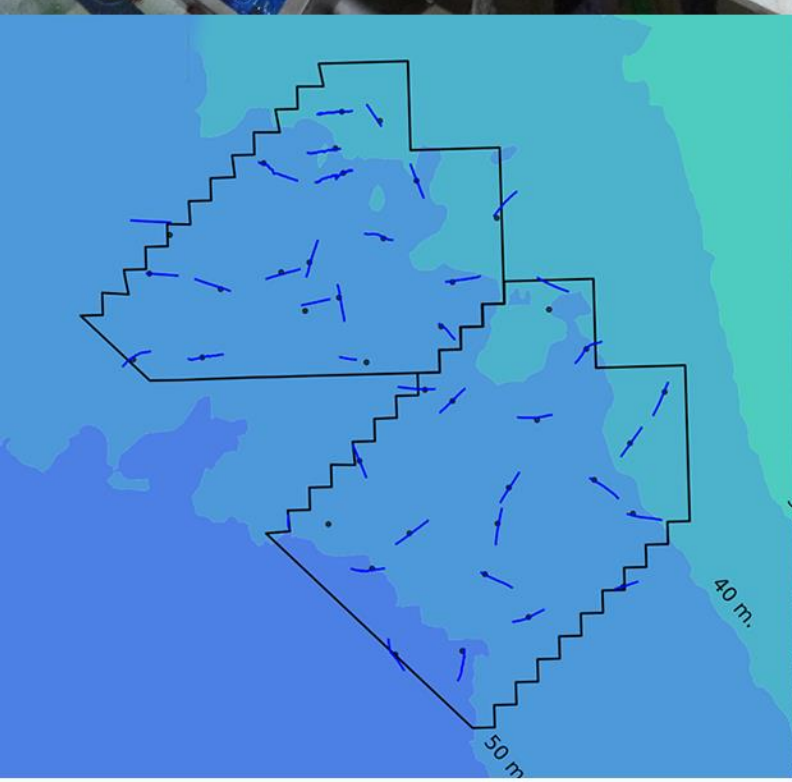
Vineyard Wind Demersal Trawl Survey



Quarterly Report

Vineyard Wind 1 Study Area

Fall 2021 (October - December)

VINEYARD WIND DEMERSAL TRAWL SURVEY

Fall 2021 Seasonal Report

Vineyard Wind 1 Study Area

December 2021

Prepared for Vineyard Wind LLC

VINEYARD WIND

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SMAST

Vineyard Wind Demersal Trawl Survey Fall 2021 Seasonal Report

Vineyard Wind 1 Study Area

UMass Dartmouth

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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 conducting fisheries studies in a 306 km^2 area referred to as "Vineyard Wind 1" or the "VW1 Study Area", which is the focus of this report. Vineyard Wind is also conducting fisheries studies in Lease Area OCS-A 0534 (the "534 Study Area") and within Lease Area OCS-A 0522 (the "522 Study Area"); these studies are reported separately.[1]

The Bureau of Ocean Energy Management (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.

[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 VW1 Study Area, which is located in the area designated as Lease Area OCS-A 0501, is referred to as the "501N Study Area" in SMAST fisheries survey reports compiled prior to the lease area segregation. Similarly, the 534 Study Area, which is designated as Lease Area OCS-A 0534, is referred to as the 501S Study Area in SMAST fisheries survey reports compiled prior to the lease area segregation.

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 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 VW1 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 two years of monitoring from spring 2019 to spring 2021 have been submitted to the sponsoring organization. This progress report documents survey methodology, survey effort, and data collected during the fall 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 the 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 534 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 composition for a future environmental assessment using the BACI framework as recommended by BOEM (BOEM, 2013). Tow locations within the VW1 Study Area were selected using a spatially balanced systematic unaligned sampling design. The VW1 Study Area was modified from the 2019/2020 survey year due to boundary refinements of projects within Lease Area OCS-A 0501. The current VW1 Study Area was increased from 249.3 km^2 to 306 km^2 by adding additional area to the southeastern corner. The current VW1 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 VW1 Study Area. The starting location within each sub-area was randomly selected (Figure 2).

An area located to the east of the VW1 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 VW1 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 VW1 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 VW1 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 VW1 Study Area, using the spatially balanced systematic unaligned 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 VW1 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 VW1 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 VW1 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 which reported the angle of the net belly. An angle around 0° indicated the net was on the seafloor. A towed hydrophone was placed over the side of the vessel to receive the acoustic signals from the net sensors. A processing unit, located in the wheelhouse and running the TV80 software, was used to monitor and log the data during tows (Figure 7).

2.4 Survey Operations

The survey was conducted on the F/V *Heather Lynn*, an 84' stern trawler operating out of Point Judith, Rhode Island. The F/V *Heather Lynn* is a commercial fishing vessel currently operating in the industry. Three trips to the survey areas were made during which all planned tows were completed.

- Trip 1: November 8 - 12, 2021
- Trip 2: November 19 – 20, 2021
- Trip 3: November 21 – 22, 2021

Surveys were alternated daily between the VW1 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. Two sub-sampling strategies were employed over the duration of the survey: straight sub-sampling by weight and discard by count.

<u>Straight sub-sampling by weight:</u> When catch diversity was relatively low (five to 10 species), straight sub-sampling was used. In this method, the catch was sorted by species. An aggregated species weight was measured and then a sub-sample (50 – 100 individuals) was collected for individual length and weight measurements. The ratio of the sub-sample weight to the total species weight was then used to extrapolate the length-frequency estimates. This was the predominant sub-sampling strategy.

<u>Discard by count:</u> The discard by count method was used when a large catch of large-bodied fish was caught. For this method, a sub-sample of the species (30 – 50 individuals) was collected to calculate a mean individual weight. The remaining individuals were counted and discarded. The aggregated weight for the species is the total number of individuals multiplied by the average individual weight. This method was primarily used when large volumes of spiny dogfish were caught.

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 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 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 VW1 Study Area and the Control Area (Figure 2, Table 1). Operational parameters were similar between these two survey areas (Table 2). Tow durations averaged 20.2 ± 0.6 minutes (mean ± one standard deviation) in the VW1 Study Area and 20.1 ± 0.3 minutes in the Control Area. Tow distances averaged 0.9 ± 0.03 nautical miles (nmi) in the VW1 Study Area giving an average tow speed of 2.8 ± 0.1 knots. Similarly, tow distance 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 temperatures were relatively consistent across the VW1 Study Area (14.4 ± 0°C [57.9 ± 0.9°F]) and Control Area (13.9 ± 0.5°C [57.0 ± 0.9°F]) with the temperature dropping throughout the duration of the survey (Table 2). Bottom water temperatures were comparable to those observed in 2020 (range: 13.4 – 14.8°C [56.1 - 58.6°F]).

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 33.3 ± 0.9 m (range: 31.6 – 35.3 m.) for tows in the VW1 Study Area and 33.5 ± 1.0 (range: 31.8 – 35.5 m.) in the Control Area. Wing spread averaged 13.5 ± 0.3 m for tows in the VW1 Study Area (range: 12.9 – 14.1 m) and 13.5 ± 0.7 m for tows in the Control Area (range: 11.2 – 14.0 m). Headline height averaged 4.9 ± 0.2 m for tows in the VW1 Study Area (range: 4.6 – 5.3 m) and 4.9 ± 0.2 m for tows in the Control Area (range: 4.5 – 5.2 m). All tows were in the acceptable range for all trawl geometry parameters.

3.2 Catch Data

3.2.1 VW1 Study Area

In the VW1 Study Area, a total of 27 species were caught over the duration of the survey (Table 3). Catch volume ranged from 157.5 kilograms per tow (kg/tow) to 617.1 kg/tow with an average of 309.0 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, spiny dogfish, and Atlantic longfin squid) accounted for 89.7% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Scup (*Stenotomus chysops*) was the most abundant species, accounting for 34.8% of the total catch weight. Scup ranged in size from 7 to 31 cm in length with a unimodal size distribution consisting of a peak at 24 cm (Figure 8). Scup were observed in all 20 tows at an average catch rate of 108.0 ± 18.3 kg/tow (mean ± Standard Error of the Mean [SEM], range: 13.8 – 258.2 kg/tow). Scup were caught throughout the VW1 Study Area with higher catches observed in the deeper tows along the southern boundary (Figure 9).

Little skate (*Leucoraja erinacea*) was the second most abundant species observed, accounting for 21.5% of the total catch weight. Individuals ranged in size from 13 to 34 cm (disk width) with a unimodal size distribution consisting of a peak at 26 cm (Figure 10). Little skate were observed in all 20 tows. Catch rates averaged 66.4 ± 5.6 kg/tow (range: 24.5 – 110.9 kg/tow). Little skate were observed throughout the VW1 Study Area (Figure 11).

Butterfish (*Peprilus triacanthus*) was the third most abundant species observed, accounting for 17.7% of the total catch weight. Butterfish ranged in length from 4 to 19 cm with a unimodal size distribution consisting of a peak at 8 cm (Figure 12). Butterfish were observed in all 20 tows with an average catch rate of 54.4 ± 16.9 kg/tow (range: 2.9 – 344.3 kg/tow). Butterfish were caught throughout the VW1 Study Area with increased catches in the northern half of the VW1 Study Area (Figure 13).

Spiny dogfish (*Squalus acanthias*) was the fourth most abundant species observed. Individuals ranged in length from 22 to 88 cm with a unimodal size distribution peaking at 66 cm (Figure 14). Spiny dogfish were observed in all 20 tows. Catch rates averaged 35.1 ± 10.4 kg/tow (range: 2.3 – 218.2 kg/tow). Spiny dogfish were observed throughout the VW1 Study Area with the highest catches observed in the southeast corner (Figure 15).

Atlantic longfin squid (*Dorytheuthis pealei*) is a commercially important species commonly referred to as loligo squid. Atlantic longfin squid ranged in length from 3 to 29 cm (mantle length) with a unimodal size distribution peaking at 6 cm (Figure 16). Atlantic longfin squid were observed in all 20 tows at an average catch rate of 13.4 ± 1.3 kg/tow (range: 4.3 – 27.2 kg/tow). Atlantic longfin squid were evenly caught throughout the VW1 Study Area (Figure 17). No squid "mops" were observed during this survey.

Winter skate (*Leucoraja ocellata*) was commonly caught in the VW1 Study Area. Winter skate ranged in length from 28 to 60 cm (Figure 18). Winter skate were observed in 16 of the 20 tows at an average catch rate of 7.9 ± 1.5 kg/tow (range: 0 – 24.8 kg/tow). The catch of winter skate appeared to correlate with depth. Higher catches were observed in the southern half of the VW1 Study Area (Figure 19).

Red hake (*Urophycis chuss*) was one of the dominant species in the 2019/2020 survey year. During this fall survey, the catch of red hake was common but at lower abundances. Red hake ranged in length from 22 to 39 cm with a unimodal size distribution peaking between 28 and 30 cm (Figure 20). Red hake were observed in 19 of the 20 tows at an average catch rate of 6.1 ± 1.4 kg/tow (range: 0 – 20.9 kg/tow). Red hake were observed throughout the VW1 Study Area with the highest catch associated with deeper tows to the south (Figure 21).

Northern sea robin (*Prionotus carolinus*) was observed in all 20 tows in the VW1 Study Area. Northern sea robins ranged in length from 9 to 34 cm with a unimodal peak at 26 cm (Figure 22). The average catch rate of northern sea robins was 5.5 ± 1.1 kg/tow (range: 0.9 – 17.1 kg/tow). Northern sea robins were caught throughout the VW1 Study Area with higher catches observed in the southern half of the VW1 Study Area (Figure 23).

Silver hake (*Merluccius bilinearis*), a commercially important species also commonly referred to as whiting, was an abundant species in the VW1 Study Area. Silver hake ranged in length from 7 to 39 cm. Silver hake had a narrow unimodal size distribution consisting of a peak at 25 cm (Figure 24). Silver hake were observed in all 20 tows at an average catch rate of 5.4 ± 0.8 kg/tow (range: 1.9 – 14.9 kg/tow). The catch of silver hake was distributed across the VW1 Study Area (Figure 25).

Summer flounder (*Paralichthys dentatus*) is a commercially important flatfish species commonly referred to as fluke. Summer flounder were commonly caught in the VW1 Study Area. Summer flounder ranged in length from 29 to 62 cm with a broad size distribution (Figure 26). Summer flounder were observed in 16 of the 20 tows at an average catch rate of 1.6 ± 0.3 kg/tow (range: 0 – 5.4 kg/tow). Summer flounder were caught throughout the VW1 Study Area (Figure 27).

Windowpane flounder (*Scophtalmus aquosus*) is a federally regulated commercial flatfish species found in the VW1 Study Area. Windowpane flounder ranged in length from 13 to 30 cm with a unimodal size distribution peaking at 24 cm (Figure 28). Windowpane flounder were observed in all 20 tows at an average catch rate of 1.6 ± 0.3 kg/tow (range: 0.2 – 4.4 kg/tow). Windowpane flounder were caught throughout the VW1 Study Area with higher catches observed in the northern half of the VW1 Study Area (Figure 29).

Black sea bass (*Centropristis striata*) is a commercially important species commonly observed in the VW1 Study Area. Black sea bass ranged in length from 10 to 34 cm with a unimodal size distribution peaking at 26 cm (Figure 30). Black sea bass were observed in 19 of the 20 tows at an average catch rate of 1.2 ± 0.2 kg/tow (range: 0 – 3.2 kg/tow). Black sea bass were caught throughout the VW1 Study Area with higher catches along the northern boundary (Figure 31).

Winter flounder (*Pleuronectes americanus*) was another commercially important flatfish species commonly caught in the VW1 Study Area. Winter flounder ranged in length from 20 to 48 cm with a wide size distribution (Figure 32). Winter flounder were observed in 14 of the 20 tows at an average catch rate of 0.8 ± 0.2 kg/tow (range: 0 – 2.1 kg/tow). Winter flounder were caught throughout the VW1 Study Area (Figure 33).

Fourspot flounder (*Paralichthys oblongus*) ranged in length from 12 to 37 cm with a wide size distribution (Figure 34). Fourspot flounder were observed in 14 of the 20 tows at an average catch rate of 0.5 ± 0.1 kg/tow (range: 0 – 1.8 kg/tow). Fourspot flounder were caught throughout the VW1 Study Area (Figure 35).

Less common recreational and commercial species observed included six individuals of Atlantic sea scallop (*Placopecten magellanicus*), five individuals of northern kingfish (*Menticirrhus saxatilis*, size range: 24 – 35 cm), four individuals of yellowtail flounder (*Pleuronectes ferrugineus*, size range: 22 – 25 cm), two individuals of monkfish (*Lophius americanus*, 42, 43 cm), one individual of weakfish (*Cynoscion regalis*, 35 cm), and one individual of bluefish (*Pomotomus saltatrix*, 22 cm).

3.2.2 Control Area

In the Control Area, a total of 33 species were caught over the duration of the survey (Table 4). Catch volume ranged from 160.1 kg/tow to 1,207.8 kg/tow with an average of 424.5 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, spiny dogfish, butterfish, and red hake) accounted for 88.1% 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 35.8% of the total catch weight. Scup ranged in length from 8 to 27 cm with a narrow unimodal size distribution consisting of a peak at 24 cm (Figure 8). Scup were observed in all 20 tows at an average catch rate of 152.6 ± 25.1 kg/tow (range: 23.4 – 544.2 kg/tow). Scup were caught throughout the Control Area (Figure 9).

Little skate was the second most abundant species observed in the Control Area accounting for 23.7% of the total catch weight. Individuals ranged in size from 13 to 32 cm (disk width) with a unimodal size distribution consisting of a peak at 26 cm (Figure 10). Little skate were observed in all 20 tows. Catch rates averaged 100.5 ± 8.5 kg/tow (range: 29.0 – 173.8 kg/tow). Little skate were observed throughout the Control Area (Figure 11).

Spiny dogfish was the third most abundant species observed in the Control Area accounting for 19.5% of the total catch weight. Individuals ranged in length from 46 to 82 cm with a unimodal distribution peaking at 65 cm (Figure 14). Dogfish were observed in 19 of the 20 tows. Catch rates averaged 82.6 ± 35.9 kg/tow (range: 0 – 687.4 kg/tow). The catch distribution of spiny dogfish appeared to follow the depth contour with low catches observed in shallow tows in the north of the VW1 Study Area and large catches associated with deeper tows along the southern boundary (Figure 15).

Butterfish was the fourth most abundant species observed. Butterfish ranged in length from 4 to 18 cm with a wide unimodal size distribution consisting of a peak at 7 cm (Figure 12). Butterfish were observed in 19 of the 20 tows at an average catch rate of 19.3 ± 6.5 kg/tow (range: 0 – 108.3 kg/tow). Butterfish were caught throughout the Control Area (Figure 13).

Red hake was the fifth most abundant species observed. Red hake ranged in length from 21 to 36 cm with a unimodal size distribution peaking at 28 cm (Figure 20). Red hake were observed in 18 of the 20 tows at an average catch rate of 19.1 ± 3.6 kg/tow (range: 0 – 54.9 kg/tow). Red hake were observed throughout the Control Area with higher catches associated with the northern half of the Control Area (Figure 21).

Silver hake was frequently caught in the Control Area. Silver hake ranged in length from 13 to 42 cm. Silver hake had a narrow unimodal size distribution consisting of a peak at 26 cm (Figure 24). Silver hake were observed in all 20 tows at an average catch rate of 10.7 ± 1.4 kg/tow (range: 2.9 – 30.0 kg/tow). The catch of silver hake was distributed across the Control Area (Figure 25).

Atlantic longfin squid ranged in length from 3 to 34 cm (mantle length) with a unimodal size distribution peaking at 10 cm (Figure 16). Atlantic longfin squid were observed in all 20 tows at an average catch rate of 8.8 ± 1.9 kg/tow (range: 1.1 – 35.0 kg/tow). Atlantic longfin squid were caught throughout the Control Area (Figure 17). No squid "mops" were observed during this survey.

Northern sea robins were observed in 19 of the 20 tows in the Control Area. Northern sea robins ranged in length from 8 to 32 cm with a majority of individuals between 21 and 39 cm (Figure 22). The average catch rate of northern sea robins was 7.5 ± 1.7 kg/tow (range: 0 – 31.7 kg/tow). Northern sea robins were caught throughout the Control Area with higher catches observed in the southern half of the Control Area (Figure 23).

Winter skate were commonly caught in the Control Area. Winter skate ranged in length from 21 to 57 cm (Figure 18). Winter skate were observed in 14 of the 20 tows at an average catch rate of 6.8 ± 1.7 kg/tow (range: 0 – 20.8 kg/tow). The catch of winter skate appeared to correlate with depth with higher catches observed in deeper waters in the southern half of the Control Area (Figure 19).

Windowpane flounder ranged in length from 12 to 32 cm with a unimodal size distribution peaking at 24 cm (Figure 28). Windowpane flounder were observed in all 20 tows at an average catch rate of 6.5 ± 1.5 kg/tow (range: 0.1 – 20.9 kg/tow). Windowpane flounder were caught throughout the Control Area with higher catches observed in the northern half of the Control Area (Figure 29).

Fourspot flounder was commonly caught in the Control Area. Fourspot flounder ranged in length from 12 to 42 cm with a wide unimodal size distribution peaking at 30 cm (Figure 34). Fourspot flounder were observed in 19 of the 20 tows at an average catch rate of 2.3 ± 0.4 kg/tow (range: 0 – 5.1 kg/tow). Fourspot flounder were caught throughout the Control Area (Figure 35).

Summer flounder were commonly caught in the Control Area. Summer flounder ranged in length from 30 to 68 cm with a broad size distribution (Figure 26). Summer flounder were observed in 18 of the 20 tows at an average catch rate of 1.8 ± 0.3 kg/tow (range: 0 – 4.3 kg/tow). Summer flounder were caught throughout the Control Area with the highest catches observed in the northern half of the Control Area (Figure 27).

Black sea bass ranged in length from 4 to 32 cm with a wide size distribution (Figure 30). Black sea bass were observed in 15 of the 20 tows at an average catch rate of 0.9 ± 0.3 kg/tow (range: 0 – 5.5 kg/tow). Black sea bass were caught throughout the Control Area (Figure 31).

Winter flounder ranged in length from 22 to 42 cm with a wide size distribution (Figure 32). Winter flounder were observed in 14 of the 20 tows at an average catch rate of 0.8 ± 0.2 kg/tow (range: 0 – 3.5 kg/tow). The catch of winter flounder was primarily aggregated in the northern half of the Control Area (Figure 33).

Less common recreational and commercial species observed included 10 individuals of weakfish (size range: 18 – 44 cm), six individuals of northern kingfish (size range: 25 – 34 cm), two individuals of Atlantic sea scallop, two individuals of monkfish (30, 76 cm), two individuals of haddock (*Melanogrammus aeglefinus*, 14, 20 cm), and one individual of yellowtail flounder (25 cm).

4. Acknowledgments

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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	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	7:05	N 41° 04.205	W 70° 34.408	23	7:25	N 41° 03.409	W 70° 33.873	23	14.8	100
2	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	8:25	N 41° 02.248	W 70° 34.735	24	8:45	N 41° 01.462	W 70° 35.333	25	15.1	100
3	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	9:31	N 41° 01.007	W 70° 36.101	25	9:51	N 41° 00.180	W 70° 36.543	26	14.8	100
4	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	10:36	N 40° 59.881	W 70° 35.938	26	10:56	N 40° 59.261	W 70° 34.929	27	15.1	100
5	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	12:08	N 40° 57.655	W 70° 31.175	27	12:28	N 40° 57.664	W 70° 29.803	26		100
6	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	13:27	N 40° 57.865	W 70° 31.532	26	13:50	N 40° 57.892	W 70° 32.705	27	14.8	100
7	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	14:38	N 40° 59.721	W 70° 32.573	27	14:58	N 41° 00.644	W 70° 32.597	27	15.0	100
8	VW1	11/9/2021	Clear	7-10	WSW	0.5-1.25	15:49	N 40° 59.682	W 70° 30.477	26	16:09	N 40° 59.925	W 70° 29.303	24	14.9	100
9	VW1	11/10/2021	Partly Cloudy	7-10	WSW	0.5-1.25	6:40	N 40° 57.154	W 70° 28.681	25	7:00	N 40° 57.216	W 70° 29.924	25	14.2	100
10	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	7:52	N 40° 55.039	W 70° 29.121	26	8:12	N 40° 54.136	W 70° 28.799	27	14.5	120
11	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	9:30	N 40° 51.940	W 70° 25.523	28	9:50	N 40° 51.397	W 70° 24.312	28	14.4	120
12	Control	11/10/2021	Partly Cloudy	7-10	w	0.5-1.25	10:45	N 40° 51.563	W 70° 23.732	28	11:05	N 40° 51.652	W 70° 22.339	27	14.5	120
13	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	12:00	N 40° 52.788	W 70° 22.313	26	12:21	N 40° 53.679	W 70° 22.854	26	14.4	100
14	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	13:03	N 40° 55.053	W 70° 18.800	23	13:23	N 40° 55.434	W 70° 17.665	22	14.4	100
15	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	14:10	N 40° 55.944	W 70° 16.071	21	14:30	N 40° 56.708	W 70° 16.797	21	14.0	100
16	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	15:17	N 40° 58.620	W 70° 15.812	19	15:37	N 40° 59.460	W 70° 15.404	18	13.7	100
17	Control	11/10/2021	Partly Cloudy	7-10	W	0.5-1.25	16:30	N 40° 59.667	W 70° 17.866	21	16:50	N 40° 59.621	W 70° 19.083	22	14.5	100
18	Control	11/11/2021	Clear	7-10	N	0.5-1.25	6:40	N 41° 01.791	W 70° 17.909	20	7:00	N 41° 02.676	W 70° 18.221	19	14.2	100
19	Control	11/11/2021	Clear	7-10	N	0.5-1.25	8:01	N 41° 02.703	W 70° 19.635	20	8:21	N 41° 02.757	W 70° 20.907	21	14.5	100
20	Control	11/11/2021	Clear	7-10	N	0.5-1.25	9:10	N 41° 04.584	W 70° 21.308	22	9:30	N 41° 05.562	W 70° 21.338	22	14.0	100
21	VW1	11/11/2021	Clear	7-10	N	0.5-1.25	10:12	N 41° 05.636	W 70° 23.566	21	10:32	N 41° 05.725	W 70° 24.735	22	14.5	95
22	VW1	11/11/2021	Clear	7-10	N	0.5-1.25	11:20	N 41° 06.973	W 70° 25.534	22	11:40	N 41° 07.803	W 70° 25.963	21	14.6	95
23	VW1	11/11/2021	Clear	3-6	N	0.5-1.25	12:24	N 41° 6.861	W 70° 23.297	21	12:44	N 41° 06.337	W 70° 28.270	22	14.6	95
24	VW1	11/11/2021	Clear	3-6	N	0.5-1.25	13:27	N 41° 05.921	W 70° 28.116	22	13:47	N 41° 05.025	W 70° 27.698	22	14.9	100
25	VW1	11/11/2021	Clear	3-6	N	0.5-1.25	14:40	N 41° 04.919	W 70° 30.265	23	15:00	N 41° 05.554	W 70° 31.177	23	15.0	100
26	VW1	11/11/2021	Clear	3-6	N	0.5-1.25	15:49	N 41° 04.291	W 70° 30.891	23	16:09	N 41° 03.385	W 70° 30.726	23	14.9	100
27	Control	11/20/2021	Clear	11-15	N	0.5-1.25	9:13	N 40° 53.965	W 70° 27.594	27	9:33	N 40° 53.491	W 70° 25.310	26	13.6	120
28	Control	11/20/2021	Partly Cloudy	7-10	N	0.5-1.25	10:17	N 40° 56.085	W 70° 25.021	25	10:37	N 40° 57.949	W 70° 26.199	23	13.4	100
29	VW1	11/20/2021	Partly Cloudy	7-10	N	0.5-1.25	11:21	N 40° 58.849	W 70° 26.115	24	11:41	N 40° 59.802	W 70° 25.898	23	13.6	100
30	VW1	11/20/2021	Clear	7-10	N	0.5-1.25	12:26	N 41° 01.220	W 70° 28.581	23	12:46	N 41° 01.704	W 70° 29.581	24	13.5	100
31	VW1	11/20/2021	Clear	3-6	N	0.5-1.25	13:25	N 41° 02.330	W 70° 27.487	22	13:45	N 41° 02.693	W 70° 26.344	21	13.4	100
32	VW1	11/20/2021	Clear	3-6	N	0.5-1.25	14:16	N 41° 01.950	W 70° 23.931	22	14:36	N 41° 02.647	W 70° 23.103	21	13.3	100
33	VW1	11/20/2021	Partly Cloudy	3-6	N	0.5-1.25	15:08	N 41° 02.154	W 70° 23.494	22	15:28	N 41° 01.198	W 70° 23.675	22	13.3	95
34	Control	11/20/2021	Partly Cloudy	3-6	N	0.5-1.25	16:04	N 40° 59.512	W 70° 24.276	23	16:24	N 40° 59.515	W 70° 23.057	21	13.5	100
35	Control	11/22/2021	Overcast	11-15	S	1.25-2.5	6:34	N 40° 55.395	W 70° 23.478	24	6:54	N 40° 55.807	W 70° 22.355	24	13.4	100
36	Control	11/22/2021	Mostly Cloudy	16-20	S	1.25-2.5	7:45	N 40° 55.887	W 70° 22.152	24	8:05	N 40° 56.361	W 70° 23.169	25	13.4	100
37	Control	11/22/2021	Overcast	16-20	S	1.25-2.5	8:47	N 40° 57.909	W 70° 23.425	24	9:07	N 40° 58.084	W 70° 22.096	24	13.3	100
38	Control	11/22/2021	Overcast	16-20	S	1.25-2.5	9:44	N 40° 58.942	W 70° 21.758	23	10:04	N 40° 59.866	W 70° 21.884	21	13.4	100
39	Control	11/22/2021	Overcast	11-15	S	1.25-2.5	10:42	N 41° 00.000	W 70° 21.475	21	11:02	N 40° 59.945	W 70° 20.172	22	13.4	95
40	Control	11/22/2021	Overcast	11-15	S	1.25-2.5	11:38	N 40° 58.851	W 70° 19.856	23	11:58	N 40° 58.953	W 70° 20.095	23	13.3	100

Table 2: Tow parameters for each survey tow.

Tow Number	Tow Area	Tow Duration (min.)	Tow Distance (nmi.)	Tow Speed (knots)	Start Depth (fm)	Bottom Temp. (⁰C)	Trawl Warp (fm)	Headline Height (m.)	Wing Spread (m.)	Spread Door (m.)
1	VW1	20.2	0.9	2.7	23	14.8	100	5.0	13.5	33.1
2	VW1	20.2	0.9	2.7	24	15.1	100	4.8	13.8	33.6
3	VW1	20.0	0.9	2.7	25	14.8	100	4.9	13.9	33.3
4	VW1	19.9	1.0	2.9	26	15.1	100	4.9	13.5	32.8
5	VW1	20.0	1.0	2.9	27		100			
6	VW1	22.7	0.9	2.3	26	14.8	100	5.3	13.2	32.2
7	VW1	20.0	0.9	2.8	27	15.0	100	4.8	13.7	33.6
8	VW1	20.2	0.9	2.8	26	14.9	100	4.8	13.5	33.6
9	VW1	20.2	1.0	2.8	25	14.2	100	5.0	13.8	33.0
10	Control	20.0	1.0	2.9	26	14.5	120	4.5	14.0	34.0
11	Control	19.7	1.0	3.0	28	14.4	120	4.6	14.0	35.5
12	Control	21.2	1.0	3.0	28	14.5	120	4.9	13.6	34.1
13	Control	20.2	1.0	2.9	26	14.4	100	4.9	13.6	33.5
14	Control	20.0	1.0	2.9	23	14.4	100	5.2	12.9	31.8
15	Control	20.3	0.9	2.6	21	14.0	100	4.9	11.2	32.9
16	Control	19.9	0.9	2.8	19	13.7	100	4.8		32.4
17	Control	19.8	0.9	2.8	21	14.5	100	5.1		32.4
18	Control	19.9	0.9	2.9	20	14.2	100	4.7	13.6	33.2
19	Control	20.1	1.0	3.0	20	14.5	100	4.9		33.0
20	Control	20.0	1.0	3.0	22	14.0	100	4.6	13.9	33.8
21	VW1	20.1	0.9	2.7	21	14.5	95	5.2	13.3	32.1
22	VW1	20.4	0.9	2.7	22	14.6	95	5.1	12.9	31.6
23	VW1	20.1	0.9	2.7	21	14.6	95	4.8	13.6	33.2
24	VW1	20.2	1.0	2.9	22	14.9	100	4.9	13.5	33.1
25	VW1	20.2	0.9	2.8	23	15.0	100	4.7	13.4	34.1
26	VW1	19.8	0.9	2.8	23	14.9	100	5.0	13.2	32.5
27	Control	20.1	1.0	2.9	27	13.6	120	4.9	13.4	33.5
28	Control	20.0	0.9	2.7	25	13.4	100	4.8	13.5	33.8
29	VW1	20.1	1.0	2.9	24	13.6	100	4.7	14.0	34.9
30	VW1	20.2	0.9	2.7	23	13.5	100	4.8	13.6	33.7
31	VW1	20.2	0.9	2.8	22	13.4	100	4.7	13.8	34.7
32	VW1	20.1	0.9	2.8	22	13.3	100	4.6	14.1	35.3
33	VW1	19.9	1.0	2.9	22	13.3	95	4.9	13.0	32.6
34	Control	20.2	0.9	2.7	23	13.5	100	4.8	13.9	35.1
35	Control	20.1	1.0	2.9	24	13.4	100	4.8	13.9	34.3
36	Control	20.1	0.9	2.7	24	13.4	100	4.8	13.9	33.8
37	Control	20.0	1.0	3.1	24	13.3	100	4.8	14.0	33.1
38	Control	20.1	0.9	2.8	23	13.4	100	5.0	13.2	32.7
39	Control	20.0	1.0	3.0	21	13.4	95	5.2	12.9	32.2
40	Control	20.1	0.9	2.8	23	13.3	100	4.7	13.8	34.9
Summary Statistics										
Control	Minimum	19.7	0.9	2.6	19.0	13.3	95	4.5	11.2	31.8
	Maximum	21.2	1.0	3.1	28.0	14.5	120	5.2	14.0	35.5
	Average	20.1	1.0	2.9	23.4	13.9	104	4.9	13.5	33.5
	St. Dev	0.3	0.04	0.1	2.7	0.5	8.4	0.2	0.7	1.0
VW1	Minimum	19.8	0.9	2.3	21.0	13.3	95	4.6	12.9	31.6
	Maximum	22.7	1.0	2.9	27.0	15.1	100	5.3	14.1	35.3
	Average	20.2	0.9	2.8	23.7	14.4	99	4.9	13.5	33.3
	St. Dev.	0.6	0.03	0.1	2.0	0.6	2.1	0.2	0.3	0.9

Table 3: Total and average catch weights observed within the VW1 Study Area.

Species Name	Scientific Name	Total Weight (Kg)	Catch/Tow (Kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Scup	*Stenotomus chrysops*	2173.1	108.0	18.3	34.8	20
Skate, Little	*Leucoraja erinacea*	1343.9	66.4	5.6	21.5	20
Butterfish	*Peprilus triacanthus*	1104.1	54.4	16.9	17.7	20
Dogfish, Spiny	*Squalus acanthias*	710.5	35.1	10.4	11.4	20
Squid, Atlantic Longfin	*Dorytheuthis pealei*	271.2	13.4	1.3	4.3	20
Skate, Winter	*Leucoraja ocellata*	160.7	7.9	1.5	2.6	16
Hake, Red	*Urophycis chuss*	125.3	6.1	1.4	2.0	19
Northern Sea Robin	*Prionotus carolinus*	112.6	5.5	1.1	1.8	20
Hake, Silver (Whiting)	*Merluccius bilinearis*	109.7	5.4	0.8	1.8	20
Flounder, Summer (Fluke)	*Paralichthys dentatus*	33.2	1.6	0.3	0.5	16
Flounder, Windowpane	*Scophtalmus aquosus*	31.4	1.6	0.3	0.5	20
Black Sea bass	*Centropristis striata*	24.0	1.2	0.2	0.4	19
Flounder, Winter	*Pleuronectes americanus*	15.1	0.8	0.2	0.2	14
Flounder, Fourspot	*Paralichthys oblongus*	10.3	0.5	0.1	0.2	14
Hake, Spotted	*Urophycis regia*	5.5	0.3	0.1	0.1	13
Sea Robin, Striped	*Prionotus evolans*	4.5	0.2	0.1	0.1	7
Monkfish	*Lophius americanus*	2.8	0.1	0.1	0.04	2
Skate, Barndoor	*Dipturus laevis*	1.8	0.1	0.1	0.03	2
Sea Scallop	*Placopecten magellanicus*	0.8	0.04	0.03	0.01	3
Crab, Rock	*Cancer irroratus*	0.8	0.04	0.03	0.01	2
Flounder, Gulfstream	*Citharichthys arctifrons*	0.7	0.03	0.01	0.01	5
Dogfish, Smooth	*Mustelus canis*	0.6	0.03	0.02	0.01	2
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	0.6	0.03	0.03	0.01	2
Flounder, Yellowtail	*Pleuronectes ferrugineus*	0.5	0.03	0.01	0.01	4
Weakfish	*Cynoscion regalis*	0.4	0.02	0.02	0.01	1
Kingfish, Northern	*Menticirrhus saxatilis*	0.4	0.02	0.01	0.01	2
Bluefish	*Pomatomus saltatrix*	0.2	0.01	0.01	0.00	1
Total		6244.8				

*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	SEM*	% of Total Catch	Tows with Species Present
Scup	*Stenotomus chrysops*	3056.7	152.6	25.1	35.8	20
Skate, Little	*Leucoraja erinacea*	2022.3	100.5	8.5	23.7	20
Dogfish, Spiny	*Squalus acanthias*	1664.8	82.6	35.9	19.5	19
Butterfish	*Peprilus triacanthus*	387.8	19.3	6.5	4.5	19
Hake, Red	*Urophycis chuss*	384.2	19.1	3.6	4.5	18
Hake, Silver (Whiting)	*Merluccius bilinearis*	214.2	10.7	1.4	2.5	20
Squid, Atlantic Longfin	*Dorytheuthis pealei*	176.5	8.8	1.9	2.1	20
Northern Sea Robin	*Prionotus carolinus*	150.1	7.5	1.7	1.8	19
Skate, Winter	*Leucoraja ocellata*	137.4	6.8	1.7	1.6	14
Flounder, Windowpane	*Scophtalmus aquosus*	130.9	6.5	1.5	1.5	20
Hake, Spotted	*Urophycis regia*	46.7	2.3	1.0	0.5	10
Flounder, Fourspot	*Paralichthys oblongus*	45.2	2.3	0.4	0.5	19
Flounder, Summer (Fluke)	*Paralichthys dentatus*	35.4	1.8	0.3	0.4	18
Black Sea bass	*Centropristis striata*	17.8	0.9	0.3	0.2	15
Flounder, Winter	*Pleuronectes americanus*	17.0	0.8	0.2	0.2	14
Monkfish	*Lophius americanus*	13.0	0.6	0.5	0.2	3
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	9.0	0.5	0.2	0.1	11
Weakfish	*Cynoscion regalis*	4.7	0.2	0.1	0.1	11
Skate, Barndoor	*Dipturus laevis*	2.3	0.1	0.1	0.0	4
Kingfish, Northern	*Menticirrhus saxatilis*	2.2	0.1	0.1	0.0	4
Crab, Rock	*Cancer irroratus*	2.1	0.1	0.1	0.0	6
Dogfish, Smooth	*Mustelus canis*	1.9	0.1	0.1	0.0	2
Sea Robin, Striped	*Prionotus evolans*	1.6	0.1	0.1	0.0	2
Alewife	*Alosa pseudoharengus*	0.7	0.04	0.03	0.01	2
Flounder, Gulfstream	*Citharichthys arctifrons*	0.7	0.03	0.02	0.01	4
Shad, American	*Alosa sapidissima*	0.6	0.03	0.02	0.01	3
Haddock	*Melanogrammus aeglefinus*	0.2	0.01	0.01	0.002	2
Herring, Atlantic	*Clupea harengus*	0.2	0.01	0.01	0.002	1
Sea Scallop	*Placopecten magellanicus*	0.2	0.01	0.01	0.002	2
Mackerel, Atlantic	*Scomber scombrus*	0.2	0.01	0.01	0.002	1
Sea Raven	*Hemitripterus americanus*	0.1	0.01	0.01	0.001	1
Lizardfish	*Synodontidae*	0.1	0.005	0.005	0.001	1
Flounder, Yellowtail	*Pleuronectes ferrugineus*	0.1	0.005	0.01	0.001	1
Total		8526.8				

*SEM is an acronym for Standard Error of the Mean

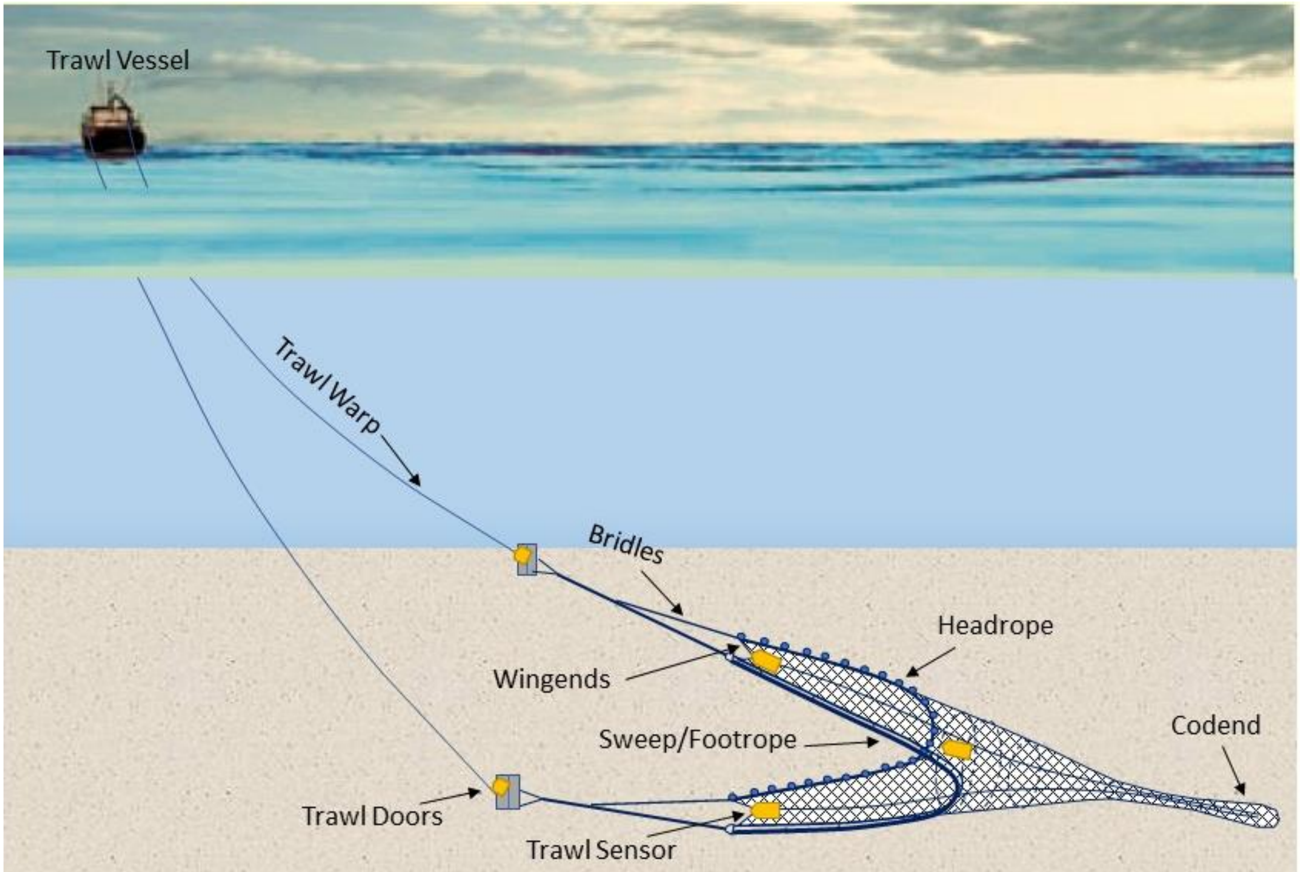


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate geometry sensors.

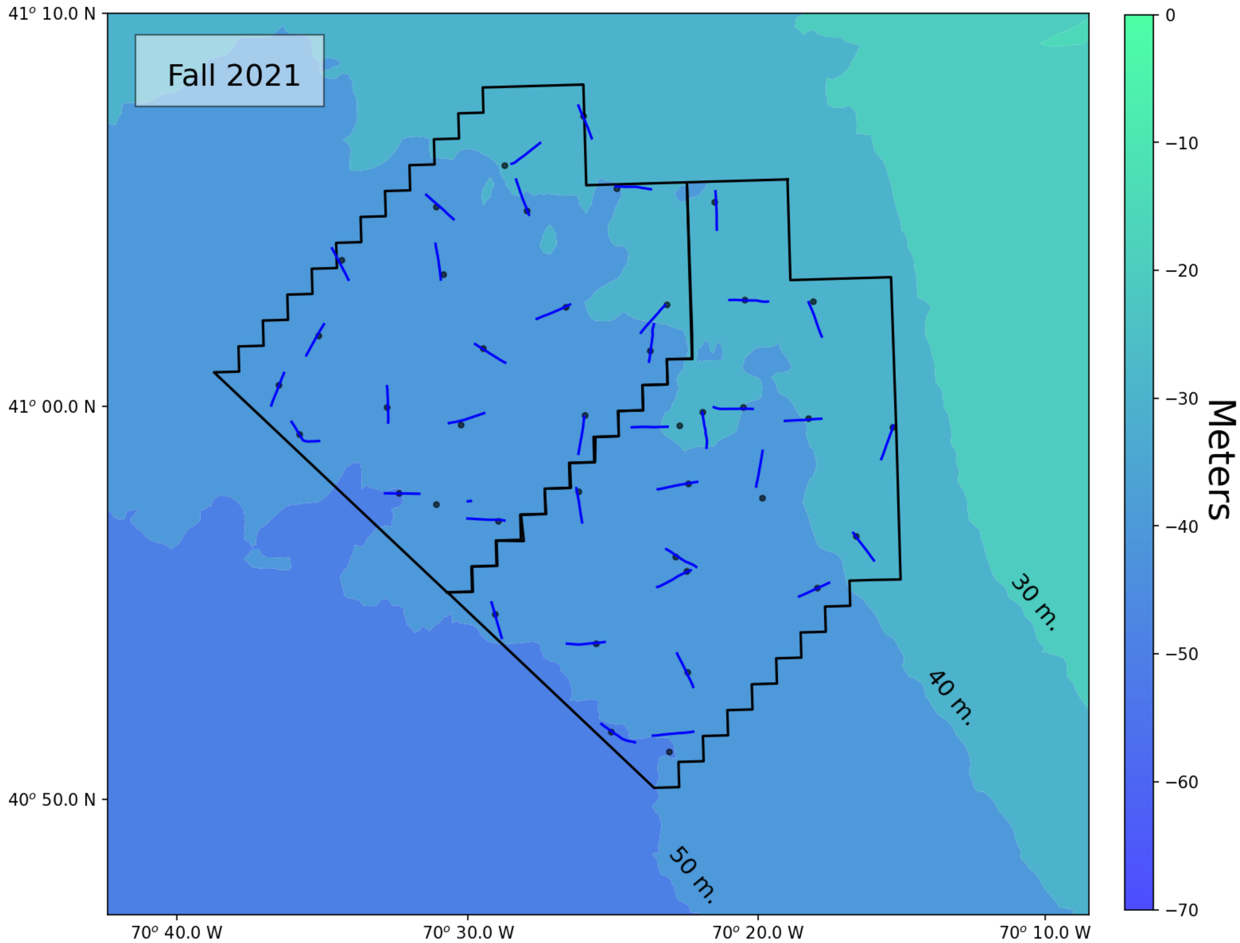


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the VW1 Study Area (left) and the Control Area (right).

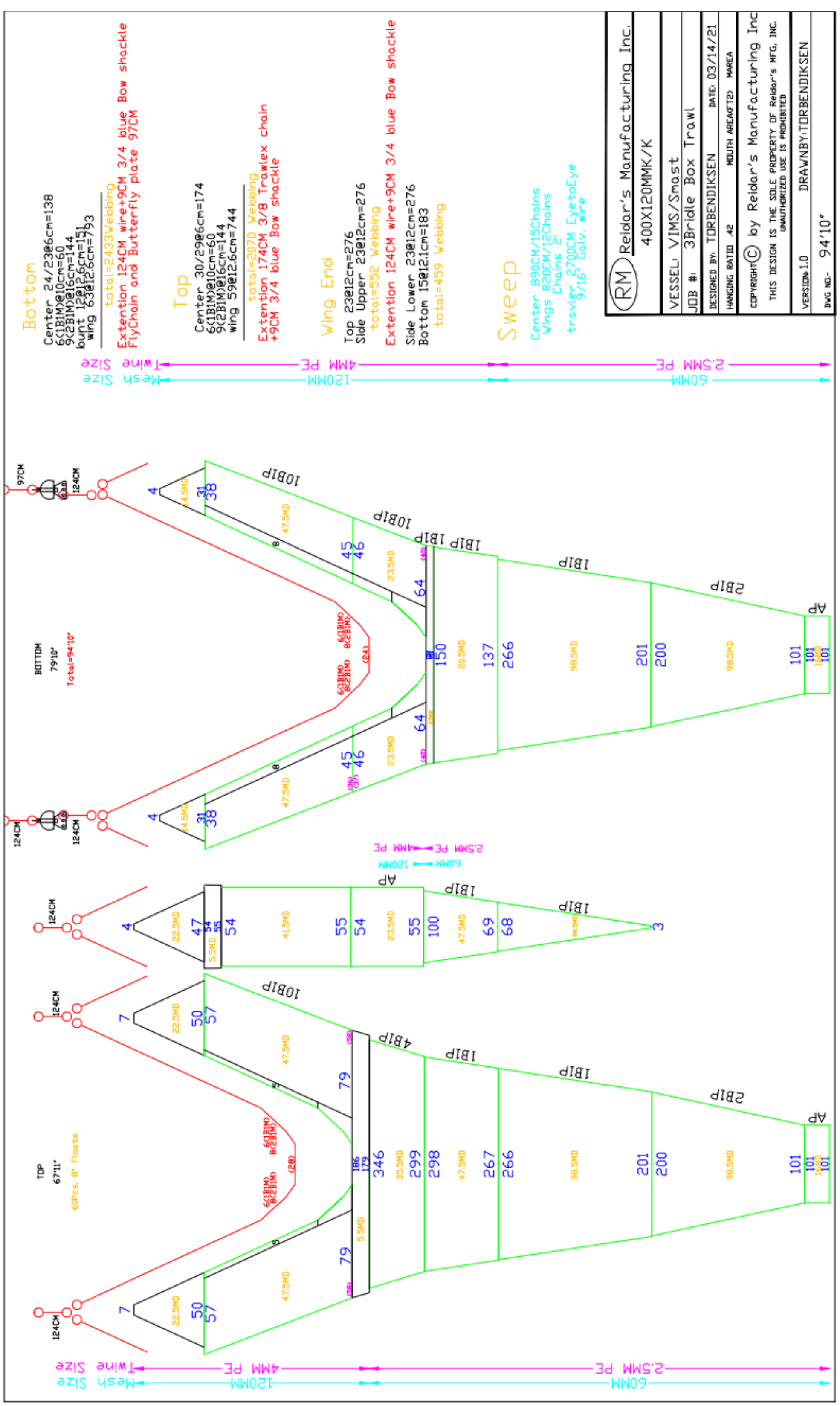


Figure 3: Schematic net plan for the NEAMAP trawl (Courtesy of Reidar's Manufacturing Inc.).

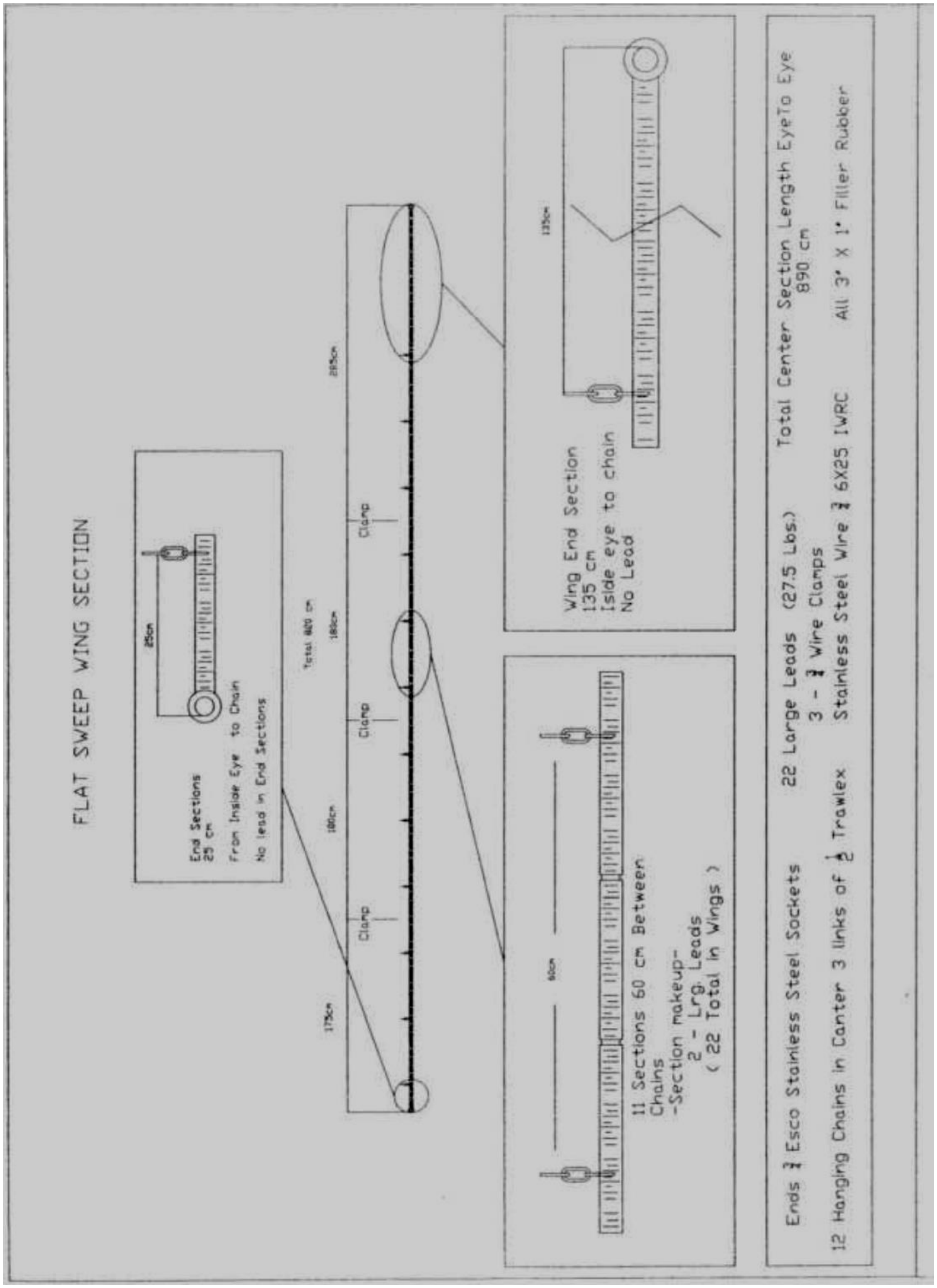


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

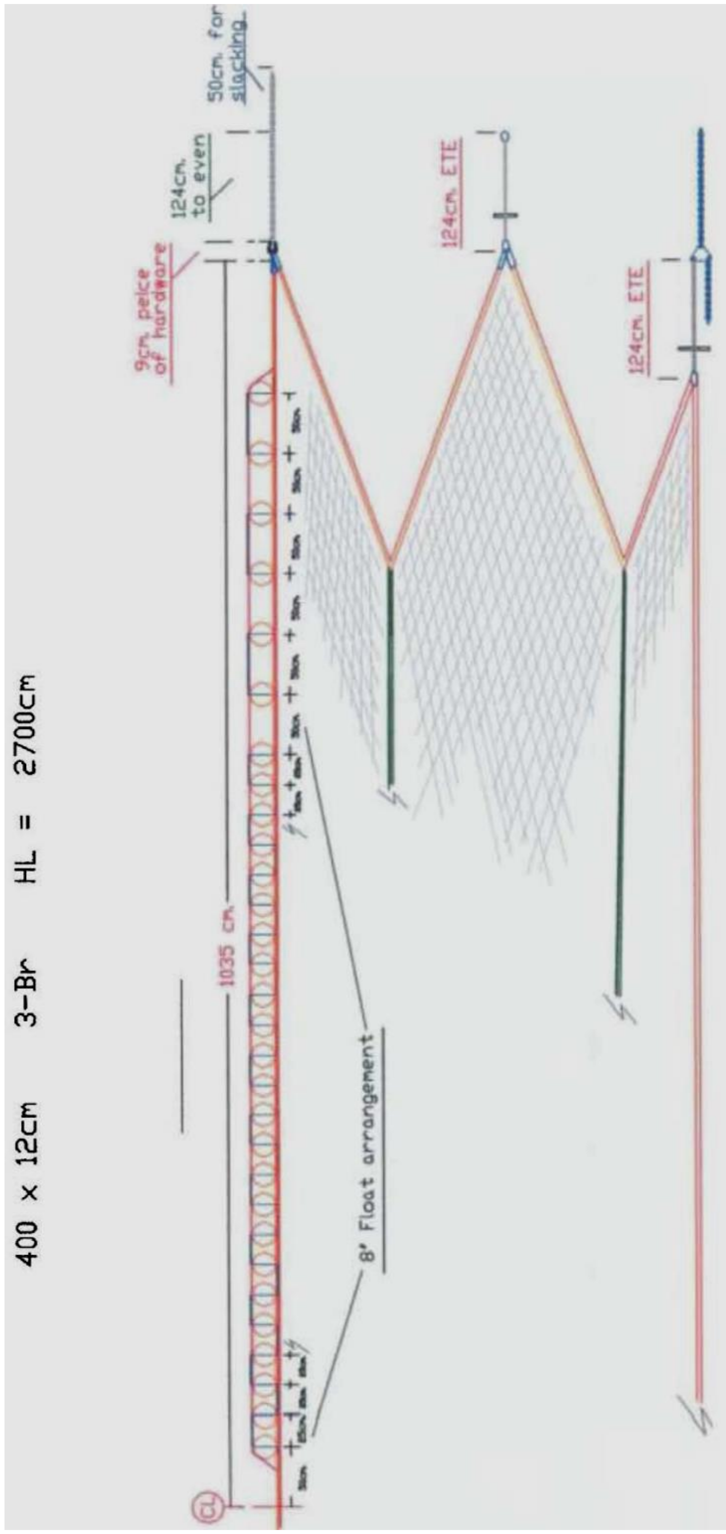


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008).

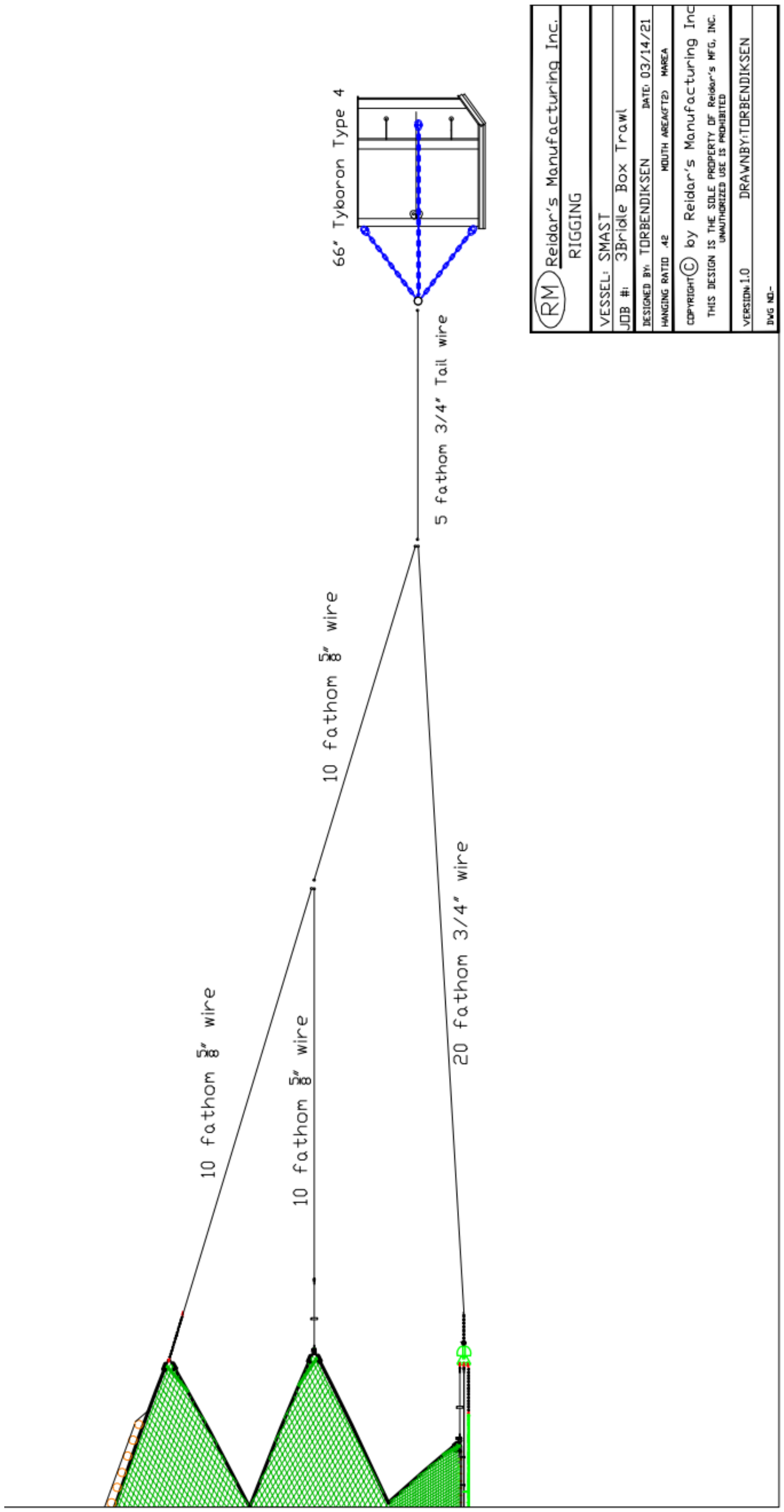


Figure 6: Bridle and door rigging schematic for the survey trawl (Courtesy of Reidar's Manufacturing Inc.).

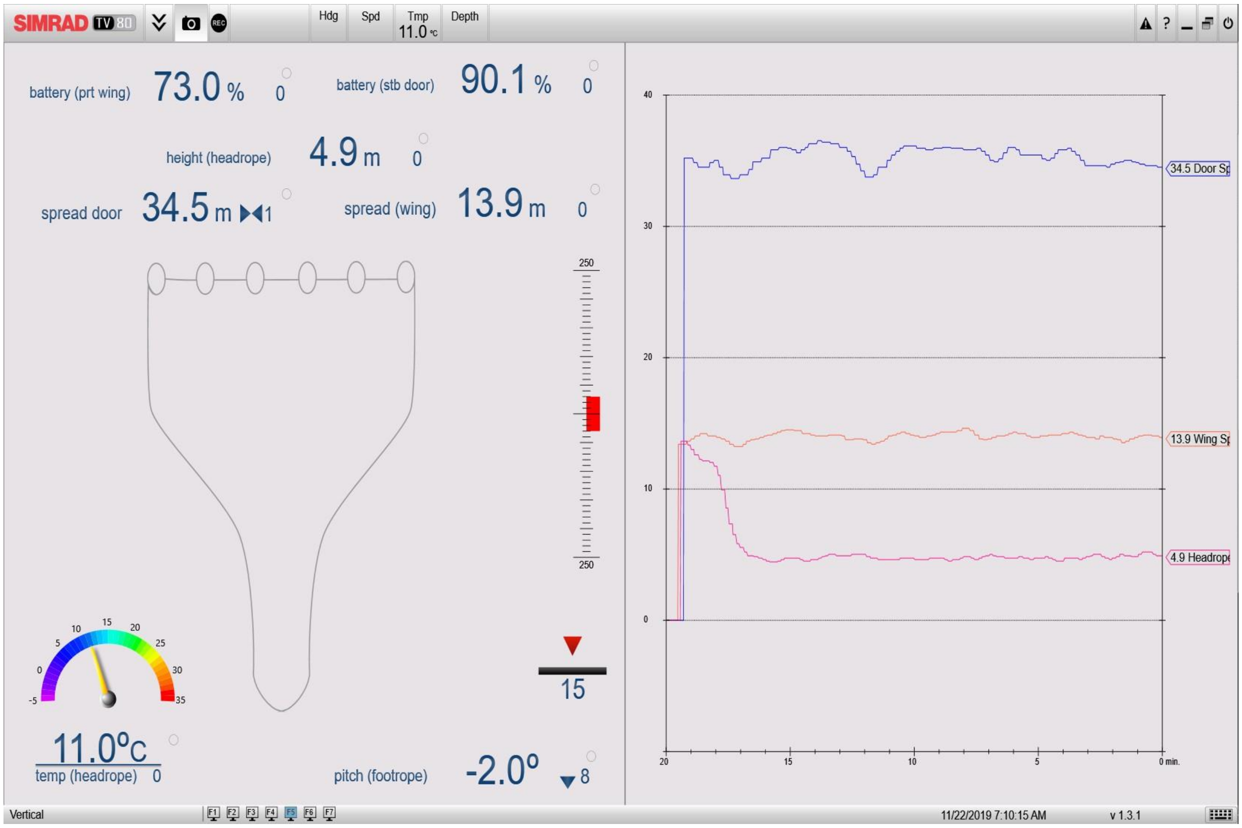
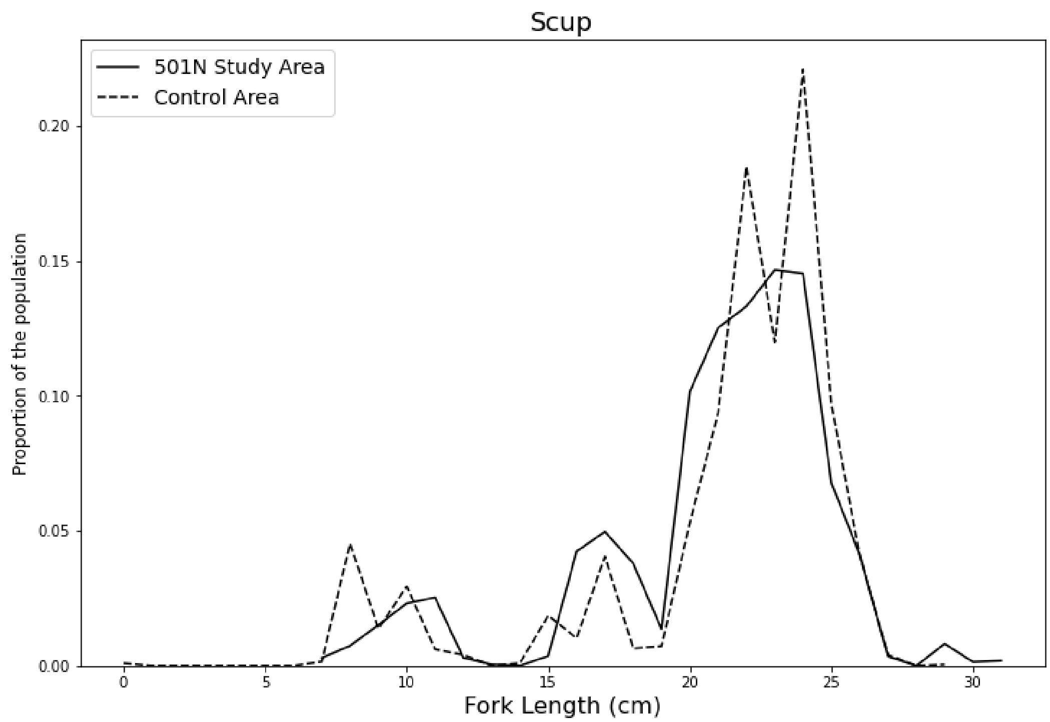


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.



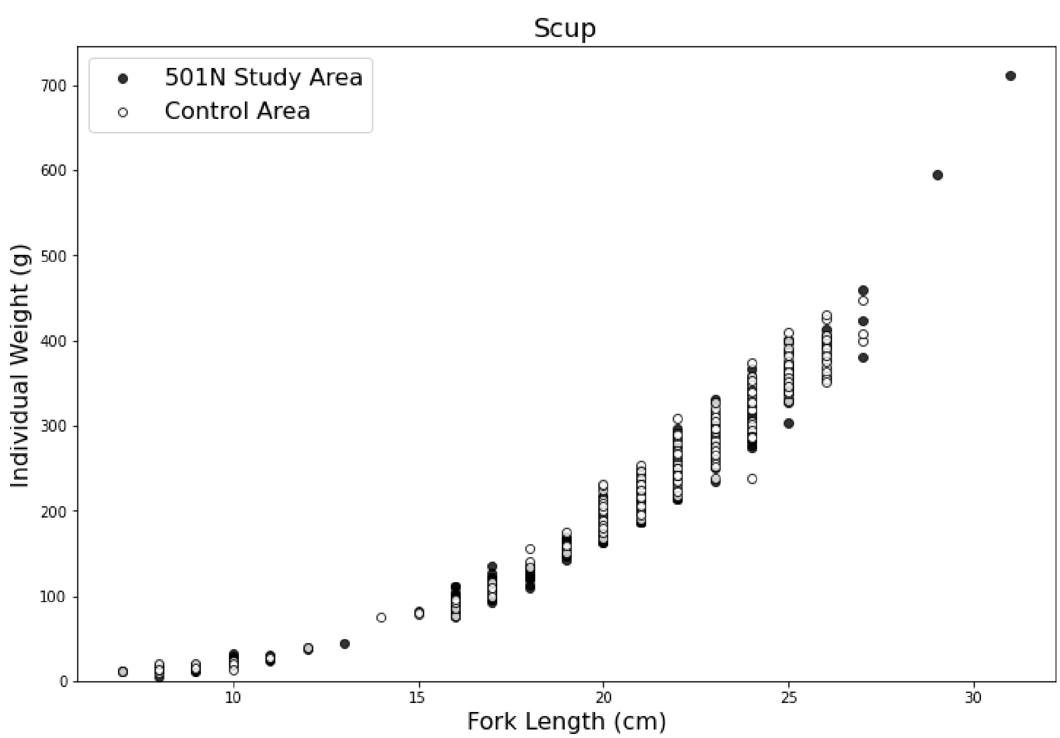


Figure 8: Population structure of scup in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

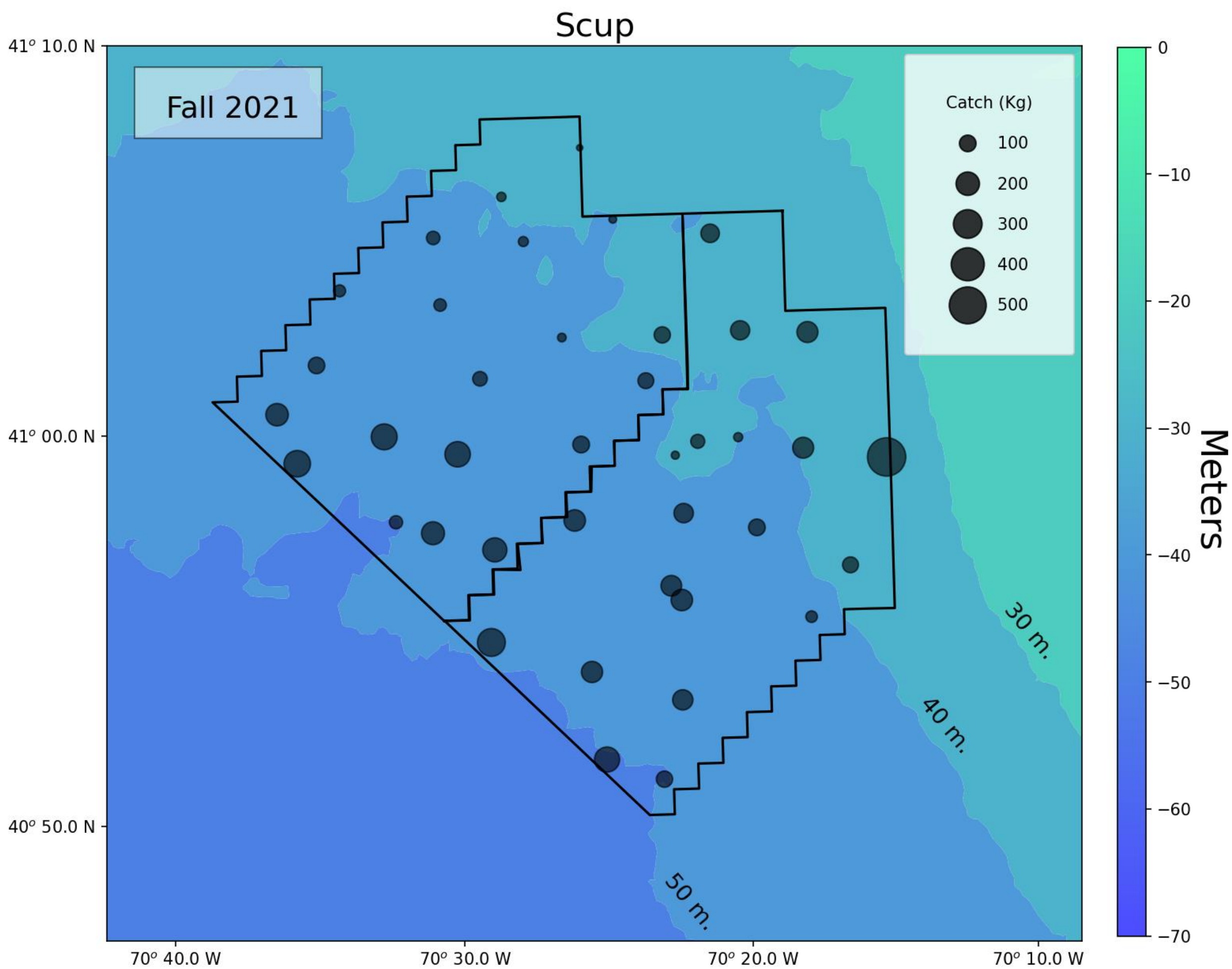
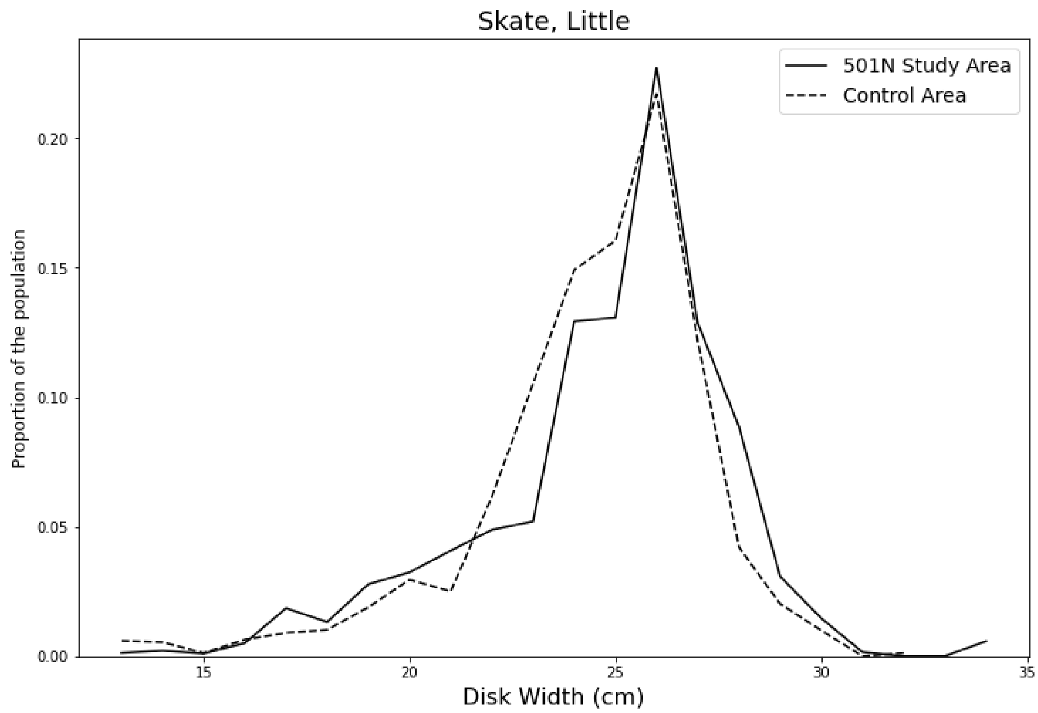


Figure 9: Distribution of the catch of scup in the VW1 Study Area (left) and Control Area (right).



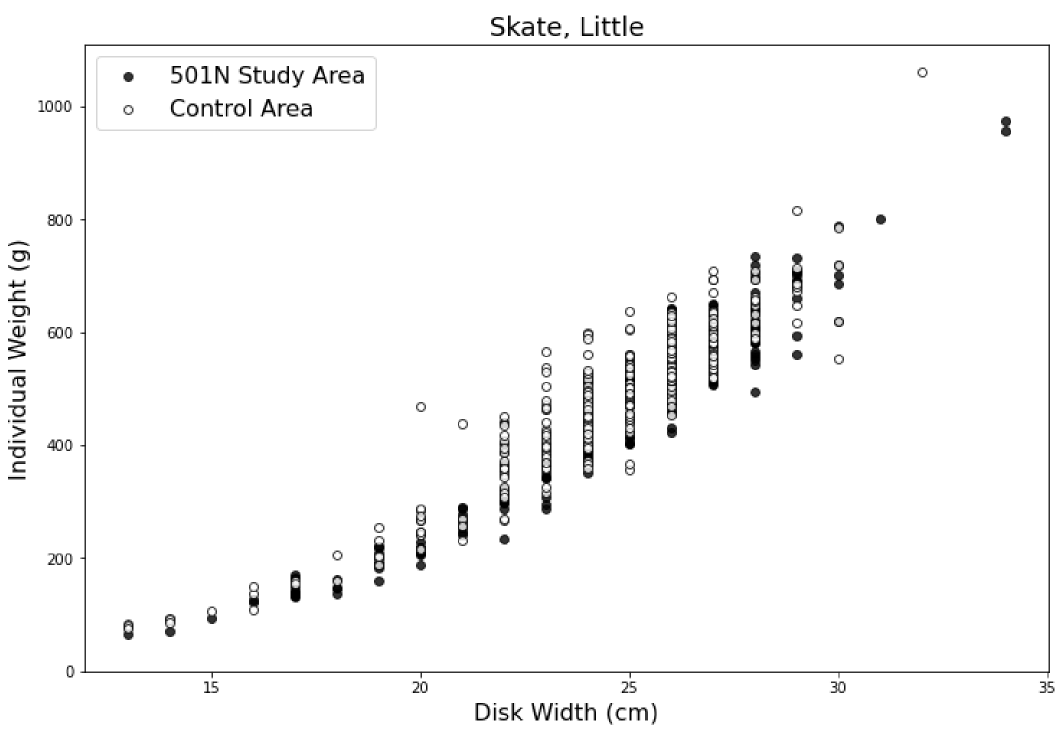


Figure 10: Population structure of little skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

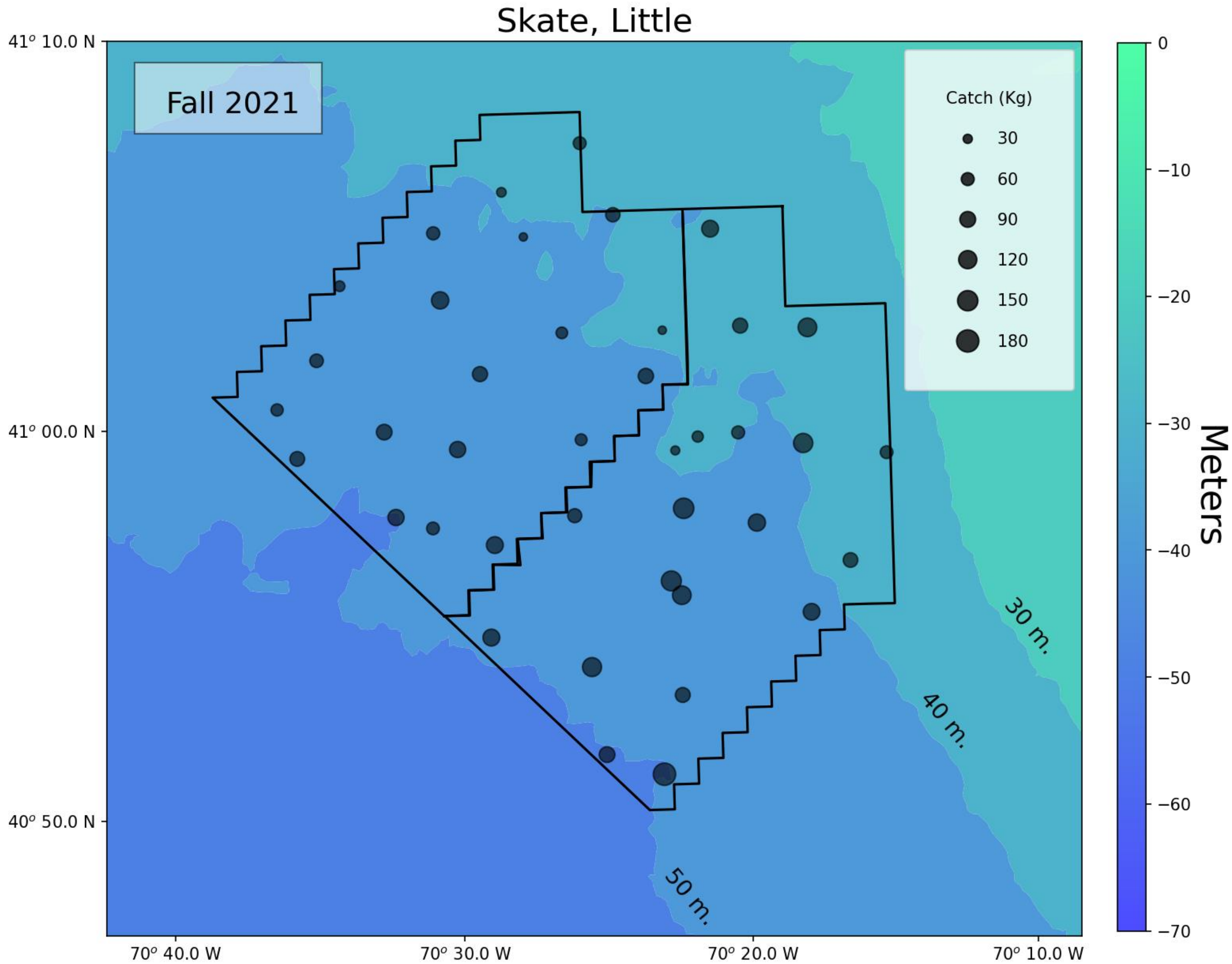
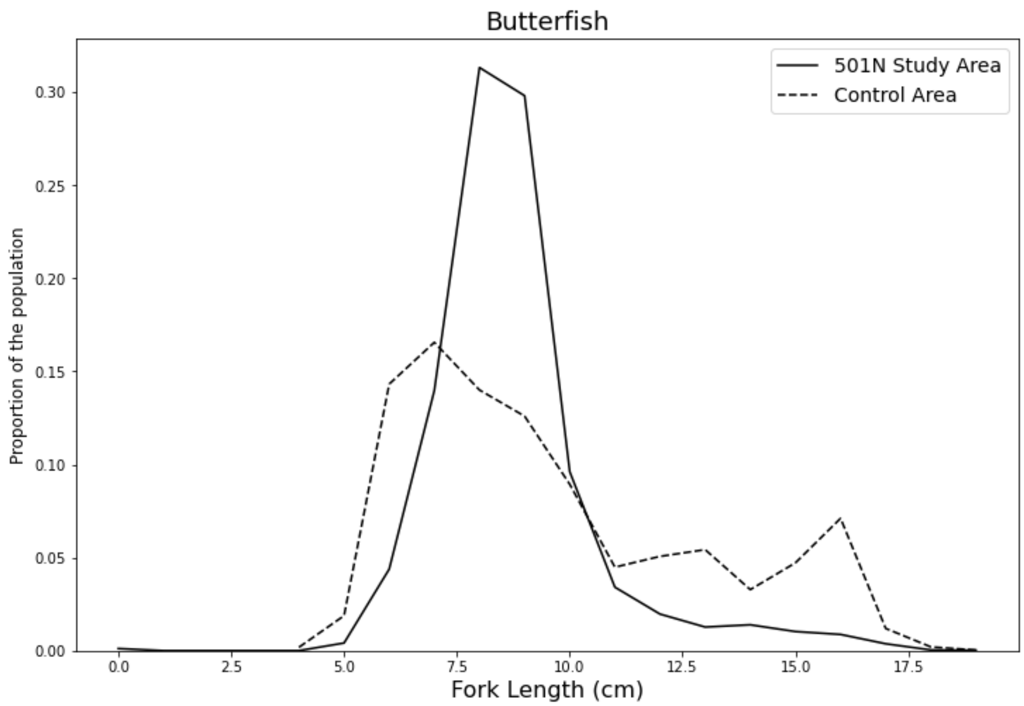


Figure 11: Distribution of the catch of little skate in the VW1 Study Area (left) and Control Area (right).



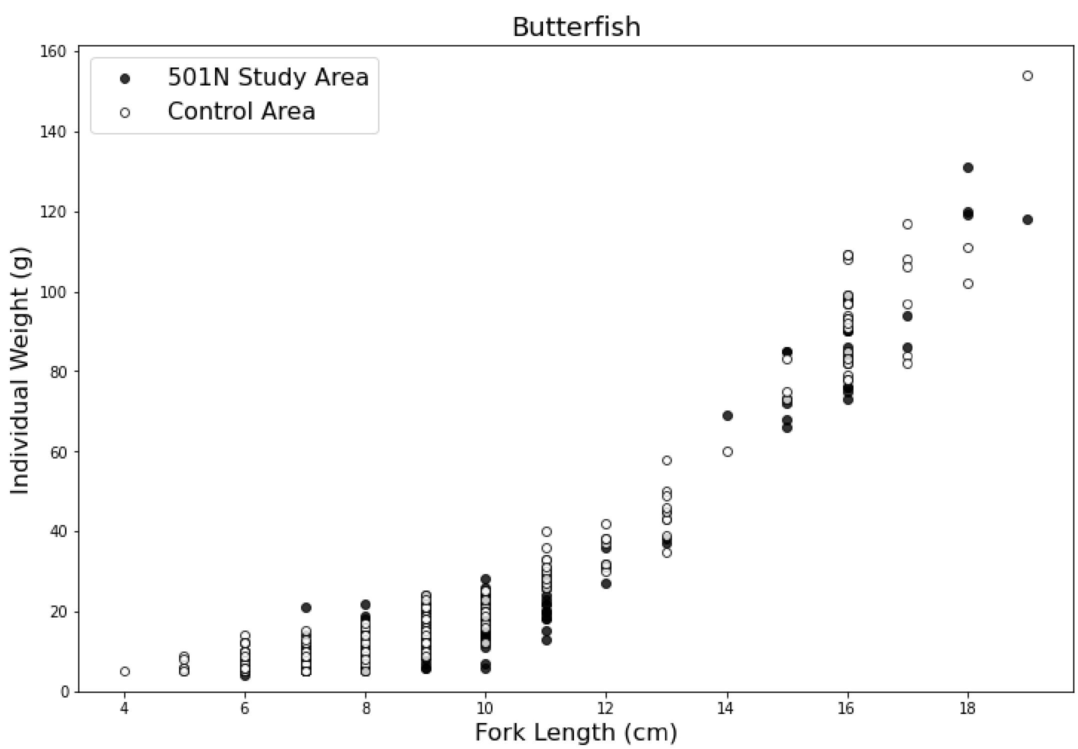


Figure 12: Population structure of butterfish in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

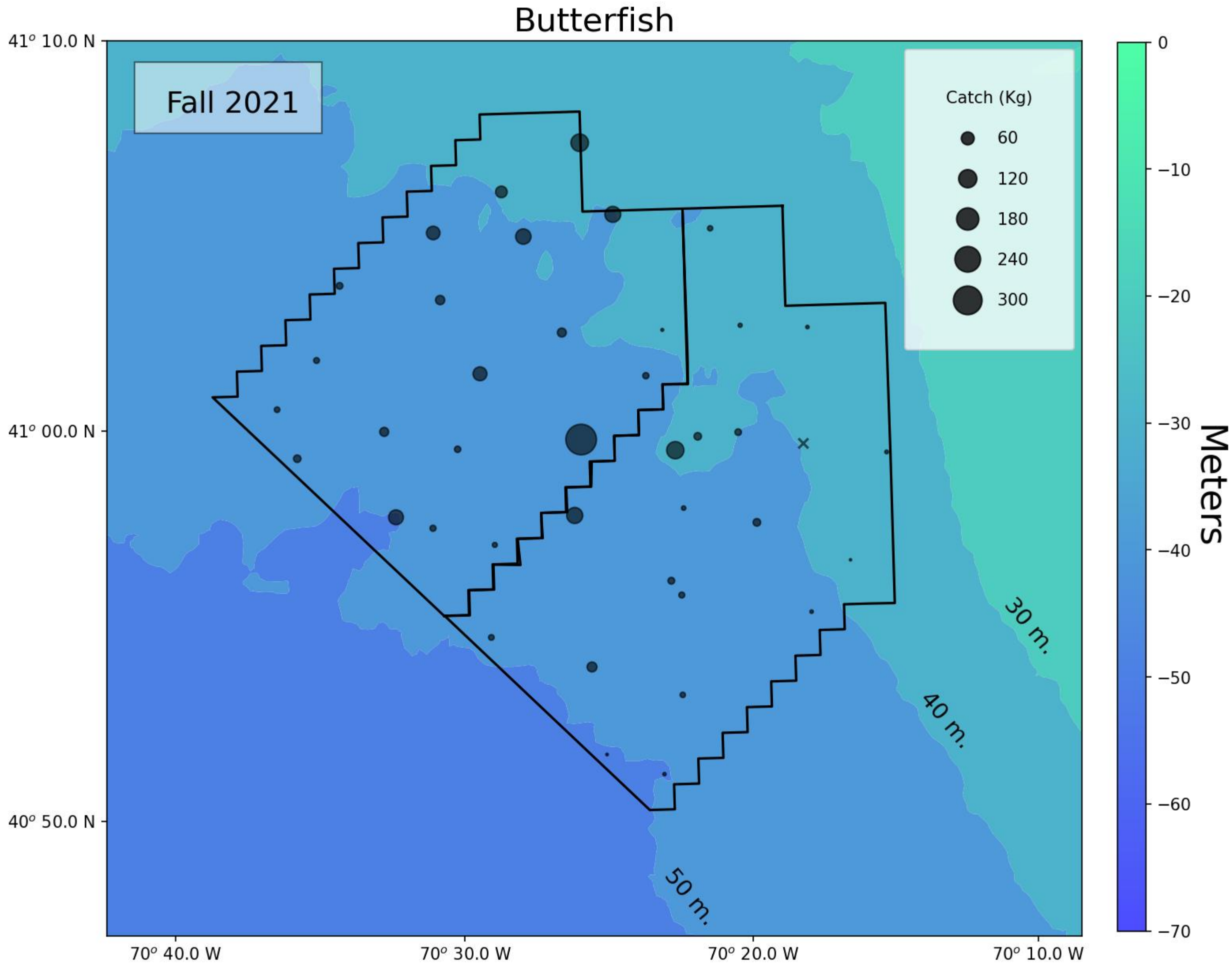
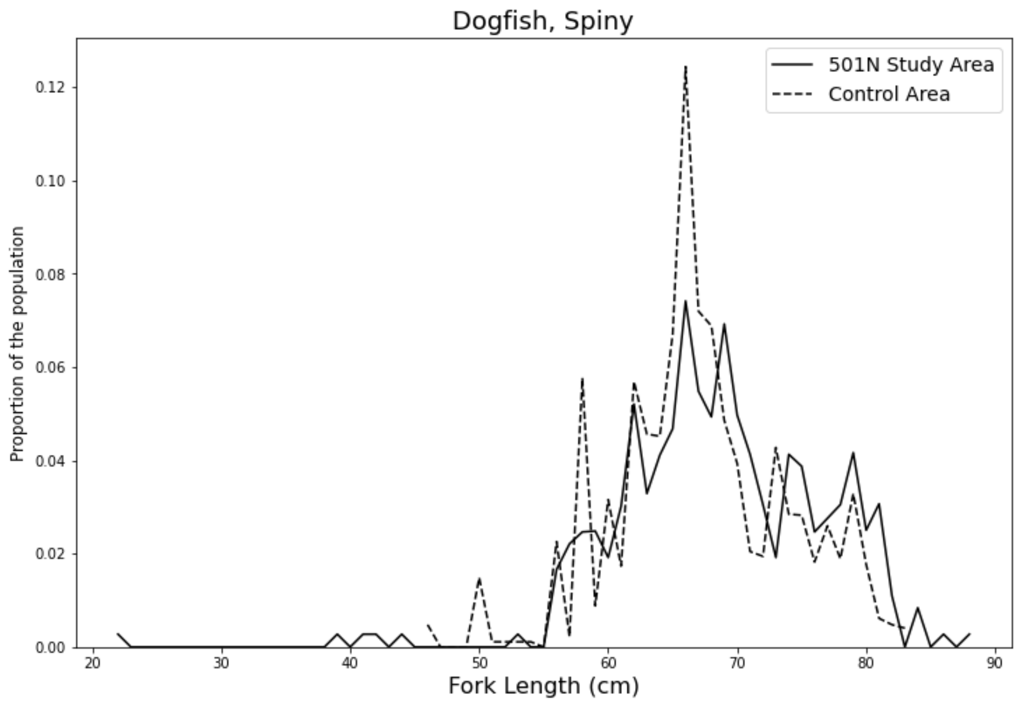


Figure 13: Distribution of the catch of butterfish in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



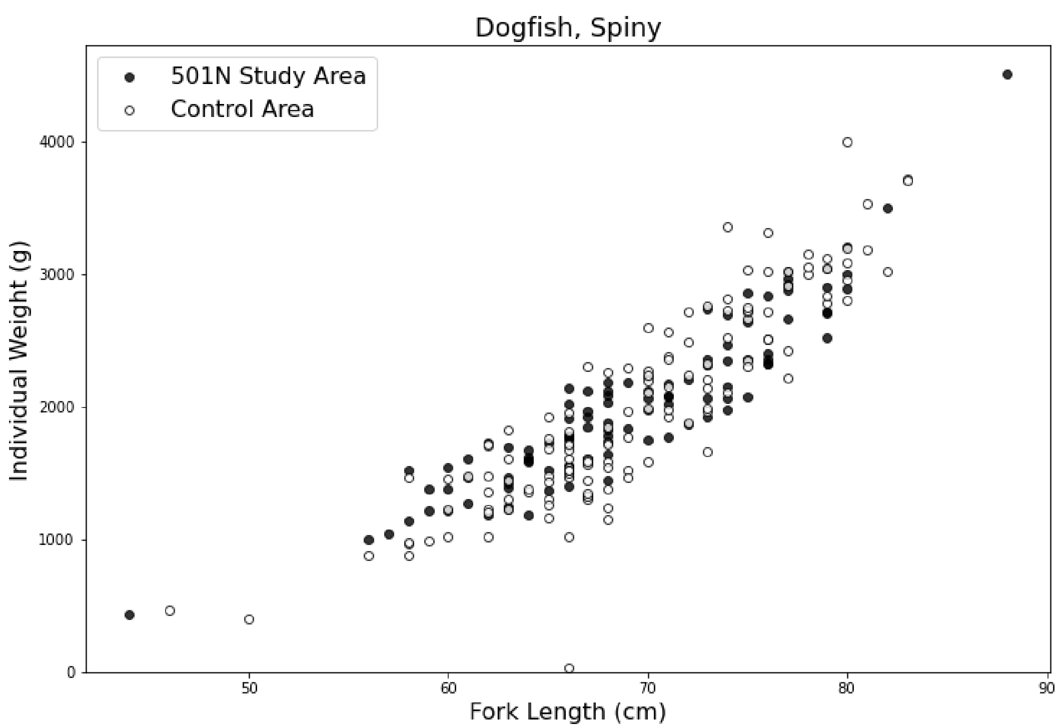


Figure 14: Population structure of spiny dogfish in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

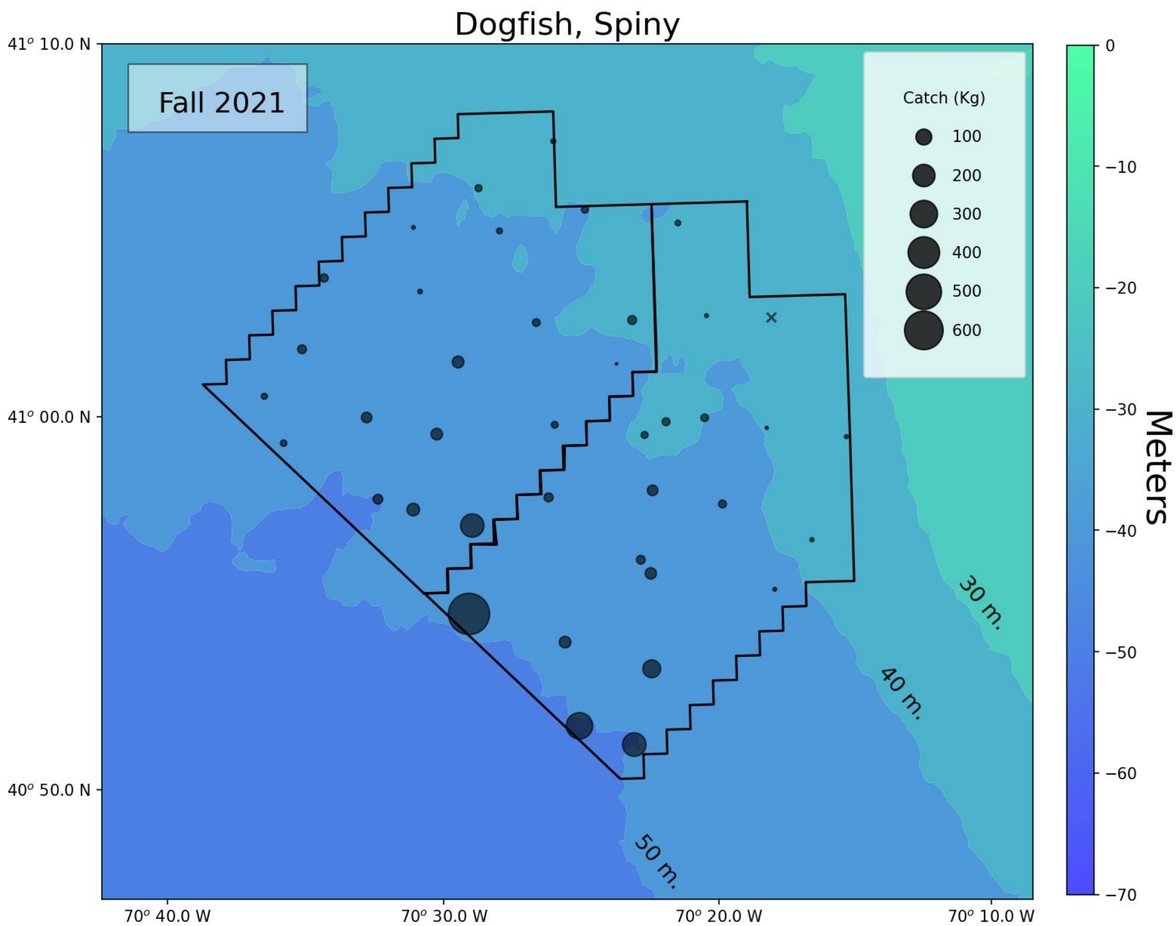
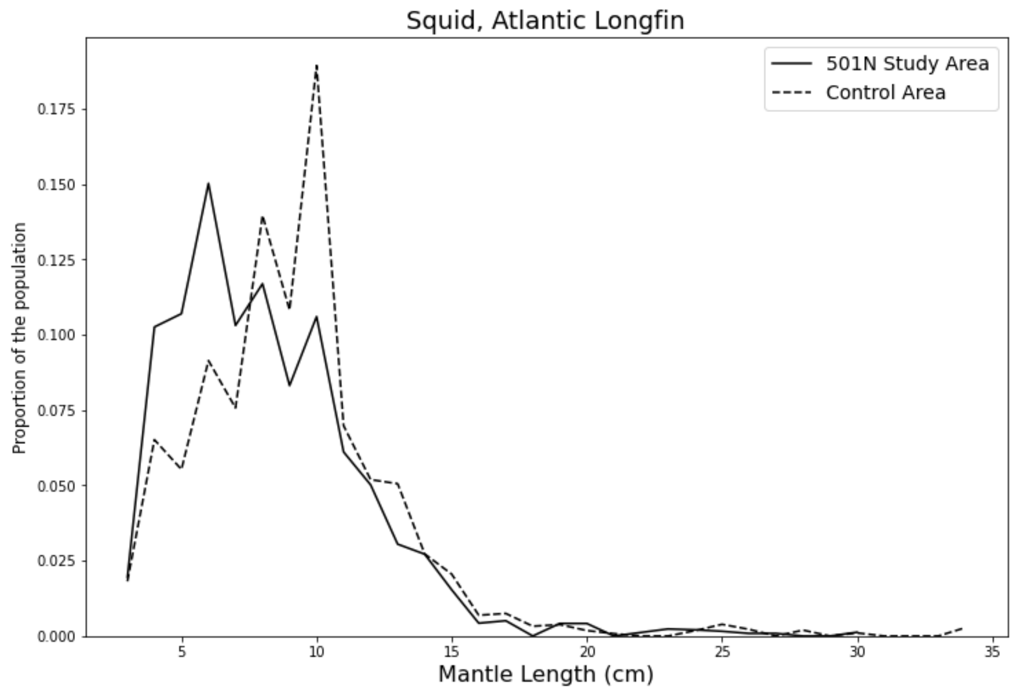


Figure 15: Distribution of the catch of spiny dogfish in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



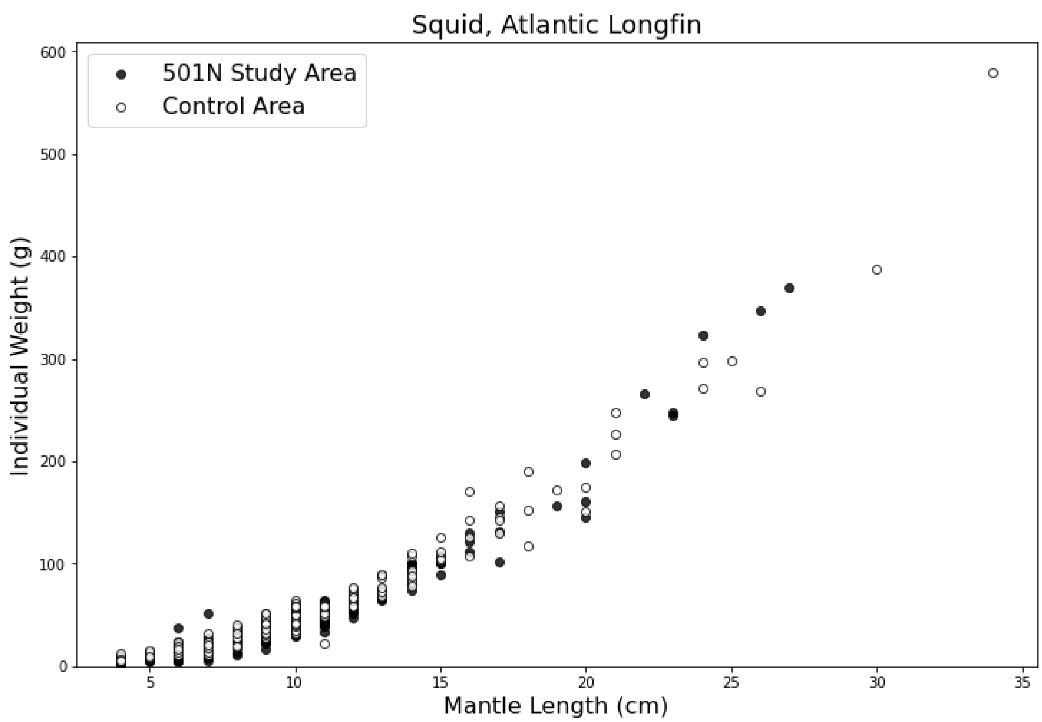


Figure 16: Population structure of Atlantic longfin squid in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

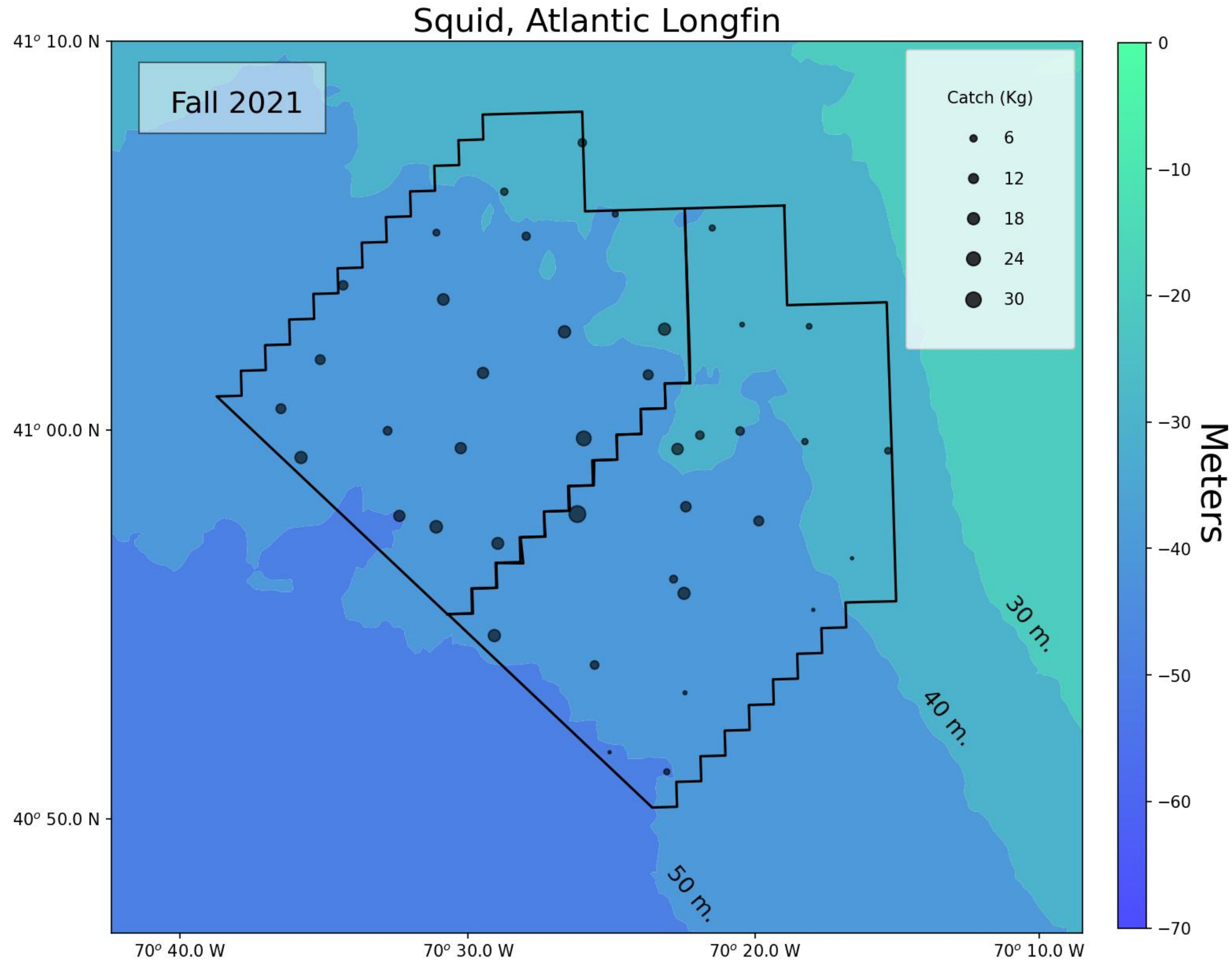
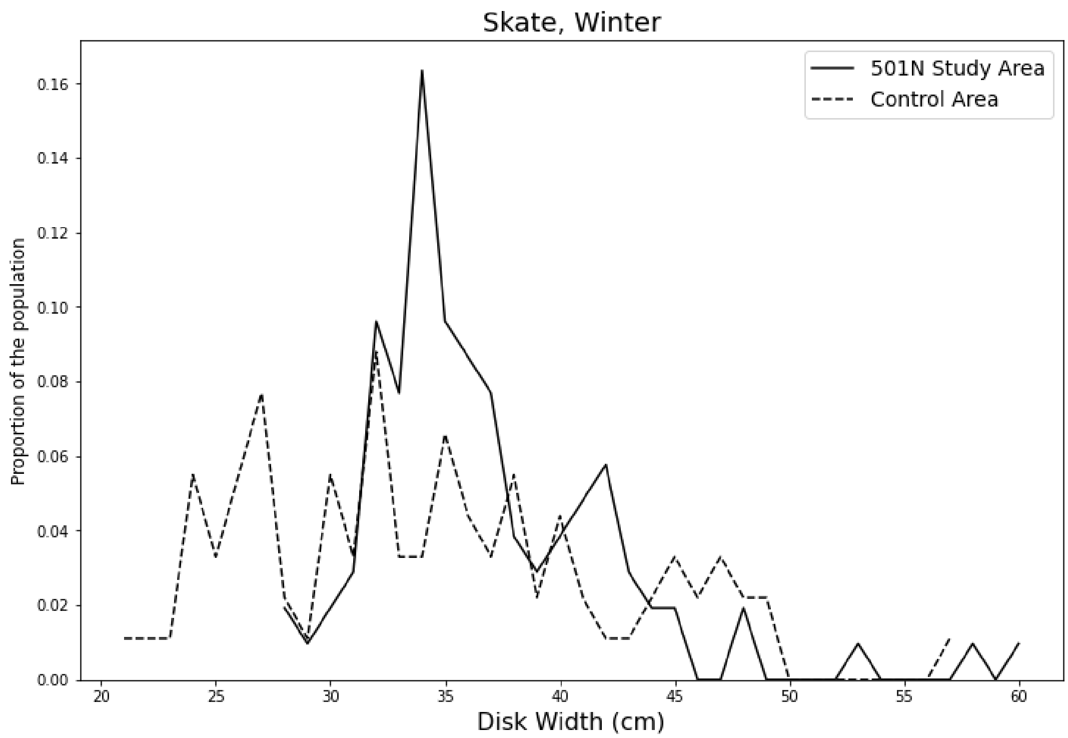


Figure 17: Distribution of the catch of Atlantic longfin squid in the VW1 Study Area (left) and Control Area (right).



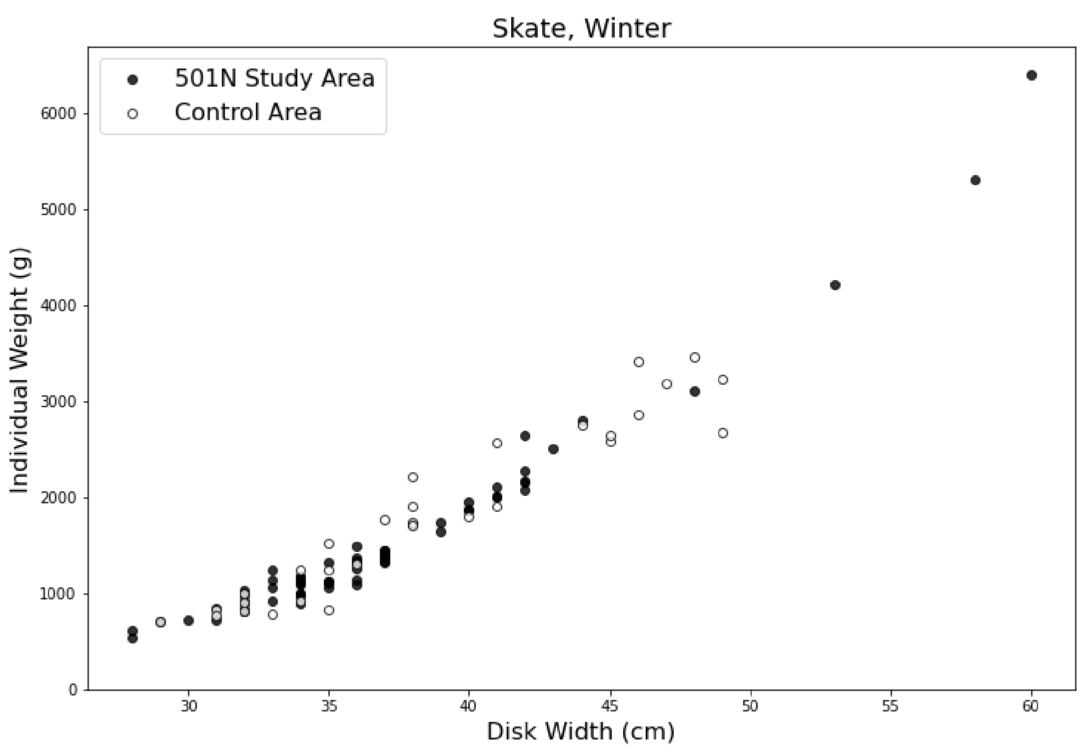


Figure 18: Population structure of winter skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

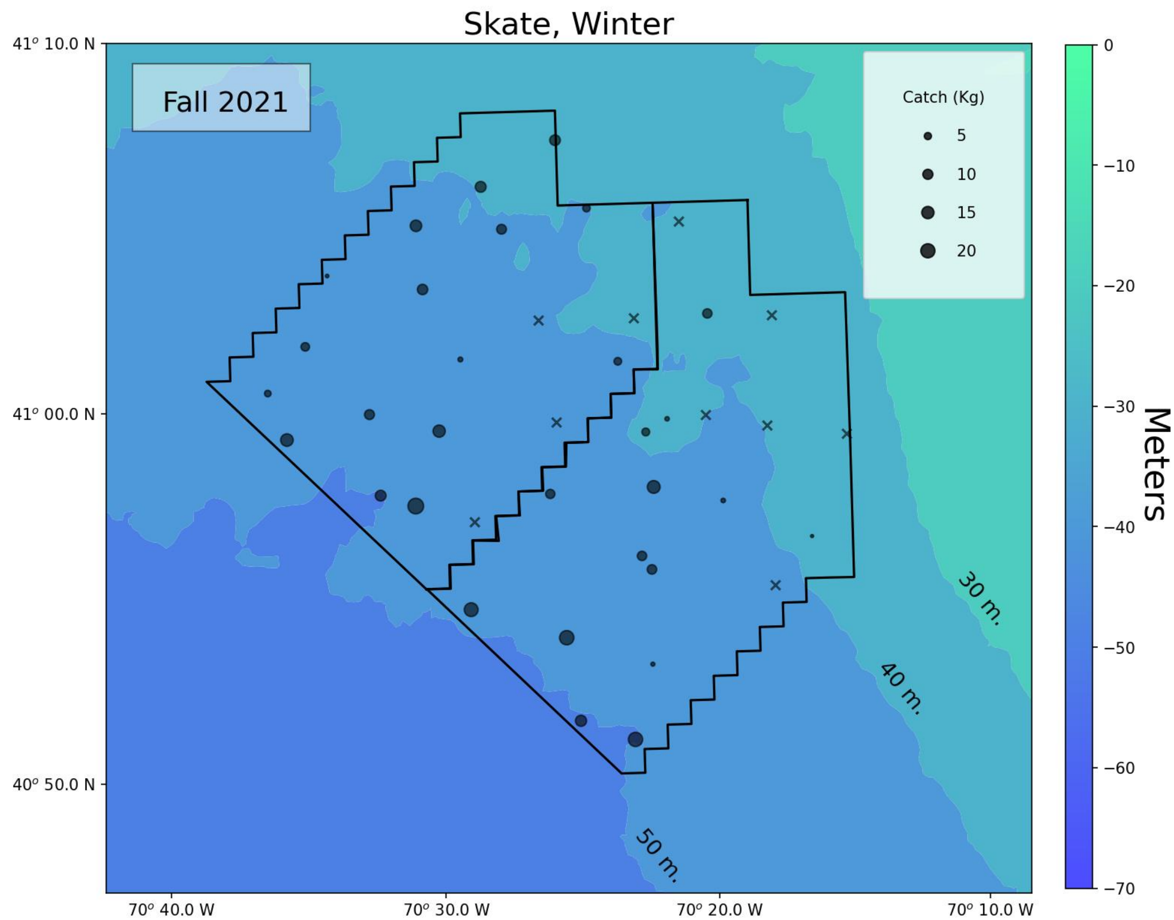
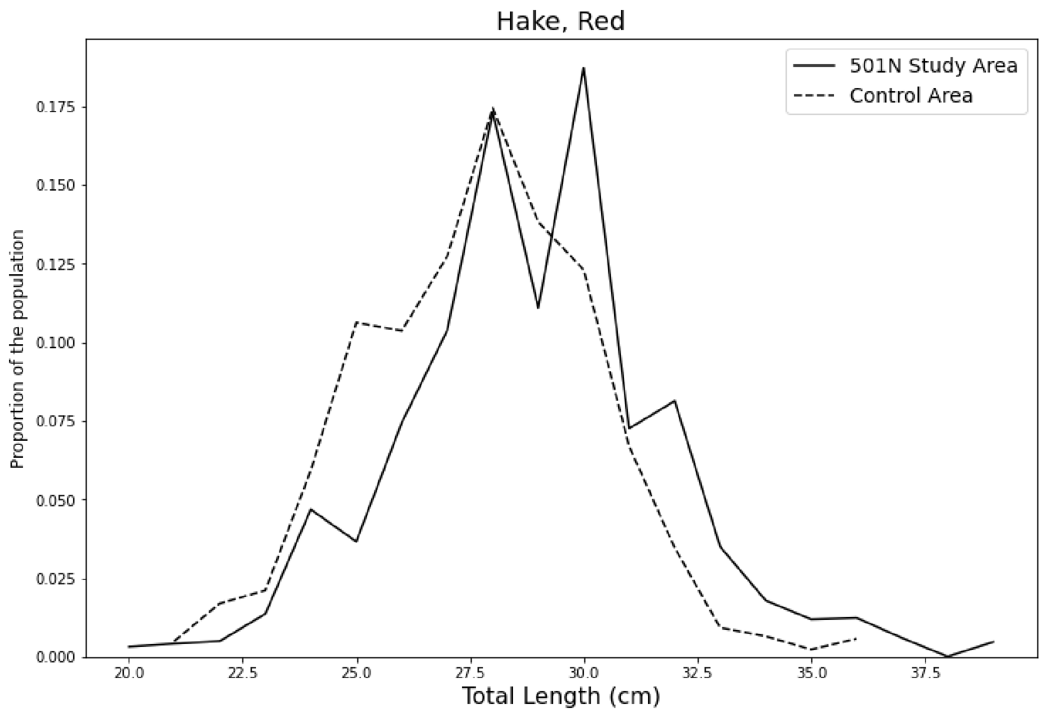


Figure 19: Distribution of the catch of winter skate in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



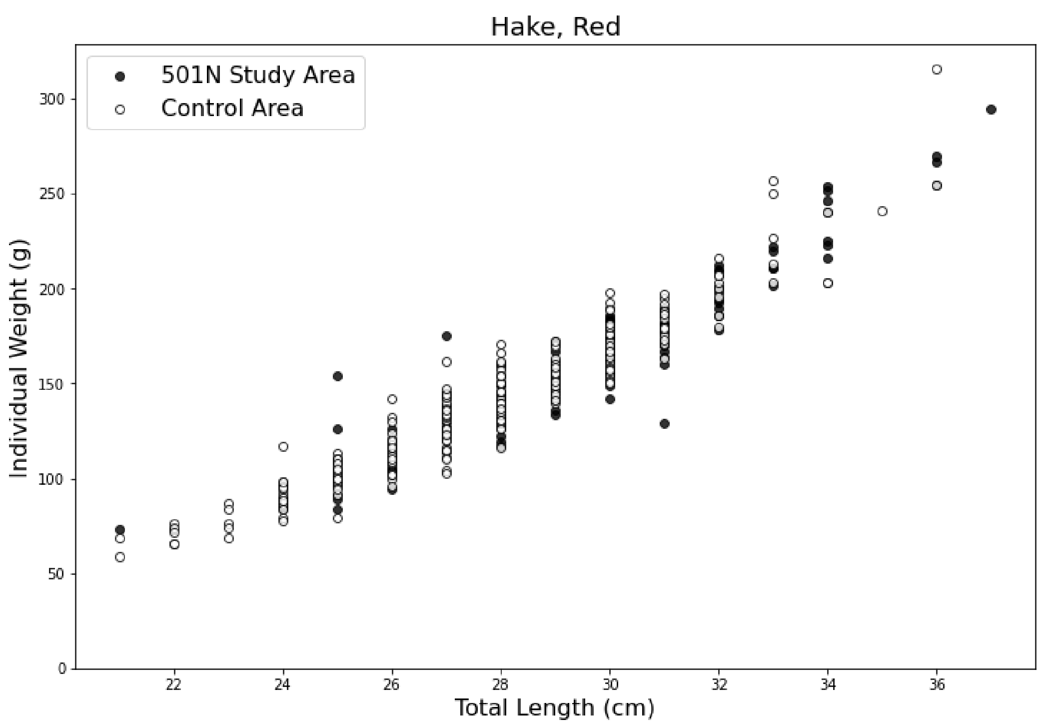


Figure 20: Population structure of red hake in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

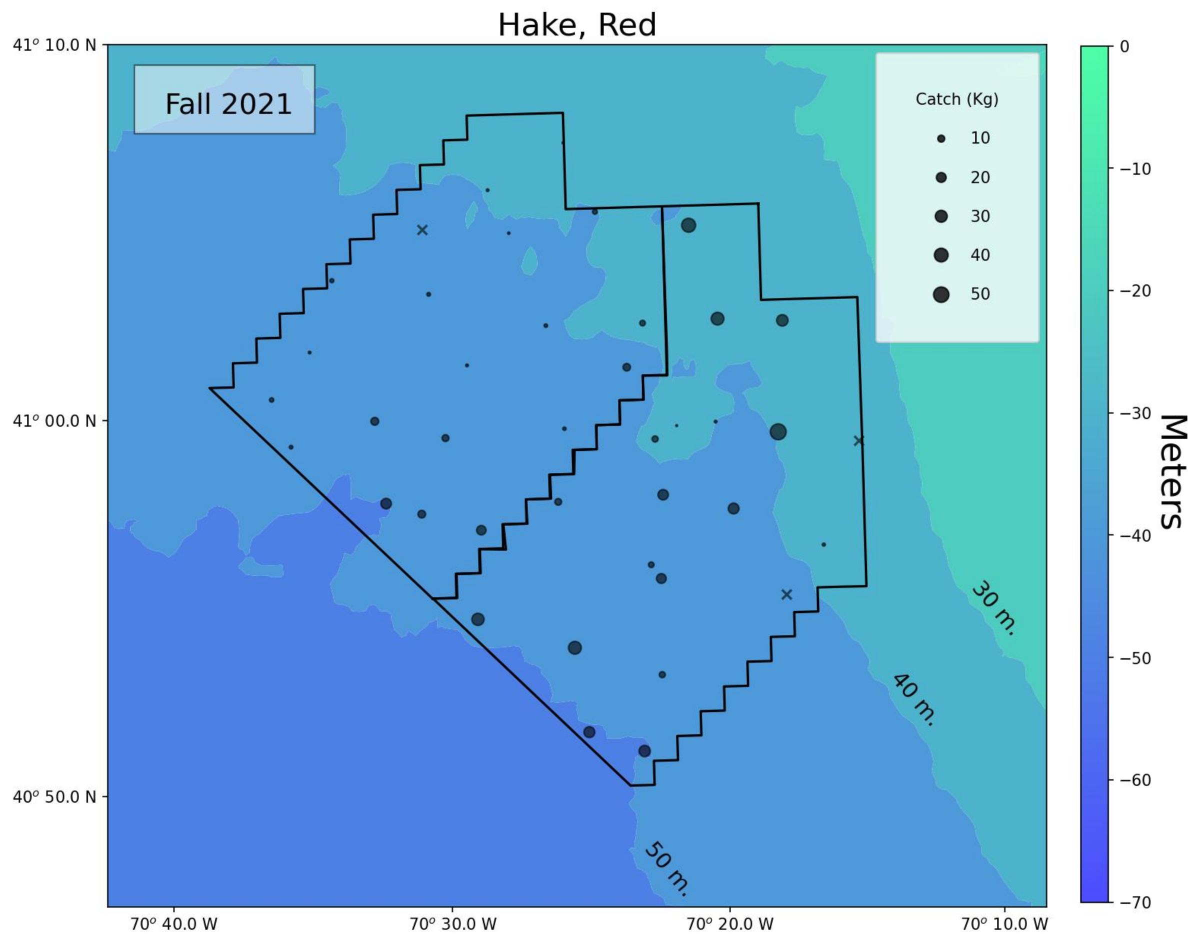
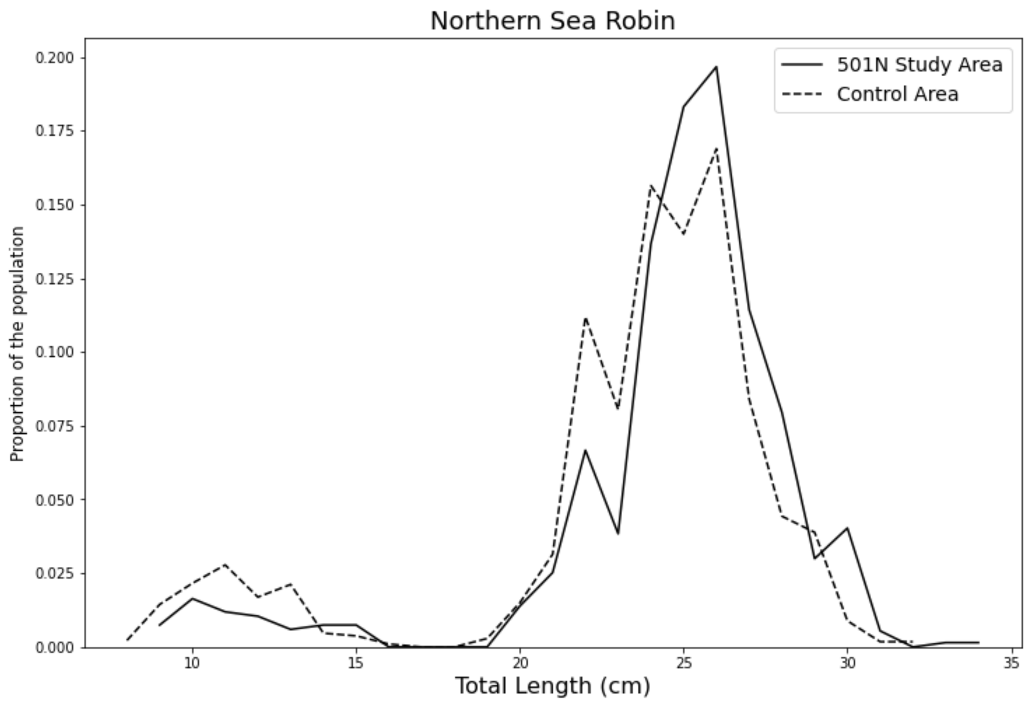


Figure 21: Distribution of the catch of red hake in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



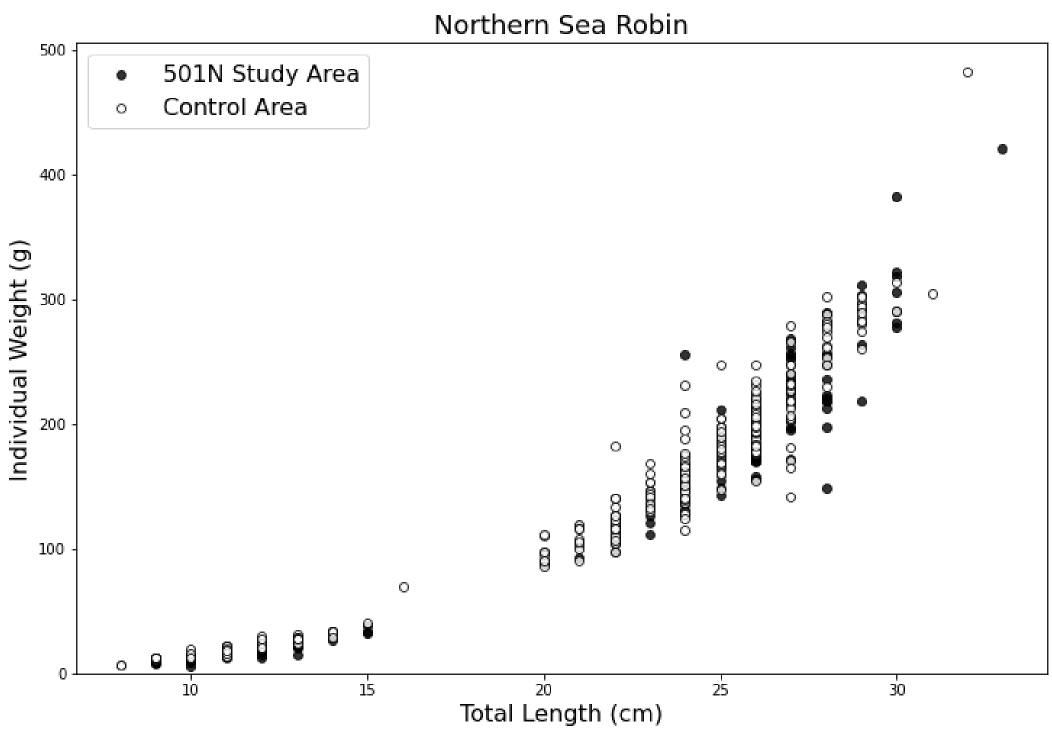


Figure 22: Population structure of northern sea robin in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

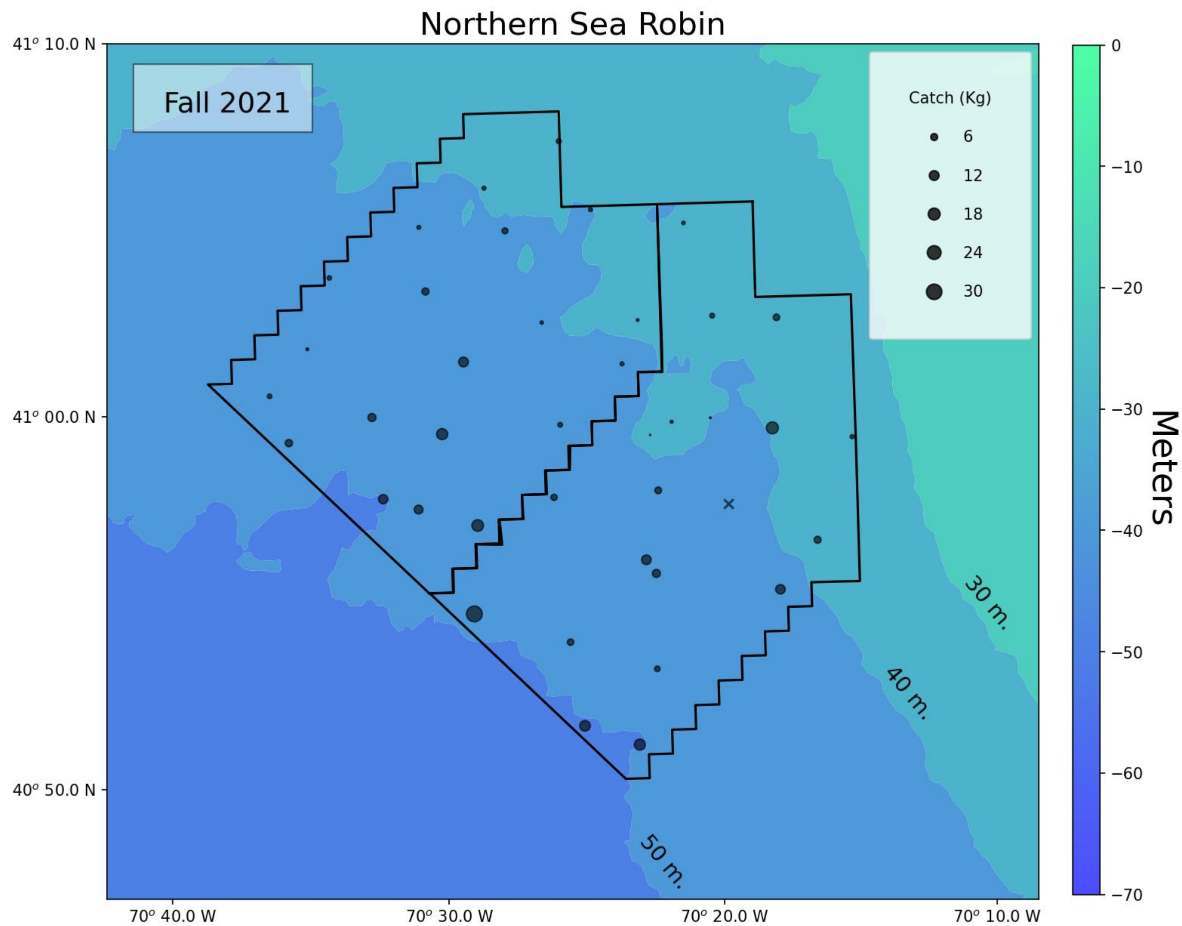
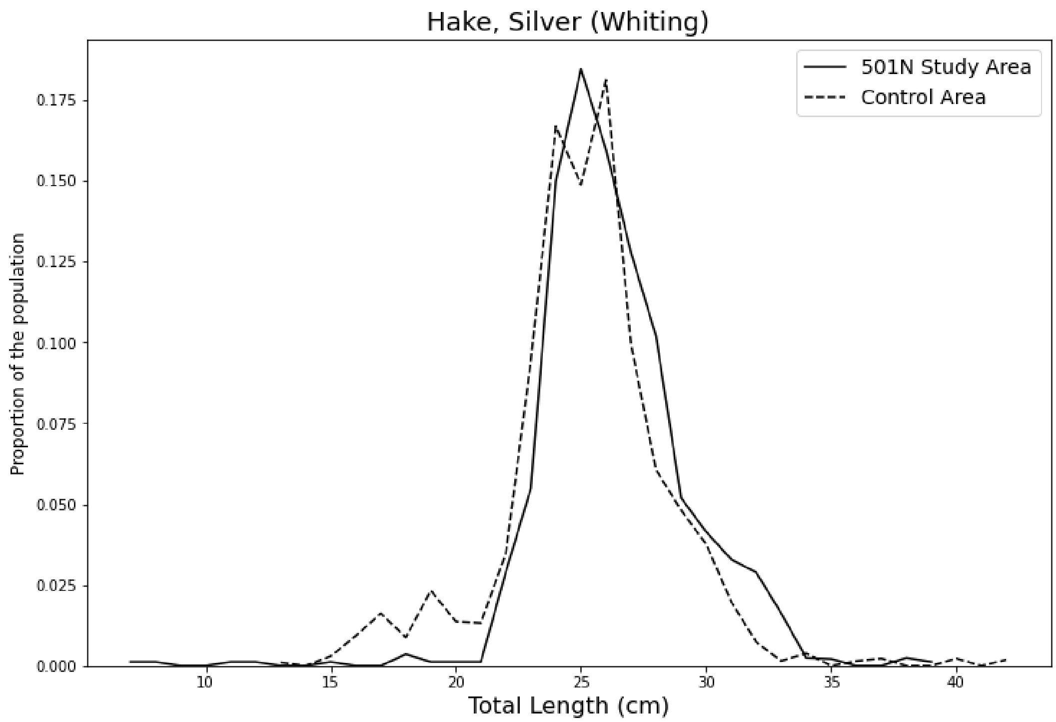


Figure 23: Distribution of the catch of northern sea robin in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



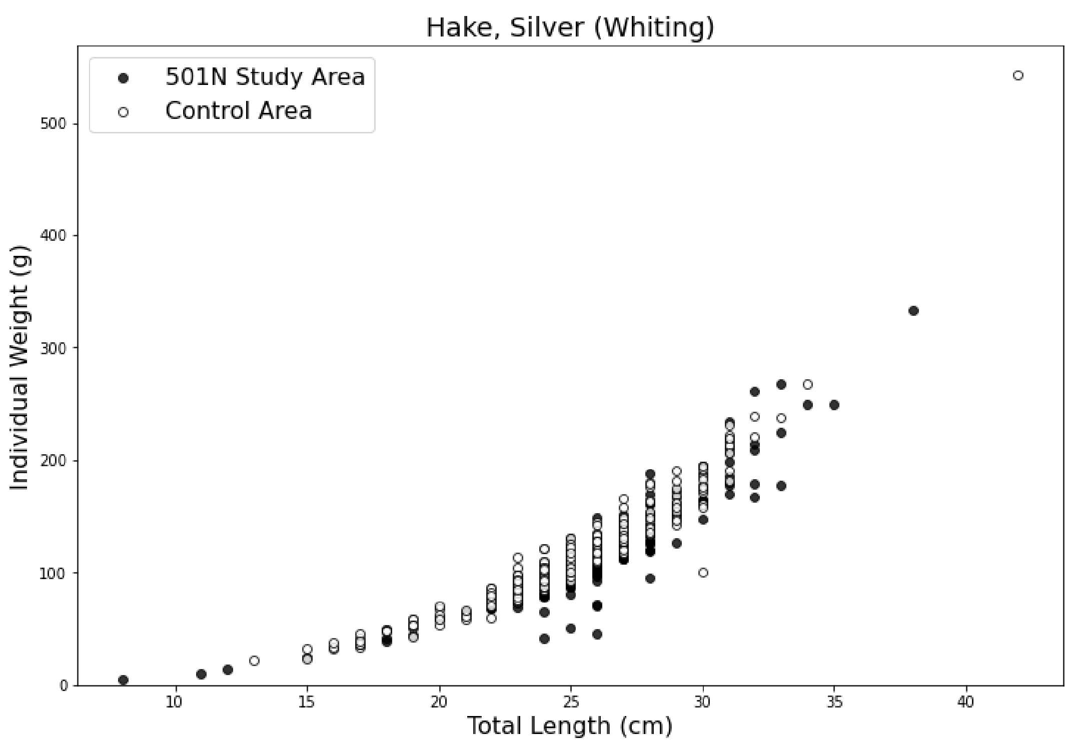


Figure 24: Population structure of silver hake in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

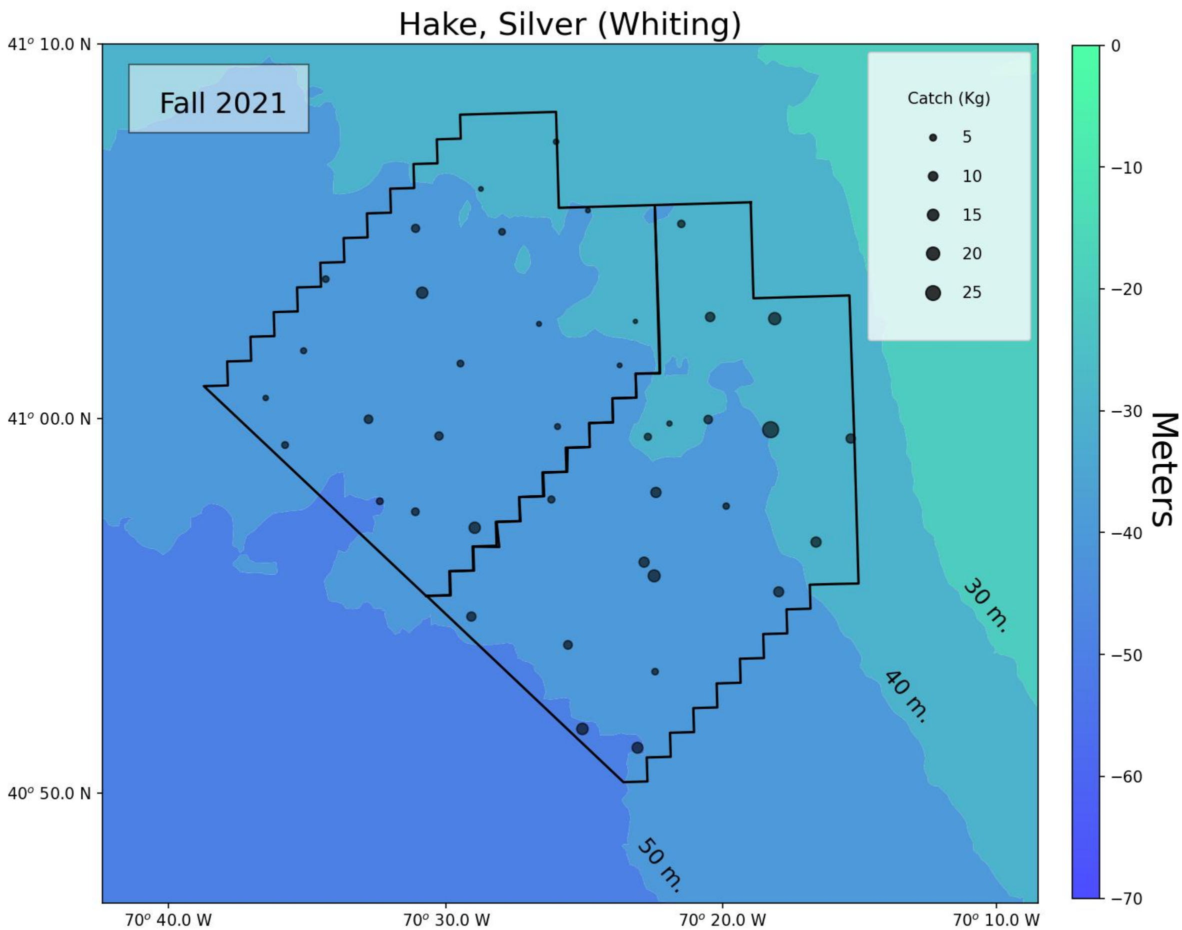


Figure 25: Distribution of the catch of silver hake in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.

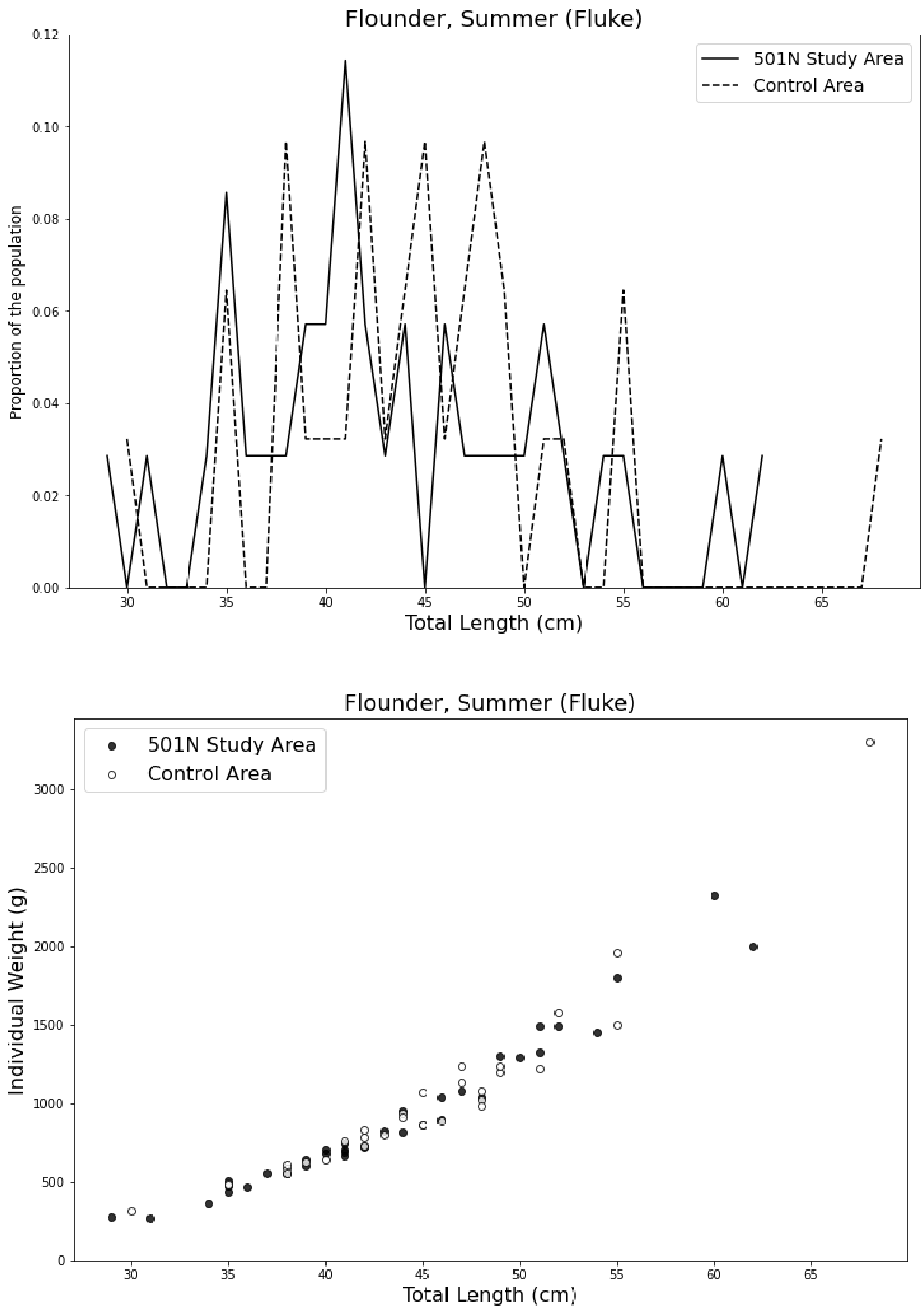


Figure 26: Population structure of summer flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

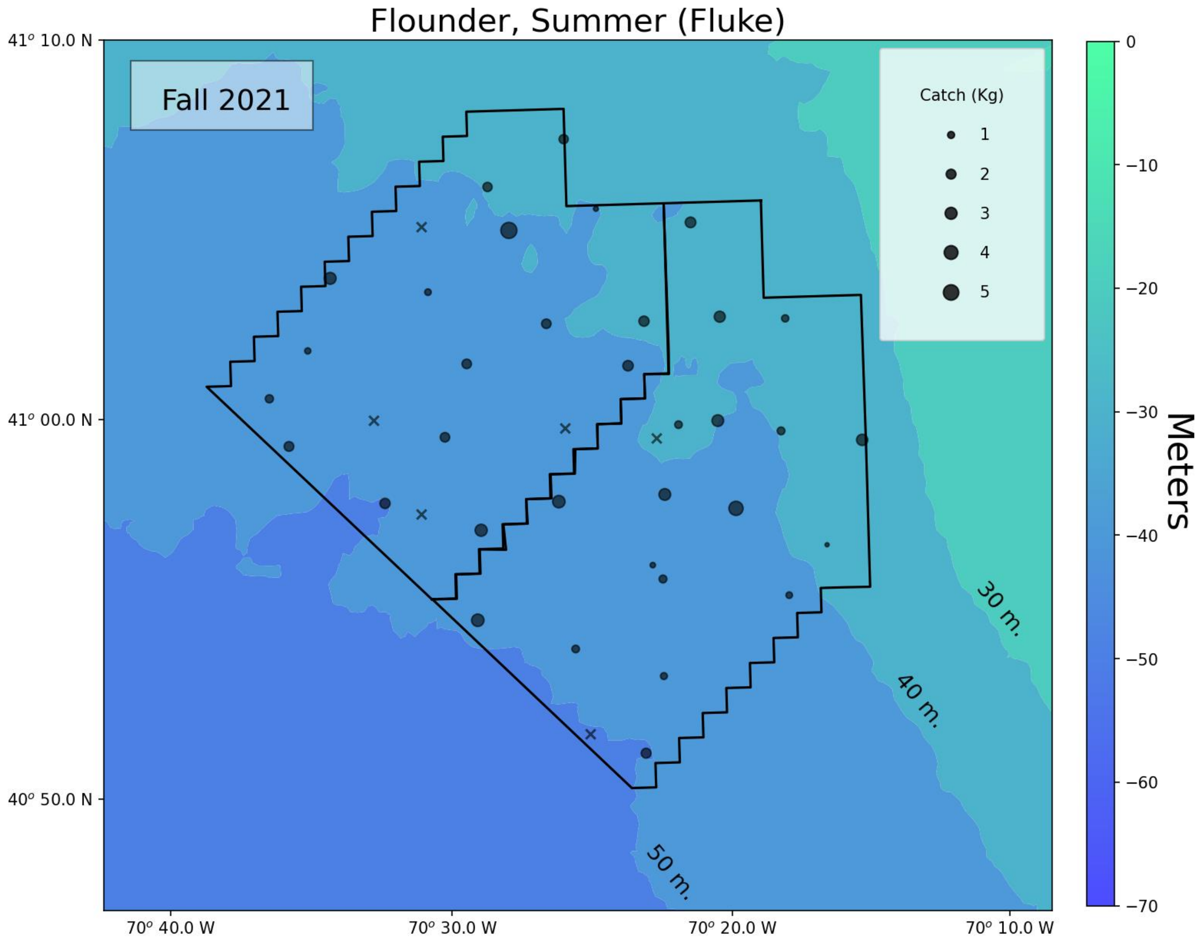
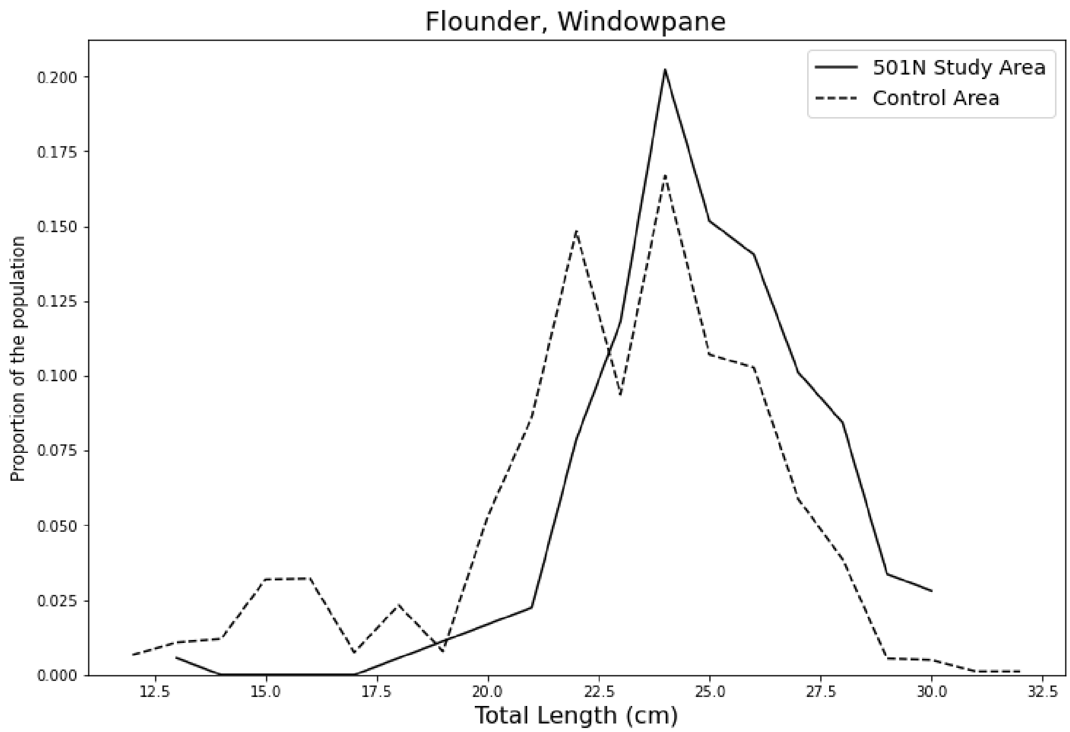


Figure 27: Distribution of the catch of summer flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



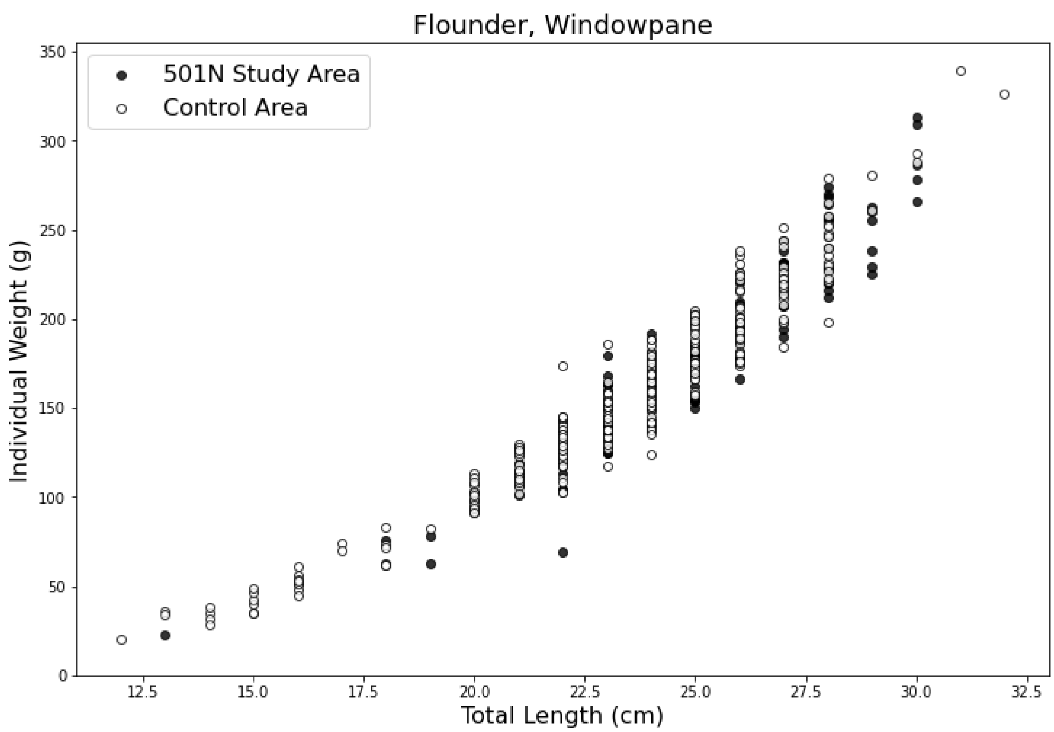


Figure 28: Population structure of windowpane flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

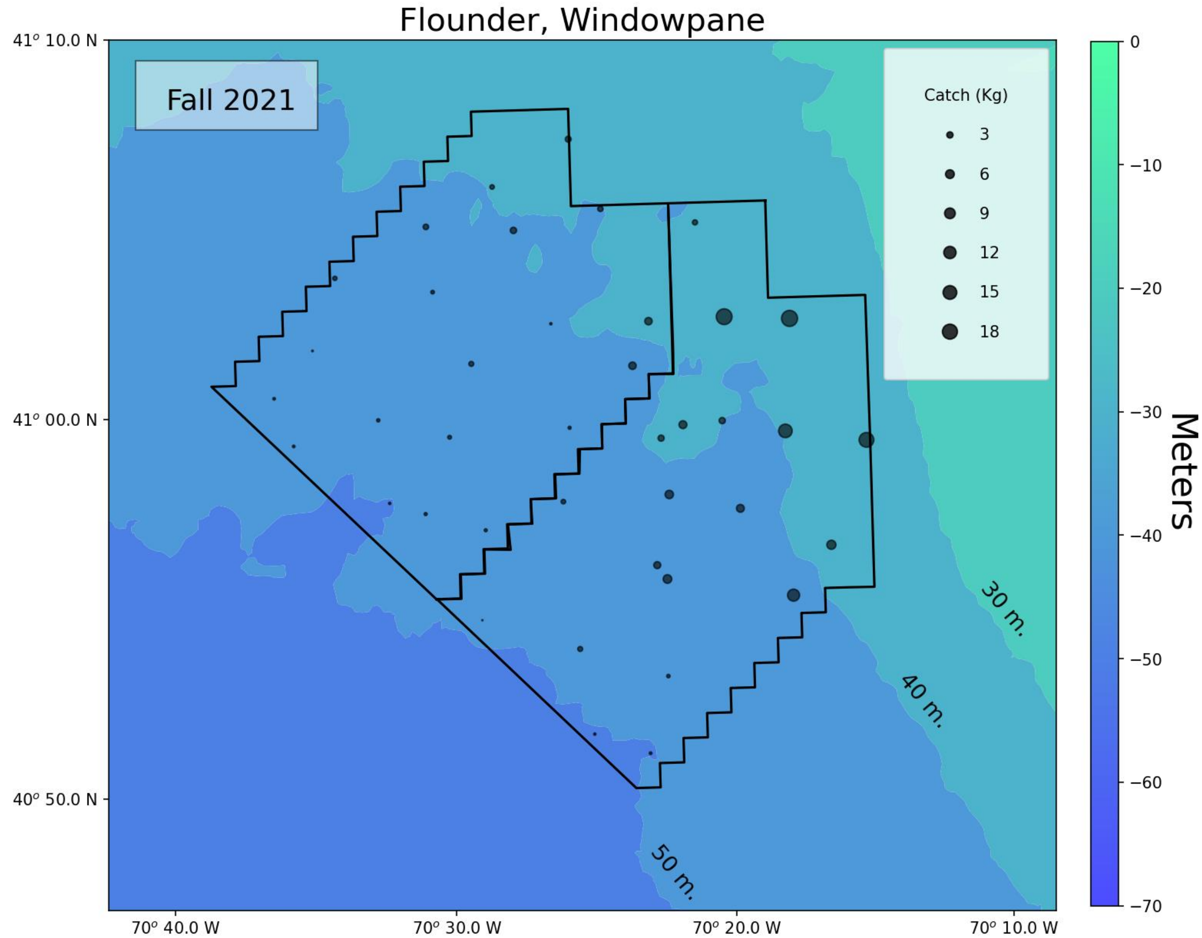
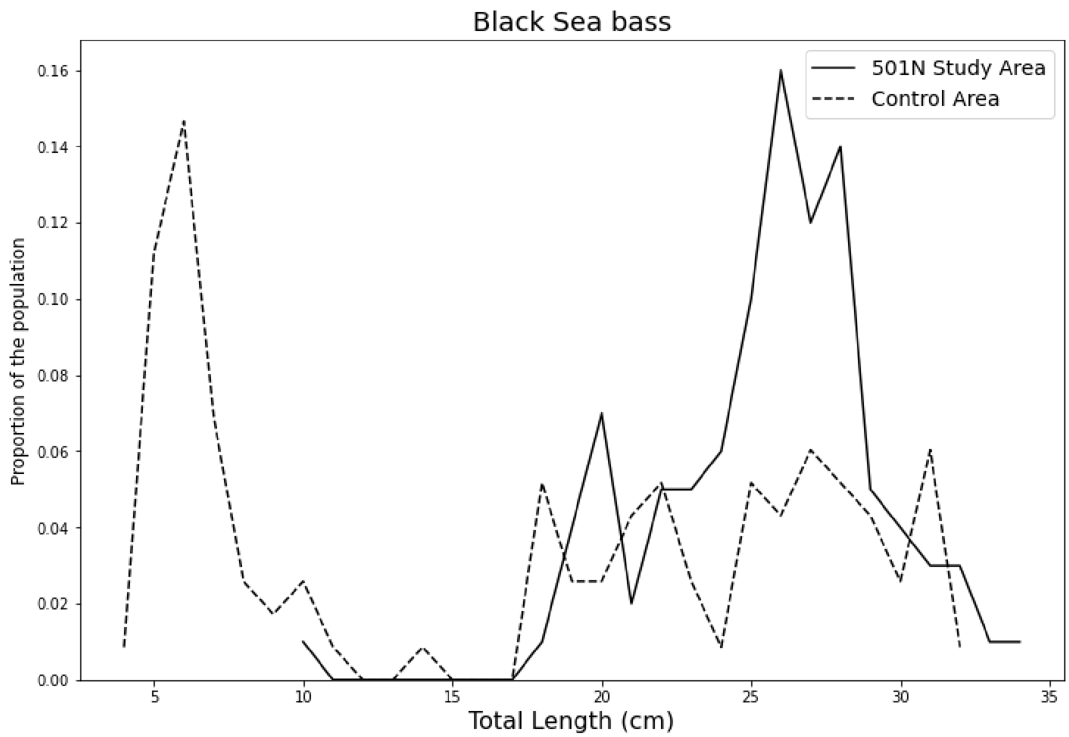


Figure 29: Distribution of the catch of windowpane flounder in the VW1 Study Area (left) and Control Area (right).



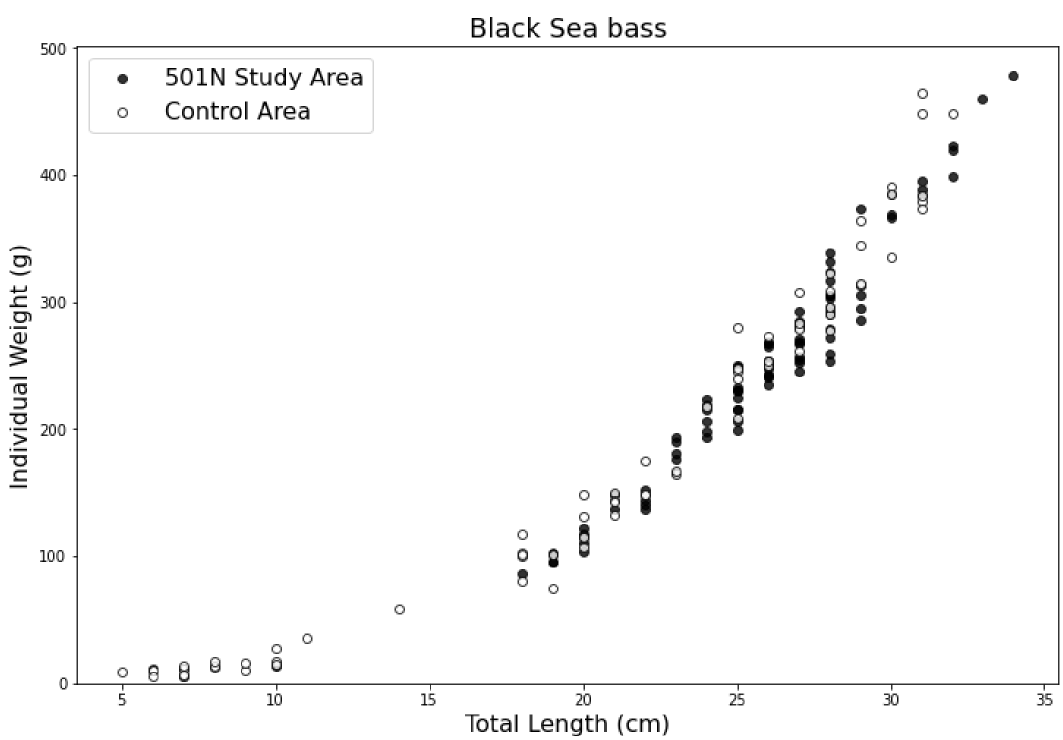


Figure 30: Population structure of black sea bass in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

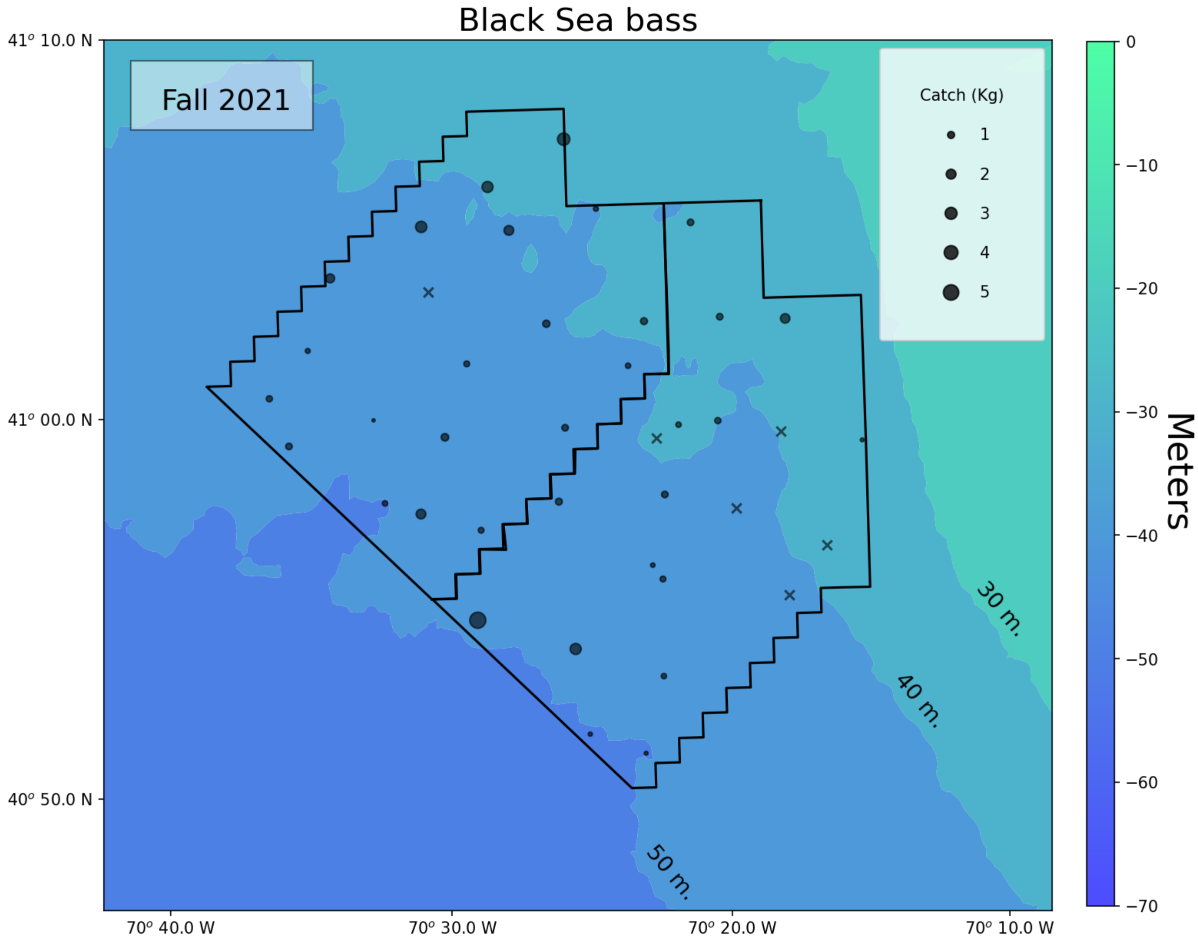
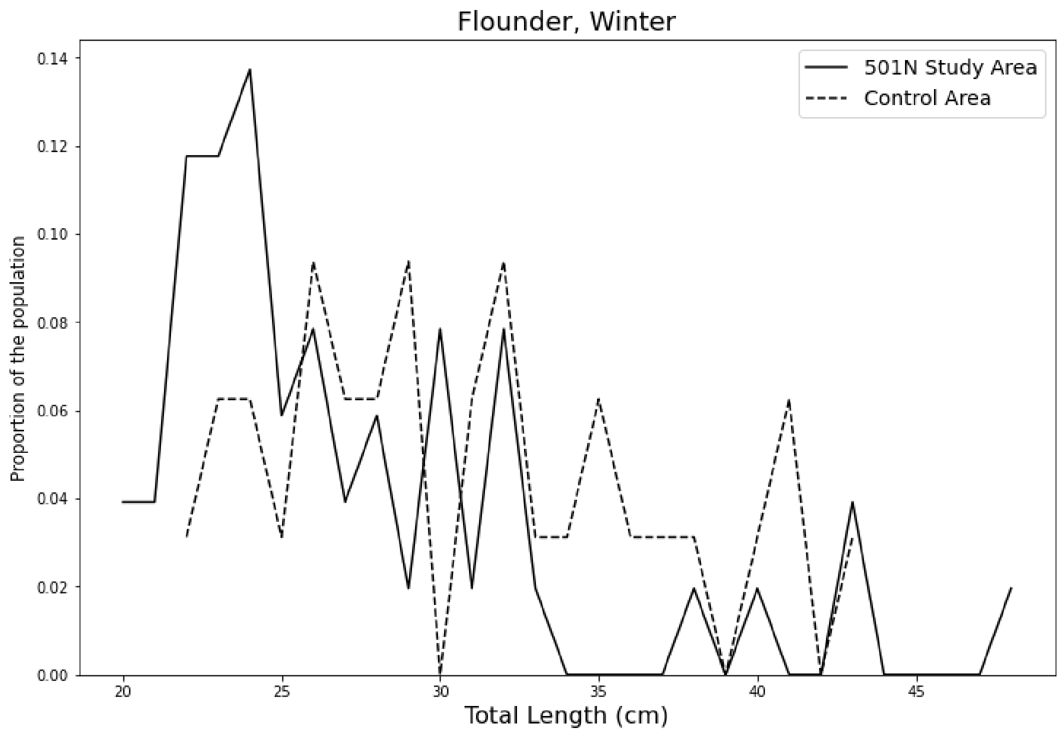


Figure 31: Distribution of the catch of black sea bass in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



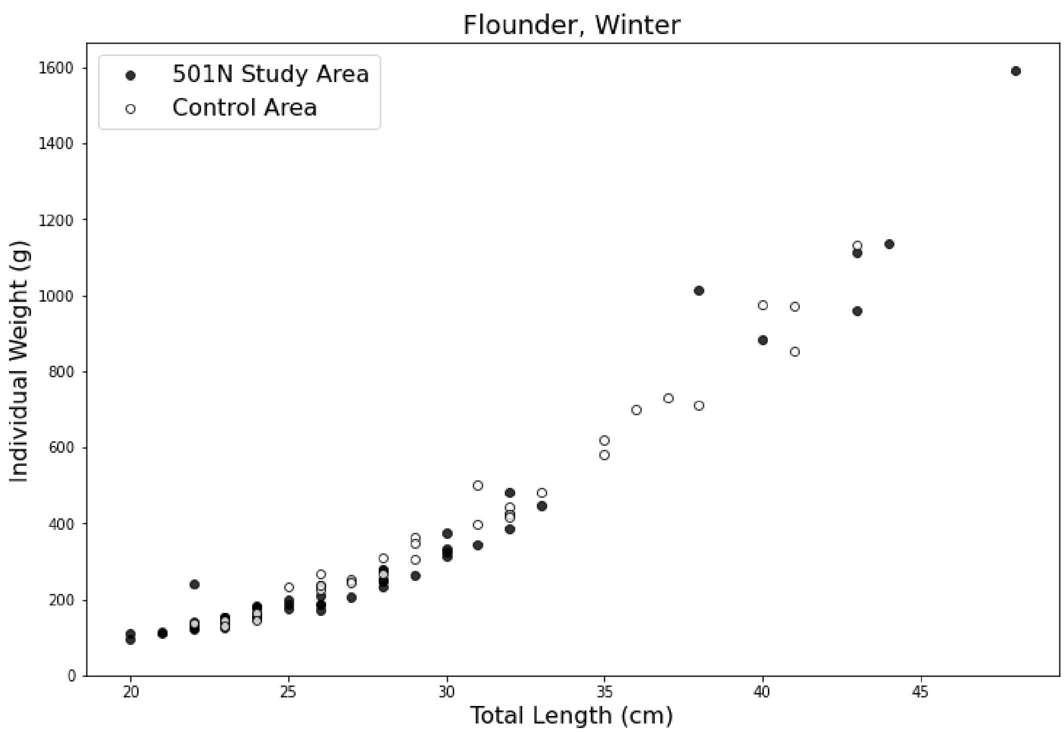


Figure 32: Population structure of winter flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

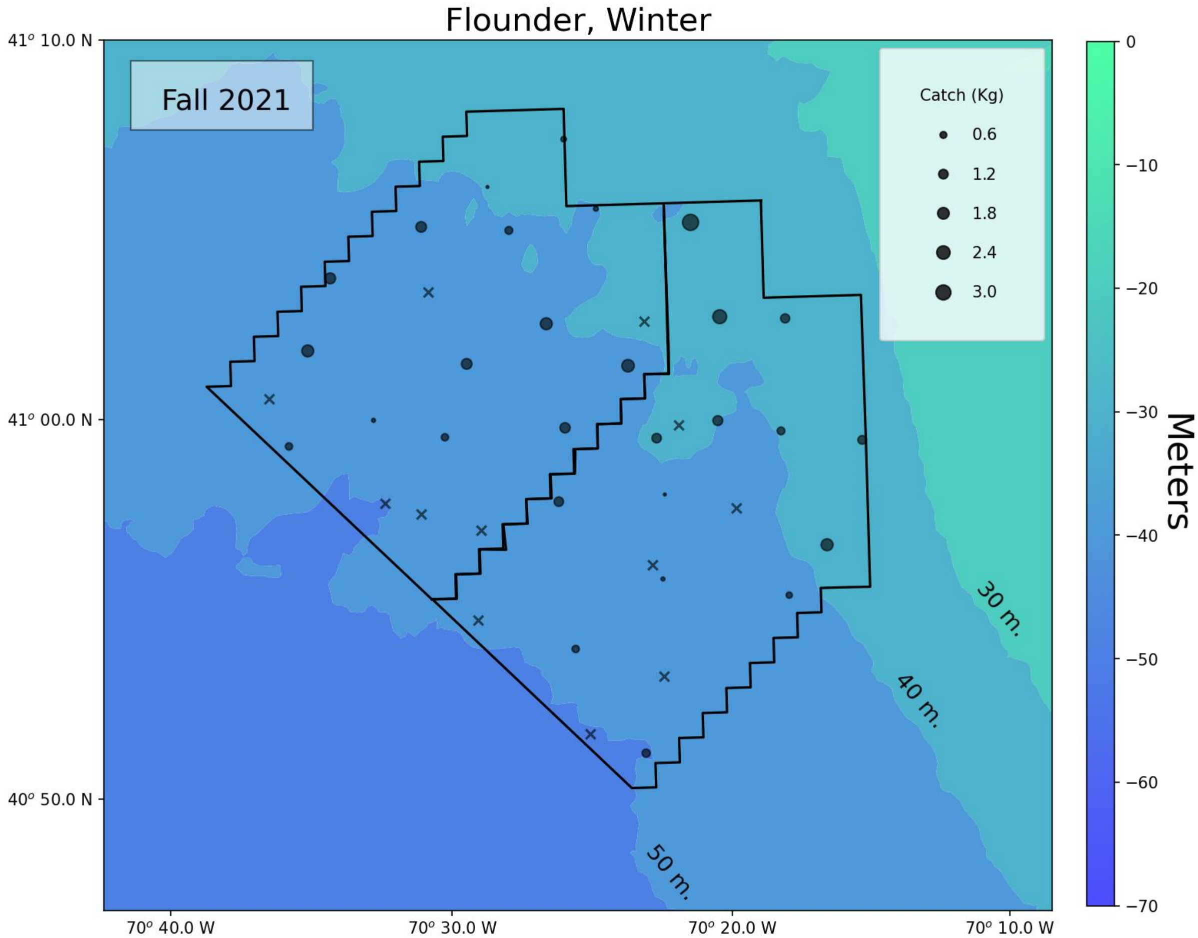
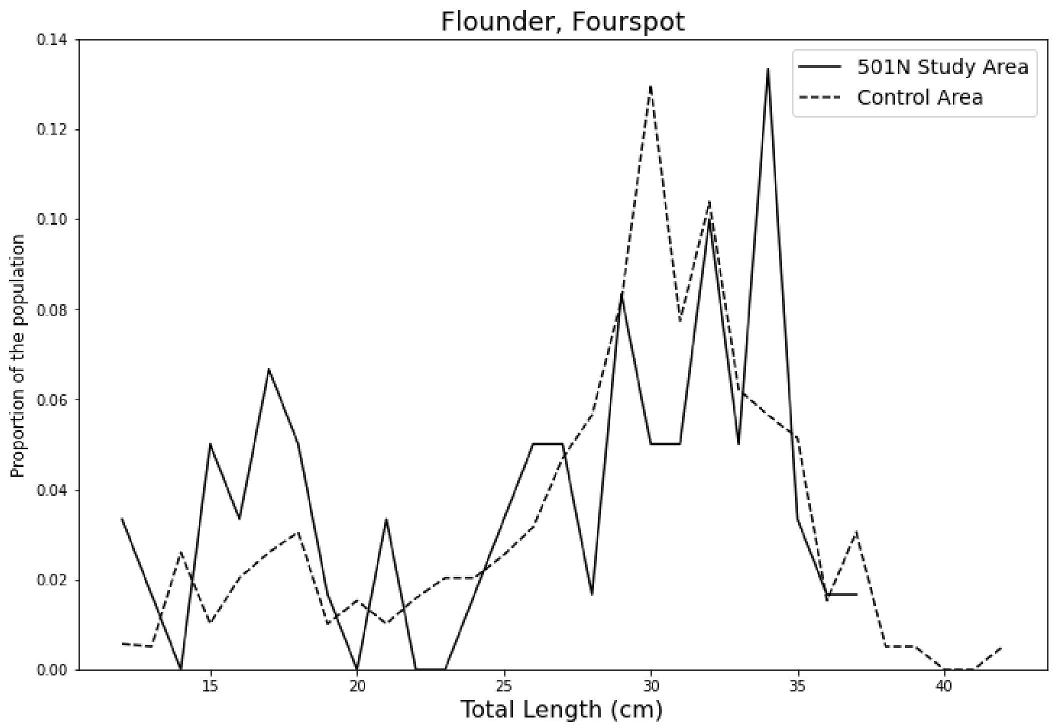


Figure 33: Distribution of the catch of winter flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



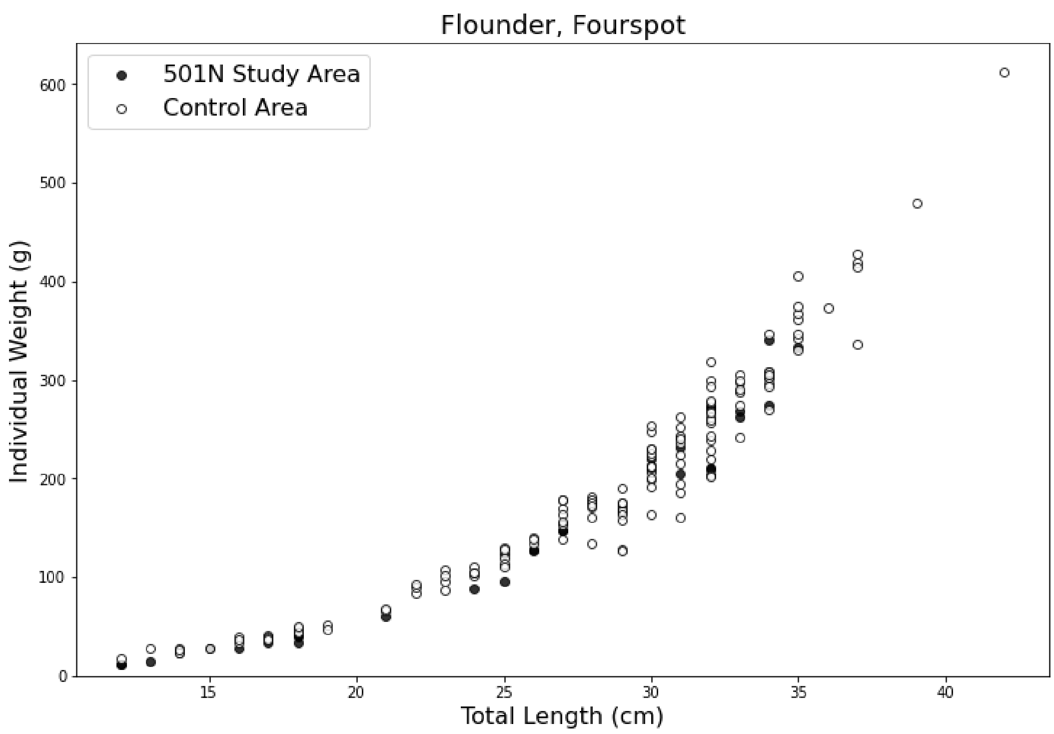


Figure 34: Population structure of fourspot flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

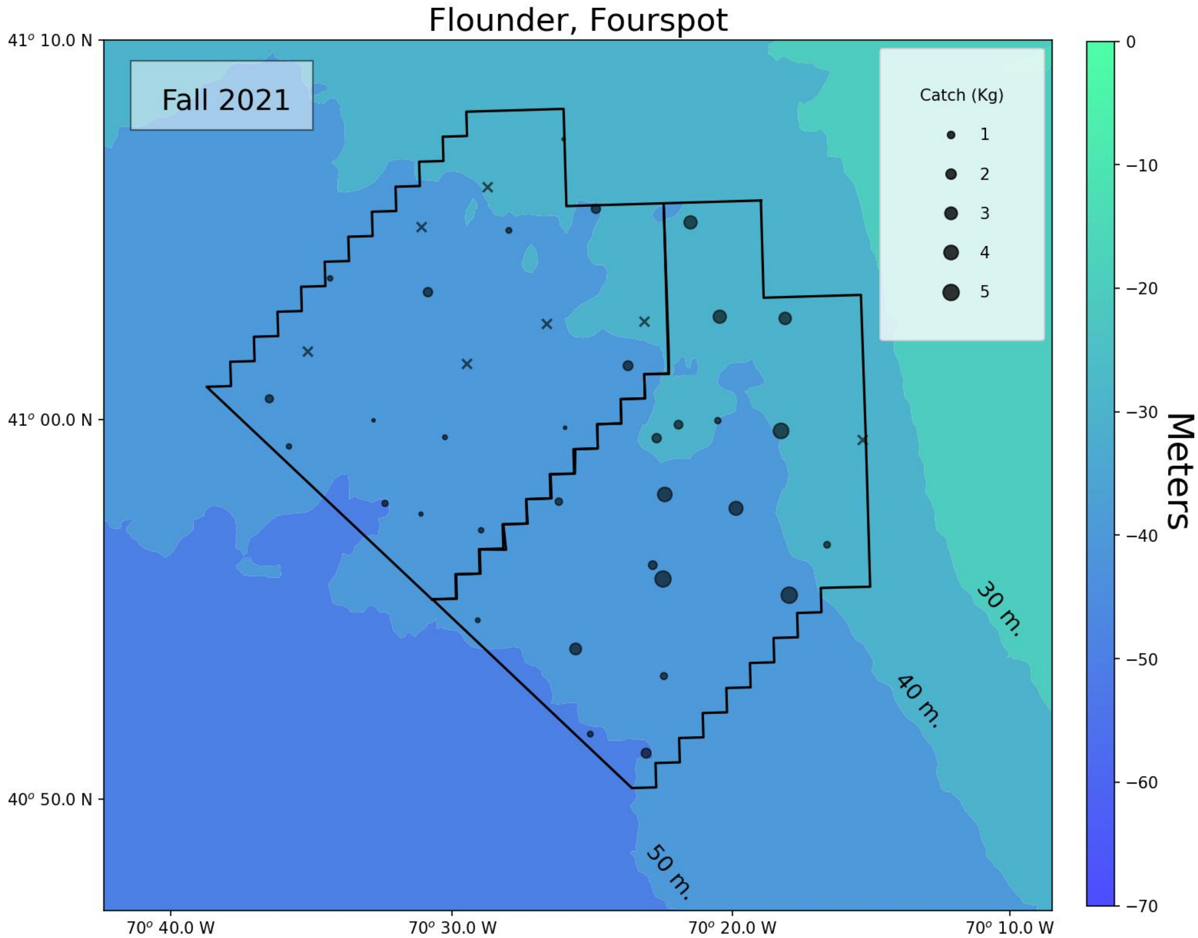


Figure 35: Distribution of the catch of fourspot flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.