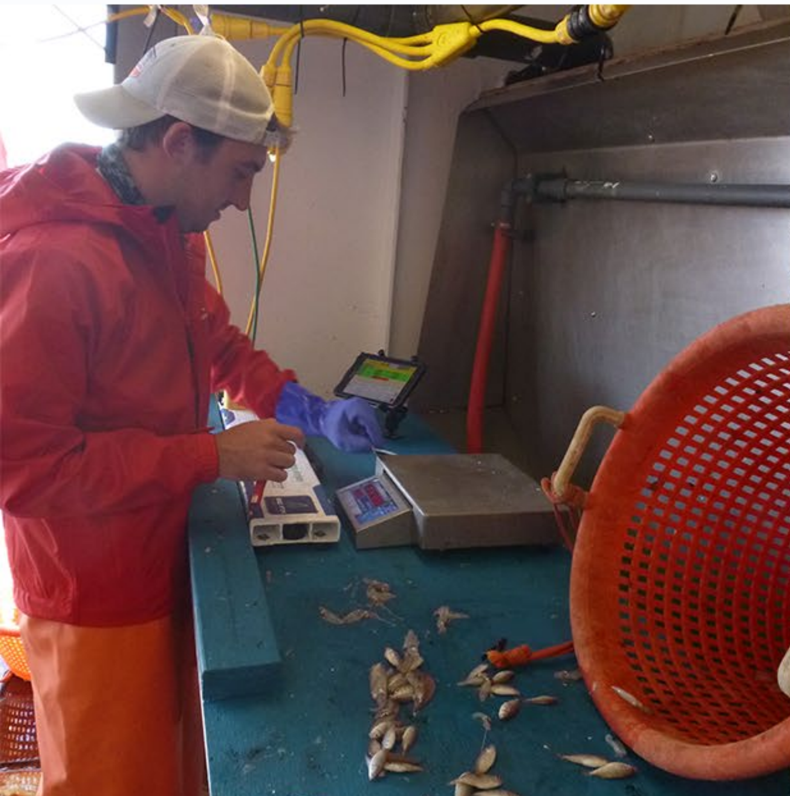
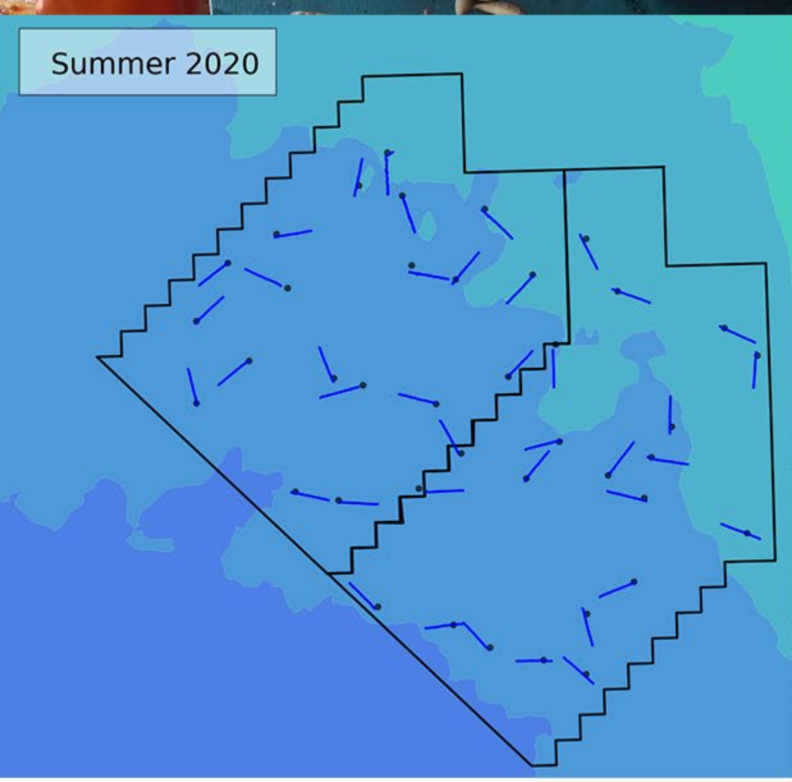
VINEYARD WIND

# Vineyard Wind Demersal Trawl Survey






# Quarterly Report

## Summer 2020 (July - September)

## 501 North Study Area

# VINEYARD WIND DEMERSAL TRAWL SURVEY

## Summer 2020 Seasonal Report

## 501 North Study Area

**October 2020**

**Prepared for Vineyard Wind, LLC**

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# Vineyard Wind Demersal Trawl Survey Summer 2020 Seasonal Report

# 501 North Study Area

**Progress Report #5**

July 1 – September 30, 2020

Project title: Vineyard Wind Demersal Trawl Survey Summer 2020 Seasonal Report – 501 North Study Area

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**SMAST-CE-REP-2020-091**

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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 306 $km^2$ area referred to as the "501 North" or "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 (522 Lease Area); these studies are reported separately.

The Bureau of Ocean Energy Management (BOEM) has statutory obligations under the National Environmental Policy Act 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 bottom trawls are a generally accepted tool for assessing the biological communities along the seafloor and are widely used by institutions worldwide for ecosystem monitoring. Since they are actively towed behind a vessel, they are less biased by fish activity and behavior 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 abundance of fishery resources. The current trawl survey closely emulates the Northeast Area Monitoring and Assessment Program (NEAMAP) survey protocol. In doing so, the goal was to ensure compatibility with other regional surveys, including the National Marine Fisheries Service (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 trawl survey. The bottom trawl survey is complimented by the drop camera survey and lobster trap survey, both are also carried out by SMAST.

The primary goal of this survey was to provide data related to fish abundance, distribution, and population structure in and around Vineyard Wind's 501N Study Area. The data will serve as a baseline to be used in a future analysis under the BACI framework. The reports for the first year's monitoring from spring 2019 to winter 2020 have been submitted to the sponsoring organization. Surveys planned for the Spring 2020 were not conducted due to the COVID-19 pandemic. This progress report documents survey methodology, survey effort, and data collected during the summer of 2020.

## 2. Methodology

The methodology for the survey was adapted from the Atlantic States Marine Fisheries Commission's (ASMFC) NEAMAP nearshore trawl survey. Initiated in 2006, NEAMAP conducts annual spring and fall trawl surveys from Cape Hatteras to Cape Cod. The NEAMAP protocol has gone through extensive peer review and is currently implemented near the Lease Area using a commercial fishing vessel (Bonzek et al., 2008). The current NEAMAP protocol samples at a resolution of ~100 sq. kilometers, which is inadequate to provide scientific information related to potential changes on a smaller scale. Adapting existing methods with increased resolution (see Section 2.1) will enable the survey to fulfill the primary goal of evaluating the impact of windfarm development while improving the consistency between survey platforms. This should facilitate easier sharing and integration of the data with state and federal agencies and allow the data from this survey to be incorporated into existing datasets to enhance our understanding of the region's ecosystem dynamics. Additionally, the methodology is consistent with other ongoing surveys of nearby study areas (Vineyard Wind's 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 was modified from the 2019/2020 survey year due to boundary refinements of projects with the Lease Area. The current 501N Study Area was increased from 249.3 $km^2$ to 306 $km^2$ by adding additional area to the southeastern corner. The current 501N Study Area was sub-divided into 20 sub-areas (each ~15.3 $km^2$), 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, further referred to as the Control Area. The selected region has similar depth contours, bottom types, and benthic habitats to the 501N Study Area. The Control Area was modified from the 2019/2020 survey year. The Control Area was shifted north with additional area added to the north of the 501N Study Area. The change was due to differences in depths and catch rates observed in the 2019/2020 survey data. The goal was to increase the similarity between the 501N Study Area and Control Area (Figure 2). Additionally, shifting effort to the north reduces the area located in the easterly adjacent OCS-A 0520 Lease Area as well as increases the overlap with Vineyard Wind's lobster and drop camera surveys. These changes increase the Control Area from 306 $km^2$ to 324 $km^2$. An additional 20 tows were completed in the Control Area (each ~16.2$km^2$). 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). This information was updated based on catch data from the 2019/2020 survey year (Rillahan and He, 2020). The results of the updated power analysis indicated that several species, including little skate, longfin squid, silver hake, and fourspot flounder, had relatively low variability and therefore high probability of detecting a small to moderate effects (~25% change) under the current monitoring effort. Many of the common species observed, including winter skate, red hake, windowpane flounder, monkfish, summer flounder, scup, yellowtail flounder, winter flounder, and butterfish had higher variability (Coefficient of Variation (CV): 1.5 - 2.3). For these species, the current monitoring would have a high probability of detecting moderate effects (i.e., 30-50% change). For species exhibiting strong seasonality and high variability (CV's: 2.5 – 4), large effects (i.e., 50-75% change) can be detected with a high probability under the current monitoring plan. For all species collected during the surveys, the current monitoring plan has the statistical power to detect a complete disappearance from either study or control area (100% change). The updated power analysis showed that increasing survey effort would only result in small improvements in detectability. 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 15.3 $km^2$ (4.5 sq. nautical miles) in the 501N Study Area and 1 station per 16.2 $km^2$ (4.7 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 Endurance, a 120' stern trawler operating out of New Bedford, MA. The change in vessels was due to required increased safety precautions due to COVID-19. The F/V Endurance is a commercial fishing vessel currently operating in the industry. Two trips to the survey area were made during which all planned tows were completed.

- Trip 1: August 24 - 29, 2020
- Trip 2: September 1 – 2, 2020

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 2019 surveys indicating that the 4:1 ratio constrained the horizontal spreading of the net increasing the headline height.

In addition to monitoring the net geometry to ensure acceptable performance (as described in Section 2.3 above), the following environmental and operational data were collected:

- Cloud cover (i.e., clear, partly cloudy, overcast, fog, etc.)
- Wind speed (Beaufort scale)
- Wind direction
- Sea state (Douglas Sea Scale)
- Start and end position (Latitude and Longitude)
- Start and end depth
- Tow speed
- Bottom temperature

Tow paths and tow speed were continuously logged using the OpenCPN charting software (opencpn.org) running on a computer with a USB GPS unit (GlobalSat BU-353-S4).

### 2.5 Catch Processing

The catch from each tow was sorted by species. Aggregated weight from each species was weighed on a motion-compensated scale (M1100, Marel Corp., Gardabaer, Iceland). Individual fish length (to the nearest centimeter) and weight (to the nearest gram) were collected. Length data was collected using a digital measuring board (DCS-5, Big Fin Scientific LLC., Austin, Texas) and individual weights were measured using a motion compensated digital scale (M1100, Marel Corp., Gardabaer, Iceland). An android tablet (Samsung Active Tab 2) running DCSLinkStream (Big Fin Scientific LLC., Austin, Texas) served as the data collection platform. Efforts were made to process all animals; however, during large catches sub-sampling was used for some abundant species. The straight sub-sampling by weight was the only sub-sampling strategy which was 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 crabs, lobsters, and some non-commercial species. For these species, aggregated weight and counts were collected. Any observation of squid eggs was documented. All the survey data was upload and stored in 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 20.1 ± 0.5 minutes (mean ± one standard deviation) in the 501N Study Area and 20.2 ± 0.5 minutes in the Control Area. Tow distances averaged 1.0 ± 0.05 nautical miles in the 501N Study Area giving an average tow speed of 3.0 ± 0.1 knots. Similarly tow distance averaged 1.0 ± 0.05 nautical miles in the Control Area giving an average tow speed of 2.9 ± 0.1 knots.

The seafloor in both areas follows a northeast to southwest depth gradient with the shallowest tow along the northeast edge (~30 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 (17.8°C at 31 m, 64°F at 17 fm) and colder water during deeper tows (13.6°C at 48 m, 56°F at 26 fm; Table 1). The 2020 survey was considerably warmer than those observed in 2019. In 2019 the average bottom water temperature was 11.4 ± 0.8°C (52.5 ± 1.4°F) in the 501N Study Area and 12.0 ± 0.6°C (53.6 ± 1.1°F) in the Control Area. In the 2020 survey the bottom water temperature averaged 15.9 ± 1.1°C (60.6 ± 2.0°F) in the 501N Study Area and 16.5 ± 1.2°C (61.7 ± 2.2°F) in the Control Area.

The trawl geometry data indicated that the trawl took about 2 to 3 minutes to open and stabilize. Once open, readings were stable throughout the duration of the tow. Door spread averaged 33.4 ± 2.0 m (range: 31.5 – 38.3 m.) for tows in the 501N Study Area and 32.2 ± 1.3 (range: 29.4 – 34.1 m.) in the Control Area. All tows were within the acceptable tolerance limit except for 1 tow at the beginning of the survey. The use of a new vessel, with thicker warp wires (1”) required slight modifications to the length of warp to achieve the desired spread. Once the adjustments were made, the thicker and heavier warp wires appeared to improve the geometry by constraining the spread of the net.

Wing spread averaged 13.4 ± 0.3 m for tows in the 501N Study Area (range: 12.9 – 13.9 m) and 13.1 ± 0.4 m for tows in the Control Area (range: 12.5 – 14.2 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 – 5.6 m) and 4.7 ± 0.3 m for tows in the control area (range: 4.2 – 5.5). Headline height was targeted to be between 5.0 and 5.5 m with acceptable deviations between 4.5 and 6.1 m. While wing spread data indicated the net was within acceptable tolerances, during seven tows the headline height was lower than desired. Six of the seven tows were at the beginning of the survey. To increase the headline height a 30 cm setback was added to the top and middle bridles after tow 14. Once the modifications to the net were done, only 1 of the remaining 26 tows was below the tolerance limit. Additionally, adjustments to the warp length were made to account for the difference in vessels. Reducing the warp length improved the geometry of the trawl.

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. As a result, we believe that the survey results are representative of the fish community in the area, however additional adjustment and testing will be 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 36.6 kg/tow to 802.3 kg/tow with an average of 305.5 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (little skate, scup, longfin squid, butterfish, and smooth dogfish) accounted for 84.5% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Little skate (*Leucoraja erinacea*) was the predominate species observed accounting for 36.7% of the total catch weight. Individuals ranged in size from 13 to 32 cm with a unimodal distribution consisting of a peak at 25 cm (Figure 8). Little skates were observed in all 20 tows. Catch rates averaged 112.1 ± 22.1 kg/tow (mean ± SEM, range: 15.6 – 361.3 kg/tow). Little skate were observed throughout the 501N Study Area (Figure 9). Low catches were observed in the northern portion of the study area, associated with shallow water. Higher catches were observed in the southern half of the study area, associated with deeper water.

Scup (*Stenotomus chysops*) was the second most abundant species accounting for 31.5% of the total catch weight. Scup ranged in size from 17 to 30 cm with a narrow unimodal size distribution consisting of a peak at 21 cm (Figure 10). Scup were observed in 18 of the 20 tows at an average catch rate of 96.5 ± 35.2 kg/tow (range: 0 – 507.8 kg/tow). Scup were caught throughout the 501N Study Area (Figure 11).

Atlantic longfin squid (*Dorytheuthis pealei*) is a commercially important species commonly referred to as loligo squid. Squid was the third most abundant species accounting for 6.6% of the total catch weight. Squid ranged in size from 3 to 25 cm mantle length with a bimodal size distribution (Figure 12). The numerically dominant peak consisted of small squid (5 cm) while a second peak of larger squid was around 12 cm (Figure 12). Squid were observed in all 20 tows at an average catch rate of 20.1 ± 2.2 kg/tow (range: 3.8 – 39.4 kg/tow). Squid were caught throughout the 501N Study Area (Figure 13). No squid “mops” were observed during this survey.

Butterfish (*Peprilus triacanthus*) was the fourth most abundant species observed. Butterfish ranged in length from 6 to 19 cm with a unimodal size distribution consisting of a peak at 8 cm (Figure 14). Butterfish were observed in 19 of the 20 tows at an average catch rate of 16.1 ± 5.0 kg/tow (range: 0 – 97.7 kg/tow). Butterfish were caught throughout the 501N Study Area (Figure 15).

Smooth dogfish (*Mustelus canis*) was the fifth most abundant species observed. Dogfish ranged in length from 53 to 100 cm with broad size distribution (Figure 16). Smooth dogfish were observed in 19 of the 20 tows at an average catch rate of 13.5 ± 3.5 kg/tow (range: 0 – 63.9 kg/tow). Smooth dogfish were caught throughout the 501N Study Area with higher catches observed in the northern half of the development area (Figure 17).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was commonly caught in the 501N Study Area. Silver hake ranged in length from 17 to 40 cm. Silver hake had a unimodal size distribution consisting of a peak at 19 cm (Figure 18). Silver hake were observed in 16 of the 20 tows at an average catch rate of 12.9 ± 6.6 kg/tow (range: 0 – 124.7 kg/tow). The catch of silver hake was associated with depth. No catch was observed during the shallowest tows. The largest tows were associated with deeper water (Figure 19). The catch patterns are presumably due to the differences in temperature associated with water depth.

Summer flounder (*Paralichthys dentatus*) is a commercially important flatfish species commonly referred to as fluke. Summer flounder were commonly caught in the study area. Summer flounder ranged in size from 38 to 70 cm with a broad size distribution (Figure 20). Summer flounder were observed in all 20 tows at an average catch rate of 8.9 ± 1.5 kg/tow (range: 0.6 – 21.9 kg/tow). Summer flounder were caught throughout the 501N Study Area (Figure 21).

Winter flounder (*Pleuronectes americanus*) was another commercially important flatfish species commonly caught in the study area. Winter flounder ranged in size from 20 to 44 cm with a unimodal size distribution peaking at 32 cm (Figure 22). Winter flounder were observed in 19 of the 20 tows at an average catch rate of 4.4 ± 1.1 kg/tow (range: 0 – 21.5 kg/tow). The catch of winter flounder was highest in the southern half of the study area (Figure 23).

Red hake (*Urophycis chuss*) was one of the dominate species in the 2019 – 2020 survey year. During this summer survey the catch of red hake was limited. Red hake ranged in size from 18 to 39 cm with a unimodal size distribution peaking at 23 cm (Figure 24). Red hake were only observed in 8 of the 20 tows at an average catch rate of 3.8 ± 2.5 kg/tow (range: 0 – 39.4 kg/tow). The catch of red hake was primarily limited to the deepest tows along the southern boundary of the 501N Study Area (Figure 25).

Similar patterns were observed in winter skates (*Leucoraja ocellata*). Winter skates ranged in size from 24 to 51 cm (Figure 26). Winter skate were observed in 9 of the 20 tows at an average catch rate of 3.0 ± 1.1 kg/tow (range: 0 – 17.7 kg/tow). The catch of winter skate was similarly limited to the deeper tows associated with the southern half of the 501N Study Area (Figure 27).

Other commercially important species frequently observed included monkfish (*Lophius americanus*), windowpane flounder (*Scophtalmus aquosus*), and black sea bass (*Centropristis striata*). Seventeen monkfish were caught during 8 tows. Monkfish ranged in size from 29 to 70 cm (Figure 28). The catch rate of monkfish averaged 1.5 ± 0.6 kg/tow (range: 0 – 11.0 kg/tow) with the catch primarily observed along the southern boundary (Figure 29).

Windowpane flounder ranged in size from 15 to 32 cm with a unimodal size distribution peaking at 28 cm (Figure 30). Windowpane flounder were observed in 15 of the 20 tows at an average catch rate of 0.8 ± 0.3 kg/tow (range: 0 – 4.2 kg/tow). Windowpane flounder were caught throughout the 501N Study Area (Figure 31).

Black sea bass ranged in size from 22 to 48 cm (Figure 32). Black sea bass were observed in 6 of the 20 tows at an average catch rate of 0.7 ± 0.3 kg/tow (range: 0 – 5.5 kg/tow). The catch of black sea bass was concentrated in the northern portion of the 501N Study Area (Figure 33).

Less common recreational and commercial species observed included 29 Atlantic sea scallops (*Placopecten* magellanicus), 16 American lobster (*Homarus* americanus), 7 yellowtail flounder (*Limanda ferruginea*, size range: 22 – 27 cm), 1 Atlantic cod (*Gadus morhua*, 54 cm), 1 bluefish (*Pomotomus saltatrix*, 57 cm), and 1 haddock (*Melanogrammus aeglefinus*, 14 cm).

One thresher shark (*Alopias vulpinus*) was caught (Figure 34). 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.

### 3.2.2 Control Area

In the Control Area, a total of 27 species were caught over the duration of the survey (Table 4). Catch volume ranged from 14.9 kg/tow to 1434.9 kg/tow with an average of 354.2 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (scup, little skate, butterfish, longfin squid, and northern sea robin) accounted for 88.9% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Scup was the most abundant species accounting for 39.5% of the total catch weight. Scup ranged in size from 5 to 33 cm with a narrow unimodal size distribution consisting of a peak at 21 -22 cm (Figure 10). Scup were observed in 17 of the 20 tows at an average catch rate of 139.4 ± 60.0 kg/tow (range: 0 – 1016.5 kg/tow). Scup were caught throughout the Control Area with the largest catches in the middle and southern portion of the study area (Figure 11).

Little skate (*Leucoraja erinacea*) was the second most abundant species observed accounting for 32.8% of the total catch weight. Individuals ranged in size from 11 to 33 cm with a unimodal distribution consisting of a peak at 24 cm (Figure 8). Little skate were observed in all 20 tows. Catch rates averaged 116.5 ± 21.8 kg/tow (range: 4.7 – 341.3 kg/tow). Little skate were observed throughout the Control Area (Figure 9). Similar to the 501N Study Area, low catches were observed in the northern portion of the Control Area, associated with shallow water. Higher catches were observed in the southern half of the Control Area, associated with deeper water.

Butterfish (*Peprilus triacanthus*) was the third most abundant species observed. Butterfish ranged in length from 4 to 18 cm with a unimodal size distribution consisting of a peak at 8 cm (Figure 14). Butterfish were observed in all 20 tows at an average catch rate of 26.7 ± 7.8 kg/tow (range: 0.1 – 107.2 kg/tow). While butterfish were caught throughout the Control Area, higher catches were observed in the middle and southern portion of the area (Figure 15).

Atlantic longfin squid was the fourth most abundant species. Squid ranged in size from 3 to 23 cm mantle length with a bimodal size distribution (Figure 12). The numerically dominant peak consisted of small squid (5 cm) while a second peak of larger squid was around 12 cm (Figure 12). Squid were observed in all 20 tows at an average catch rate of 19.6 ± 2.3 kg/tow (range: 4.1 – 41.8 kg/tow). Squid were caught throughout the Control Area (Figure 13). No squid "mops" were observed during this survey.

Northern sea robin (*Prionotus carolinus*) was the fifth most abundant species observed. Sea robins ranged in size from 17 to 32 cm with a unimodal size distribution peaking at 27 cm (Figure 35). Sea robins were observed in 10 of the 20 tows at an average catch rate of 12.6 ± 7.3 kg/tow (range: 0 – 131.1 kg/tow). The catch of sea robin was concentrated in the southern half of the Control Area with large catches along the southeastern boundary (Figure 36).

Silver hake was commonly caught in the Control Area. Silver hake ranged in length from 16 to 31 cm. Silver hake had a unimodal size distribution consisting of a peak at 20 cm (Figure 18). Silver hake were observed in 10 of the 20 tows at an average catch rate of 9.6 ± 4.6 kg/tow (range: 0 – 65.4 kg/tow). The catch of silver hake was associated with depth with no catch observed during the shallowest tows. The largest tows were associated with deeper water (Figure 19).

Smooth dogfish (*Mustelus canis*) were regularly caught in the Control Area. Dogfish ranged in length from 53 to 101 cm with broad size distribution (Figure 16). Smooth dogfish were observed in 16 of the 20 tows at an average catch rate of 8.9 ± 2.3 kg/tow (range: 0 – 46.8 kg/tow). Smooth dogfish were caught throughout the Control Area (Figure 17).

Summer flounder were commonly caught in the Control Area. Summer flounder ranged in size from 36 to 74 cm with a broad size distribution (Figure 20). Summer flounder were observed in 19 of the 20 tows at an average catch rate of 8.9 ± 1.6 kg/tow (range: 0.6 – 28.4 kg/tow). Summer flounder were caught throughout the Control Area (Figure 21).

Winter flounder was another commercially important flatfish species commonly caught in the Control Area. Winter flounder ranged in size from 20 to 39 cm with a unimodal size distribution peaking at 23 cm (Figure 22). Winter flounder were observed in 16 of the 20 tows at an average catch rate of 0.7 ± 0.1 kg/tow (range: 0 – 1.8 kg/tow). Winter flounder were caught throughout the Control Area (Figure 23).

Other commercially important species frequently observed included monkfish, windowpane flounder and black sea bass. Four monkfish were caught during 3 tows. Monkfish ranged in size from 36 to 45 cm (Figure 28). The catch rate of monkfish averaged 0.24 ± 0.1 kg/tow (range: 0 – 1.7 kg/tow) with the catch solely observed along the southern boundary (Figure 29).

Windowpane flounder ranged in size from 16 to 32 cm with a bimodal size distribution with peaks at 19 and 29 cm (Figure 30). Windowpane flounder were observed in 18 of the 20 tows at an average catch rate of 1.4 ± 0.5 kg/tow (range: 0 – 9.1 kg/tow). Windowpane flounder were caught throughout the Control Area (Figure 31).

Black sea bass ranged in size from 29 to 51 cm (Figure 32). Black sea bass were observed in 14 of the 20 tows at an average catch rate of 1.4 ± 0.4 kg/tow (range: 0 – 7.6 kg/tow). The catch of black sea bass was concentrated in the northern portion of the Control Area (Figure 33).

Less common recreational and commercial species observed included 23 Atlantic sea scallops, 7 American lobster, 6 yellowtail flounder (size range: 22 – 36 cm) and 6 bluefish.

## 4. Acknowledgements

We would like to thank the owner/captain (Armando Estudante) and crew (Virgilio Martins and Antonio Lamiero) of the F/V Endurance for their help sorting, processing and measuring the catch. Additionally, we would like to thank Susan Inglis (SMAST), Mike Coute (SMAST) and Keith Hankowsky (SMAST) for their help with data collection at sea.

## 5. References


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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) | Bottom Temp. (°C) | Trawl Warp (fm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 501N | 8/25/2020 | Clear | 7-10 | SW | 0.5-1.25 | 7:06 | N 41° 04.134 | W 70° 32.288 | 23 | 7:26 | N 41° 04.292 | W 70° 31.051 | 21 | 16.0 | 100 |
| 2 | 501N | 8/25/2020 | Clear | 7-10 | SW | 0.5-1.25 | 9:54 | N 41° 04.921 | W 70° 29.603 | 21 | 10:14 | N 41° 06.139 | W 70° 29.263 | 21 | 16.1 | 100 |
| 3 | 501N | 8/25/2020 | Clear | 7-10 | SW | 0.5-1.25 | 11:09 | N 41° 06.270 | W 70° 28.352 | 21 | 11:29 | N 41° 05.217 | W 70° 28.381 | 21 | 16.3 | 90 |
| 4 | 501N | 8/25/2020 | Partly Cloudy | 7-10 | SW | 0.5-1.25 | 12:28 | N 41° 05.237 | W 70° 27.934 | 21 | 12:48 | N 41° 04.236 | W 70° 27.483 | 21 | 16.6 | 90 |
| 5 | 501N | 8/25/2020 | Partly Cloudy | 7-10 | SW | 0.5-1.25 | 14:07 | N 41° 03.175 | W 70° 27.660 | 22 | 14:27 | N 41° 02.986 | W 70° 26.351 | 21 | 15.9 | 90 |
| 6 | 501N | 8/25/2020 | Partly Cloudy | 11-15 | SW | 0.5-1.25 | 15:34 | N 41° 02.848 | W 70° 26.208 | 21 | 15:54 | N 41° 03.681 | W 70° 25.258 | 22 | 16.1 | 90 |
| 7 | 501N | 8/25/2020 | Partly Cloudy | 11-15 | SW | 0.5-1.25 | 16:41 | N 41° 04.860 | W 70° 25.175 | 20 | 17:01 | N 41° 04.025 | W 70° 24.124 | 21 | 16.9 | 90 |
| 8 | 501N | 8/25/2020 | Partly Cloudy | 16-20 | SW | 0.5-1.25 | 18:09 | N 41° 03.044 | W 70° 23.419 | 20 | 18:29 | N 41° 02.318 | W 70° 24.339 | 21 | 16.4 | 80 |
| 9 | Control | 8/26/2020 | Clear | 16-20 | NW | 0.5-1.25 | 6:44 | N 41° 04.155 | W 70° 21.817 | 20 | 7:04 | N 41° 03.213 | W 70° 21.215 | 20 | 16.3 | 90 |
| 10 | Control | 8/26/2020 | Clear | 16-20 | NW | 0.5-1.25 | 8:57 | N 41° 02.601 | W 70° 20.767 | 20 | 9:17 | N 41° 02.294 | W 70° 19.414 | 19 | 17.1 | 90 |
| 11 | Control | 8/26/2020 | Clear | 16-20 | NW | 0.5-1.25 | 10:17 | N 41° 01.681 | W 70° 17.076 | 18 | 10:37 | N 41° 01.215 | W 70° 15.810 | 17 | 17.1 | 80 |
| 12 | Control | 8/26/2020 | Partly Cloudy | 16-20 | NW | 0.5-1.25 | 11:33 | N 41° 01.029 | W 70° 15.777 | 17 | 11:53 | N 41° 00.073 | W 70° 15.886 | 18 | 17.2 | 80 |
| 13 | Control | 8/26/2020 | Partly Cloudy | 11-15 | NW | 0.5-1.25 | 13:01 | N 40° 56.079 | W 70° 15.756 | 19 | 13:22 | N 40° 56.474 | W 70° 17.049 | 20 | 17.8 | 80 |
| 14 | Control | 8/26/2020 | Partly Cloudy | 11-15 | NW | 0.5-1.25 | 14:21 | N 40° 57.111 | W 70° 19.644 | 22 | 14:42 | N 40° 57.377 | W 70° 20.957 | 22 | 17.4 | 90 |
| 15 | Control | 8/26/2020 | Clear | 7-10 | NW | 0.5-1.25 | 15:17 | N 40° 57.824 | W 70° 20.877 | 22 | 15:37 | N 40° 58.646 | W 70° 20.038 | 23 | 17.2 | 100 |
| 16 | Control | 8/26/2020 | Clear | 7-10 | NW | 0.5-1.25 | 16:39 | N 40° 58.255 | W 70° 19.541 | 23 | 16:59 | N 40° 58.053 | W 70° 18.162 | 21 | 17.1 | 100 |
| 17 | Control | 8/27/2020 | Mostly Cloudy | 7-10 | NW | 0.5-1.25 | 6:33 | N 40° 58.855 | W 70° 18.787 | 21 | 6:53 | N 40° 59.853 | W 70° 18.747 | 21 | 17.5 | 90 |
| 18 | Control | 8/27/2020 | Mostly Cloudy | 7-10 | NW | 0.5-1.25 | 8:26 | N 40° 55.001 | W 70° 19.963 | 22 | 8:46 | N 40° 54.629 | W 70° 21.245 | 22 | 16.6 | 90 |
| 19 | Control | 8/27/2020 | Mostly Cloudy | 7-10 | NW | 0.5-1.25 | 10:24 | N 40° 54.382 | W 70° 21.900 | 22 | 10:44 | N 40° 53.366 | W 70° 21.552 | 24 | 16.0 | 90 |
| 20 | Control | 8/27/2020 | Partly Cloudy | 3-6 | NW | 0.5-1.25 | 11:44 | N 40° 52.333 | W 70° 21.508 | 24 | 12:04 | N 40° 53.043 | W 70° 22.539 | 24 | 15.7 | 100 |
| 21 | Control | 8/27/2020 | Partly Cloudy | 3-6 | NW | 0.1-0.5 | 13:45 | N 40° 52.953 | W 70° 22.961 | 24 | 14:05 | 40° N 40.52.96 | W 70° 24.161 | 25 | 15.4 | 90 |
| 22 | Control | 8/27/2020 | Partly Cloudy | 3-6 | NW | 0.1-0.5 | 15:41 | N 40° 53.290 | W 70° 25.145 | 26 | 16:01 | N 40° .53.971 | W 70° 25.949 | 25 | 14.7 | 100 |
| 23 | Control | 8/28/2020 | Overcast | 3-6 | SW | 0.5-1.25 | 6:18 | N 40° 53.957 | W 70° 25.987 | 25 | 6:38 | N 40° 53.855 | W 70° 27.276 | 26 | 13.8 | 100 |
| 24 | Control | 8/28/2020 | Obscured | 3-6 | SW | 0.5-1.25 | 7:39 | N 40° 54.423 | W 70° 29.064 | 26 | 7:59 | N 40° 55.052 | W 70° 29.851 | 26 | 13.9 | 100 |
| 25 | 501N | 8/28/2020 | Overcast | 3-6 | SW | 0.5-1.25 | 9:40 | N 40° 37.445 | W 70° 31.809 | 26 | 10:00 | N 40° 57.236 | W 70° 30.569 | 24 | 13.6 | 100 |
| 26 | 501N | 8/28/2020 | Partly Cloudy | 3-6 | SW | 0.5-1.25 | 11:54 | N 40° 57.122 | W 70° 28.891 | 24 | 12:14 | N 40° 57.174 | W 70° 30.201 | 24 | 14.2 | 90 |
| 27 | 501N | 8/28/2020 | Mostly Cloudy | 3-6 | SW | 0.5-1.25 | 13:43 | N 40° 57.421 | W 70° 27.201 | 24 | 14:03 | N 40° 57.448 | W 70° 25.937 | 23 | 15.9 | 90 |
| 28 | Control | 8/28/2020 | Partly Cloudy | 3-6 | SW | 0.5-1.25 | 14:45 | N 40° 57.682 | W 70° 23.784 | 23 | 15:05 | N 40° 58.444 | W 70° 22.959 | 22 | 17.3 | 90 |
| 29 | Control | 8/28/2020 | Partly Cloudy | 3-6 | SW | 0.5-1.25 | 16:24 | N 41° 00.108 | W 70° 22.754 | 21 | 16:44 | N 41° 01.093 | W 70° 22.769 | 21 | 17.3 | 80 |
| 30 | 501N | 8/28/2020 | Partly Cloudy | 3-6 | SW | 0.5-1.25 | 17:20 | N 41° 01.075 | W 70° 23.488 | 21 | 17:40 | N 41° 00.422 | W 70° 24.305 | 22 | 16.4 | 80 |
| 31 | Control | 8/29/2020 | Obscured | 3-6 | SW | 0.5-1.25 | 6:30 | N 40° 58.723 | W 70° 22.534 | 21 | 6:50 | N 40° 58.499 | W 70° 23.767 | 22 | 17.7 | 90 |
| 32 | Control | 8/29/2020 | Overcast | 7-10 | SW | 0.5-1.25 | 7:54 | N 40° 58.432 | W 70° 26.079 | 22 | 8:14 | N 40° 59.283 | W 70° 26.690 | 23 | 17.3 | 90 |
| 33 | 501N | 8/29/2020 | Overcast | 7-10 | SW | 0.5-1.25 | 9:05 | N 40° 59.747 | W 70° 26.934 | 22 | 9:25 | N 40° 54.988 | W 70° 28.079 | 23 | 17.0 | 85 |
| 34 | 501N | 8/29/2020 | Overcast | 7-10 | SW | 0.5-1.25 | 10:30 | N 41° 00.186 | W 70° 24.505 | 23 | 10:50 | N 40° 59.927 | W 70° 30.784 | 25 | 15.8 | 90 |
| 35 | 501N | 8/29/2020 | Mostly Cloudy | 11-15 | SW | 0.5-1.25 | 11:55 | N 41° 00.340 | W 70° 30.352 | 24 | 12:15 | N 41° 01.235 | W 70° 30.811 | 24 | 15.8 | 90 |
| 36 | 501N | 8/29/2020 | Overcast | 11-15 | SW | 0.5-1.25 | 13:49 | N 41° 00.928 | W 70° 33.223 | 24 | 14:09 | N 41° 00.285 | W 70° 34.302 | 25 | 14.8 | 100 |
| 37 | 501N | 8/29/2020 | Rain | 11-15 | SW | 0.5-1.25 | 15:01 | N 40° 59.765 | W 70° 35.074 | 26 | 15:21 | N 41° 00.707 | W 70° 35.340 | 25 | 14.2 | 100 |
| 38 | 501N | 8/29/2020 | Rain | 11-15 | SW | 0.5-1.25 | 16:46 | N 41° 01.906 | W 70° 35.068 | 24 | 17:06 | N 41° 02.570 | W 70° 34.122 | 23 | 14.5 | 90 |
| 39 | 501N | 9/2/2020 | Overcast | 11-15 | ESE | 0.5-1.25 | 7:12 | N 41° 02.887 | W 70° 32.135 | 23 | 7:32 | N 41° 03.307 | W 70° 33.331 | 24 | 17.5 | 90 |
| 40 | 501N | 9/2/2020 | Overcast | 11-15 | ESE | 0.5-1.25 | 8:22 | N 41° 03.528 | W 70° 33.838 | 23 | 8:42 | N 41° 02.897 | W 70° 34.926 | 23 | 17.6 | 90 |

**Table 2: Tow parameters for each survey tow.**

| Tow # | Tow Area | Tow Duration (min.) | Tow Distance (nm.) | Tow Speed (knots) | Start Depth (fm) | Trawl Warp (fm) | Bottom Temp. ($^oC$) | Headline Height (m.) | Wing Spread (m.) | Spread Door (m.) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 501N | 19.6 | 1.0 | 2.9 | 23 | 100 | 16.0 | 4.1 | 13.2 | |
| 2 | 501N | 18.6 | 1.0 | 3.1 | 21 | 100 | 16.1 | 4.1 | 13.9 | |
| 3 | 501N | 21.1 | 1.1 | 3.0 | 21 | 90 | 16.3 | 4.3 | 13.4 | 38.3 |
| 4 | 501N | 20.0 | 1.0 | 3.0 | 21 | 90 | 16.6 | 4.5 | 13.3 | 36.9 |
| 5 | 501N | 20.6 | 1.0 | 3.0 | 22 | 90 | 15.9 | 4.5 | 13.6 | |
| 6 | 501N | 20.8 | 1.1 | 3.1 | 21 | 90 | 16.1 | 4.5 | 13.2 | |
| 7 | 501N | 20.4 | 1.1 | 3.1 | 20 | 90 | 16.9 | 4.2 | 13.9 | |
| 8 | 501N | 19.9 | 1.0 | 3.0 | 20 | 80 | 16.4 | 4.4 | 13.3 | |
| 9 | Control | 20.2 | 1.0 | 2.9 | 20 | 90 | 16.3 | 4.7 | 12.5 | 29.4 |
| 10 | Control | 20.9 | 1.0 | 3.0 | 20 | 90 | 17.1 | 4.3 | 14.2 | 34.1 |
| 11 | Control | 20.0 | 1.0 | 3.0 | 18 | 80 | 17.1 | 4.6 | 12.8 | 32.6 |
| 12 | Control | 19.8 | 0.9 | 2.8 | 17 | 80 | 17.2 | 4.5 | 12.6 | 31.7 |
| 13 | Control | 21.3 | 1.1 | 3.0 | 19 | 80 | 17.8 | 4.5 | 13.1 | 33.0 |
| 14 | Control | 21.1 | 1.0 | 2.9 | 22 | 90 | 17.4 | 5.5 | 13.3 | 32.8 |
| 15 | Control | 20.2 | 1.1 | 3.1 | 22 | 100 | 17.2 | 4.8 | 12.5 | 30.4 |
| 16 | Control | 20.1 | 1.1 | 3.2 | 23 | 100 | 17.1 | 4.7 | 13.3 | 32.5 |
| 17 | Control | 20.5 | 1.0 | 2.8 | 21 | 90 | 17.5 | 4.9 | 12.9 | 30.0 |
| 18 | Control | 20.0 | 1.0 | 3.0 | 22 | 90 | 16.6 | 4.9 | 12.9 | 32.1 |
| 19 | Control | 20.4 | 1.0 | 2.9 | 22 | 90 | 16.0 | 4.5 | 13.4 | 33.1 |
| 20 | Control | 20.2 | 1.0 | 3.0 | 24 | 100 | 15.7 | 4.2 | 13.3 | 32.9 |
| 21 | Control | 19.3 | 0.9 | 2.8 | 24 | 90 | 15.4 | 4.5 | 13.3 | 32.3 |
| 22 | Control | 19.5 | 0.9 | 2.9 | 26 | 100 | 14.7 | 4.7 | 13.9 | 33.2 |
| 23 | Control | 20.1 | 1.0 | 2.9 | 25 | 100 | 13.8 | 4.5 | 13.8 | 34.0 |
| 24 | Control | 20.2 | 0.9 | 2.8 | 26 | 100 | 13.9 | 4.7 | 13.3 | 33.8 |
| 25 | 501N | 20.3 | 1.0 | 2.9 | 26 | 100 | 13.6 | 4.5 | 13.8 | 34.0 |
| 26 | 501N | 20.1 | 1.0 | 3.0 | 24 | 90 | 14.2 | 4.9 | 13.1 | 31.6 |
| 27 | 501N | 20.2 | 1.0 | 2.9 | 24 | 90 | 15.9 | 4.6 | 13.3 | 32.5 |
| 28 | Control | 20.3 | 1.0 | 2.9 | 23 | 90 | 17.3 | 4.6 | 13.1 | 31.7 |
| 29 | Control | 19.6 | 1.0 | 2.9 | 21 | 80 | 17.3 | 4.9 | 12.6 | 30.4 |
| 30 | 501N | 19.8 | 0.9 | 2.7 | 21 | 80 | 16.4 | 5.6 | 12.9 | 31.8 |
| 31 | Control | 20.4 | 1.0 | 2.8 | 21 | 90 | 17.7 | 4.6 | 13.2 | 32.1 |
| 32 | Control | 20.0 | 1.0 | 2.9 | 22 | 90 | 17.3 | 4.8 | 13.0 | 31.2 |
| 33 | 501N | 20.1 | 1.0 | 3.0 | 22 | 85 | 17.0 | 4.7 | 13.1 | 32.2 |
| 34 | 501N | 20.1 | 1.0 | 3.1 | 23 | 90 | 15.8 | 4.6 | 13.5 | 33.2 |
| 35 | 501N | 20.6 | 1.0 | 2.8 | 24 | 90 | 15.8 | 4.5 | 13.3 | 33.2 |
| 36 | 501N | 20.2 | 1.0 | 2.9 | 24 | 100 | 14.8 | 4.6 | 13.4 | 32.8 |
| 37 | 501N | 20.0 | 1.0 | 2.9 | 26 | 100 | 14.2 | 4.6 | 13.1 | 31.5 |
| 38 | 501N | 20.2 | 1.0 | 3.0 | 24 | 90 | 14.5 | 4.7 | 13.3 | 32.4 |
| 39 | 501N | 20.2 | 1.0 | 3.0 | 23 | 90 | 17.5 | 4.5 | 13.6 | 33.8 |
| 40 | 501N | 20.0 | 1.0 | 2.9 | 23 | 90 | 17.6 | 4.5 | 13.4 | 33.0 |
| Summary Statistics | | | | | | | | | | |
| Control | Minimum | 19.3 | 0.9 | 2.8 | 17.0 | 80 | 13.8 | 4.2 | 12.5 | 29.4 |
| | Maximum | 21.3 | 1.1 | 3.2 | 26.0 | 100 | 17.8 | 5.5 | 14.2 | 34.1 |
| | Average | 20.2 | 1.0 | 2.9 | 21.9 | 91 | 16.5 | 4.7 | 13.1 | 32.2 |
| | St. Dev | 0.5 | 0.05 | 0.1 | 2.4 | 7 | 1.2 | 0.3 | 0.4 | 1.3 |
| 501N | Minimum | 18.6 | 0.9 | 2.7 | 20.0 | 80 | 13.6 | 4.1 | 12.9 | 31.5 |
| | Maximum | 21.1 | 1.1 | 3.1 | 26.0 | 100 | 17.6 | 5.6 | 13.9 | 38.3 |
| | Average | 20.1 | 1.0 | 3.0 | 22.7 | 91 | 15.9 | 4.5 | 13.4 | 33.4 |
| | St. Dev. | 0.5 | 0.05 | 0.1 | 1.8 | 6 | 1.1 | 0.3 | 0.3 | 2.0 |

**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* | | |
| **Skate, Little** | *Leucoraja erinacea* | 2258.8 | 112.1 | 22.1 | 36.7 | 20 |
| **Scup** | *Stenotomus chrysops* | 1938.8 | 96.5 | 35.2 | 31.5 | 18 |
| **Squid, Atlantic Longfin** | *Dorytheuthis pealei* | 404.8 | 20.1 | 2.2 | 6.6 | 20 |
| **Butterfish** | *Peprilus triacanthus* | 321.6 | 16.1 | 5.0 | 5.2 | 19 |
| **Dogfish, Smooth** | *Mustelus canis* | 272.9 | 13.5 | 3.5 | 4.4 | 19 |
| **Hake, Silver (Whiting)** | *Merluccius bilinearis* | 258.9 | 12.9 | 6.6 | 4.2 | 16 |
| **Flounder, Summer (Fluke)** | *Paralichthys dentatus* | 178.0 | 8.9 | 1.5 | 2.9 | 20 |
| **Flounder, Winter** | *Pleuronectes americanus* | 88.8 | 4.4 | 1.1 | 1.4 | 19 |
| **Hake, Red** | *Urophycis chuss* | 76.2 | 3.8 | 2.5 | 1.2 | 8 |
| **Skate, Winter** | *Leucoraja ocellata* | 61.3 | 3.0 | 1.1 | 1.0 | 9 |
| **Hake, Spotted** | *Urophycis regia* | 48.5 | 2.4 | 0.8 | 0.8 | 11 |
| **Flounder, Fourspot** | *Paralichthys oblongus* | 43.0 | 2.1 | 0.5 | 0.7 | 20 |
| **Sculpin, Longhorn** | *Myoxocephalus octodecimspinosus* | 32.4 | 1.6 | 1.6 | 0.5 | 3 |
| **Monkfish** | *Lophius americanus* | 30.1 | 1.5 | 0.6 | 0.5 | 8 |
| **Skate, Barndoor** | *Dipturus laevis* | 29.2 | 1.4 | 0.4 | 0.5 | 15 |
| **Crab, Rock** | *Cancer irroratus* | 22.3 | 1.1 | 0.5 | 0.4 | 6 |
| **Northern Sea Robin** | *Prionotus carolinus* | 20.5 | 1.0 | 0.3 | 0.3 | 13 |
| **Flounder, Windowpane** | *Scophtalmus aquosus* | 15.9 | 0.8 | 0.3 | 0.3 | 15 |
| **Black Sea bass** | *Centropristis striata* | 13.6 | 0.7 | 0.3 | 0.2 | 6 |
| **Dogfish, Spiny** | *Squalus acanthias* | 8.2 | 0.4 | 0.2 | 0.1 | 4 |
| **Bluefish** | *Pomatomus saltatrix* | 7.5 | 0.4 | 0.2 | 0.1 | 4 |
| **Lobster, American** | *Homarus americanus* | 7.4 | 0.4 | 0.1 | 0.1 | 10 |
| **Sea Scallop** | *Placopecten magellanicus* | 4.6 | 0.2 | 0.1 | 0.1 | 7 |
| **Atlantic Cod** | *Gadus morhua* | 1.7 | 0.1 | 0.1 | 0.0 | 1 |
| **Flounder, Yellowtail** | *Pleuronectes ferrugineus* | 1.1 | 0.1 | 0.0 | 0.0 | 6 |
| **Flounder, Gulfstream** | *Citharichthys arctifrons* | 0.9 | 0.0 | 0.0 | 0.0 | 4 |
| **Herring, Atlantic** | *Clupea harengus* | 0.7 | 0.0 | 0.0 | 0.0 | 3 |
| **Alewife** | *Alosa pseudoharengus* | 0.4 | 0.0 | 0.0 | 0.0 | 3 |
| **Haddock** | *Melanogrammus aeglefinus* | 0.2 | 0.0 | 0.0 | 0.0 | 2 |
| **Shark, Thresher** | *Alopias vulpinus* | 0 | 0 | 0 | 0 | 1 |
| **Total** | | 6148.2 | | | | |

*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) Mean | Catch/Tow (Kg) SEM* | % of Total Catch | Tows with Species Present |
|---|---|---|---|---|---|---|
| **Scup** | *Stenotomus chrysops* | 2811.5 | 139.4 | 60.0 | 39.5 | 17 |
| **Skate, Little** | *Leucoraja erinacea* | 2335.7 | 116.4 | 21.8 | 32.8 | 20 |
| **Butterfish** | *Peprilus triacanthus* | 538.5 | 26.7 | 7.8 | 7.6 | 20 |
| **Squid, Atlantic Longfin** | *Dorytheuthis pealei* | 394.1 | 19.6 | 2.3 | 5.5 | 20 |
| **Northern Sea Robin** | *Prionotus carolinus* | 248.6 | 12.6 | 7.3 | 3.5 | 10 |
| **Hake, Silver (Whiting)** | *Merluccius bilinearis* | 193.6 | 9.7 | 4.6 | 2.7 | 10 |
| **Dogfish, Smooth** | *Mustelus canis* | 180.6 | 8.9 | 2.3 | 2.5 | 16 |
| **Flounder, Summer (Fluke)** | *Paralichthys dentatus* | 179.7 | 8.9 | 1.6 | 2.5 | 19 |
| **Hake, Spotted** | *Urophycis regia* | 69.2 | 3.5 | 1.8 | 1.0 | 8 |
| **Flounder, Fourspot** | *Paralichthys oblongus* | 38.7 | 1.9 | 0.5 | 0.5 | 16 |
| **Black Sea bass** | *Centropristis striata* | 29.0 | 1.4 | 0.4 | 0.4 | 14 |
| **Flounder, Windowpane** | *Scophtalmus aquosus* | 28.8 | 1.4 | 0.5 | 0.4 | 18 |
| **Skate, Winter** | *Leucoraja ocellata* | 16.1 | 0.8 | 0.3 | 0.2 | 6 |
| **Flounder, Winter** | *Pleuronectes americanus* | 14.9 | 0.7 | 0.1 | 0.2 | 16 |
| **Bluefish** | *Pomatomus saltatrix* | 8.6 | 0.4 | 0.2 | 0.1 | 5 |
| **Hake, Red** | *Urophycis chuss* | 8.5 | 0.4 | 0.4 | 0.1 | 2 |
| **Skate, Barndoor** | *Dipturus laevis* | 7.1 | 0.4 | 0.1 | 0.1 | 9 |
| **Monkfish** | *Lophius americanus* | 4.8 | 0.2 | 0.1 | 0.1 | 3 |
| **Sea Scallop** | *Placopecten magellanicus* | 3.5 | 0.2 | 0.1 | 0.0 | 4 |
| **Lobster, American** | *Homarus americanus* | 3.3 | 0.2 | 0.1 | 0.0 | 3 |
| **Flounder, Gulfstream** | *Citharichthys arctifrons* | 1.5 | 0.1 | 0.0 | 0.0 | 8 |
| **Flounder, Yellowtail** | *Pleuronectes ferrugineus* | 1.1 | 0.1 | 0.0 | 0.0 | 5 |
| **Crab, Rock** | *Cancer irroratus* | 1.1 | 0.1 | 0.0 | 0.0 | 2 |
| **Menhaden, Atlantic** | *Brevoortia tyrannus* | 1.0 | 0.0 | 0.0 | 0.0 | 3 |
| **Sculpin, Longhorn** | *Myoxocephalus octodecimspinosus* | 0.3 | 0.0 | 0.0 | 0.0 | 1 |
| **Mackeral, Atlantic** | *Scomber scombrus* | 0.2 | 0.0 | 0.0 | 0.0 | 1 |
| **Alewife** | *Alosa pseudoharengus* | 0.1 | 0.0 | 0.0 | 0.0 | 1 |
| **Total** | | 7120.3 | | | | |

*SEM is an acronym for Standard Error of the Mean

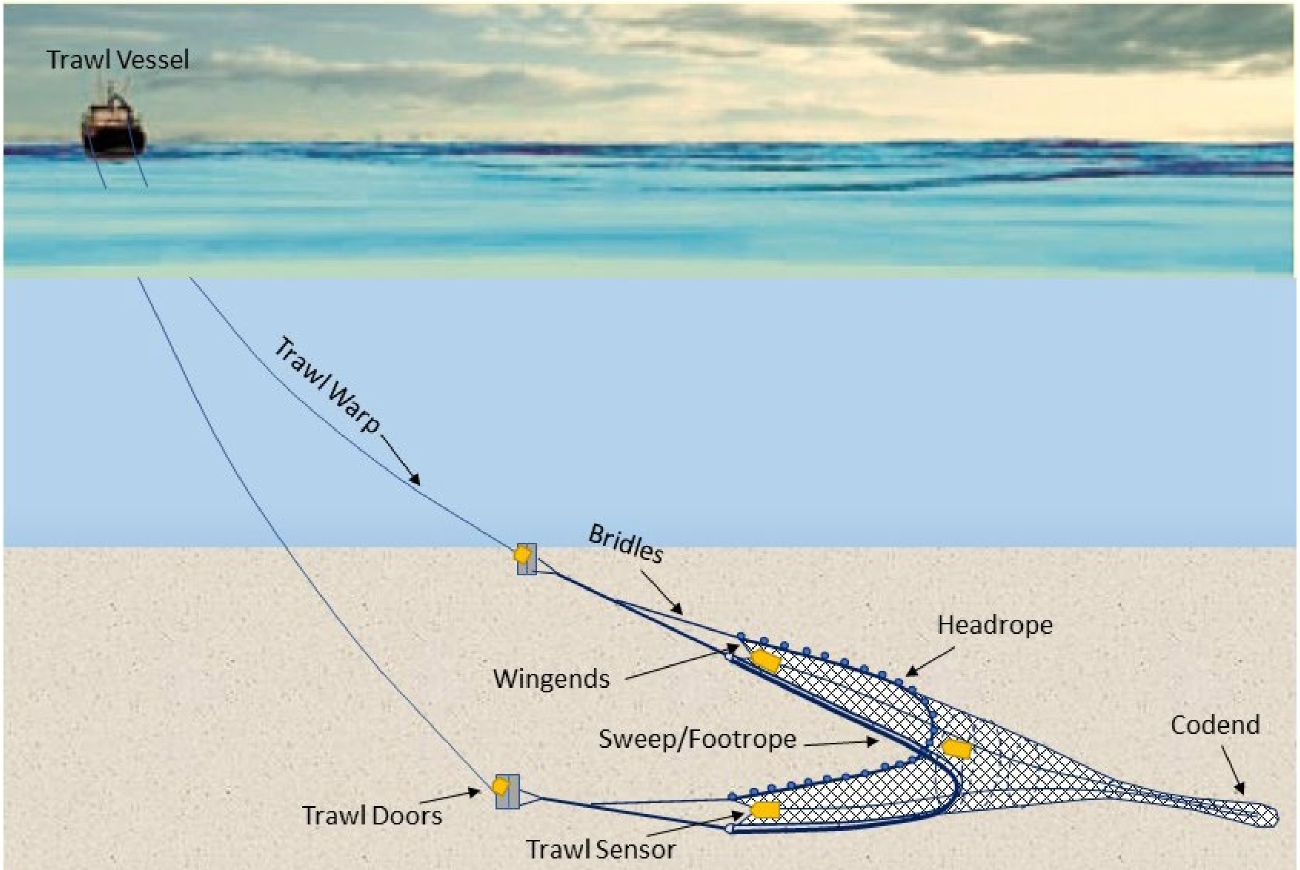



**Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.**

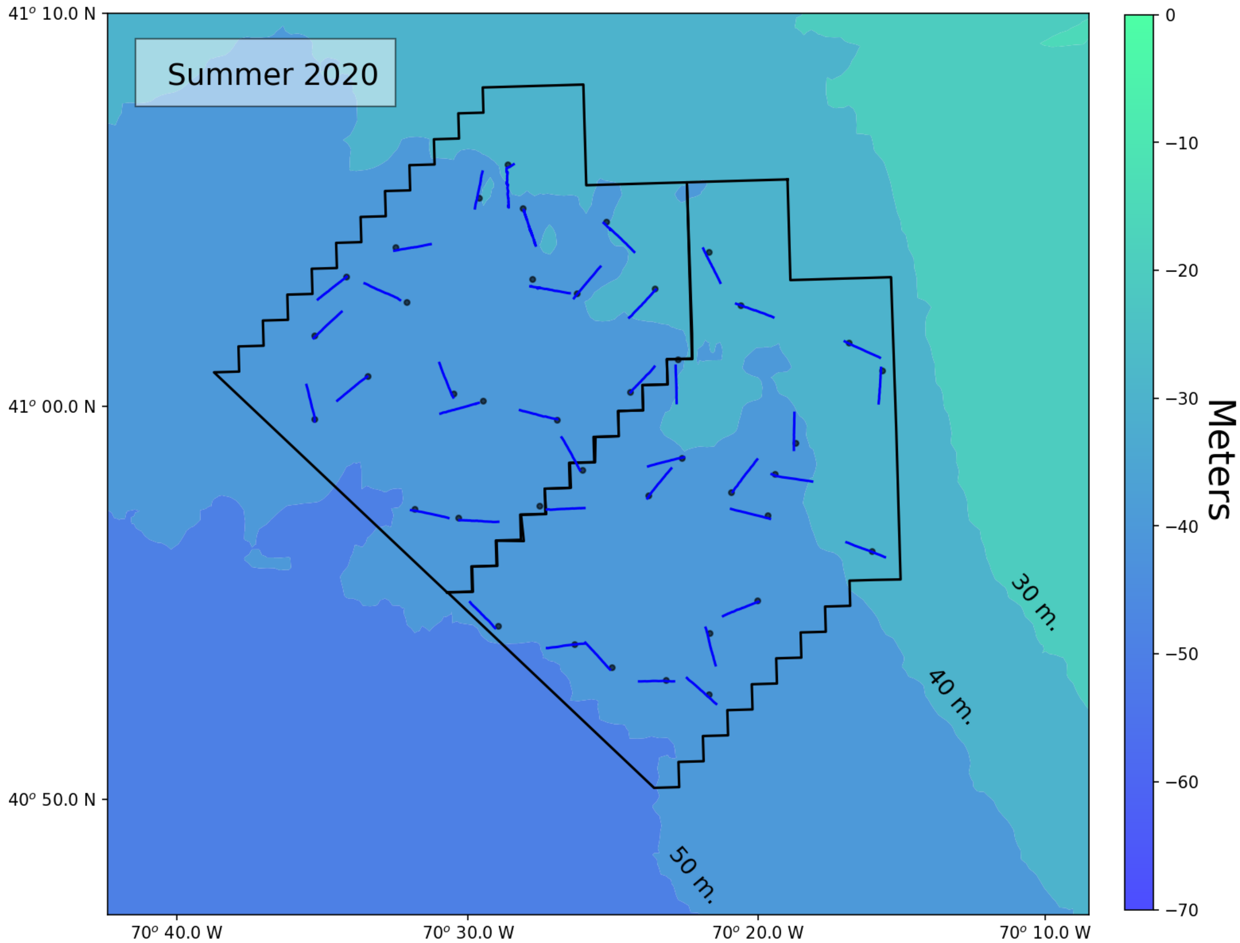



**Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 501N Study Area (left) and the Control Area (right).**

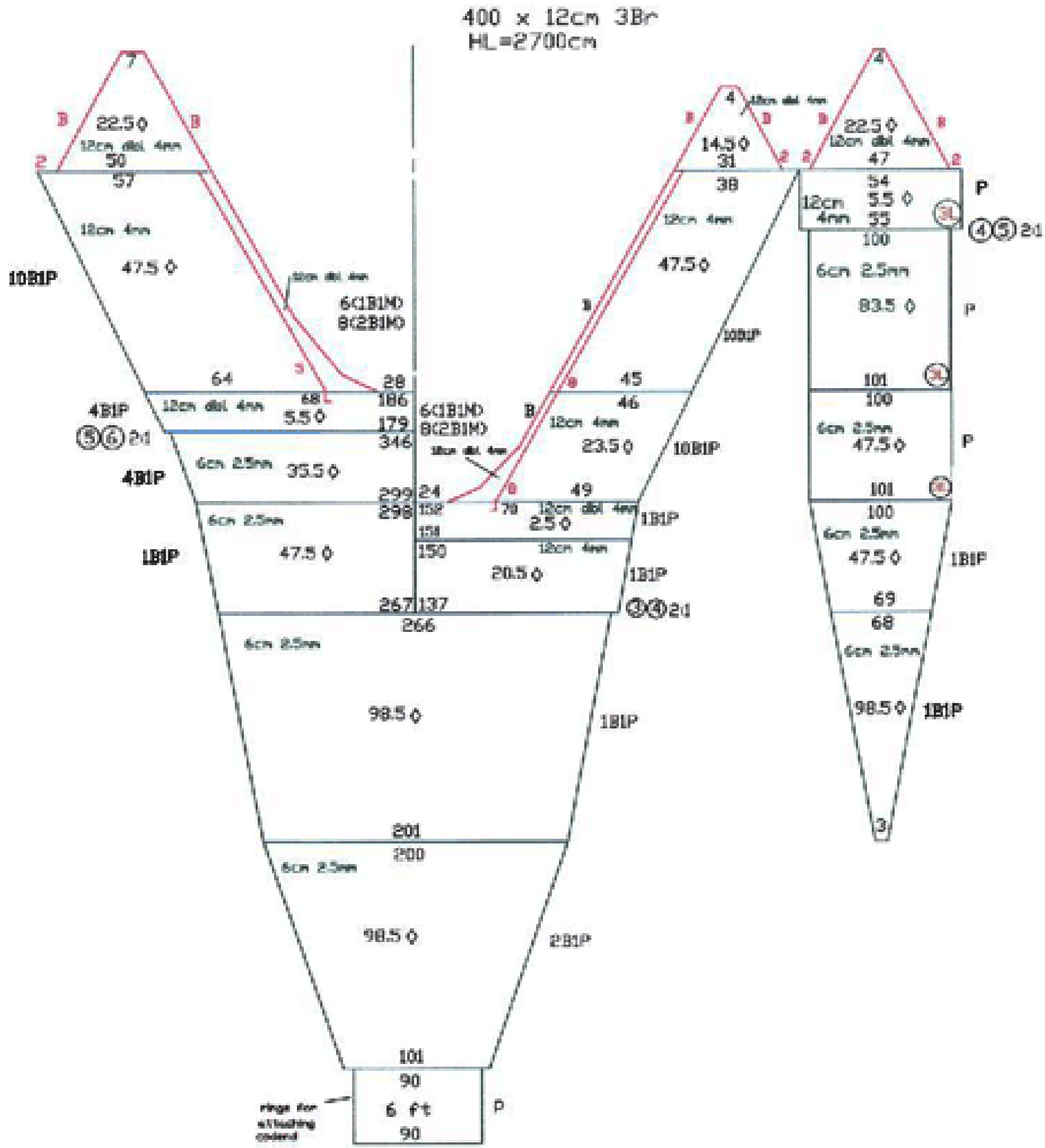



**Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al. 2008).**

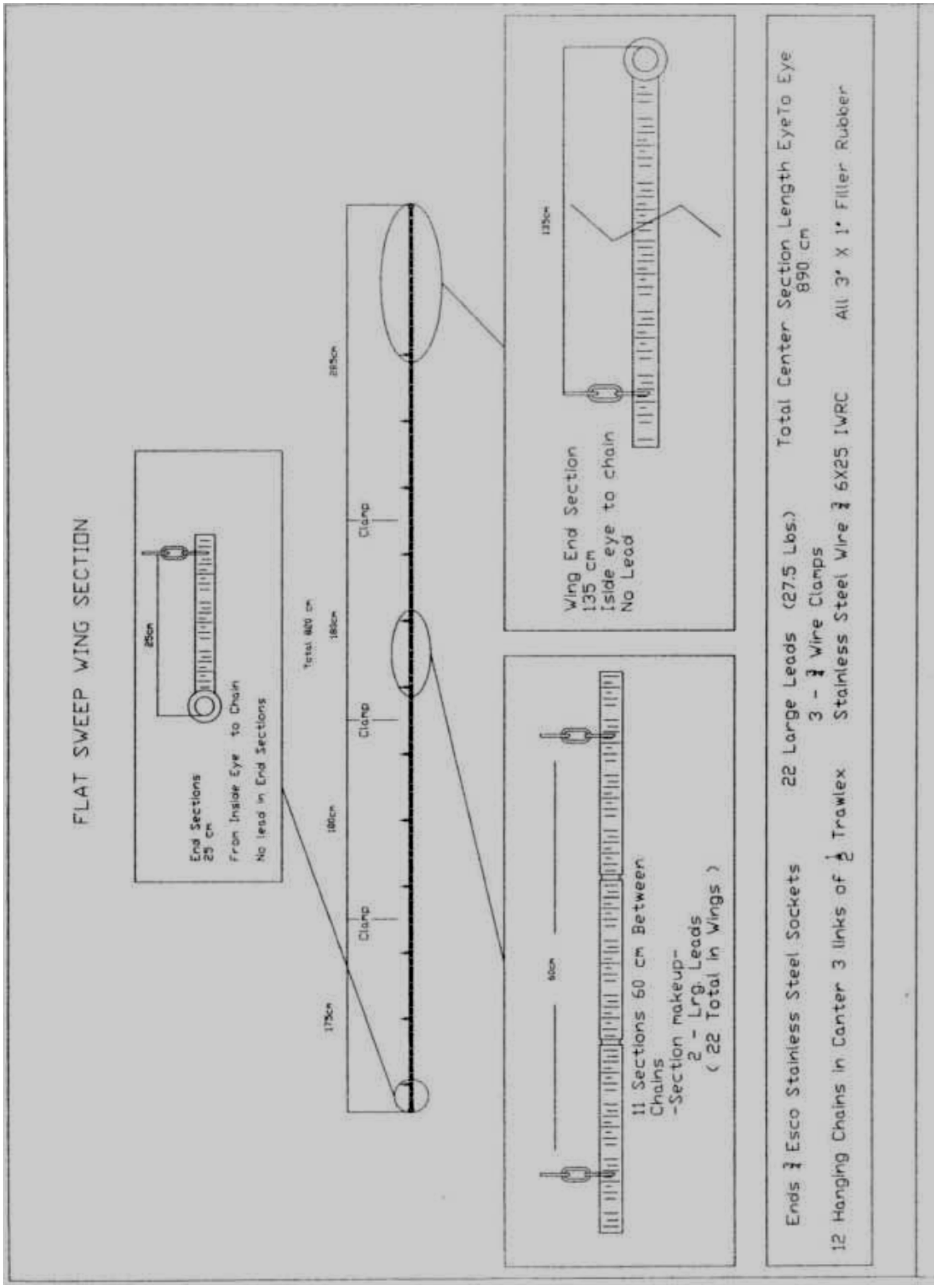



**Figure 4: Sweep diagram for the survey trawl (Bonzek et al. 2008).**

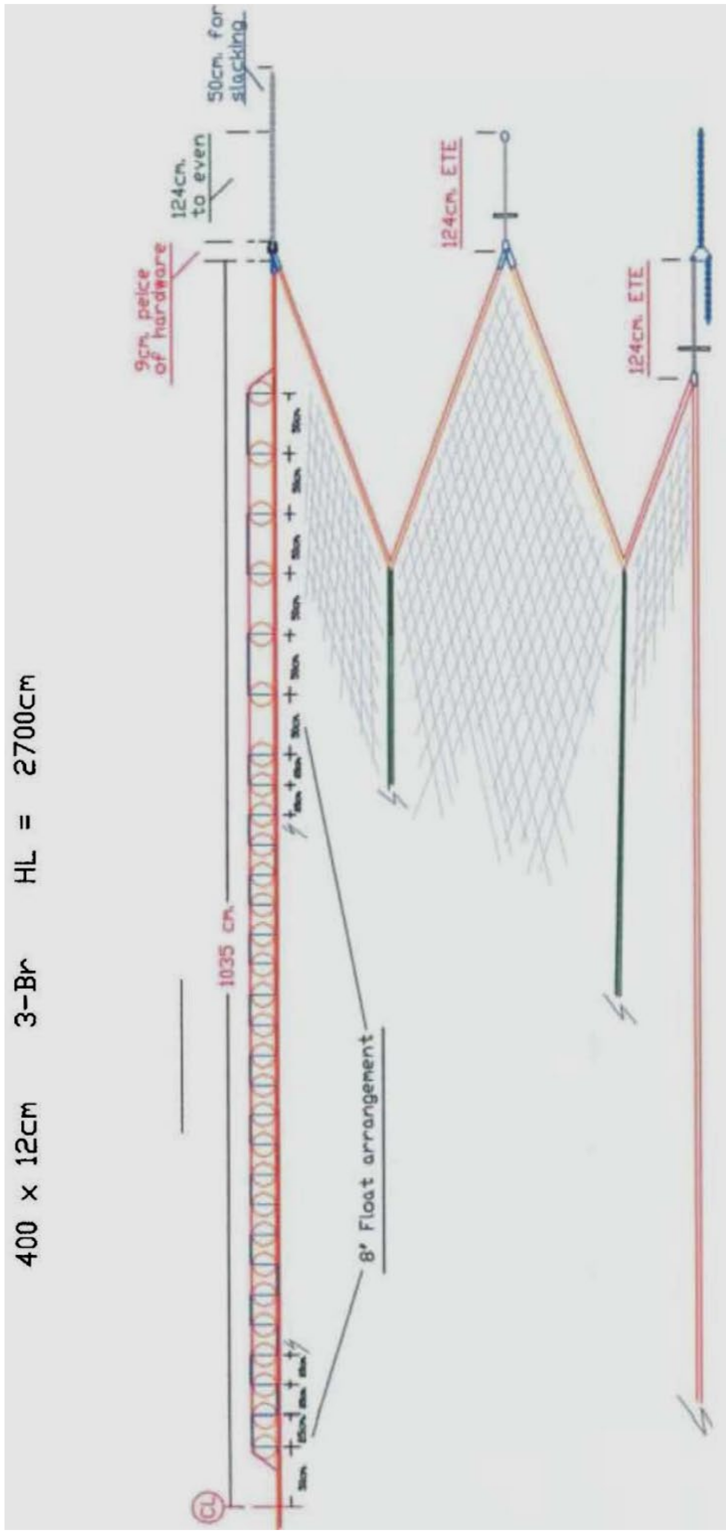



**Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al. 2008).**

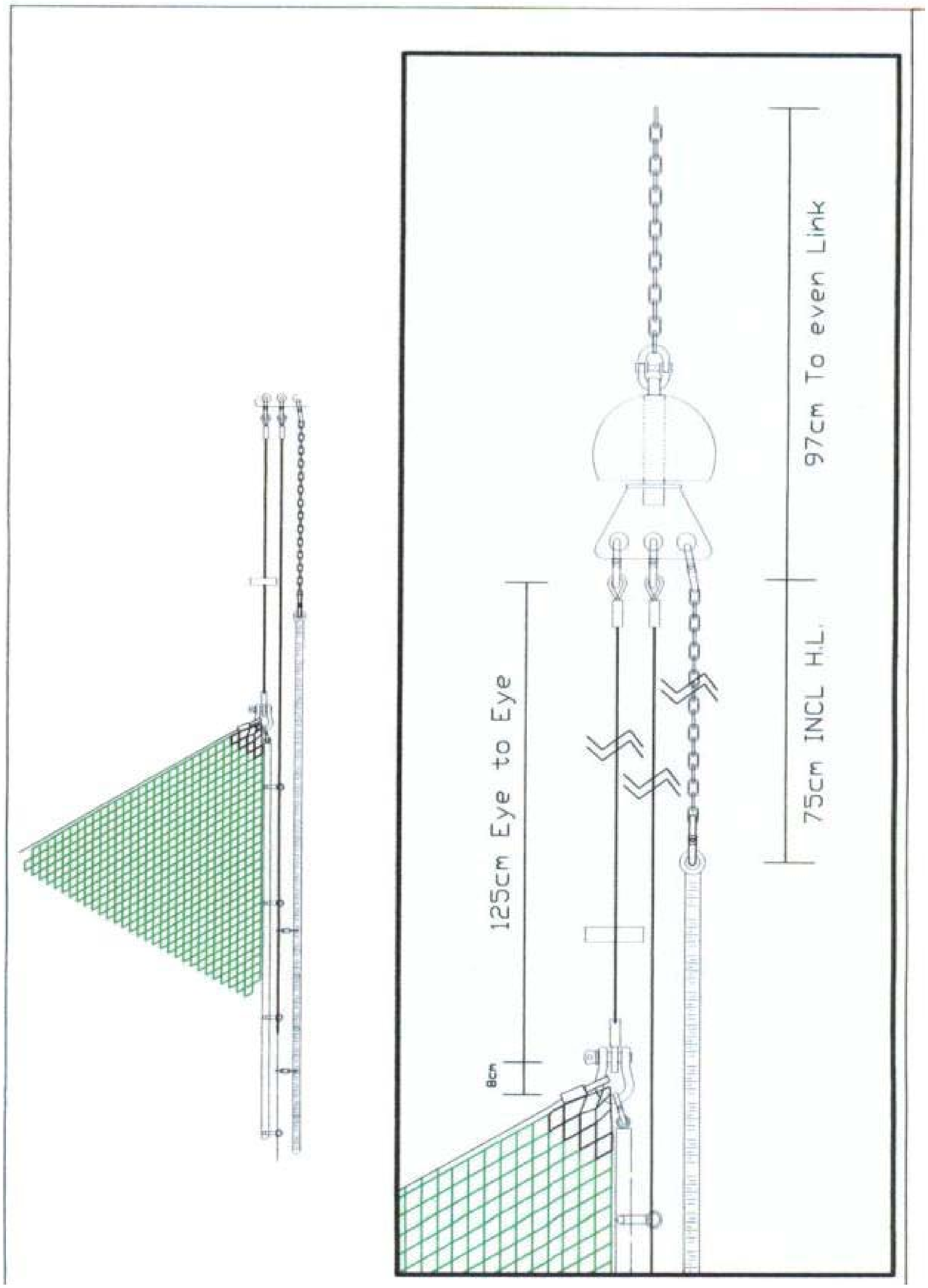



**Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al. 2008).**

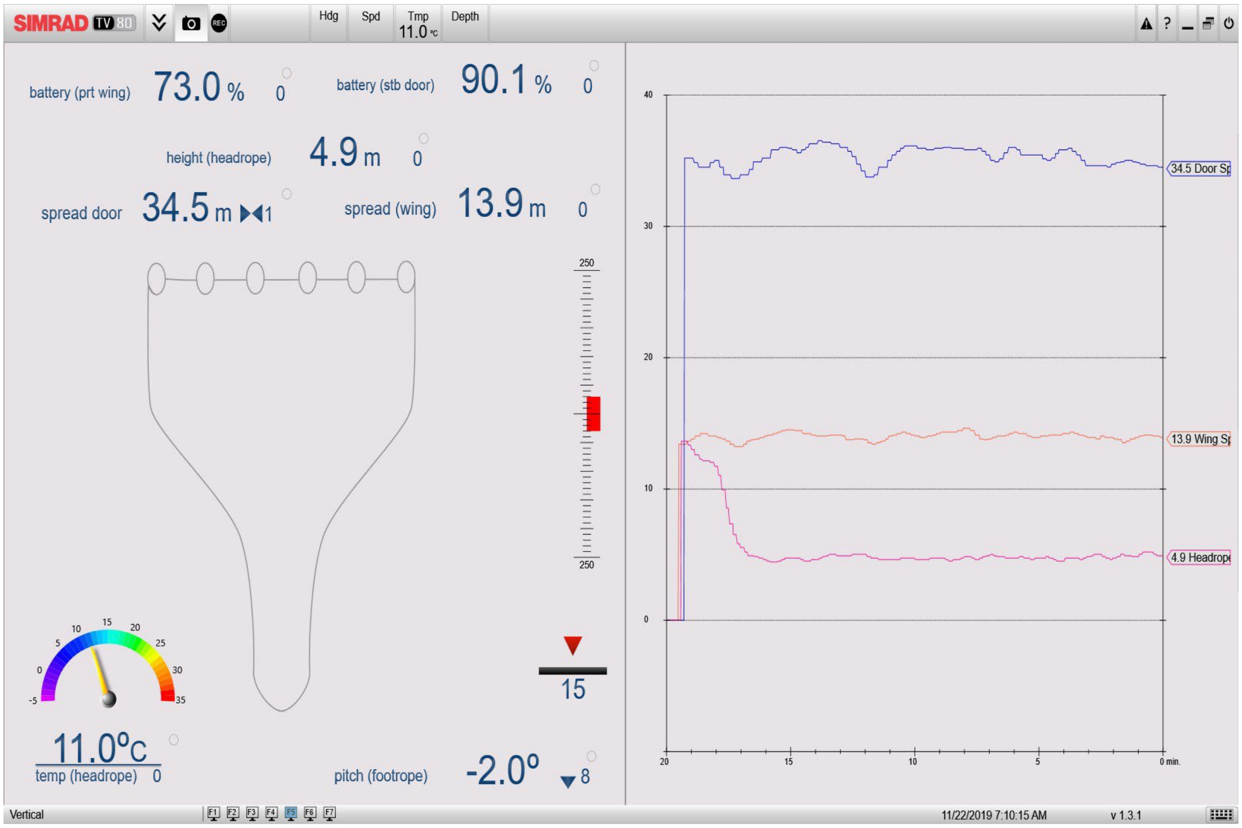
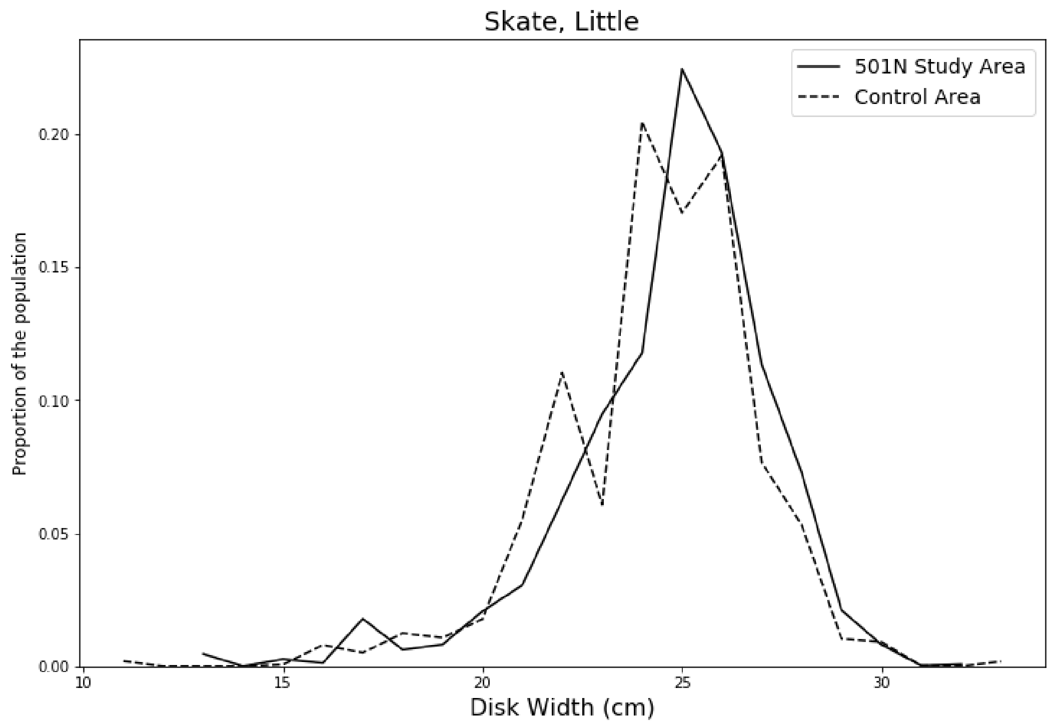



**Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.**



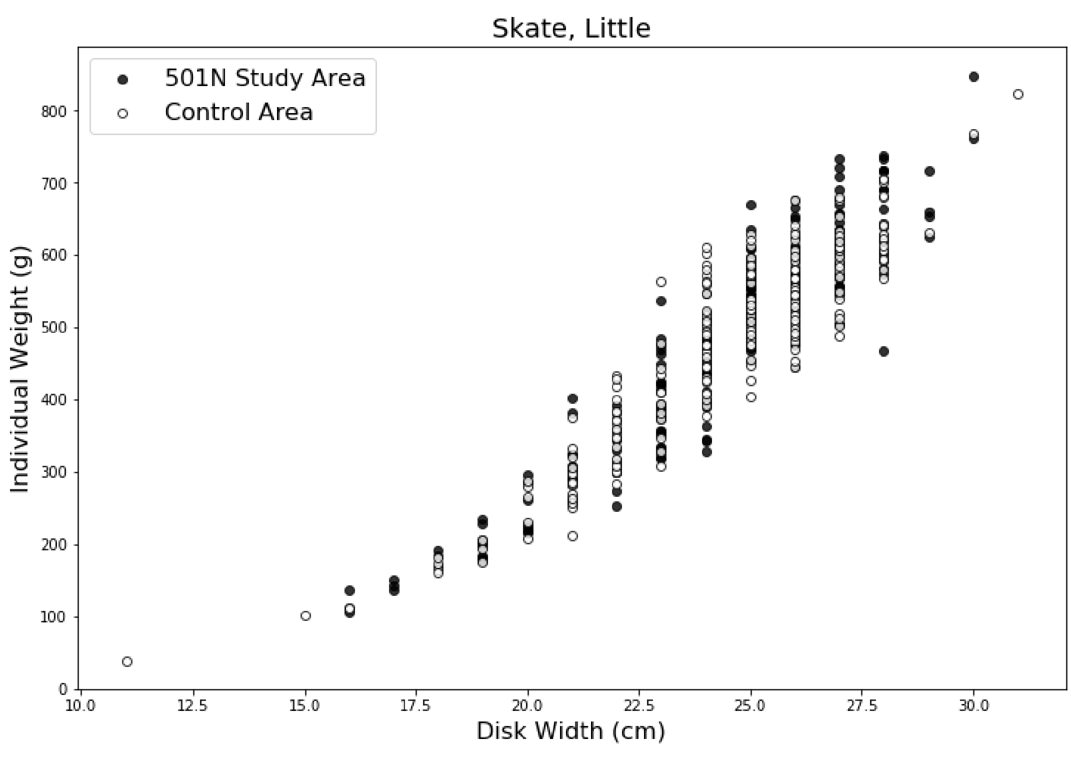




**Figure 8: Population structure of little skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

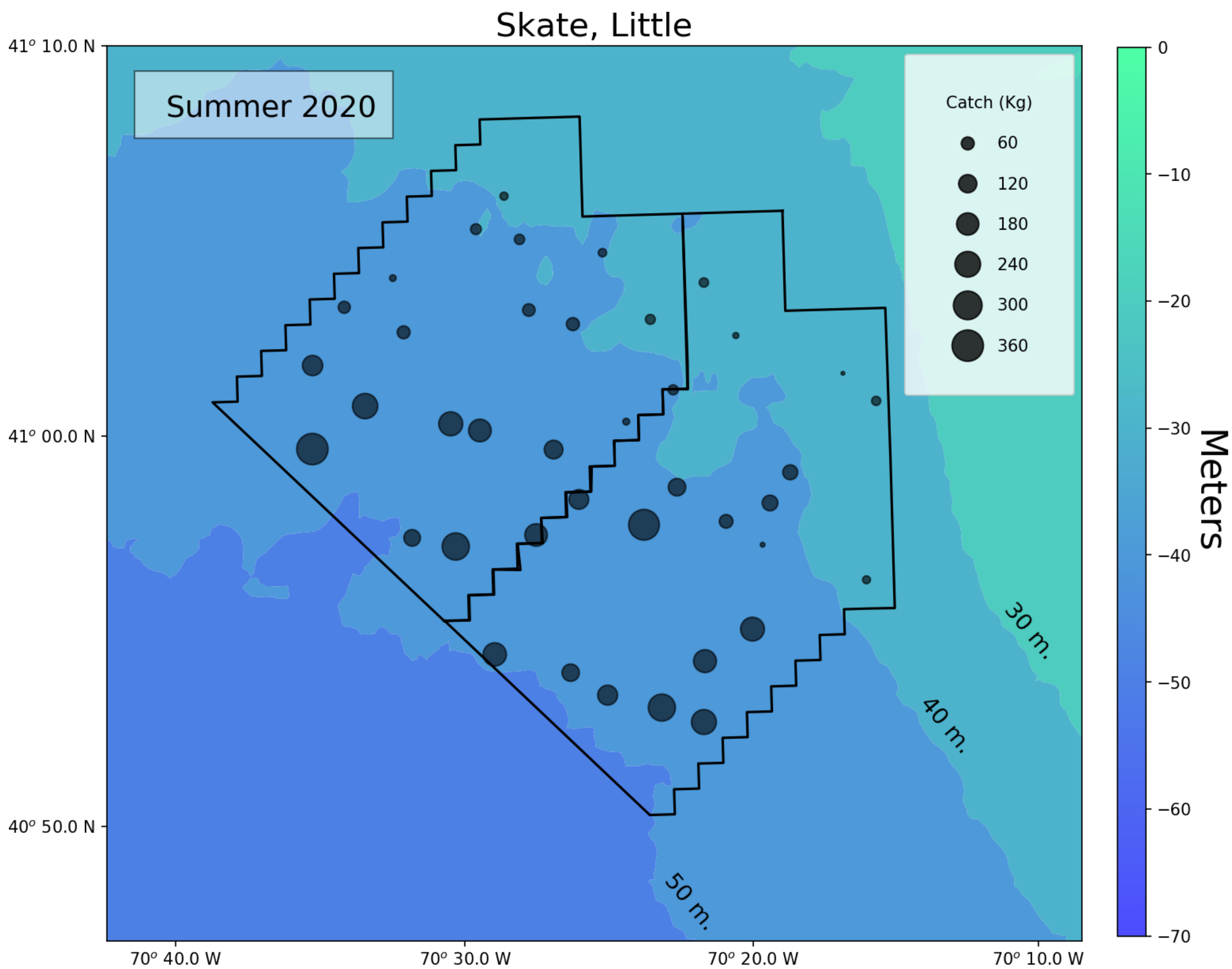
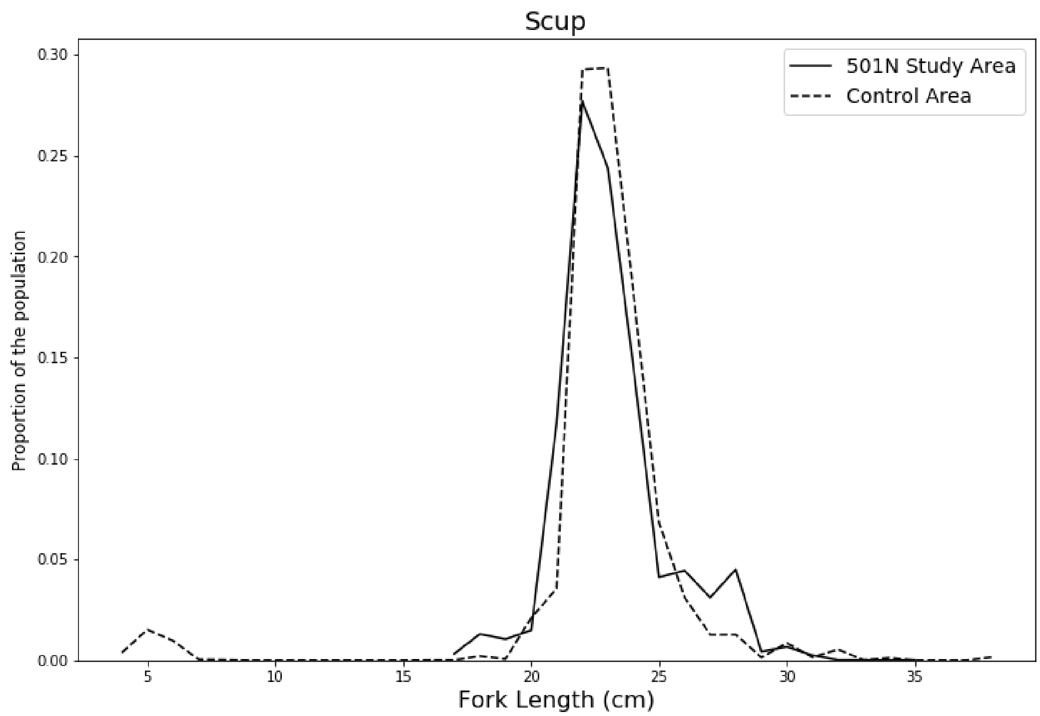



**Figure 9: Distribution of the catch of little skate in the 501N Study Area (left) and Control Area (right).**



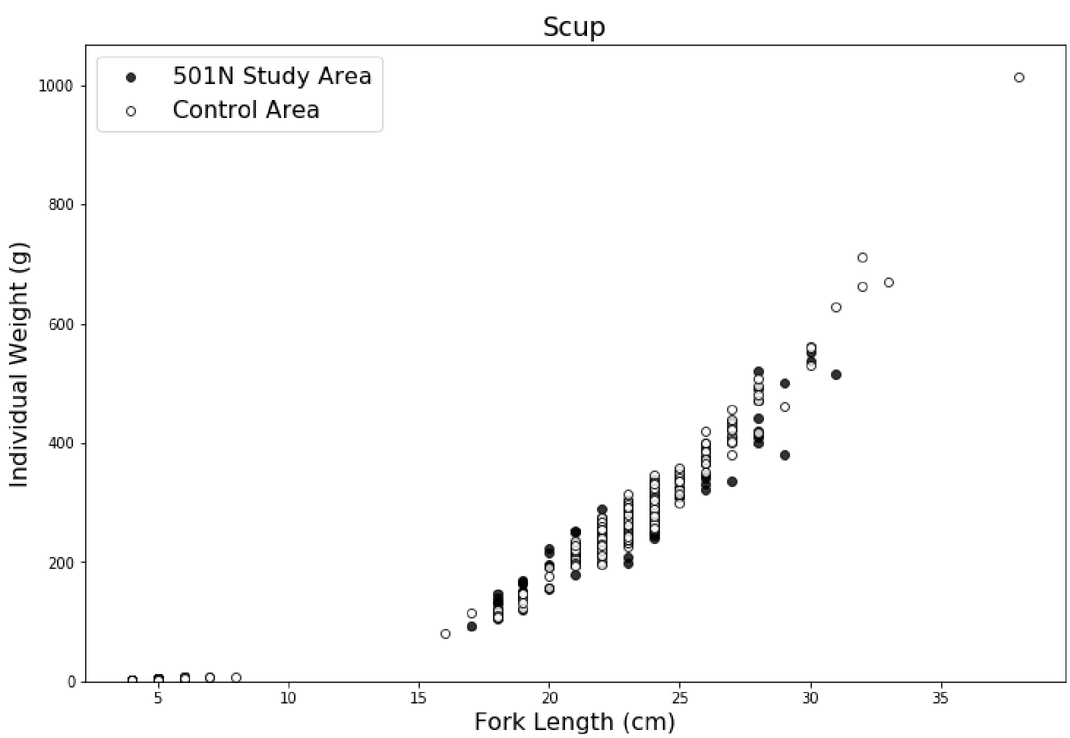




**Figure 10: Population structure of scup in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

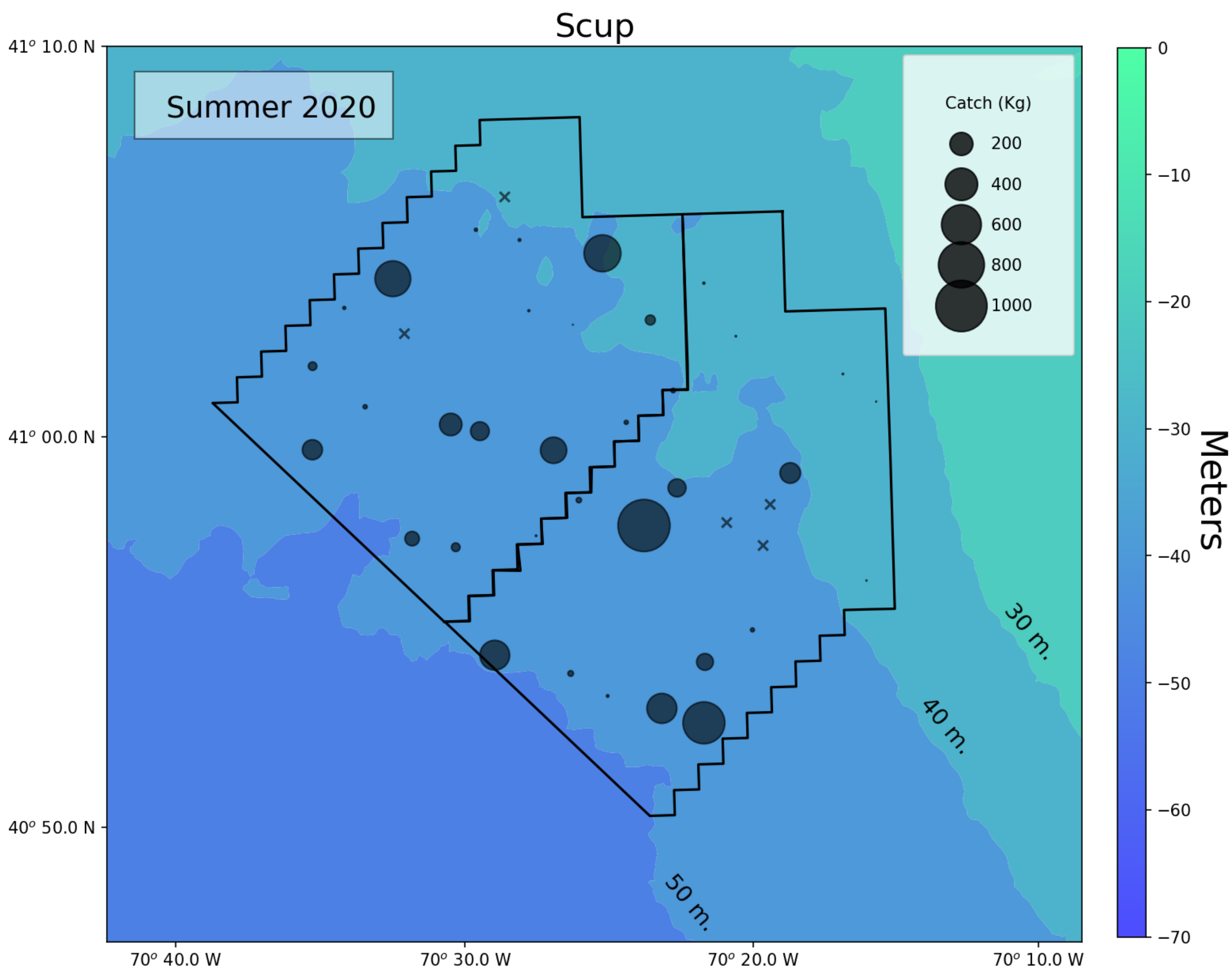
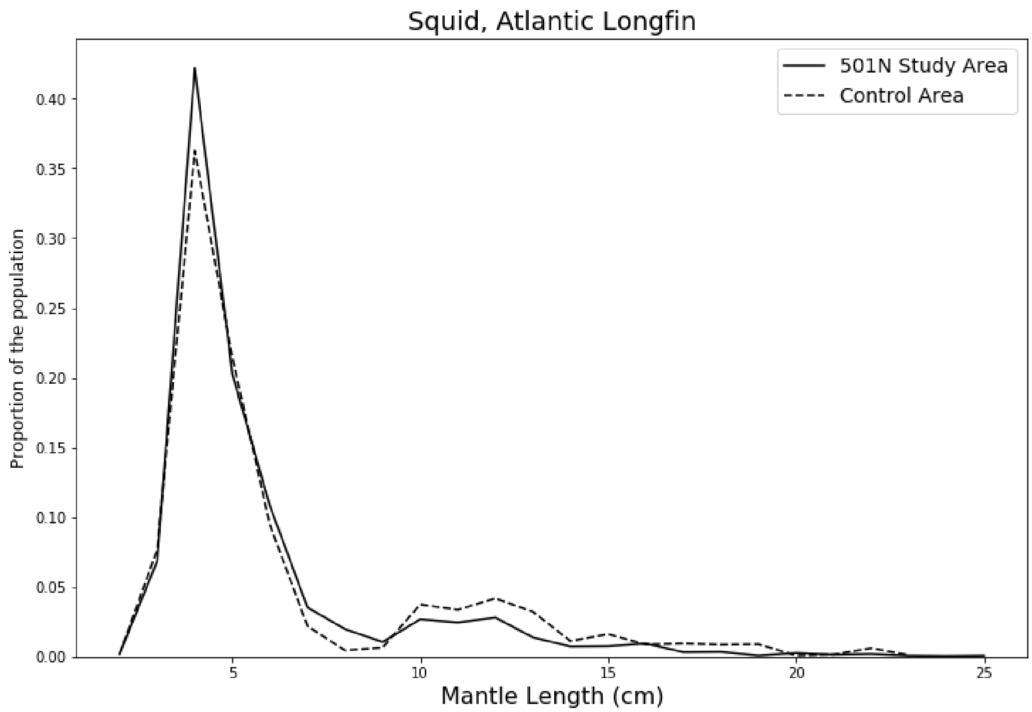



**Figure 11: Distribution of the catch of scup in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



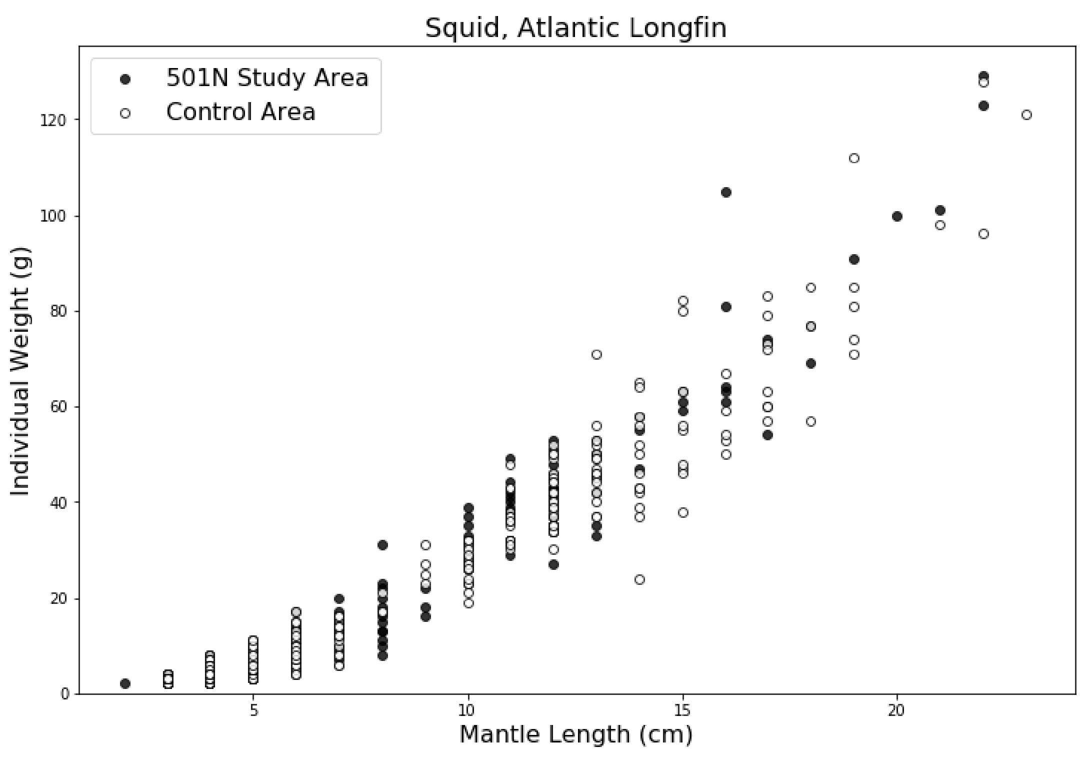




**Figure 12: Population structure of Atlantic longfin squid in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

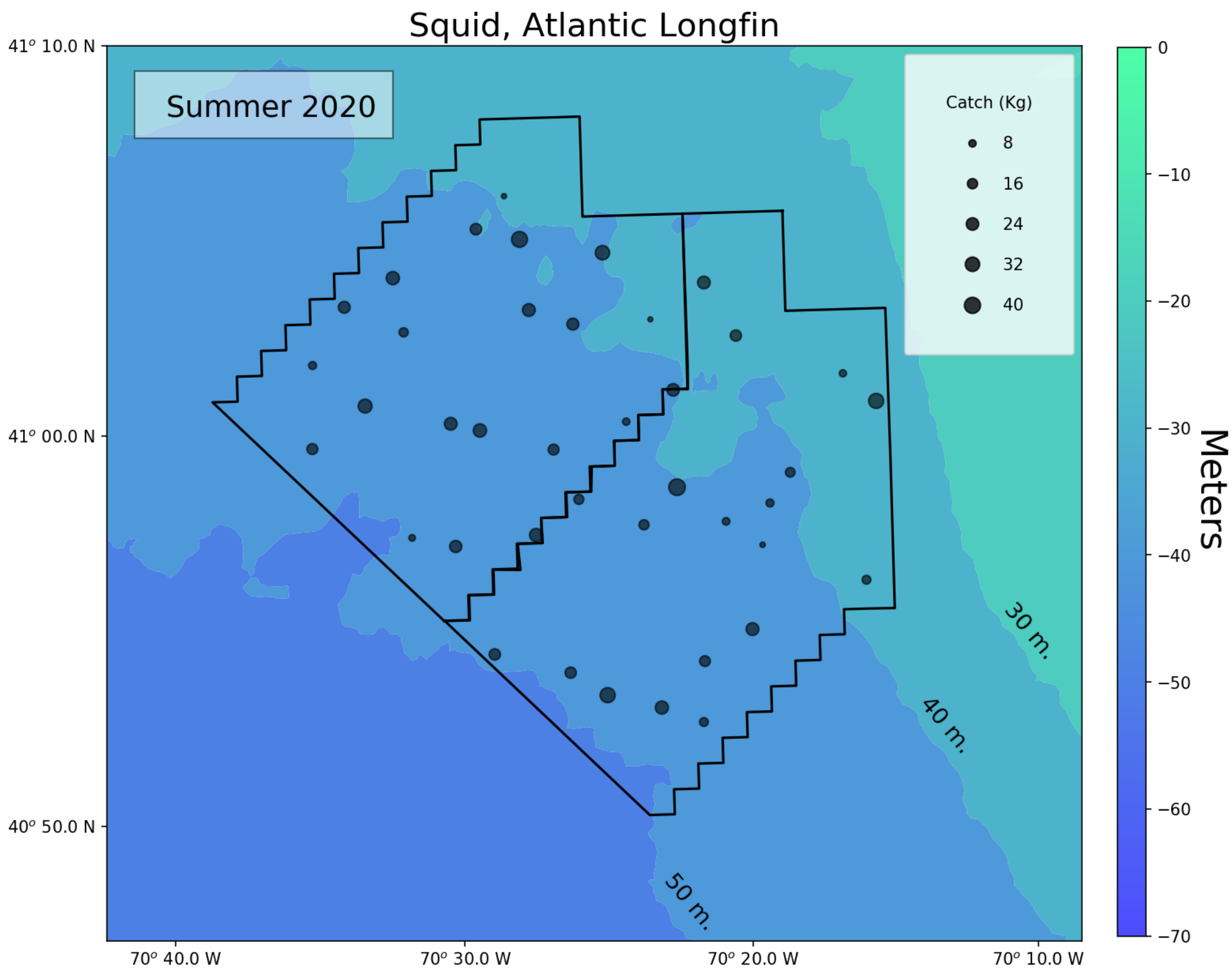
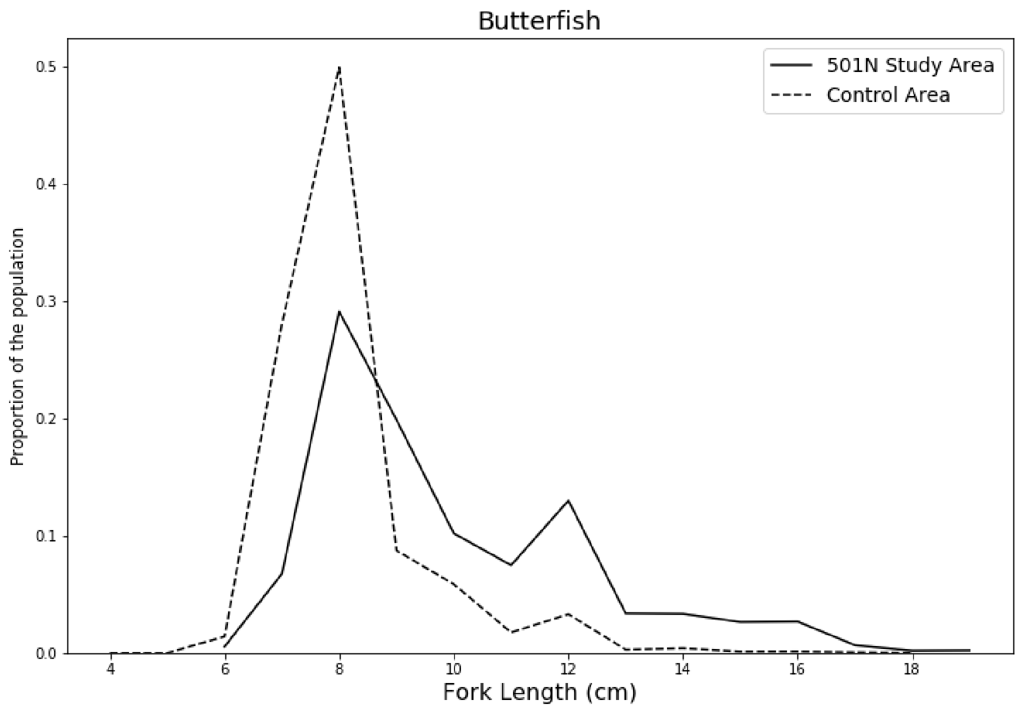



**Figure 13: Distribution of the catch of Atlantic longfin squid in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



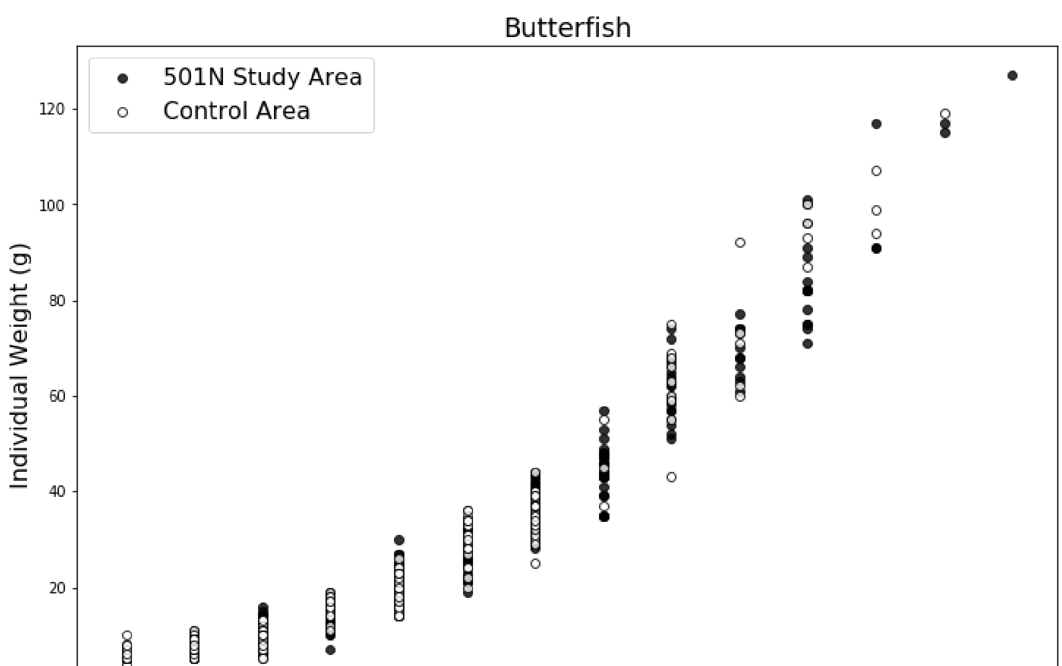




**Figure 14: Population structure of butterfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

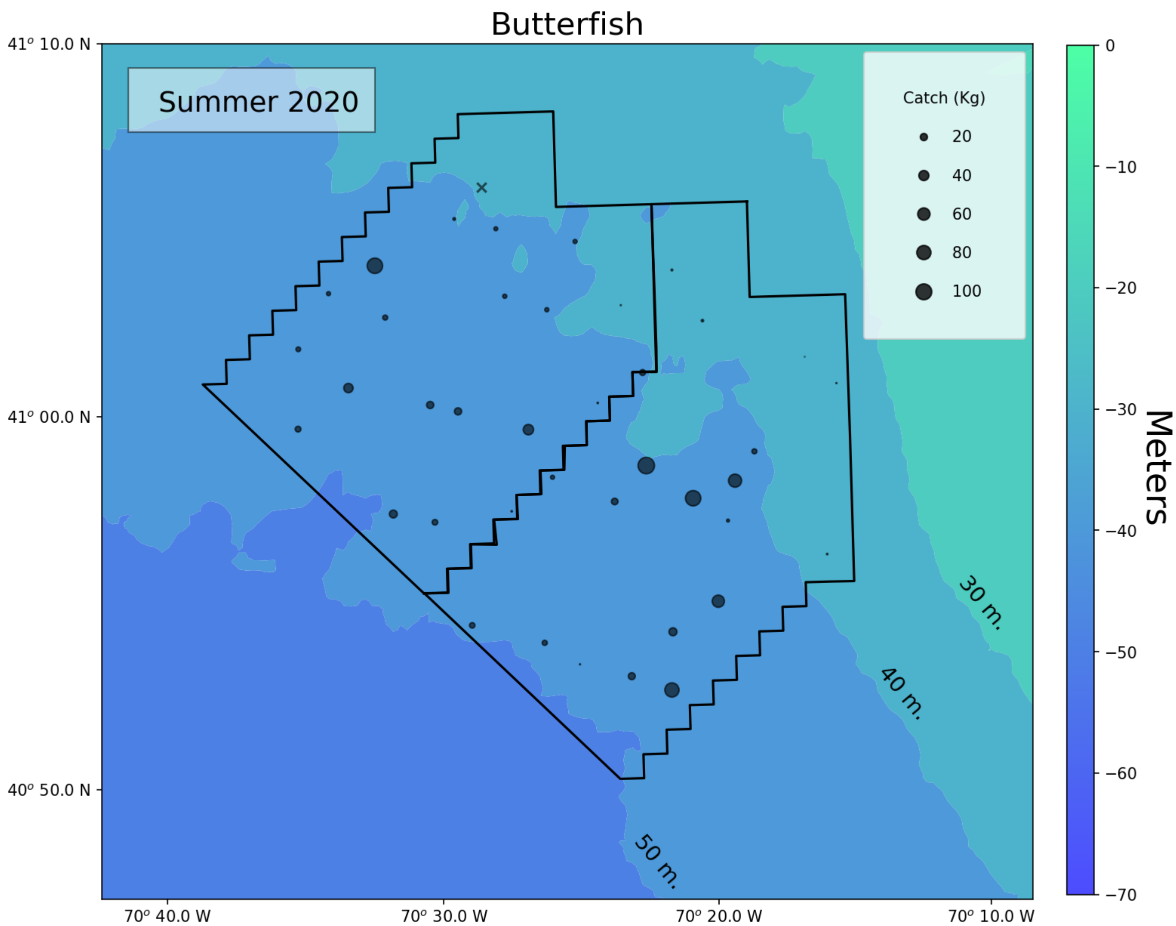
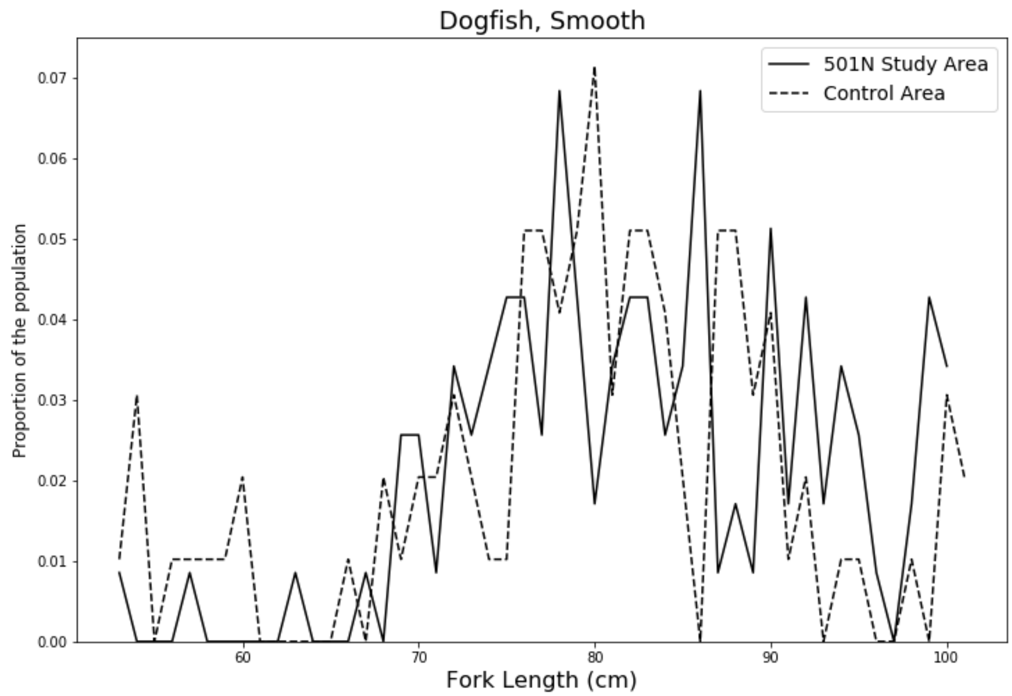



**Figure 15: Distribution of the catch of butterfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



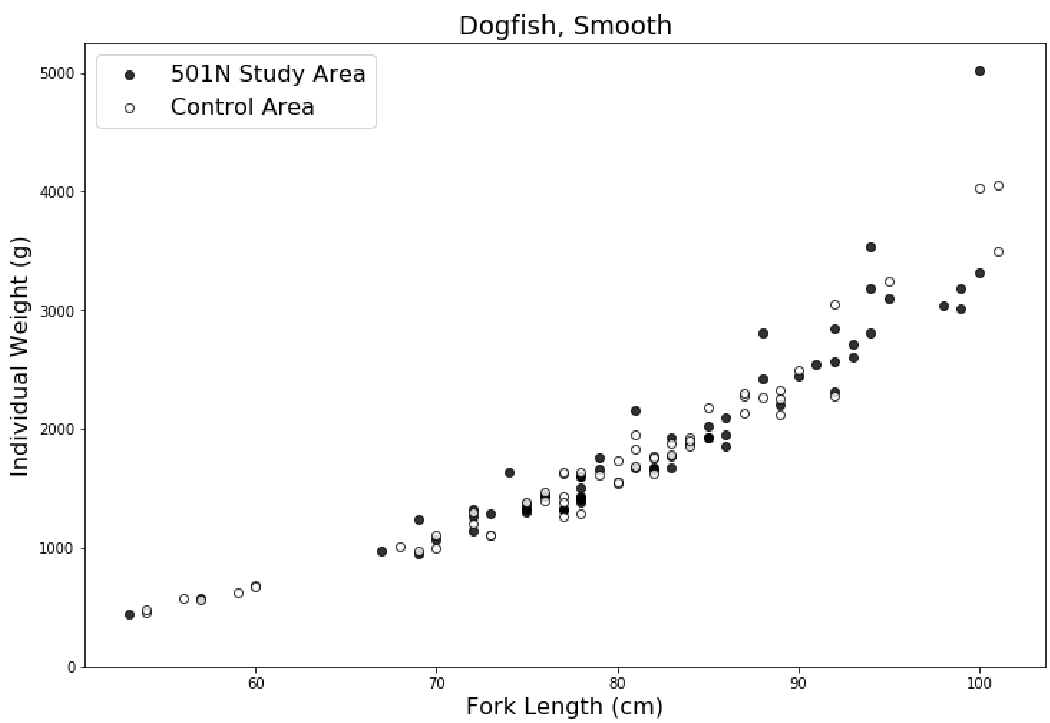




**Figure 16: Population structure of smooth dogfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

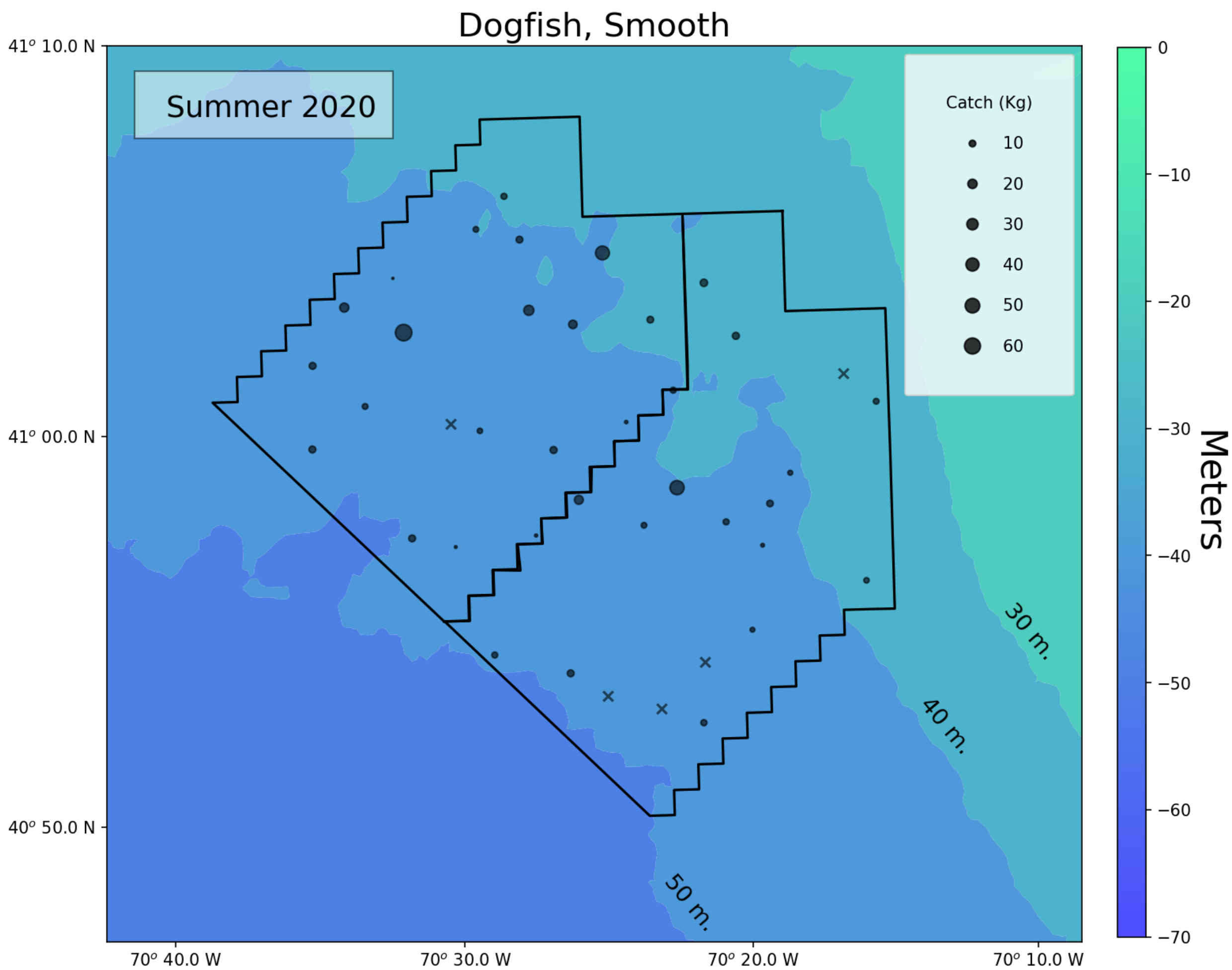
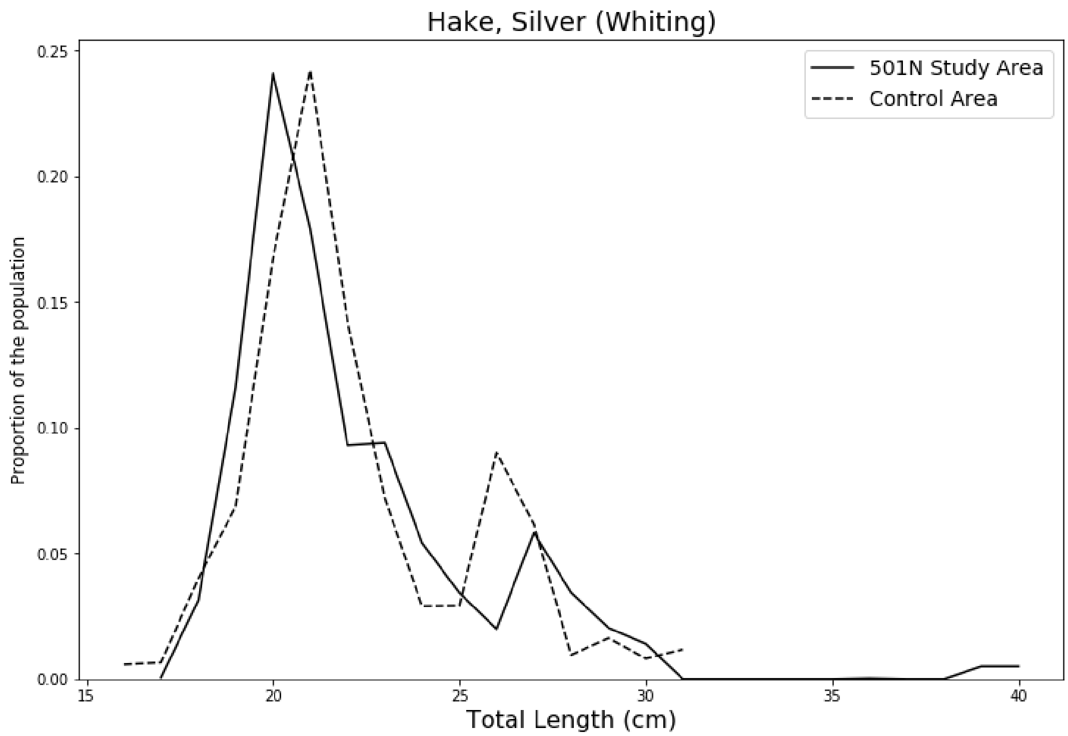



**Figure 17: Distribution of the catch of smooth dogfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



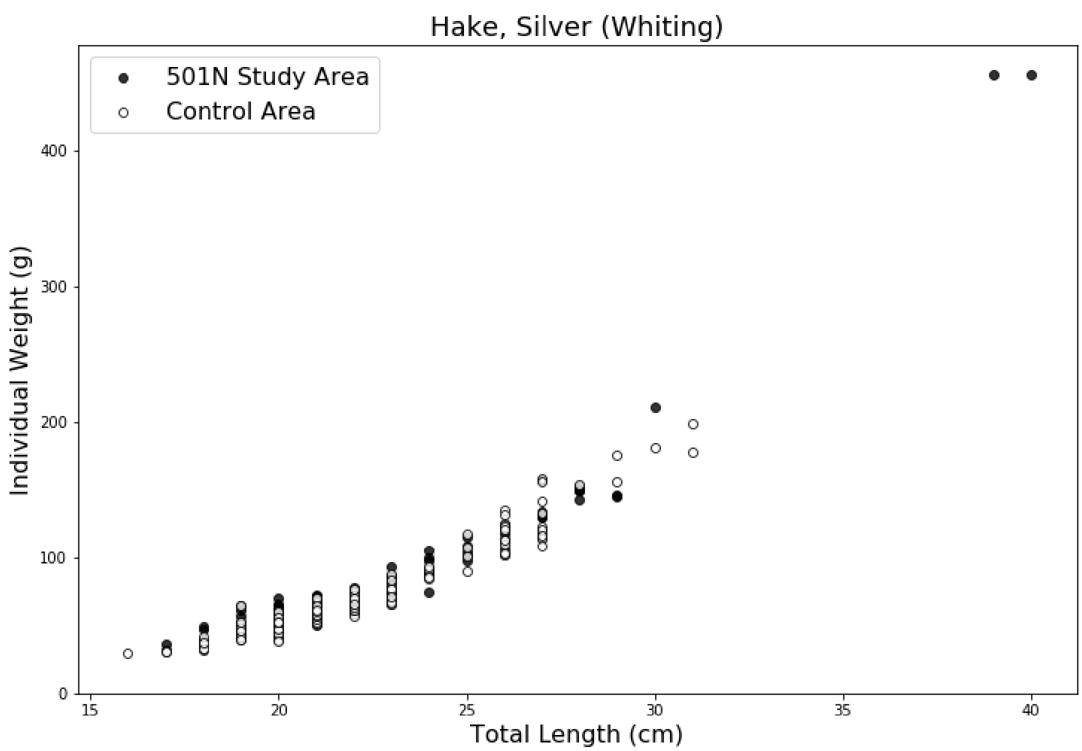




**Figure 18: Population structure of silver hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

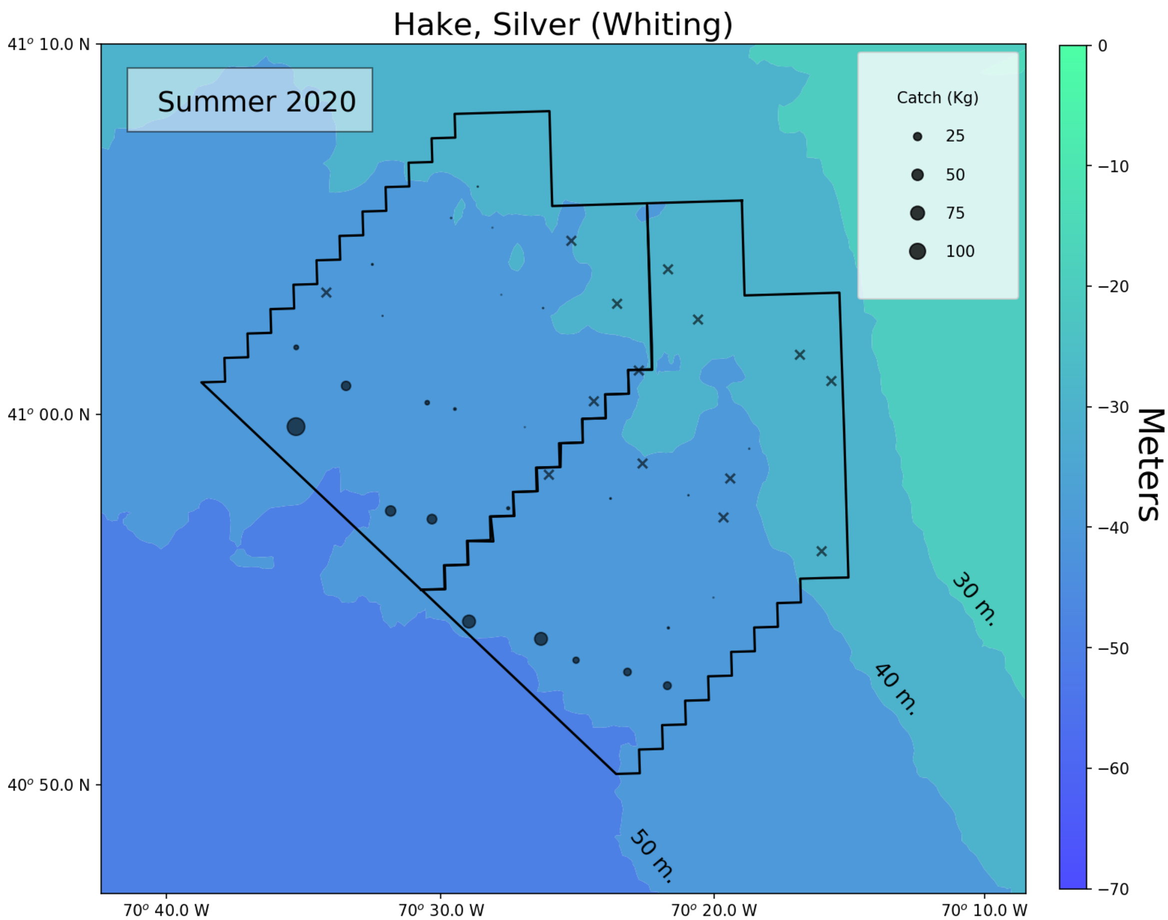
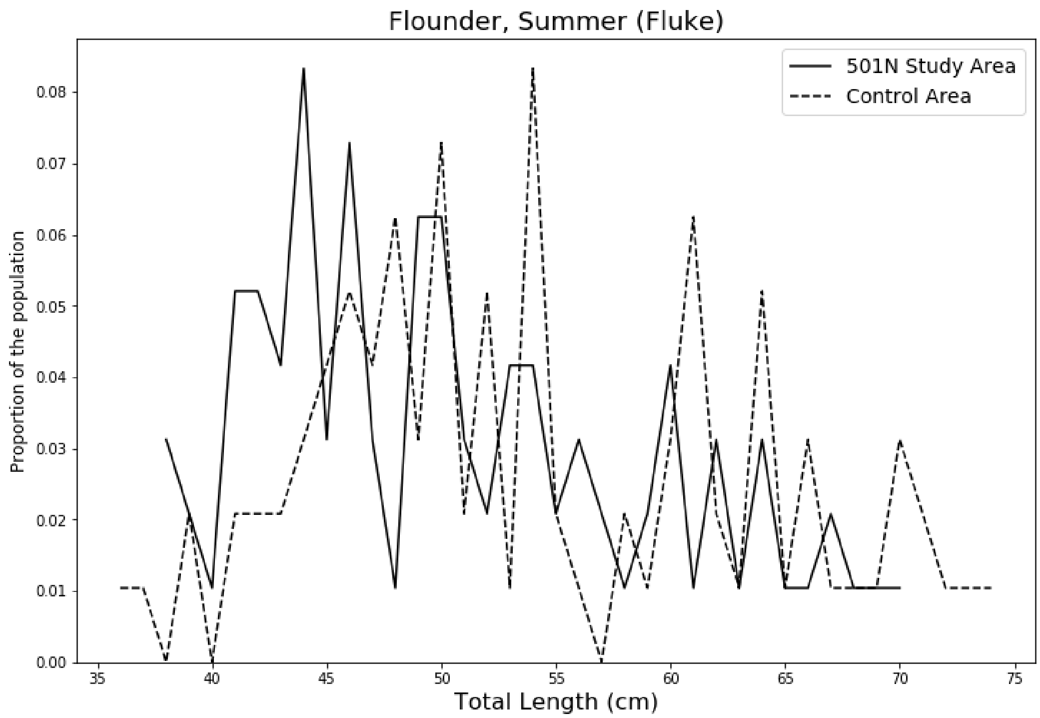



**Figure 19: Distribution of the catch of silver hake in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



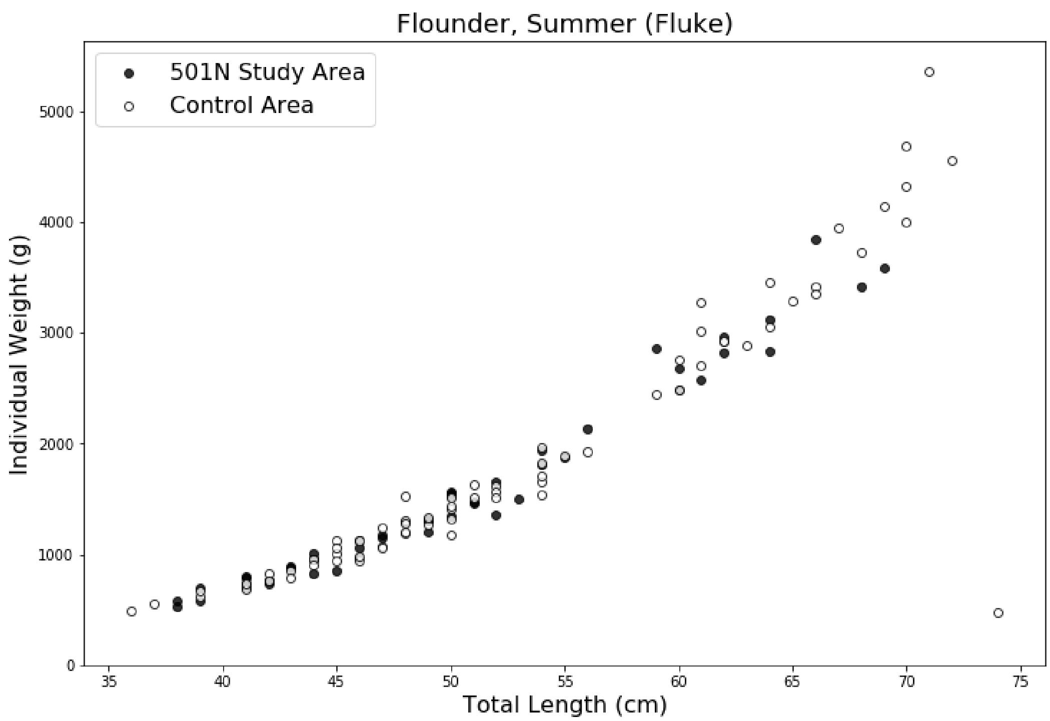




**Figure 20: Population structure of summer flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

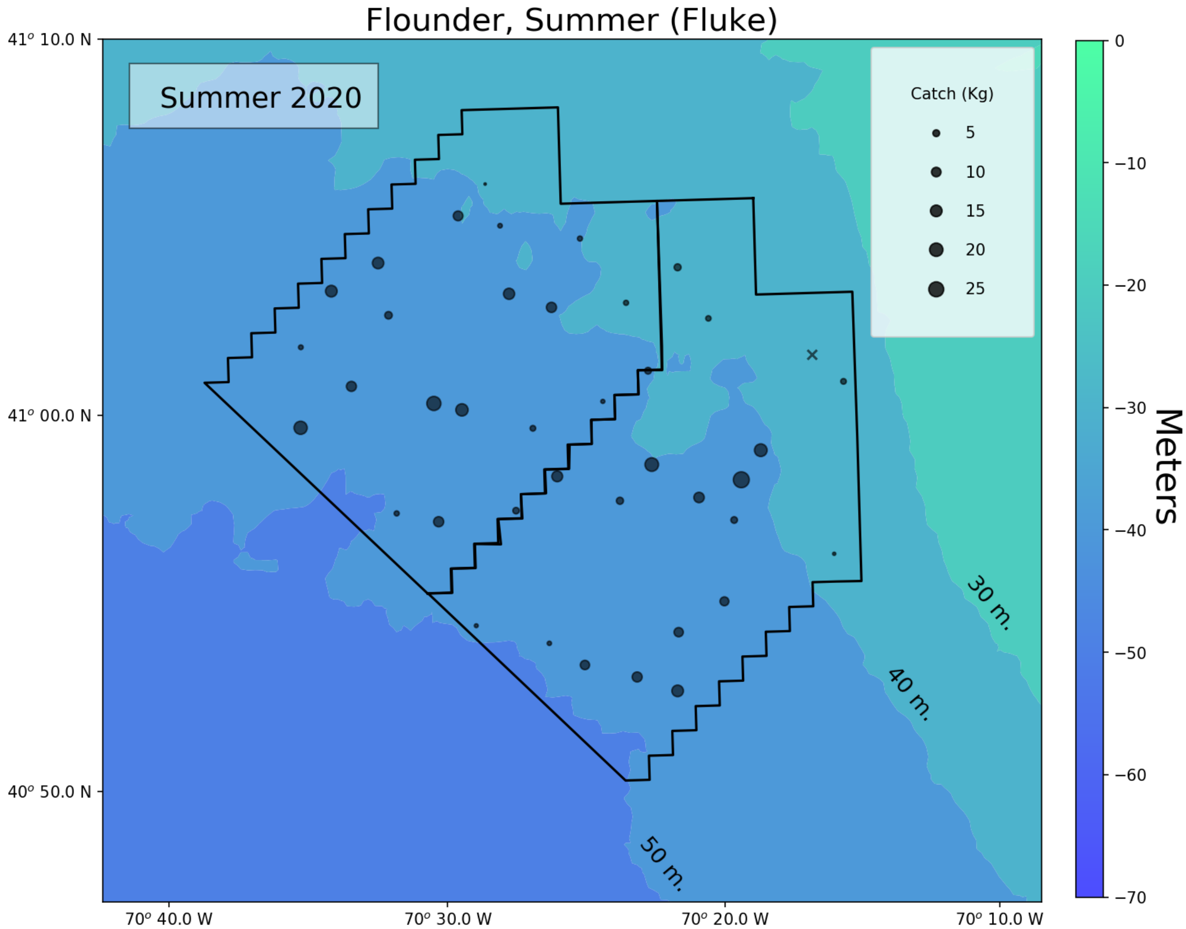
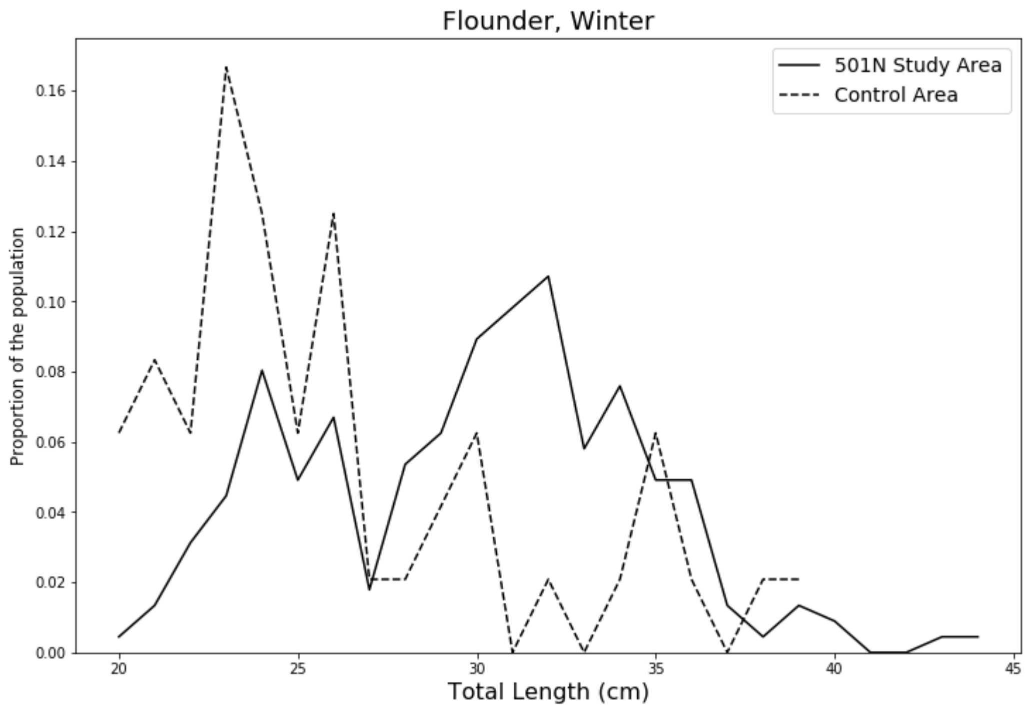



**Figure 21: Distribution of the catch of summer flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



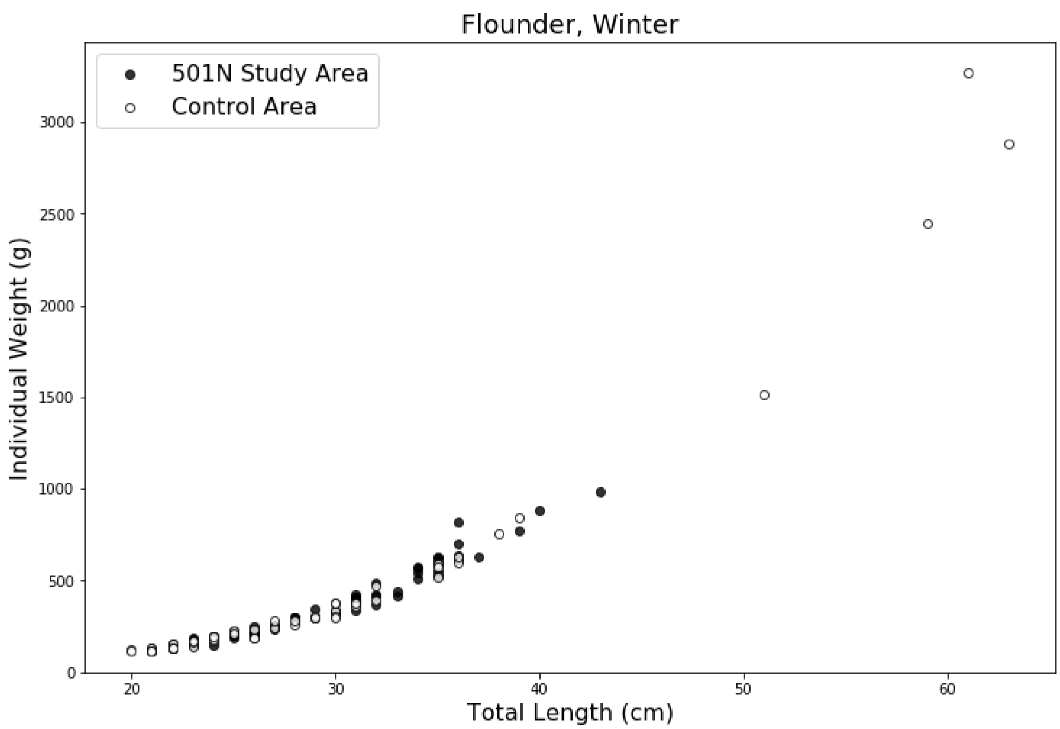




**Figure 22: Population structure of winter flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

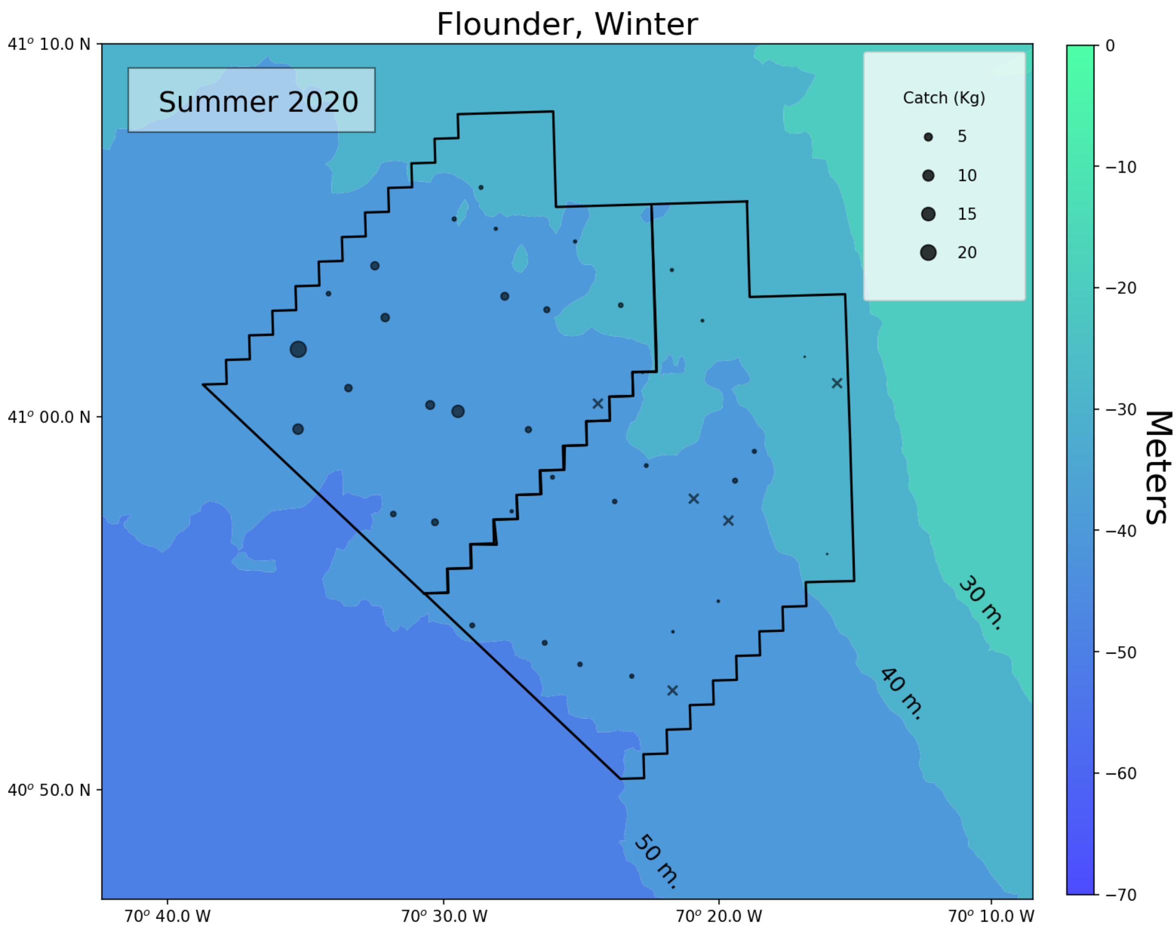
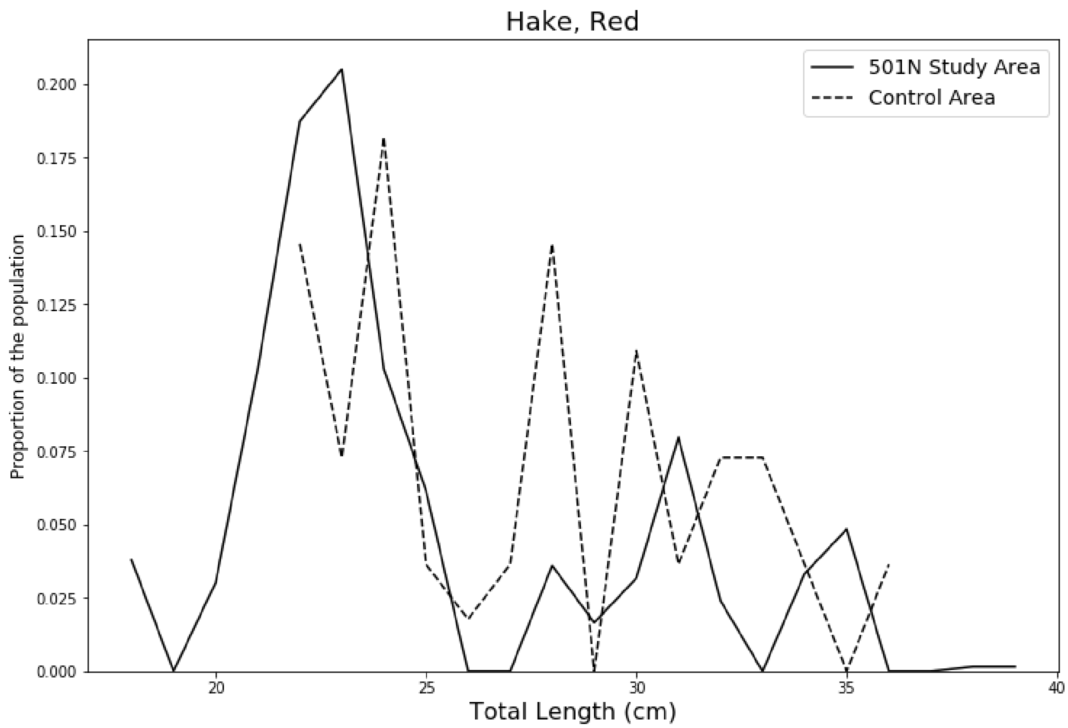



**Figure 23: Distribution of the catch of winter flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



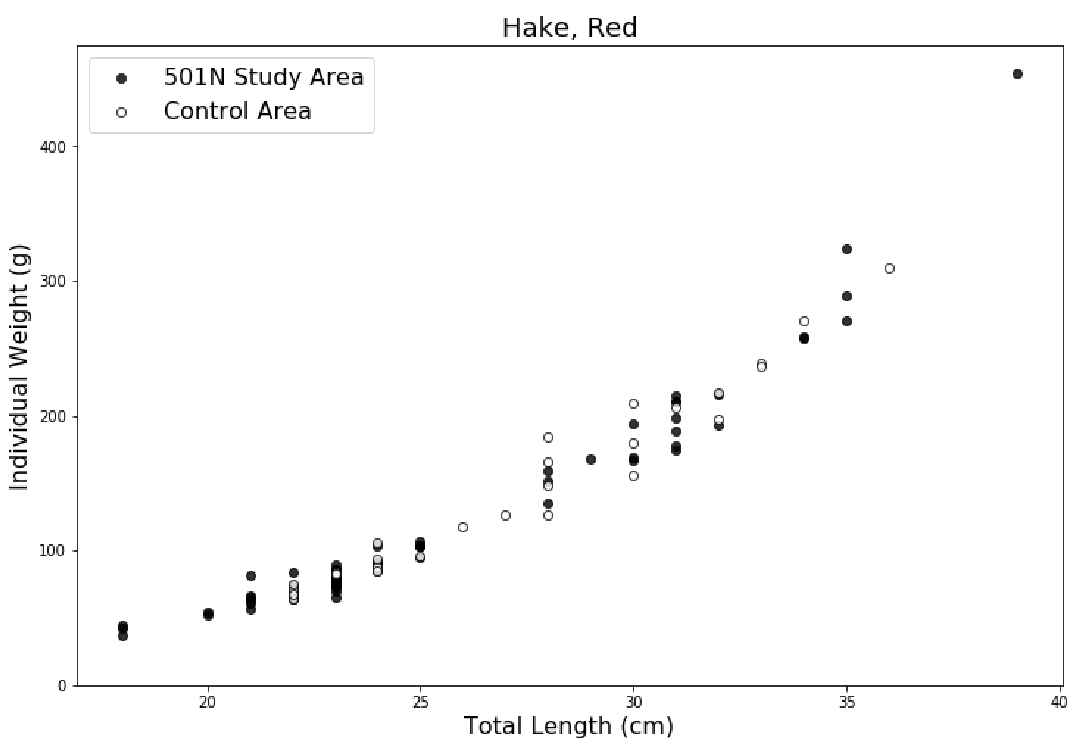




**Figure 24: Population structure of red hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

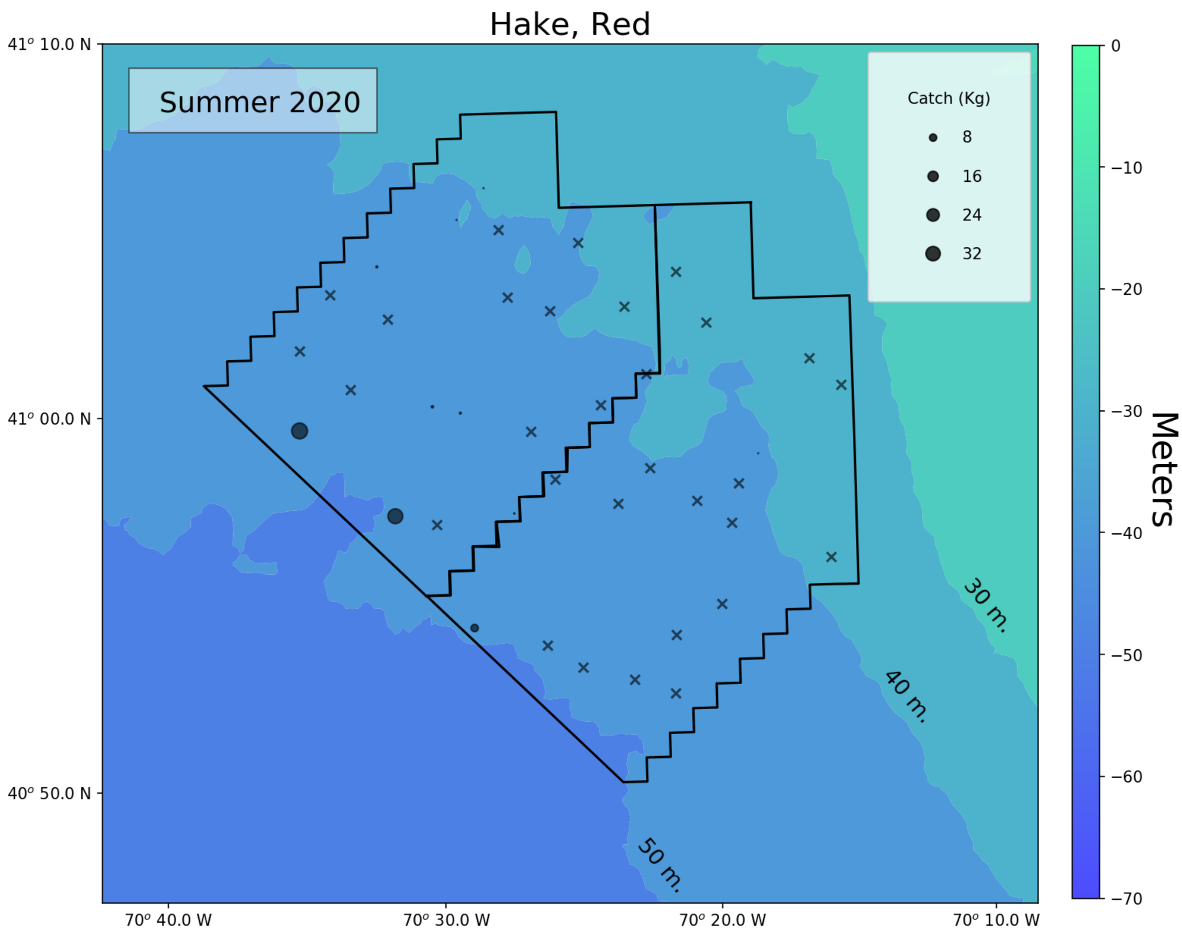
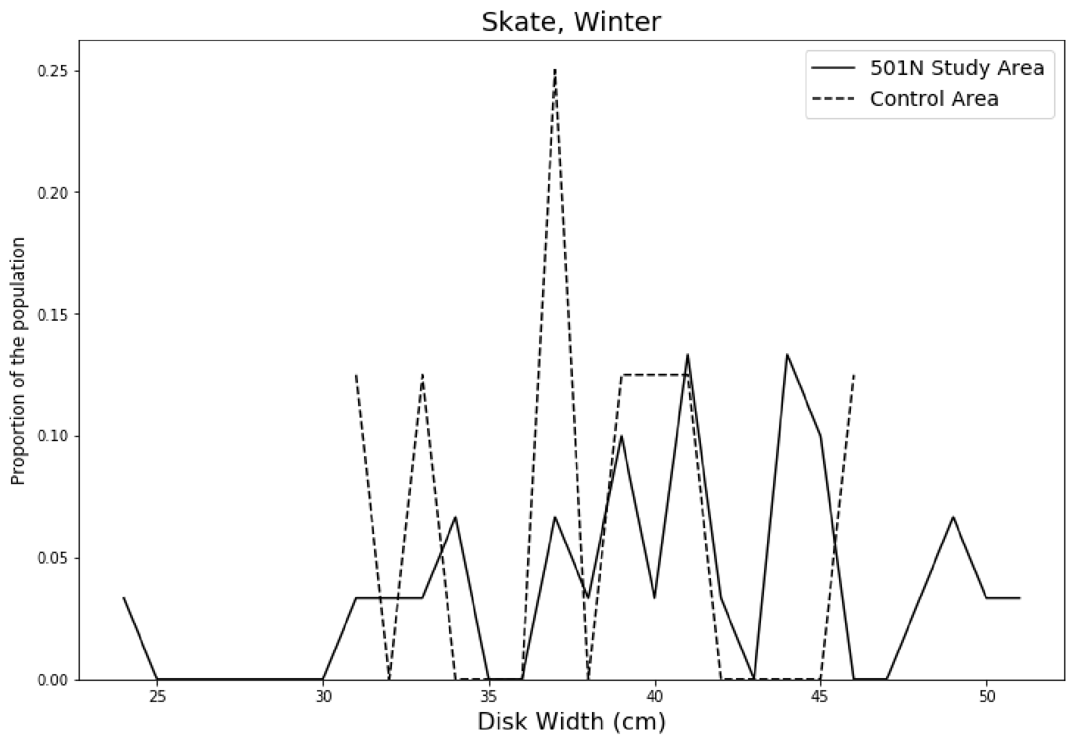



**Figure 25: Distribution of the catch of red hake in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



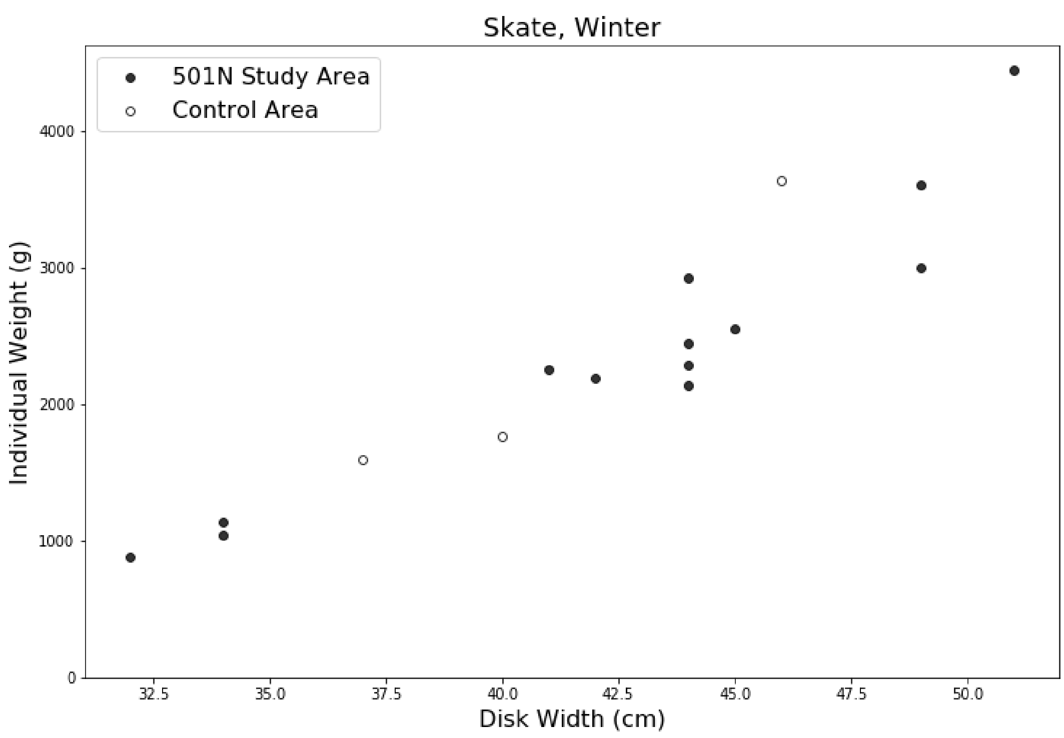




**Figure 26: Population structure of winter skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

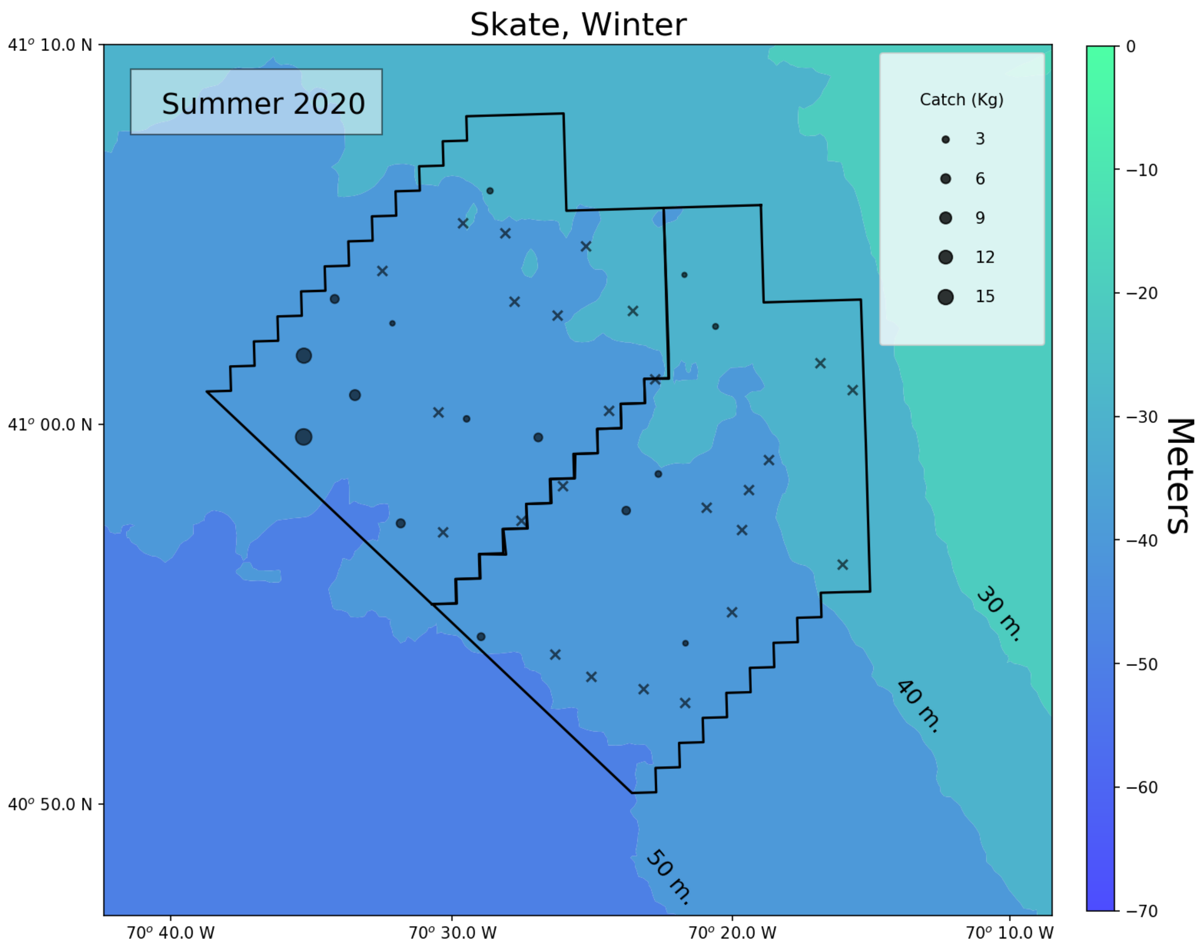
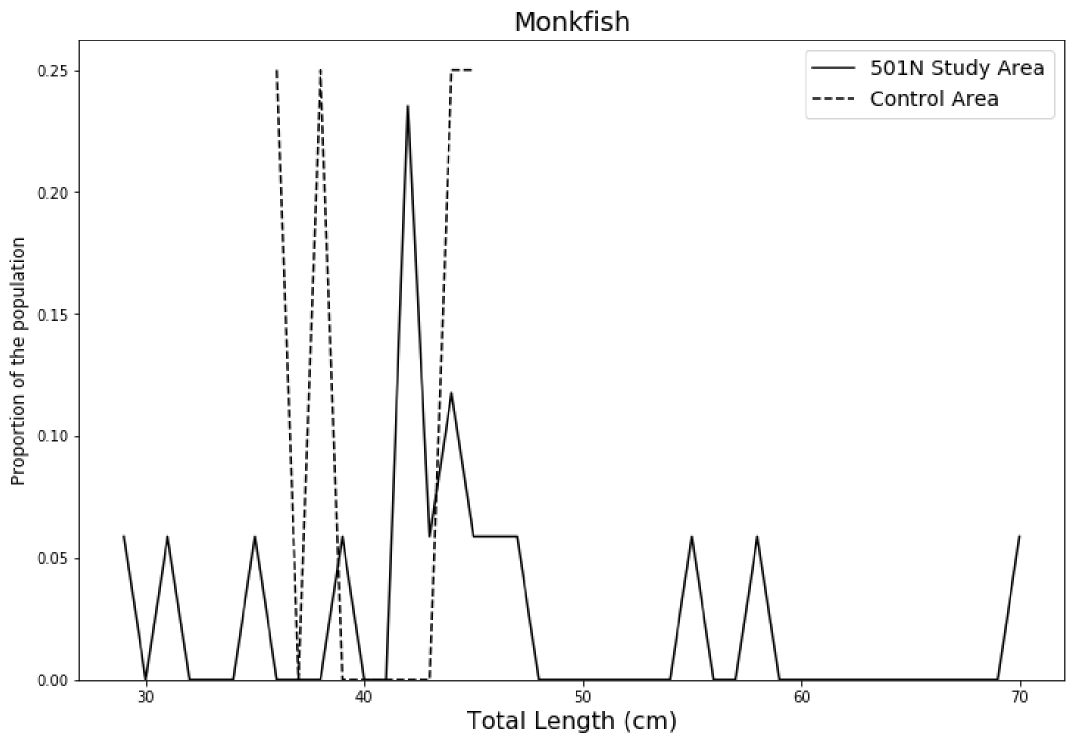



**Figure 27: Distribution of the catch of winter skate in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



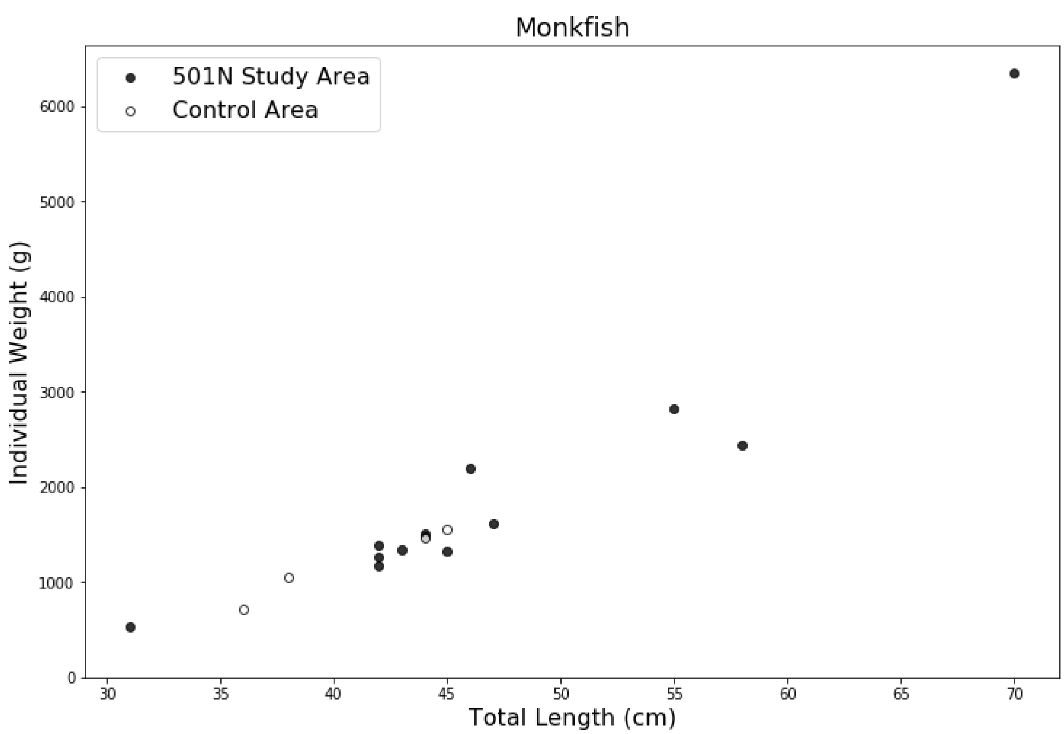




**Figure 28: Population structure of monkfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

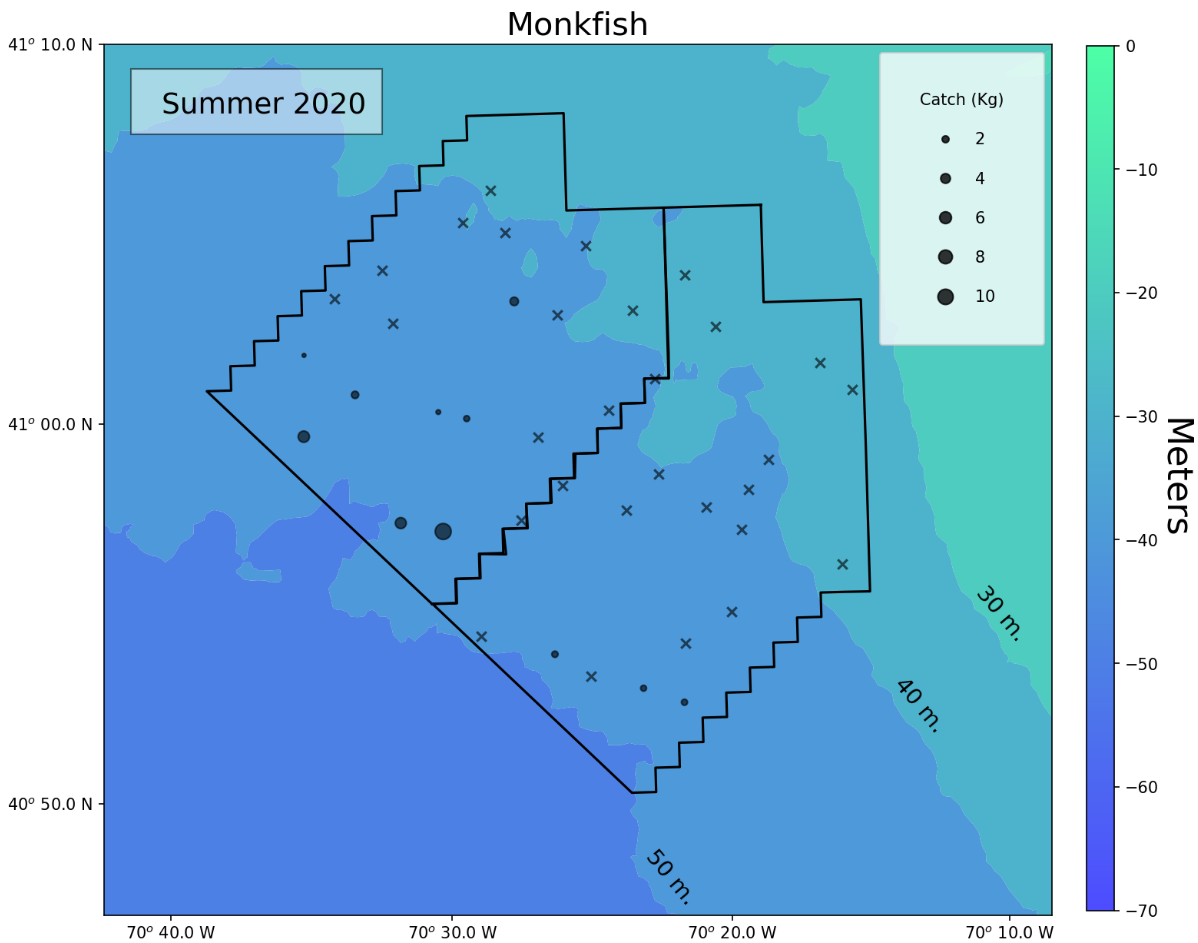



**Figure 29: Distribution of the catch of monkfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**

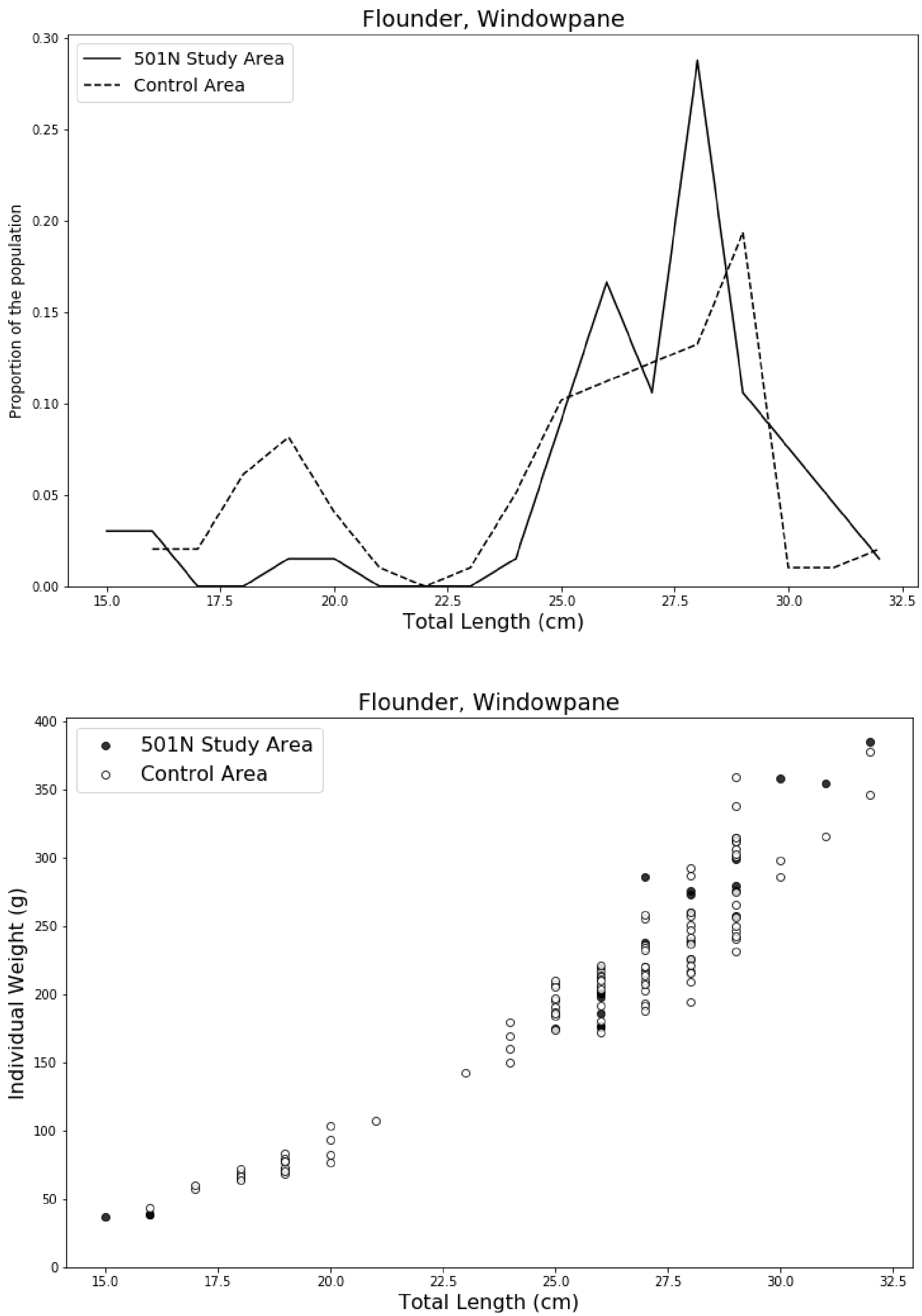



**Figure 30: Population structure of windowpane flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

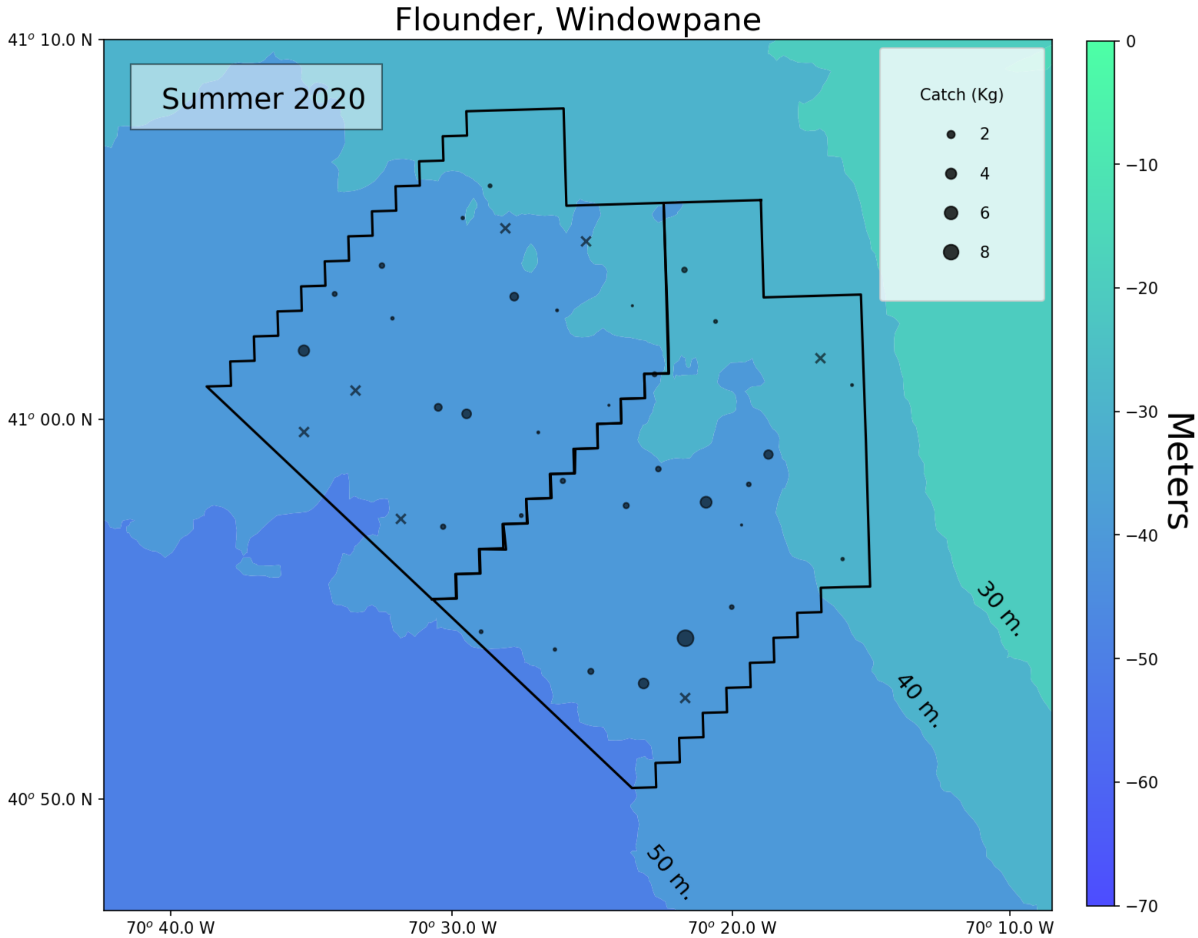



**Figure 31: Distribution of the catch of windowpane flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**

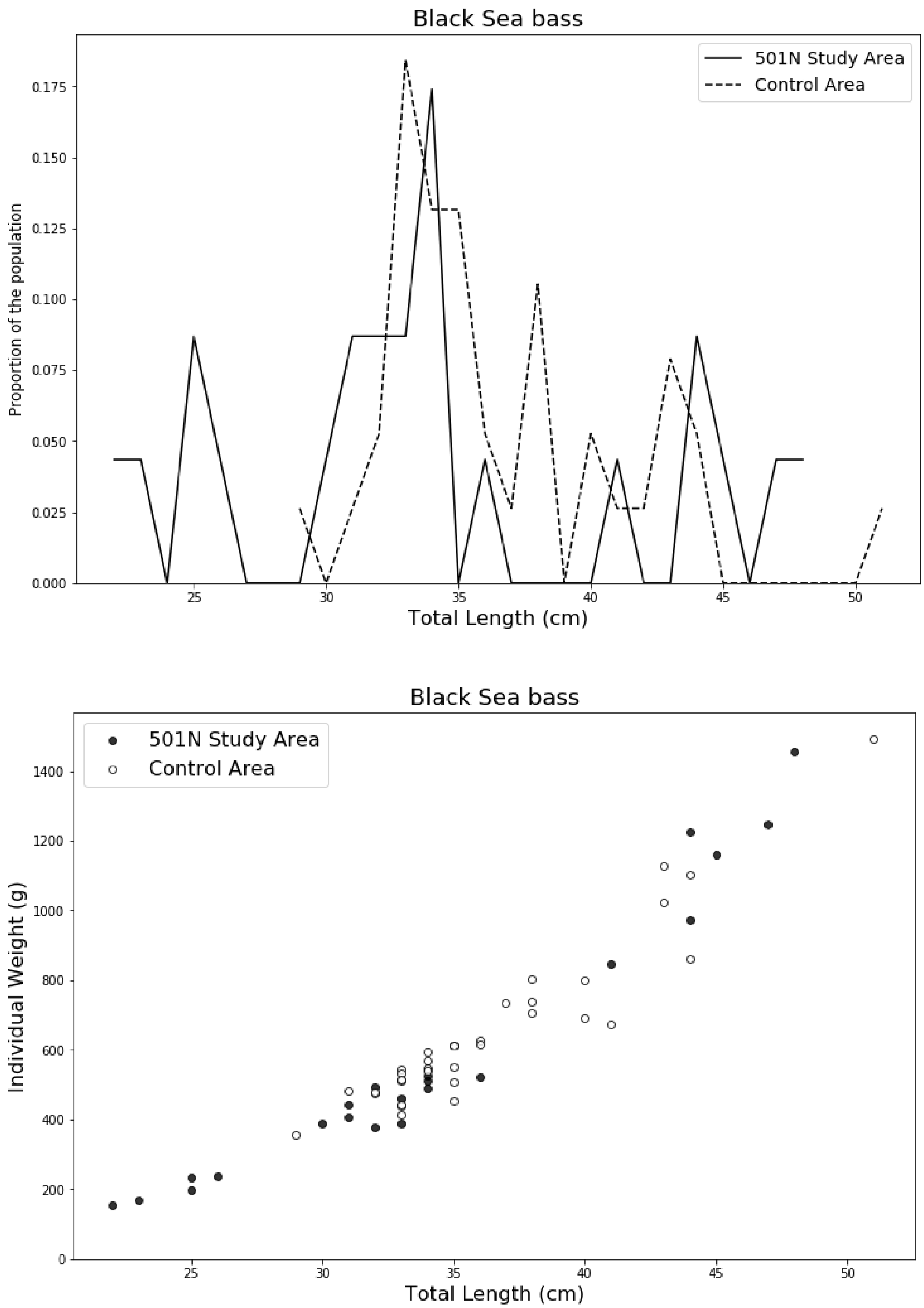



**Figure 32: Population structure of black sea bass in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

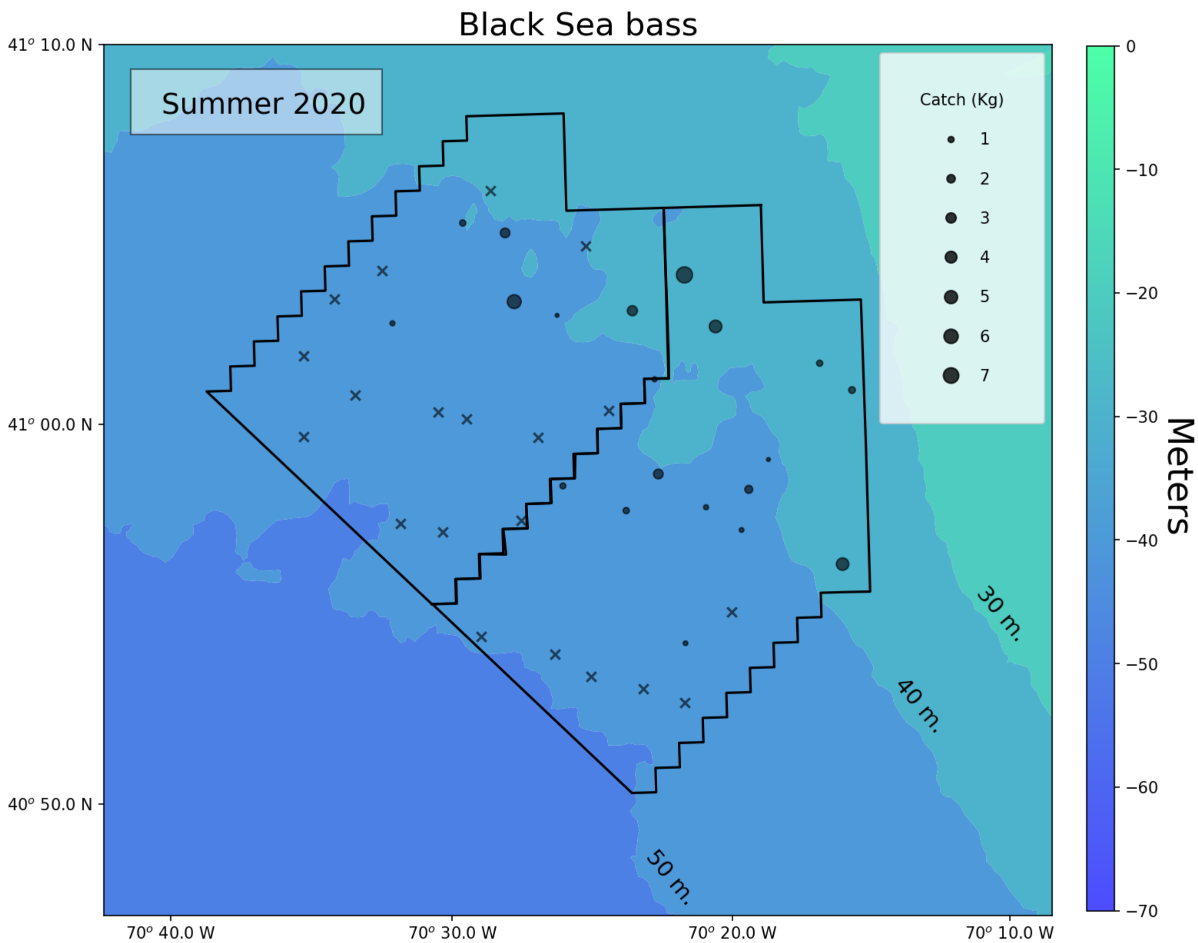



**Figure 33: Distribution of the catch of black sea bass in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**

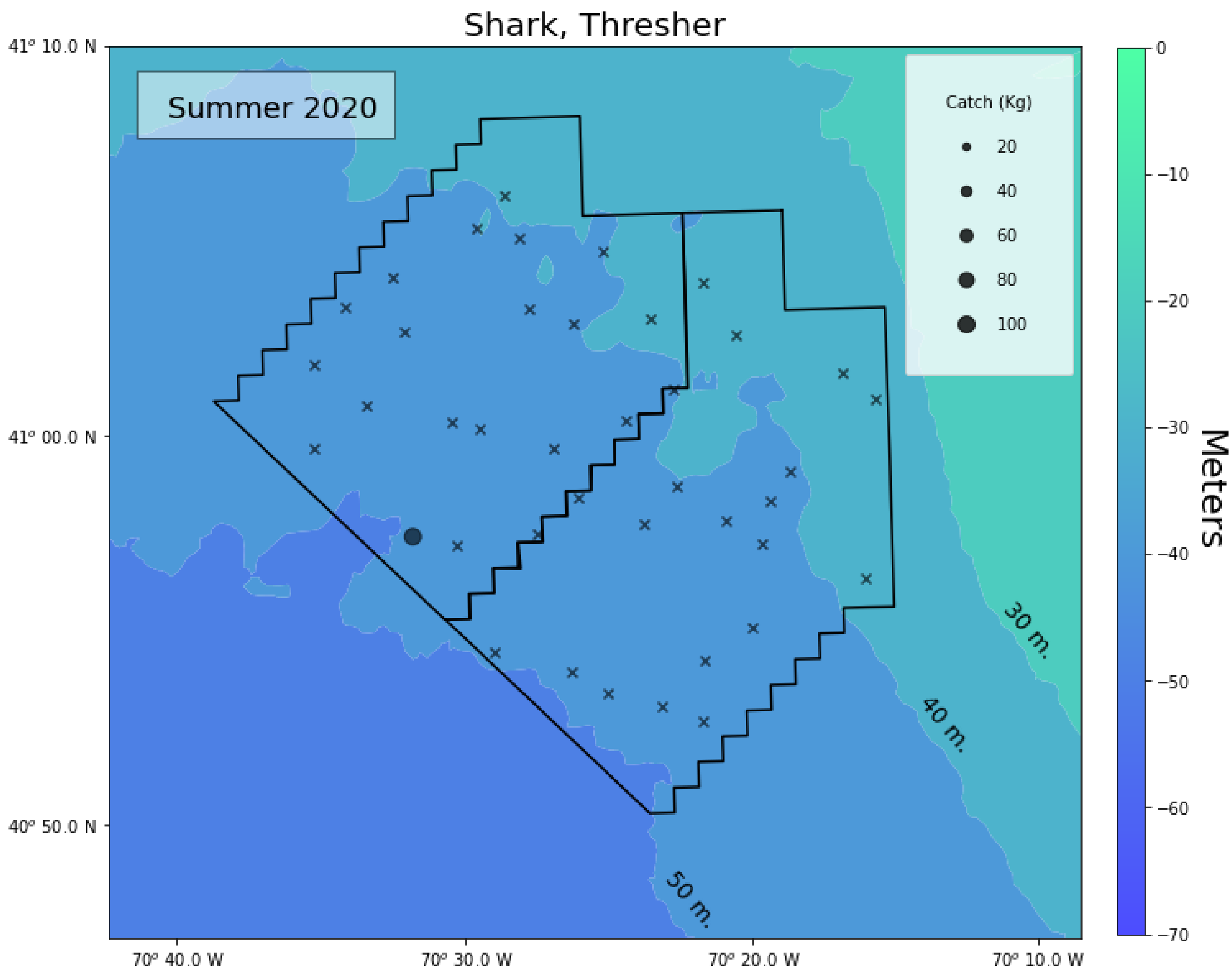
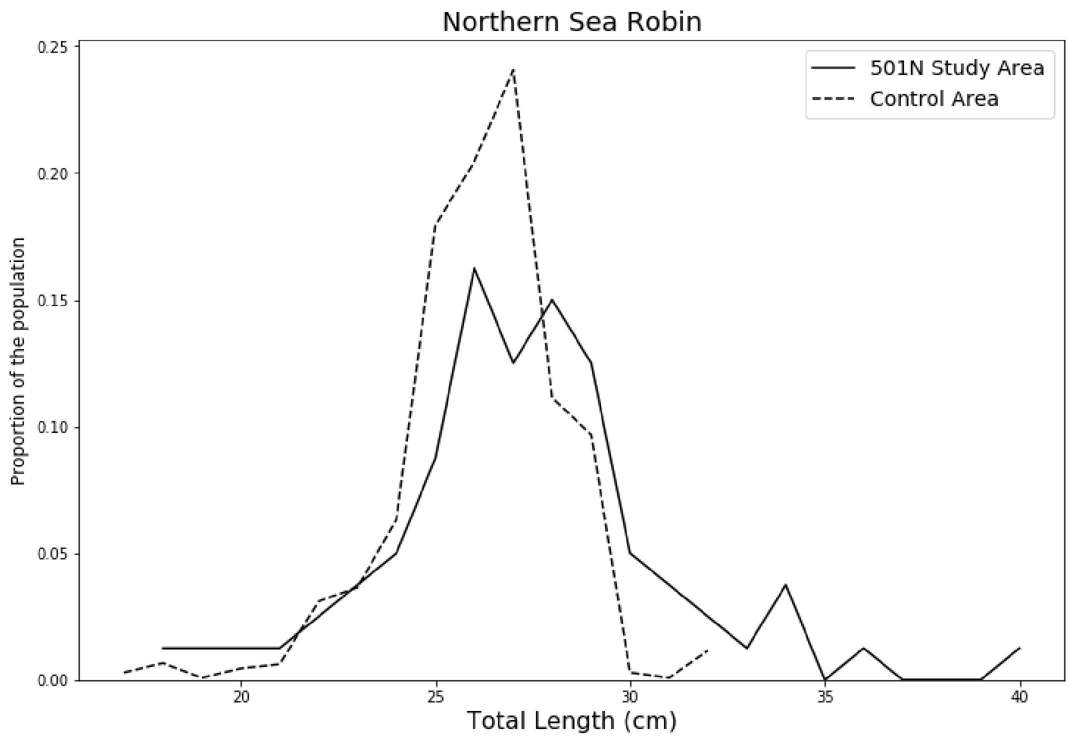



**Figure 34: Distribution of the catch of thresher shark in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**



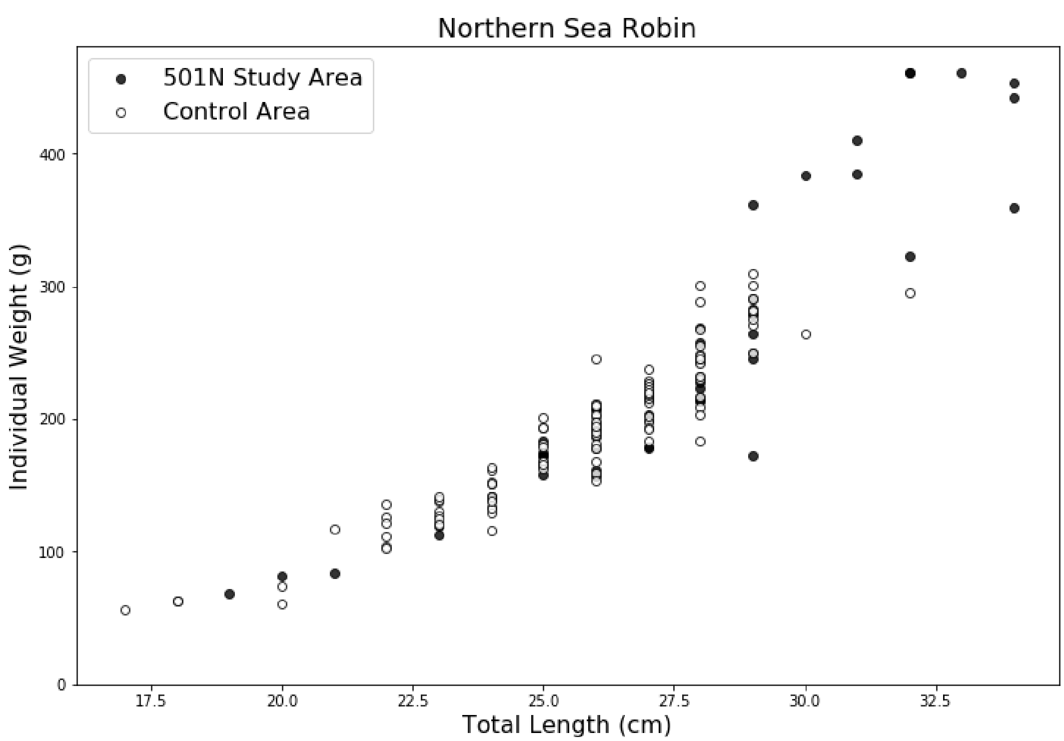




**Figure 35: Population structure of northern sea robin in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).**

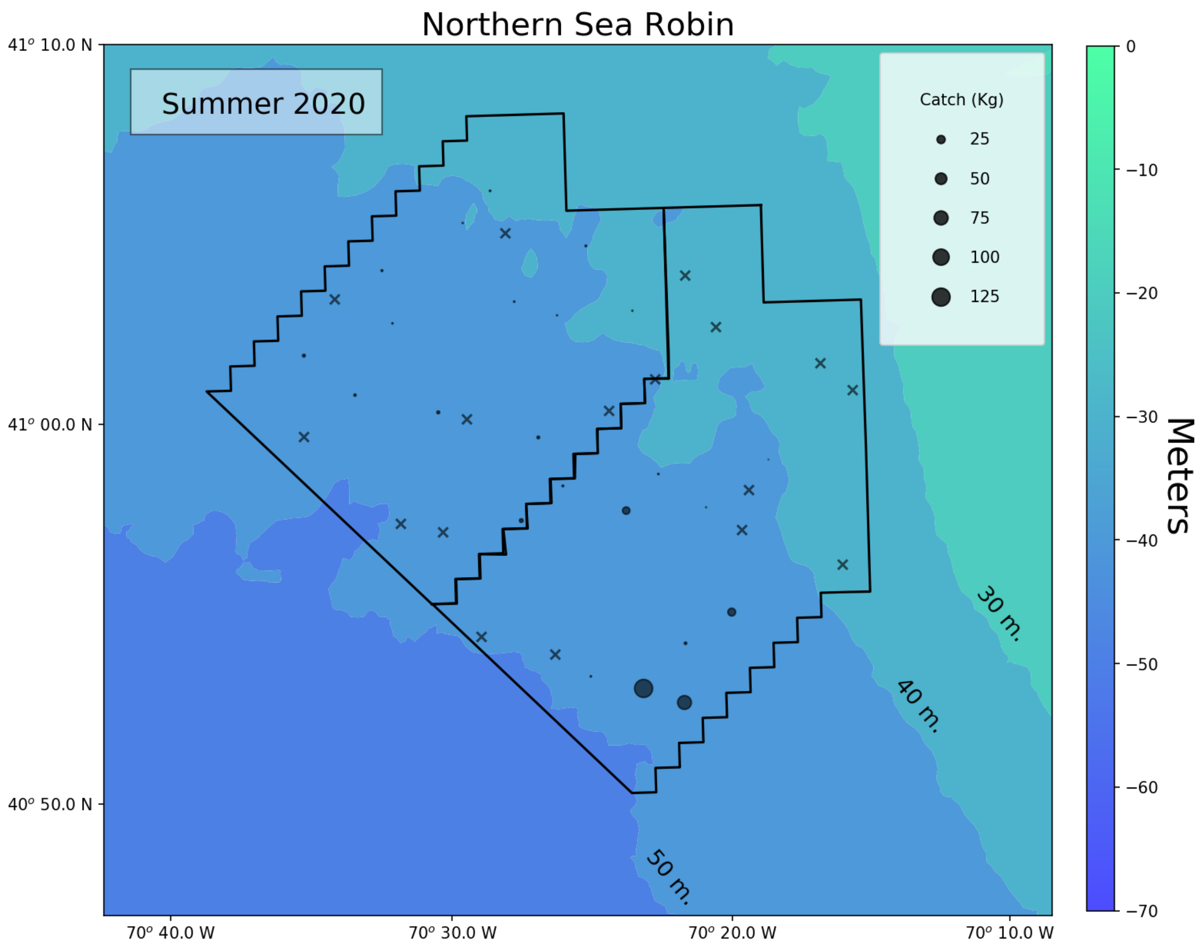



**Figure 36: Distribution of the catch of northern sea robin in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.**