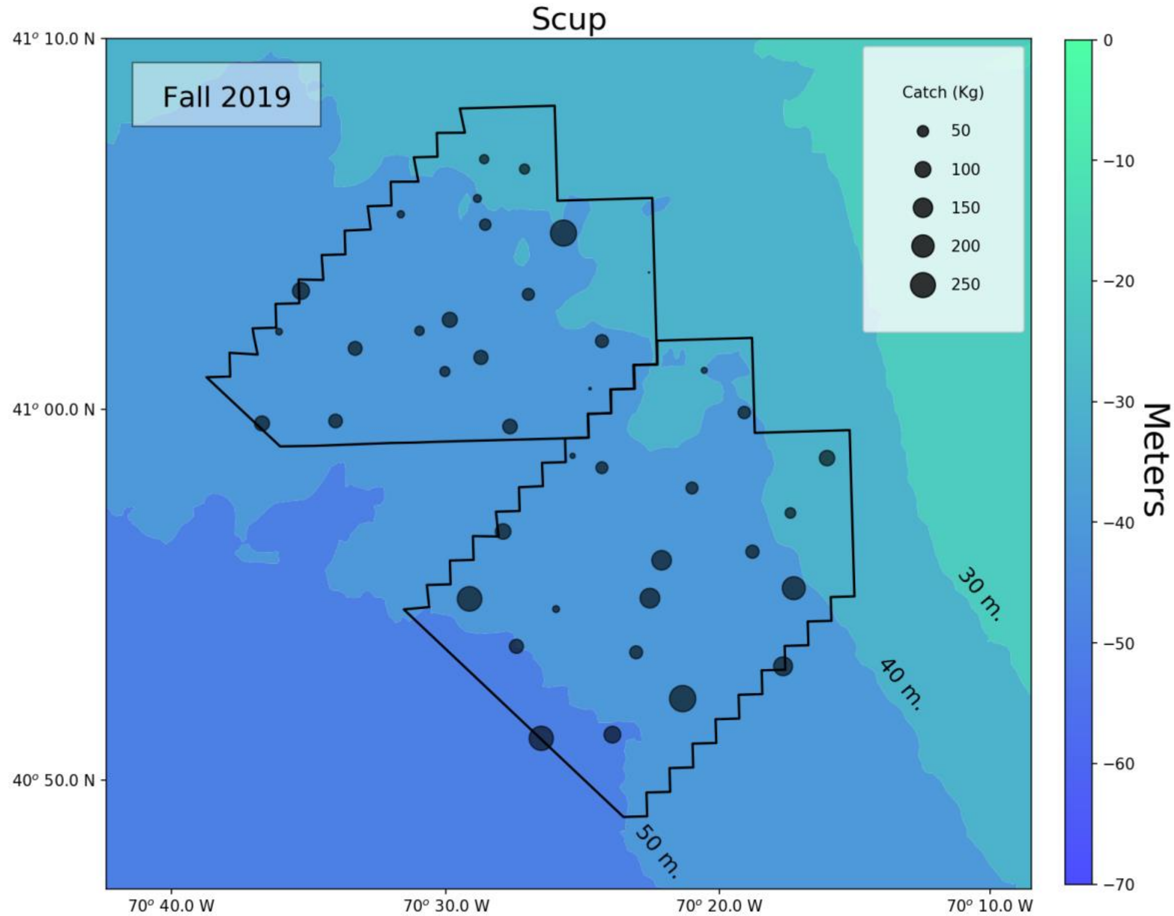
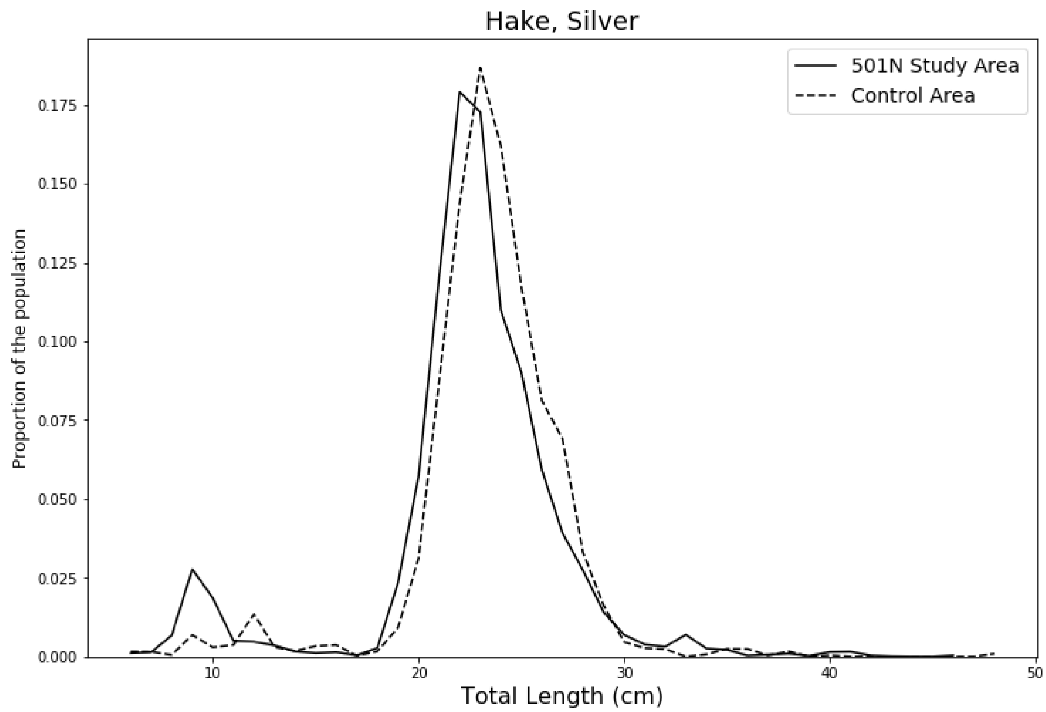


Figure 13: Distribution of the catch of scup in the 501N Study Area (left) and Control Area (right).



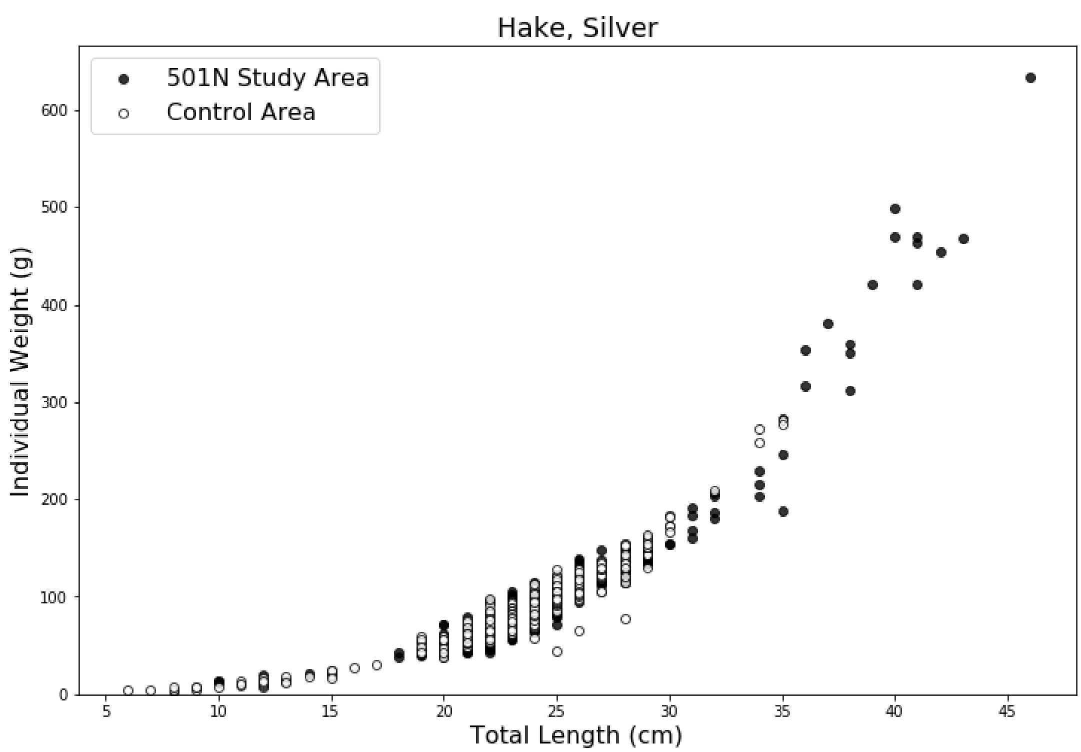


Figure 14: Population structure of silver hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

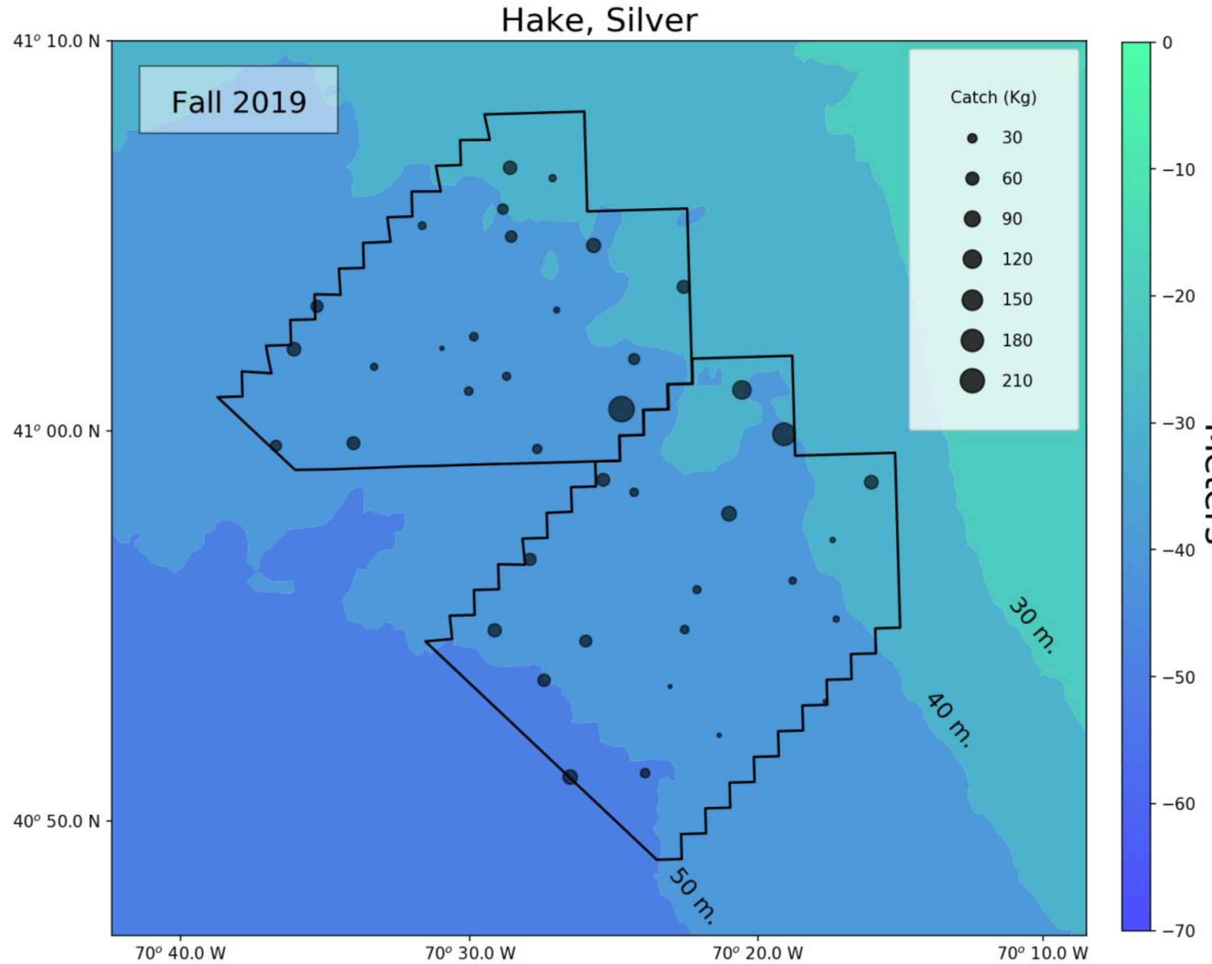
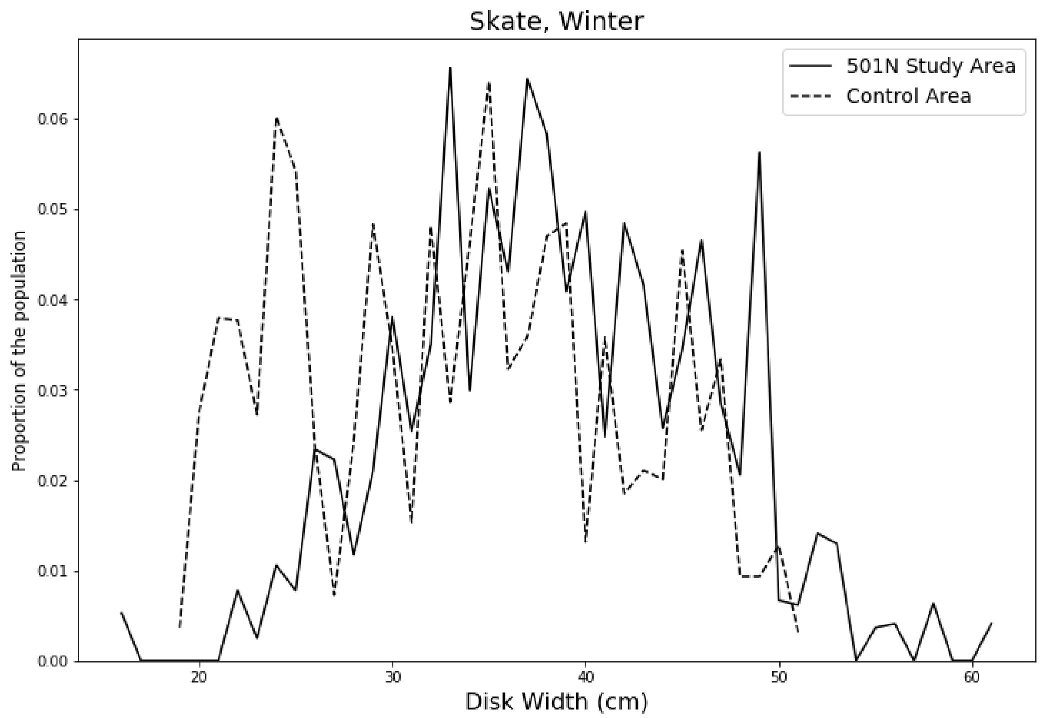


Figure 15: Distribution of the catch of silver hake in the 501N Study Area (left) and Control Area (right).



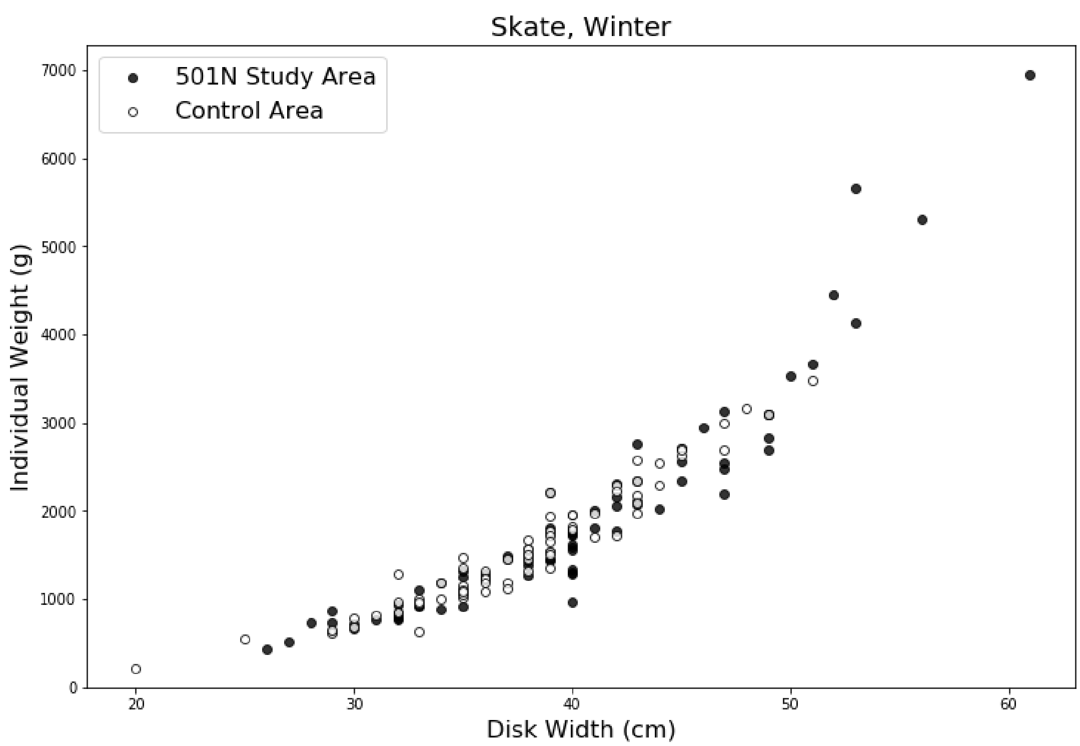


Figure 16: Population structure of winter skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

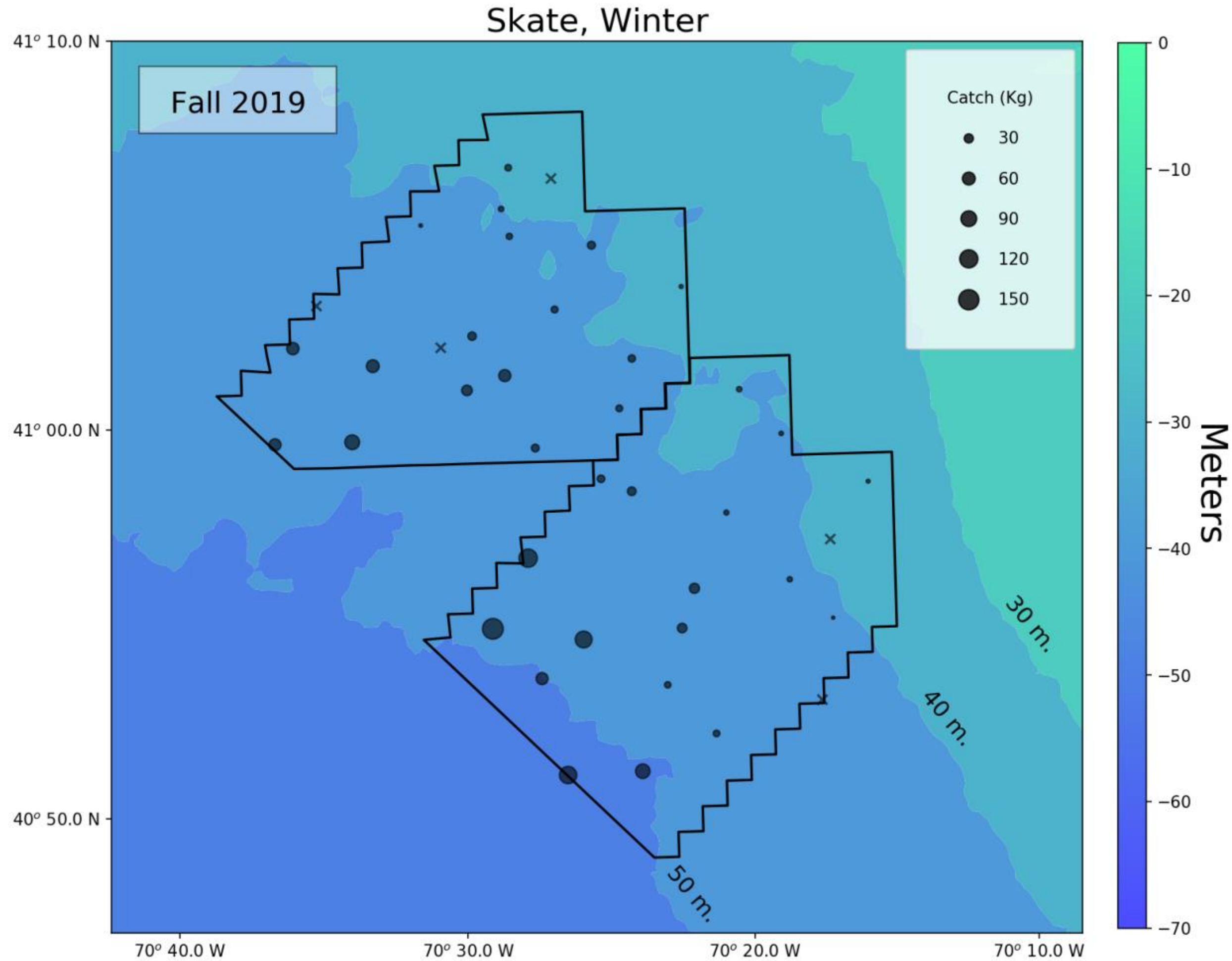
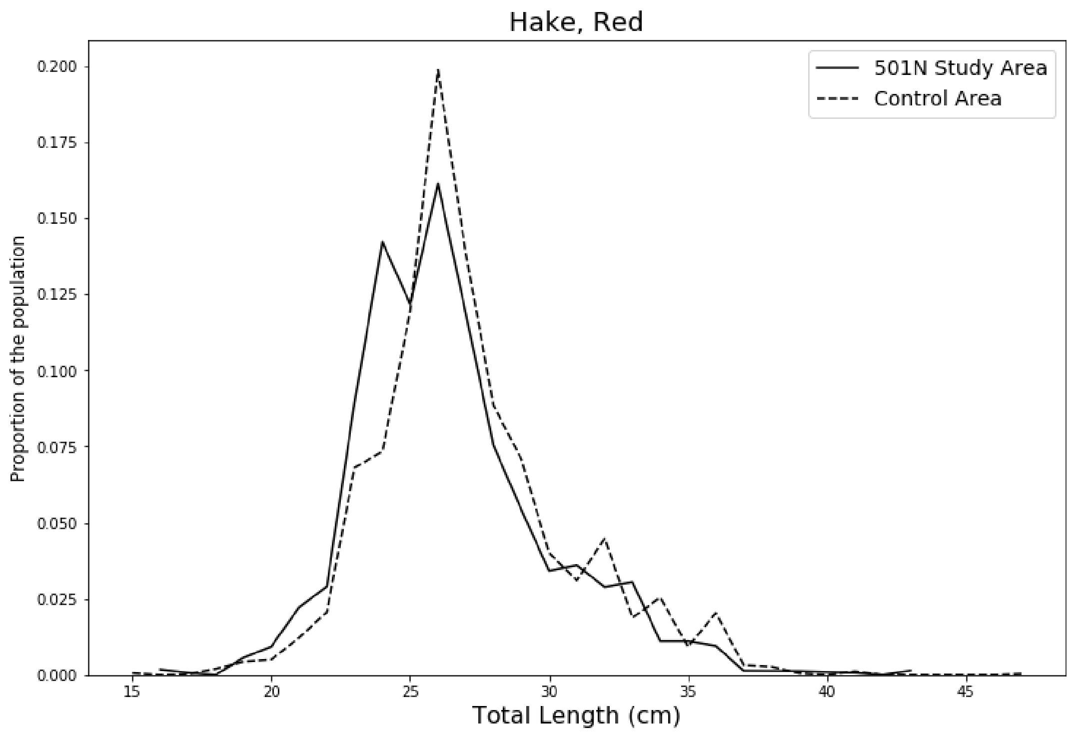


Figure 17: Distribution of the catch of winter skate in the 501N Study Area (left) and Control Area (right). X denotes zero catch. Tows with zero catch are denoted with an X.



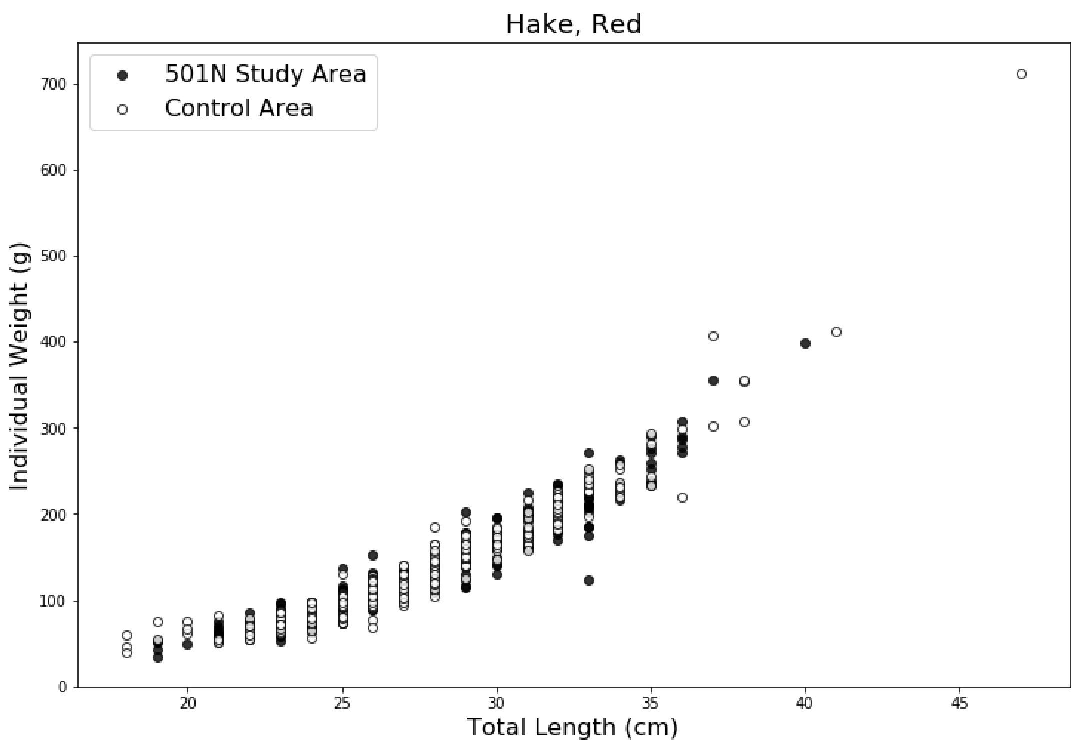


Figure 18: Population structure of red hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

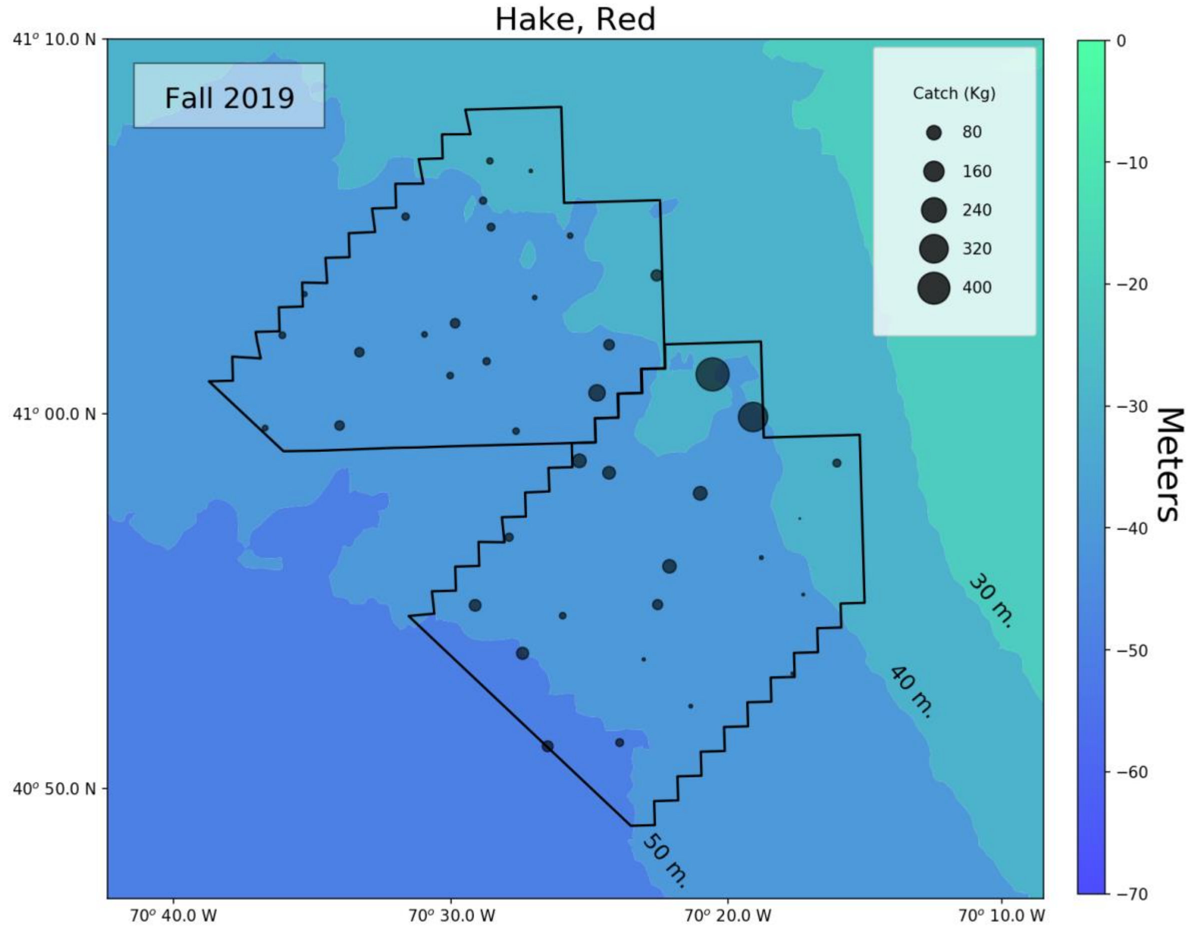
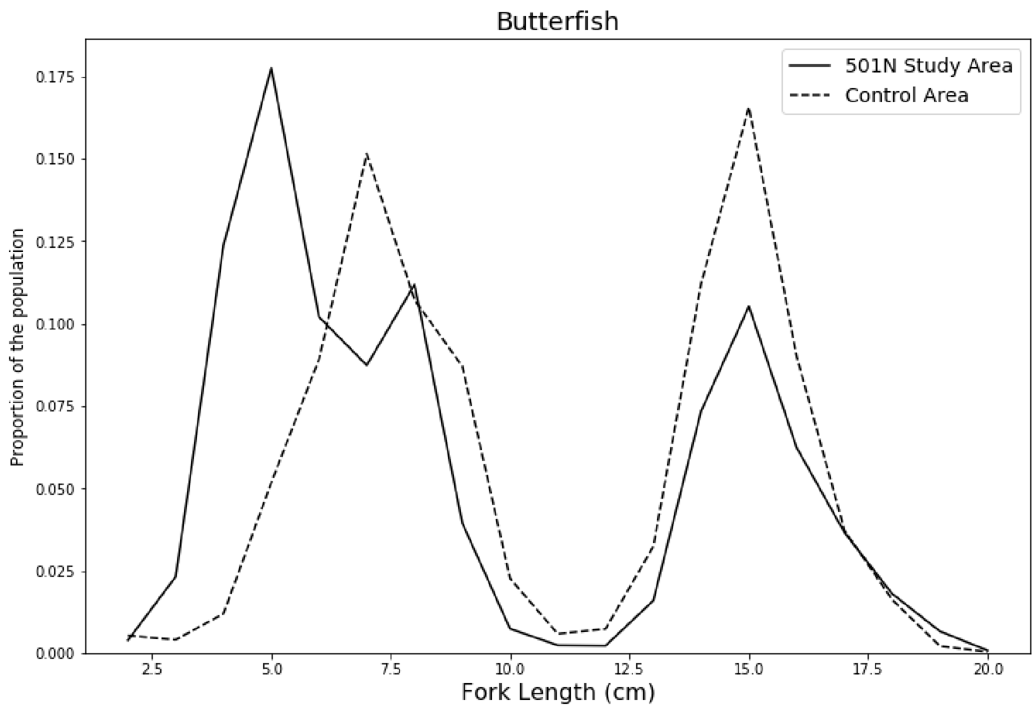


Figure 19: Distribution of the catch of red hake in the 501N Study Area (left) and Control Area (right).



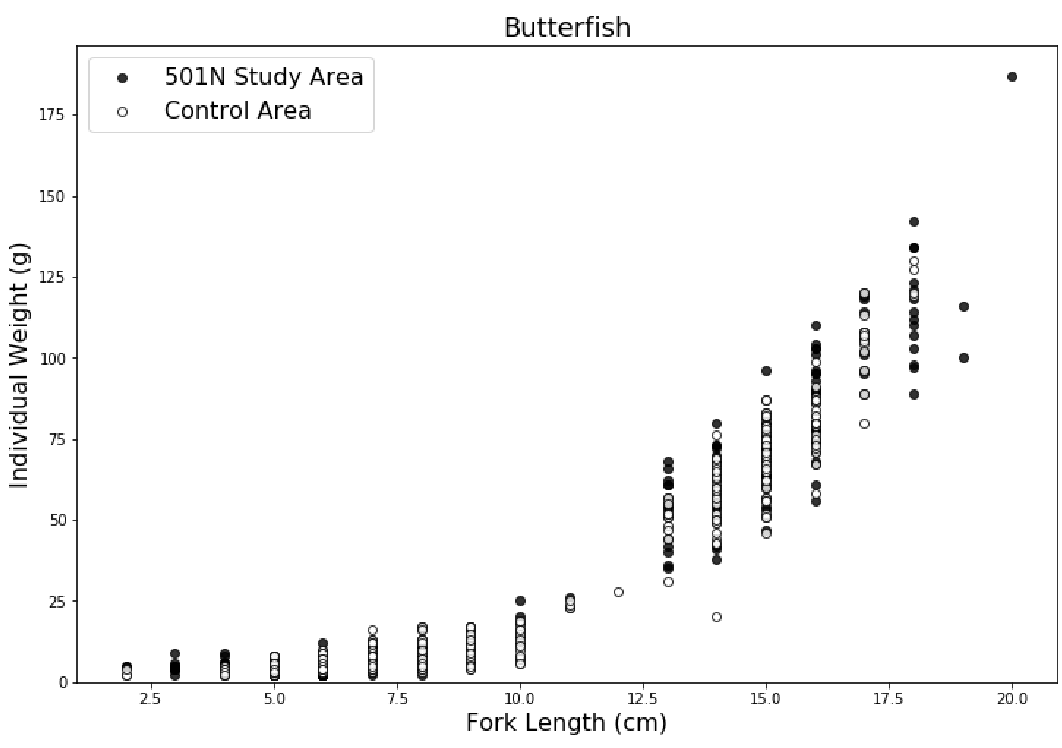


Figure 20: Population structure of butterfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

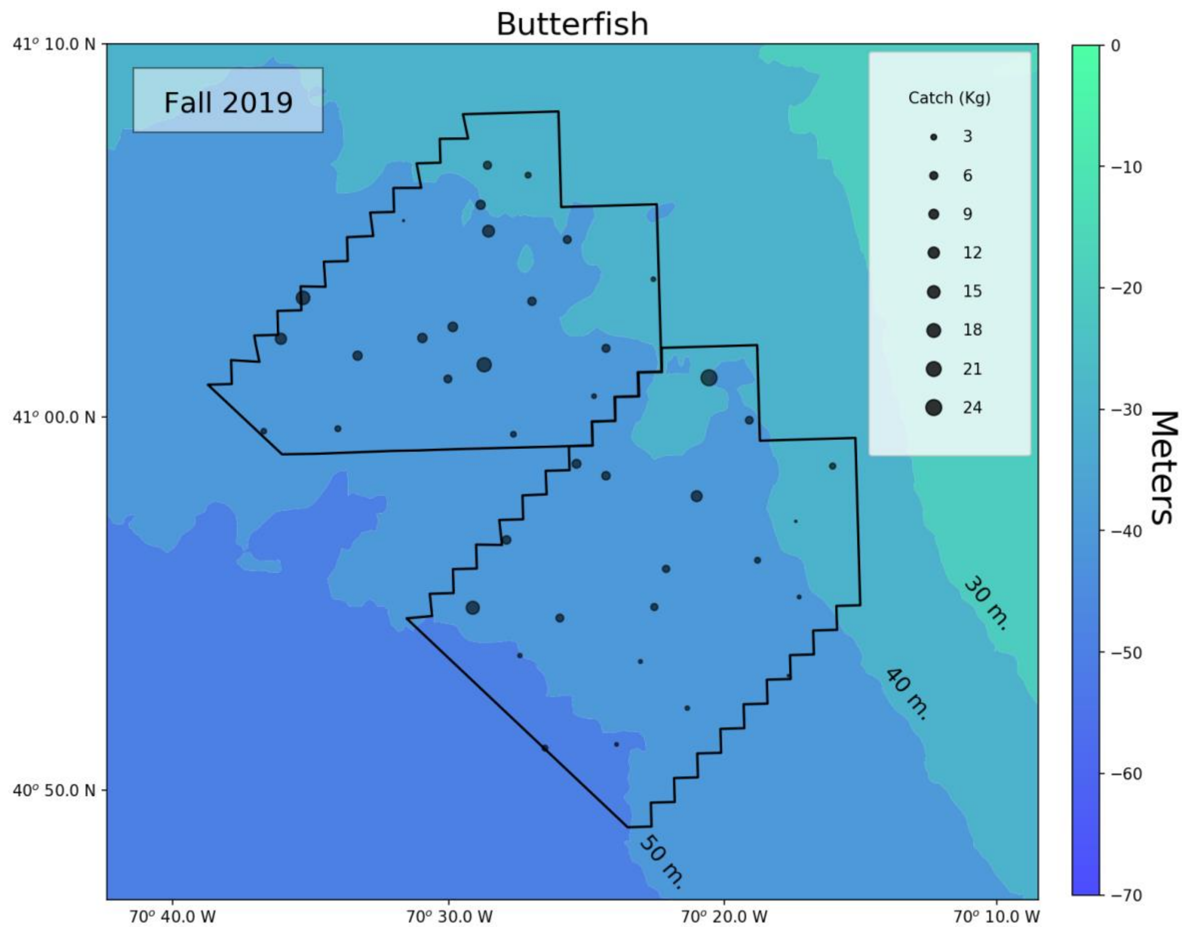
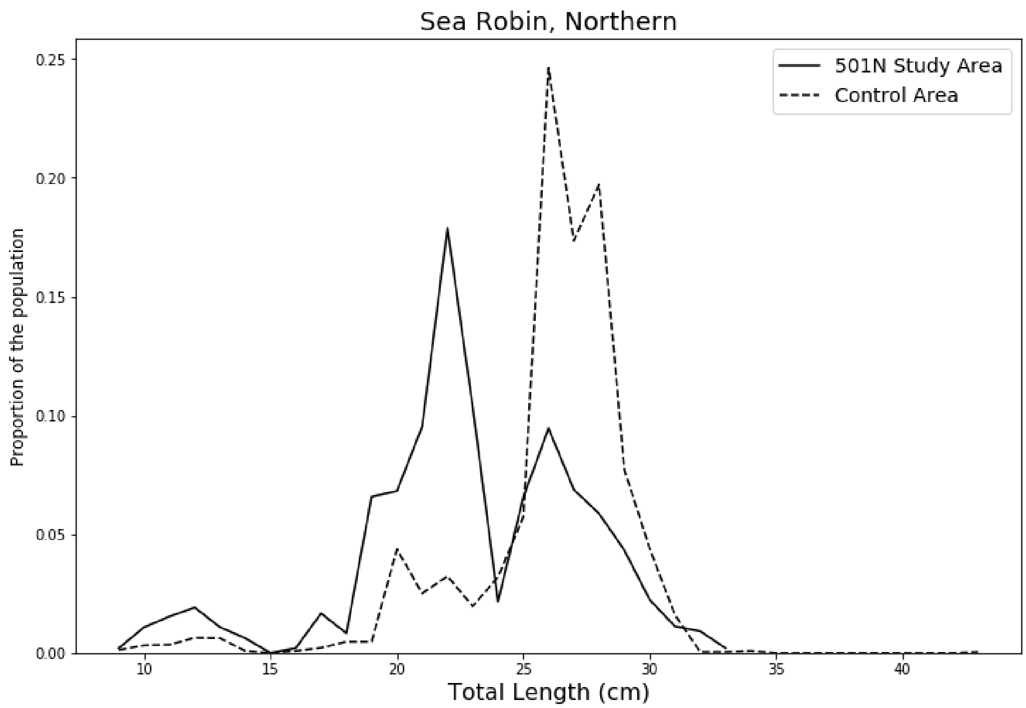


Figure 21: Distribution of the catch of butterfish in the 501N Study Area (left) and Control Area (right).



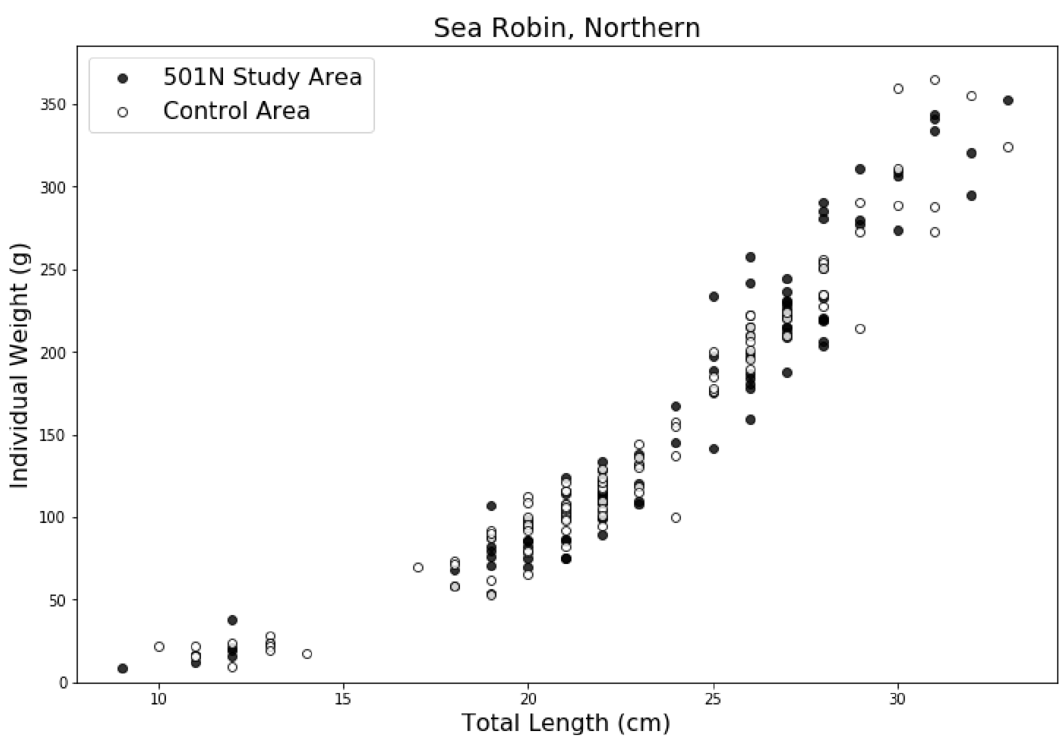


Figure 22: Population structure of northern sea robin in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

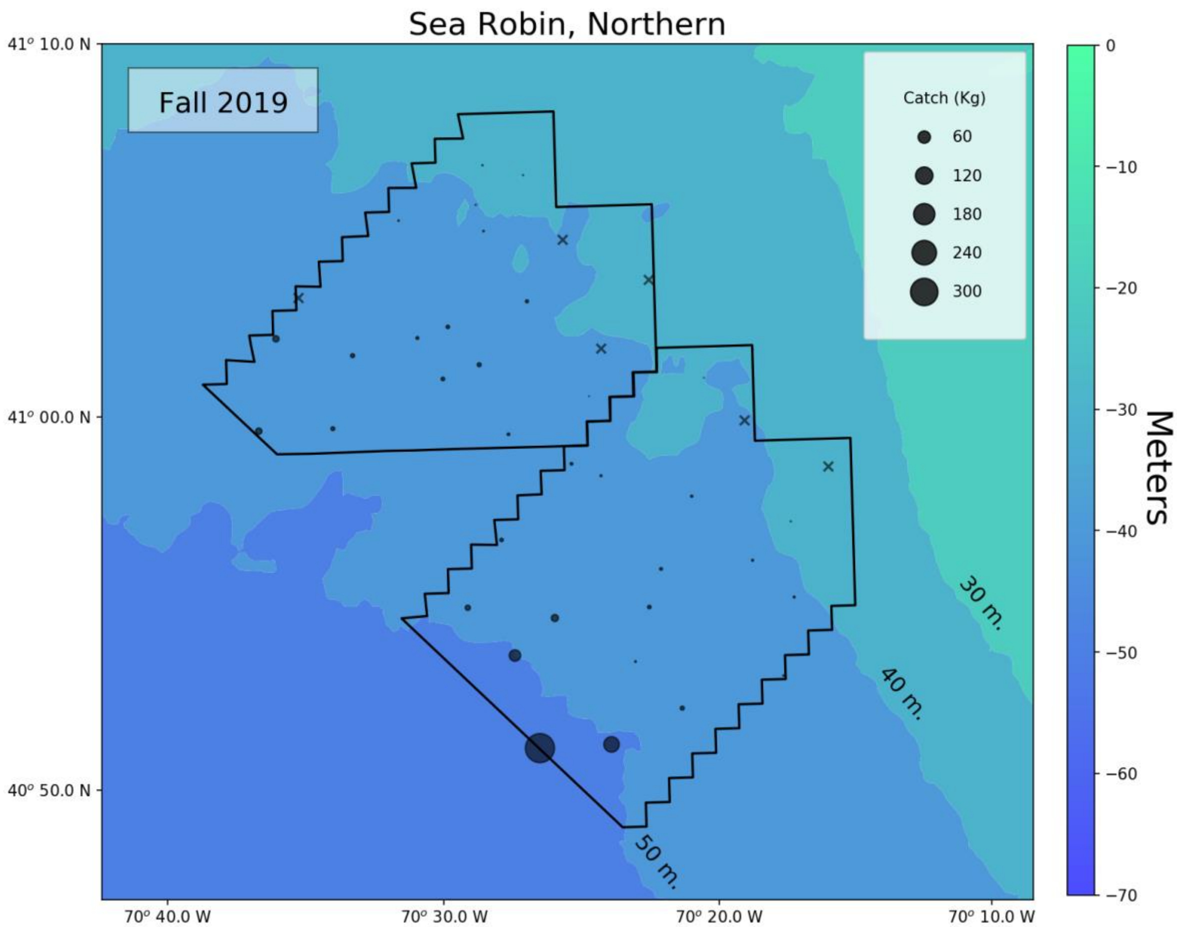
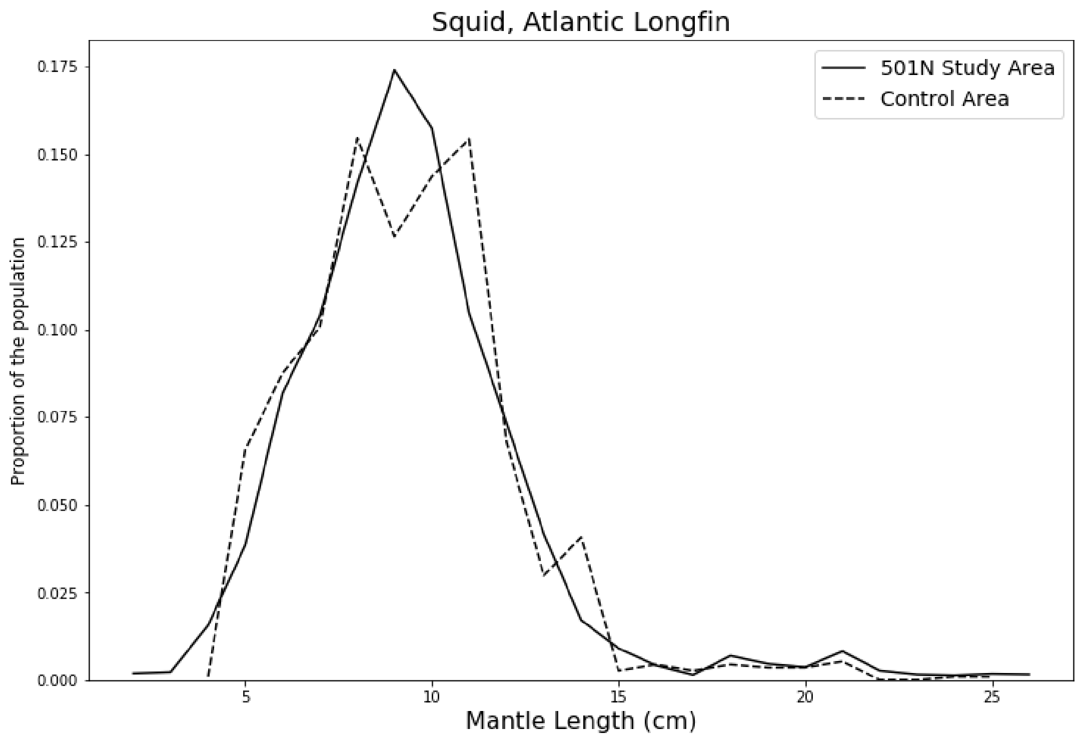


Figure 23: Distribution of the catch of northern sea robin in the 501N Study Area (left) and Control Area (right). X denotes zero catch. Tows with zero catch are denoted with an X.



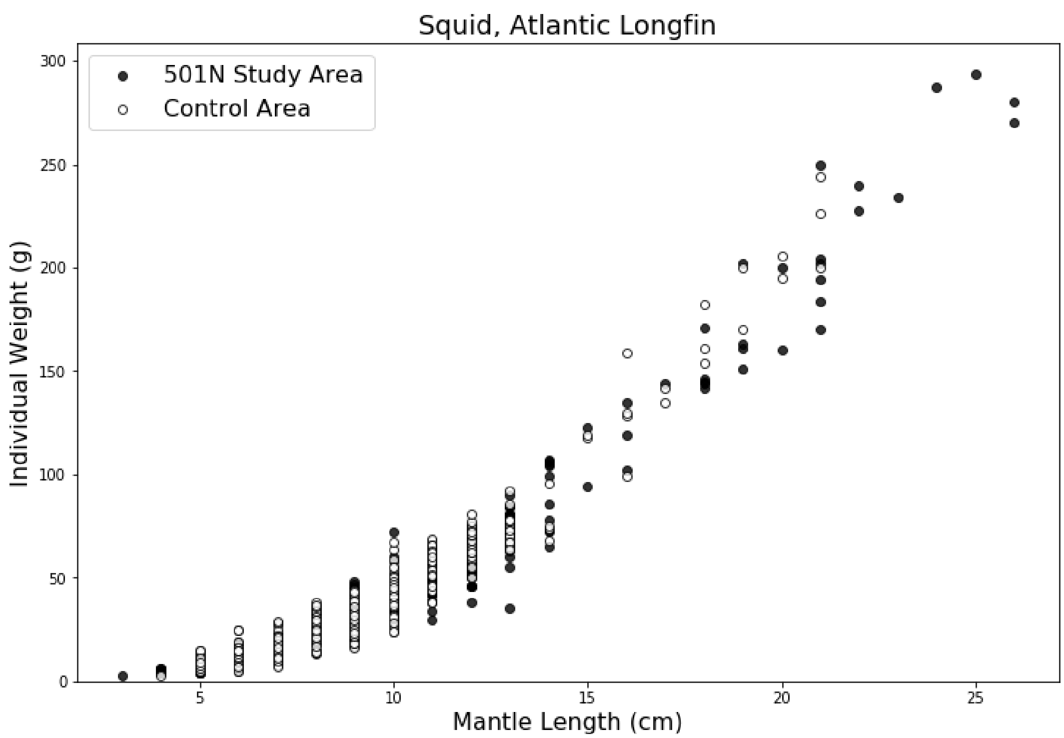


Figure 24: Population structure of longfin squid in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

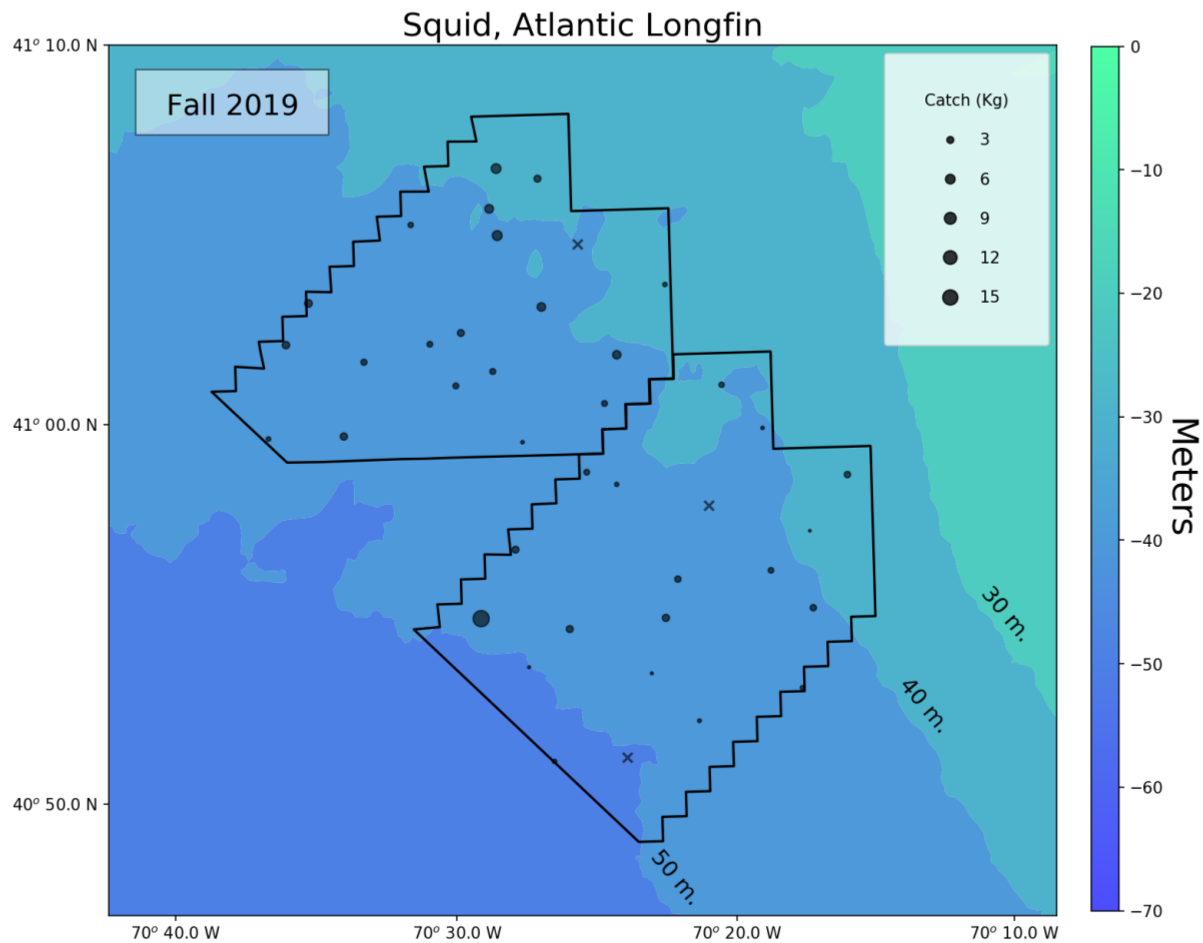


Figure 25: Distribution of the catch of longfin squid in the 501N Study Area (left) and Control Area (right). X denotes zero catch. Tows with zero catch are denoted with an X.

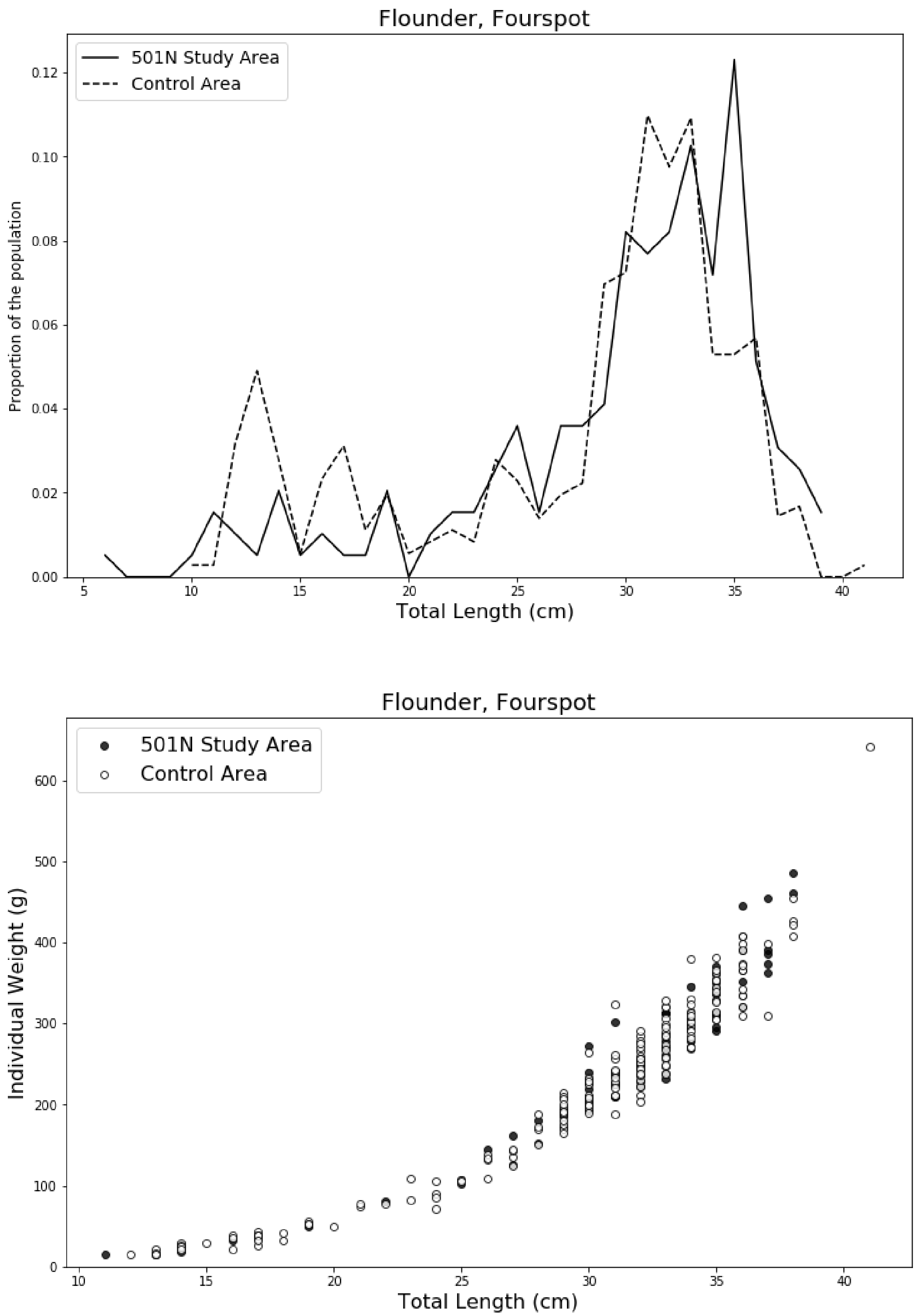


Figure 26: Population structure of fourspot flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

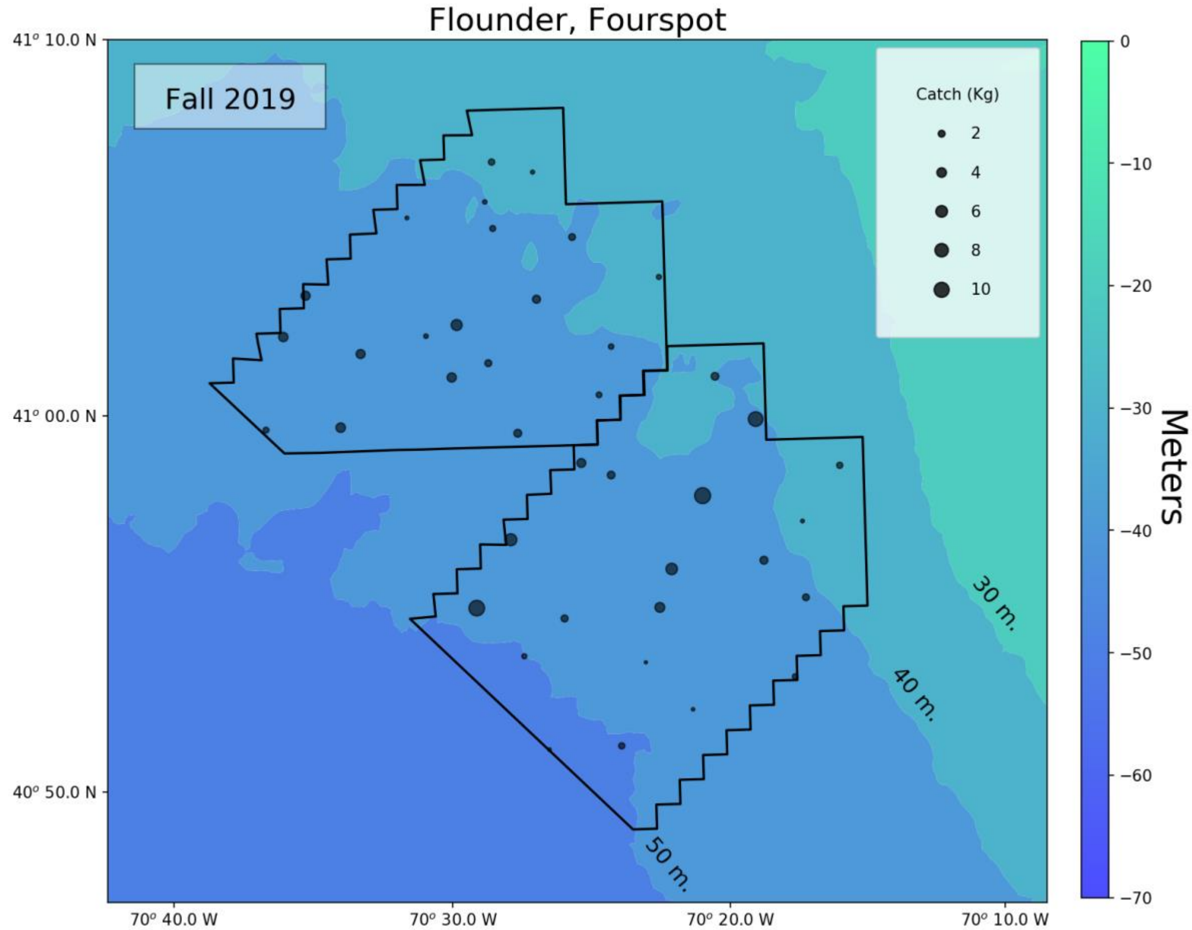
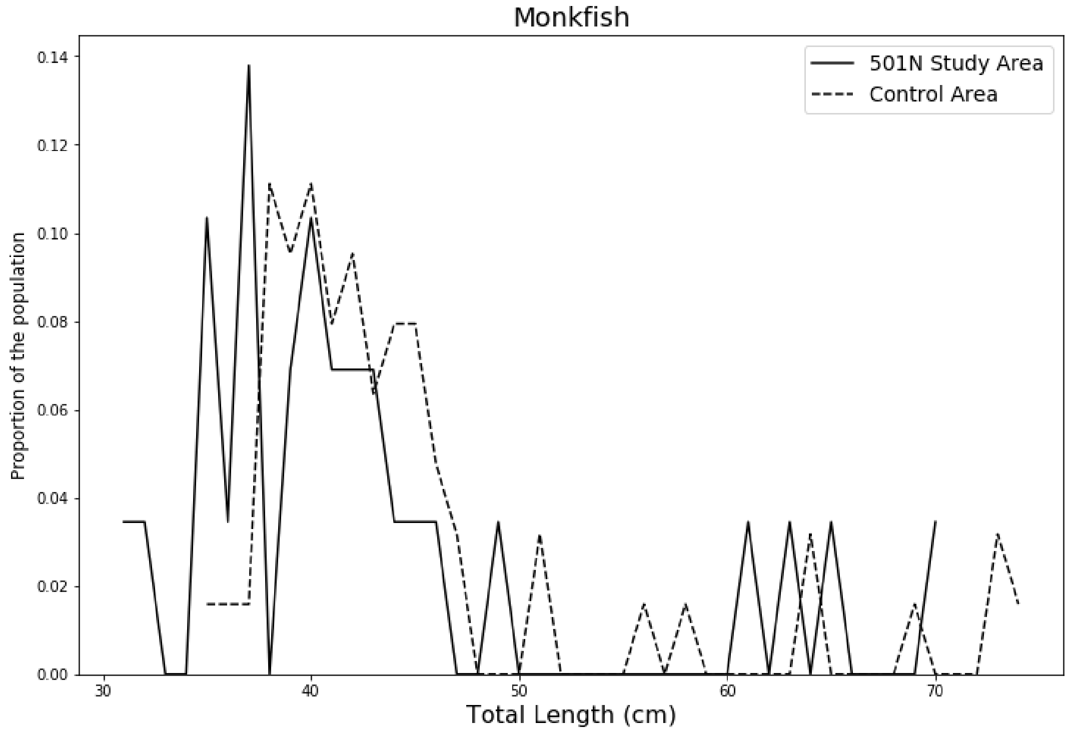


Figure 27: Distribution of the catch of fourspot flounder in the 501N Study Area (left) and Control Area (right).



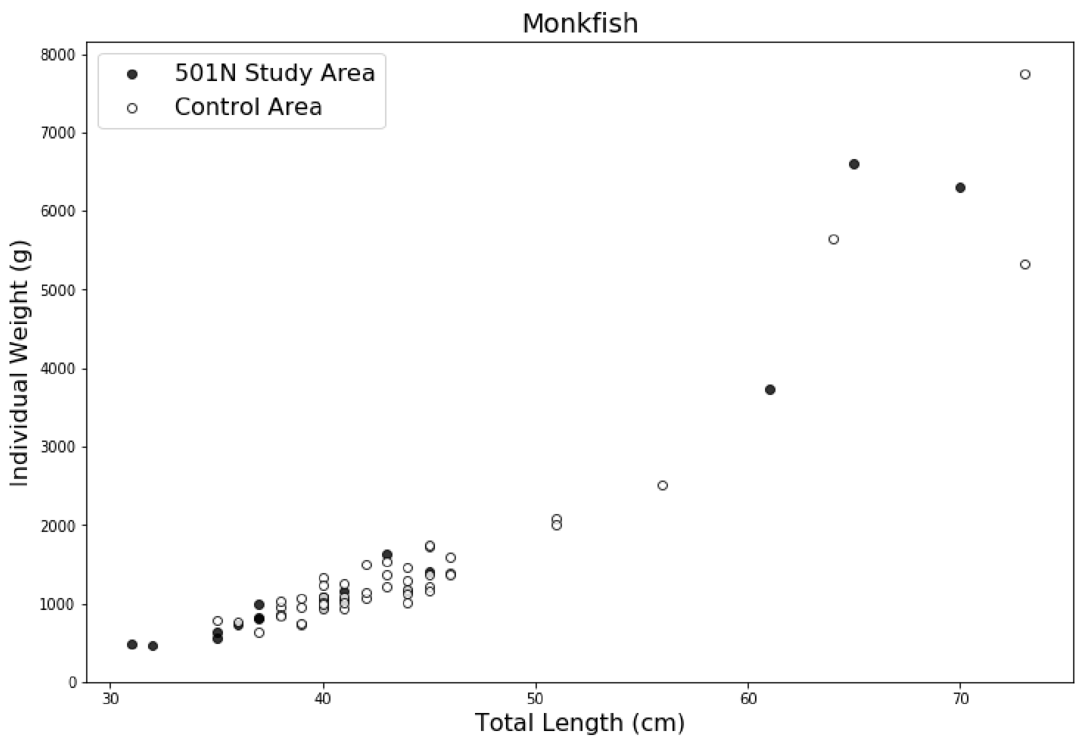


Figure 28: Population structure of monkfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

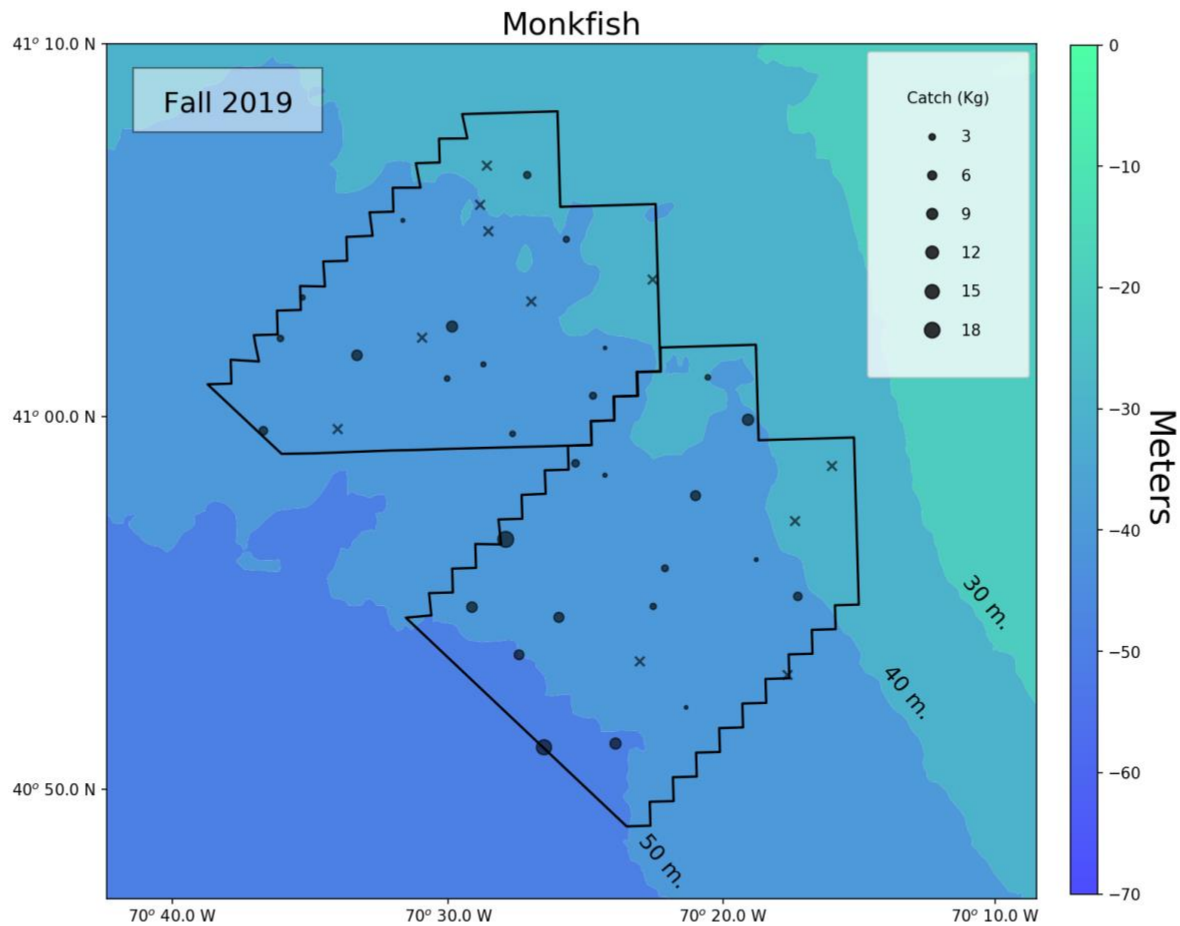
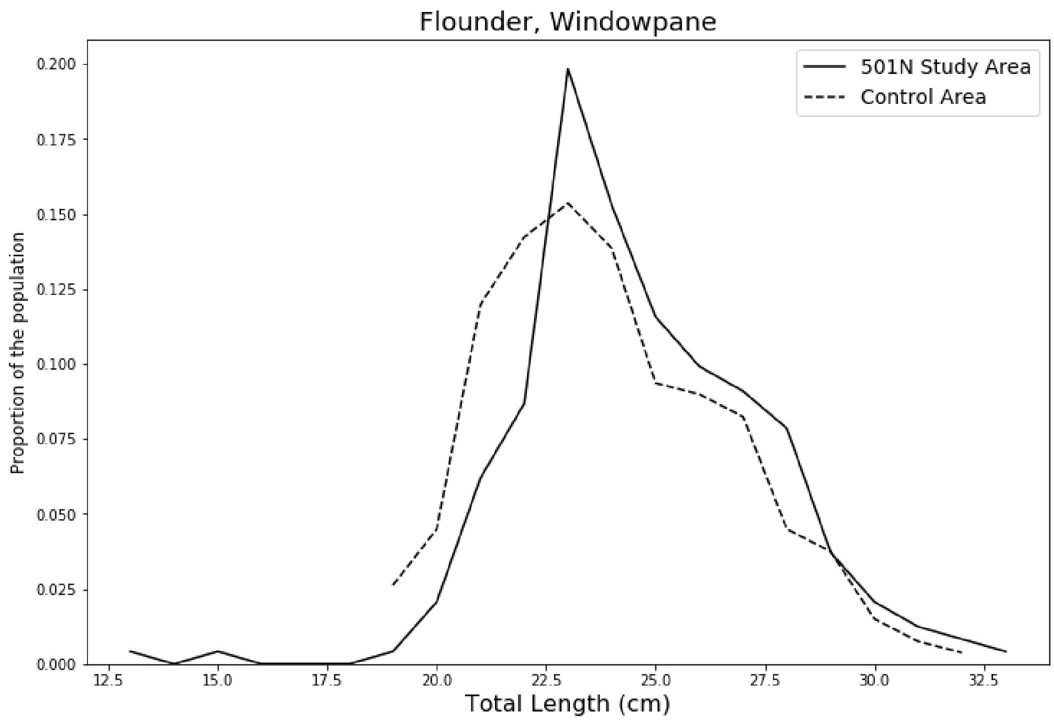


Figure 29: Distribution of the catch of monkfish in the 501N Study Area (left) and Control Area (right). X denotes zero catch. Tows with zero catch are denoted with an X.



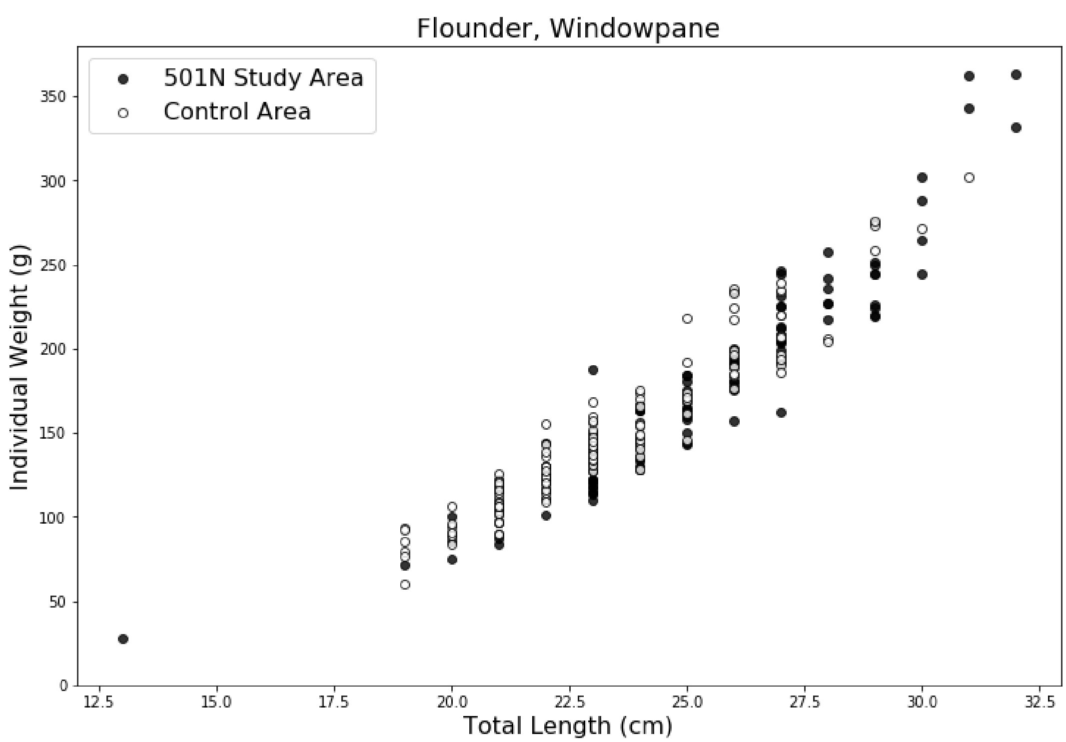


Figure 30: Population structure of windowpane flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

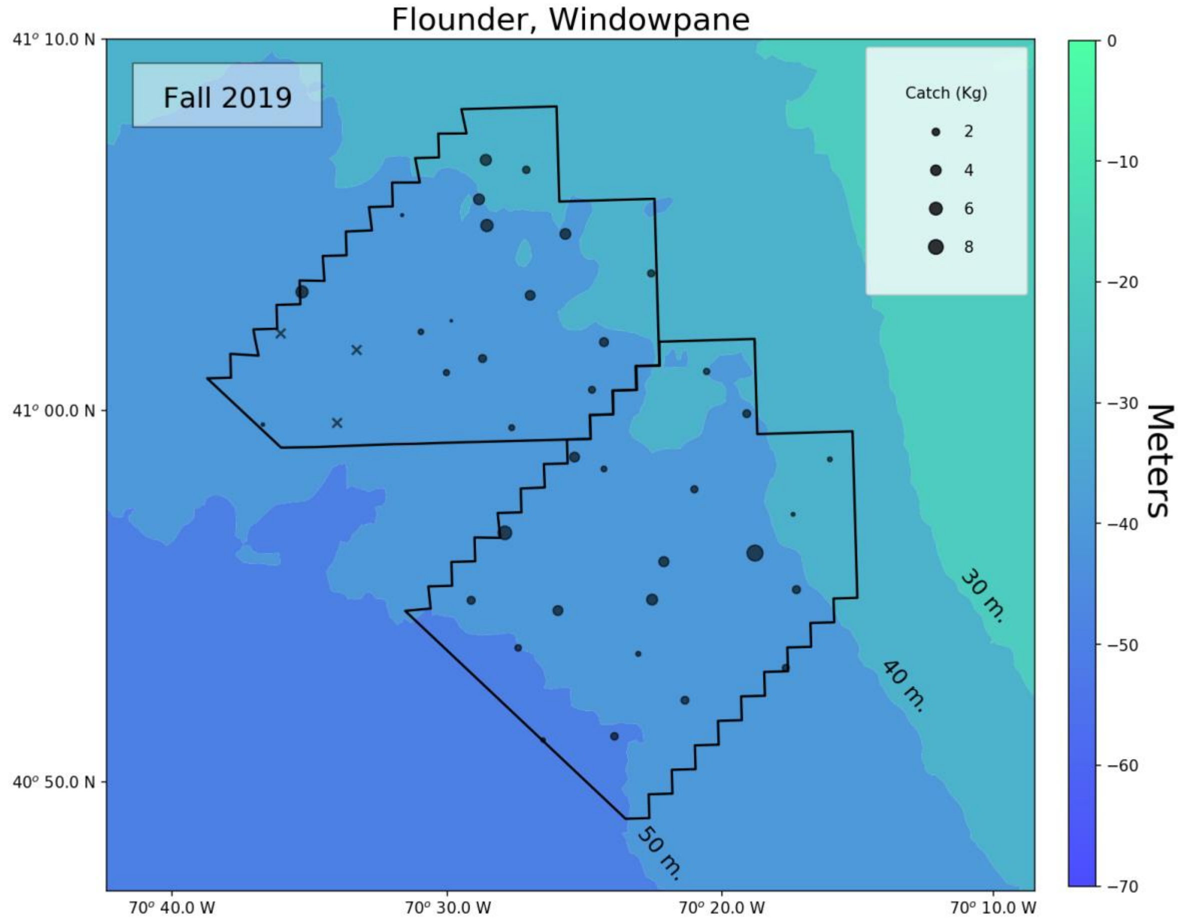
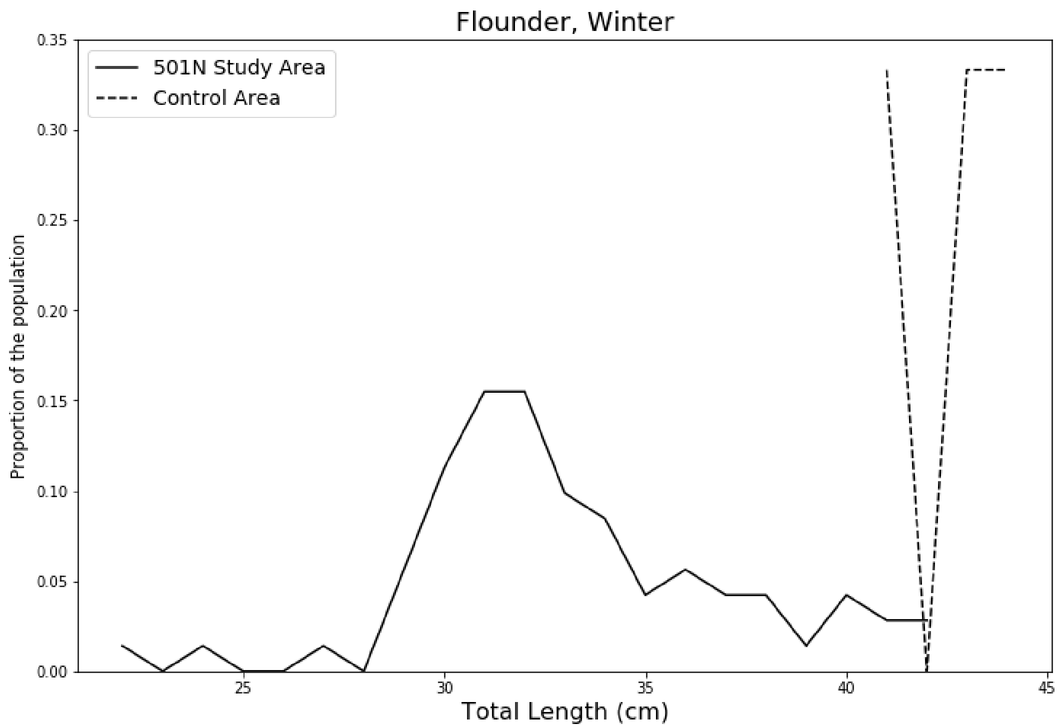


Figure 31: Distribution of the catch of windowpane flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



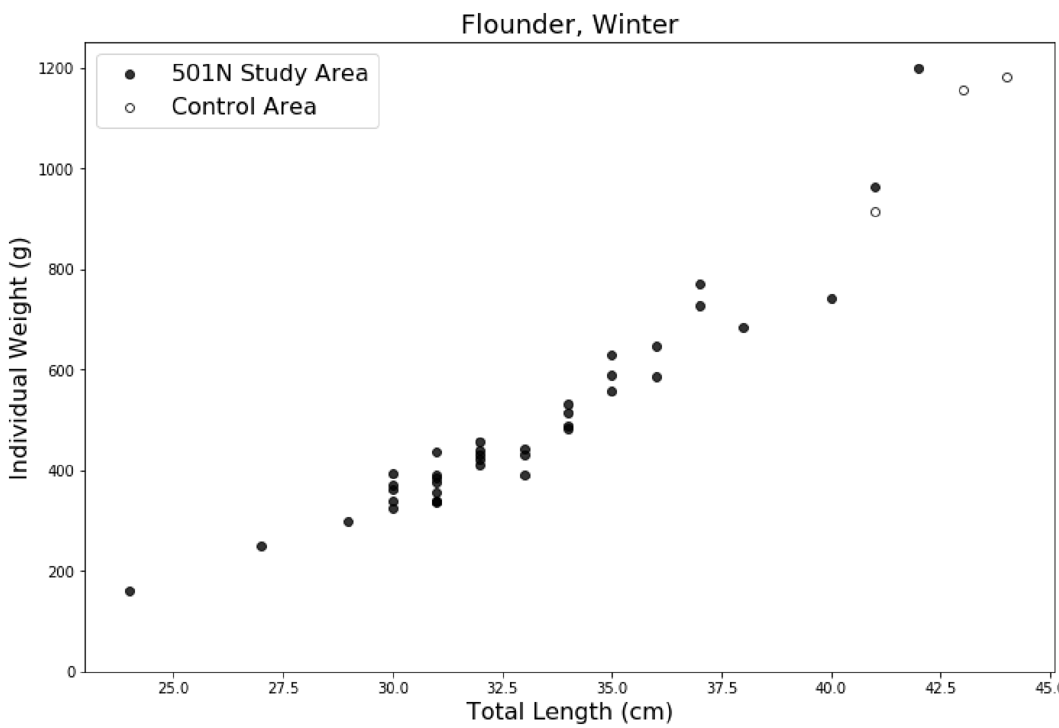


Figure 32: Population structure of winter flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

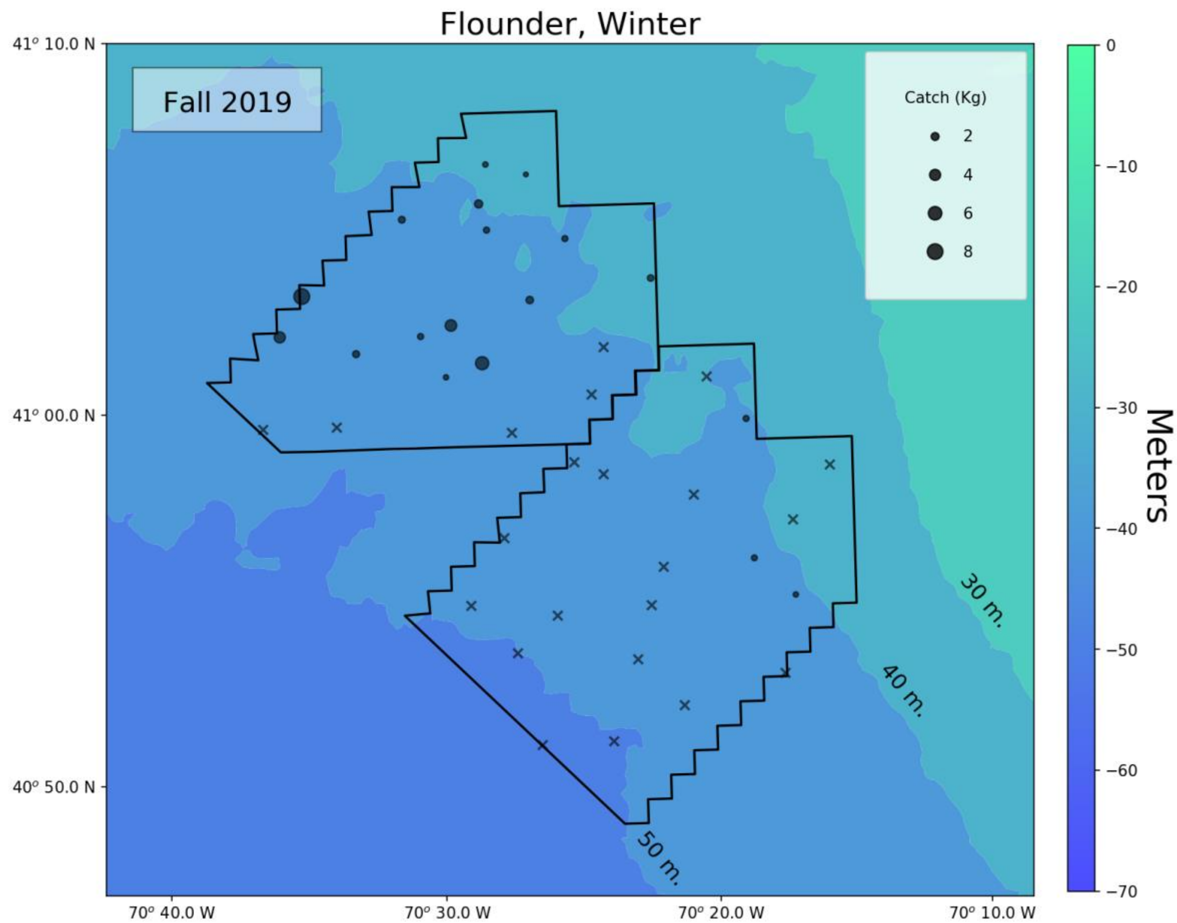
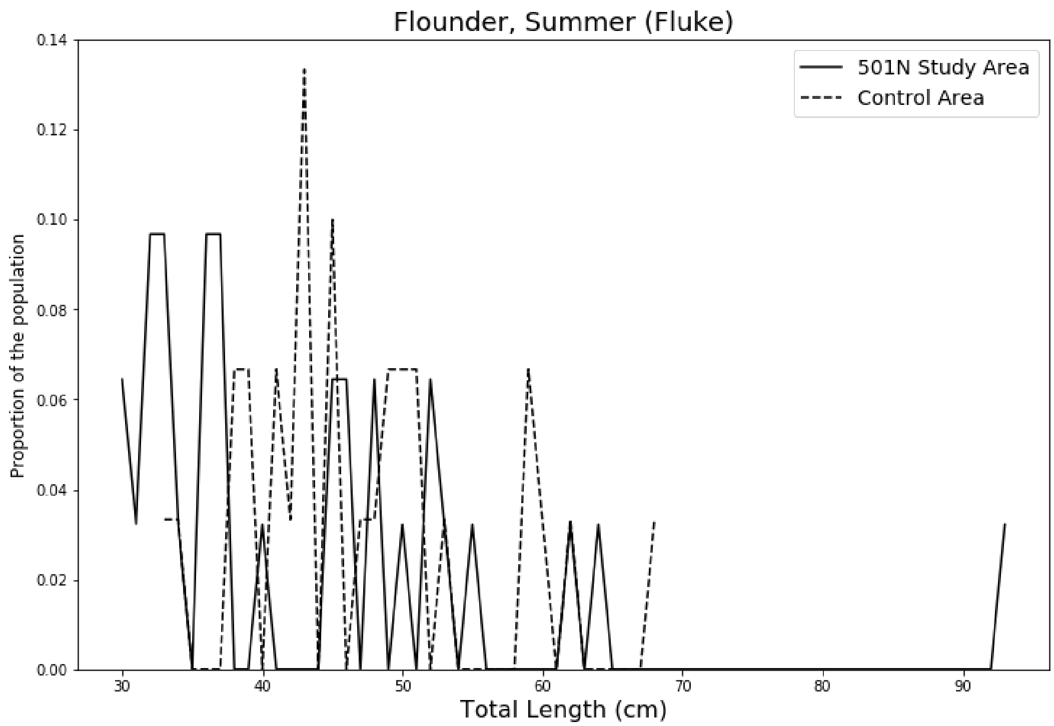


Figure 33: Distribution of the catch of winter flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



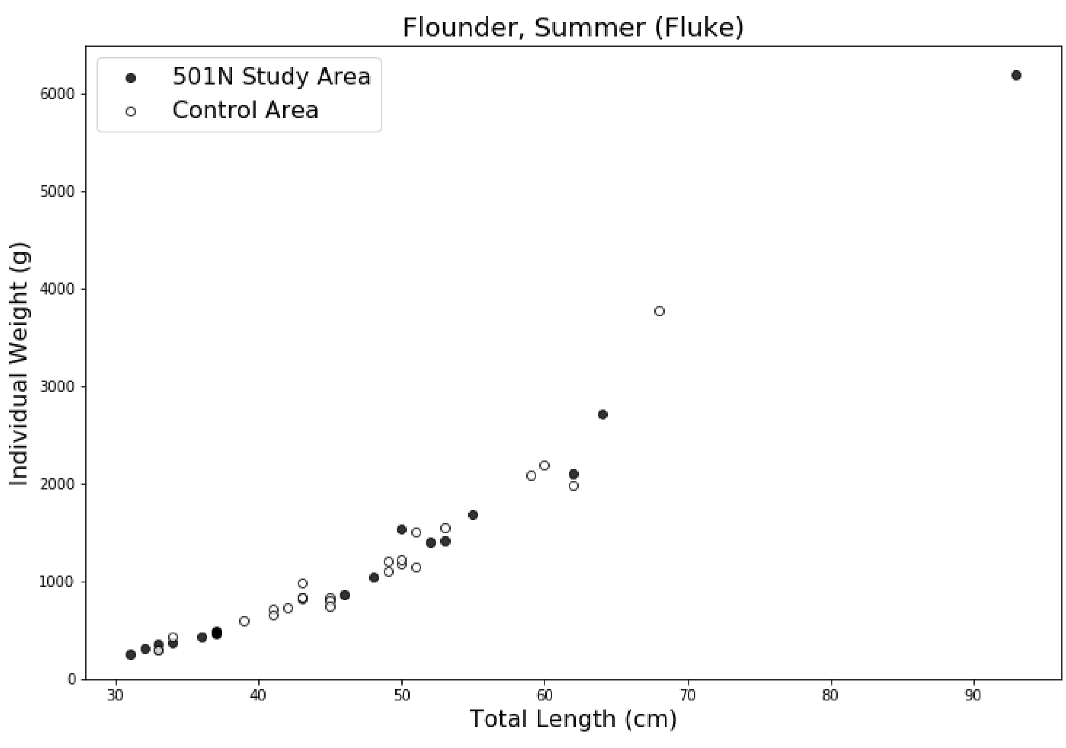


Figure 34: Population structure of summer flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

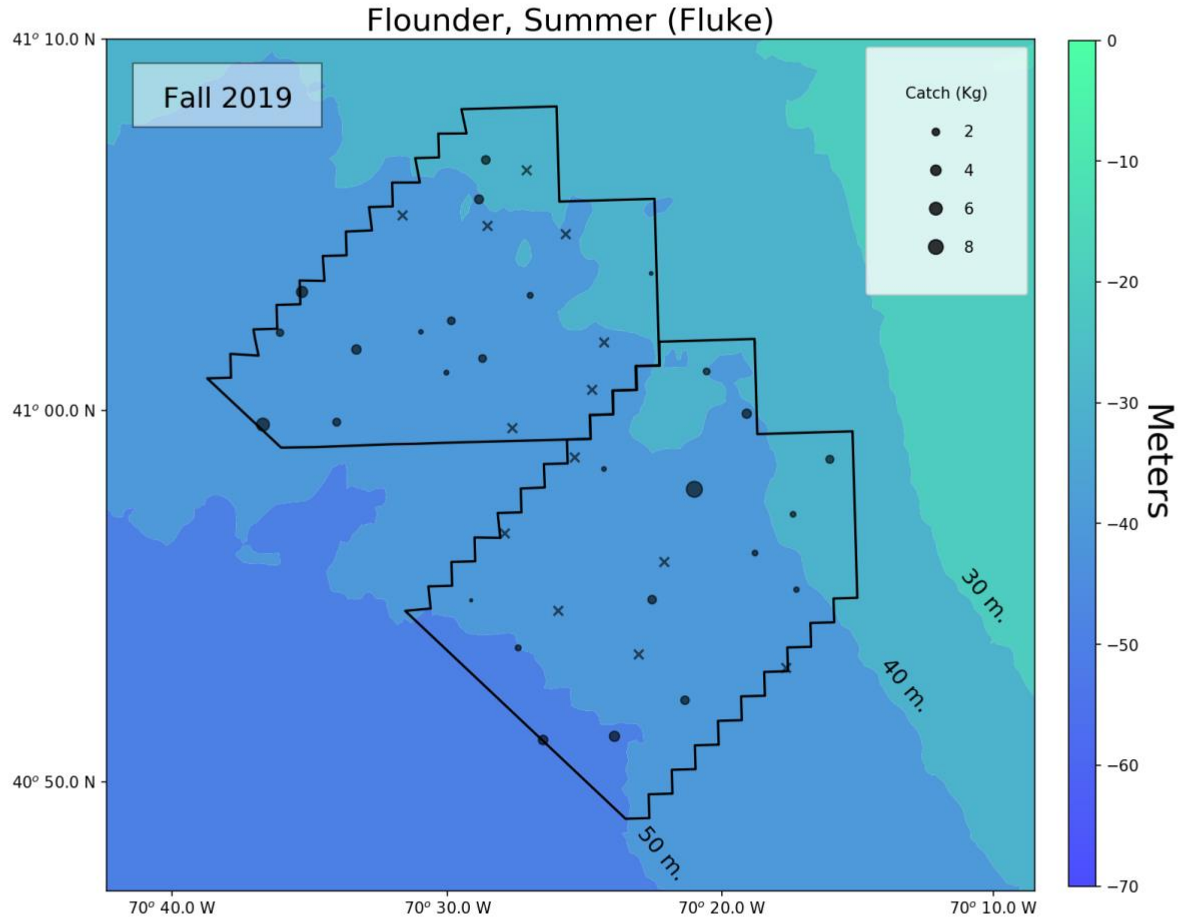


Figure 35: Distribution of the catch of summer flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.