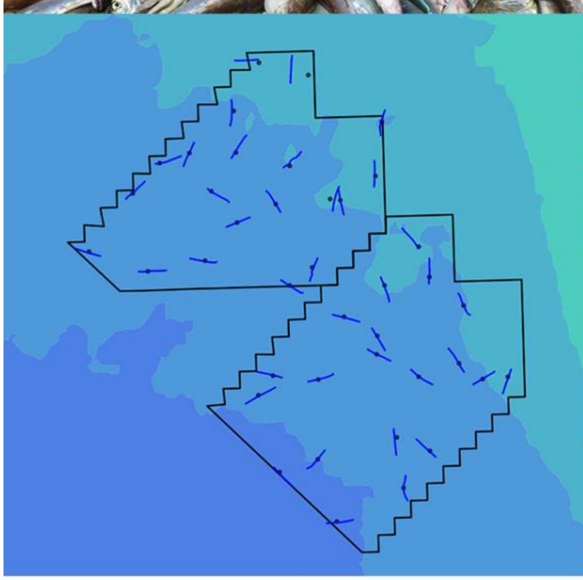
Vineyard Wind Demersal Trawl Survey






Quarterly Report

Summer 2019 (July - September)

501 North Study Area

March 2020

SMAST-CE-REP-2020-078

VINEYARD WIND DEMERSAL TRAWL SURVEY

Summer 2019 Seasonal Report

501 North Study Area

March 2020

Prepared for Vineyard Wind, LLC

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Vineyard Wind Demersal Trawl Survey Summer 2019 Seasonal Report

501 North Study Area

<u>Progress Report #2</u>

July 1 – September 30, 2019

Project title:	Vineyard Wind Demersal Trawl Survey Summer 2019 Seasonal Report – 501 North Study Area
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SMAST-CE-REP-2020-078

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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

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 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 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 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 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 (±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. 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^{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. Two seven-day trips to the survey area were made (Trip 1: August 17 – 23, 2019; Trip 2: August 25 – 31, 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 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 75 fathoms (137 m.) for tows in 20 to 23 fathoms (36 to 42 m), 95 fathoms (174 m) in depths between 23 and 24 fathoms (42 to 44 m) and 100 fathoms (183 m) in depths between 24 and 28 fathoms (44 to 51 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 sub-sampling 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

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 20.0 ± 0.6 minutes (mean ± one standard deviation) in both the 501N Study Area and the Control Area. Tow distances averaged 1.0 ± 0.04 nautical miles in the 501N Study Area giving an average tow speed of 3.0 ± 0.1 knots. Similarly tow distance averaged 1.0 ± 0.01 nautical miles in the Control Area giving an average tow speed of 3.1 ± 0.2 knots. The only outlier was tow 37 in the control area which had a tow speed of 4.0 knots due to trailing wind and tide. The faster towing speed was required to maintain the trawl geometry.

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 followed a similar gradient with warmer water observed during shallow tows (13.1°C at 35 m) and colder water during deeper tows (10.9°C at 50 m) (Table 2).

The trawl geometry data indicated that the trawl took about 2 to 3 minutes to open and stabilize (Table 2). Once open, readings were stable through the duration of the tow. Door spread averaged 35.7 ± 1.8 m (range: 33.1 – 38.2 m.) for tows in the 501N Study Area and 35.9 ± 1.6 (range: 33.4 – 38.6 m.) in the Control Area. On average, door spread was within the acceptable range however eight tows were slightly higher 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 13.9 ± 0.6 m for tows in the 501N Study Area (range: 12.9 – 14.6 m) and 14.1 ± 0.6 m for tows in the Control Area (range: 12.9 – 15.1 m). All tows were within the acceptable tolerance limits for wingspread. Headline height averaged 4.5 ± 0.3 m for tows in the 501N Study Area (range: 4.1 – 5.2 m) and 4.5 ± 0.2 m for tows in the Control Area (range: 4.2 – 4.9). 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 between the spring and summer surveys increased the average headline height from 4.1 and 4.2 m. in the 501N Study Area and Control Area, respectively, to 4.5 m. in both areas. 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 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 31 species were caught over the duration of the survey (Table 3). Catch volume ranged from 87.4 kg/tow to 617.5 kg/tow with an average of 351.3 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (little skate, silver hake, red hake, butterfish and scup) accounted for 90% of the total catch weight. Adding the next five most abundant species (spiny dogfish, longfin squid, fourspot flounder, cancer crab and winter skate) would encompass 97% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Little skate (*Leucoraja erinaca*), was the predominate species observed. Little skates were observed in every tow with an average catch rate of 138.7 ± 13.8 kg/tow (mean ± SE, range: 35.0 – 295.4 kg/tow). Little skate were caught throughout the 501N Study Area (Figure 8).

Silver hake (*Merluccius bilinearis*), also commonly referred to as whiting, was the second most abundant species observed. Silver hake ranged in length from 9 to 49 cm with a bimodal size distribution consisting of peaks at 20 and 26 cm (Figure 9). Silver hake was observed in every tow with an average catch rate of 65.0 ± 8.8 kg/tow (mean ± SE, range: 9.4 – 173.2 kg/tow). Silver hake were caught throughout the 501N Study Area (Figure 10).

Red hake (*Urophycis chuss*), butterfish (*Peprilus triacanthus)* and scup (*Stenotomus chrysops*) were the third, fourth and fifth most abundant species, respectively. Caught in every tow, the red hake ranged from 18 to 41 cm in length, with a unimodal size distribution (Figure 11). The catch of red hake averaged 58.3 ± 12.4 kg/tow (range: 9.6 – 268.2 kg/tow) with increased catch along the depth gradient (i.e. higher catches in deeper water, Figure 12). Butterfish were caught in 18 of the 20 tows. Sizes ranging from 11 to 18 cm with unimodal distribution peaking at 13 cm. (Figure 13). Butterfish catch rates averaged 41.4 ± 12.9 kg/tow (range: 0 - 222.54 kg/tow). Butterfish were observed across the 501N Study Area (Figure 14). Finally, scup were caught in 11 of the 20 tows. Scup were between 16 and 30 cm with a unimodal distribution peaking at 21 cm (Figure 15). The average catch rate of scup was 14.1 ± 7.3 kg/tow (range: 0 - 138.3 kg/tow). The catch of scup was higher in shallow tows along the northern edge of the Study Area (Figure 16).

Additional common species included spiny dogfish (*Squalus acanthias*), longfin squid (*Doryteuthis pealeii),* fourspot flounder (*Hippoglossina oblonga*) and Cancer crab (*Cancer sp.*). Spiny dogfish were caught in 19 of the 20 tows with catch rates averaging 10.5 ± 4.2 kg/tow (range: 0 – 63.9 kg/tow). Dogfish were primarily caught in shallower waters in the northern region of the 501N Study Area (Figure 17). Longfin squid, a commercially important species, ranged in size from 3 to 24 cm mantle length with a bimodal distribution with peaks at 5 and 12 cm (Figure 18). Longfin squid were caught in every tow but at relatively low abundance. The catch of longfin squid averaged 4.8 ± 0.5 kg/tow (range: 1.3 – 7.8 kg/tow; Figure 19). No squid mops were observed during the survey. Similarly, fourspot flounder and cancer crab were caught in most tows, 20 tows and 19 tows respectively, at relatively low abundance. Fourspot flounder catch averaged 3.7 ± 0.6 kg/tow (range: 0.8 – 12.3 kg/tow; Figures 20, 21) while cancer crab averaged 2.9 ± 0.4 kg/tow (range: 0 – 7.0 kg/tow; Figure 22).

Other commercially important species observed included monkfish (*Lophius americanus*), American lobster (*Homarus americanus*) and several flatfish species including winter flounder

(*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), yellowtail flounder (*Limanda ferruginea*) and windowpane flounder (*Scophthalmus aquosus*). Monkfish had a wide size distribution (20 - 58 cm) peaking between 30-35 cm (Figure 23). The catch rate averaged 10.6 ± 2.4 kg/tow (range: 0.8 – 37 kg/tow). Monkfish were observed throughout the 501N Study Area (Figure 24). Windowpane flounder and winter flounder were the most abundant flatfish with 83 and 76 individuals, respectively. Windowpane flounder ranged in size from 14 to 35 cm (Figure 25). Catch rates averaged 0.8 ± 0.2 kg/tow (range: 0 – 4.4 kg/tow, Figure 26). Winter flounder ranged in size from 9 to 41 cm (Figure 27). Catch rates averaged 1.6 ± 0.5 kg/tow (range: 0 – 7.9 kg/tow, Figure 28). Thirty-two yellowtail flounder were caught ranging from 17 to 33 cm. (Figure 29). The average catch rate was 0.2 ± 0.1 kg/tow (range: 0 – 0.8 kg/tow, Figure 30). Additionally, 6 summer flounder and 11 lobsters were caught. Summer flounder ranged in size from 46 to 64 cm (Figure 31, 32).

Two thresher sharks (*Alopias vulpinus*) were caught. Both animals were estimated to be ~2.5 m long (fork length). The sharks were immediately returned to the sea and were observed to swim away.

3.2.2 Control Area

Species composition in the Control Area were similar to that observed in the 501N Study Area. A total of 33 species were caught over the duration of the survey (Table 4). Catch volume ranged from 171.9 kg/tow to 2455.8 kg/tow with an average of 526.1 kg/tow. As with the 501N Study Area, the majority of the catch was comprised of a small subset of the observed species. The five most abundant species (red hake, little skate, butterfish, silver hake, and alewife) accounted for 89% of the total catch weight. Including the next five most abundant species (scup, spiny dogfish, summer flounder, longfin squid and fourspot, flounder) would encompass 97% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Red hake was the predominate species observed, accounting for 28% of the total catch weight. Red hake ranged in length from 18 to 40 cm with a unimodal size distribution peaking at 23 cm (Figure 11). Red hake were observed in every tow with an average catch rate of 148.5 ± 28.2 kg/tow (range: 0.2 – 340.8 kg/tow). The highest catches of red hake were in the southern half of the Control Area (Figure 12).

Little skate was the second most abundant species observed. Little skates were observed in 19 of the 20 tows with an average catch rate of 114.9 ± 15.7 kg/tow (range: 0 – 300.0 kg/tow). Little skate were caught throughout the Control Area (Figure 8).

Butterfish and silver hake were also caught in every tow. Butterfish ranged in size from 8 to 19 cm (Figure 13). Butterfish catch rates averaged 99.2 ± 27.7 kg/tow (range: 2.3 - 472.3 kg/tow) and were found throughout the Control Area (Figure 14). Silver hake had a bimodal size distribution ranging from 7 to 47 cm with peaks at 20 cm and 25 cm (Figure 9). The silver hake catch averaged 84.6 ± 12.1 kg/tow (range: 42.6 - 262.2 kg/tow). The catch was distributed throughout the Control Area (Figure 10).

Alewife (*Alosa pseudoharengus*) was the fifth most abundant species. Alewife ranged in size from 9 to 21 cm with a unimodal peak between 17 and 18 cm (Figure 33). While the average catch rate was 22.7 ± 15.3 kg/tow this was largely driven by a single tow which had 298.1 kg. Alewife were primarily found in the southern half of the Control Area (Figure 34).

Additional common species included spiny dogfish, summer flounder, longfin squid, fourspot flounder, and monkfish. Spiny dogfish were caught in 19 of the 20 tows with catch rates averaging 7.8 ± 1.5 kg/tow (range: 0 – 22.1 kg/tow; Figure 17). Longfin squid, fourspot flounder, and monkfish were caught in every tow. Squid had a bimodal length distribution with peaks at 5 and 12 cm mantle length (Figure 18). Higher catches were observed in the northern half of the area with catch rates averaging 6.5 ± 0.6 kg/tow (range: 1.9 – 11.9 kg/tow, Figure 19). No squid mops were observed in the Control Area. Fourspot flounder ranged in size from 8 to 40 cm (Figure 20). Fourspot flounder were found throughout the Control Area with catch rates averaging 3.9 ± 0.5 kg/tow (range: 0.4 – 8.7 kg/tow, Figure 121). Monkfish had a wide size range (25 – 74 cm; Figure 23). The average catch rate of monkfish was 3.6 ± 0.7 (range: 0.2 – 9.5 kg/tow) and were found throughout the Control Area (Figure 24).

Other common commercial species included scup, summer flounder, winter flounder, windowpane flounder and yellowtail flounder. Scup were caught in 16 of the 20 tows. Individuals ranged in size from 19 to 32 cm with a unimodal distribution peaking at 21 cm (Figure 15). The average catch rate of scup was 16.7 ± 6.9 kg/tow (range: 0 – 118.6 kg/tow). Scup catches were higher in shallower water to the north (Figure 16). Of the flatfish, summer flounder had the highest catch rates (average: 7.0 ± 1.6 kg/tow) due to their large size (27 – 76 cm) while winter flounder were the most numerous (84 individuals). The catch of winter flounder averaged 1.6 ± 0.5 kg/tow with sizes ranging from 19 to 41 cm (Figure 27, 28). Forty-nine windowpane flounder were caught at an average catch rate of 0.6 ± 0.3 kg/tow. Twenty-seven yellowtail flounder were caught at an average catch rate of 0.3 ± 0.1 kg/tow. The catches of these flounder were generally higher in the shallower northern half of the Control Area (Figure 26, 28, 30, 32).

Less common commercial species included American lobster (*Homarus americanus,* 7 individuals), Atlantic sea scallop (*Placopecten magellanicus*, 5 individuals), haddock (*Melanogrammus* aeglefinus, 1 individual) and bluefish (*Pomatomus saltatrix*, 1 individual).

One thresher shark (*Alopias vulpinus*) was caught. The animal was estimated to be ~2.0 m long (fork length). The shark was immediately returned to the sea and was observed to swim away.

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**	8/18/2019	Obscured	3-6	SW	0.1-0.5	8:58	N 41^0 08.018	W 70^0 29.801	20	9:18	N 41^0 08.053	W 70^0 28.630	21	75
2	**501N**	8/18/2019	Overcast	3-6	SW	0.1-0.5	10:59	N 41^0 08.161	W 70^0 26.863	21	11:19	N 41^0 07.182	W 70^0 26.977	21	75
3	**501N**	8/18/2019	Overcast	0	SW	0.1-0.5	12:46	N 41^0 04.433	W 70^0 26.863	22	13:06	N 41^0 03.849	W 70^0 27.404	22	75
4	**501N**	8/18/2019	Mostly Cloudy	1-2	SW	0.1-0.5	14:14	N 41^0 05.113	W 70^0 29.302	22	14:34	N 41^0 04.243	W 70^0 30.061	22	75
5	**501N**	8/18/2019	Partly Cloudy	3-6	SW	0.1-0.5	15:42	N 41^0 03.985	W 70^0 29.302	24	16:02	N 41^0 04.868	W 70^0 31.962	24	75
6	**501N**	8/18/2019	Partly Cloudy	3-6	SW	0.1-0.5	17:03	N 41^0 05.527	W 70^0 30.098	22	17:23	N 41^0 06.490	W 70^0 30.032	22	75
7	**Control**	8/19/2019	Partly Cloudy	1-2	SW	0.1-0.5	7:09	N 40^0 59.634	W 70^0 22.081	22	7:29	N 40^0 39.566	W 70^0 42.492	21	75
8	**Control**	8/19/2019	Obscured	1-2	SW	0.1-0.5	8:42	N 41^0 01.416	W 70^0 21.338	22	9:02	N 41^0 00.656	W 70^0 20.551	22	75
9	**Control**	8/19/2019	Obscured	3-6	SW	0.1-0.5	10:14	N 41^0 00.260	W 70^0 20.008	22	10:34	N 40^0 59.286	W 70^0 20.051	23	75
10	**Control**	8/19/2019	Overcast	3-6	SW	0.1-0.5	11:53	N 40^0 38.874	W 70^0 18.525	22	12:13	N 40^0 58.054	W 70^0 17.961	22	75
11	**Control**	8/19/2019	Clear	1-2	SW	0.1-0.5	13:44	N 40^0 56.755	W 70^0 19.073	22	14:05	N 40^0 55.841	W 70^0 18.311	22	75
12	**Control**	8/19/2019	Clear	3-6	SW	0.1-0.5	15:22	N 40^0 55.367	W 70^0 17.824	21	15:42	N 40^0 55.839	W 70^0 16.176	21	75
13	**Control**	8/19/2019	Clear	7-10	SW	0.1-0.5	16:40	N 40^0 55.909	W 70^0 15.914	20	17:00	N 40^0 53.987	W 70^0 16.346	21	75
14	**Control**	8/20/2019	Partly Cloudy	7-10	W	0.5-1.25	7:51	N 40^0 52.580	W 70^0 19.842	24	8:11	N 40^0 53.267	W 70^0 20.792	24	95
15	**Control**	8/20/2019	Clear	7-10	W	0.5-1.25	9:23	N 40^0 50.912	W 70^0 21.289	26	9:44	N 40^0 51.859	W 70^0 21.360	26	95
16	**Control**	8/20/2019	Clear	7-10	W	0.5-1.25	11:08	N 40^0 52.684	W 70^0 21.826	25	11:28	N 40^0 53.673	W 70^0 21.938	25	95
17	**Control**	8/20/2019	Clear	7-10	W	0.5-1.25	13:26	N 40^0 55.953	W 70^0 20.998	23	13:45	N 40^0 55.371	W 70^0 19.921	23	95
18	**Control**	8/20/2019	Clear	7-10	W	0.1-0.5	14:47	N 40^0 56.336	W 70^0 22.081	23	15:07	N 40^0 56.779	W 70^0 23.218	23	95
19	**Control**	8/20/2019	Partly Cloudy	3-6	W	0.1-0.5	15:57	N 40^0 56.741	W 70^0 22.333	23	16:17	N 40^0 57.384	W 70^0 22.978	23	95
20	**Control**	8/20/2019	Partly Cloudy	3-6	W	0.1-0.5	17:09	N 40^0 57.844	W 70^0 23.645	23	17:31	N 40^0 58.109	W 70^0 24.853	23	95
21	**501N**	8/21/2019	Clear	3-6	S	0.1-0.5	7:12	N 41^0 06.068	W 70^0 22.177	20	7:32	N 41^0 05.047	W 70^0 22.405	22	75
22	**501N**	8/21/2019	Mostly Cloudy	7-10	S	0.1-0.5	8:30	N 41^0 04.057	W 70^0 22.752	21	8:50	N 41^0 03.067	W 70^0 22.789	20	75
23	**501N**	8/21/2019	Obscured	7-10	S	0.1-0.5	9:55	N 41^0 02.936	W 70^0 24.588	21	10:15	N 41^0 02.013	W 70^0 24.349	22	75
24	**501N**	8/21/2019	Overcast	10-15	S	0.5-1.25	10:49	N 41^0 03.069	W 70^0 24.586	22	11:09	N 41^0 02.152	W 70^0 24.913	22	95
25	**501N**	8/21/2019	Overcast	10-15	S	0.5-1.25	12:34	N 41^0 02.947	W 70^0 28.278	23	12:54	N 41^0 02.131	W 70^0 27.584	22	95
26	**501N**	8/21/2019	Mostly Cloudy	10-15	S	0.5-1.25	13:45	N 41^0 01.938	W 70^0 29.171	23	14:05	N 41^0 01.587	W 70^0 30.357	25	100
27	**501N**	8/21/2019	Mostly Cloudy	16-20	S	0.5-1.25	14:53	N 41^0 02.546	W 70^0 30.234	25	15:13	N 41^0 03.065	W 70^0 31.284	23	100
28	**501N**	8/22/2019	Mostly Cloudy	7-10	SW	0.5-1.25	7:06	N 41^0 00.231	W 70^0 30.918	25	7:26	N 41^0 00.371	W 70^0 32.224	26	100
29	**501N**	8/22/2019	Mostly Cloudy	7-10	SW	0.5-1.25	8:40	N 40^0 59.919	W 70^0 33.488	26	8:59	N 40^0 59.891	W 70^0 34.866	26	100
30	**501N**	8/22/2019	Partly Cloudy	7-10	SW	0.5-1.25	9:59	N 41^0 00.509	W 70^0 36.836	25	10:18	N 41^0 00.819	W 70^0 38.119	24	100
31	**501N**	8/22/2019	Partly Cloudy	7-10	SW	0.5-1.25	11:22	N 41^0 02.723	W 70^0 35.459	24	11:42	N 41^0 03.372	W 70^0 32.636	24	100
32	**501N**	8/22/2019	Partly Cloudy	7-10	SW	0.5-1.25	12:42	N 41^0 04.053	W 70^0 33.917	23	13:02	N 41^0 04.348	W 70^0 32.636	24	100
33	**501N**	8/26/2019	Clear	16-20	NE	1.25-2.5	9:18	N 40^0 59.543	W 70^0 26.132	23	9:38	N 41^0 00.321	W 70^0 25.718	22	95
34	**501N**	8/26/2019	Partly Cloudy	16-20	NE	1.25-2.5	10:37	N 40^0 58.992	W 70^0 26.537	23	10:57	N 40^0 59.494	W 70^0 27.599	23	95
35	**Control**	8/26/2019	Partly Cloudy	16-20	NE	1.25-2.5	12:14	N 40^0 55.827	W 70^0 25.018	24	12:34	N 40^0 55.638	W 70^0 26.284	24	100
36	**Control**	8/26/2019	Mostly Cloudy	16-20	NE	1.25-2.5	13:44	N 40^0 55.965	W 70^0 28.890	26	14:04	N 40^0 55.722	W 70^0 27.617	26	100
37	**Control**	8/26/2019	Partly Cloudy	16-20	NE	1.25-2.5	14:57	N 40^0 54.732	W 70^0 24.470	27	15:17	N 40^0 55.350	W 70^0 27.959	26	100
38	**Control**	8/26/2019	Clear	16-20	NE	1.25-2.5	16:10	N 40^0 52.198	W 70^0 26.352	27	16:30	N 40^0 52.882	W 70^0 25.469	27	100
39	**Control**	8/27/2019	Clear	3-6	E	0.5-1.25	7:01	N 40^0 50.177	W 70^0 24.109	27	7:21	N 40^0 50.059	W 70^0 25.421	27	100
40	**Control**	8/27/2019	Clear	3-6	E	0.5-1.25	8:39	N 40^0 51.532	W 70^0 27.178	28	8:59	N 40^0 52.239	W 70^0 28.064	28	100

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	501N	20.0	2.7	0.90	12.0		5.0	33.1
2	501N	21.8	2.9	1.04	12.1	13.3	4.6	34.2
3	501N	19.2	2.9	0.93	11.2	13.2	5.1	33.6
4	501N	20.6	3.0	1.05	10.8	13.3	4.6	34.4
5	501N	20.6	2.9	1.00	10.6	12.9	5.0	33.2
6	501N	19.9	3.0	0.99	11.0	13.3	4.7	34.0
7	Control	20.3	3.0	1.00	12.0		4.5	33.6
8	Control	19.9	3.0	0.98	12.2	13.1	4.6	33.8
9	Control	20.3	2.9	0.98	12.6	12.9	4.8	33.4
10	Control	19.6	2.9	0.95	12.6	14.2	4.8	34.0
11	Control	21.1	3.1	1.09	12.4	13.9	4.6	34.6
12	Control	20.2	2.8	0.96	12.6	13.4	4.7	34.1
13	Control	20.1	3.0	1.02	13.1	13.6	4.7	34.5
14	Control	20.2	3.0	1.00	12.7	14.6	4.4	36.6
15	Control	20.3	2.9	1.00	11.7	14.2	4.3	36.2
16	Control	19.4	3.1	1.00	12.5	13.9	4.2	35.3
17	Control	18.9	3.2	1.01	12.3	14.5	4.3	37.0
18	Control	19.7	3.0	0.98	11.7	14.5	4.2	36.4
19	Control	19.2	3.1	0.98	11.8	14.7	4.2	36.2
20	Control	21.7	2.9	1.06	11.8	14.5	4.4	36.3
21	501N	20.0	3.0	1.00	12.4	13.8	4.7	34.4
22	501N	20.1	3.0	0.99	11.9	13.4	4.4	33.9
23	501N	19.5	2.9	0.96	11.5	13.7	5.2	34.9
24	501N	19.5	3.0	0.97	11.4	14.0	4.2	36.2
25	501N	19.3	3.0	0.98	11.1	14.1	4.3	37.0
26	501N	19.7	3.0	0.97	11.2	14.4	4.2	37.3
27	501N	19.7	3.0	0.97	11.1	14.2	4.3	36.3
28	501N	20.3	3.1	1.04	10.4	14.2	4.3	38.1
29	501N	20.0	3.2	1.05	10.3	14.6	4.3	37.9
30	501N	19.7	3.2	1.04	10.5	14.6	4.2	38.2
31	501N	20.0	3.0	0.98	10.5	14.3	4.3	37.8
32	501N	20.0	3.1	1.03	11.0	14.5	4.3	37.9
33	501N	21.1	2.7	0.94	12.4		4.5	35.5
34	501N	19.8	3.0	1.00	13.5		4.1	35.8
35	Control	20.2	3.0	1.02	11.5		4.8	37.1
36	Control	19.8	3.1	1.01	10.9	14.8	4.3	38.6
37	Control	20.0	4.0	1.32	11.1	14.6	4.3	38.0
38	Control	19.7	3.0	0.99	11.7	15.1	4.9	38.1
39	Control	20.2	3.0	1.02	12.0	14.0	4.3	36.8
40	Control	19.3	3.0	0.98	11.1	14.2	4.4	37.2
Summary Statistics								
Control	Minimum	18.9	2.8	1.0	10.9	12.9	4.2	33.4
	Maximum	21.7	4.0	1.3	13.1	15.1	4.9	38.6
	Average	20.0	3.1	1.0	12.0	14.1	4.5	35.9
	St. Dev	0.6	0.2	0.1	0.6	0.6	0.2	1.6
501N	Minimum	19.2	2.7	0.9	10.3	12.9	4.1	33.1
	Maximum	21.8	3.2	1.0	13.5	14.6	5.2	38.2
	Average	20.0	3.0	1.0	11.4	13.9	4.5	35.7
	St. Dev	0.6	0.1	0.04	0.8	0.6	0.3	1.8

Table 3: Total and average catch weights observed with the 501N Study Area.

Species Name	Scientific Name	Total Weight (Kg)	Catch/Tow (Kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Skate, Little	*Leucoraja erinacea*	2774.9	138.7	13.9	39.5	20
Hake, Silver	*Merluccius bilinearis*	1299.1	65.0	8.8	18.5	20
Hake, Red	*Urophycis chuss*	1165.8	58.3	12.4	16.6	20
Butterfish	*Peprilus triacanthus*	829.0	41.4	12.9	11.8	18
Scup	*Stenotomus chrysops*	281.0	14.1	7.3	4.0	11
Dogfish, Spiny	*Squalus acanthias*	210.0	10.5	4.2	3.0	18
Squid, Atlantic Longfin	*Doryteuthis pealeii*	96.0	4.8	0.5	1.4	20
Flounder, Fourspot	*Hippoglossina oblonga*	74.8	3.7	0.6	1.1	20
Crab, Rock	*Cancer sp.*	58.1	2.9	0.4	0.8	19
Skate, Winter	*Leucoraja ocellata*	42.0	2.1	0.5	0.6	13
Monkfish	*Lophius americanus*	39.5	2.0	0.7	0.6	14
Flounder, Winter	*Pseudopleuronectes americanus*	31.8	1.6	0.5	0.5	13
Skate, Barndoor	*Dipturus laevis*	19.8	1.0	0.3	0.3	17
Herring, Blueback	*Alosa aestivalis*	17.3	0.9	0.6	0.3	3
Flounder, Windowpane	*Scophthalmus aquosus*	15.2	0.8	0.2	0.2	15
Hake, Spotted	*Urophycis regius*	11.9	0.6	0.3	0.2	3
Flounder, Summer (Fluke)	*Paralichthys dentatus*	11.3	0.6	0.3	0.2	5
Dogfish, Smooth	*Mustelus canis*	11.2	0.6	0.3	0.2	3
Sea Robin, Northern	*Prionotus carolinus*	9.3	0.5	0.3	0.1	6
Flounder, Gulfstream	*Citharichthys arctifrons*	9.1	0.5	0.3	0.1	15
Sea Scallop	*Placopecten magellanicus*	6.0	0.3	0.1	0.1	7
Flounder, Yellowtail	*Limanda ferruginea*	4.3	0.2	0.1	0.1	15
Lobster, American	*Homarus americanus*	2.4	0.1	0.0	0.0	6
Northern moon Snail	*Polinices heros*	1.5	0.1	0.1	0.0	2
Sculpin, Longhorn	*Myoxocephalus octodecemspinosus*	0.7	0.03	0.02	0.0	3
Ocean Pout	*Zoarces americanus*	0.5	0.03	0.02	0.0	2
Alewife	*Alosa pseudoharengus*	0.3	0.01	0.01	0.0	2
Mackerel, Atlantic	*Scomber scombrus*	0.2	0.01		0.0	1
Shad, American	*Alosa sapidissima*	0.1	0.01		0.0	1
Sea Raven	*Hemitripterus americanus*	0.1	0.01		0.0	1
Shark, Thresher	*Alopias vulpinus*					2
Total		**7023.1**				

*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*		
Hake, Red	*Urophycis chuss*	2970.5	148.5	28.2	28.2	20
Skate, Little	*Leucoraja erinacea*	2298.7	114.9	15.7	21.8	19
Butterfish	*Peprilus triacanthus*	1984.7	99.2	27.7	18.9	20
Hake, Silver	*Merluccius bilinearis*	1692.8	84.6	12.1	16.1	20
Alewife	*Alosa pseudoharengus*	453.7	22.7	15.3	4.3	9
Scup	*Stenotomus chrysops*	333.7	16.7	6.9	3.2	16
Dogfish, Spiny	*Squalus acanthias*	156.1	7.8	1.5	1.5	19
Flounder, Summer (Fluke)	*Paralichthys dentatus*	139.1	7.0	1.6	1.3	14
Squid, Atlantic Longfin	*Doryteuthis pealeii*	130.4	6.5	0.6	1.2	20
Flounder, Fourspot	*Hippoglossina oblonga*	78.9	3.9	0.5	0.7	20
Monkfish	*Lophius americanus*	72.0	3.6	0.7	0.7	20
Skate, Winter	*Leucoraja ocellata*	33.5	1.7	0.6	0.3	7
Flounder, Winter	*Pseudopleuronectes americanus*	32.0	1.6	0.5	0.3	15
Crab, Rock	*Cancer sp.*	30.0	1.5	0.2	0.3	18
Hake, Spotted	*Urophycis regius*	29.0	1.5	0.6	0.3	7
Skate, Barndoor	*Dipturus laevis*	20.6	1.0	0.3	0.2	17
Dogfish, Smooth	*Mustelus canis*	14.1	0.7	0.3	0.1	5
Flounder, Gulfstream	*Citharichthys arctifrons*	12.2	0.6	0.2	0.1	15
Flounder, Windowpane	*Scophthalmus aquosus*	11.6	0.6	0.2	0.1	10
Sea Robin, Northern	*Prionotus carolinus*	8.2	0.4	0.3	0.1	6
Flounder, Yellowtail	*Limanda ferruginea*	5.1	0.3	0.1	0.0	10
Shad, American	*Alosa sapidissima*	3.1	0.2	0.1	0.0	2
Mackerel, Atlantic	*Scomber scombrus*	2.0	0.1	0.1	0.0	5
Haddock	*Melanogrammus aeglefinus*	2.0	0.1		0.0	1
Lobster, American	*Homarus americanus*	1.8	0.1	0.0	0.0	6
Bluefish	*Pomatomus saltatrix*	1.5	0.1		0.0	1
Ocean Pout	*Zoarces americanus*	1.4	0.1	0.1	0.0	2
Sea Scallop	*Placopecten magellanicus*	1.3	0.1	0.04	0.0	4
Skate, Thorny	*Amblyraja radiata*	0.8	0.04		0.0	1
Sculpin, Longhorn	*Myoxocephalus octodecemspinosus*	0.7	0.1		0.0	1
American Eel	*Anguilla rostrata*	0.2	0.01		0.0	1
Herring, Atlantic	*Clupea harengus*	0.1	0.01		0.0	1
Shark, Thresher	*Alopias vulpinus*					1
Total		**10521.7**				

*SEM is an acronym for Standard Error of the Mean

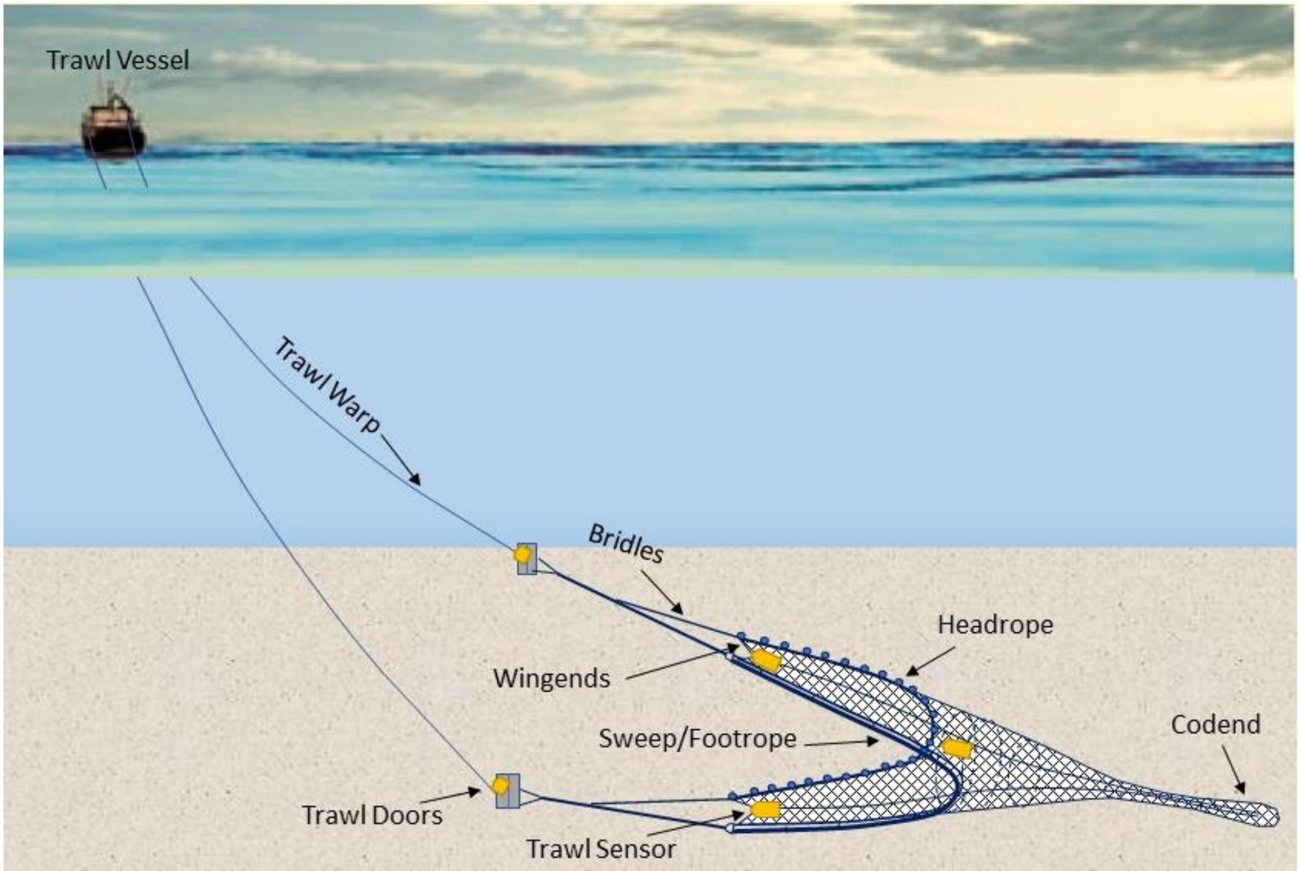


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

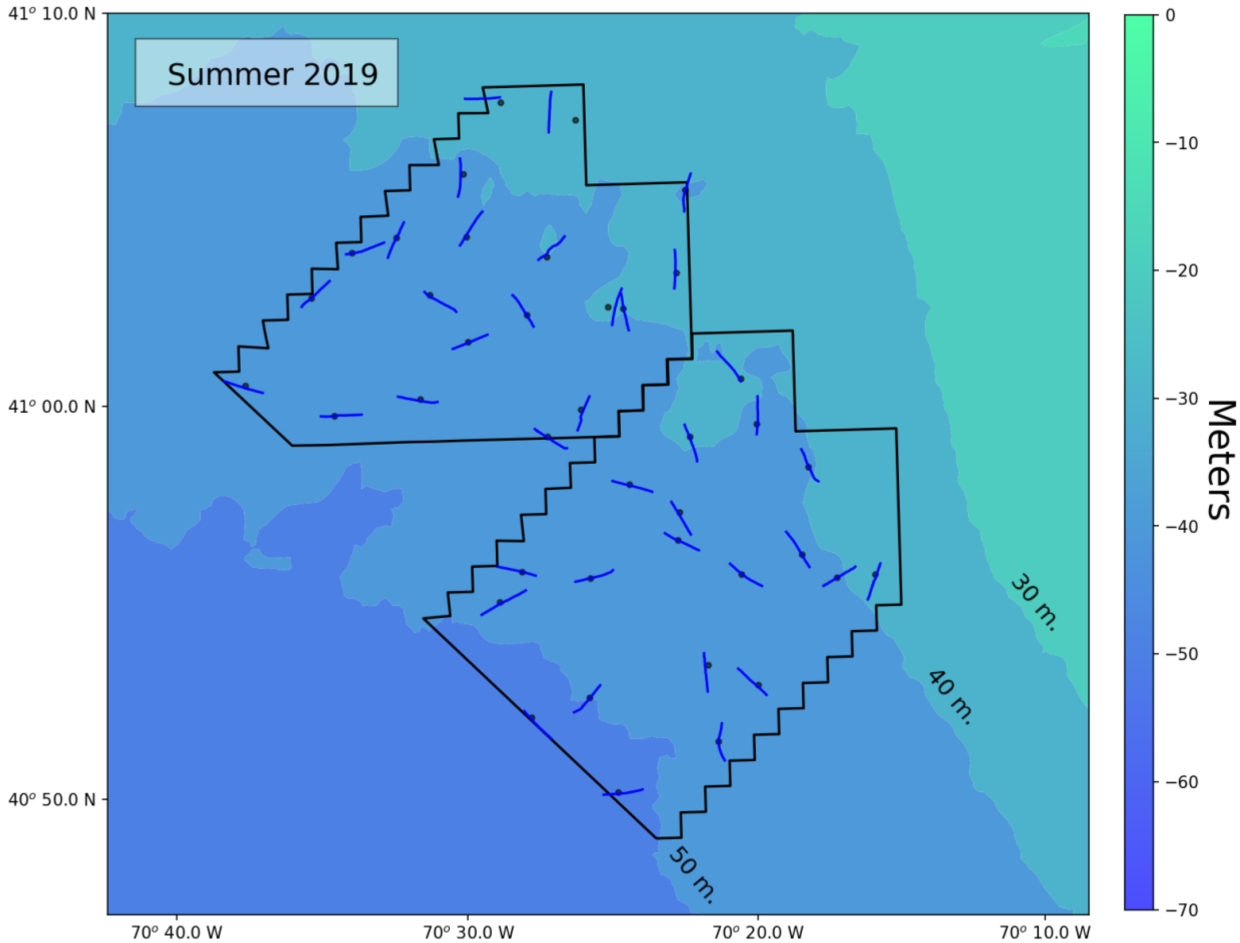


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 501N Study Area (left) and the Control Area (right)

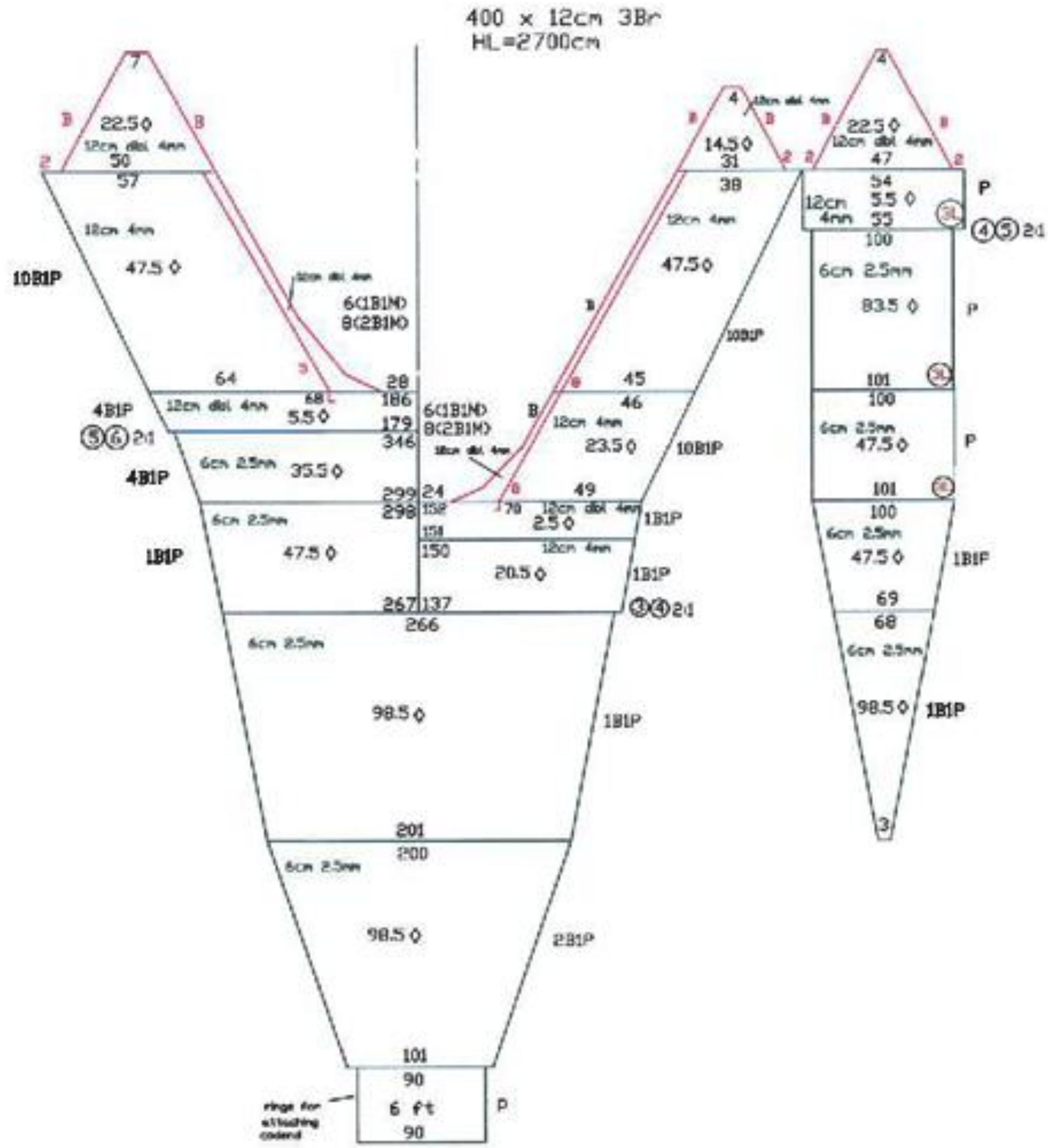


Figure 3: Schematic net plan for the NEAMAP trawl (Bonsek et al. 2008).

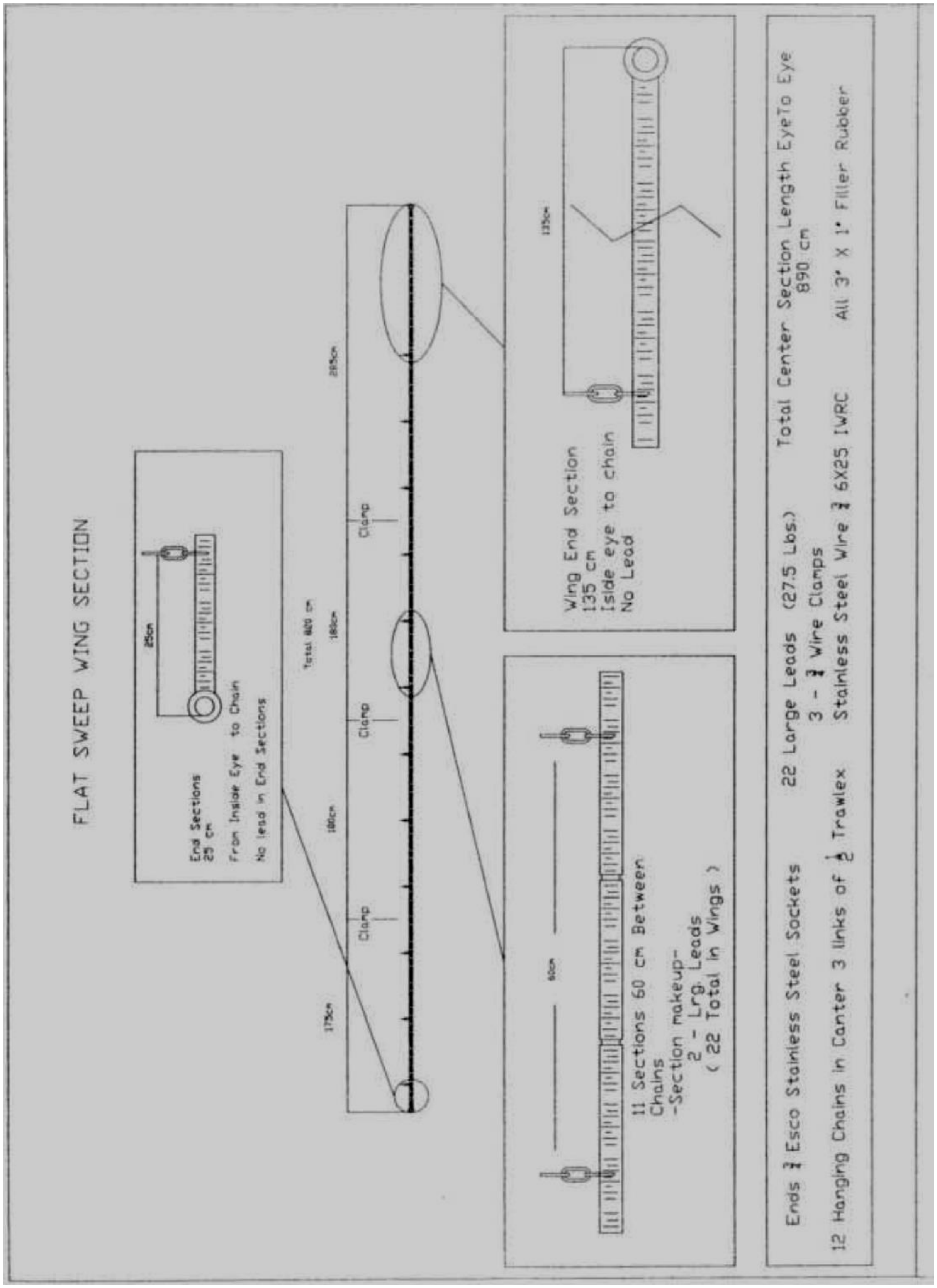


Figure 4: Sweep diagram for the survey trawl (Bonsek et al. 2008).

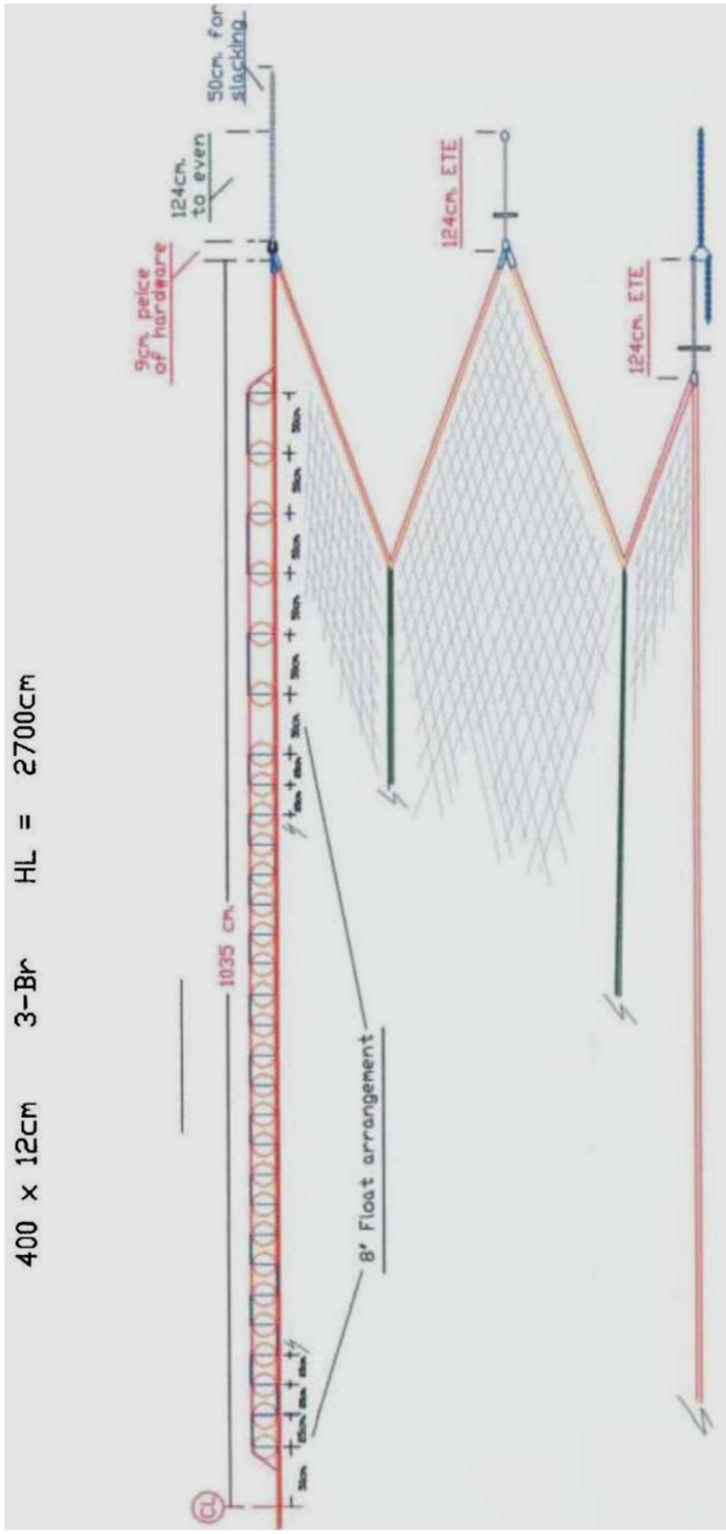


Figure 5: Headrope and rigging plan for the survey trawl (Bonsek et al. 2008).

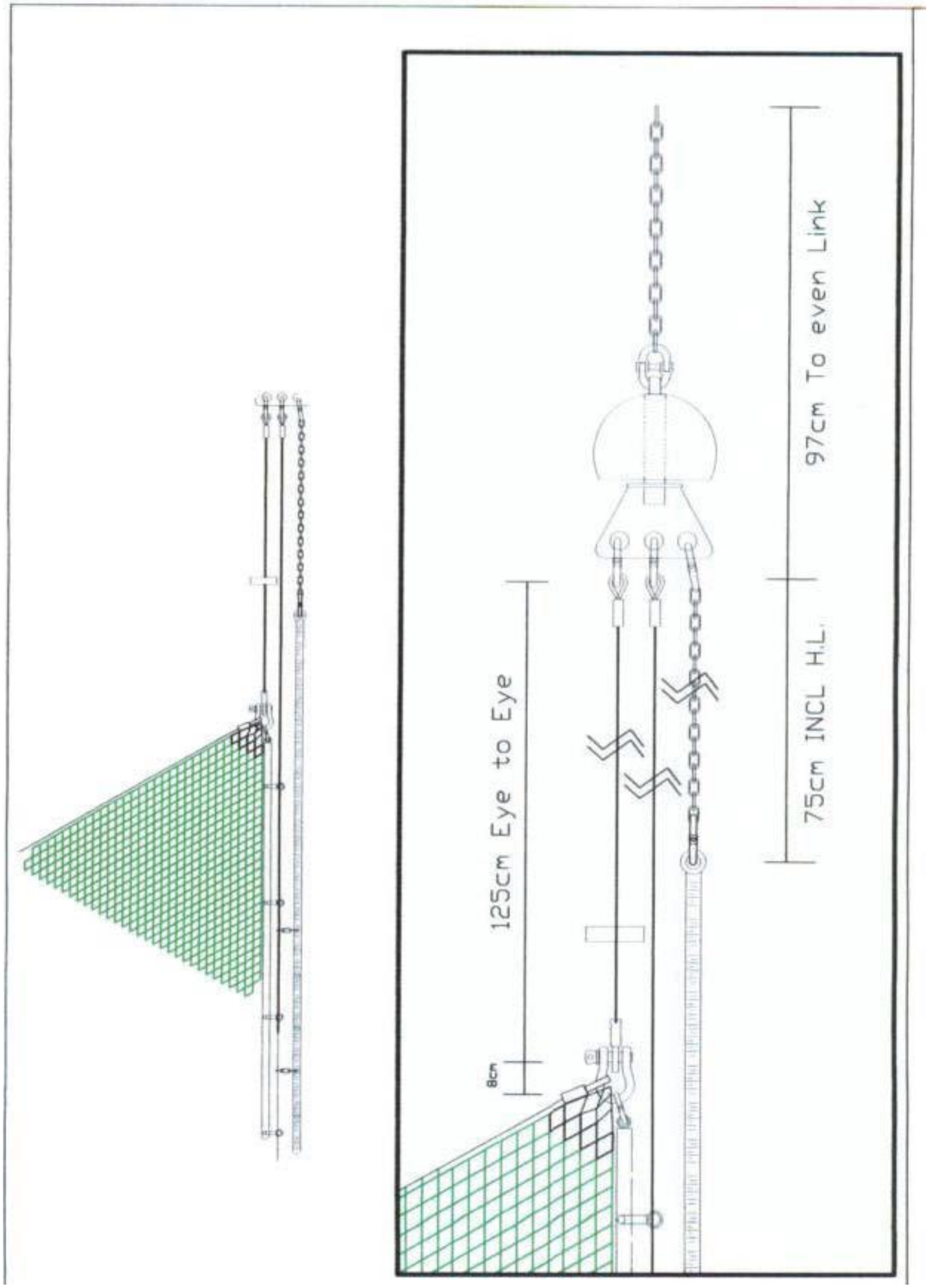


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonsek et al. 2008).

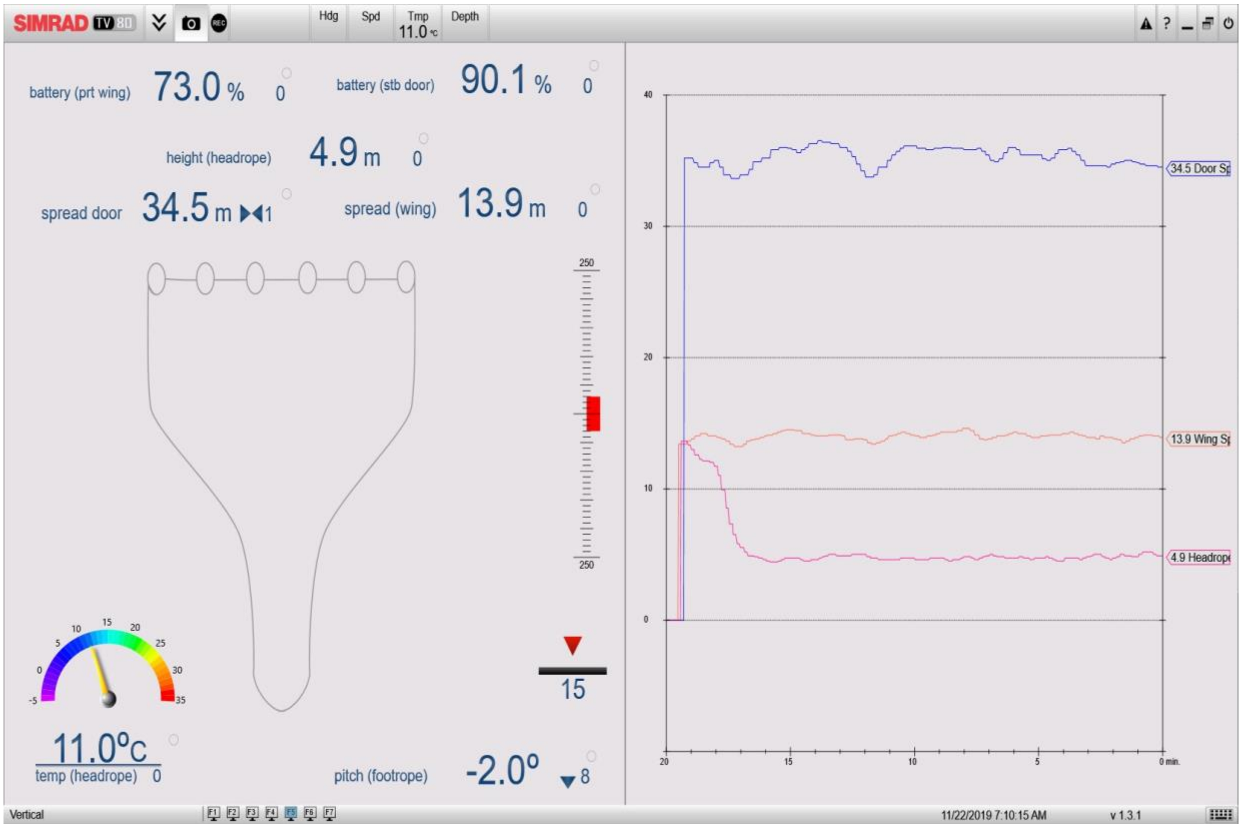


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.

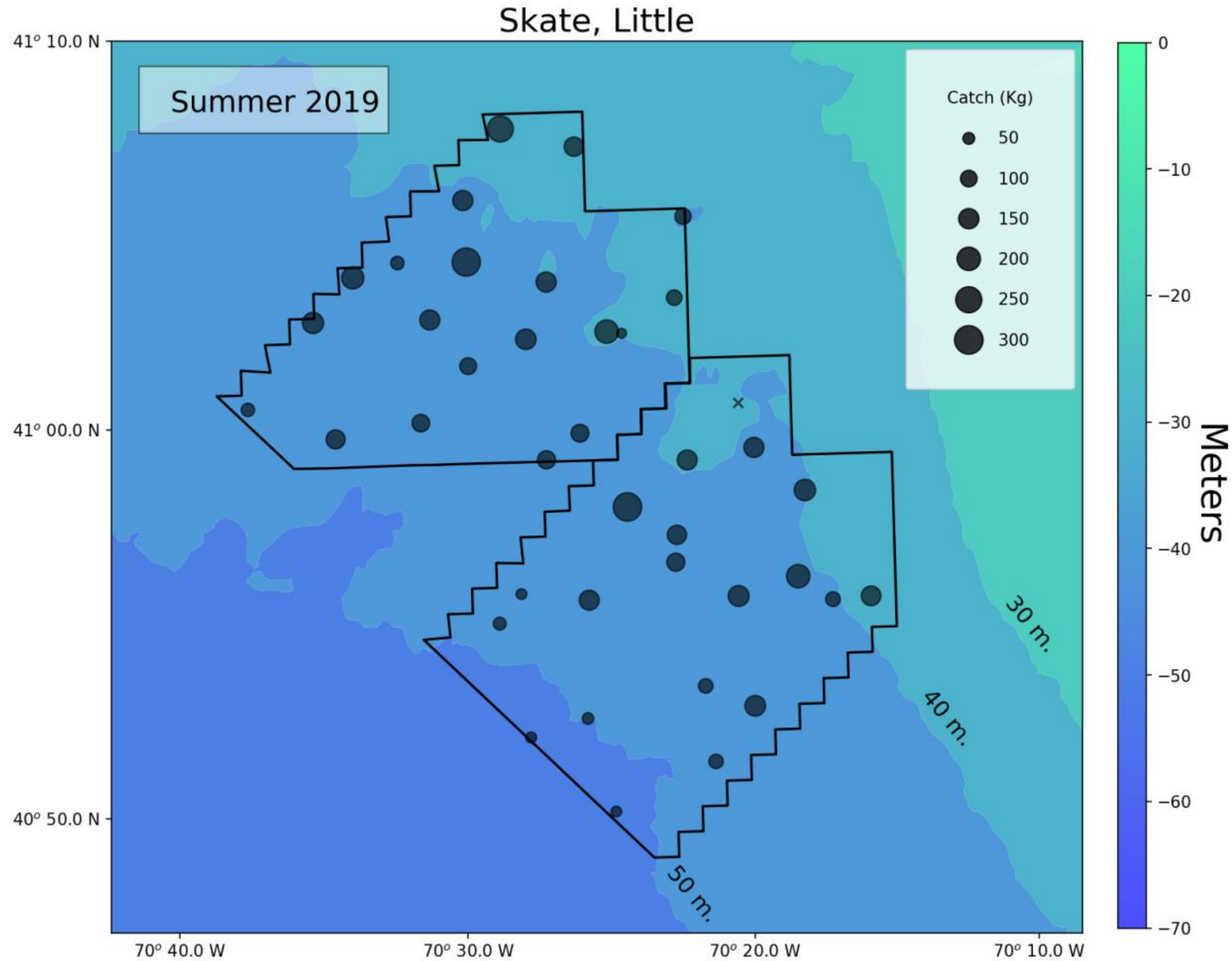


Figure 8: Distribution of the catch of little skate in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.

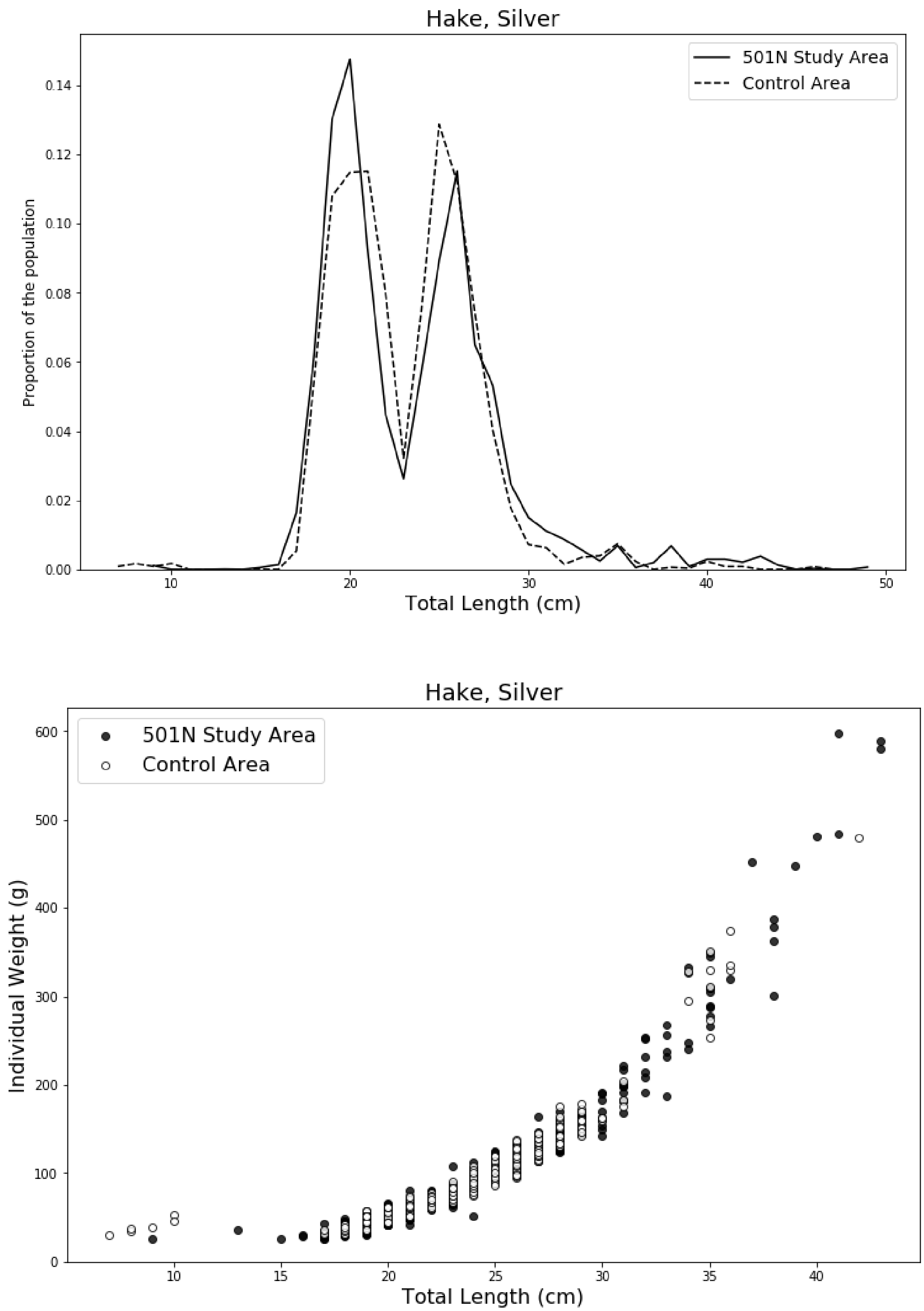


Figure 9: Population structure of silver hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

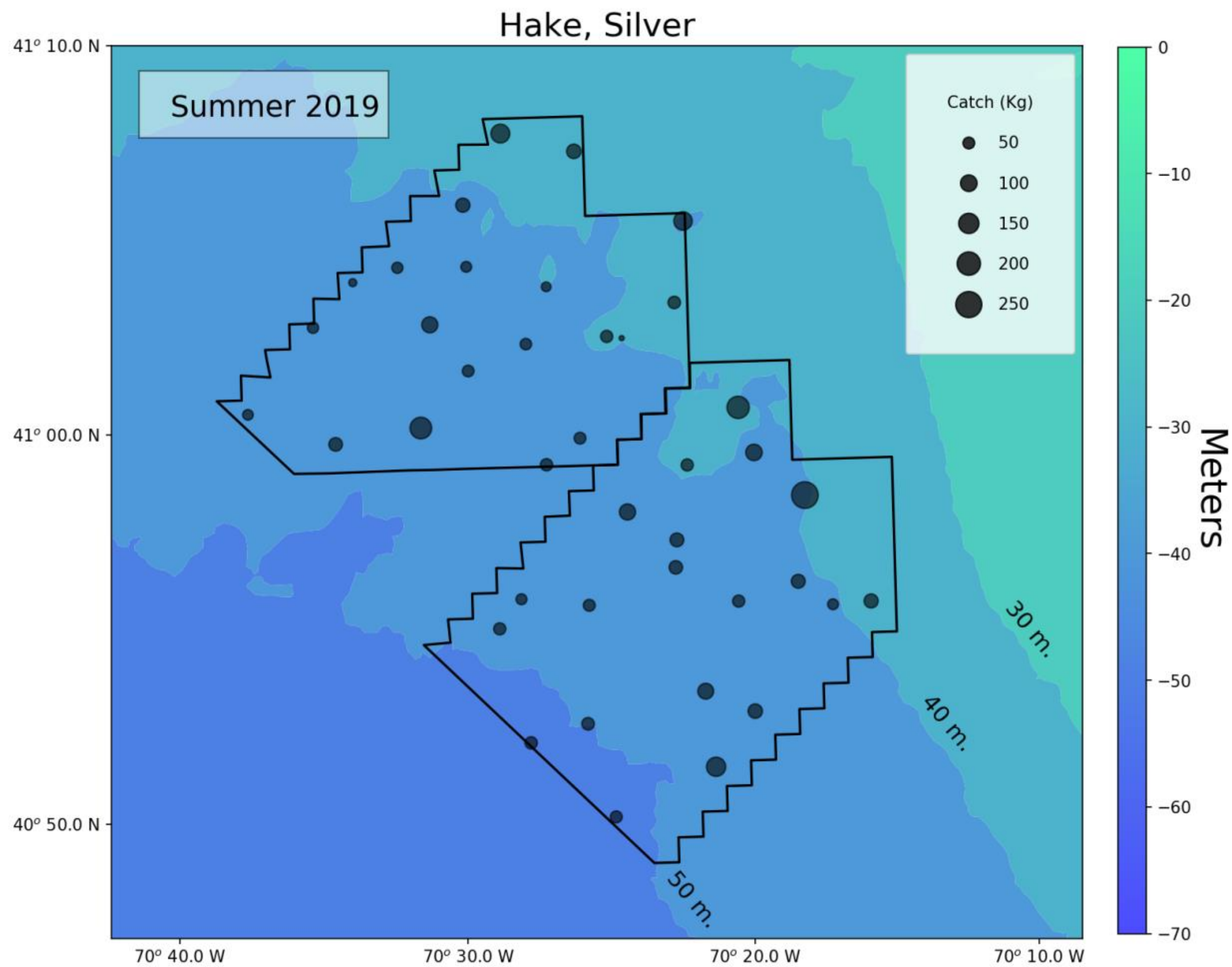
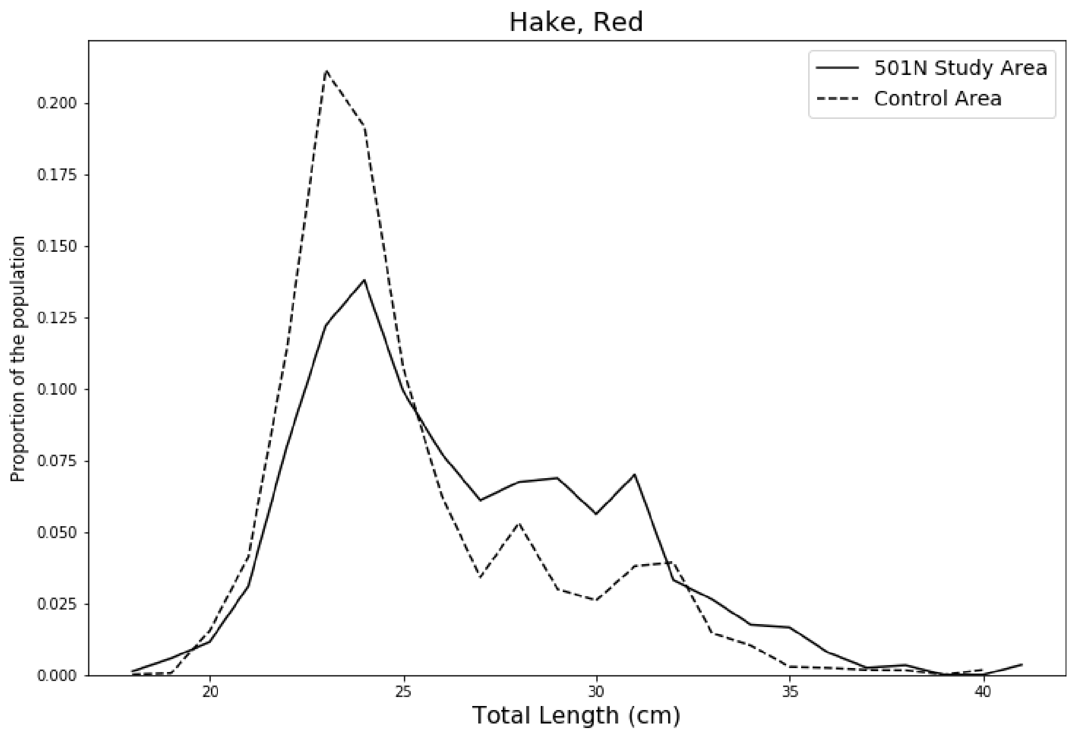


Figure 10: Distribution of the catch of silver hake in the 501N Study Area (left) and Control Area (right).



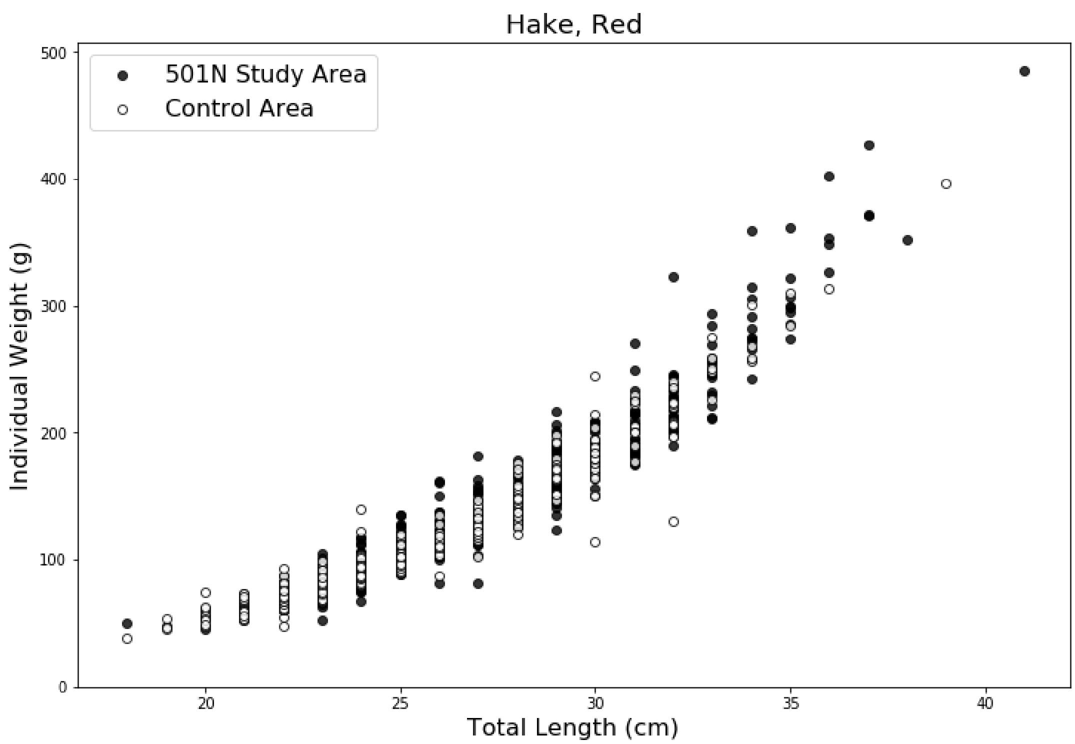


Figure 11: Population structure of red hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

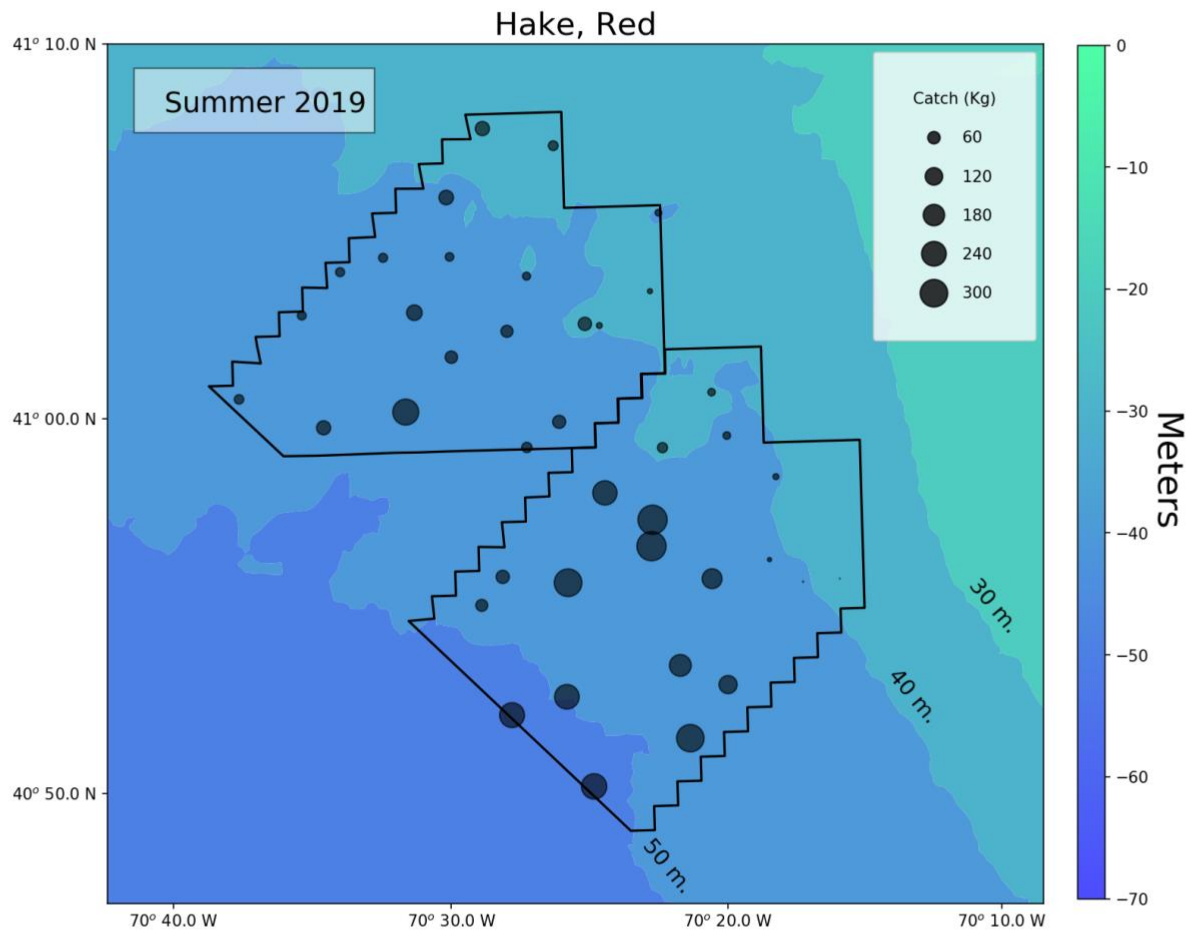
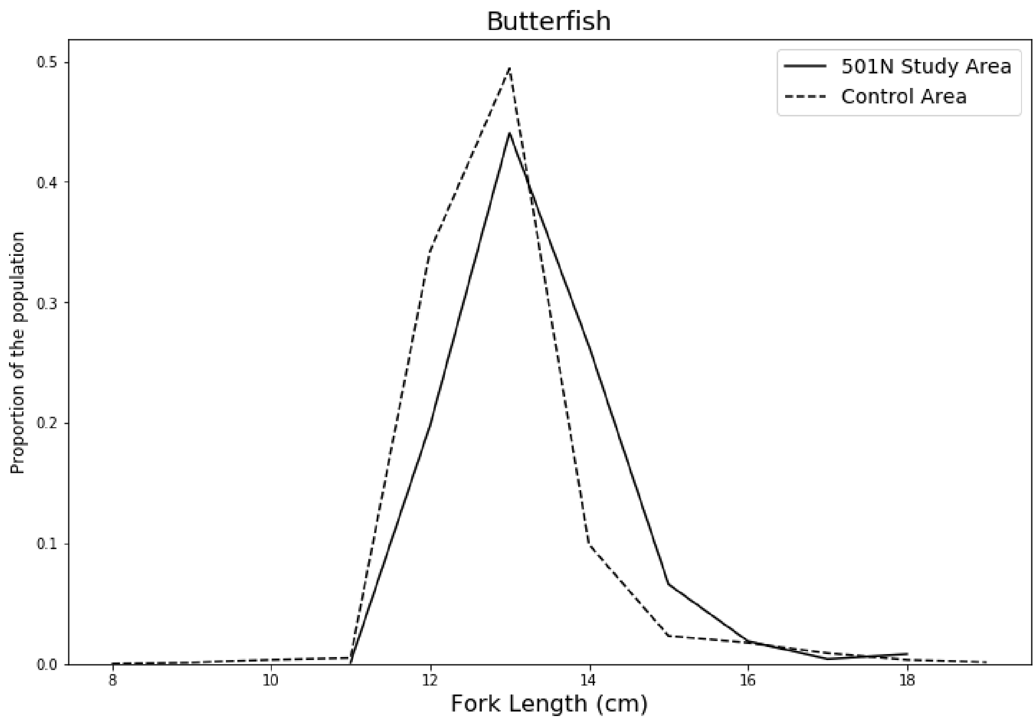


Figure 12: Distribution of the catch of red hake in the 501N Study Area (left) and Control Area (right).



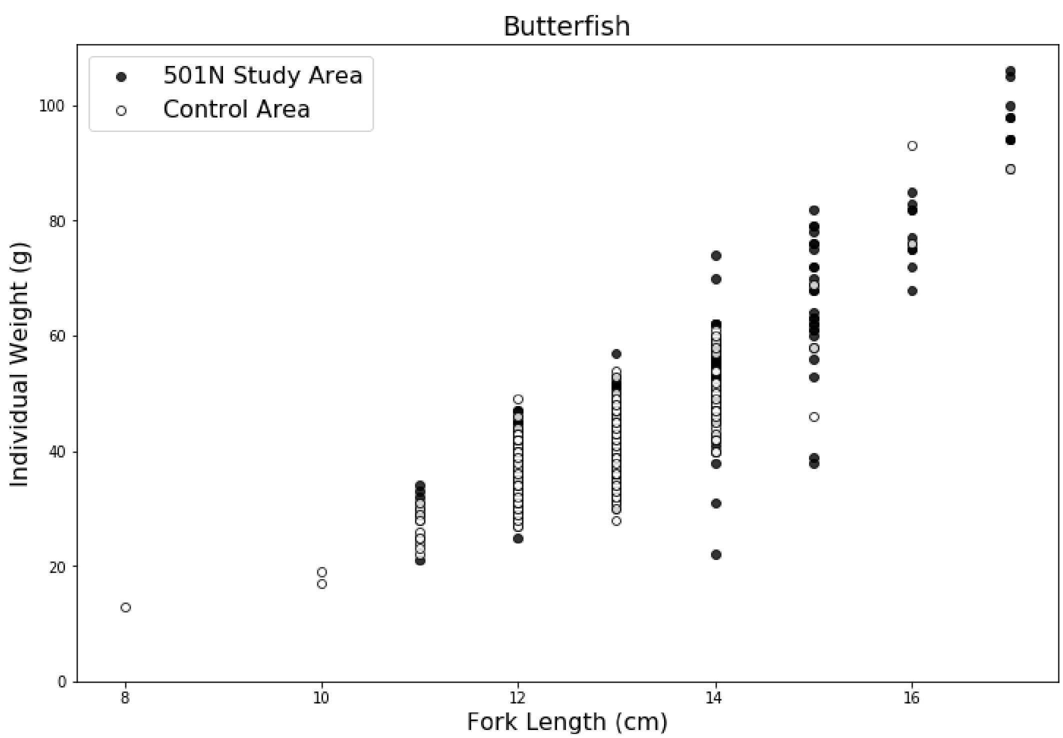


Figure 13: Population structure of butterfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

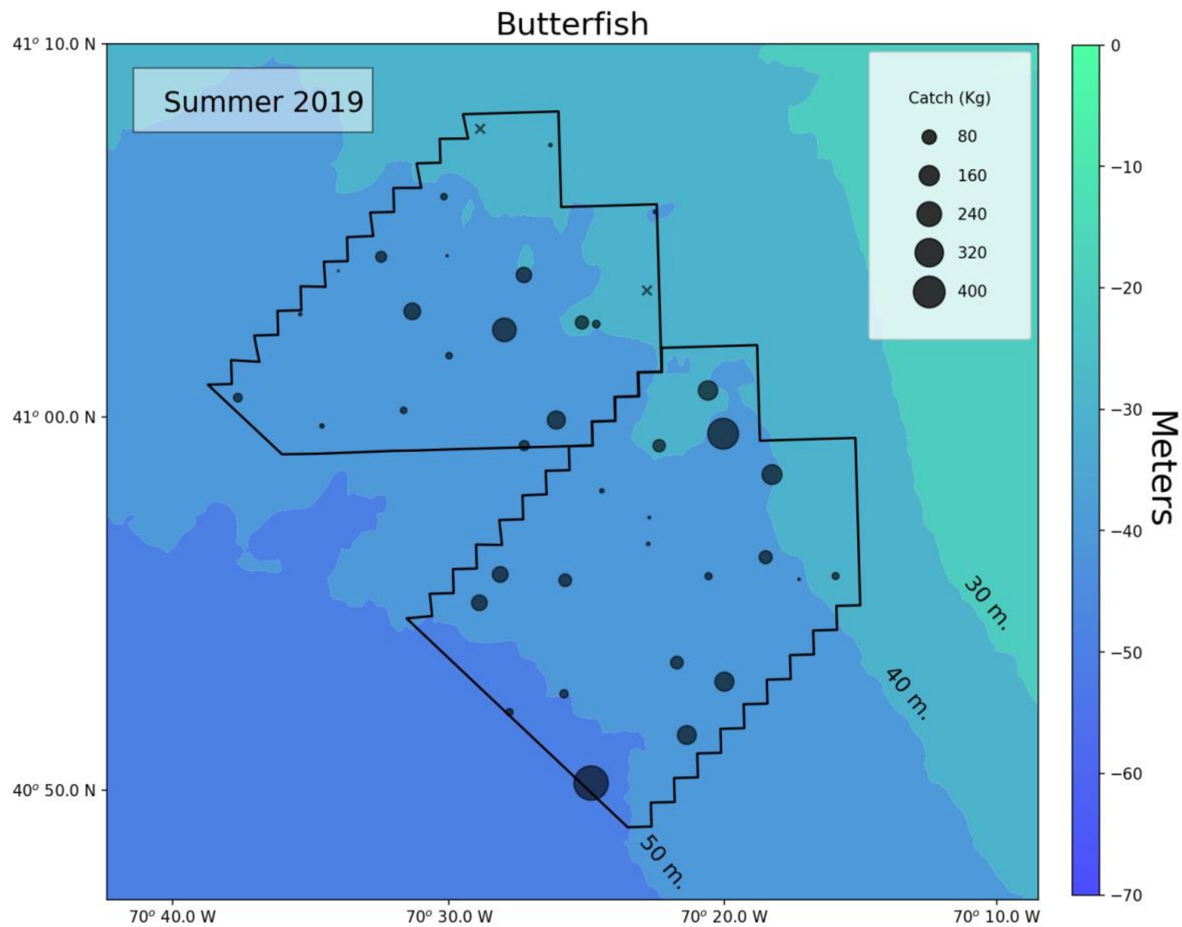
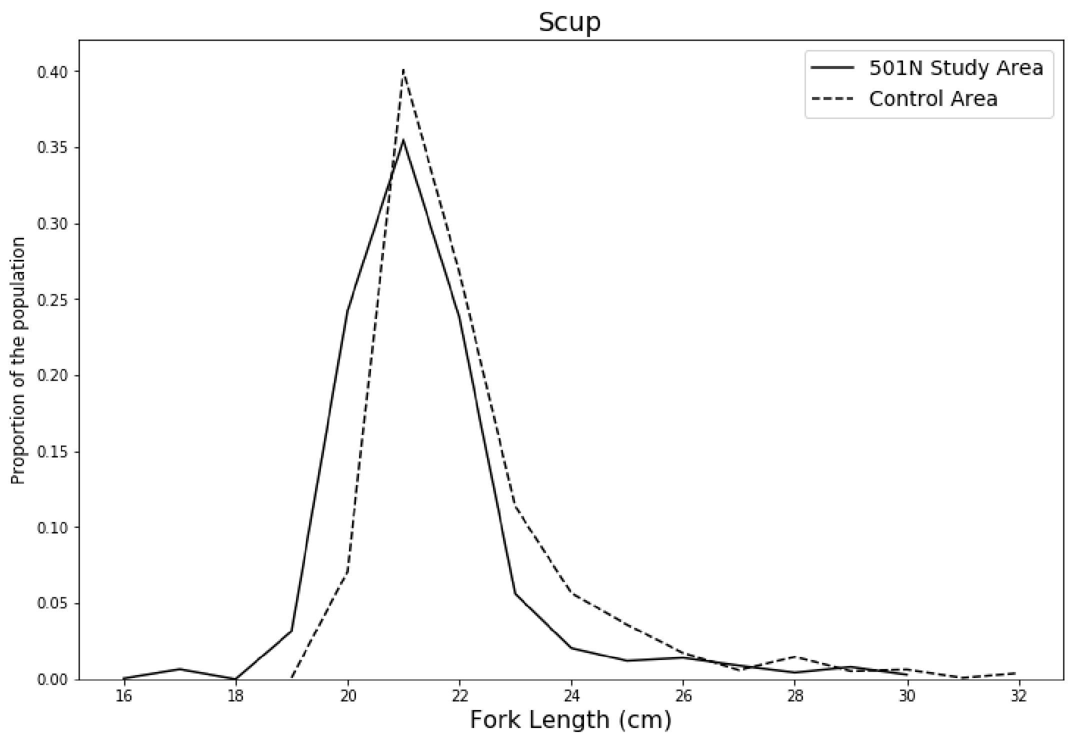


Figure 14: Distribution of the catch of butterfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



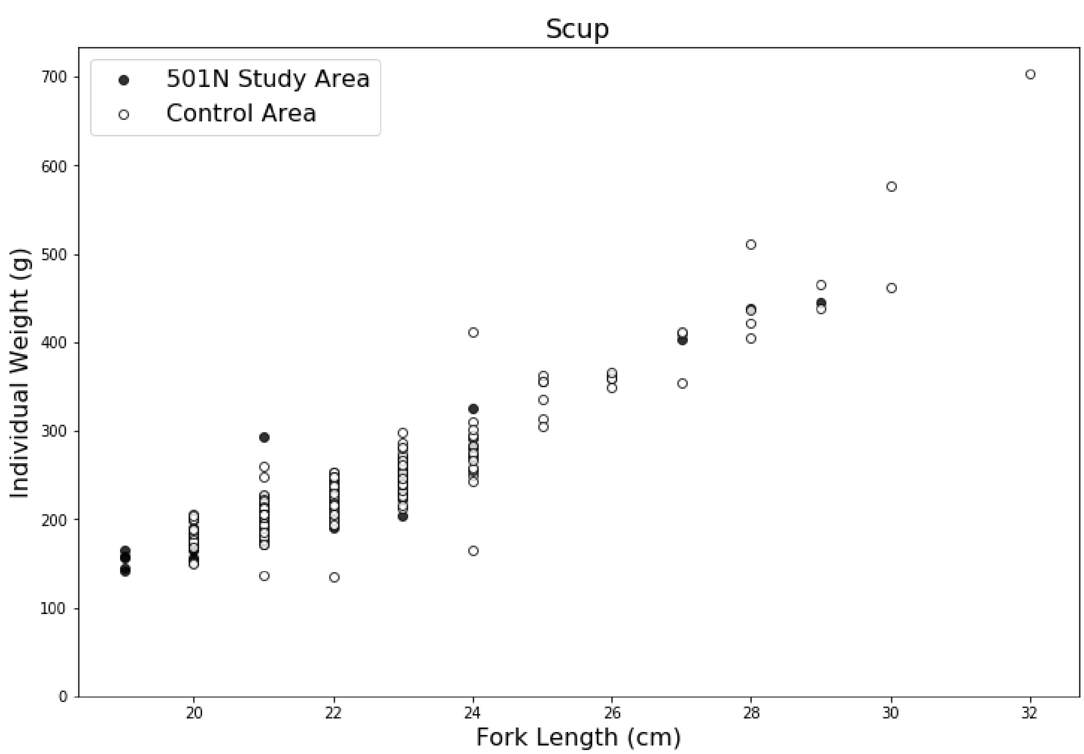
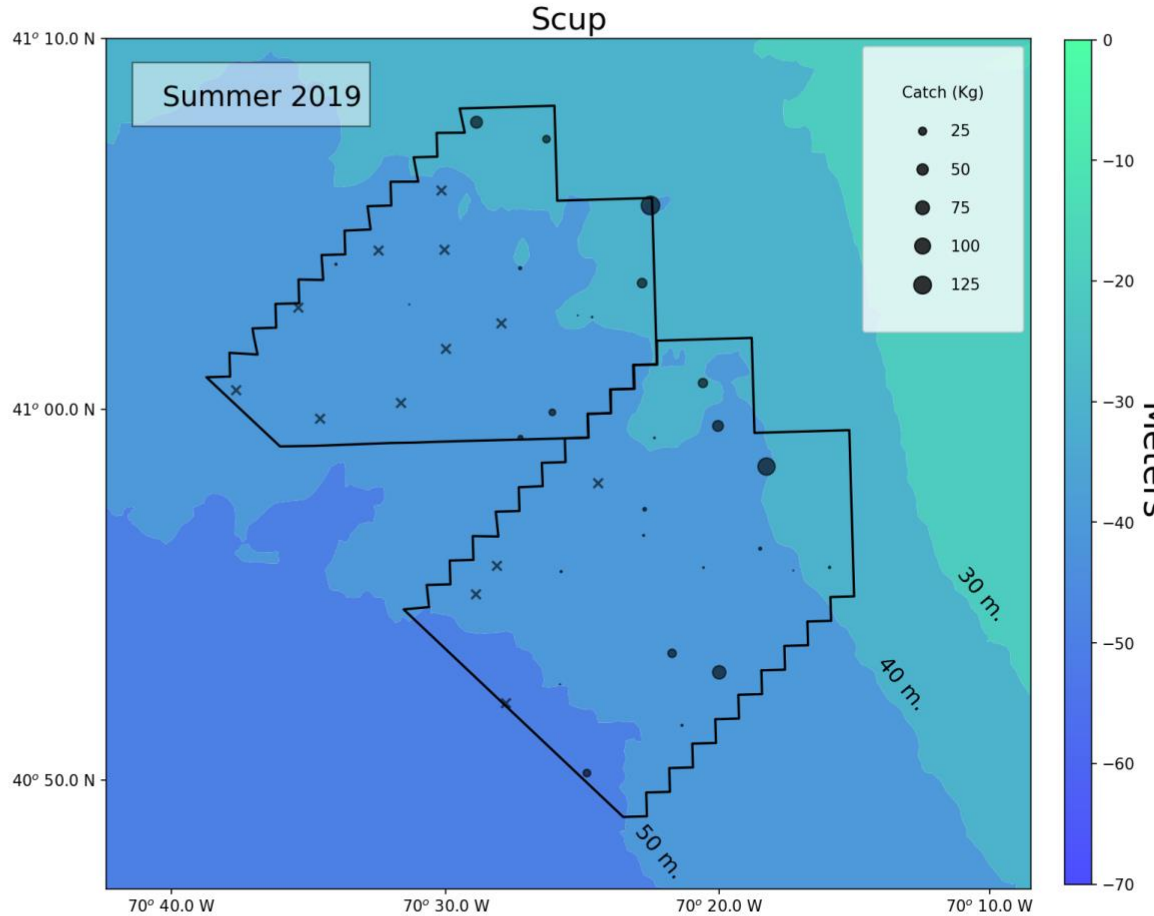


Figure 15: Population structure of scup in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).



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

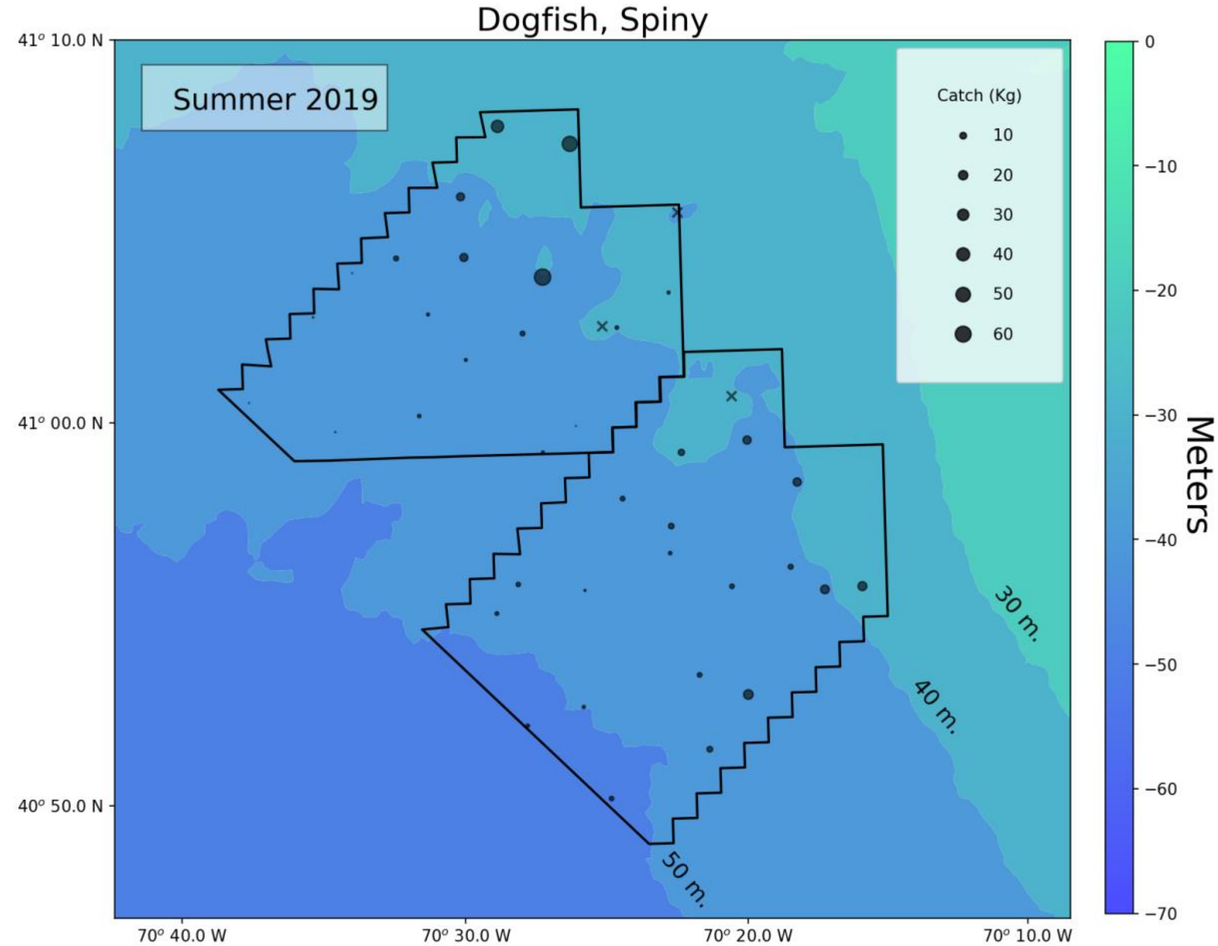
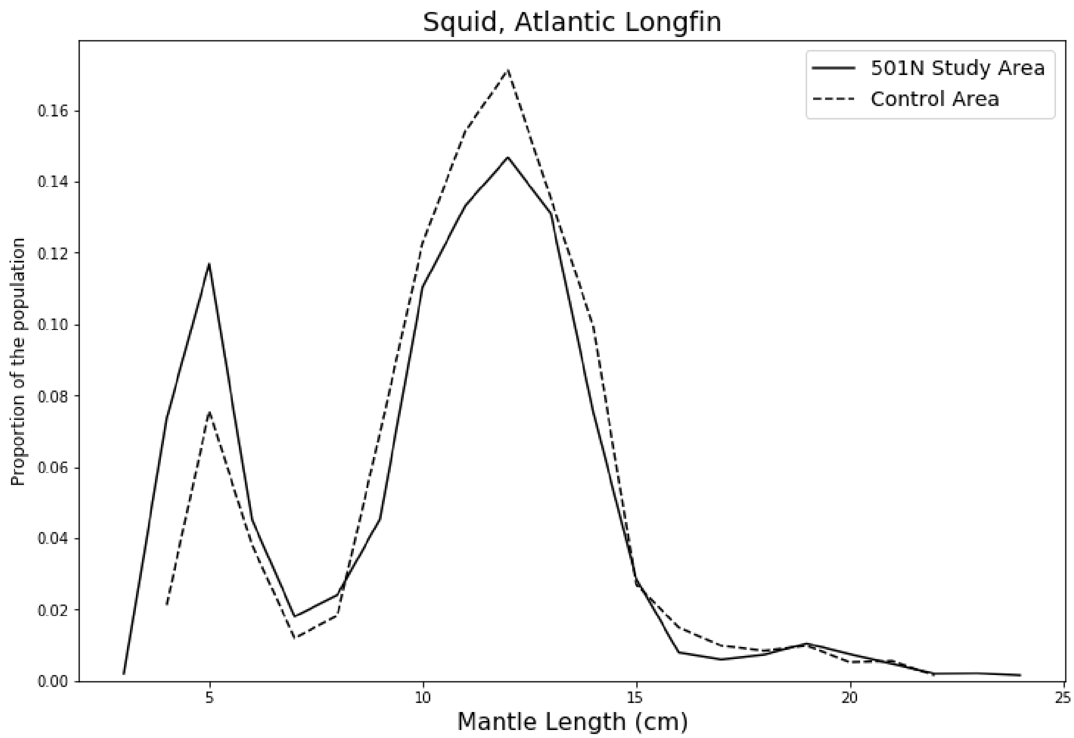


Figure 16: Distribution of the catch of spiny dogfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



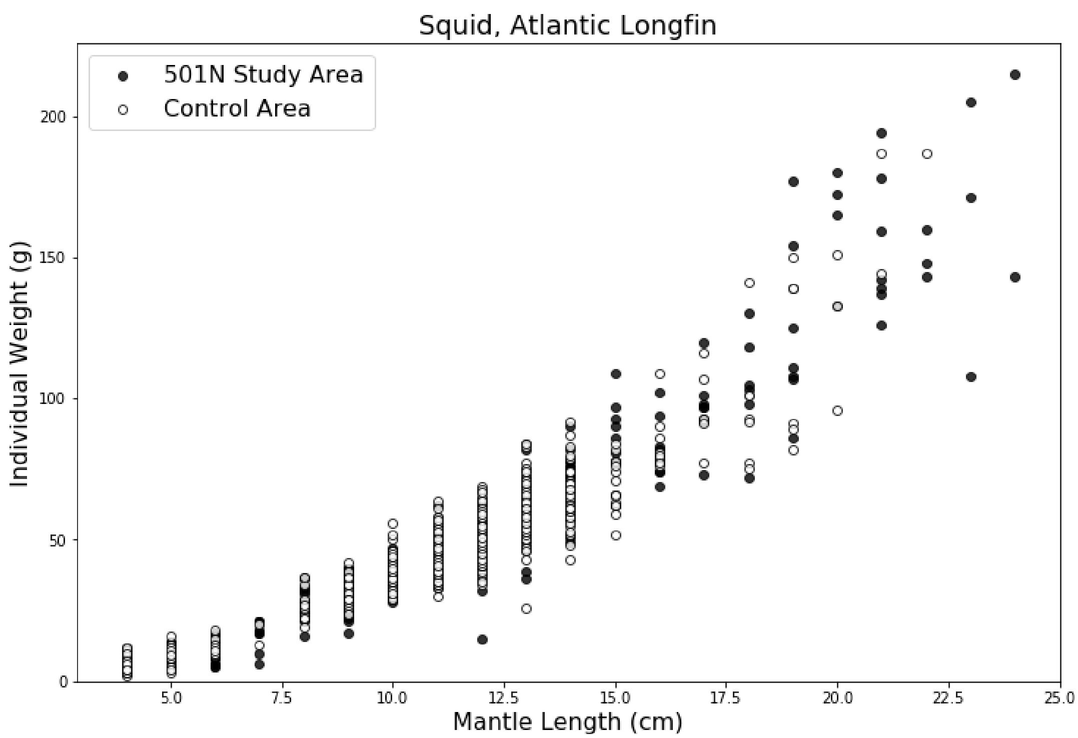


Figure 17: Population structure of longfin squid in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

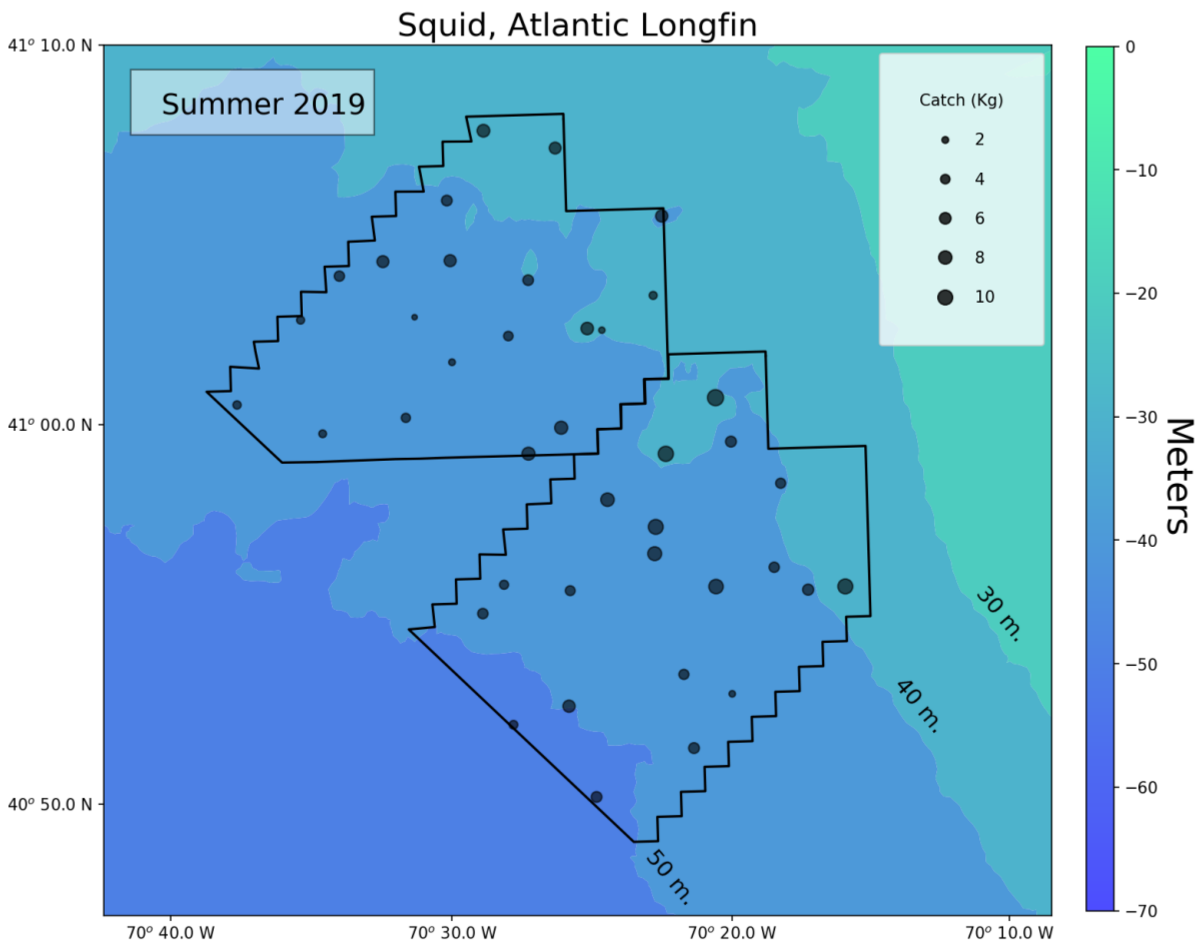
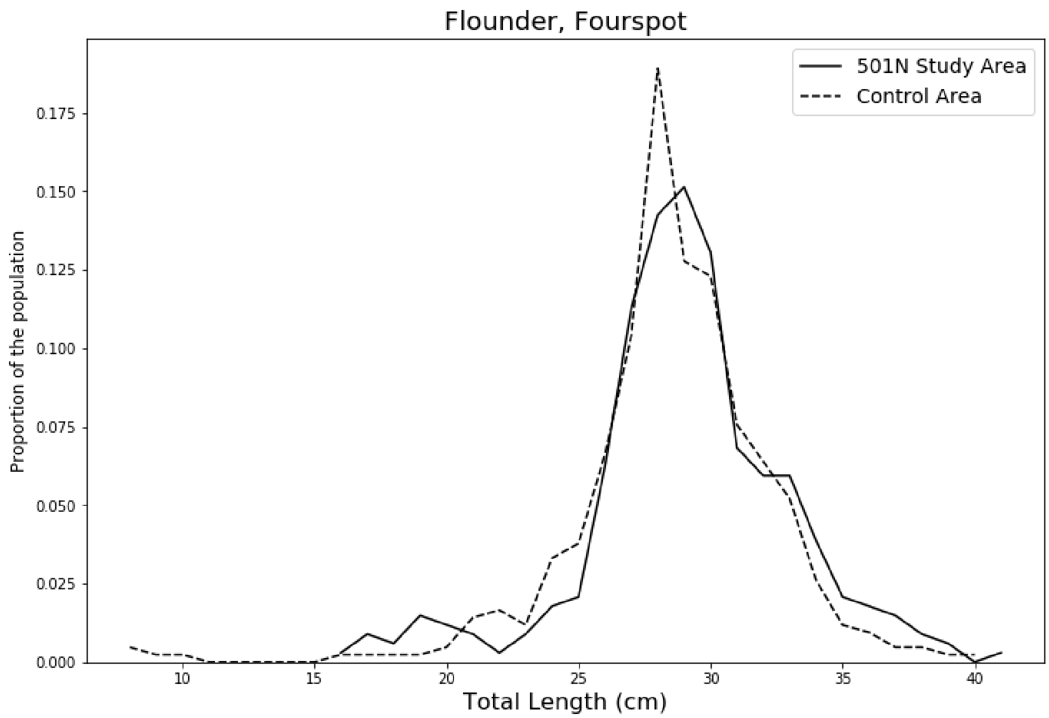


Figure 18: Distribution of the catch of longfin squid in the 501N Study Area (left) and Control Area (right).



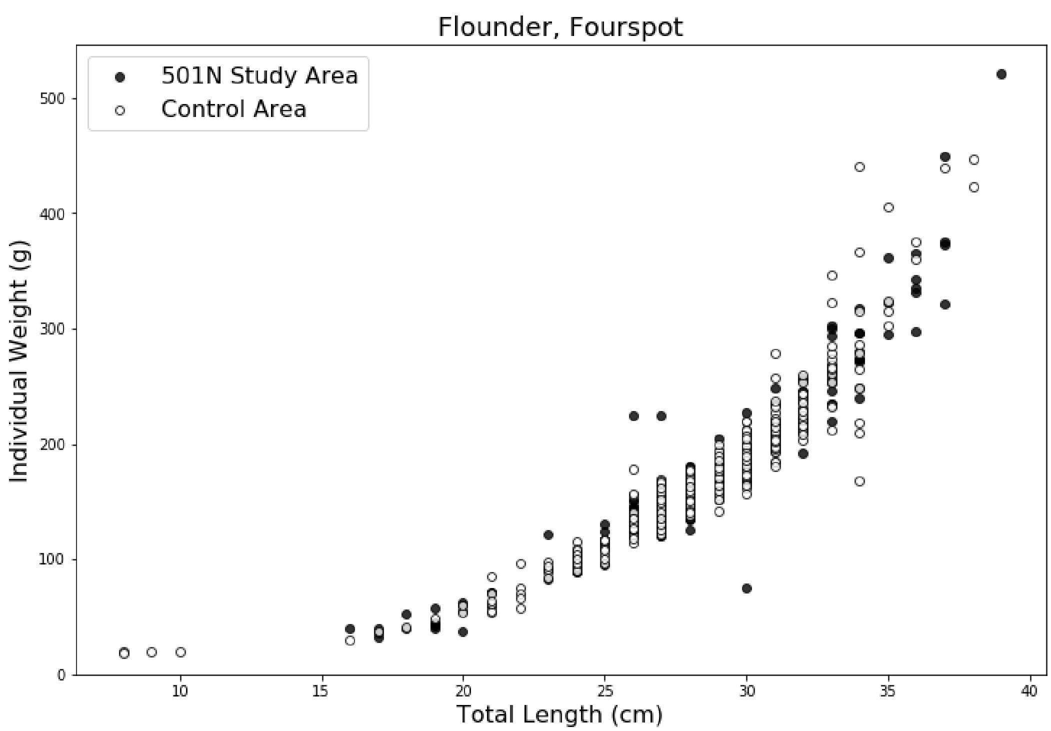


Figure 19: Population structure of fourspot flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

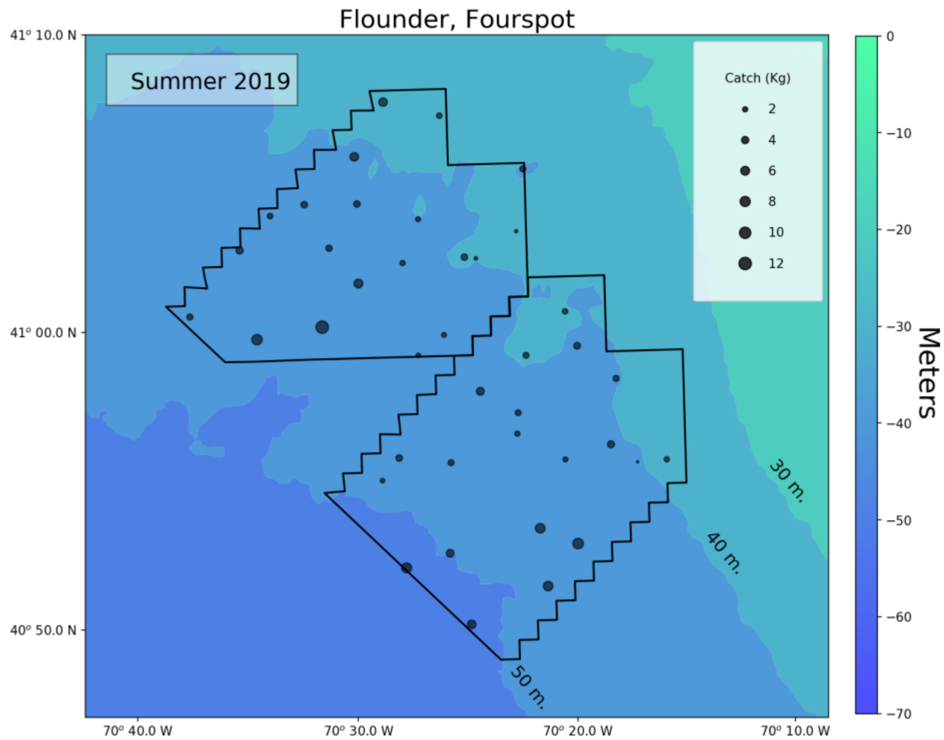


Figure 20: Distribution of the catch of fourspot flounder in the 501N Study Area (left) and Control Area (right).

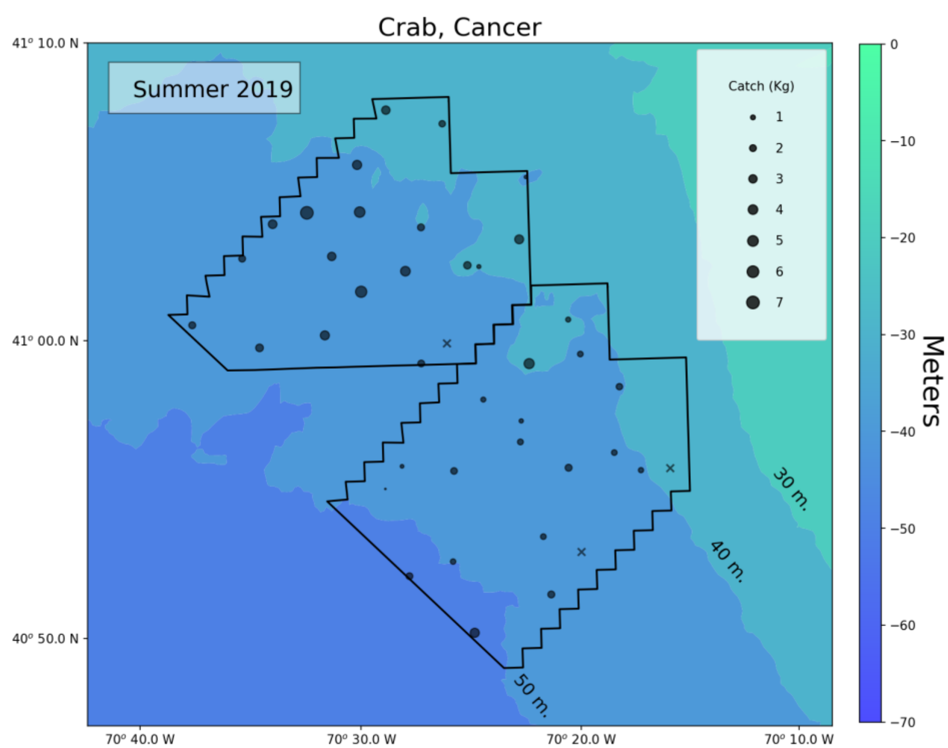


Figure 21: Distribution of the catch of cancer crab in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.

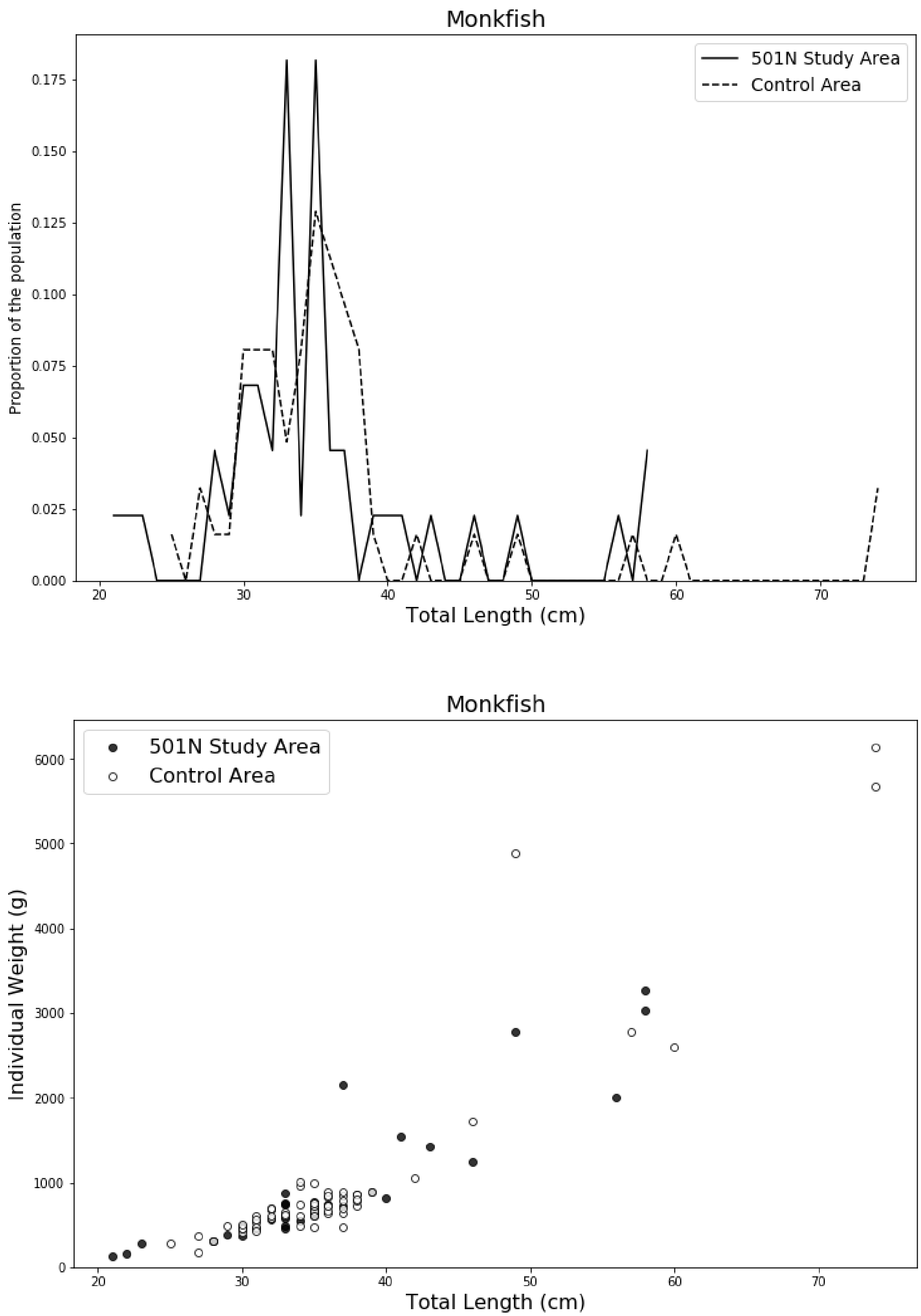


Figure 22: Population structure of monkfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

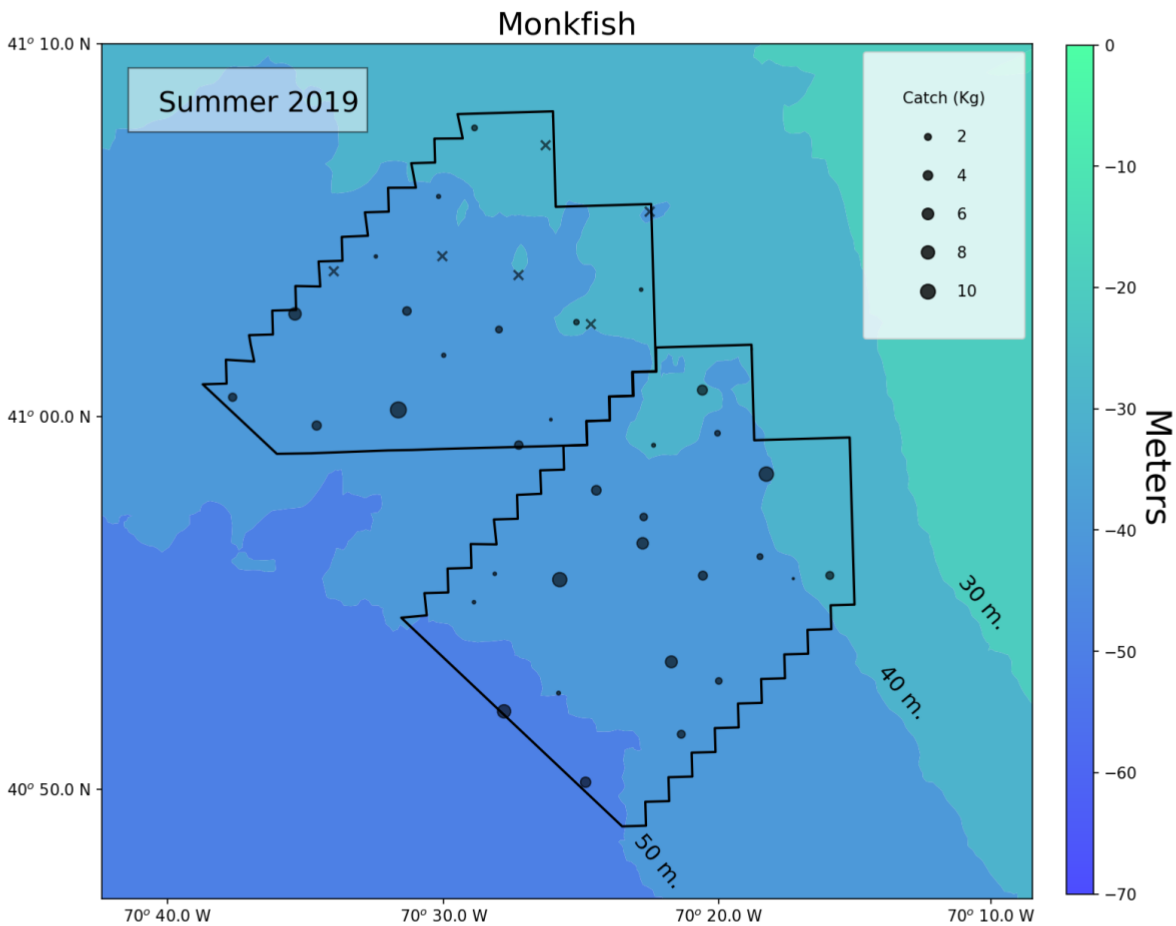
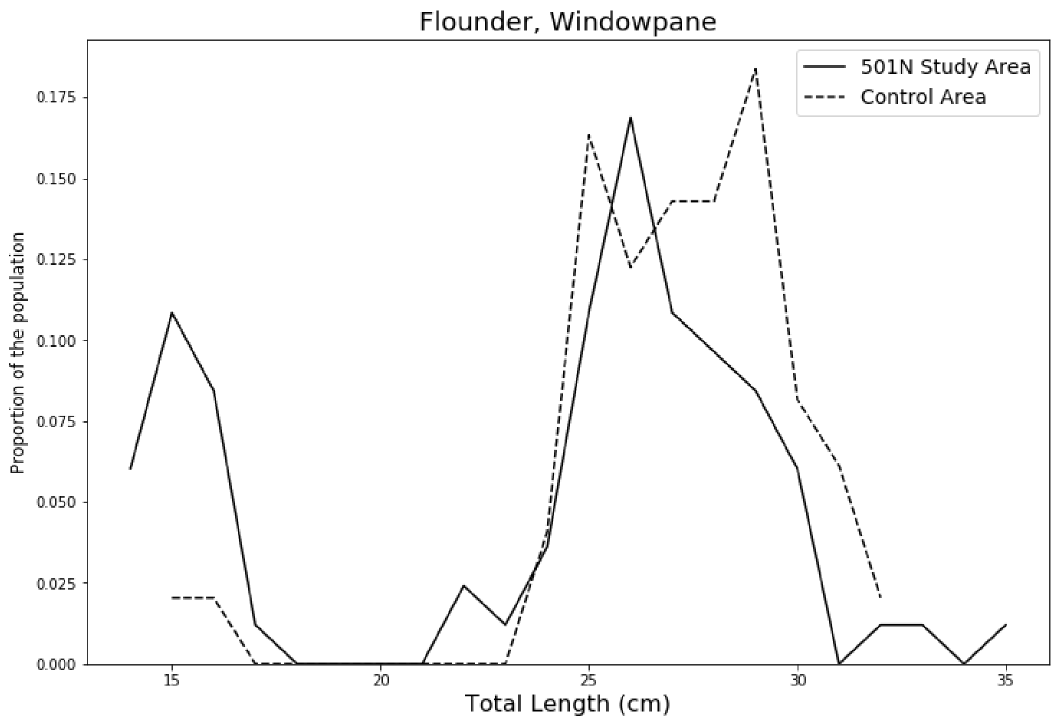


Figure 23: Distribution of the catch of monkfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



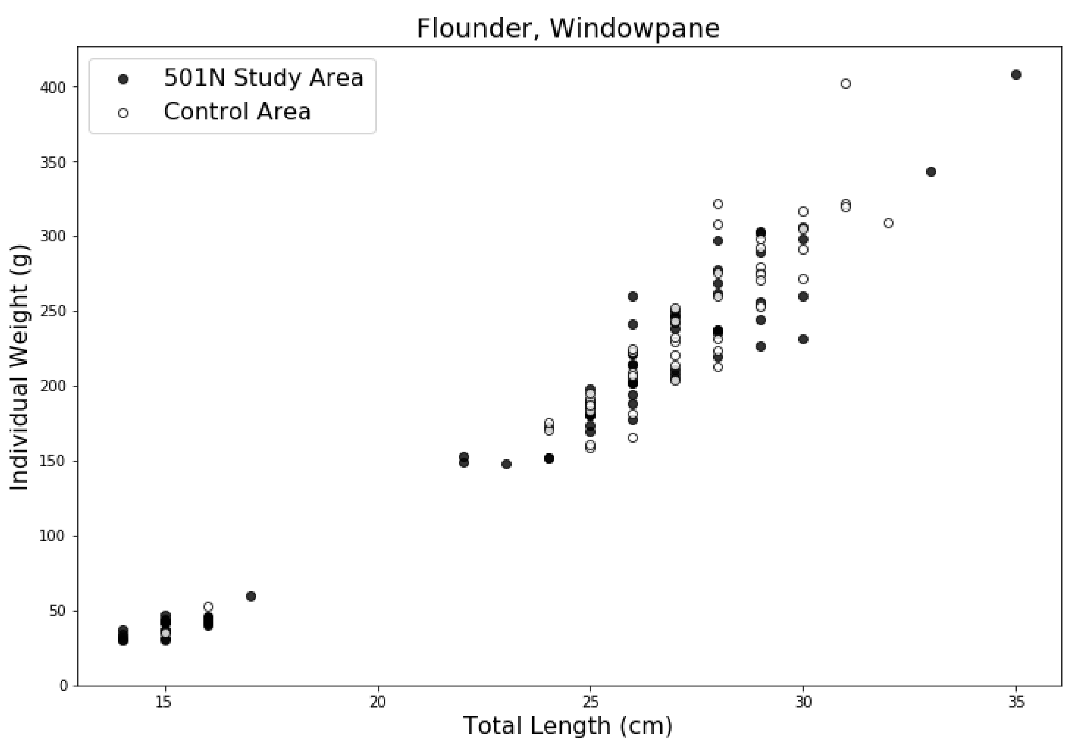


Figure 24: Population structure of windowpane flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

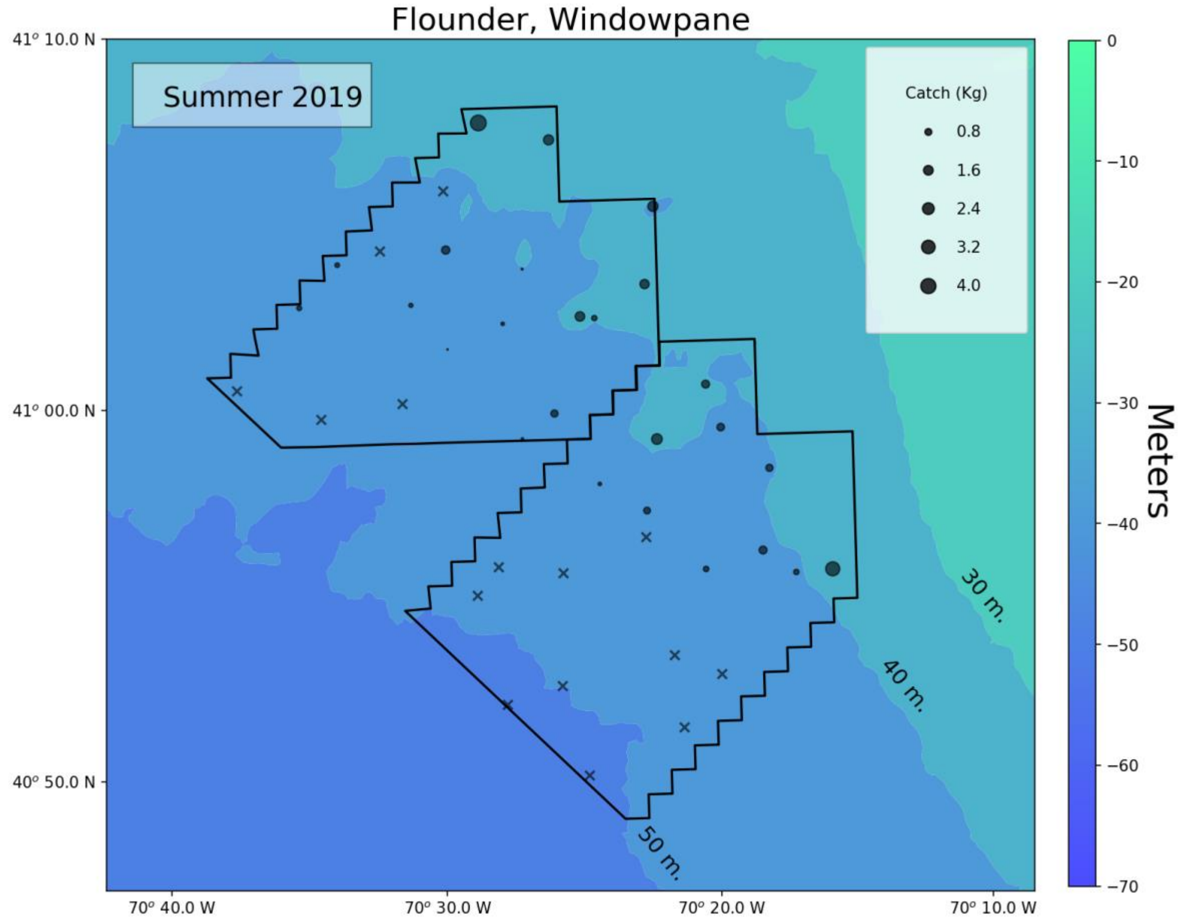
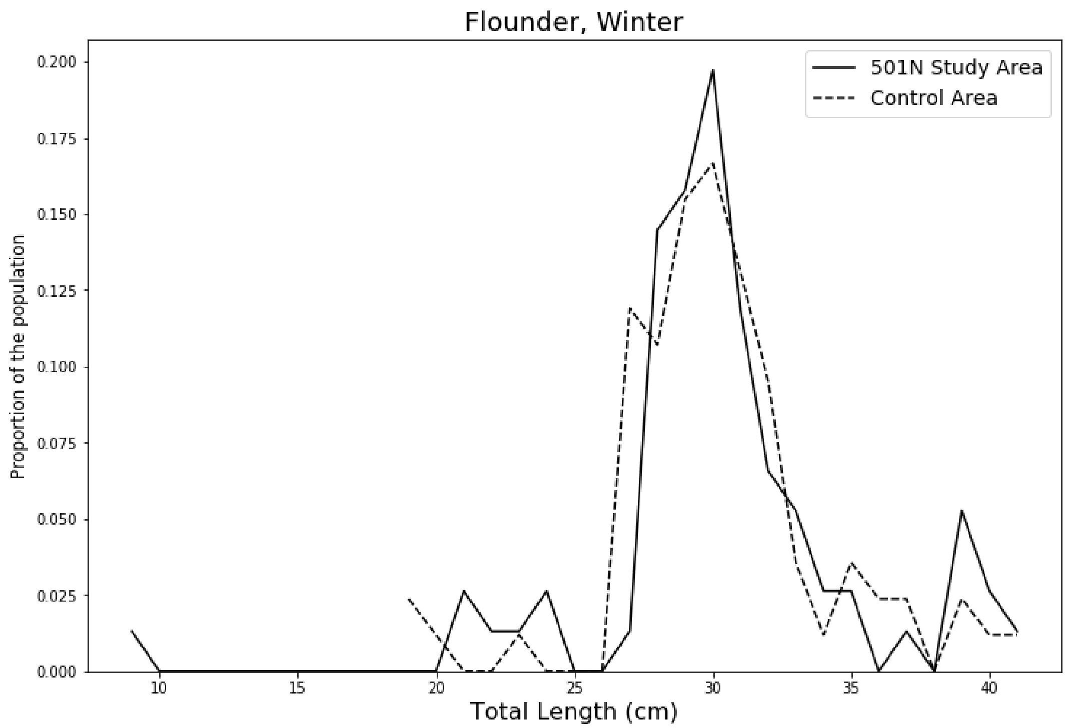


Figure 25: Distribution of the catch of windowpane flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



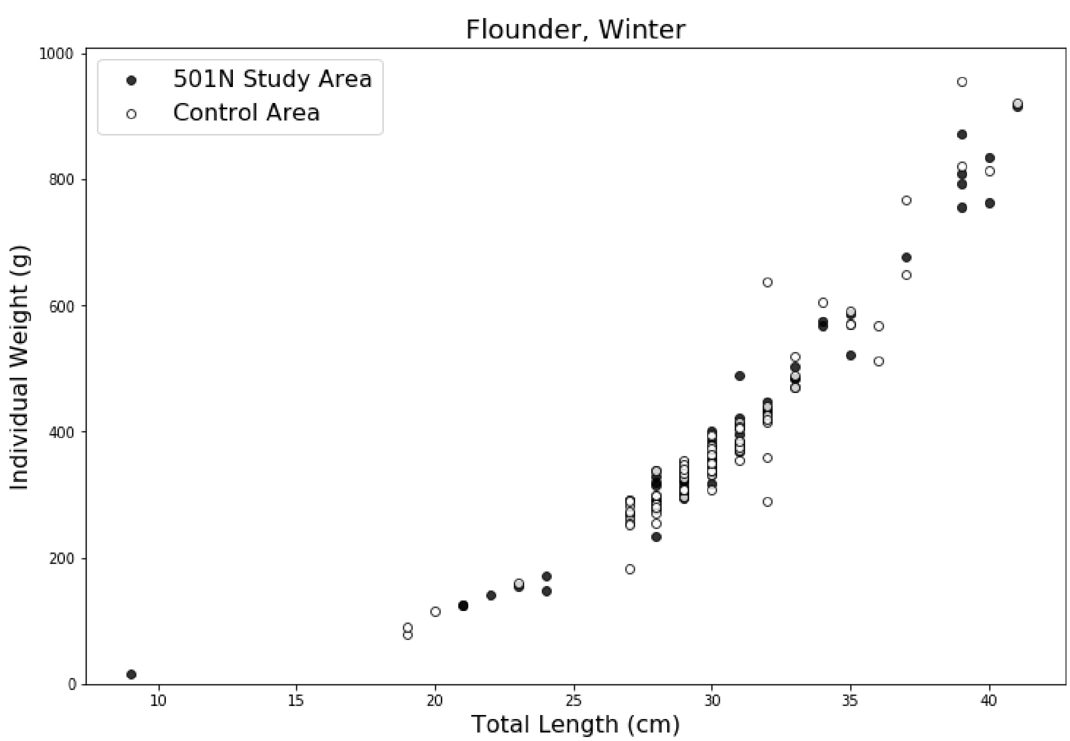


Figure 26: Population structure of winter flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

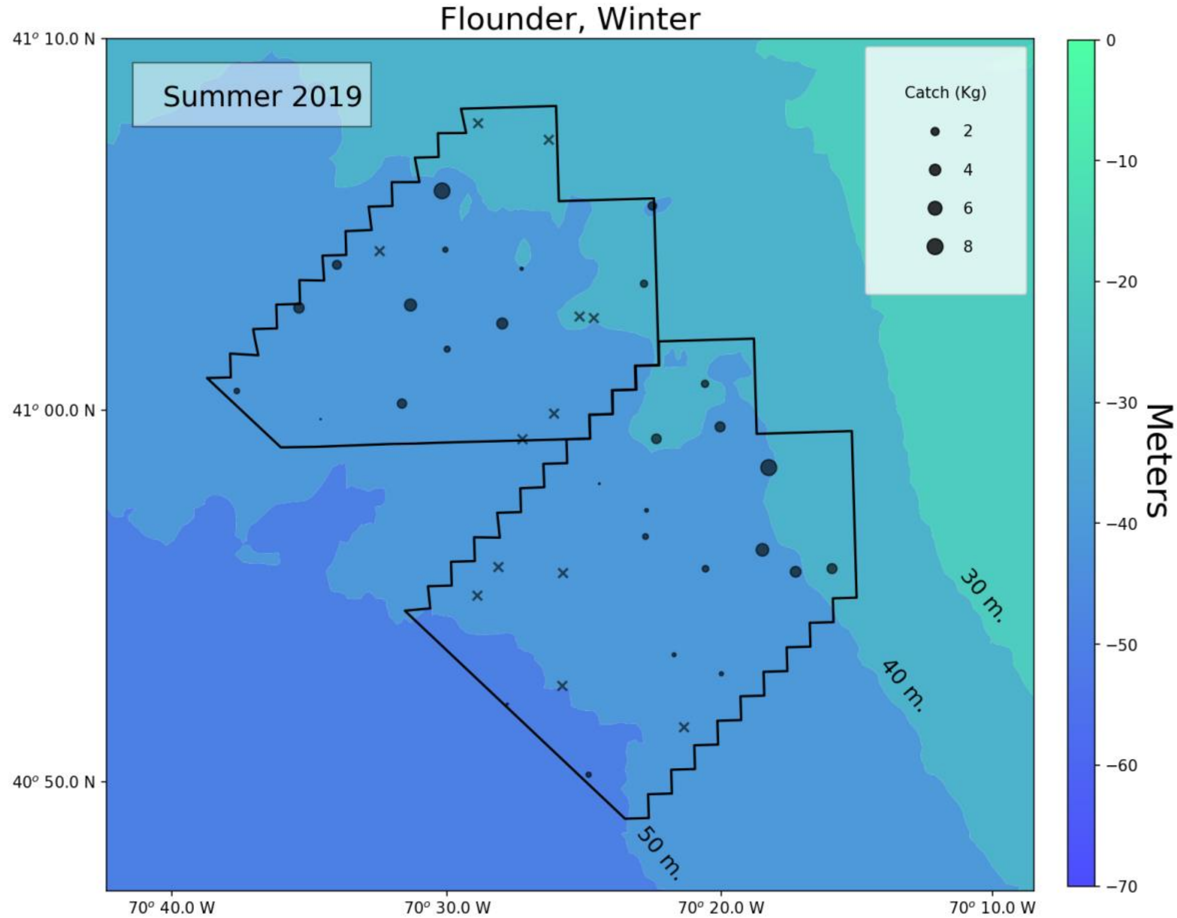
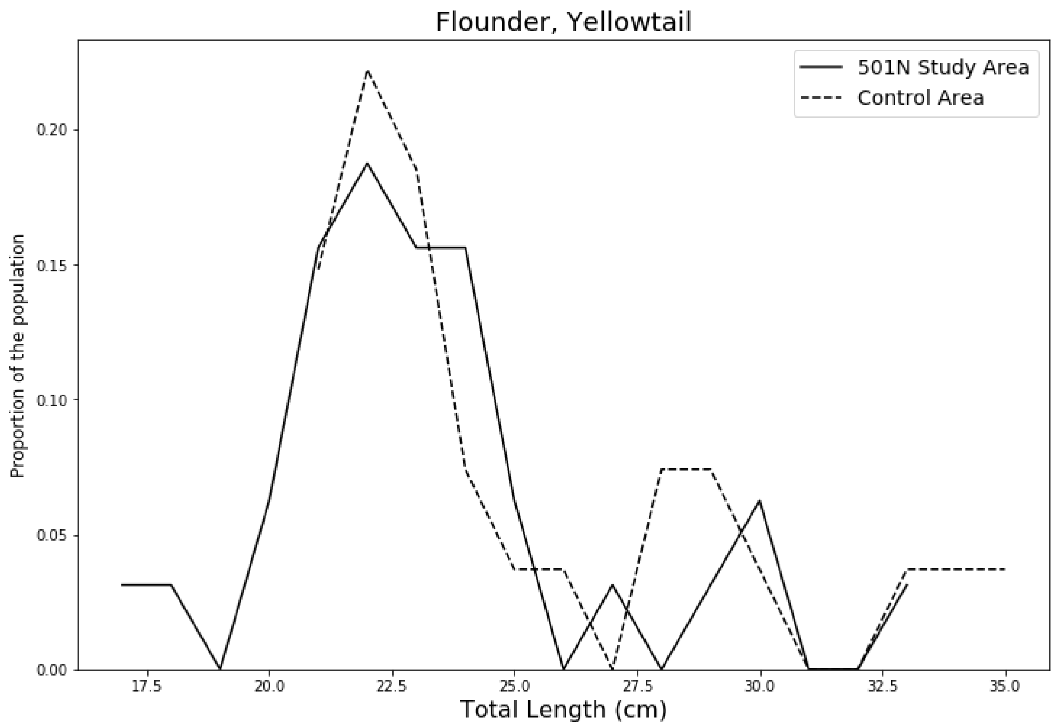


Figure 27: Distribution of the catch of winter flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



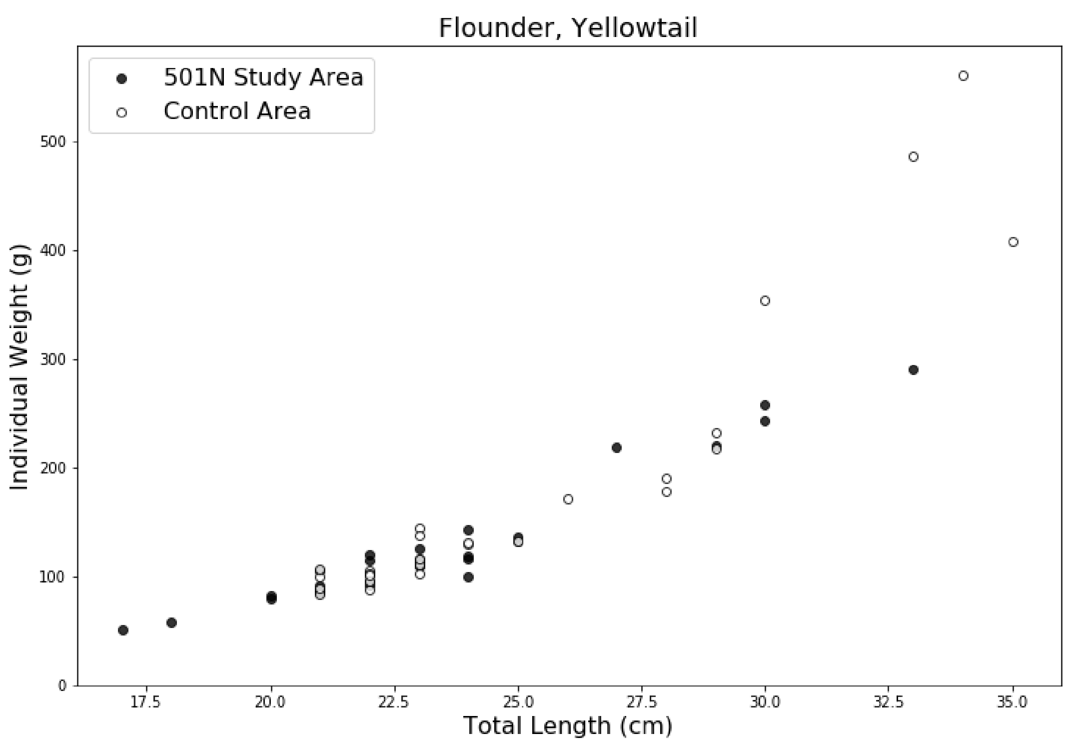


Figure 28: Population structure of yellowtail flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

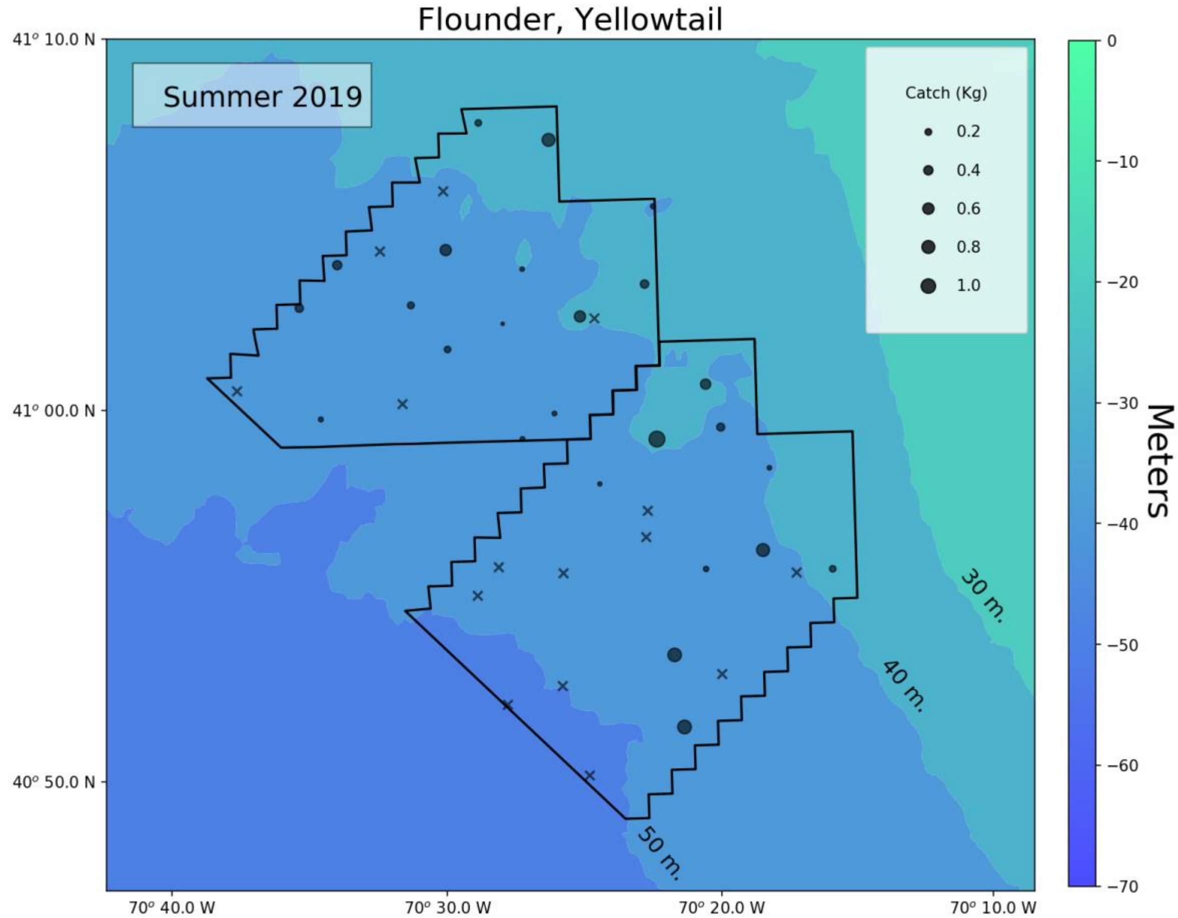
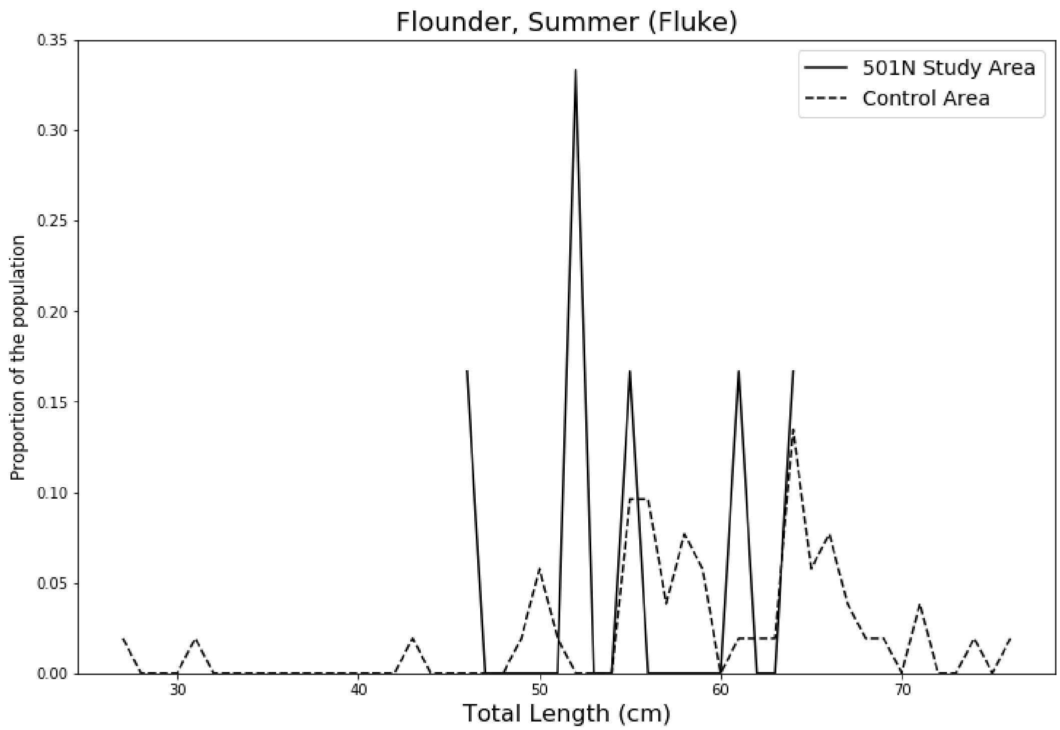


Figure 29: Distribution of the catch of yellowtail flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.



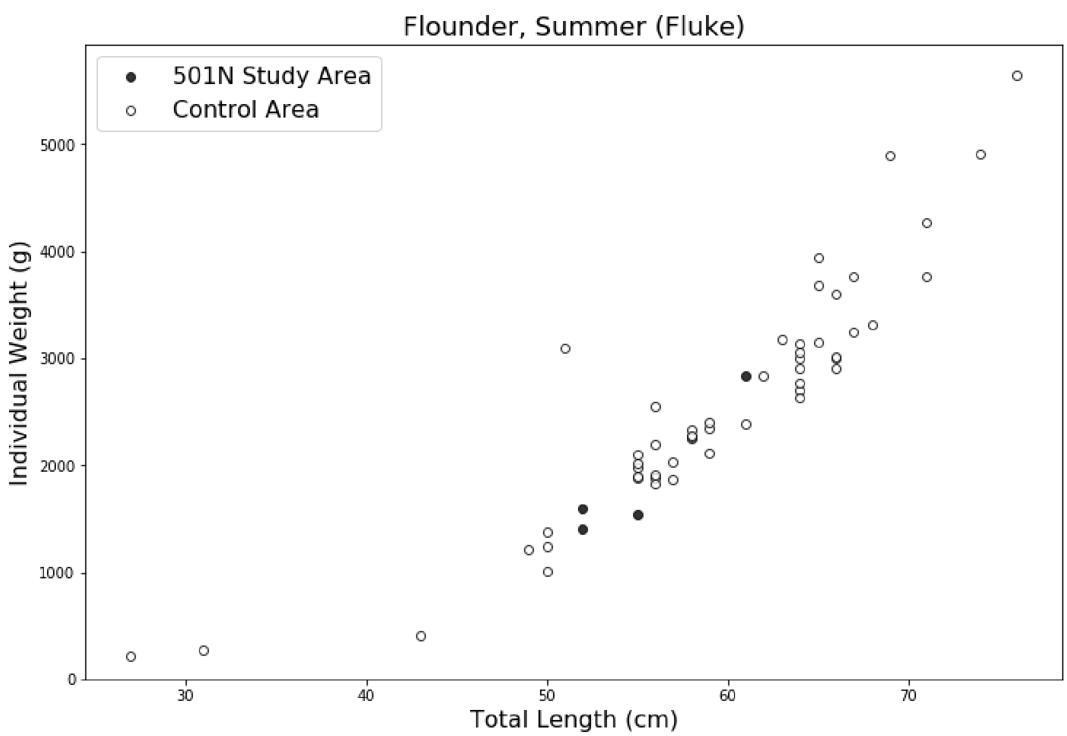


Figure 30: Population structure of summer flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

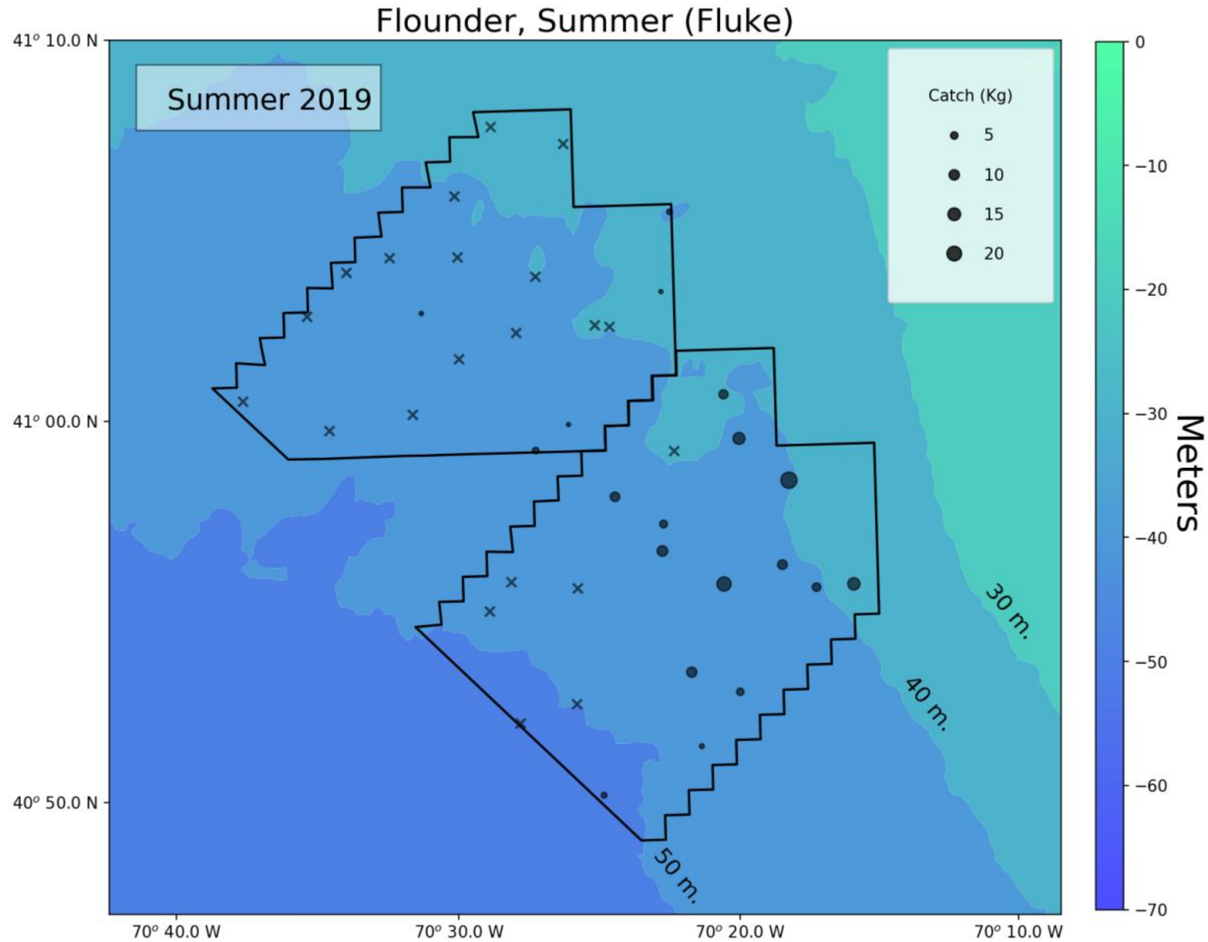


Figure 31: Distribution of the catch of summer flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.

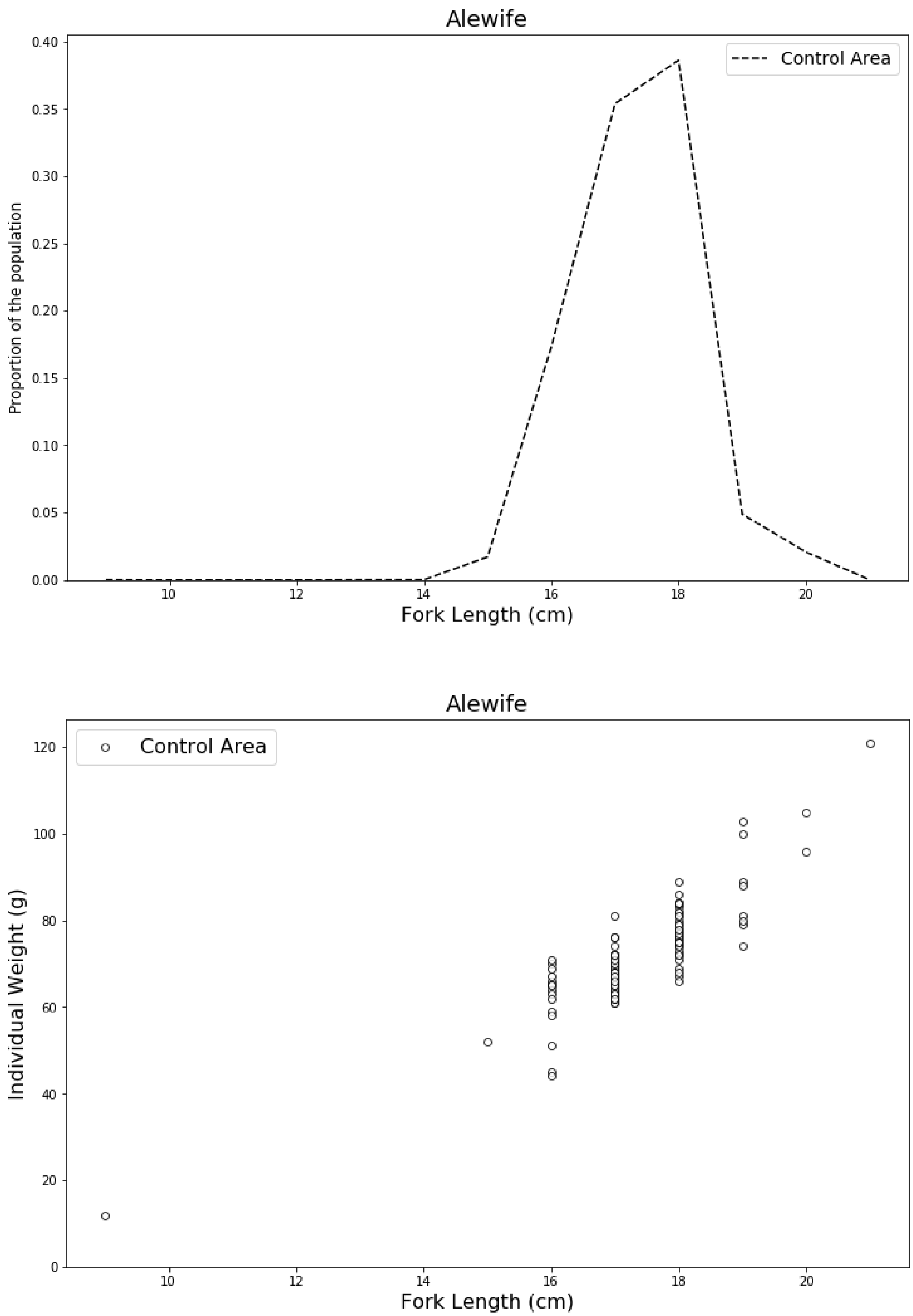


Figure 32: Population structure of alewife in the Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom). No alewife were caught in the Study Area.

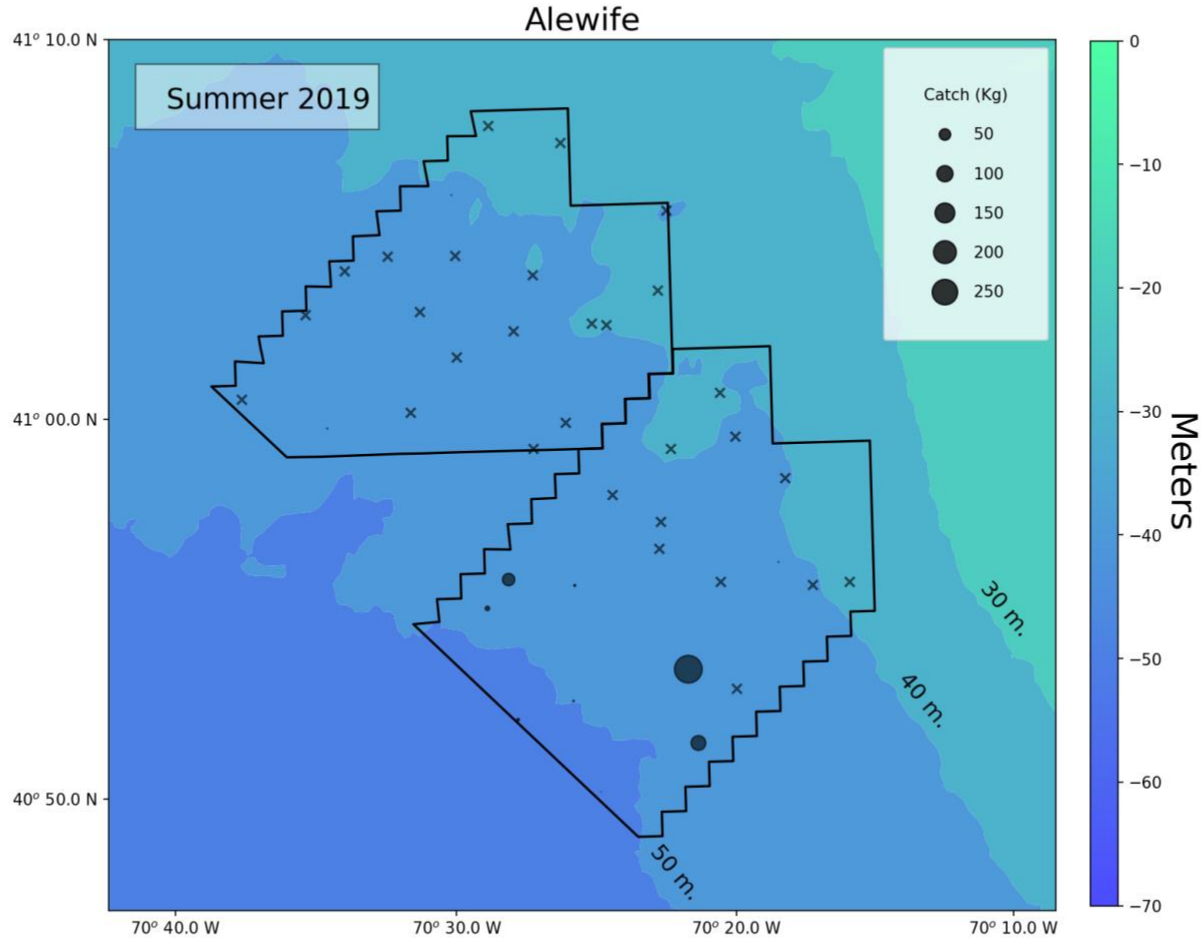


Figure 33: Distribution of the catch of alewife in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an X.