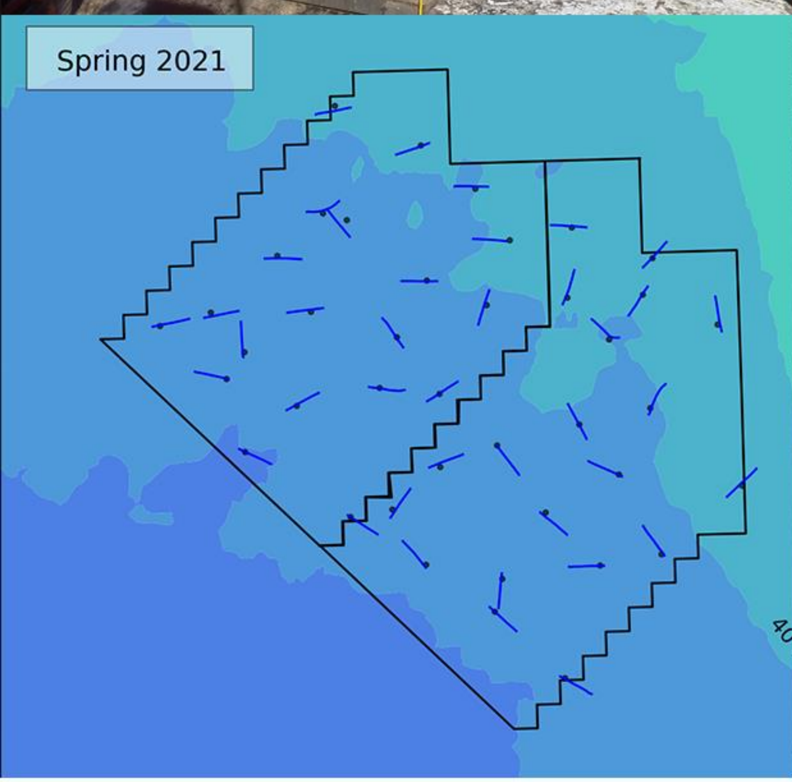
Vineyard Wind Demersal Trawl Survey



Quarterly Report

Spring 2021 (April - June)

501 North Study Area

VINEYARD WIND DEMERSAL TRAWL SURVEY

Spring 2021 Seasonal Report

501N Study Area

June 2021

Prepared for Vineyard Wind, LLC

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Vineyard Wind Demersal Trawl Survey Spring 2021 Seasonal Report

501N Study Area

<u>Progress Report #8</u>
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1. Introduction

In 2015, Vineyard Wind LLC (Vineyard Wind) leased a 675 square kilometer (km^2) area for renewable energy development on the Outer Continental Shelf, Lease Area OCS-A 0501, which is 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 "501 North" or the 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 "501S Study Area") and within Lease Area OCS-A 0522 (the "522 Study Area"); these studies are reported separately.[1]

BOEM has statutory obligations under the National Environmental Policy Act to evaluate the environmental, social, and economic impacts of a potential project. Additionally, BOEM has statutory obligations under the Outer Continental Shelf Lands Act to ensure any on-lease activities "protect the environment, conserve natural resources, prevent interference with reasonable use of the U.S. Exclusive Economic Zone, and consider the use of the sea as a fishery."

To address the potential impacts, Vineyard Wind, in collaboration with the University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST), has developed a monitoring plan to assess the potential environmental impacts of the proposed development on marine fish and invertebrate communities. The impact of the development will be evaluated using the Before-After-Control-Impact (BACI) framework. This framework is commonly used to assess the environmental impact of an activity (i.e., wind farm development and operation). Under this framework, monitoring will occur prior to development (Before), and then during construction and operation (After). During these periods, changes in the ecosystem will be compared between the development site (Impact) and a control site (Control). The control site will be in the general vicinity with similar characteristics to the impact areas (i.e., depth, habitat type, seabed characteristics, etc.). The goal of the monitoring plan is to assess the impact that wind farm construction and operation have on the ecosystem within an ever-changing ocean.

The current monitoring plan incorporates multiple surveys utilizing a range of survey methods to assess different facets of the regional ecology. The trawl survey is one component of the overall

[1] The Bureau of Ocean Energy Management (BOEM) segregated Lease Area OCS-A 0501 into two lease areas – OCS-A 0501 and OCS-A 0534 – in June 2021. The 501S Study Area is now located in the area designated as Lease Area OCS-A 0534 and referred to as the 501S Study Area in SMAST fisheries survey reports published prior to 2022.

survey plan. A demersal otter trawl, further referred to as a trawl, is a net that is towed behind a vessel along the seafloor and expanded horizontally by a pair of otter boards or trawl doors (Figure 1). Trawls tend to be relatively indiscriminate in the fish and invertebrates they collect; hence, bottom trawls are a generally accepted tool for assessing the biological communities along the seafloor and are widely used by institutions worldwide for ecosystem monitoring. Since they are actively towed behind a vessel, they are less biased by fish activity and behavior than passive fishing gear (i.e., gillnets, longlines, traps, etc.), which relies on animals moving to the gear. As such, state and federal fisheries management agencies heavily rely on trawl surveys to evaluate ecosystem changes and to assess the abundance of fishery resources. The current trawl survey closely emulates the Northeast Area Monitoring and Assessment Program (NEAMAP) survey protocol. In doing so, the goal was to ensure compatibility with other regional surveys, including the National Marine Fisheries Service annual spring and fall trawl surveys, the annual NEAMAP spring and fall trawl surveys, and state trawl surveys including the Massachusetts Division of Marine Fisheries trawl survey. The bottom trawl survey is complemented by the drop camera survey and lobster trap survey, both are also carried out by SMAST.

The primary goal of this survey was to provide data related to fish abundance, distribution, and population structure in and around the 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 of monitoring, which occurred from spring 2019 to winter 2020, have been submitted to the sponsoring organization. The surveys planned for spring 2020 were not conducted due to the COVID-19 pandemic. This progress report documents survey methodology, survey effort, and data collected during the spring of 2021.

2. Methodology

The methodology for the survey was adapted from the Atlantic States Marine Fisheries Commission's NEAMAP nearshore trawl survey. Initiated in 2006, NEAMAP conducts annual spring and fall trawl surveys from Cape Hatteras to Cape Cod. The NEAMAP survey protocol has gone through extensive peer review and is currently implemented near Lease Area OCS-A 0501 using a commercial fishing vessel (Bonzek et al., 2008). The current NEAMAP protocol samples at a resolution of ~100 km^2, which is inadequate to provide scientific information related to potential changes on a smaller scale. Adapting existing methods with increased resolution (see Section 2.1) will enable the survey to fulfill the primary goal of evaluating the impact of wind farm development while improving the consistency between survey platforms. This should facilitate easier sharing and integration of the data with state and federal agencies and allow the data from this survey to be incorporated into existing datasets to enhance our understanding of the region's ecosystem dynamics. Additionally, the methodology is consistent with other ongoing surveys of nearby study areas (i.e., the 501S Study Area and 522 Study Area).

2.1 Survey Design

The current survey is designed to provide baseline data on catch rates, population structure, and community structure for a future environmental assessment 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 within Lease Area OCS-A 0501. 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 501N Study Area. The starting location within each sub-area was 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 an 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 Lease Area OCS-A 0520 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 ~16.2km^2). Tow locations were selected in the same manner as the 501N Study Area, using the spatially balanced 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, Atlantic longfin squid, silver hake, and fourspot flounder, had relatively low variability and therefore a high probability of detecting 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: 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 the 501N Study Area 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 501N 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 survey area represent 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 one station per 15.3 km^2 (4.5 square nautical miles nmi^2]) in the 501N Study Area and one station per 16.2 km^2 (4.7 nmi^2) in the Control Area. As previously mentioned, the NEAMAP nearshore survey samples at a density of one station per ~100 km^2 (30 nmi^2).

2.2 Trawl Net

To ensure standardization and compatibility between these surveys and ongoing regional surveys, and to take advantage of the well-established survey protocol, the otter trawl used in this survey has an identical design to the trawl used for the NEAMAP surveys, including otter boards, ground cables, and sweeps. This trawl was designed by the Mid-Atlantic and New England Fisheries Management Council’s Trawl Advisory Panel (NTAP). As a result, the net design has been accepted by management authorities, the scientific community, and the commercial fishing industry in the region.

The survey trawl is a three-bridle four-seam bottom trawl (Figure 3). This net style allows for a high vertical opening (~5 meters [m]) relative to the size of the net and consistent trawl geometry. These features make it a suitable net to sample a wide diversity of species with varying life history characteristics (i.e., demersal, pelagic, benthic, etc.). To effectively capture benthic organisms, a "flat sweep" was used (Figure 4). A "flat sweep" contains tightly packed rubber disks and lead weights, which ensures close contact with the substrate and minimizes the escape of fish under the net. This is permissible due to the soft bottom (i.e., sand/mud) in the survey areas. To ensure the retention of small individuals, a 1" mesh size knotless liner was used within a 12-centimeter (cm) diamond mesh codend. Thyboron Type IV 66" trawl doors were used to horizontally open the net. The trawl doors were connected to the trawl by a series of steel wire bridles (see Figures 5 and 6 for a diagram of the trawl's rigging during the surveys). For a detailed description of the trawl design, see Bonzek et al. (2008).

2.3 Trawl Geometry and Acoustic Monitoring Equipment

To ensure standardization between tows, the net geometry was required to be within pre-specified tolerances (±10%) for each of the geometry metrics (door spread, wing spread, and headline height). These metrics were developed by the NTAP and are part of the operational criteria in the NEAMAP survey protocol. Headline height was targeted to be between 5.0 and 5.5 m with acceptable deviations between 4.5 and 6.1 m. Wing spread was targeted between 13.0 and 14.0 m (acceptable range: 11.7 – 15.4 m). Door spread was targeted between 32.0 and 33.0 m (acceptable range: 28.8 – 37.4 m).

The 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 that reported the angle of the net belly. An angle around 0° indicated the net was on the seafloor. A towed hydrophone was placed over the side of the vessel to receive the acoustic signals from the net sensors. A processing unit, located in the wheelhouse and running the TV80 software, was used to monitor and log the data during tows (Figure 7).

2.4 Survey Operations

The survey was conducted on the F/V *Heather Lynn*, an 84' stern trawler operating out of Point Judith, Rhode Island. The F/V *Heather Lynn* is a commercial fishing vessel currently operating in the industry. One trip was made during which all planned tows were completed (between May 3 and 8, 2021).

Surveys were alternated daily between the 501N Study Area and Control 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 were 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 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 were uploaded 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 survey areas (Table 2). Tow durations averaged 20.0 ± 0.1 minutes (mean ± one standard deviation) in the 501N Study Area and 20.0 ± 0.2 minutes in the Control Area. Tow distances averaged 1.0 ± 0.03

nautical miles (nmi) in the 501N Study Area giving an average tow speed of 2.9 ± 0.1 knots. Similarly, tow distances averaged 1.0 ± 0.04 nmi 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 northeastern edge (~30 m). Depth increased to a maximum of 50 m along the southwestern boundary. Bottom water temperature followed a similar gradient with warmer water observed during shallow tows (9.1°C at 33 m [48°F at 18 fm]) and colder water during deeper tows (6.4°C at 49 m [43.5°F at 27 fm], Table 1). The spring 2021 survey was considerably cooler than the spring 2019 survey. This is presumably due to the 2021 survey occurring approximately five weeks earlier than in 2019. In the spring 2019 survey, the average bottom water temperature in the 501N Study Area was 10.0 ± 0.7°C (50.0 ± 1.3°F) and 9.6 ± 0.6°C (49.3 ± 1.1°F) in the Control Area. In the spring 2021 survey, the average bottom water temperature in the 501N Study Area was 6.7 ± 0.3°C (44.1 ± 0.5°F) and 7.6 ± 0.8°C (45.7 ± 1.4°F) in the Control Area.

The trawl geometry data indicated that the trawl took about two to three minutes to open and stabilize. Once open, readings were stable throughout the duration of the tow. Door spread averaged 34.5 ± 0.8 m (range: 32.5 – 35.7 m) for tows in the 501N Study Area and 34.3 ± 1.2 (range: 32.3 – 37.0 m) for tows in the Control Area. Wing spread averaged 13.9 ± 0.6 m for tows in the 501N Study Area (range: 11.9 – 14.7 m) and 13.9 ± 0.3 m for tows in the Control Area (range: 13.4 – 14.5 m). Headline height averaged 5.0 ± 0.2 m for tows in the 501N Study Area (range: 4.7 – 5.2 m) and 4.9 ± 0.3 m for tows in the Control Area (range: 4.5 – 5.4 m). All tows were in the acceptable range for all trawl geometry parameters.

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 15.8 kilograms per tow (kg/tow) to 204.4 kg/tow with an average of 106.0 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (winter skate, little skate, red hake, silver hake, and spiny dogfish) accounted for 81.0% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Winter skate (*Leucoraja ocellata*) was the predominant species observed, accounting for 31.5% of the total catch weight. Individuals ranged in size from 28 to 54 cm (disk width) with a wide unimodal size distribution (Figure 8). Winter skate were observed in 19 of the 20 tows. Catch rates averaged 33.4 ± 4.5 kg/tow (mean ± Standard Error of the Mean [SEM], range: 0 – 72.5 kg/tow). Winter skate were observed to be dispersed throughout the 501N Study Area (Figure 9).

Little skate (*Leucoraja erinacea*) was the second most abundant species observed, accounting for 31.5% of the total catch weight. Individuals ranged in size from 8 to 33 cm (disk width) with a unimodal distribution consisting of a peak at 26 cm (Figure 10). Little skate were observed in all 20 tows. Catch rates averaged 33.4 ± 3.9 kg/tow (range: 2.9 – 70.5 kg/tow). Little skate were observed to be dispersed throughout the 501N Study Area (Figure 11).

Red hake (*Urophycis chuss*) was one of the dominant species in the 2019/2020 survey year. During this spring survey, red hake was the third most abundant species observed. Individuals ranged in length from 10 to 38 cm with a unimodal size distribution peaking at 28 cm (Figure 12). Red hake were observed in 19 of the 20 tows at an average catch rate of 9.0 ± 1.3 kg/tow (range: 0 – 25.1 kg/tow). Red hake were observed throughout the 501N Study Area (Figure 13).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was commonly caught in the 501N Study Area. Individuals ranged in length from 10 to 39 cm. Silver hake had a unimodal size distribution consisting of a peak at 24 cm (Figure 14). Silver hake were observed in all 20 tows at an average catch rate of 5.1 ± 0.7 kg/tow (range: 0.3 – 11.1 kg/tow). Silver hake were observed throughout the 501N Study Area (Figure 15).

Spiny dogfish (*Squalus acanthias*) was the fifth most abundant species observed. Individuals ranged in length from 20 to 70 cm with a broad size distribution (Figure 16). Spiny dogfish were observed in eight of the 20 tows at an average catch rate of 5.0 ± 4.7 kg/tow (range: 0 – 93.28 kg/tow). The majority of the catch (94%) was caught in a single tow in the southeastern corner of the 501N Study Area (Figure 17). The rest of the catch was primarily observed at lower densities in the southeastern corner of the 501N Study Area.

Black sea bass (*Centropristis striata*) is a commercially important species that was frequently caught in the 501N Study Area. Individuals ranged in length from 16 to 55 cm with a broad size distribution (Figure 18). Black sea bass were observed in 19 of the 20 tows at an average catch rate of 4.9 ± 0.6 kg/tow (range: 0 – 10.3 kg/tow). Black sea bass were caught throughout the 501N Study Area (Figure 19).

Three species of herring were regularly caught within the 501N Study Area: Atlantic herring (*Clupea harengus*), blueback herring (*Alosa aestivalis*), and alewife (*Alosa pseudoharengus*). Atlantic herring ranged in length from 18 to 27 cm with a narrow unimodal size distribution consisting of a peak at 21 cm (Figure 20). Atlantic herring were observed in 14 of the 20 tows at an average catch rate of 3.3 ± 2.1 kg/tow (range: 0 – 42.8 kg/tow). Atlantic herring were caught throughout the 501N Study Area with a single tow accounting for 65% of the total catch, by weight (Figure 21).

Blueback herring ranged in length from 19 to 25 cm with a narrow unimodal size distribution consisting of a peak at 23 cm (Figure 22). Blueback herring were observed in 11 of the 20 tows at an average catch rate of 2.3 ± 1.2 kg/tow (range: 0 – 24.2 kg/tow). Similar to Atlantic herring, blueback herring were caught throughout the 501N Study Area with a single tow accounting for 53% of the total catch, by weight (Figure 23).

Alewife ranged in length from 18 to 28 cm with a narrow unimodal size distribution consisting of a peak at 20 cm (Figure 24). Alewife were observed in 12 of the 20 tows at an average catch rate of 1.0 ± 0.3 kg/tow (range: 0 – 4.8 kg/tow). The catch of alewife was distributed across the 501N Study Area (Figure 25).

Fourspot flounder (*Paralichthys oblongus*) was the most abundant flatfish species caught in the 501N Study Area. Fourspot flounder ranged in length from 22 to 40 cm with a unimodal size distribution peaking at 32 cm (Figure 26). Fourspot flounder were observed in 18 of the 20 tows at an average catch rate of 1.2 ± 0.2 kg/tow (range: 0 – 2.4 kg/tow). The catch of fourspot flounder was highest in the southern half of the 501N Study Area (Figure 27).

Butterfish (*Peprilus triacanthus*) ranged in length from 9 to 20 cm with a unimodal size distribution consisting of a peak at 13 cm (Figure 28). Butterfish were observed in 19 of the 20 tows at an average catch rate of 1.0 ± 0.2 kg/tow (range: 0 – 2.5 kg/tow). Butterfish were caught throughout the 501N Study Area (Figure 29).

Scup (*Stenotomus chysops*) is a commercially important species in the region. Individuals ranged in length from 9 to 32 cm with a bimodal size distribution consisting of peaks at 11 and 25 cm (Figure 30). Scup were observed in 12 of the 20 tows at an average catch rate of 0.8 ± 0.3 kg/tow (range: 0 – 4.9 kg/tow). Scup were caught throughout the 501N Study Area (Figure 31).

Summer flounder (*Paralichthys dentatus*) is a commercially important flatfish species commonly referred to as fluke. Summer flounder were commonly caught in the 501N Study Area. Individuals ranged in length from 31 to 50 cm with a broad size distribution (Figure 32). Summer flounder were observed in 11 of the 20 tows at an average catch rate of 0.5 ± 0.2 kg/tow (range: 0 – 2.5 kg/tow). Summer flounder were caught throughout the 501N Study Area (Figure 33).

Atlantic longfin squid (*Dorytheuthis pealei*) is a commercially important species commonly referred to as loligo squid. Individuals ranged in length from 5 to 23 cm (mantle length) with a unimodal size distribution peaking at 12 cm (Figure 34). Atlantic longfin squid were observed in 16 of the 20 tows at an average catch rate of 0.4 ± 0.1 kg/tow (range: 0 – 1.8 kg/tow). Atlantic longfin squid were caught throughout the 501N Study Area (Figure 35). No squid "mops" were observed during this survey.

Windowpane flounder (*Scophtalmus aquosus*) ranged in length from 19 to 30 cm with a unimodal size distribution peaking at 22 cm (Figure 36). Windowpane flounder were observed in 11 of the 20 tows at an average catch rate of 0.2 ± 0.1 kg/tow (range: 0 – 1.0 kg/tow). Windowpane flounder were observed throughout the 501N Study Area with the highest catches in the northern half of the 501N Study Area (Figure 37).

Less common recreational and commercial species observed included 8.7 kg of Atlantic sea scallops (*Placopecten* magellanicus), five winter flounder (*Pleuronectes americanus*, size range: 28 – 45 cm), three monkfish (*Lophius americanus,* 30, 35, 50 cm), and two yellowtail flounder (*Limanda ferruginea*, 37, 43 cm).

3.2.2 Control Area

In the Control Area, a total of 30 species were caught over the duration of the survey (Table 4). Catch volume ranged from 63.7 kg/tow to 520.7 kg/tow with an average of 205.9 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (spiny dogfish, little skate, winter skate, red hake, and silver hake) accounted for 88.3% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Spiny dogfish was the most abundant species observed in the Control Area, accounting for 28.4% of the total catch. Individuals ranged in length from 19 to 83 cm with a broad size distribution (Figure 16). Spiny dogfish were observed in 12 of the 20 tows at an average catch rate of 58.7 ± 27.9 kg/tow (range: 0 – 393.0 kg/tow). Three large tows along the southern border of the Control Area accounted for 86% of the total catch, by weight (Figure 17). No spiny dogfish were observed in the northern half of the Control Area.

Little skate was the second most abundant species observed, accounting for 27.4% of the total catch weight. Individuals ranged in size from 14 to 34 cm (disk width) with a unimodal distribution consisting of a peak at 27 cm (Figure 10). Little skate were observed in all 20 tows. Catch rates averaged 56.3 ± 8.2 kg/tow (range: 15.6 – 145.1 kg/tow). The catch of little skate appeared to follow the depth gradient in the Control Area with catch increasing with depth – the highest catches were observed along the northern boundary of the Control Area with catch decreasing to the south (Figure 11).

Winter skate was the third most abundant species observed, accounting for 19.4% of the total catch weight. Individuals ranged in size from 26 to 56 cm (disk width) with a wide unimodal size distribution (Figure 8). Winter skate were observed in all 20 tows. Catch rates averaged 39.9 ± 3.7 kg/tow (range: 13.9 – 78.3 kg/tow). Winter skate were observed to be dispersed throughout the Control Area (Figure 9).

Red hake was one of the dominant species in the 2019/2020 survey year. During this spring survey, red hake was commonly observed in the catch. Individuals ranged in length from 10 to 41 cm with a unimodal size distribution peaking at 28 cm (Figure 12). Red hake were observed in all 20 tows at an average catch rate of 17.4 ± 2.8 kg/tow (range: 0.9 – 57.9 kg/tow). Red hake were observed throughout the Control Area (Figure 13).

Silver hake was commonly caught in the Control Area. Individuals ranged in length from 10 to 36 cm with a unimodal size distribution consisting of a peak at 24 cm (Figure 14). Silver hake were observed in all 20 tows at an average catch rate of 9.4 ± 1.4 kg/tow (range: 2.1 – 24.8 kg/tow). Silver hake were observed throughout the Control Area (Figure 15).

Alewife ranged in length from 17 to 27 cm with a narrow unimodal size distribution consisting of a peak at 19 cm (Figure 24). Alewife were observed in 15 of the 20 tows at an average catch rate of 5.4 ± 2.9 kg/tow (range: 0 – 56.9 kg/tow). The catch of alewife was distributed across the Control Area with two large tows along the northern boundary (Figure 25).

Black sea bass were frequently caught in the Control Area. Individuals ranged in length from 11 to 52 cm with a broad size distribution (Figure 18). Black sea bass were observed in 19 of the 20 tows at an average catch rate of 2.9 ± 0.4 kg/tow (range: 0 – 6.9 kg/tow). Higher catches of black sea bass were observed in the northern half of the Control Area (Figure 19).

Fourspot flounder was the most abundant flatfish species caught in the Control Area. Individuals ranged in length from 14 to 43 cm with a unimodal size distribution peaking at 30 cm (Figure 26). Fourspot flounder were observed in all 20 tows at an average catch rate of 2.3 ± 0.3 kg/tow (range: 0.3 – 4.9 kg/tow). The catch of fourspot flounder was highest in the northern half of the Control Area (Figure 27).

Atlantic herring ranged in length from 18 to 29 cm with a narrow unimodal size distribution consisting of a peak at 21 cm (Figure 20). Atlantic herring were observed in 18 of the 20 tows at an average catch rate of 2.2 ± 1.4 kg/tow (range: 0 – 28.0 kg/tow). Atlantic herring were caught throughout the Control Area with a single tow accounting for 63% of the catch total (Figure 21).

Butterfish ranged in length from 6 to 20 cm with a unimodal size distribution consisting of a peak at 12 cm (Figure 28). Butterfish were observed in 18 of the 20 tows at an average catch rate of 2.1 ± 0.4 kg/tow (range: 0 – 4.5 kg/tow). Butterfish were primarily caught in the northern half of the Control Area (Figure 29).

Summer flounder were commonly caught in the Control Area. Individuals ranged in length from 29 to 67 cm with a broad size distribution (Figure 32). Summer flounder were observed in 11 of the 20 tows at an average catch rate of 0.9 ± 0.4 kg/tow (range: 0 – 7.2 kg/tow). The catch of summer flounder was dispersed throughout the Control Area (Figure 33).

Scup ranged in length from 10 to 29 cm with a broad size distribution (Figure 30). Scup were observed in 14 of the 20 tows at an average catch rate of 0.4 ± 0.1 kg/tow (range: 0 – 2.1 kg/tow). Scup were caught throughout the Control Area (Figure 31).

Windowpane flounder ranged in length from 20 to 32 cm with a unimodal size distribution peaking at 23 cm (Figure 36). Windowpane flounder were observed in 13 of the 20 tows at an average catch rate of 0.3 ± 0.1 kg/tow (range: 0 – 1.8 kg/tow). Windowpane flounder were observed throughout the Control Area with the highest catches in the northern half of the Control Area (Figure 37).

Atlantic longfin squid were commonly caught in the Control Area but at low abundances. Individuals ranged in length from 6 to 23 cm (mantle length) with a unimodal size distribution peaking at 12 cm (Figure 34). Atlantic longfin squid were observed in 17 of the 20 tows at an average catch rate of 0.2 ± 0.04 kg/tow (range: 0 – 0.7 kg/tow). Atlantic longfin squid were caught throughout the Control Area (Figure 35). No squid "mops" were observed during this survey.

Less common recreational and commercial species observed included 5.1 kg of Atlantic sea scallops, 11 monkfish (size range: 28 – 82 cm), 10 winter flounder (size range: 15 – 41 cm), three Atlantic cod (*Gadus morhua*, 41, 49, 51 cm), and one yellowtail flounder (22 cm).

4. Acknowledgments

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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	5/4/2021	Fog	7-10	SE	0.5-1.25	7:03	N 41° 07.137	W 70° 30.570	20	7:23	N 41° 07.341	W 70° 29.319	20	6.6	95
2	501N	5/4/2021	Fog	7-10	SE	0.5-1.25	8:03	N 41° 04.767	W 70° 29.799	21	8:23	N 41° 04.491	W 70° 30.947	21	6.4	95
3	501N	5/4/2021	Fog	7-10	SE	0.5-1.25	9:01	N 41° 04.549	W 70° 30.214	22	9:21	N 41° 03.788	W 70° 29.404	23	6.4	100
4	501N	5/4/2021	Fog	7-10	SE	0.5-1.25	10:04	N 41° 06.037	W 70° 27.674	20	10:24	N 41° 06.338	W 70° 26.490	20	7.0	95
5	501N	5/4/2021	Fog	7-10	SE	0.5-1.25	10:56	N 41° 05.144	W 70° 25.572	20	11:16	N 41° 05.121	W 70° 24.373	20	7.2	95
6	501N	5/4/2021	Fog	7-10	SE	0.5-1.25	12:01	N 41° 03.692	W 70° 24.925	22	12:21	N 41° 03.621	W 70° 23.732	21	7.3	100
7	501N	5/4/2021	Overcast	7-10	SE	0.5-1.25	13:01	N 41° 02.266	W 70° 24.388	22	13:21	N 41° 01.347	W 70° 24.789	22	7.2	100
8	501N	5/4/2021	Overcast	7-10	SE	0.5-1.25	13:55	N 41° 02.544	W 70° 26.272	22	14:15	N 41° 02.559	W 70° 27.546	23	6.9	100
9	501N	5/4/2021	Overcast	11-15	SE	0.5-1.25	14:48	N 41° 01.531	W 70° 28.249	24	15:08	N 41° 00.740	W 70° 27.525	23	6.6	100
10	501N	5/4/2021	Overcast	11-15	SE	0.5-1.25	15:49	N 40° 59.257	W 70° 26.667	24	16:09	N 40° 59.771	W 70° 25.574	23	6.5	100
11	501N	5/4/2021	Overcast	16-20	SE	0.5-1.25	16:51	N 40° 59.569	W 70° 27.483	24	17:11	N 40° 59.662	W 70° 28.789	25	6.5	100
12	Control	5/5/2021	Overcast	7-10	SE	0.5-1.25	6:30	N 41° 04.043	W 70° 22.095	22	6:50	N 41° 03.972	W 70° 20.836	21	7.8	100
13	Control	5/5/2021	Overcast	7-10	SE	0.5-1.25	7:41	N 41° 02.790	W 70° 21.298	21	8:01	N 41° 01.862	W 70° 21.731	22	7.5	100
14	Control	5/5/2021	Overcast	7-10	SE	0.5-1.25	8:48	N 41° 01.444	W 70° 20.679	22	9:08	N 41° 00.926	W 70° 19.711	22	7.6	100
15	Control	5/5/2021	Overcast	7-10	SE	0.5-1.25	9:43	N 41° 01.539	W 70° 19.339	22	10:03	N 41° 02.317	W 70° 18.642	20	8.3	100
16	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	10:48	N 41° 02.855	W 70° 18.792	20	11:08	N 41° 03.528	W 70° 17.948	19	8.7	95
17	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	11:57	N 41° 02.036	W 70° 16.199	18	12:17	N 41° 01.057	W 70° 15.991	19	9.1	95
18	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	13:00	N 40° 59.626	W 70° 18.064	21	13:20	N 40° 58.813	W 70° 18.602	22	8.7	95
19	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	14:05	N 40° 58.164	W 70° 20.937	24	14:25	N 40° 59.124	W 70° 21.589	22	7.8	100
20	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	15:16	N 40° 57.541	W 70° 20.857	23	15:36	N 40° 57.116	W 70° 19.666	23	7.2	100
21	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	16:11	N 40° 55.738	W 70° 18.922	23	16:31	N 40° 54.927	W 70° 18.170	23	7.5	100
22	Control	5/5/2021	Fog	7-10	SE	0.5-1.25	17:09	N 40° 56.508	W 70° 15.886	21	17:29	N 40° 57.277	W 70° 14.802	19	8.6	95
23	Control	5/6/2021	Mostly Cloudy	7-10	NW	0.5-1.25	6:26	N 40° 51.154	W 70° 20.881	26	6:46	N 40° 51.648	W 70° 21.005	26	7.3	100
24	Control	5/6/2021	Mostly Cloudy	7-10	NW	0.5-1.25	7:23	N 40° 52.908	W 70° 23.569	26	7:43	N 40° 53.573	W 70° 24.513	26	7.0	120
25	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	8:40	N 40° 53.561	W 70° 24.191	26	9:00	N 40° 54.491	W 70° 24.060	25	6.9	120
26	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	9:49	N 40° 54.655	W 70° 21.615	24	10:09	N 40° 54.667	W 70° 20.366	24	7.1	100
27	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	10:45	N 40° 55.545	W 70° 21.698	23	11:05	N 40° 56.158	W 70° 22.645	24	7.1	100
28	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	11:38	N 40° 57.204	W 70° 23.404	23	11:58	N 40° 57.987	W 70° 24.156	23	7.0	100
29	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	12:34	N 40° 57.773	W 70° 25.432	24	12:54	N 40° 57.431	W 70° 26.635	24	6.8	100
30	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	13:24	N 40° 56.842	W 70° 27.336	25	13:44	N 40° 56.066	W 70° 28.055	25	6.6	100
31	Control	5/6/2021	Clear	11-15	NW	0.5-1.25	14:18	N 40° 55.409	W 70° 27.606	26	14:38	N 40° 54.681	W 70° 26.808	26	6.7	120
32	501N	5/6/2021	Clear	11-15	NW	0.5-1.25	15:13	N 40° 55.621	W 70° 28.551	26	15:33	N 40° 56.141	W 70° 29.592	26	6.6	120
33	501N	5/6/2021	Clear	11-15	NW	0.5-1.25	16:17	N 40° 57.582	W 70° 32.378	27	16:37	N 40° 58.002	W 70° 33.509	28	6.5	120
34	501N	5/6/2021	Clear	7-10	NW	0.5-1.25	17:17	N 40° 59.059	W 70° 31.738	26	17:37	N 40° 59.513	W 70° 30.601	26	6.7	120
35	501N	5/7/2021	Partly Cloudy	3-6	E	0.1-0.5	6:26	N 41° 00.130	W 70° 35.055	27	6:46	N 40° 59.920	W 70° 33.847	26	6.4	120
36	501N	5/7/2021	Clear	3-6	E	0.1-0.5	7:26	N 41° 00.529	W 70° 33.319	26	7:46	N 41° 01.490	W 70° 33.385	27	6.4	120
37	501N	5/7/2021	Clear	3-6	E	0.1-0.5	8:24	N 41° 01.728	W 70° 31.691	25	8:44	N 41° 01.843	W 70° 30.413	25	6.6	100
38	501N	5/7/2021	Clear	3-6	E	0.1-0.5	9:18	N 41° 03.190	W 70° 31.187	23	9:38	N 41° 03.223	W 70° 32.496	25	6.6	100
39	501N	5/7/2021	Clear	3-6	E	0.1-0.5	10:17	N 41° 01.584	W 70° 35.275	24	10:37	N 41° 01.382	W 70° 36.591	24	6.4	100
40	501N	5/7/2021	Clear	3-6	E	0.1-0.5	11:06	N 41° 01.616	W 70° 37.682	25	11:26	N 41° 01.788	W 70° 33.468	26	6.6	100

Table 2: Tow parameters for each survey tow.

Tow #	Tow Area	Tow Duration (min.)	Tow Distance (nmi.)	Tow Speed (knots)	Start Depth (fm)	Bottom Temp. (°C)	Trawl Warp (fm)	Headline Height (m.)	Wing Spread (m.)	Spread Door (m.)
1	501N	20.3	1.0	2.9	20	6.6	95	4.8	14.0	34.9
2	501N	19.8	1.0	2.9	21	6.4	95	5.2	13.6	32.6
3	501N	20.2	1.0	2.9	22	6.4	100	4.7	11.9	35.0
4	501N	20.0	1.0	2.9	20	7.0	95	5.0	14.7	34.6
5	501N	20.2	0.9	2.7	20	7.2	95	4.9	13.7	33.8
6	501N	20.0	0.9	2.7	22	7.3	100	4.7	14.5	34.3
7	501N	19.8	1.0	3.0	22	7.2	100	4.8	14.6	34.9
8	501N	20.2	1.0	2.9	22	6.9	100	4.8	14.0	34.3
9	501N	20.1	1.0	2.9	24	6.6	100	4.9	14.1	34.6
10	501N	20.3	1.0	3.0	24	6.5	100	5.2	13.7	32.5
11	501N	20.2	1.0	2.9	24	6.5	100	4.7	14.2	35.5
12	Control	20.0	1.0	2.9	22	7.8	100	4.8	14.0	34.2
13	Control	20.1	1.0	3.0	21	7.5	100	5.1	13.6	33.5
14	Control	20.2	0.9	2.8	22	7.6	100	4.7	14.0	34.7
15	Control	20.2	0.9	2.8	22	8.3	100	4.6	13.9	35.3
16	Control	20.4	0.9	2.8	20	8.7	95	4.7	14.0	34.6
17	Control	20.2	1.0	2.9	18	9.1	95	4.8	13.8	33.7
18	Control	20.1	1.0	2.9	21	8.7	95	4.9	13.4	33.1
19	Control	20.1	1.1	3.2	24	7.8	100	4.9	13.8	33.6
20	Control	20.3	1.0	3.0	23	7.2	100	4.9	13.7	34.4
21	Control	20.2	1.0	3.0	23	7.5	100	4.8		34.3
22	Control	20.3	1.1	3.3	21	8.6	95	5.2	13.9	32.3
23	Control	20.4	1.0	2.9	26	7.3	100	5.3	13.6	33.9
24	Control	20.1	1.0	2.9	26	7.0	120	4.6	14.2	36.7
25	Control	20.1	1.0	2.9	26	6.9	120	4.9	14.2	35.7
26	Control	20.0	1.0	2.9	24	7.1	100	4.9	14.1	34.7
27	Control	20.1	0.9	2.8	23	7.1	100	5.3	13.7	33.3
28	Control	20.2	1.0	2.9	23	7.0	100	5.3	13.6	33.4
29	Control	20.0	1.0	3.0	24	6.8	100	5.4	13.5	32.9
30	Control	20.0	1.0	2.9	25	6.6	100	5.1	14.0	34.2
31	Control	19.9	1.0	2.9	26	6.7	120	4.5	14.5	37.0
32	501N	20.0	1.0	2.9	26	6.6	120	5.2	13.9	34.2
33	501N	20.0	1.0	2.9	27	6.5	120	5.1	14.0	35.3
34	501N	20.0	1.0	3.0	26	6.7	120	5.0	14.2	35.5
35	501N	20.1	0.9	2.8	27	6.4	120	5.2	13.7	34.0
36	501N	19.9	1.0	2.9	26	6.4	120	4.8	14.2	35.7
37	501N	20.2	1.0	2.9	25	6.6	100	5.1	13.9	34.1
38	501N	20.0	1.0	3.0	23	6.6	100	4.9	14.0	34.8
39	501N	20.1	1.0	3.0	24	6.4	100	4.9	13.9	34.5
40	501N	19.5	1.0	2.9	25	6.6	100	5.0	13.8	34.3
Summary Statistics										
Control	Minimum	19.9	0.9	2.8	18	6.6	95	4.5	13.4	32.3
	Maximum	20.4	1.1	3.3	26	9.1	120	5.4	14.5	37.0
	Average	20.1	1.0	2.9	23.0	7.6	102	4.9	13.9	34.3
	St. Dev	0.1	0.04	0.1	2.2	0.8	8	0.3	0.3	1.2
501N	Minimum	19.5	0.9	2.7	20	6.4	95	4.7	11.9	32.5
	Maximum	20.3	1.0	3.0	27	7.3	120	5.2	14.7	35.7
	Average	20.0	1.0	2.9	23.5	6.7	104	5.0	13.9	34.5
	St. Dev.	0.2	0.03	0.1	2.3	0.3	10	0.2	0.6	0.8

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, Winter	*Leucoraja ocellata*	669.8	33.4	4.5	31.5	19
Skate, Little	*Leucoraja erinacea*	669.4	33.4	3.9	31.5	20
Hake, Red	*Urophycis chuss*	180.5	9.0	1.3	8.5	19
Hake, Silver (Whiting)	*Merluccius bilinearis*	103.1	5.1	0.7	4.9	20
Dogfish, Spiny	*Squalus acanthias*	99.1	5.0	4.7	4.7	8
Black Sea bass	*Centropristis striata*	98.1	4.9	0.6	4.6	19
Herring, Atlantic	*Clupea harengus*	66.0	3.3	2.1	3.1	14
Herring, Blueback	*Alosa aestivalis*	45.3	2.3	1.2	2.1	11
Flounder, Fourspot	*Paralichthys oblongus*	23.1	1.2	0.2	1.1	18
Alewife	*Alosa pseudoharengus*	20.1	1.0	0.3	0.9	12
Butterfish	*Peprilus triacanthus*	19.9	1.0	0.2	0.9	19
Ocean Pout	*Zoarces americanus*	19.0	0.9	0.2	0.9	11
Northern Sea Robin	*Prionotus carolinus*	17.3	0.9	0.2	0.8	17
Scup	*Stenotomus chrysops*	15.9	0.8	0.3	0.7	12
Flounder, Summer (Fluke)	*Paralichthys dentatus*	11.0	0.5	0.2	0.5	11
Crab, Rock	*Cancer irroratus*	9.9	0.5	0.2	0.5	13
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	9.5	0.5	0.2	0.4	12
Sea Scallop	*Placopecten magellanicus*	8.7	0.4	0.1	0.4	12
Menhaden, Atlantic	*Brevoortia tyrannus*	8.5	0.4	0.2	0.4	4
Squid, Atlantic Longfin	*Dorytheuthis pealei*	7.7	0.4	0.1	0.4	16
Skate, Barndoor	*Dipturus laevis*	5.4	0.3	0.1	0.3	11
Flounder, Windowpane	*Scophtalmus aquosus*	3.4	0.2	0.1	0.2	11
Monkfish	*Lophius americanus*	3.0	0.1	0.1	0.1	3
Flounder, Winter	*Pleuronectes americanus*	2.9	0.1	0.1	0.1	4
Flounder, Gulfstream	*Citharichthys arctifrons*	2.5	0.1	0.0	0.1	13
Dogfish, Smooth	*Mustelus canis*	2.3	0.1	0.1	0.1	1
Mackeral, Atlantic	*Scomber scombrus*	1.7	0.1	0.0	0.1	6
Flounder, Yellowtail	*Pleuronectes ferrugineus*	1.4	0.1	0.1	0.1	2
Eel, Conger	*Conger Oceanicus*	0.7	0.0	0.0	0.0	1
Sea Raven	*Hemitripterus americanus*	0.4	0.0	0.0	0.0	1
Total		2125.5				

*SEM is an acronym for Standard Error of the Mean

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

Species Name	Scientific Name	Total Weight (Kg)	Catch/Tow (Kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Dogfish, Spiny	*Squalus acanthias*	1177.5	58.7	27.9	28.4	12
Skate, Little	*Leucoraja erinacea*	1134.4	56.3	8.2	27.4	20
Skate, Winter	*Leucoraja ocellata*	803.0	39.9	3.7	19.4	20
Hake, Red	*Urophycis chuss*	350.8	17.4	2.8	8.5	20
Hake, Silver (Whiting)	*Merluccius bilinearis*	189.5	9.4	1.4	4.6	20
Alewife	*Alosa pseudoharengus*	107.9	5.4	2.9	2.6	15
Black Sea bass	*Centropristis striata*	58.1	2.9	0.4	1.4	19
Flounder, Fourspot	*Paralichthys oblongus*	45.8	2.3	0.3	1.1	20
Herring, Atlantic	*Clupea harengus*	44.5	2.2	1.4	1.1	18
Butterfish	*Peprilus triacanthus*	42.3	2.1	0.4	1.0	18
Monkfish	*Lophius americanus*	24.0	1.2	0.6	0.6	8
Northern Sea Robin	*Prionotus carolinus*	23.3	1.2	0.2	0.6	19
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	22.7	1.1	0.3	0.5	12
Flounder, Summer (Fluke)	*Paralichthys dentatus*	17.7	0.9	0.4	0.4	11
Mackeral, Atlantic	*Scomber scombrus*	17.3	0.9	0.4	0.4	10
Ocean Pout	*Zoarces americanus*	16.9	0.8	0.2	0.4	12
Herring, Blueback	*Alosa aestivalis*	9.5	0.5	0.2	0.2	6
Skate, Barndoor	*Dipturus laevis*	7.8	0.4	0.1	0.2	12
Dogfish, Smooth	*Mustelus canis*	7.8	0.4	0.2	0.2	3
Scup	*Stenotomus chrysops*	7.7	0.4	0.1	0.2	14
Flounder, Windowpane	*Scophtalmus aquosus*	6.2	0.3	0.1	0.1	13
Sea Scallop	*Placopecten magellanicus*	5.1	0.3	0.1	0.1	10
Crab, Rock	*Cancer irroratus*	5.1	0.3	0.1	0.1	9
Squid, Atlantic Longfin	*Dorytheuthis pealei*	4.6	0.2	0.0	0.1	17
Flounder, Winter	*Pleuronectes americanus*	4.1	0.2	0.1	0.1	4
Atlantic Cod	*Gadus morhua*	3.1	0.2	0.1	0.1	3
Flounder, Gulfstream	*Citharichthys arctifrons*	2.4	0.1	0.0	0.1	12
Sea Raven	*Hemitripterus americanus*	1.2	0.1	0.1	0.0	2
Shad, American	*Alosa sapidissima*	0.8	0.0	0.0	0.0	3
Flounder, Yellowtail	*Pleuronectes ferrugineus*	0.1	0.0	0.0	0.0	1
Total		4141.1				

*SEM is an acronym for Standard Error of the Mean

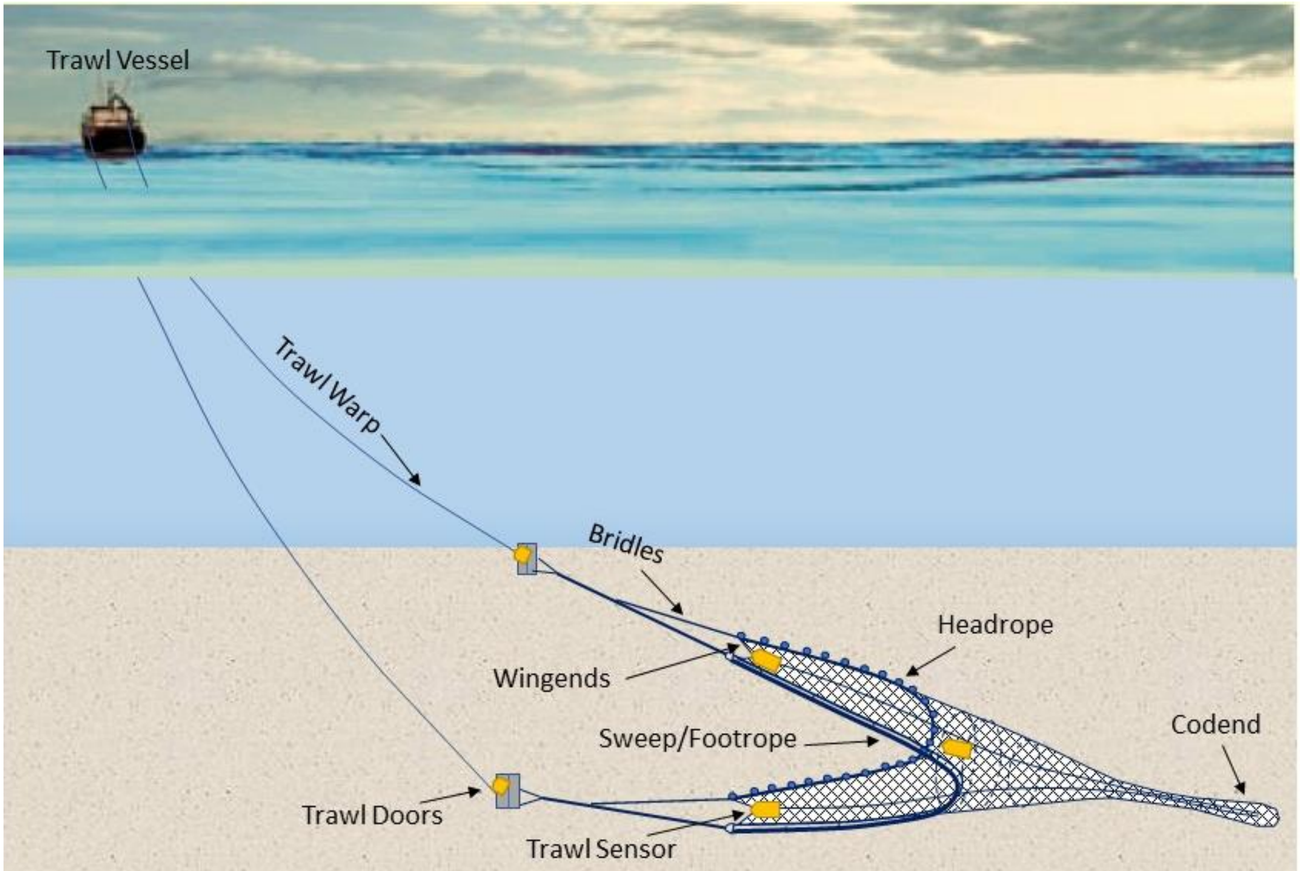


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

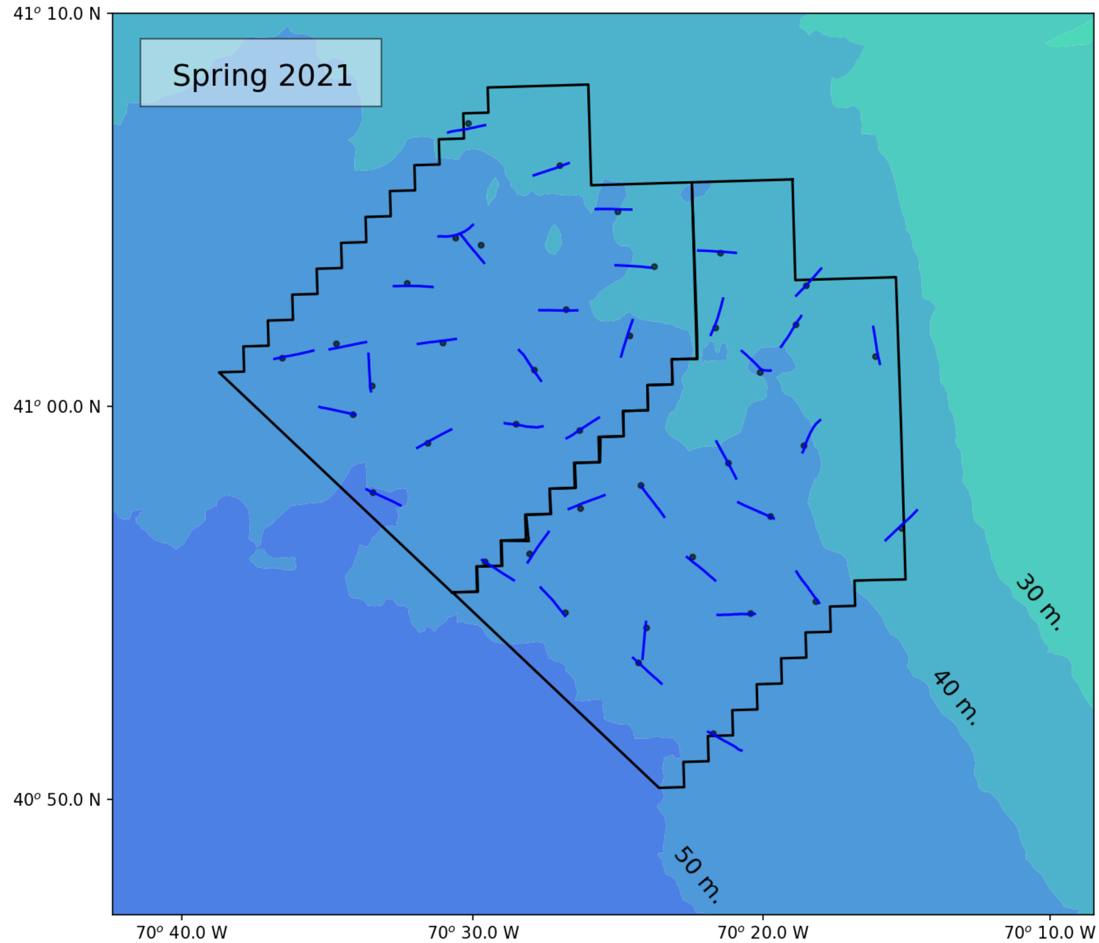


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the 501N Study Area (left) and the Control Area (right).

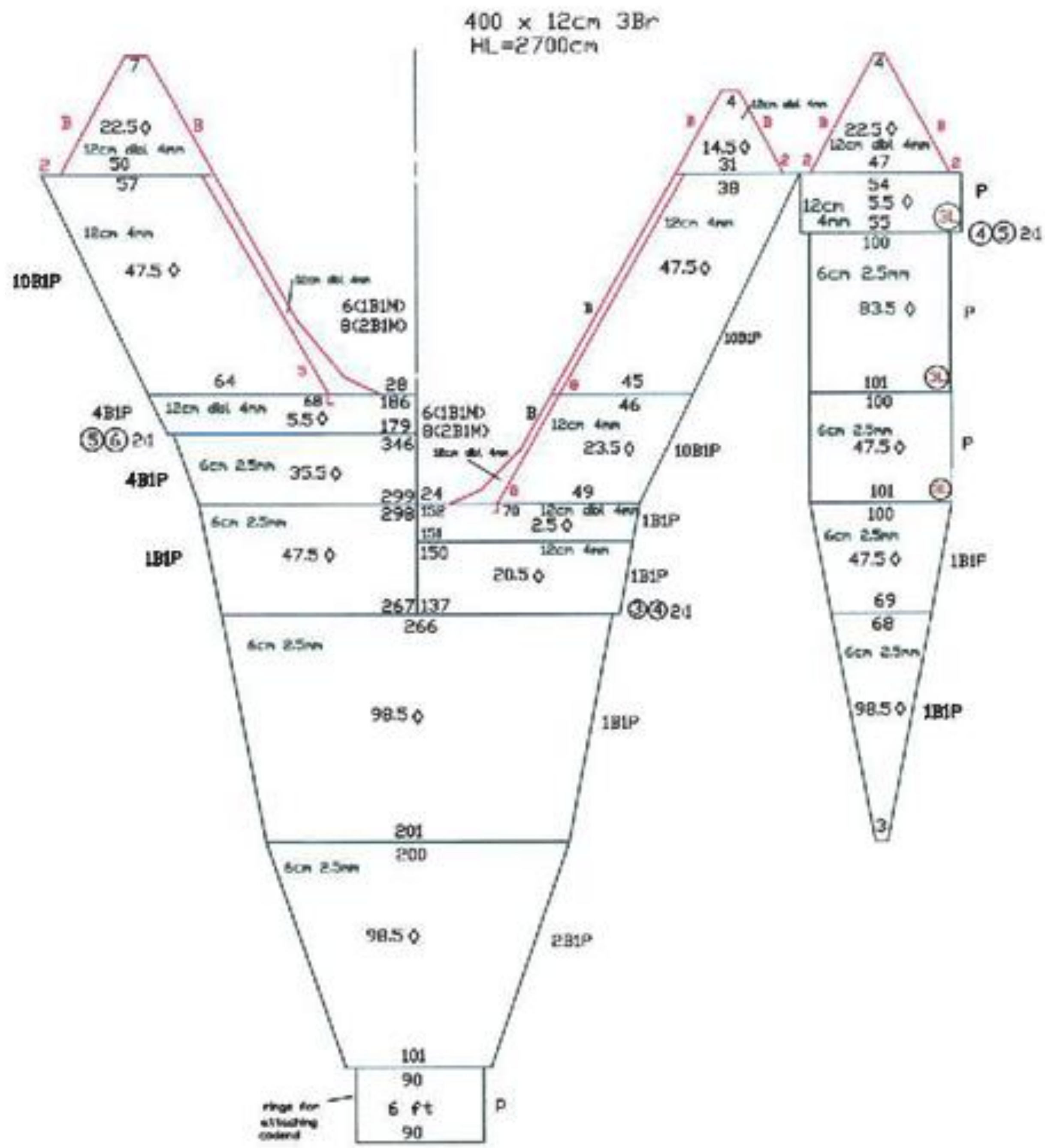


Figure 3: Schematic net plan for the NEAMAP trawl (Bonzek et al., 2008).

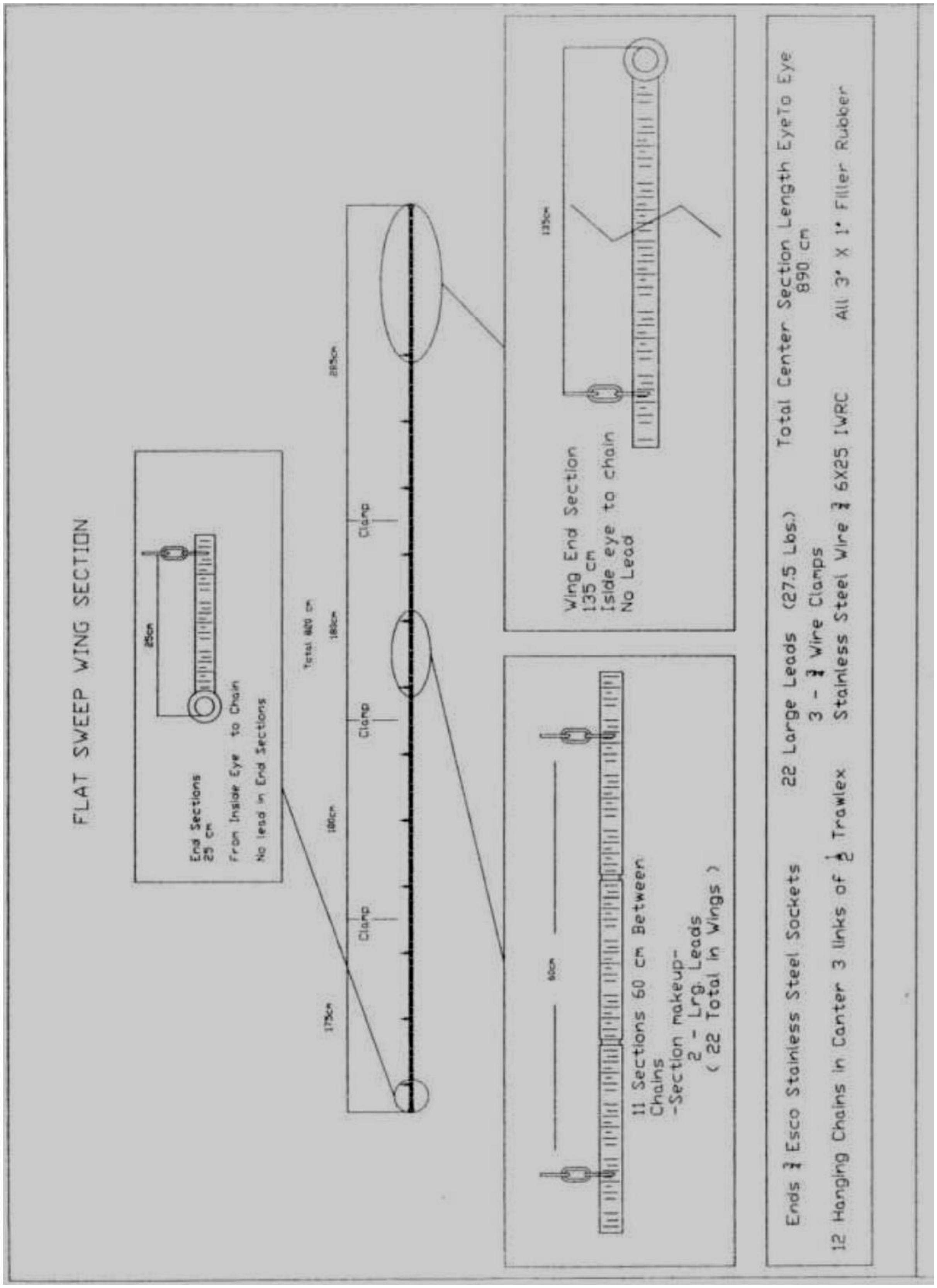


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

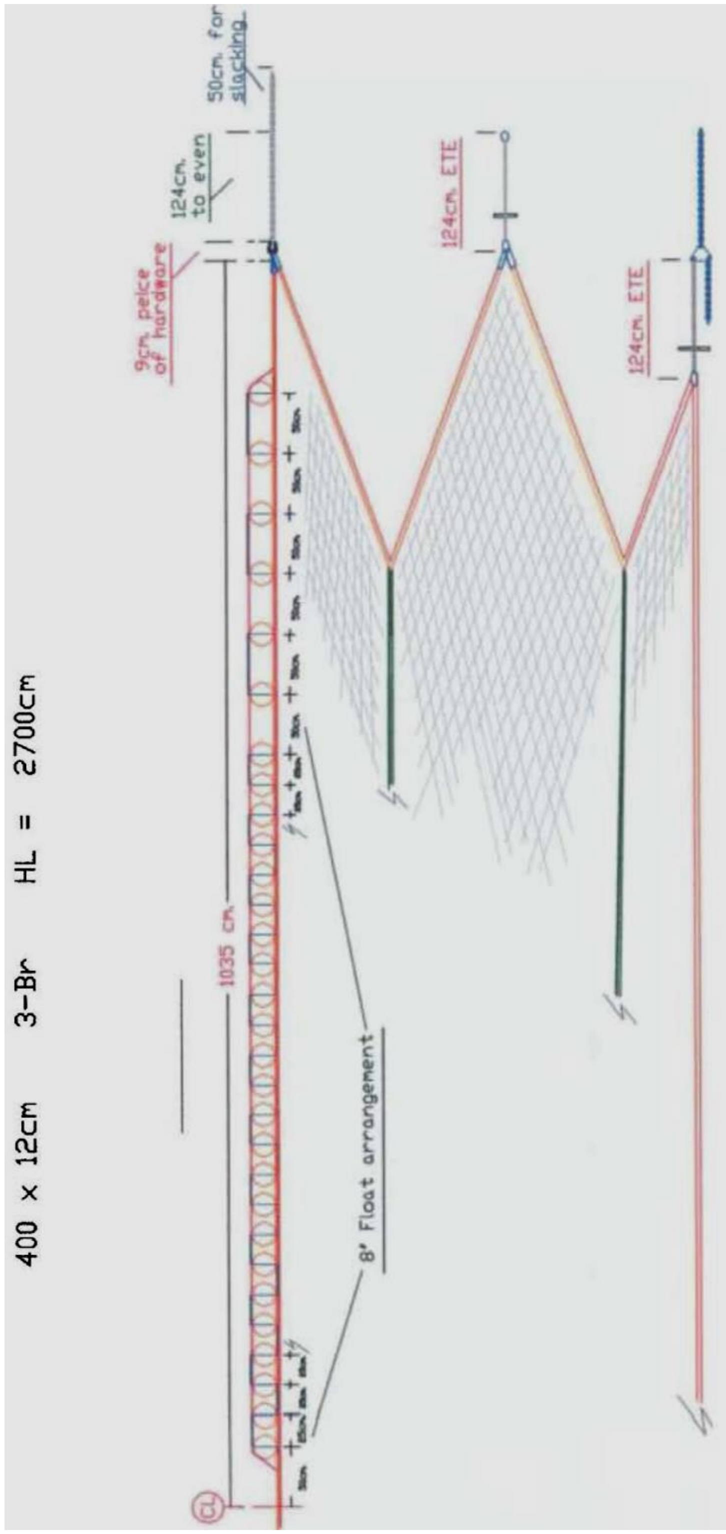


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008).

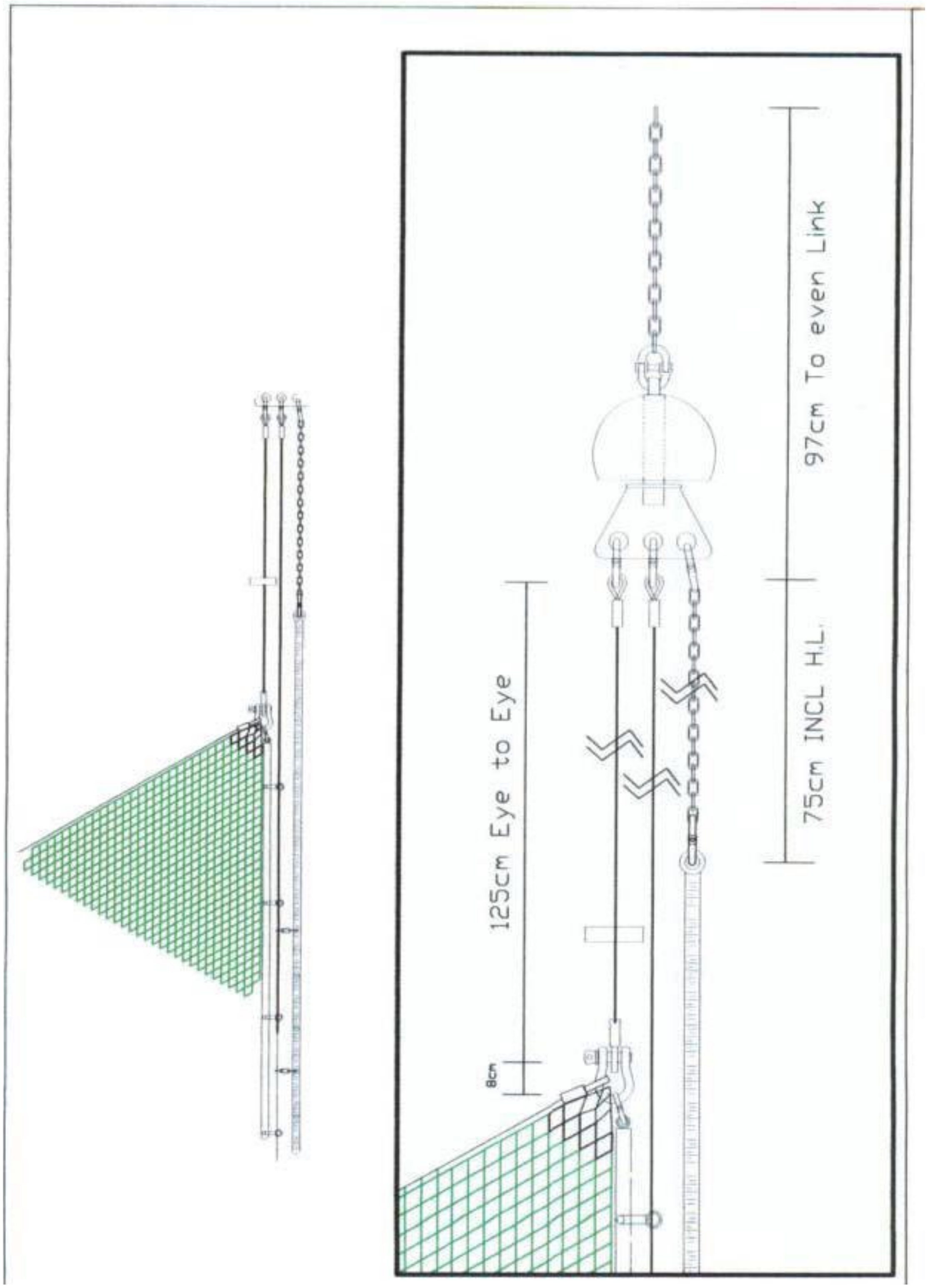


Figure 6: Lower wing and bobbin schematic for the survey trawl (Bonzek et al., 2008).

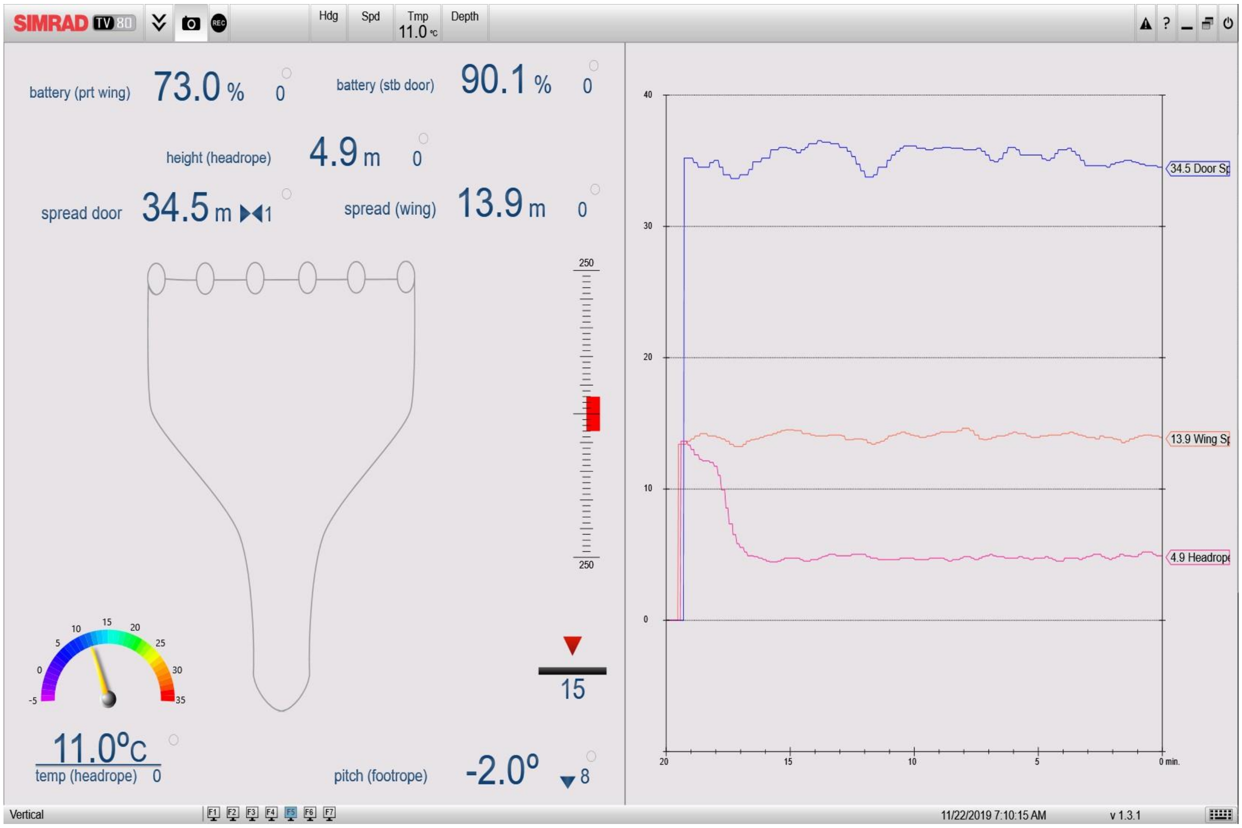


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.

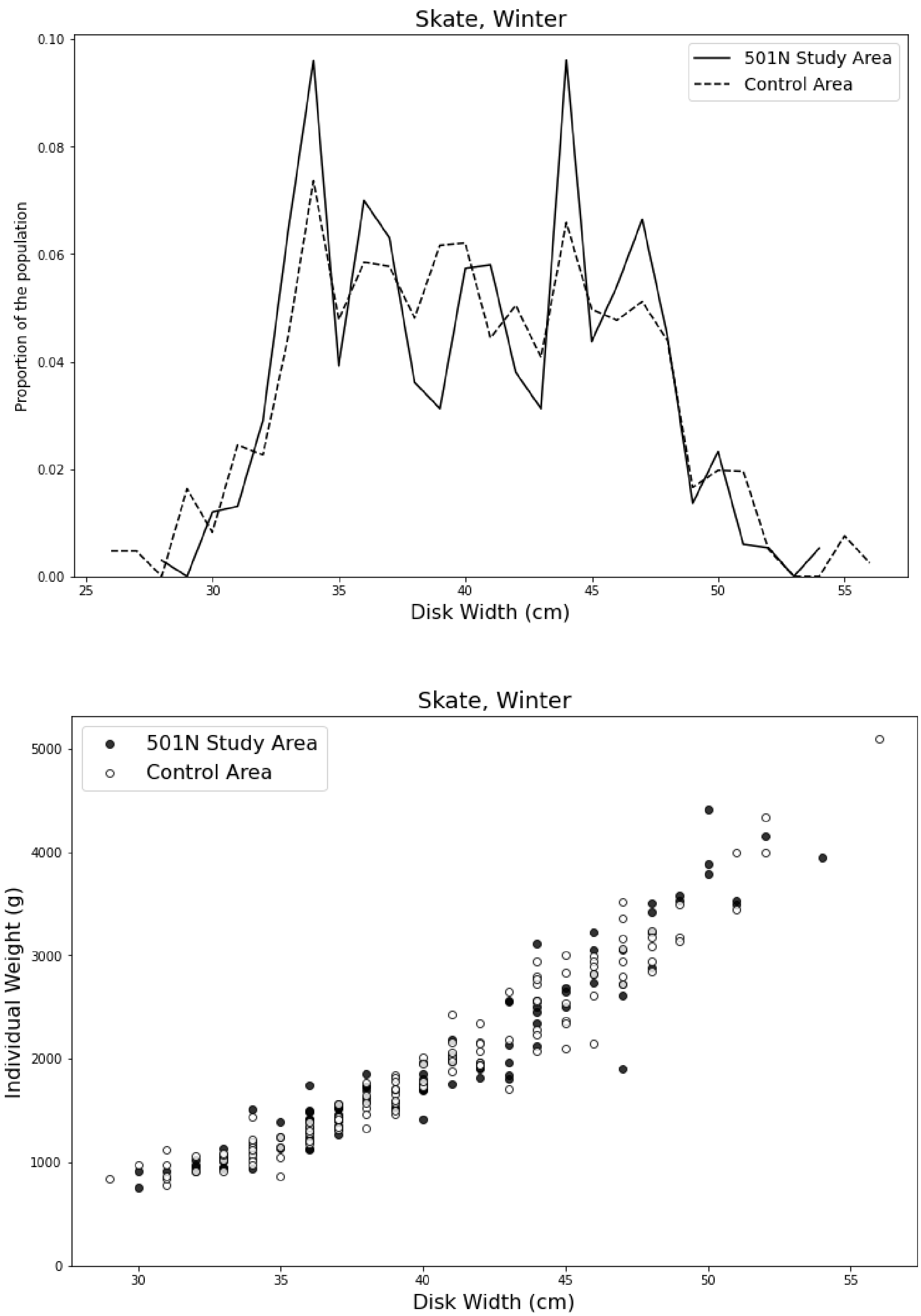


Figure 8: Population structure of winter skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

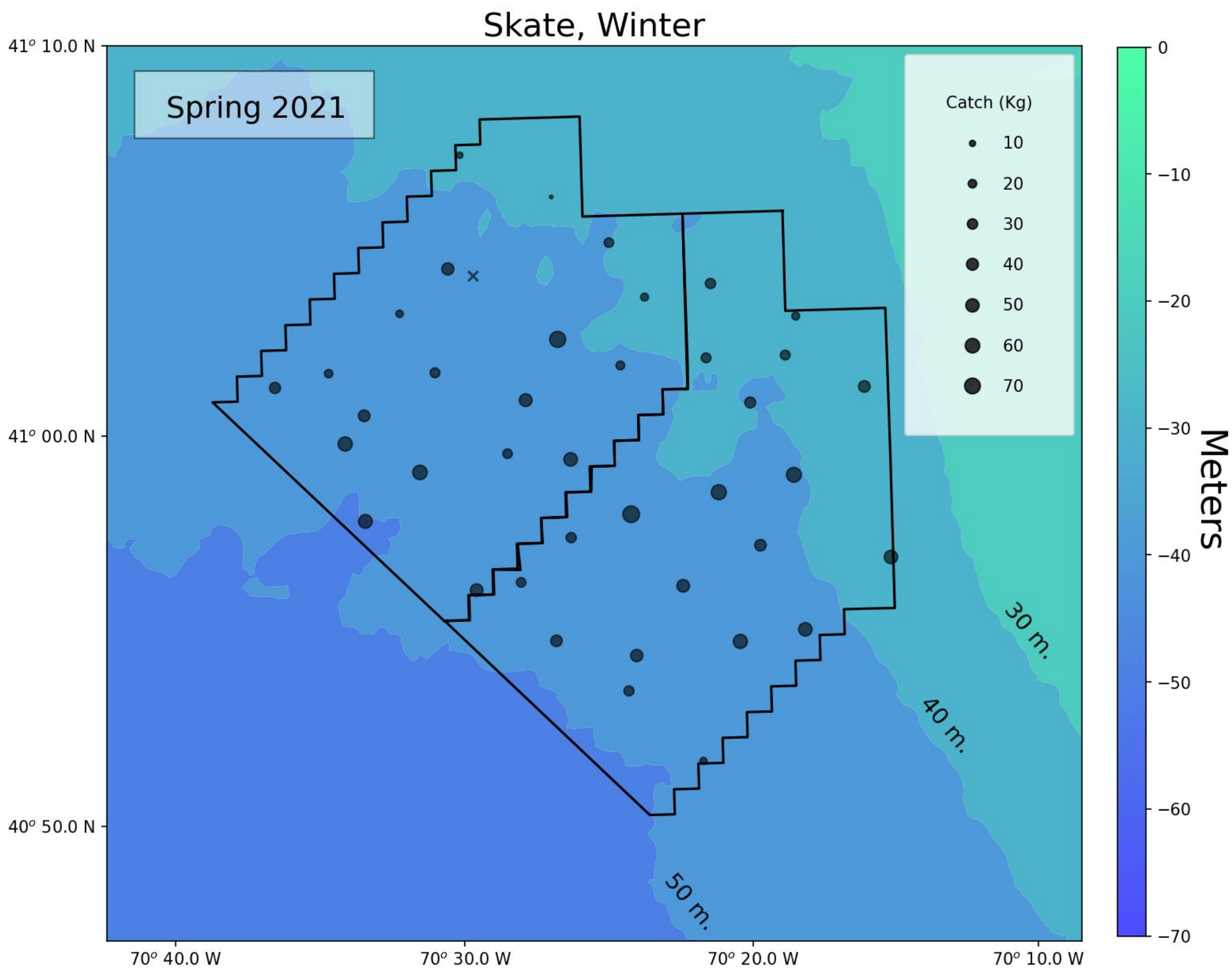
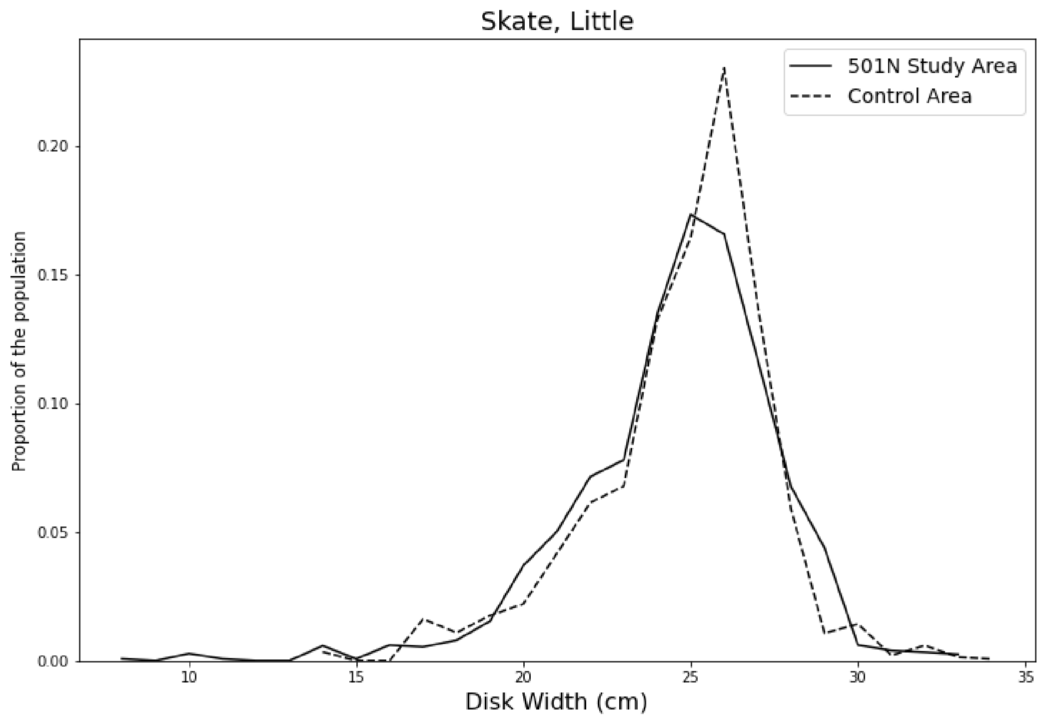


Figure 9: Distribution of the catch of winter skate in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



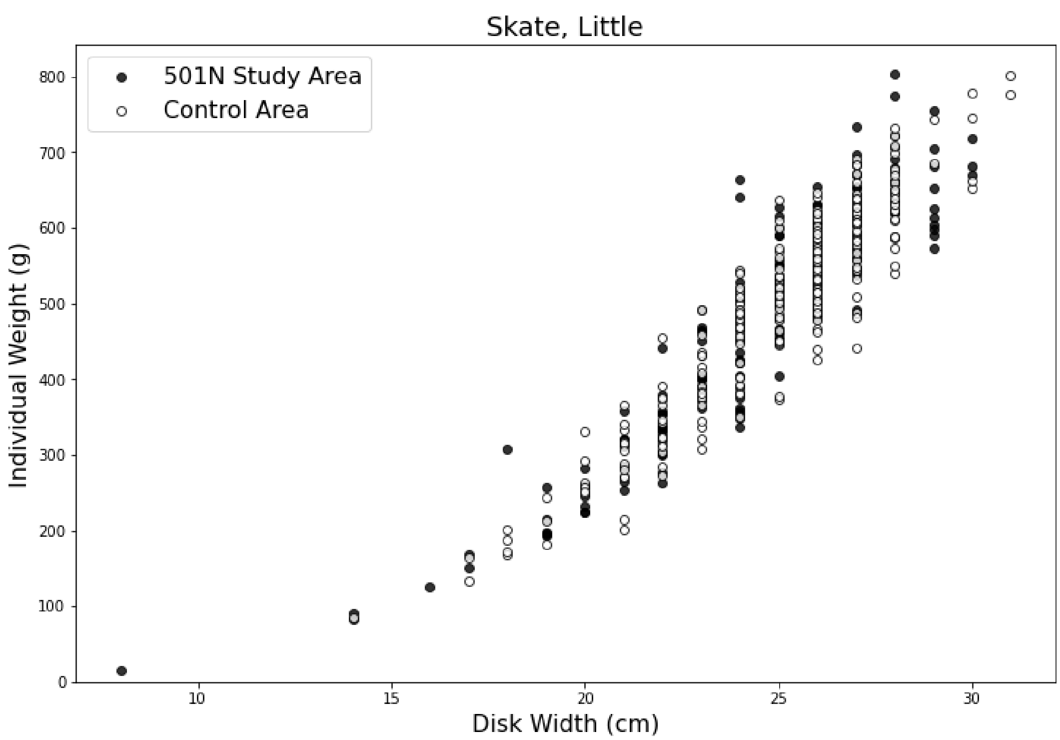


Figure 10: Population structure of little skate in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

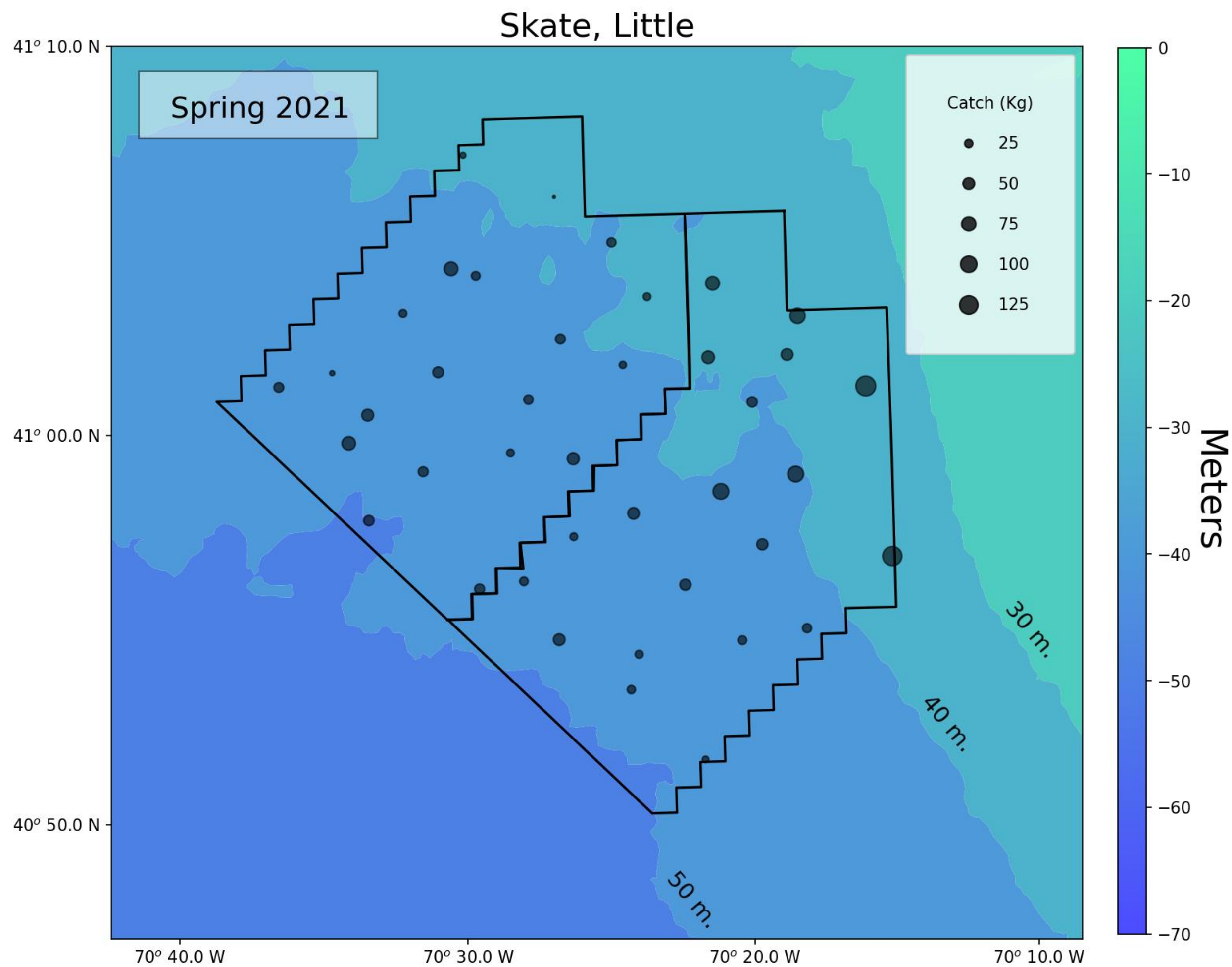
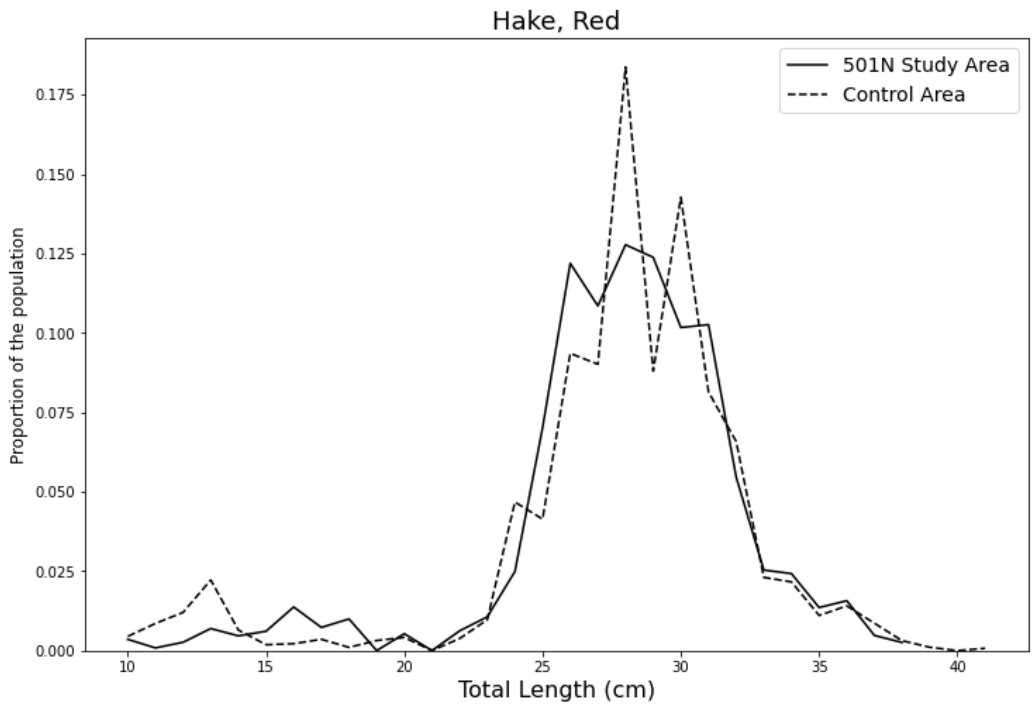


Figure 11: Distribution of the catch of little skate in the 501N Study Area (left) and Control Area (right).



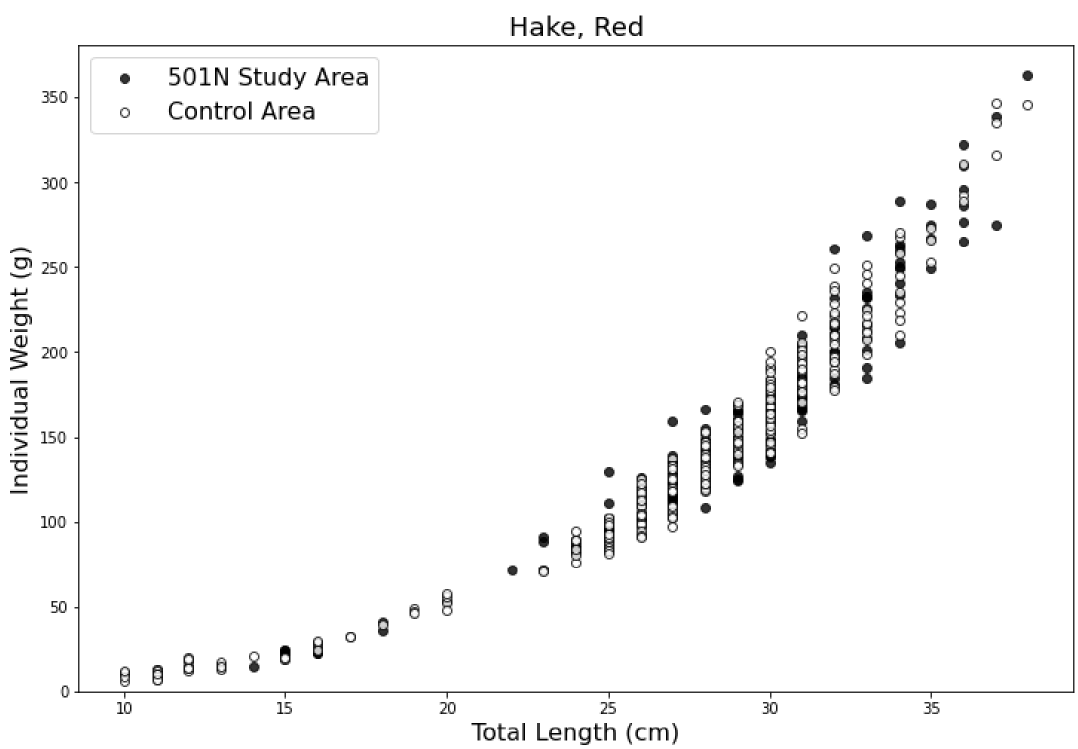


Figure 12: Population structure of red hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

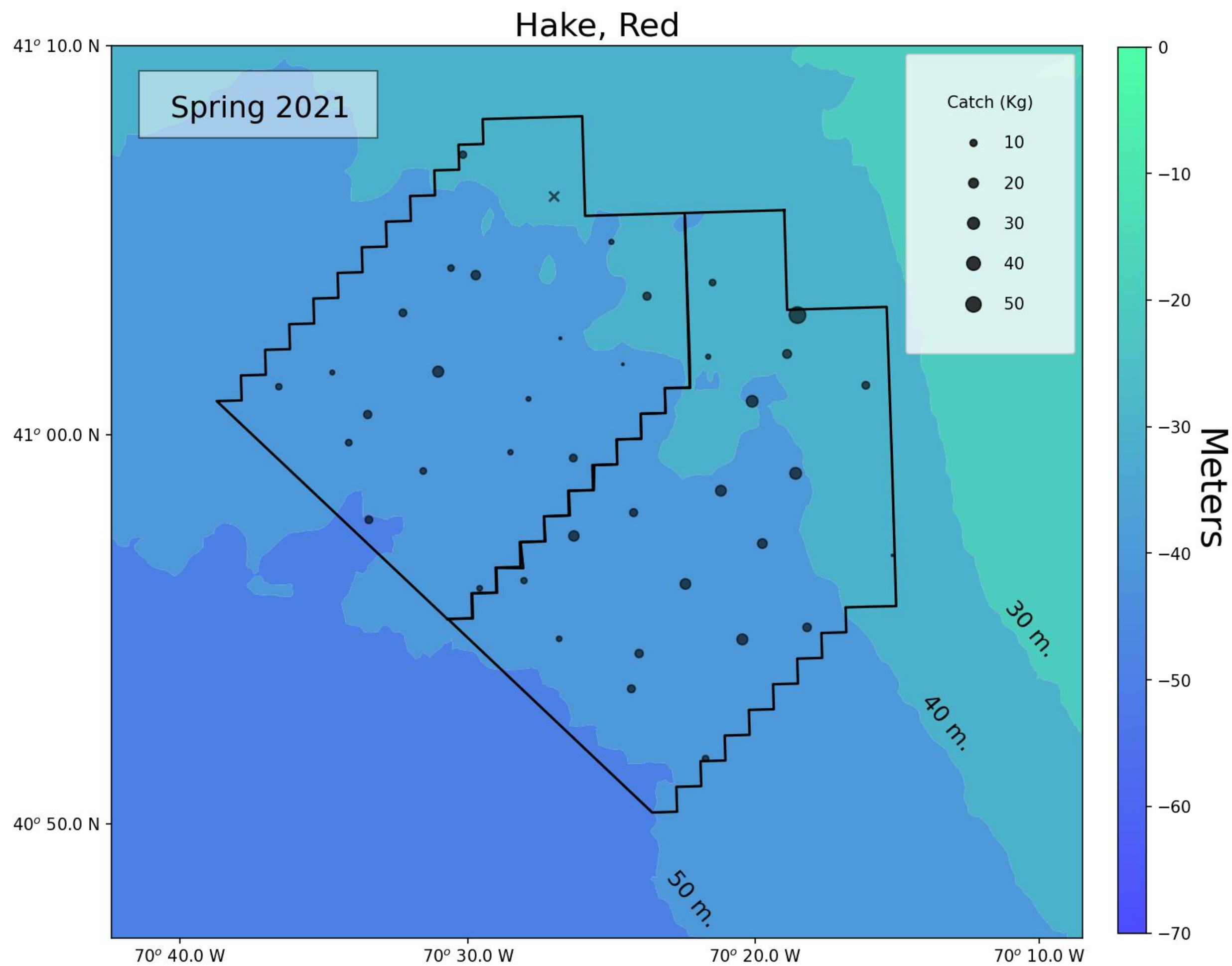
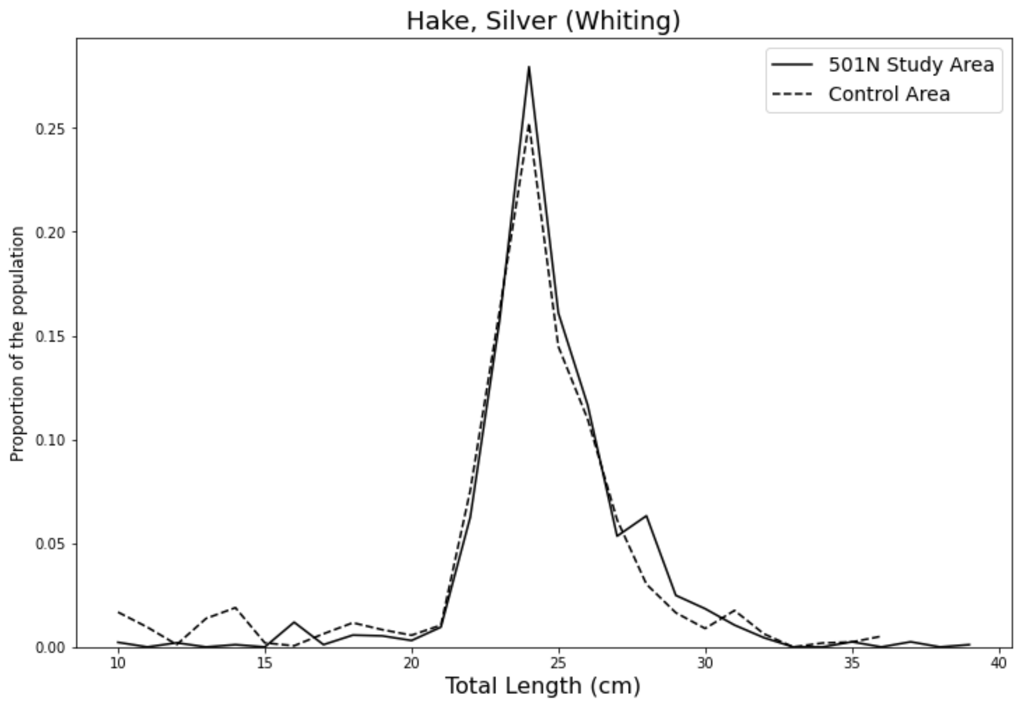


Figure 13: Distribution of the catch of red hake in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



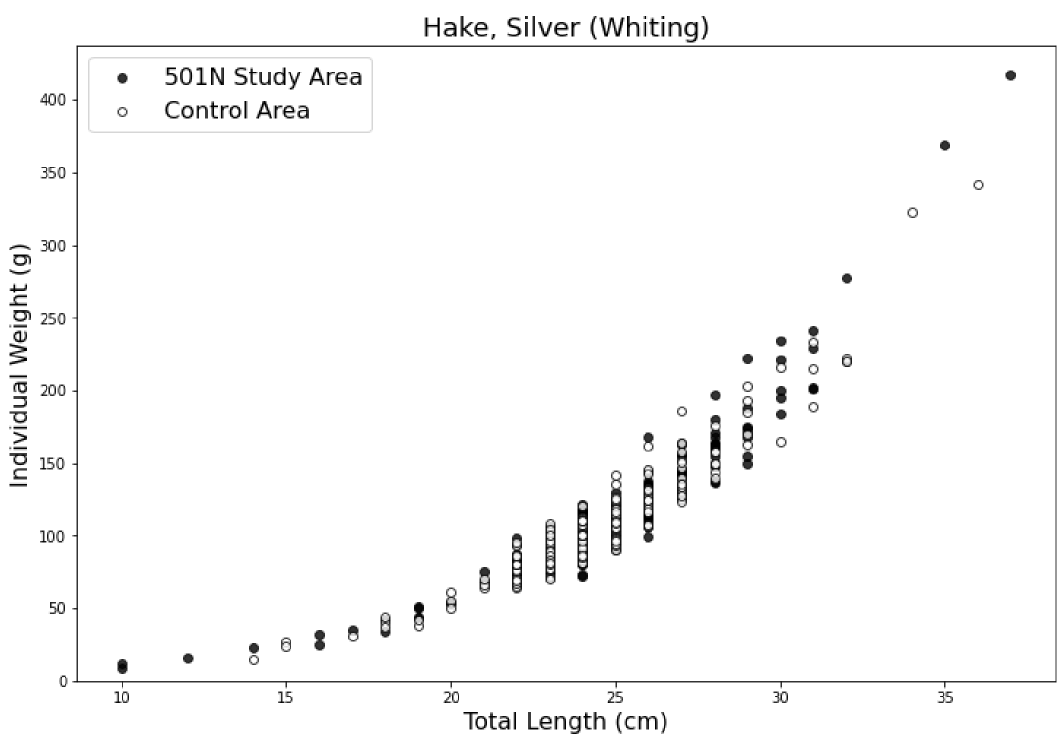


Figure 14: Population structure of silver hake in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

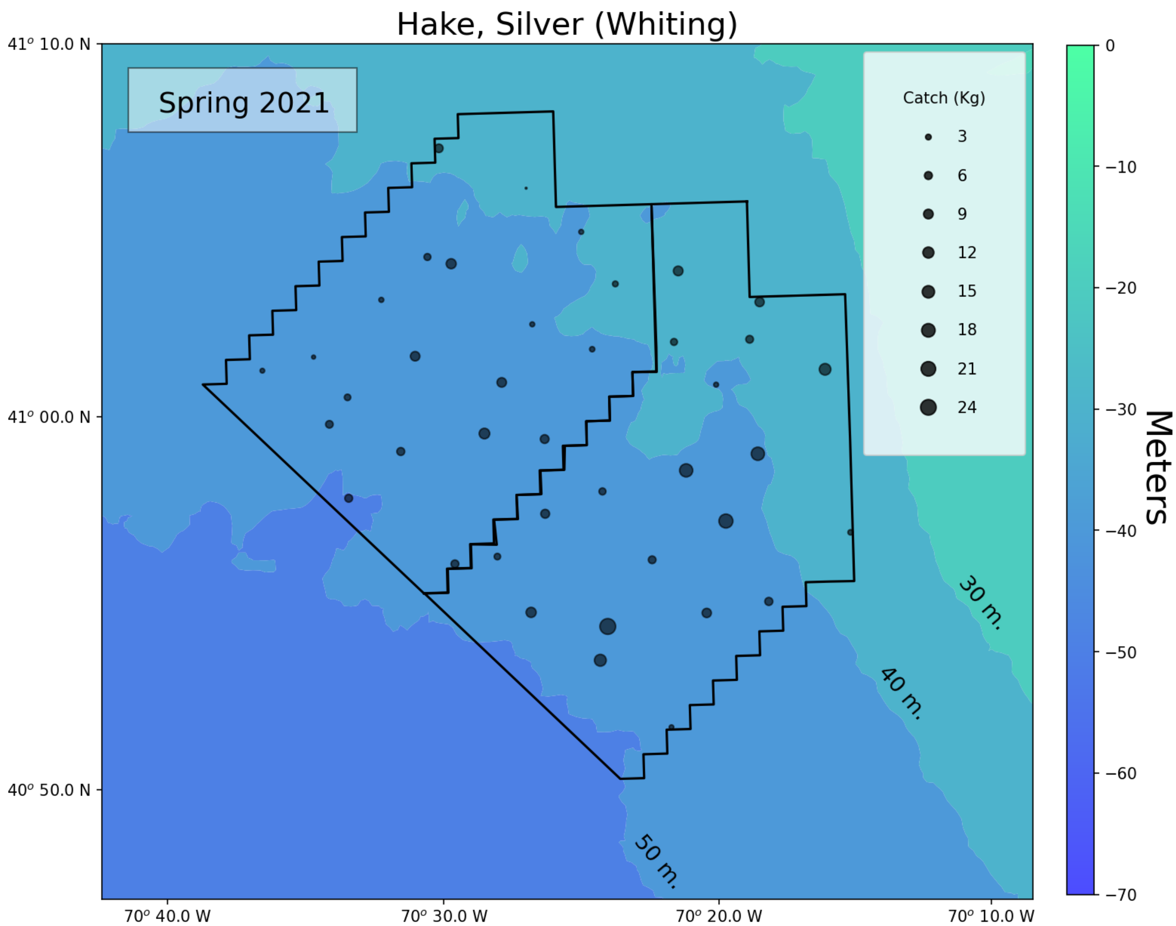
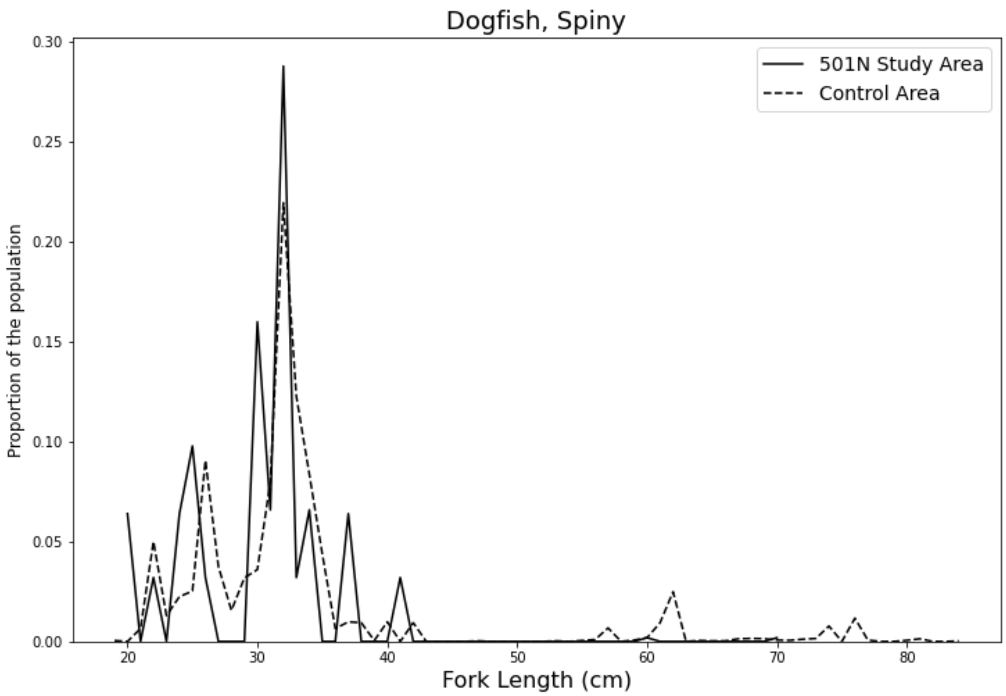


Figure 15: Distribution of the catch of silver hake in the 501N Study Area (left) and Control Area (right).



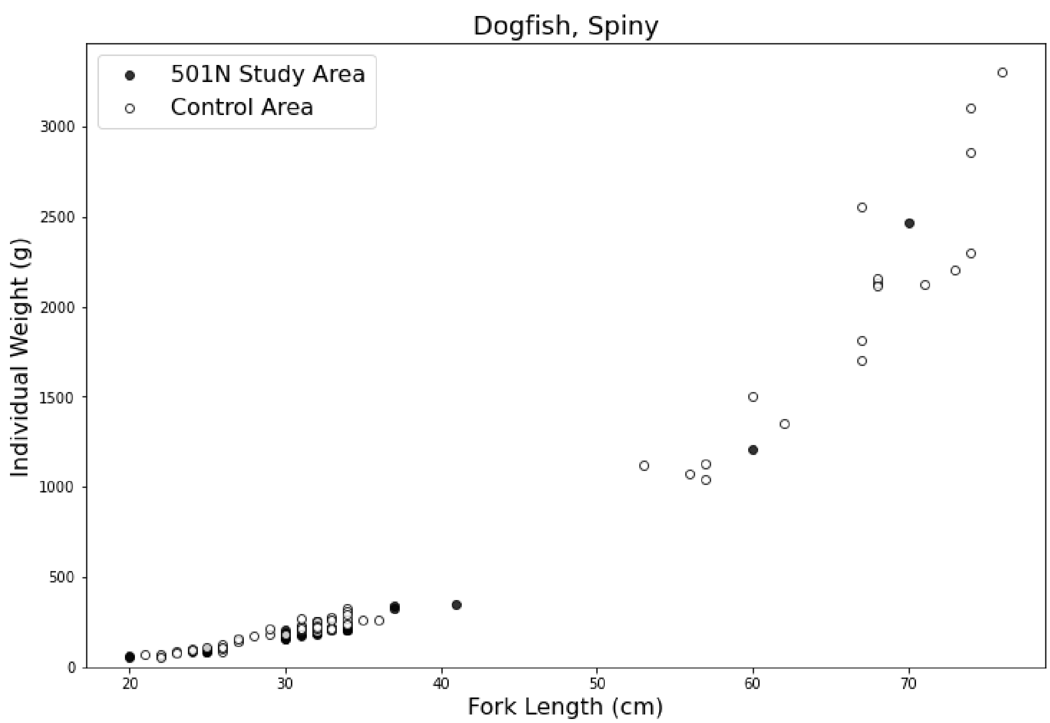


Figure 16: Population structure of spiny dogfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

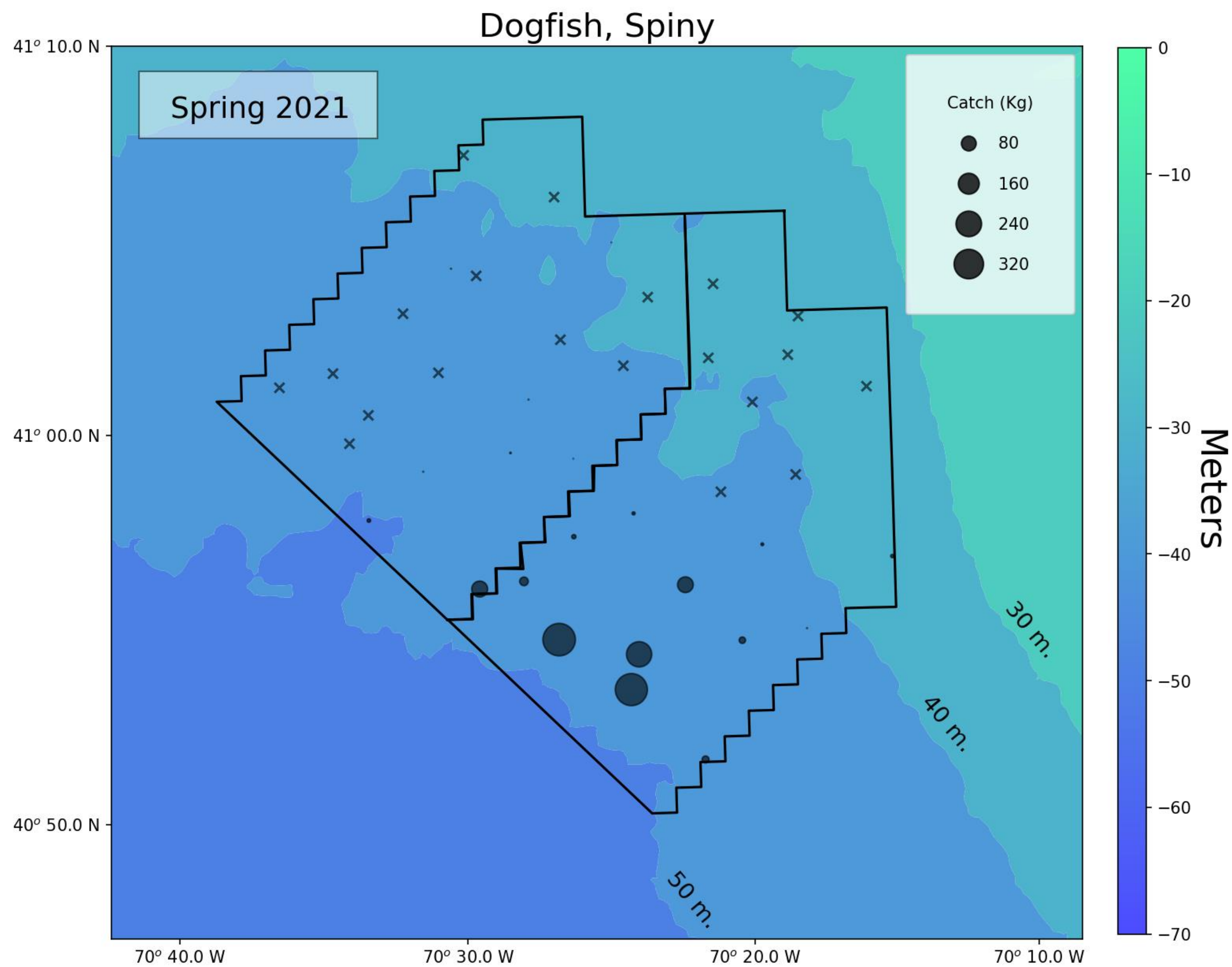
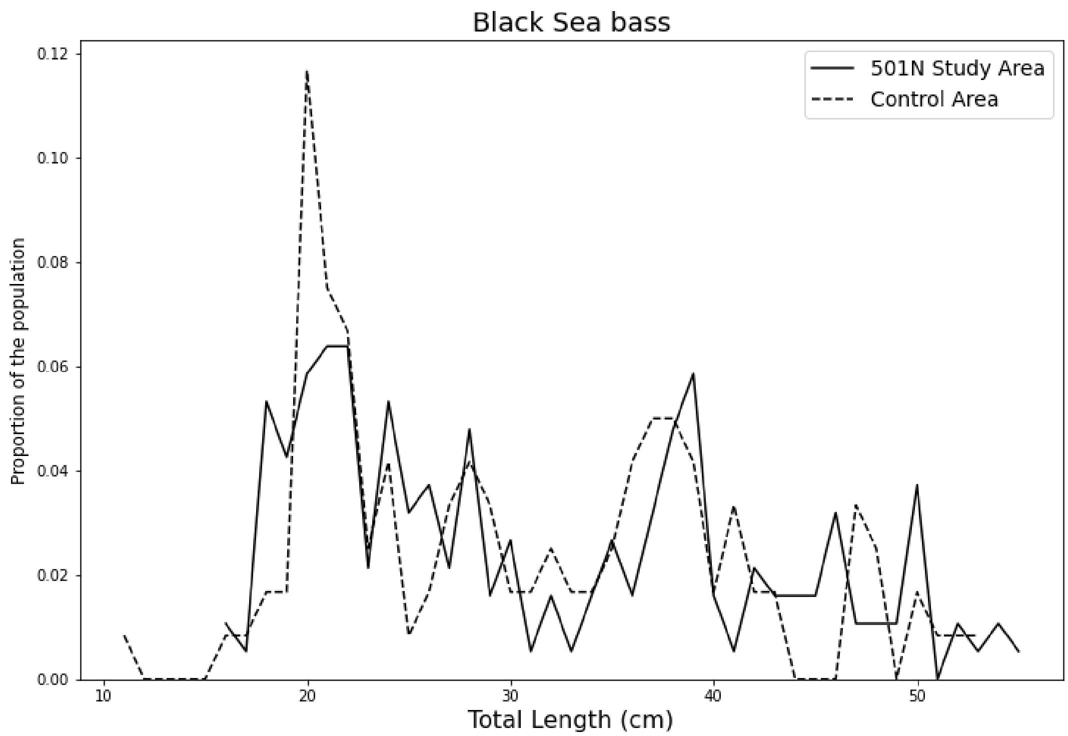


Figure 17: Distribution of the catch of spiny dogfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



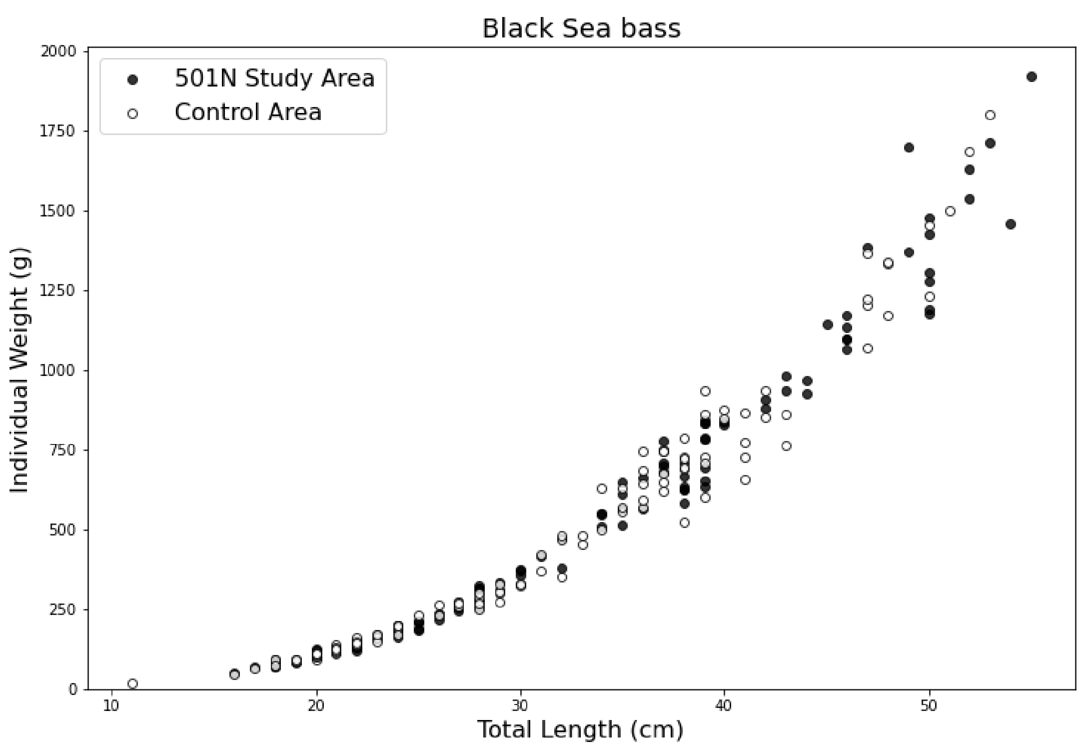


Figure 18: Population structure of black sea bass in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

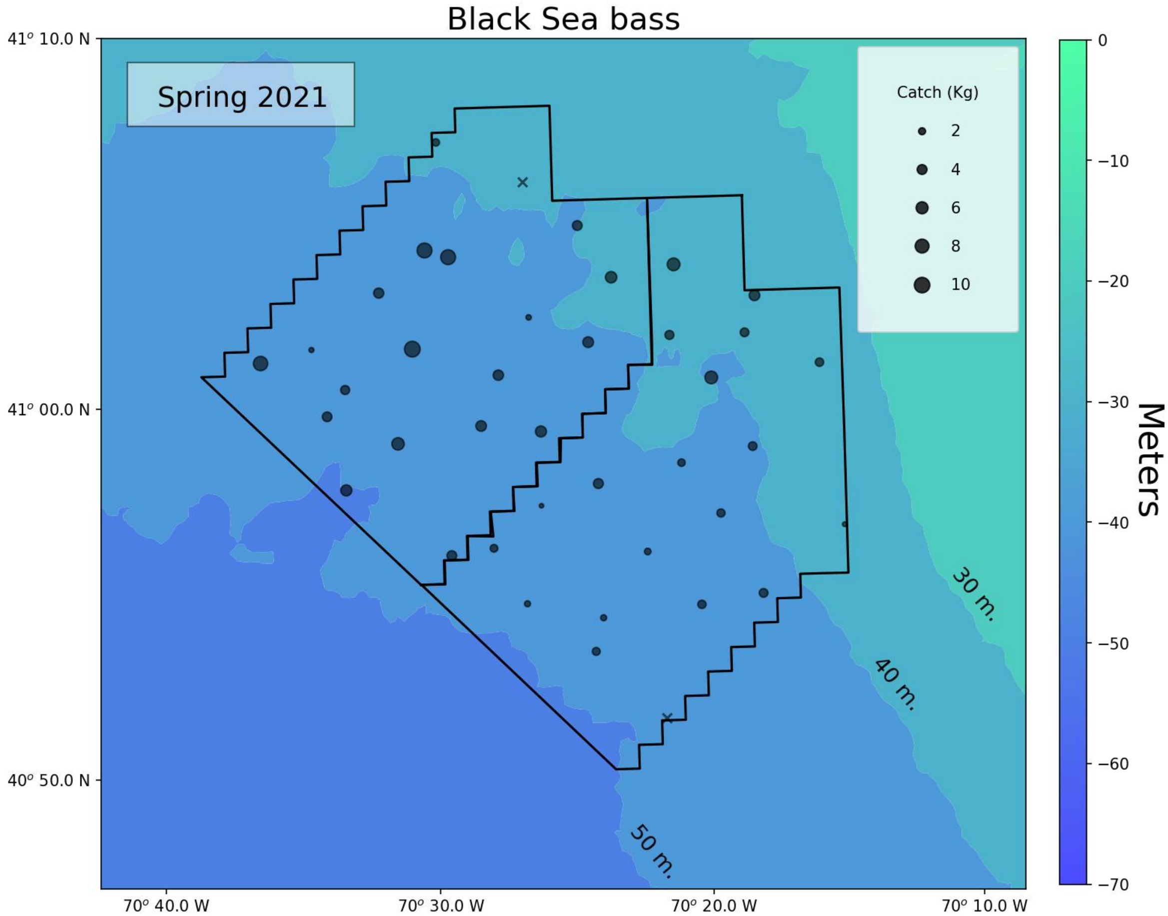
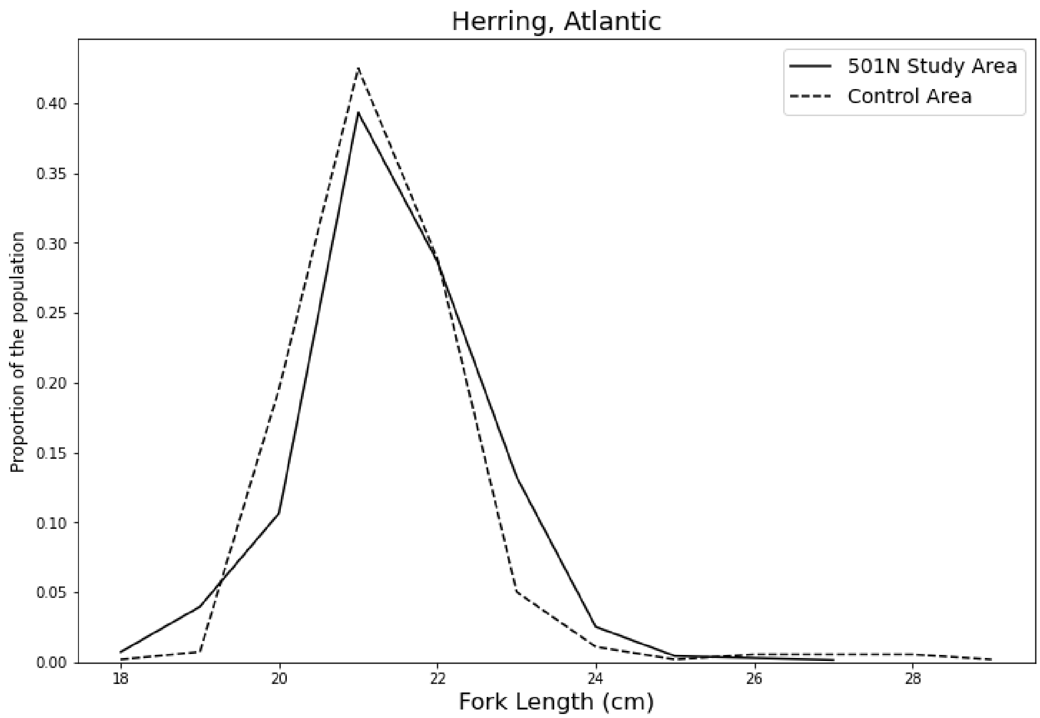


Figure 19: Distribution of the catch of black sea bass in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



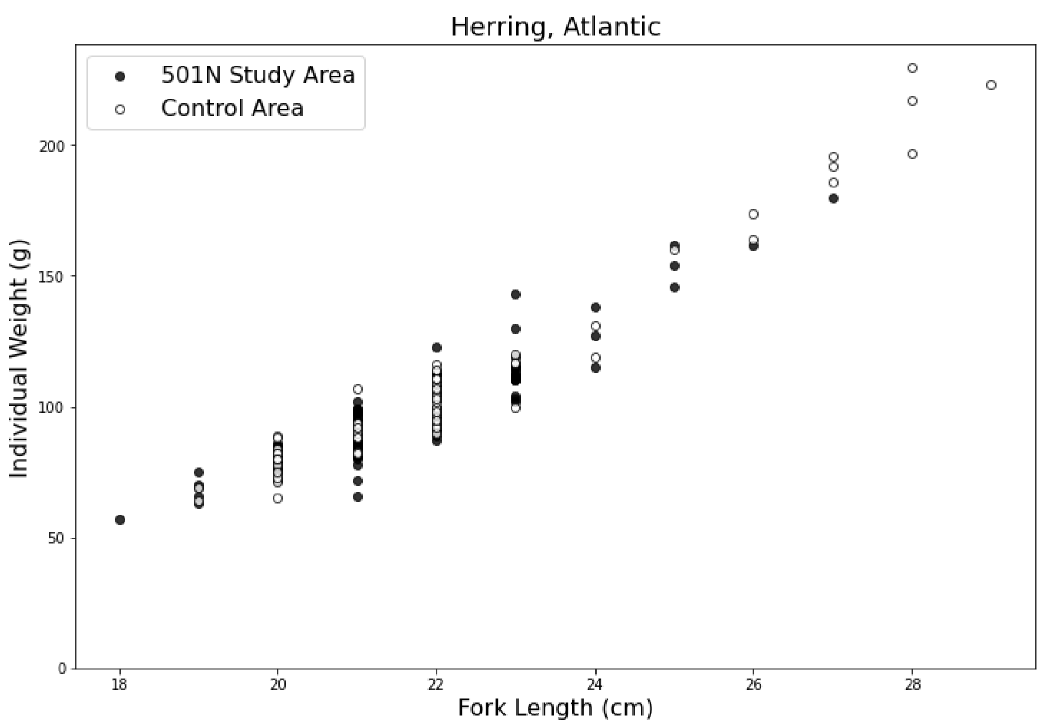


Figure 20: Population structure of Atlantic herring in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

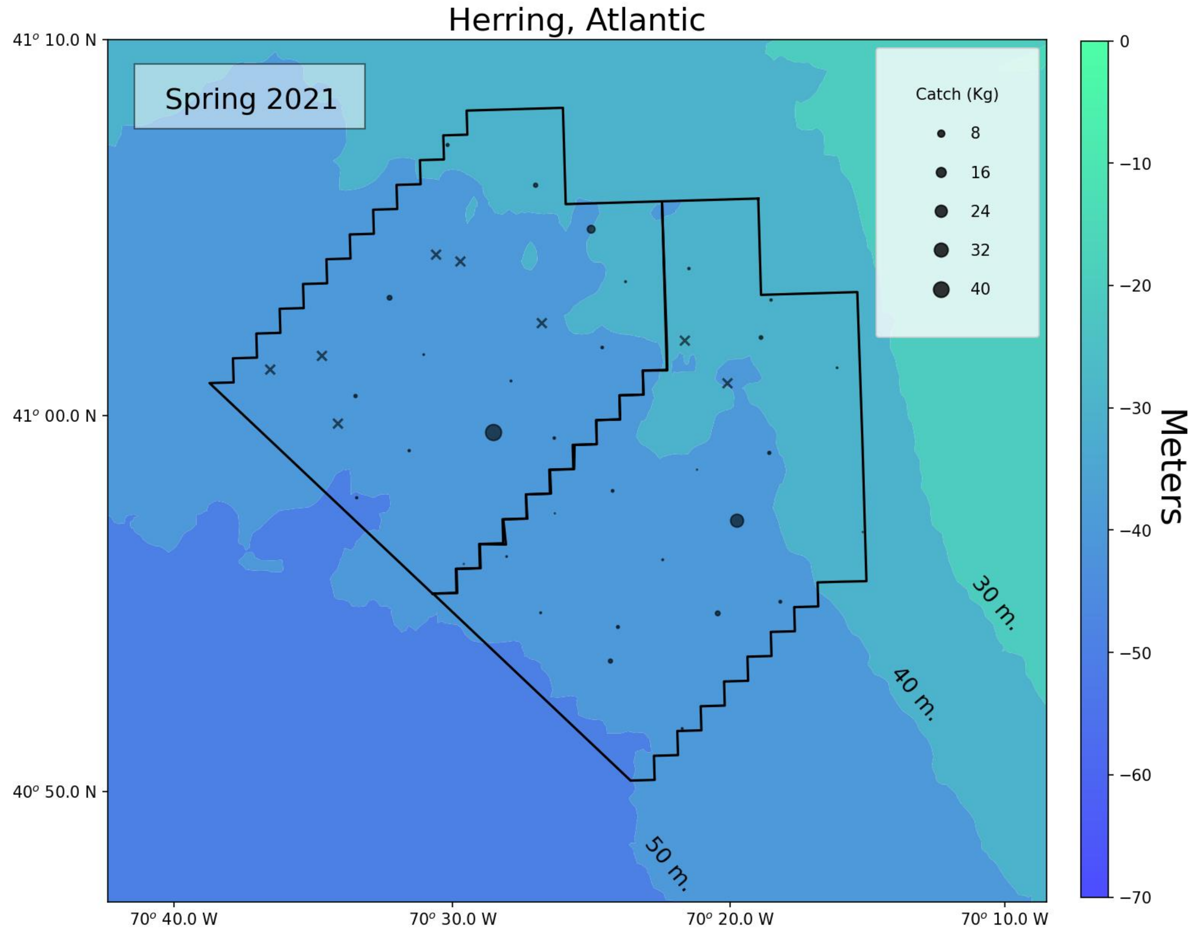


Figure 21: Distribution of the catch of Atlantic herring in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.

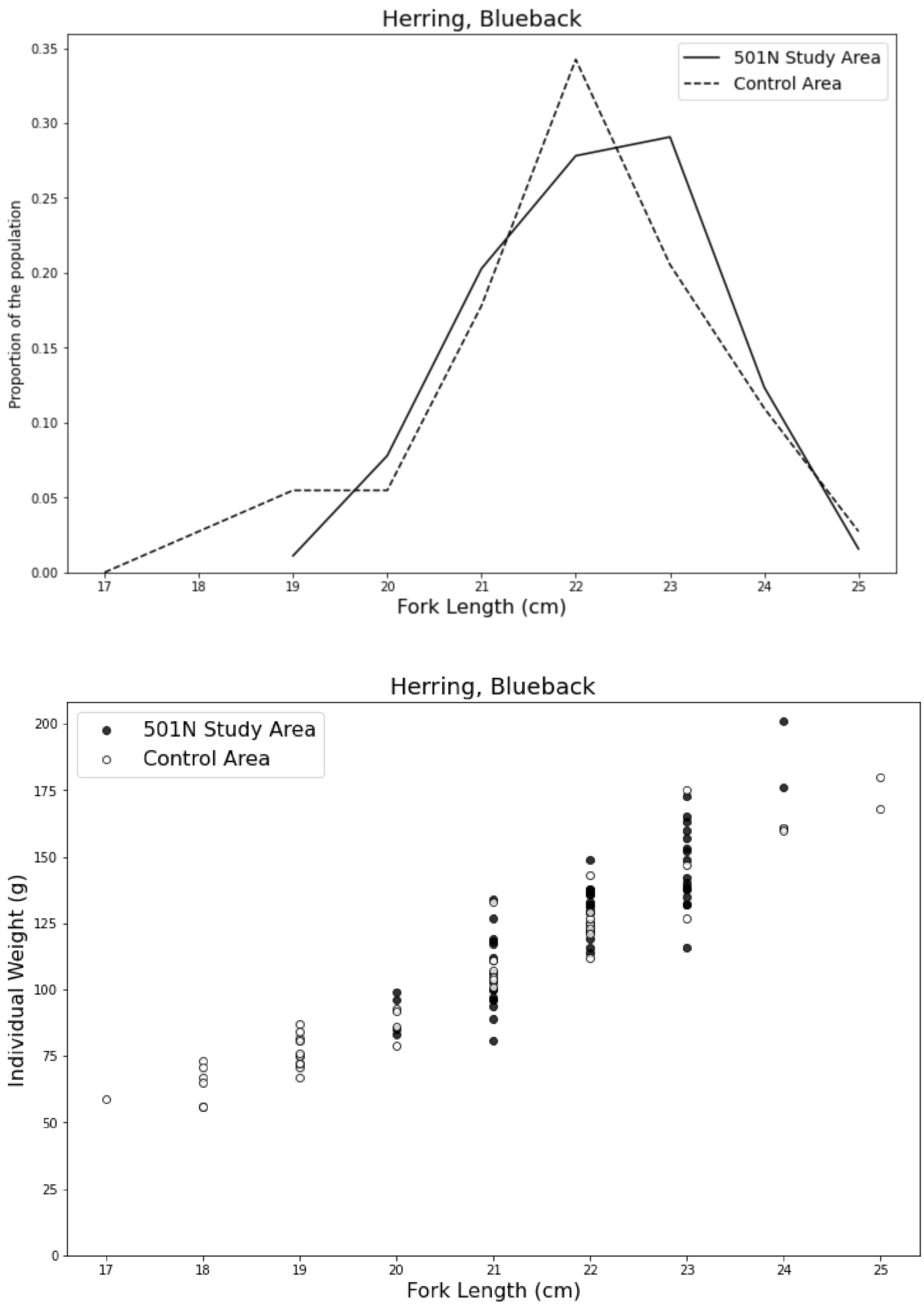


Figure 22: Population structure of blueback herring in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

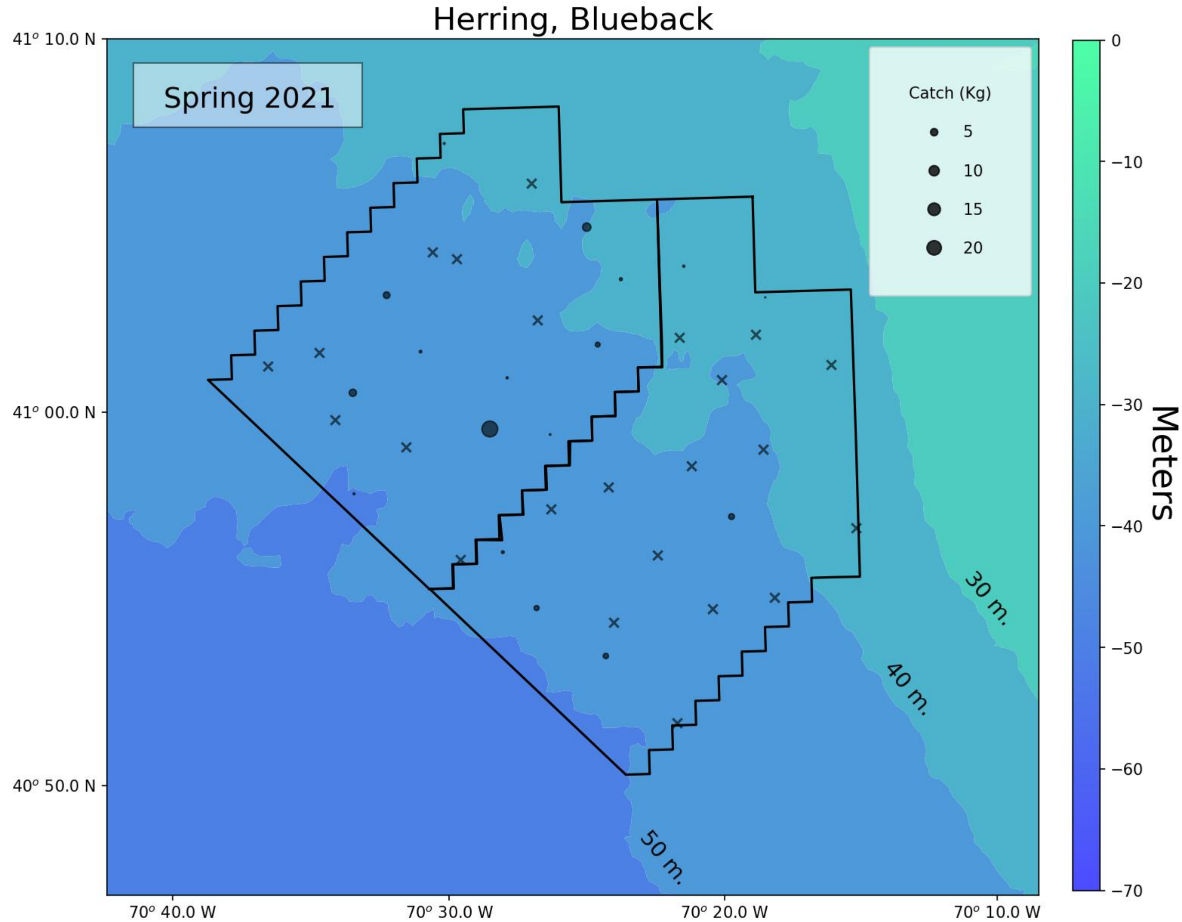


Figure 23: Distribution of the catch of blueback herring in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.

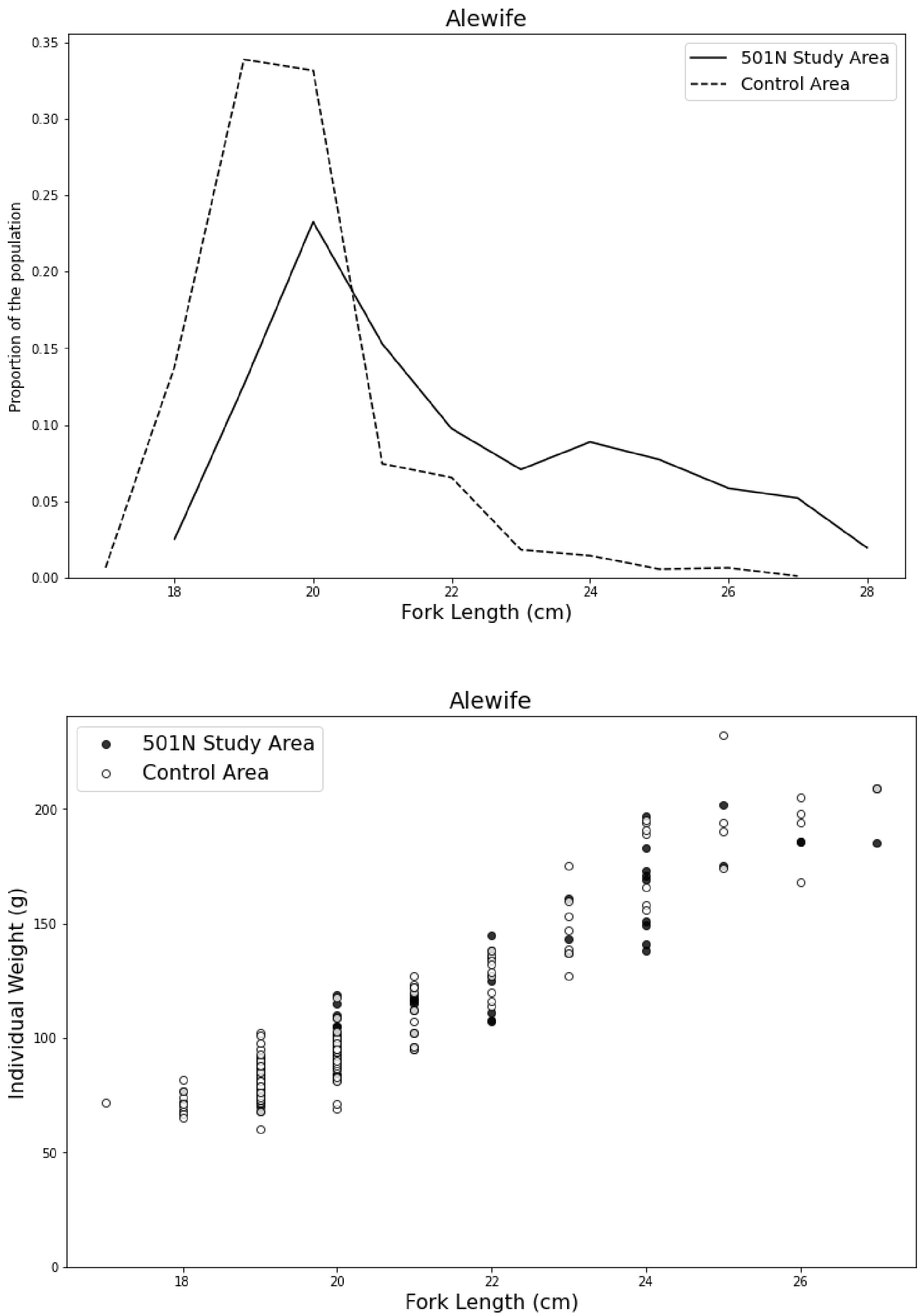


Figure 24: Population structure of alewife in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

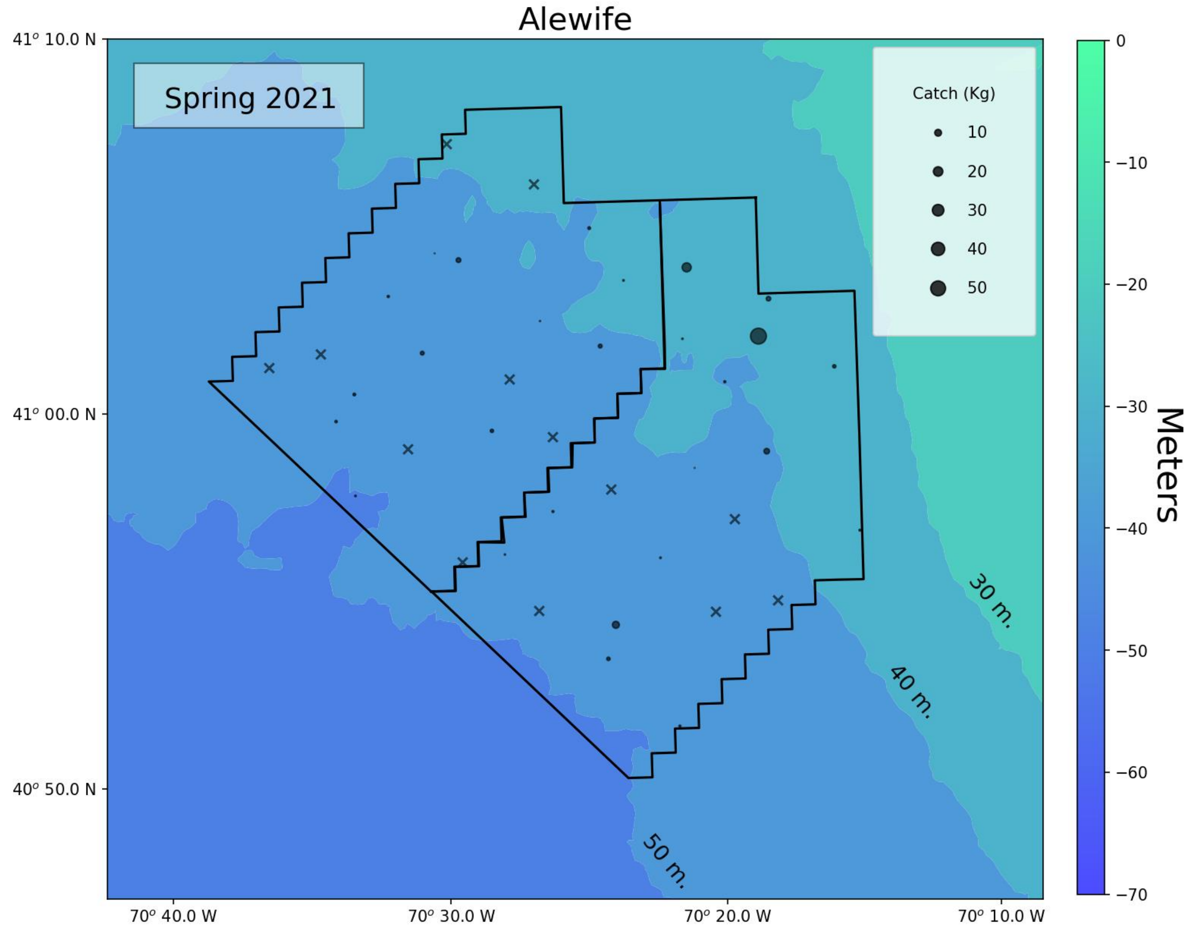
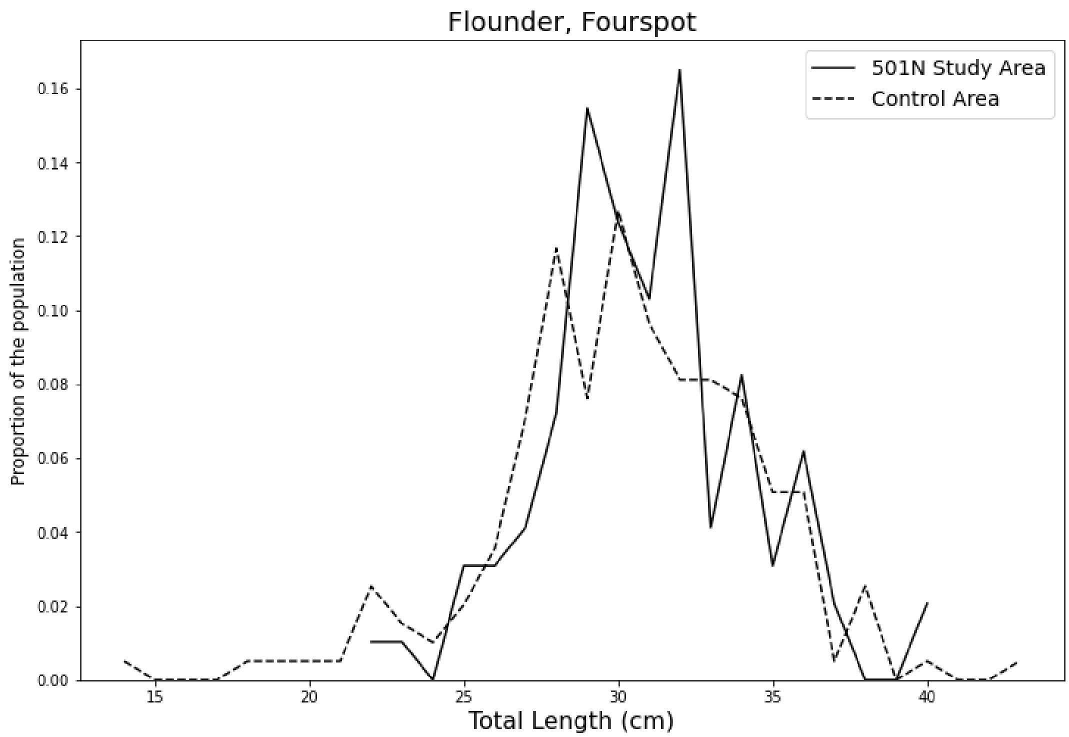


Figure 25: Distribution of the catch of alewife in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



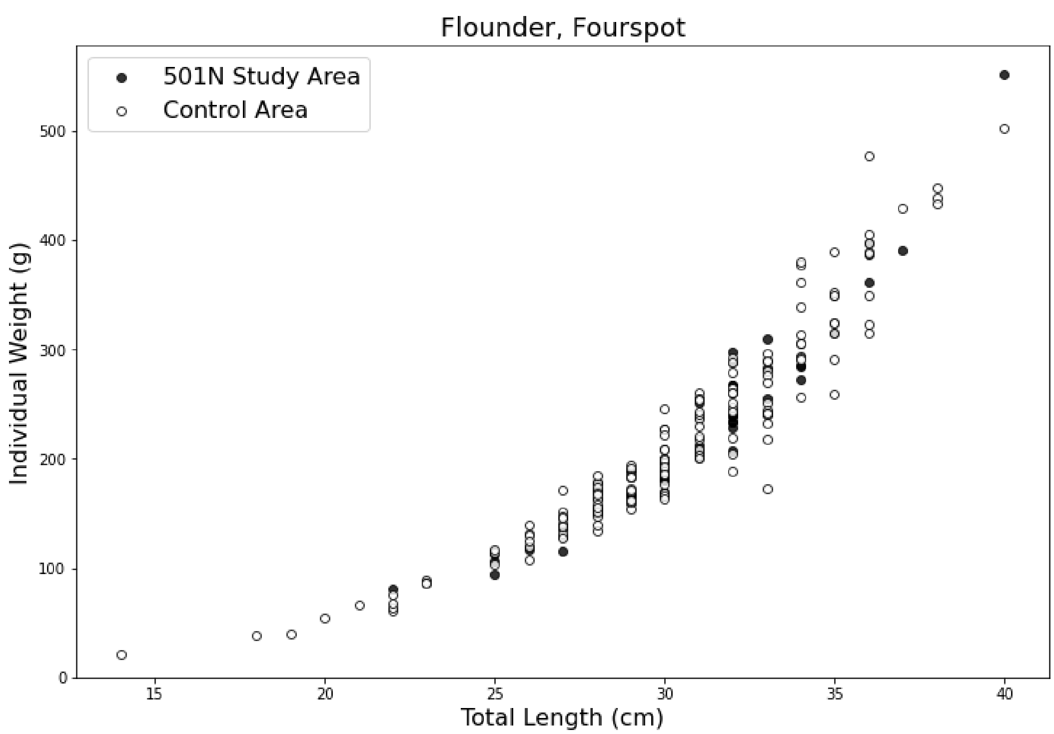


Figure 26: Population structure of fourspot flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

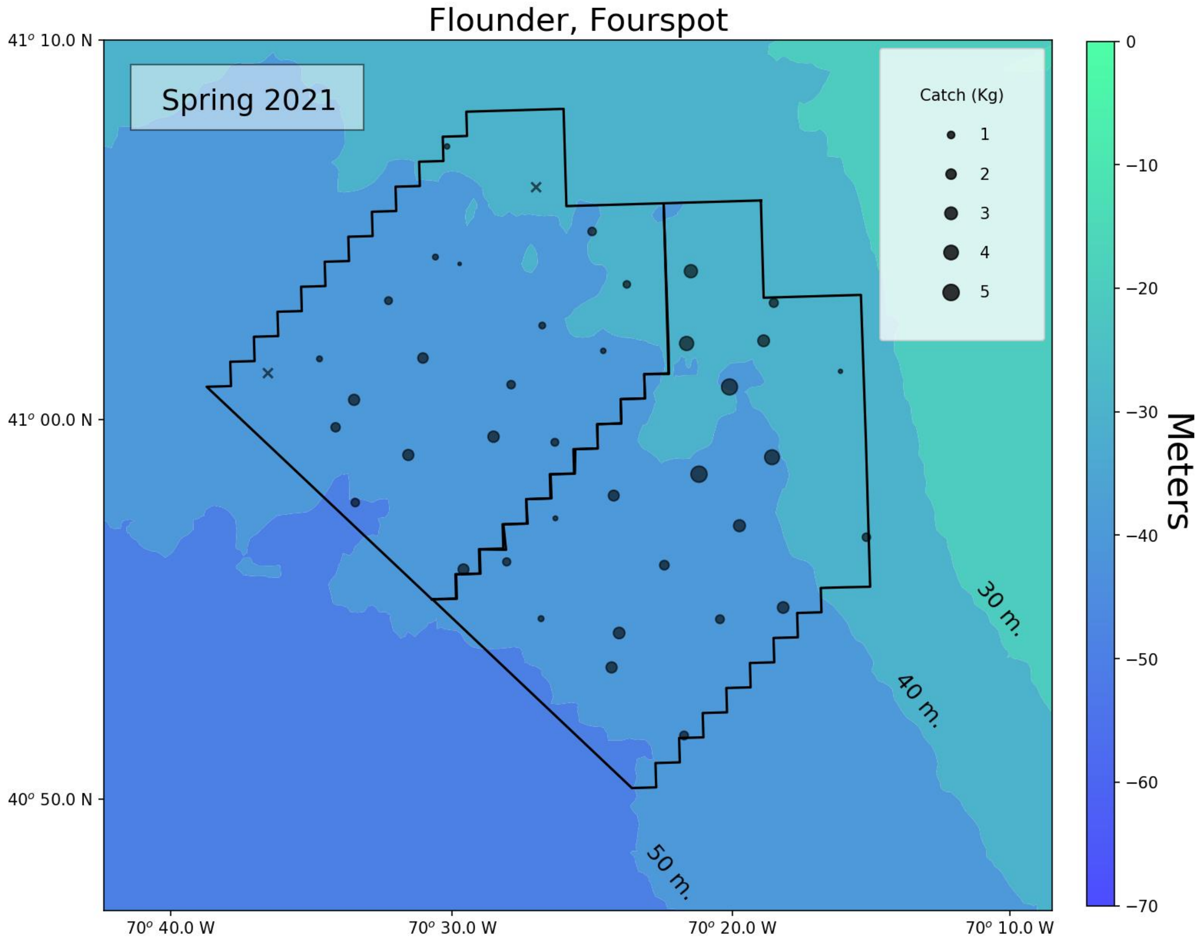
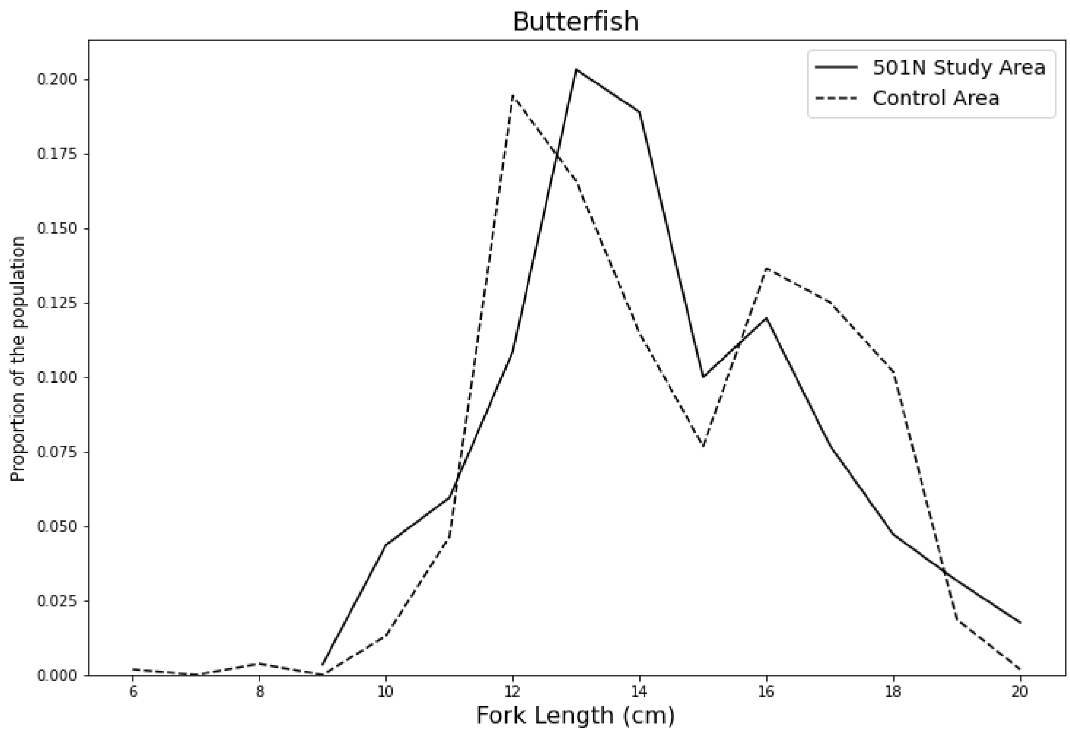


Figure 27: Distribution of the catch of fourspot flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



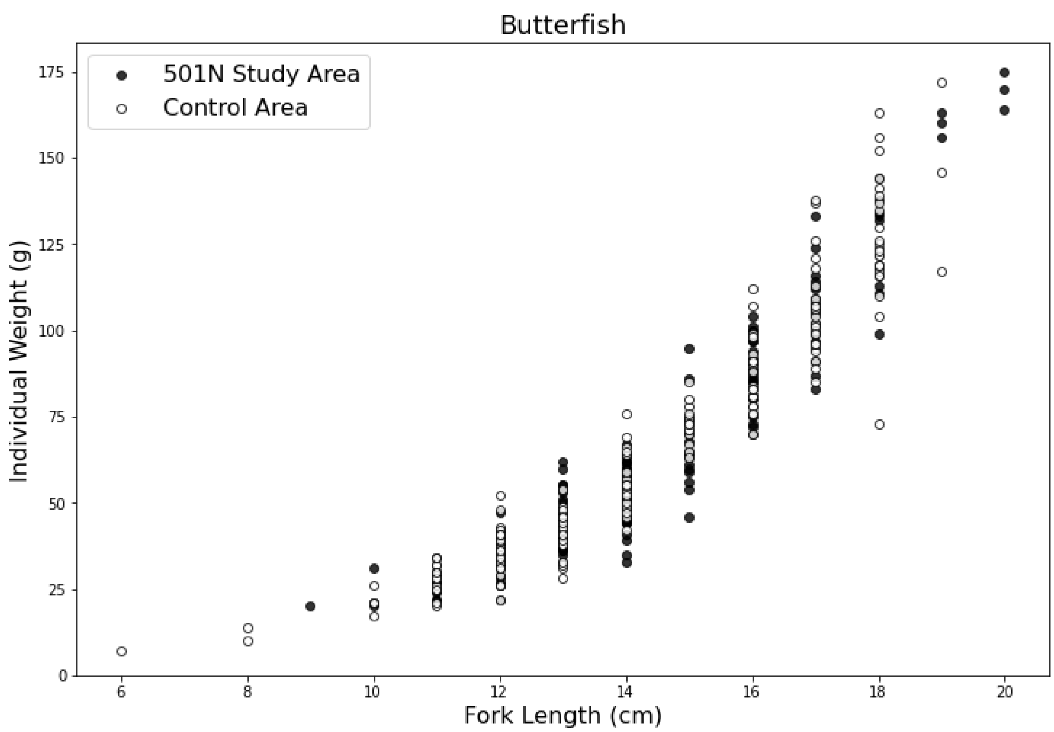


Figure 28: Population structure of butterfish in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

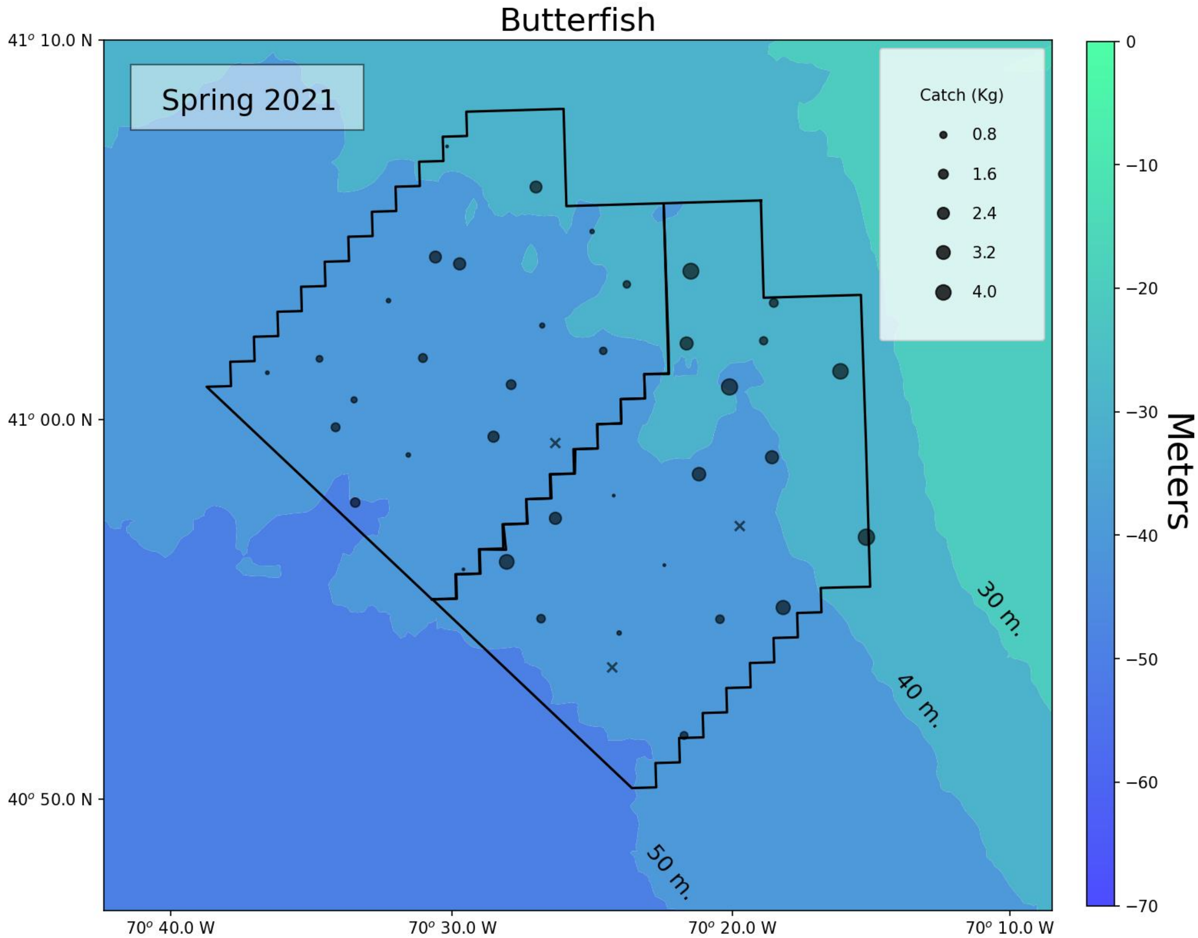
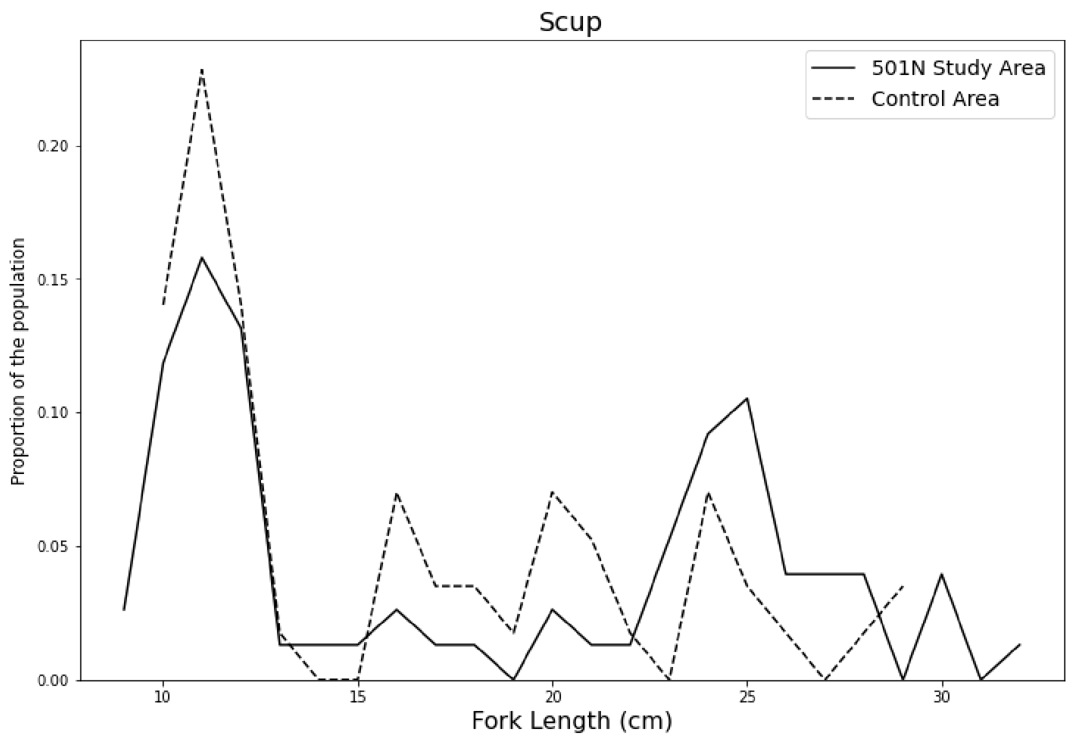


Figure 29: Distribution of the catch of butterfish in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



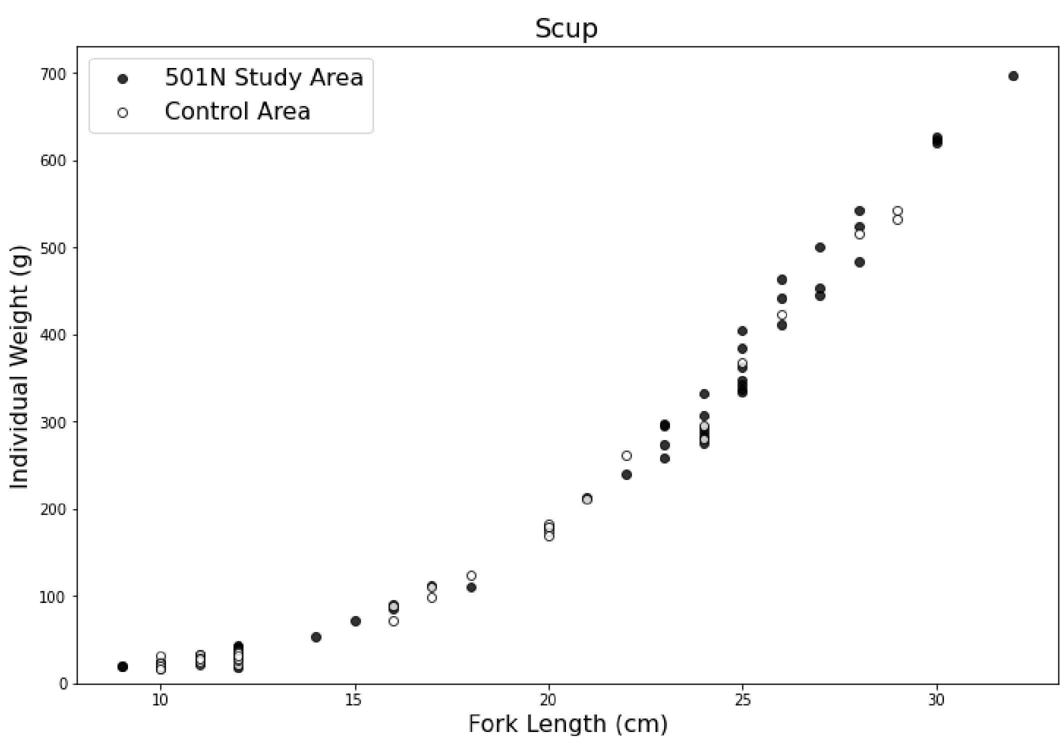


Figure 30: Population structure of scup in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

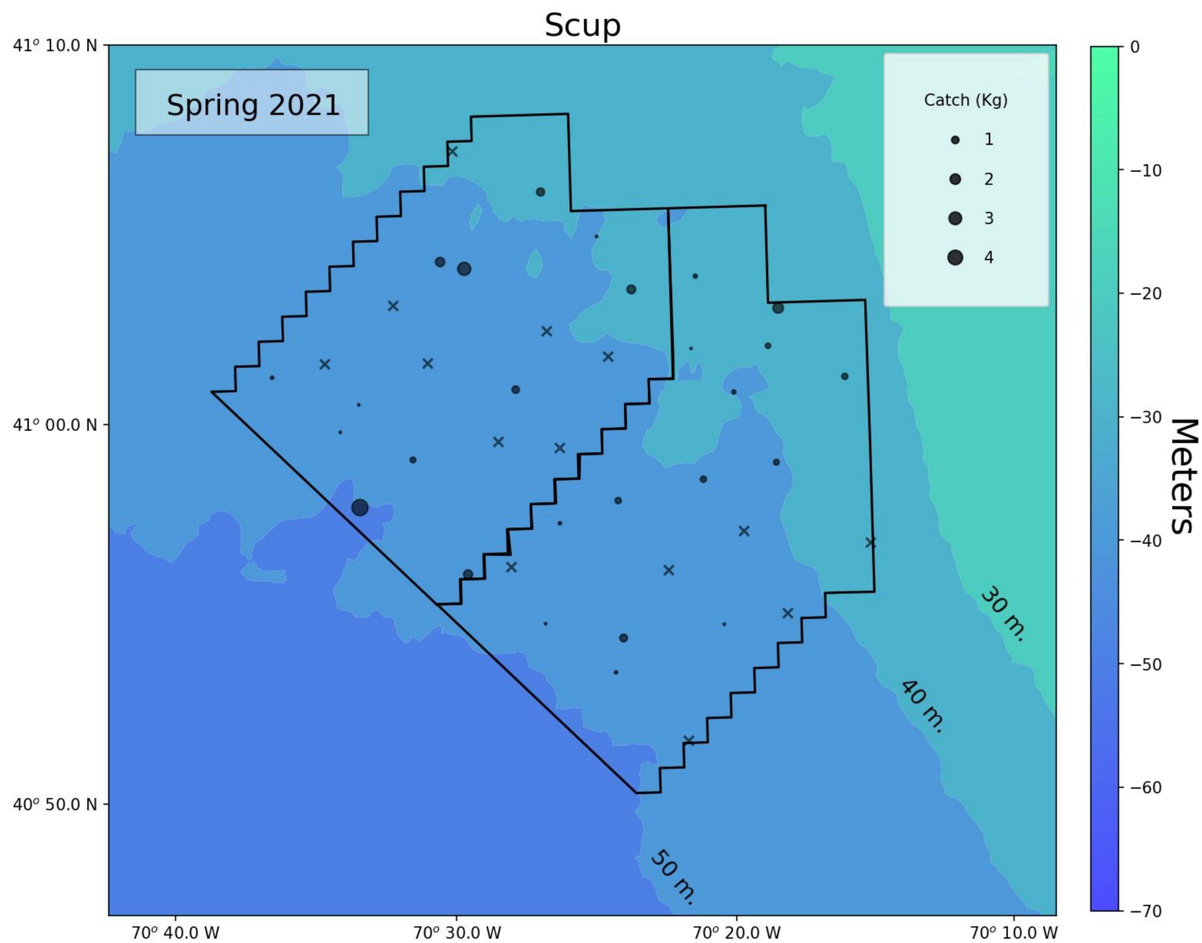
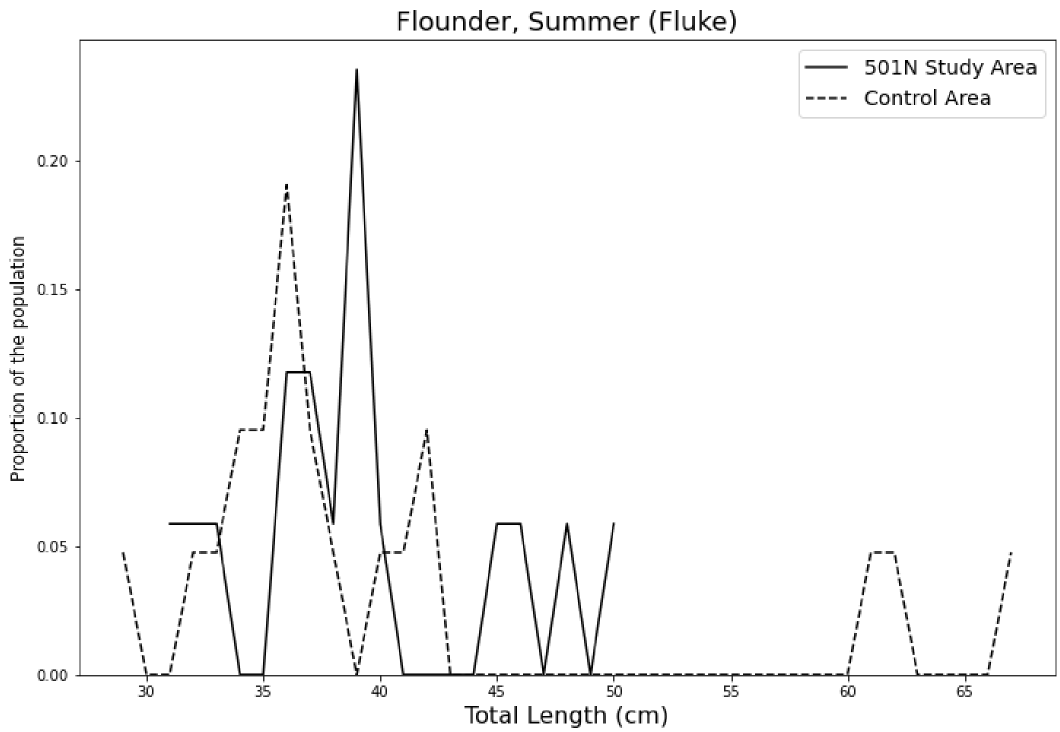


Figure 31: Distribution of the catch of scup in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



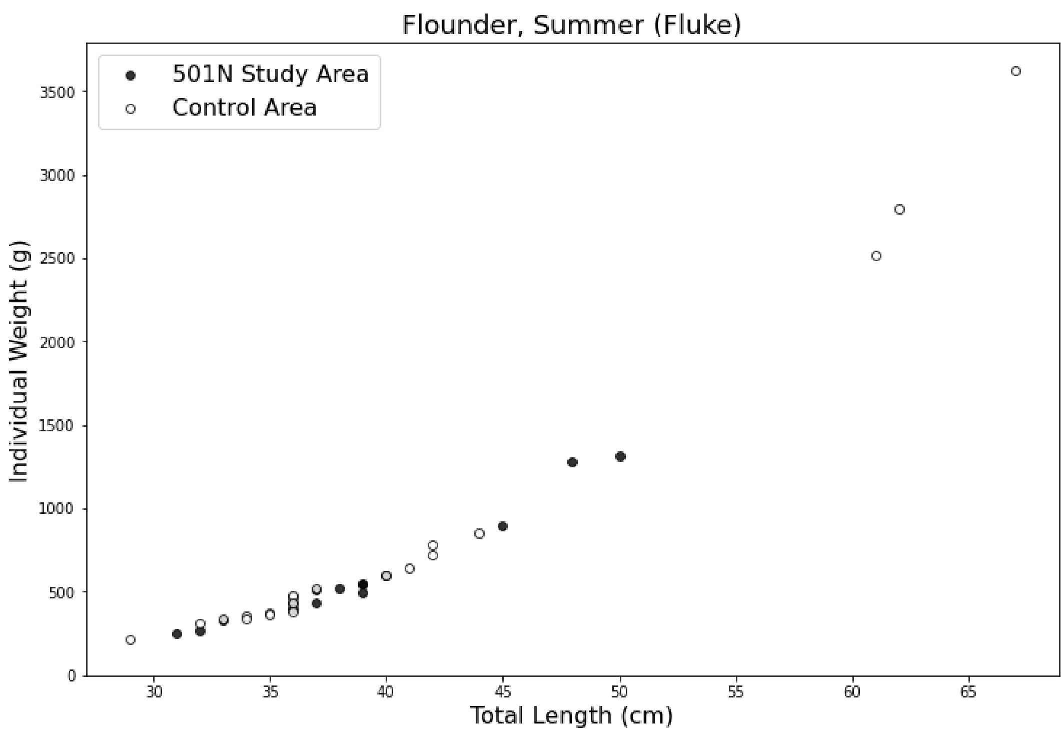


Figure 32: Population structure of summer flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

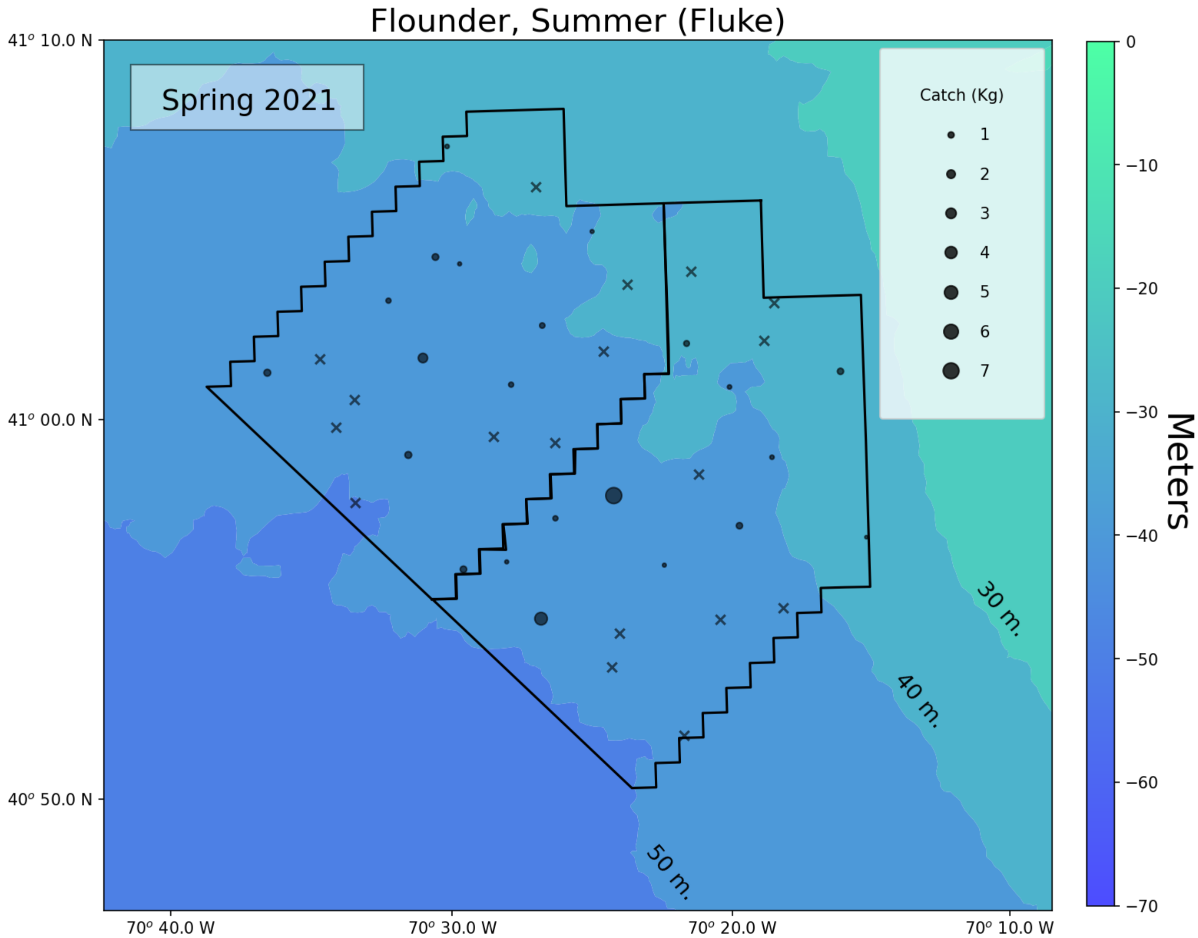
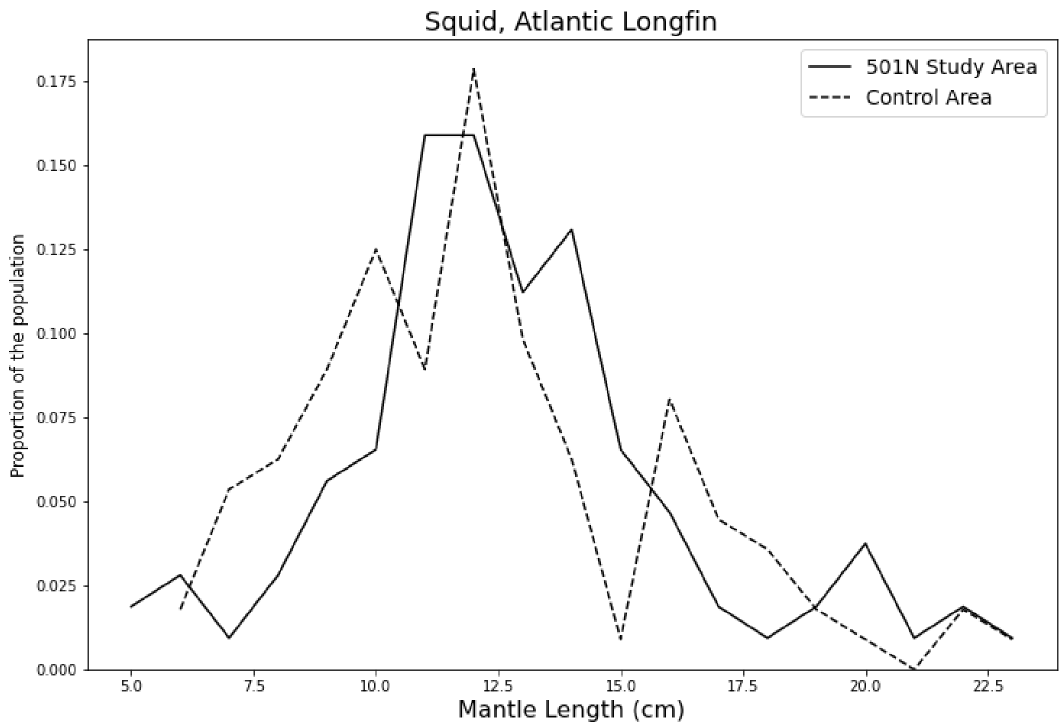


Figure 33: Distribution of the catch of summer flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



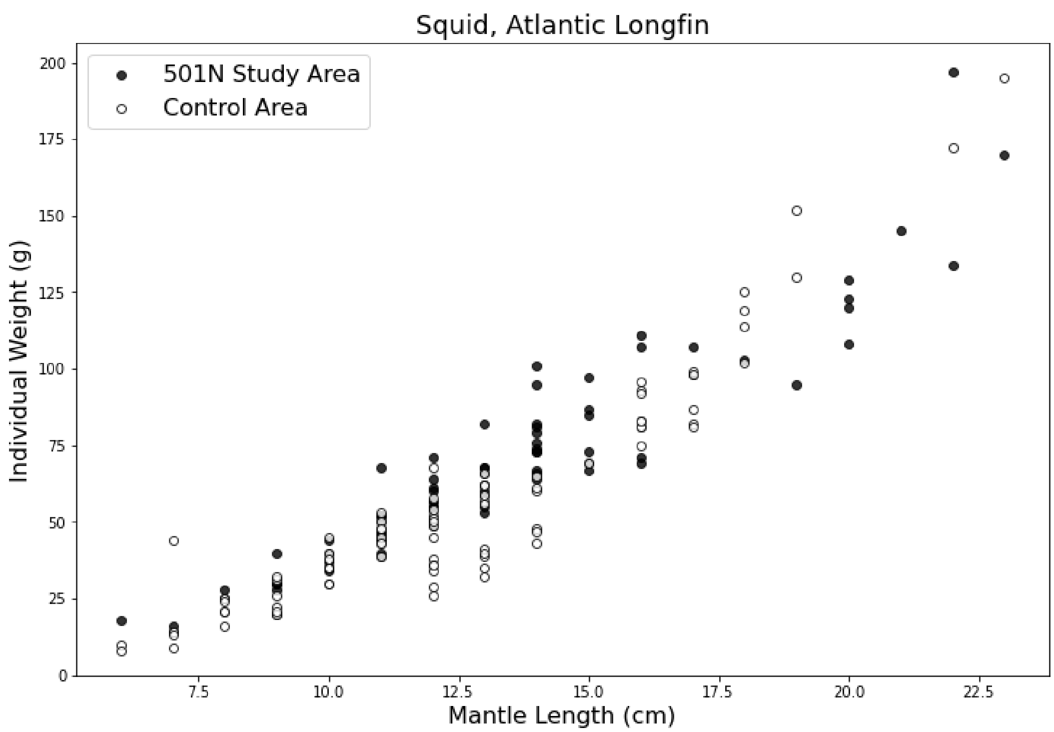


Figure 34: Population structure of Atlantic longfin squid in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

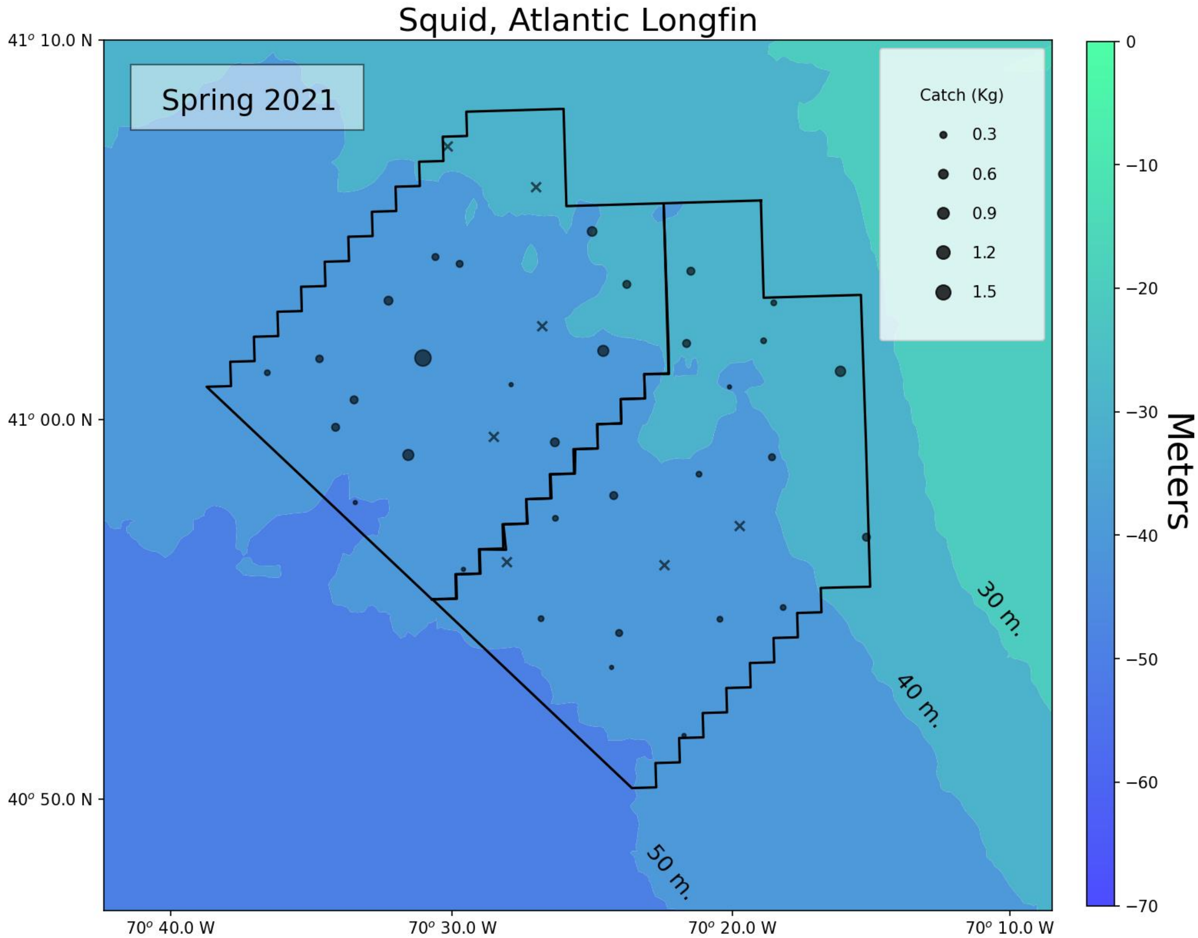
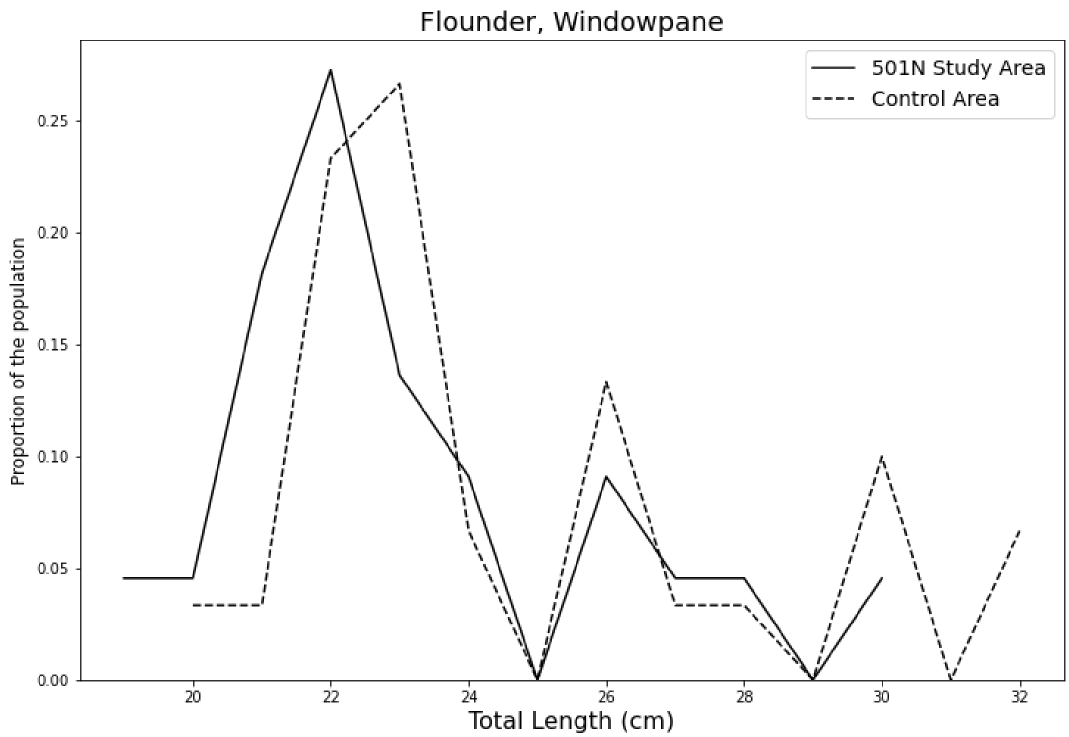


Figure 35: Distribution of the catch of Atlantic longfin squid in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



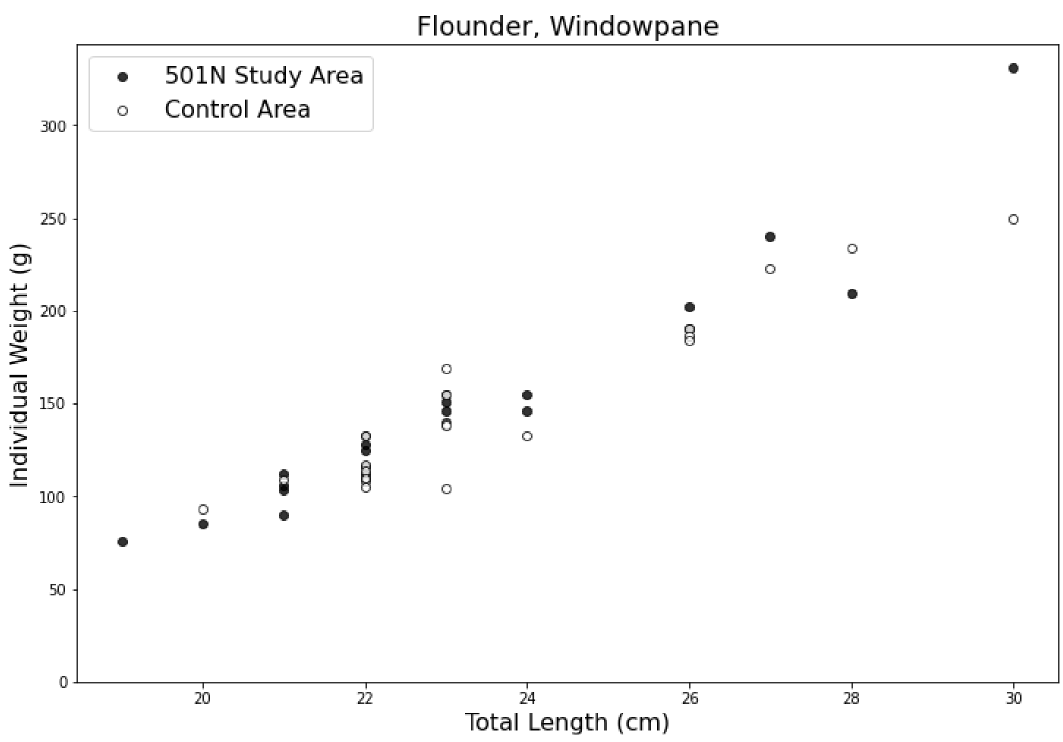


Figure 36: Population structure of windowpane flounder in the 501N Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

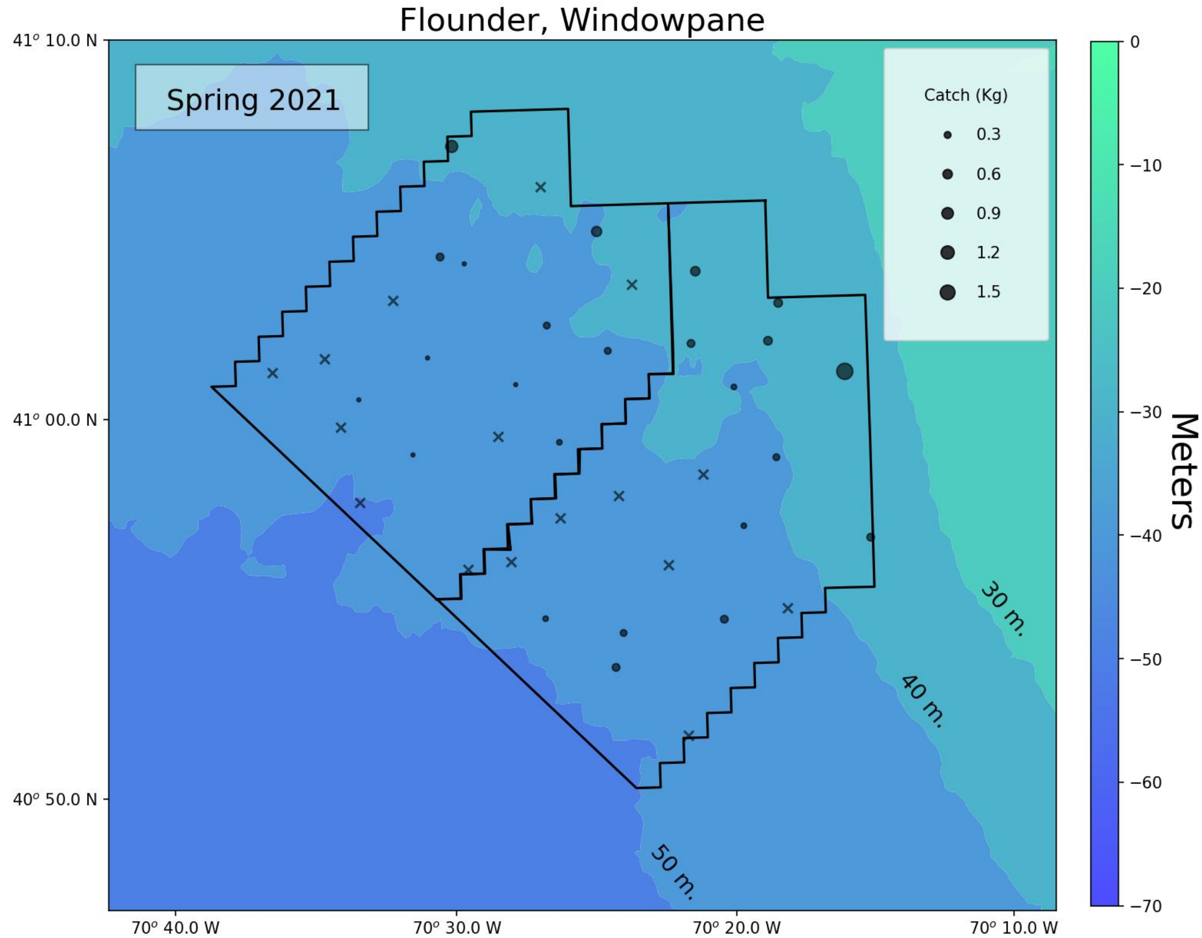


Figure 37: Distribution of the catch of windowpane flounder in the 501N Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.