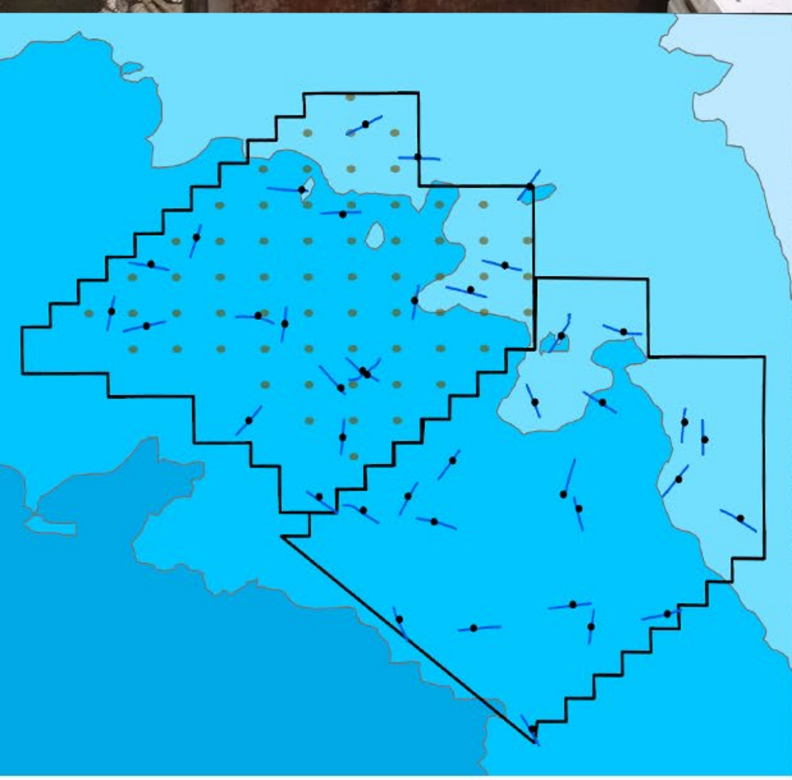
Vineyard Wind 1 Demersal Trawl Survey



Vineyard Wind 1 Study Area

Quarterly Report

Spring 2023 (April - June)

VINEYARD WIND 1 DEMERSAL TRAWL SURVEY

Spring 2023 Seasonal Report

Vineyard Wind 1 Study Area

September 2023

Prepared for Vineyard Wind 1 LLC

VINEYARD WIND

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SMAST

Vineyard Wind 1 Demersal Trawl Survey Spring 2023 Seasonal Report

Vineyard Wind 1 Study Area

UMass Dartmouth

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1. Introduction

In 2015, Vineyard Wind 1 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 the "VW1 Study Area," which is the focus of this report. Fisheries studies were also conducted in Vineyard Wind shareholder company lease areas. These include Lease Area OCS-A 0534 (the "534 Study Area") and Lease Area OCS-A 0522 (the "522 Study Area"); these studies were 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 occurs 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) to assess if there is any impact due to the development of wind farms. The control site will be in the general vicinity with similar characteristics to the study area (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 may 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 marine ecosystem. 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 NEAMP survey protocol has also been adopted by trawl surveys conducted in other offshore wind development areas in the northeast US by other institutions. The bottom trawl survey is complemented by the drop camera survey and the lobster trap survey in the same area, also carried out by SMAST (reported separately).

The primary goal of this survey was to provide data related to fish abundance as represented by catch per unit effort (CPUE), distribution, and population structure in the VW1 Study Area and an adjacent area (Control Area). Offshore construction activities for the Vineyard Wind 1 project began in the spring of 2023. The data will serve to assess the impact that offshore construction activities may have on fish communities. The reports for the first three years of pre-construction baseline monitoring from spring 2019 to summer 2022 have been submitted to the sponsoring organization. This progress report documents the survey methodology, survey effort, and data collected during the spring of 2023.

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 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 sampling design. The current VW1 Study Area (total area: 265 km^2) was sub-divided into 20 sub-areas (each ~13.25 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). Prior to the start of this survey, scour protection had been placed at several wind turbine locations. Scour protection consists of stone and rock material (~10 – 30 centimeter [cm] diameter) placed around a wind turbine's foundation to minimize the removal of seabed sediment by hydrodynamic forces from currents and/or waves. The scour protection consists of rock piles of ~50 meters (m) in diameter from the foundation, which makes the area untrawlable with demersal trawls. To address this, alternative tow locations were created for each sub-area. If the primary tow location was located within an area with scour protection, the alternative tow location was used. Additionally, tow directions were selected to avoid towing the trawl across the scour protection.

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 (total area: 269.5 km^2) was sub-divided into 20 sub-areas (each ~13.5 km^2). An additional 20 tows, one per sub-area, were completed in the Control Area. The tow locations were selected in the same manner as the VW1

Study Area, using the spatially balanced sampling design, except that no alternative tow locations were needed as there were no construction-related seabed obstructions in the area.

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 and 2020/2021 survey years (Rillahan and He, 2020, Rillahan and He, 2021). The results of the updated power analysis indicated that several species, including little skate (*Leucoraja erinacea*), Atlantic longfin squid (*Dorytheuthis pealei*), silver hake (*Merluccius bilinearis*), and fourspot flounder (*Paralichthys oblongus*), had relatively low variability and therefore a high probability of detecting small to moderate effects (i.e., ~25% change) under the current monitoring effort. Many other common species observed, including winter skate (*Leucoraja ocellata*), red hake (*Urophycis chuss*), windowpane flounder (*Scophtalmus aquosus*), monkfish (*Lophius americanus*), summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), yellowtail flounder (*Pleironectes ferrugineus*), winter flounder (*Pleuronectes americanus*), and butterfish (*Peprilus triacanthus*), had higher variability (Coefficient of variation [CV]: 1.5 – 2.3). For these species, the current monitoring effort 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 (i.e., 100% change). The updated power analysis showed that increasing the survey effort would only result in small improvements in the detectability of change.

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. 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. The distributed approach, applied here, assumes that the catch characteristics across each survey area represent the ecosystem. Additionally, surveying each site seasonally accounts for temporal variations in fish populations. 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 13.25 km^2 (3.86 square nautical miles [nmi^2]) in the VW1 Study Area and one station per 13.5 km^2 (3.94 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 Survey Advisory Panel, the predecessor of the Northeast Trawl Advisory Panel (NTAP). As a result, the net design has been accepted by management authorities, the scientific community, and the commercial fishing industry in the region.

The survey trawl is a three-bridle, four-seam bottom trawl (Figure 3). This net style allows for a high vertical opening (~5 m) relative to the size of the net and consistent trawl geometry. These features make it suitable 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-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 8).

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 between May 17 and 22, 2023. The F/V *Heather Lynn* is a commercial fishing vessel currently operating in the industry. One trip to the survey areas was made during which all planned tows were completed.

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 to provide the desired 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).

A CTD sonde (RBR Concerto[3], RBR LTD, Ottawa, Canada) was deployed off the side of the vessel at the conclusion of each tow. The CTD sonde was lowered to the seafloor at a rate of ~30 cm per second. Upon hitting the seafloor, the sonde was immediately retrieved. The CTD sonde recorded water column profiles of conductivity/salinity, temperature, and pressure/depth at a sampling rate of 8 Hertz.

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. Only one sub-sampling strategy was employed over the duration of the survey: straight sub-sampling by weight.

Straight sub-sampling by weight: When catch diversity was relatively low (5 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.

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 20.1 ± 0.2 minutes (mean ± one standard deviation) in the VW1 Study Area and 20.1 ± 0.2 minutes in the Control Area. Tow distances averaged 0.94 ± 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 0.95 ± 0.03 nmi in the Control Area giving an average tow speed of 2.8 ± 0.1 knots.

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 34.6 ± 1.1 m (range: 32.5 – 36.0 m) for tows in the VW1 Study Area and 34.8 ± 1.7 m (range: 31.8 – 36.5 m) in the Control Area. Wing spread averaged 13.5 ± 0.4 m for tows in the VW1 Study Area (range: 12.2 – 14.0 m) and 13.7 ± 0.3 m for tows in the Control Area (range: 13.0 – 14.1 m). Headline height averaged 4.9 ± 0.3 m for tows in the VW1 Study Area (range: 4.5 – 5.5 m) and 4.7 ± 0.2 m for tows in the Control Area (range: 4.4 – 5.2 m). All tows were in the acceptable range for all trawl geometry parameters.

The seafloor in both areas follows a northeast-to-southwest depth gradient with the shallowest tow along the northeastern edge (~33 m). Depth increased to a maximum of 50 m along the southwestern boundary. Bottom water temperature followed the depth gradient with warmer temperatures observed in the shallow tows for the north (~10°C [50°F] at 20 – 21 fathoms [fm] [37 – 38 m]). Bottom water temperature was 8 – 9°C (46 – 48°F) during deeper tows in the southern half of the study areas (24 – 26 fm [44 – 48 m]). CTD sonde data indicated that the surface water was similar across tow locations between 10 - 11°C (50 – 51.8°F). Deeper tows had a visible thermocline between 20 – 30 m (11 – 16 fm) in both study areas (Figures 8 and 9). Shallower tows in both survey areas exhibited less thermal stratification.

3.2 Catch Data

3.2.1 VW1 Study Area

In the VW1 Study Area, a total of 29 species were caught over the duration of the survey (Table 3). Catch volume ranged from 79.5 to 755.6 kilograms per tow (kg/tow) with an average of 193.6 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (butterfish, silver hake, little skate, red hake, and alewife) accounted for 82.0% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Butterfish was the most abundant species, accounting for 39.2% of the total catch weight. Individuals ranged in length from 8 to 21 cm with a unimodal size distribution consisting of a peak at 14 cm (Figure 10). Butterfish were observed in all 20 tows at an average catch rate of 76.1 ± 29.8 kg/tow (mean ± Standard Error of the Mean [SEM], range: 1.6 – 614.9 kg/tow). Butterfish were caught throughout the VW1 Study Area with the largest catch in the northwest corner of the VW1 Study Area (Figure 11).

Silver hake, a commercially important species also commonly referred to as whiting, was frequently observed in the VW1 Study Area. Silver hake was the second most abundant species, accounting for 11.8% of the total catch weight. Individuals ranged in length from 11 to 47 cm with a bimodal distribution consisting of a large peak at 16 cm and a smaller peak at 25 cm (Figure 12). Silver hake were observed in all 20 tows at an average catch rate of 22.9 ± 2.9 kg/tow (range: 5.2 – 52.4 kg/tow). Silver hake were observed throughout the VW1 Study Area (Figure 13).

Little skate was the third most abundant species observed, accounting for 11.6% of the total catch weight. Individuals ranged in size from 12 to 35 cm (disk width) with a unimodal size distribution consisting of a peak at 26 cm (Figure 14). Little skate were observed in all 20 tows with an average catch rate of 22.4 ± 2.3 kg/tow (range: 10.6 – 52.6 kg/tow). Little skate were caught throughout the VW1 Study Area (Figure 15).

Red hake was the fourth most abundant species observed, accounting for 9.9% of the total catch weight. Individuals ranged in length from 13 to 43 cm with a bimodal size distribution consisting of a small peak at 18 cm and a larger peak at 28 cm (Figure 16). Red hake were observed in all 20 tows. Catch rates averaged 19.0 ± 2.6 kg/tow (range: 6.6 – 55.8 kg/tow). Red hake were distributed throughout the VW1 Study Area (Figure 17).

Alewife (*Alosa pseudoharengus*) was the fifth most abundant species observed, accounting for 9.5% of the total catch weight. Individuals ranged in length from 12 to 27 cm with a bimodal size distribution consisting of a small peak at 16 cm and a larger peak at 21 cm (Figure 18). Alewife were observed in 19 of the 20 tows. Catch rates averaged 18.7 ± 6.7 kg/tow (range: 0 – 106.3 kg/tow). Small catches of alewife were observed across the VW1 Study Area with two larger catches (106 and 90 kilograms [kg]) observed in the northeast section of the study area (Figure 19).

Winter skate were commonly caught in the VW1 Study Area. Individuals ranged in size from 24 to 53 cm (disk width) with a wide size distribution (Figure 20). Winter skate were observed in 19 of the 20 tows. Catch rates averaged 8.8 ± 1.0 kg/tow (range: 0 – 15.2 kg/tow). Winter skate were observed to be dispersed throughout the VW1 Study Area (Figure 21).

Spiny dogfish (*Squalus acanthias*) was another common elasmobranch observed in the VW1 Study Area. Individuals ranged in length from 60 to 94 cm with a broad size distribution (Figure 22). Spiny dogfish were observed in 13 of the 20 tows at an average catch rate of 3.7 ± 1.0 kg/tow (range: 0 – 16.4 kg/tow). The catch of spiny dogfish was dispersed across the VW1 Study Area (Figure 23).

Atlantic longfin squid is a commercially important species commonly referred to as loligo squid. Atlantic longfin squid ranged in length from 3 to 21 cm (mantle length) with a unimodal size distribution peaking at 8 cm (Figure 24). Atlantic longfin squid were observed in all 20 tows at an average catch rate of 2.9 ± 0.7 kg/tow (range: 0.8 – 15.2 kg/tow). Atlantic longfin squid were caught throughout the VW1 Study Area with higher catches observed along the northern edge of the area (Figure 25). No squid "mops" were observed during this survey.

Barndoor skate (*Dipturus laevis*) were commonly caught in the VW1 Study Area. Individuals ranged in size from 17 to 79 cm (disk width) with a wide size distribution (Figure 26). Barndoor skate were observed in 16 of the 20 tows. Catch rates averaged 2.8 ± 0.8 kg/tow (range: 0 – 11.8 kg/tow). Barndoor skate were observed to be dispersed throughout the VW1 Study Area (Figure 27).

Summer flounder is a commercially important flatfish species commonly referred to as fluke. Summer flounder were commonly caught in the VW1 Study Area. Individuals ranged in length from 27 to 59 cm with a broad size distribution (Figure 28). Summer flounder were observed in 18 of the 20 tows at an average catch rate of 2.5 ± 0.6 kg/tow (range: 0 – 10.0 kg/tow). Summer flounder were caught throughout the VW1 Study Area with the highest catches observed across the center of the area (Figure 29).

Monkfish is a commercially important species that was frequently caught in the VW1 Study Area. Individuals ranged in length from 22 to 83 cm with a broad size distribution (Figure 30). A total of 18 monkfish were caught in 13 of the 20 tows. Catch rates averaged 1.6 ± 0.6 kg/tow (range: 0 – 10.8 kg/tow). The catch of monkfish was primarily concentrated in the southeastern corner of the VW1 Study Area (Figure 31).

Black sea bass (*Centropristis striata*) is another commercially important species that was frequently caught in the VW1 Study Area. Individuals ranged in length from 14 to 42 cm with a unimodal size distribution peaking at 20 cm (Figure 32). Black sea bass were observed in 19 of the 20 tows at an average catch rate of 1.2 ± 0.3 kg/tow (range: 0 – 5.2 kg/tow). Black sea bass were caught throughout the VW1 Study Area (Figure 33).

Fourspot flounder was another common flatfish observed in the VW1 Study Area. Fourspot flounder ranged in length from 17 to 41 cm with a unimodal size distribution peaking at 28 cm (Figure 34). Fourspot flounder were observed in all 20 tows at an average catch rate of 1.0 ± 0.2 kg/tow (range: 0.1 – 2.7 kg/tow). Fourspot flounder were caught throughout the VW1 Study Area (Figure 35).

Windowpane flounder is a federally regulated commercial flatfish species found in the VW1 Study Area. Individuals ranged in length from 14 to 31 cm with a wide size distribution peaking at 25 cm (Figure 36). Windowpane flounder were observed in 17 of the 20 tows at an average catch rate of 0.5 ± 0.1 kg/tow (range: 0 – 1.0 kg/tow). Windowpane flounder were caught throughout the VW1 Study Area (Figure 37).

Less common recreational and commercial species observed included six individuals of winter flounder (size: 26 – 40 cm) and 10 individuals of Atlantic sea scallop (*Placopecten magellanicus*).

3.2.2 Control Area

In the Control Area, a total of 31 species were caught over the duration of the survey (Table 4). Catch volume ranged from 53.8 to 1,031.8 kg/tow with an average of 221.5 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. The five most abundant species (silver hake, spiny dogfish, little skate, red hake, and butterfish) accounted for 82.0% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Silver hake was the most abundant species, accounting for 49.9% of the total catch weight. Individuals ranged in length from 5 to 34 cm with a bimodal distribution consisting of a large peak at 18 cm and a smaller peak at 25 cm (Figure 12). Silver hake were observed in all 20 tows at an average catch rate of 110.2 ± 47.1 kg/tow (range: 9.7 – 931.7 kg/tow). Silver hake were observed throughout the Control Area with several large catches in the northeast corner of the area (Figure 13).

Spiny dogfish was the second most abundant species in the Control Area, accounting for 10.5% of the total catch weight. Individuals ranged in length from 30 to 93 cm with a broad size distribution (Figure 22). Spiny dogfish were observed in all 20 tows at an average catch rate of 23.6 ± 10.6 kg/tow (range: 2.0 – 213.8 kg/tow). The catch of spiny dogfish was dispersed across the Control Area with catches increasing to the south (Figure 23). The largest catch (213.8 kg) was collected in the southeastern corner of the Control Area.

Little skate was the third most abundant species observed, accounting for 9.0% of the total catch weight. Individuals ranged in length from 14 to 31 cm (disk width) with a unimodal size distribution consisting of a peak a 26 cm (Figure 14). Little skate were observed in all 20 tows with an average catch rate of 19.8 ± 2.7 kg/tow (range: 2.8 – 51.5 kg/tow). Little skate were caught throughout the Control Area (Figure 15).

Red hake was the fourth most abundant species observed, accounting for 6.6% of the total catch weight. Individuals ranged in length from 13 to 40 cm with a bimodal size distribution consisting of peaks at 17 cm and 29 cm (Figure 16). Red hake were observed in all 20 tows. Catch rates averaged 14.5 ± 2.2 kg/tow (range: 2.0 – 35.9 kg/tow). Red hake were distributed throughout the Control Area (Figure 17).

Butterfish was the fifth most abundant species, accounting for 6.1% of the total catch weight. Individuals ranged in length from 8 to 20 cm with a unimodal size distribution consisting of a peak at 14 cm (Figure 10). Butterfish were observed in 19 of the 20 tows at an average catch rate of 13.7 ± 4.0 kg/tow (range: 0 – 54.8 kg/tow). Butterfish were caught sporadically throughout the Control Area (Figure 11).

Winter skate were commonly caught in the Control Area. Individuals ranged in size from 27 to 62 cm (disk width) with a wide size distribution (Figure 20). Winter skate were observed in all 20 tows. Catch rates averaged 12.4 ± 1.8 kg/tow (range: 1.3 – 31.1 kg/tow). Winter skate were observed to be distributed across the Control Area (Figure 21).

Alewife was a common species observed in the Control Area. Individuals ranged in length from 13 to 28 cm with a bimodal size distribution consisting of a small peak at 16 cm and a larger peak at 22 cm (Figure 18). Alewife were observed in 13 of the 20 tows. Catch rates averaged 6.4 ± 2.9 kg/tow (range: 0 – 55.7 kg/tow). The catch of alewife was primarily concentrated in the southern half of the Control Area (Figure 19).

Summer flounder is a commercially important flatfish species that was frequently caught in the Control Area. Individuals ranged in length from 32 to 67 cm with a broad size distribution (Figure 28). Summer flounder were observed in 16 of the 20 tows at an average catch rate of 3.5 ± 0.7 kg/tow (range: 0 – 8.8 kg/tow). Summer flounder were caught throughout the Control Area with an aggregation of catch in the northeastern corner of the area (Figure 29).

Barndoor skate were commonly observed in the Control Area. Individuals ranged in size from 17 to 84 cm (disk width) with a wide size distribution (Figure 26). Barndoor skate were observed in 16 of the 20 tows. Catch rates averaged 3.4 ± 1.1 kg/tow (range: 0 – 14.4 kg/tow). Barndoor skate were observed to be sporadically dispersed across the Control Area (Figure 27).

Monkfish is a commercially important species that was frequently caught in the Control Area. Individuals ranged in length from 20 to 78 cm with a broad size distribution (Figure 30). Monkfish were caught in 13 of the 20 tows. Catch rates averaged 2.8 ± 0.8 kg/tow (range: 0 – 15.0 kg/tow). The catch of monkfish was primarily concentrated in the southern half of the Control Area (Figure 31).

Fourspot flounder was a frequently observed flatfish in the Control Area. Fourspot flounder ranged in length from 16 to 39 cm with a unimodal size distribution peaking at 27 cm (Figure 34). Fourspot flounder were observed in all 20 tows at an average catch rate of 1.9 ± 0.2 kg/tow (range: 0.3 – 3.9 kg/tow). Fourspot flounder appeared evenly distributed across the Control Area (Figure 35).

Atlantic longfin squid is a commercially important species observed in the Control Area. Atlantic longfin squid ranged in length from 3 to 18 cm (mantle length) with a unimodal size distribution peaking at 10 cm (Figure 24). Atlantic longfin squid were observed in all 20 tows at an average catch rate of 1.2 ± 0.2 kg/tow (range: 0.2 – 2.8 kg/tow). Atlantic longfin squid were caught throughout the Control Area (Figure 25). No squid "mops" were observed during this survey.

Black sea bass is another commercially important species that was frequently caught in the Control Area. Individuals ranged in length from 16 to 55 cm with a unimodal size distribution peaking at 20 cm (Figure 32). Black sea bass were observed in 17 of the 20 tows at an average catch rate of 0.8 ± 0.1 kg/tow (range: 0 – 2.1 kg/tow). Black sea bass were caught throughout the Control Area (Figure 33).

Windowpane flounder is a federally regulated commercial flatfish species found in the Control Area. Individuals ranged in length from 11 to 28 cm with a wide size distribution peaking at 25 cm (Figure 36). Windowpane flounder were observed in 17 of the 20 tows at an average catch rate of 0.6 ± 0.1 kg/tow (range: 0 – 1.4 kg/tow). Windowpane flounder were caught throughout the Control Area (Figure 37).

Less common recreational and commercial species observed included three individuals of yellowtail flounder (size: 15, 30, 44 cm), two individuals of Atlantic cod (*Gadus morhua*, size: 51, 52 cm), two individuals of Atlantic sea scallop, one individual of winter flounder (size: 27 cm) and one individual of northern kingfish (*Menticirrhus saxatilis*, size: 33 cm).

4. Acknowledgements

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Table 1: Operational and environmental conditions for each survey tow.

Tow Number	Tow Area	Date	Sky Condition	Wind State (Knots)	Wind Direction	Sea State (m.)	Start Time	Start Latitude	Start Longitude	Start Depth (fm)	End Time	End Latitude	End Longitude	End Depth (fm)	Bottom Temp. (°C)	Trawl Warp (fm)
1	VW1	5/18/2023	Clear	7-10	N	0.5-1.25	7:32	N 41° 04.597	W 70° 32.302	24	7:52	N 41° 03.717	W 70° 32.599	25		100
2	VW1	5/18/2023	Clear	7-10	N	0.5-1.25	9:10	N 41° 03.382	W 70° 33.422	25	9:30	N 41° 03.542	W 70° 34.423	23.5	8.7	100
3	VW1	5/18/2023	Clear	7-10	N	0.5-1.25	10:22	N 41° 02.583	W 70° 34.868	24	10:42	N 41° 01.669	W 70° 35.067	25	8.6	100
4	VW1	5/18/2023	Clear	7-10	N	0.5-1.25	11:25	N 41° 01.640	W 70° 34.535	26	11:45	N 41° 01.911	W 70° 33.345	26	8.6	100
5	VW1	5/18/2023	Clear	3-6	N	0.5-1.25	12:37	N 41° 02.051	W 70° 31.271	25	12:57	N 41° 01.898	W 70° 30.080	25	8.7	100
6	VW1	5/18/2023	Clear	3-6	N	0.5-1.25	13:34	N 41° 02.329	W 70° 29.697	25	13:54	N 41° 01.404	W 70° 29.822	25	8.7	100
7	VW1	5/18/2023	Clear	3-6	N	0.1-0.5	14:37	N 40° 59.554	W 70° 30.431	25	14:57	N 40° 58.772	W 70° 31.163	25	8.6	100
8	VW1	5/18/2023	Clear	3-6	N	0.1-0.5	15:45	N 40° 57.212	W 70° 28.992	25	16:05	N 40° 56.644	W 70° 28.099	25	8.7	100
9	VW1	5/18/2023	Clear	3-6	N	0.1-0.5	16:40	N 40° 58.291	W 70° 27.990	25	17:00	N 40° 59.243	W 70° 27.915	24	8.9	100
10	VW1	5/18/2023	Clear	3-6	N	0.1-0.5	17:39	N 40° 59.964	W 70° 27.921	24	17:59	N 41° 00.717	W 70° 28.662	24	8.9	100
11	VW1	5/18/2023	Clear	7-10	N	0.5-1.25	18:39	N 41° 00.959	W 70° 27.949	24	18:59	N 41° 00.332	W 70° 26.901	24	8.9	100
12	Control	5/19/2023	Partly Cloudy	11-15	S	0.5-1.25	7:00	N 40° 58.405	W 70° 24.444	24	7:20	N 40° 57.614	W 70° 25.057	24	9.4	2.8
13	Control	5/19/2023	Clear	7-10	S	1.25-2.5	8:12	N 40° 57.491	W 70° 25.701	24	8:32	N 40° 56.615	W 70° 26.140	25	9.1	100
14	Control	5/19/2023	Clear	7-10	S	1.25-2.5	9:18	N 40° 56.859	W 70° 27.882	25	9:38	N 40° 56.371	W 70° 26.845	25	8.9	100
15	Control	5/19/2023	Mostly Cloudy	7-10	S	1.25-2.5	10:25	N 40° 54.010	W 70° 26.361	26	10:45	N 40° 53.089	W 70° 25.931	27	8.4	100
16	Control	5/19/2023	Mostly Cloudy	11-15	S	0.5-1.25	11:32	N 40° 53.408	W 70° 24.390	26	11:52	N 40° 53.525	W 70° 23.146	26	8.6	100
17	Control	5/19/2023	Mostly Cloudy	11-15	S	0.5-1.25	12:32	N 40° 51.041	W 70° 22.467	27	12:52	N 40° 50.221	W 70° 21.938	27	8.6	100
18	Control	5/19/2023	Mostly Cloudy	7-10	S	0.5-1.25	13:39	N 40° 53.090	W 70° 20.467	25	13:59	N 40° 54.017	W 70° 20.334	24	9.1	100
19	Control	5/19/2023	Mostly Cloudy	7-10	S	0.5-1.25	14:34	N 40° 54.049	W 70° 21.165	25	14:54	N 40° 54.195	W 70° 20.445	24	9.1	100
20	Control	5/19/2023	Mostly Cloudy	7-10	S	0.5-1.25	15:27	N 40° 53.776	W 70° 18.859	23	15:47	N 40° 54.039	W 70° 17.707	23	9.4	100
21	Control	5/19/2023	Mostly Cloudy	7-10	S	0.5-1.25	16:28	N 40° 56.267	W 70° 15.503	20	16:48	N 40° 56.839	W 70° 16.561	21	10.1	95
22	Control	5/19/2023	Mostly Cloudy	7-10	SE	0.5-1.25	17:38	N 40° 58.387	W 70° 17.104	21	17:58	N 40° 59.226	W 70° 17.134	21	10.2	95
23	Control	5/19/2023	Mostly Cloudy	7-10	S	0.5-1.25	18:37	N 40° 59.641	W 70° 17.651	21	18:57	N 40° 58.161	W 70° 17.751	22	10.2	95
24	Control	5/20/2023	Mostly Cloudy	7-10	SE	1.25-2.5	6:57	N 40° 56.518	W 70° 25.663	25	7:17	N 40° 56.236	W 70° 24.506	25	9.1	100
25	Control	5/20/2023	Mostly Cloudy	11-15	SE	1.25-2.5	8:06	N 40° 57.242	W 70° 21.231	24	8:26	N 40° 58.194	W 70° 20.963	23	9.6	100
26	Control	5/20/2023	Mostly Cloudy	11-15	SE	1.25-2.5	9:06	N 40° 57.128	W 70° 20.963	24	9:26	N 40° 56.243	W 70° 20.693	24	9.6	100
27	Control	5/20/2023	Mostly Cloudy	11-15	SE	1.25-2.5	10:05	N 40° 57.212	W 70° 18.284	22	10:25	N 40° 58.069	W 70° 17.551	21	9.9	95
28	Control	5/20/2023	Mostly Cloudy	11-15	SE	1.25-2.5	11:08	N 40° 59.531	W 70° 19.764	23	11:28	N 41° 00.086	W 70° 20.722	22	9.8	100
29	Control	5/20/2023	Rain	11-15	SE	1.25-2.5	12:03	N 40° 59.379	W 70° 22.041	22	12:23	N 41° 00.264	W 70° 22.432	21	9.5	95
30	Control	5/20/2023	Overcast	16-20	SE	1.25-2.5	12:52	N 41° 01.192	W 70° 21.743	21	13:12	N 41° 02.026	W 70° 21.168	21	9.9	95
31	Control	5/20/2023	Obscured	16-20	SE	1.25-2.5	13:48	N 41° 01.939	W 70° 20.129	21	14:08	N 41° 01.714	W 70° 19.007	21	10.1	95
32	VW1	5/20/2023	Mostly Cloudy	16-20	SE	1.25-2.5	14:53	N 41° 02.699	W 70° 23.712	21	15:13	N 41° 02.962	W 70° 24.887	22	9.8	95
33	VW1	5/20/2023	Mostly Cloudy	16-20	SE	1.25-2.5	16:03	N 41° 02.980	W 70° 25.722	23	16:23	N 41° 02.617	W 70° 25.892	23	9.7	100
34	VW1	5/20/2023	Mostly Cloudy	16-20	SE	1.25-2.5	17:03	N 41° 00.937	W 70° 26.864	23	17:23	N 41° 00.343	W 70° 27.664	24	9.5	100
35	VW1	5/21/2023	Obscured	7-10	S	1.25-2.5	7:21	N 41° 03.454	W 70° 22.663	21	7:41	N 41° 03.711	W 70° 23.803	22	10.4	95
36	VW1	5/21/2023	Mostly Cloudy	7-10	S	1.25-2.5	8:17	N 41° 05.426	W 70° 22.742	22	8:37	N 41° 06.241	W 70° 22.120	21	10.6	95
37	VW1	5/21/2023	Obscured	7-10	S	1.25-2.5	9:24	N 41° 06.509	W 70° 25.145	21	9:44	N 41° 06.535	W 70° 26.354	21	10.3	95
38	VW1	5/21/2023	Mostly Cloudy	7-10	S	1.25-2.5	10:31	N 41° 05.027	W 70° 27.505	22	10:51	N 41° 04.973	W 70° 28.663	22	9.8	2.7
39	VW1	5/21/2023	Mostly Cloudy	11-15	S	1.25-2.5	11:42	N 41° 05.594	W 70° 29.098	21	12:02	N 41° 05.663	W 70° 30.299	23	9.7	95
40	VW1	5/21/2023	Mostly Cloudy	11-15	S	1.25-2.5	12:41	N 41° 07.185	W 70° 27.905	22	13:01	N 41° 07.686	W 70° 26.885	21	10.2	95

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. (°C)	Trawl Warp (fm)	Headline Height (m)	Wing Spread (m)	Spread Door (m)
1	VW1	19.9	0.92	2.8	24		100			
2	VW1	20.2	0.91	2.7	25	8.7	100	4.7	13.7	35.1
3	VW1	20.0	0.94	2.8	24	8.6	100	5.2	13.3	33.4
4	VW1	20.6	0.97	2.8	26	8.6	100	4.5	13.9	36.0
5	VW1	20.0	0.94	2.8	25	8.7	100	4.5	14.0	35.7
6	VW1	20.0	0.94	2.8	25	8.7	100	4.8	13.4	34.0
7	VW1	20.0	0.99	3.0	25	8.6	100	4.9	13.5	34.2
8	VW1	19.9	0.90	2.7	25	8.7	100	4.5	13.9	35.9
9	VW1	20.1	0.97	2.9	25	8.9	100	5.0	13.5	34.4
10	VW1	20.0	0.96	2.9	24	8.9	100	5.0	13.5	33.7
11	VW1	19.9	0.96	2.9	24	8.9	100	4.5	14.0	35.9
12	Control	20.1	0.93	2.8	24	9.4	2.8	4.7	13.7	35.3
13	Control	20.3	0.96	2.8	24	9.1	100	4.6	13.8	35.6
14	Control	20.3	0.97	2.9	25	8.9	100	4.8	13.7	
15	Control	20.9	0.99	2.8	26	8.4	100	4.8	13.8	35.5
16	Control	20.2	0.95	2.8	26	8.6	100	4.7	13.9	36.1
17	Control	19.9	0.93	2.8	27	8.6	100	4.8	13.8	35.8
18	Control	20.0	0.94	2.8	25	9.1	100	4.6	13.7	36.1
19	Control	20.0	0.95	2.8	25	9.1	100	4.5	14.0	36.5
20	Control	20.0	0.93	2.8	23	9.4	100	4.5	13.9	
21	Control	20.2	1.00	3.0	20	10.1	95	5.1	13.1	33.0
22	Control	20.0	0.95	2.9	21	10.2	95	5.2	13.0	32.2
23	Control	20.0	0.93	2.8	21	10.2	95	4.4	14.1	
24	Control	20.0	0.93	2.8	25	9.1	100	4.6	13.9	
25	Control	20.1	0.99	2.9	24	9.6	100	4.7	13.9	
26	Control	20.1	0.92	2.7	24	9.6	100	4.5	14.0	
27	Control	20.2	1.04	3.1	22	9.9	95	5.1	13.0	31.8
28	Control	20.1	0.93	2.8	23	9.8	100	4.5	13.8	
29	Control	19.8	0.94	2.8	22	9.5	95	4.6	13.7	
30	Control	20.0	1.00	2.9	21	9.9	95	4.5	14.0	
31	Control	20.2	0.90	2.7	21	10.1	95	4.6	13.7	
32	VW1	20.0	0.95	2.8	21	9.8	95	5.2	13.1	
33	VW1	20.1	0.94	2.8	23	9.7	100	4.9	13.4	
34	VW1	20.0	0.95	2.9	23	9.5	100	5.0	13.3	
35	VW1	20.0	0.91	2.7	21	10.4	95	5.5	12.2	
36	VW1	19.9	0.95	2.9	22	10.6	95	5.0	13.2	
37	VW1	20.3	0.93	2.7	21	10.3	95	4.8	13.4	34.3
38	VW1	20.2	0.89	2.7	22	9.8	2.7	4.7	13.6	
39	VW1	20.0	0.92	2.7	21	9.7	95	4.5	13.8	
40	VW1	20.3	0.95	2.8	22	10.2	95	5.1	13.4	32.5
Summary Statistics										
Control	Minimum	19.8	0.9	2.7	20.0	8.4	2.8	4.4	13.0	31.8
	Maximum	20.9	1.0	3.1	27.0	10.2	100.0	5.2	14.1	36.5
	Average	20.1	0.95	2.8	23.5	9.4	93.4	4.7	13.7	34.8
	St. Dev	0.2	0.03	0.1	2.0	0.6	21.5	0.2	0.3	1.7
VW1	Minimum	19.9	0.9	2.7	21.0	8.6	2.7	4.5	12.2	32.5
	Maximum	20.6	1.0	3.0	26.0	10.6	100.0	5.5	14.0	36.0
	Average	20.1	0.94	2.8	23.4	9.3	93.6	4.9	13.5	34.6
	St. Dev.	0.2	0.03	0.1	1.7	0.7	21.5	0.3	0.4	1.1

Table 3: Total and average catch weights from 20 tows within the VW1 Study Area.

Species Name	Scientific Name	Total Weight (kg)	Catch/Tow (kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Butterfish	*Peprilus triacanthus*	1422.6	76.1	29.8	39.2	20
Hake, Silver (Whiting)	*Merluccius bilinearis*	429.5	22.9	2.9	11.8	20
Skate, Little	*Leucoraja erinacea*	420.4	22.4	2.3	11.6	20
Hake, Red	*Urophycis chuss*	359.0	19.0	2.6	9.9	20
Alewife	*Alosa pseudoharengus*	345.4	18.7	6.7	9.5	19
Skate, Winter	*Leucoraja ocellata*	166.6	8.8	1.0	4.6	19
Dogfish, Spiny	*Squalus acanthias*	69.96	3.7	1.0	1.9	13
Squid, Atlantic Longfin	*Dorytheuthis pealei*	54.1	2.9	0.7	1.5	20
Skate, Barndoor	*Dipturus laevis*	50.2	2.7	0.8	1.4	16
Flounder, Summer (Fluke)	*Paralichthys dentatus*	46.0	2.5	0.6	1.3	18
Crab, Rock	*Cancer irroratus*	40.8	2.2	0.5	1.1	18
Dogfish, Smooth	*Mustelus canis*	39.4	2.1	0.5	1.1	11
Monkfish	*Lophius americanus*	31.2	1.6	0.6	0.9	13
Black Sea bass	*Centropristis striata*	22.8	1.2	0.3	0.6	19
Ocean Pout	*Zoarces americanus*	22.3	1.2	0.5	0.6	7
Herring, Blueback	*Alosa aestivalis*	20.8	1.0	0.8	0.6	8
Flounder, Fourspot	*Paralichthys oblongus*	18.2	1.0	0.2	0.5	20
Shad, American	*Alosa sapidissima*	13.3	0.7	0.2	0.4	18
Herring, Atlantic	*Clupea harengus*	9.9	0.5	0.2	0.3	12
Sea Robin, Northern	*Prionotus carolinus*	9.6	0.5	0.1	0.3	16
Scup	*Stenotomus chrysops*	9.0	0.5	0.4	0.2	10
Flounder, Windowpane	*Scophtalmus aquosus*	8.6	0.5	0.1	0.2	17
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	6.2	0.3	0.1	0.2	10
Flounder, Winter	*Pleuronectes americanus*	4.0	0.2	0.1	0.1	4
Mackeral, Atlantic	*Scomber scombrus*	4.0	0.2	0.1	0.1	6
Flounder, Gulfstream	*Citharichthys arctifrons*	3.6	0.2	0.1	0.1	11
Sea Scallop, Atlantic	*Placopecten magellanicus*	0.8	0.04	0.02	0.02	6
Squid, Shortfin	*Illex illecebrosus*	0.4	0.02	0.02	0.01	1
Sea Raven	*Hemitripterus americanus*	0.2	0.01	0.01	0.01	1
Total		3628.8				

*SEM - Standard Error of the Mean

Table 4: Total and average catch weights from 20 tows within the Control Area.

Species Name	Scientific Name	Total Weight (kg)	Catch/Tow (kg)		% of Total Catch	Tows with Species Present
			Mean	SEM*		
Hake, Silver (Whiting)	*Merluccius bilinearis*	2136.1	110.2	47.1	49.9	20
Dogfish, Spiny	*Squalus acanthias*	451.6	23.6	10.6	10.5	20
Skate, Little	*Leucoraja erinacea*	383.5	19.8	2.7	9.0	20
Hake, Red	*Urophycis chuss*	280.7	14.5	2.2	6.6	20
Butterfish	*Peprilus triacanthus*	263.1	13.7	4.0	6.1	19
Skate, Winter	*Leucoraja ocellata*	240.1	12.4	1.8	5.6	20
Alewife	*Alosa pseudoharengus*	124.3	6.4	2.9	2.9	13
Flounder, Summer (Fluke)	*Paralichthys dentatus*	66.6	3.5	0.7	1.6	16
Skate, Barndoor	*Dipturus laevis*	65.6	3.4	1.1	1.5	16
Monkfish	*Lophius americanus*	54.0	2.8	0.8	1.3	13
Dogfish, Smooth	*Mustelus canis*	39.3	2.0	0.5	0.9	12
Flounder, Fourspot	*Paralichthys oblongus*	37.4	1.9	0.2	0.9	20
Squid, Atlantic Longfin	*Dorytheuthis pealei*	23.4	1.2	0.2	0.5	20
Ocean Pout	*Zoarces americanus*	21.3	1.1	0.3	0.5	12
Black Sea bass	*Centropristis striata*	15.9	0.8	0.1	0.4	17
Sea Robin, Northern	*Prionotus carolinus*	14.9	0.8	0.1	0.3	19
Crab, Rock	*Cancer irroratus*	11.6	0.6	0.1	0.3	13
Shad, American	*Alosa sapidissima*	11.0	0.6	0.1	0.3	17
Flounder, Windowpane	*Scophtalmus aquosus*	10.6	0.6	0.1	0.2	17
Herring, Blueback	*Alosa aestivalis*	9.5	0.5	0.3	0.2	5
Mackeral, Atlantic	*Scomber scombrus*	6.0	0.3	0.2	0.1	5
Flounder, Gulfstream	*Citharichthys arctifrons*	4.2	0.2	0.1	0.1	13
Atlantic Cod	*Gadus morhua*	3.0	0.2	0.1	0.1	2
Herring, Atlantic	*Clupea harengus*	2.7	0.1	0.1	0.1	9
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	2.5	0.1	0.0	0.1	7
Sea Raven	*Hemitripterus americanus*	1.8	0.1	0.1	0.04	3
Scup	*Stenotomus chrysops*	1.4	0.1	0.0	0.03	7
Flounder, Winter	*Pleuronectes americanus*	1.3	0.1	0.1	0.03	1
Flounder, Yellowtail	*Pleuronectes ferrugineus*	0.6	0.03	0.02	0.01	2
Kingfish, Northern	*Menticirrhus saxatilis*	0.5	0.03	0.03	0.01	1
Sea Scallop, Atlantic	*Placopecten magellanicus*	0.2	0.01	0.01	0.00	2
Total		4284.69				

*SEM - Standard Error of the Mean

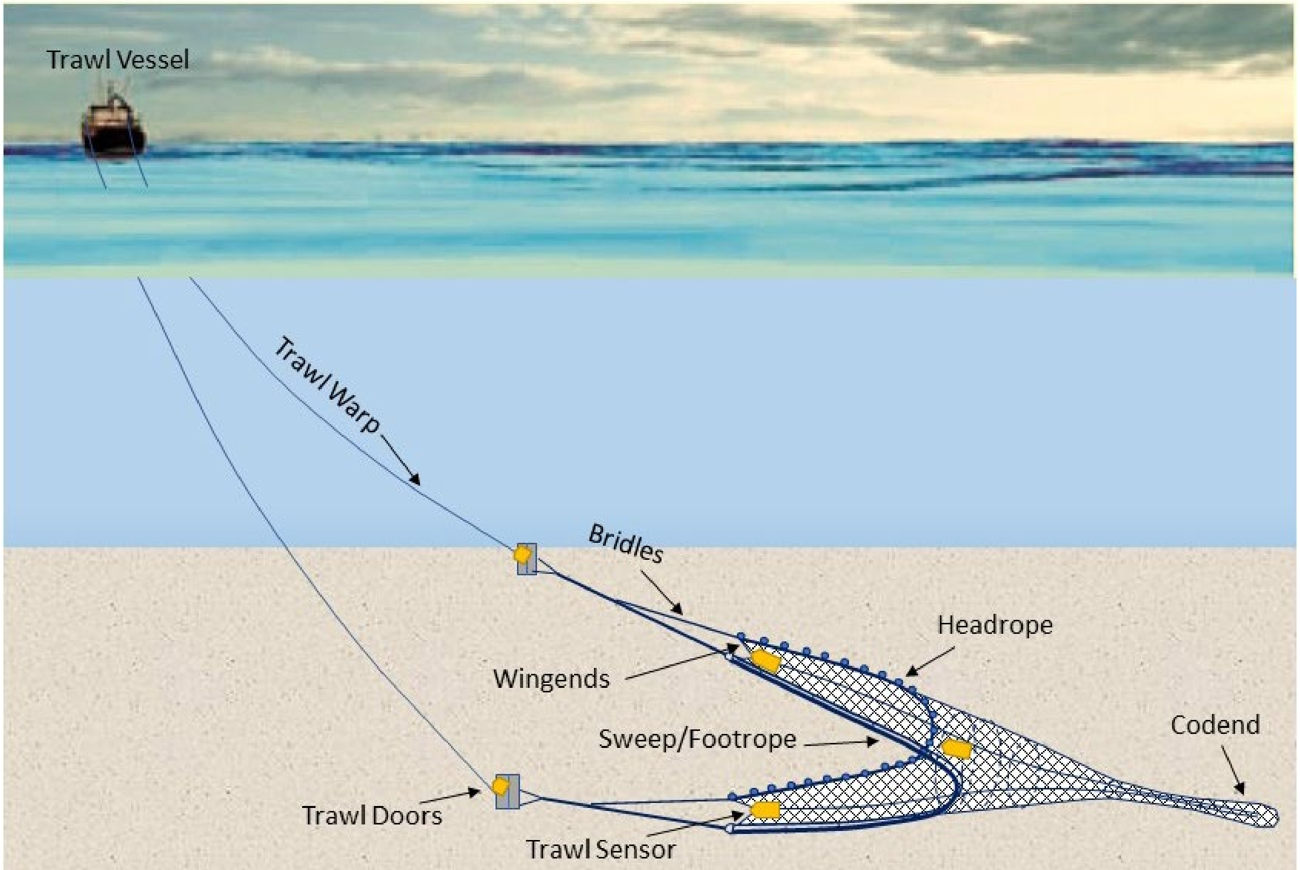


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate Simrad PX trawl geometry sensors.

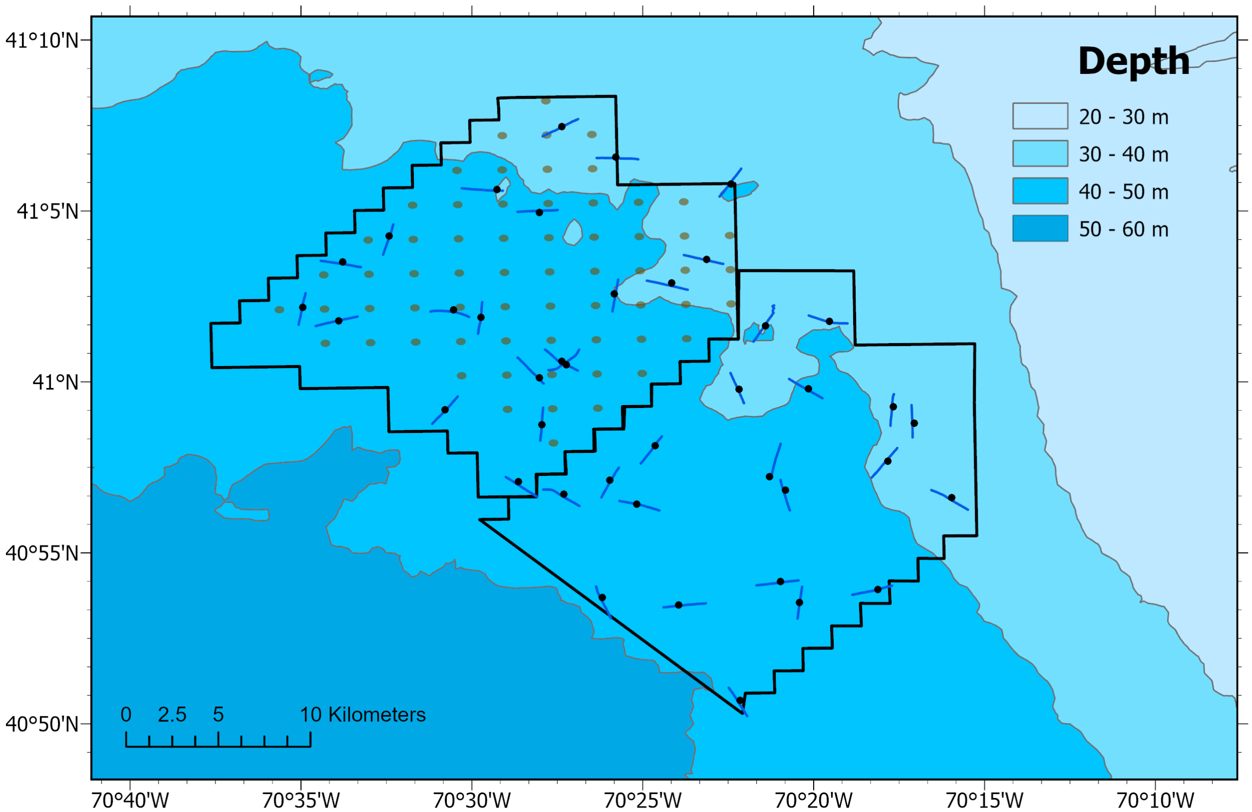


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the VW1 Study Area (left) and the Control Area (right). Prior to the start of the survey, scour protection (gray dots) had been installed in all wind turbine locations.

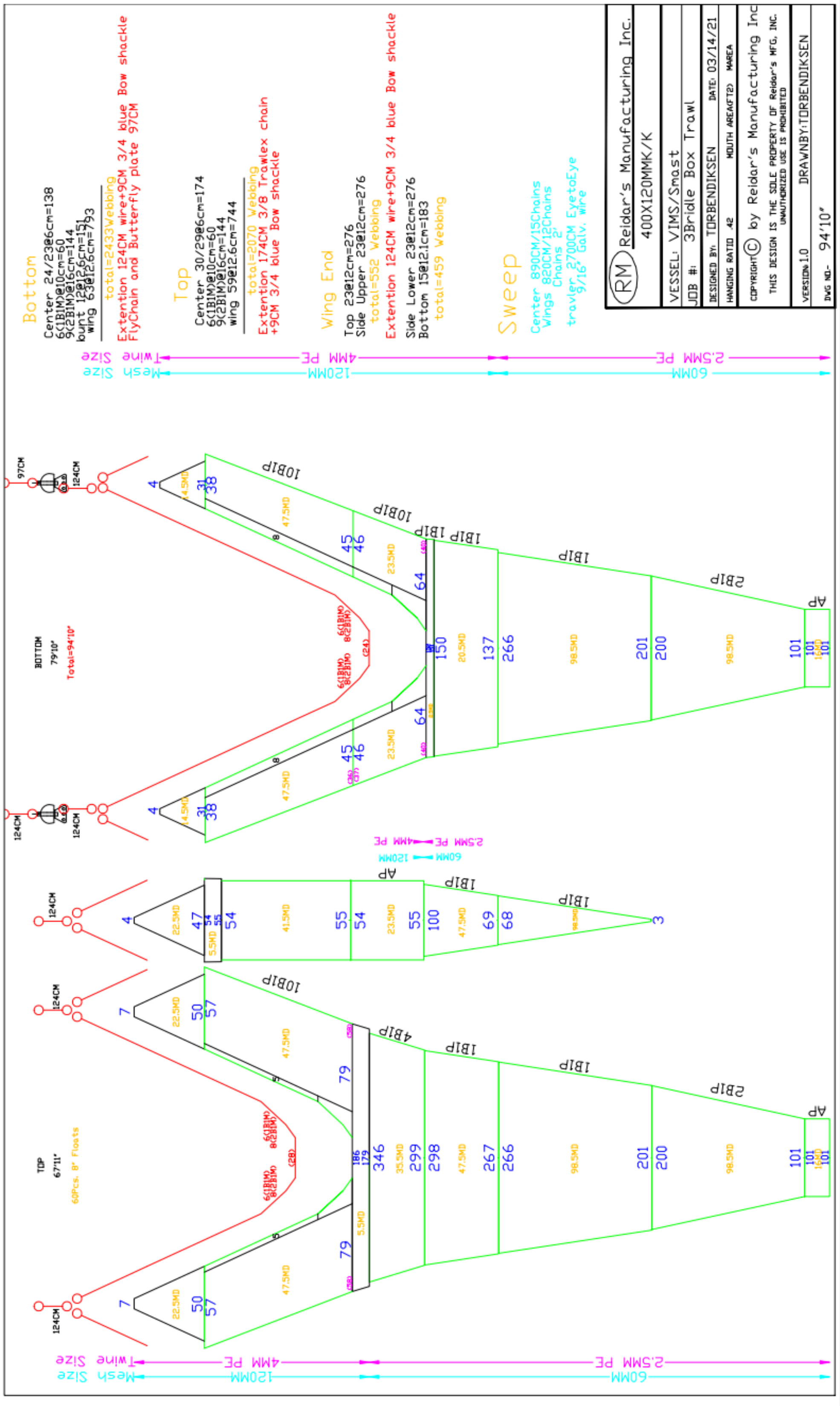


Figure 3: Schematic net plan for the NEAMAP trawl (Courtesy of Reidar's Manufacturing Inc.).

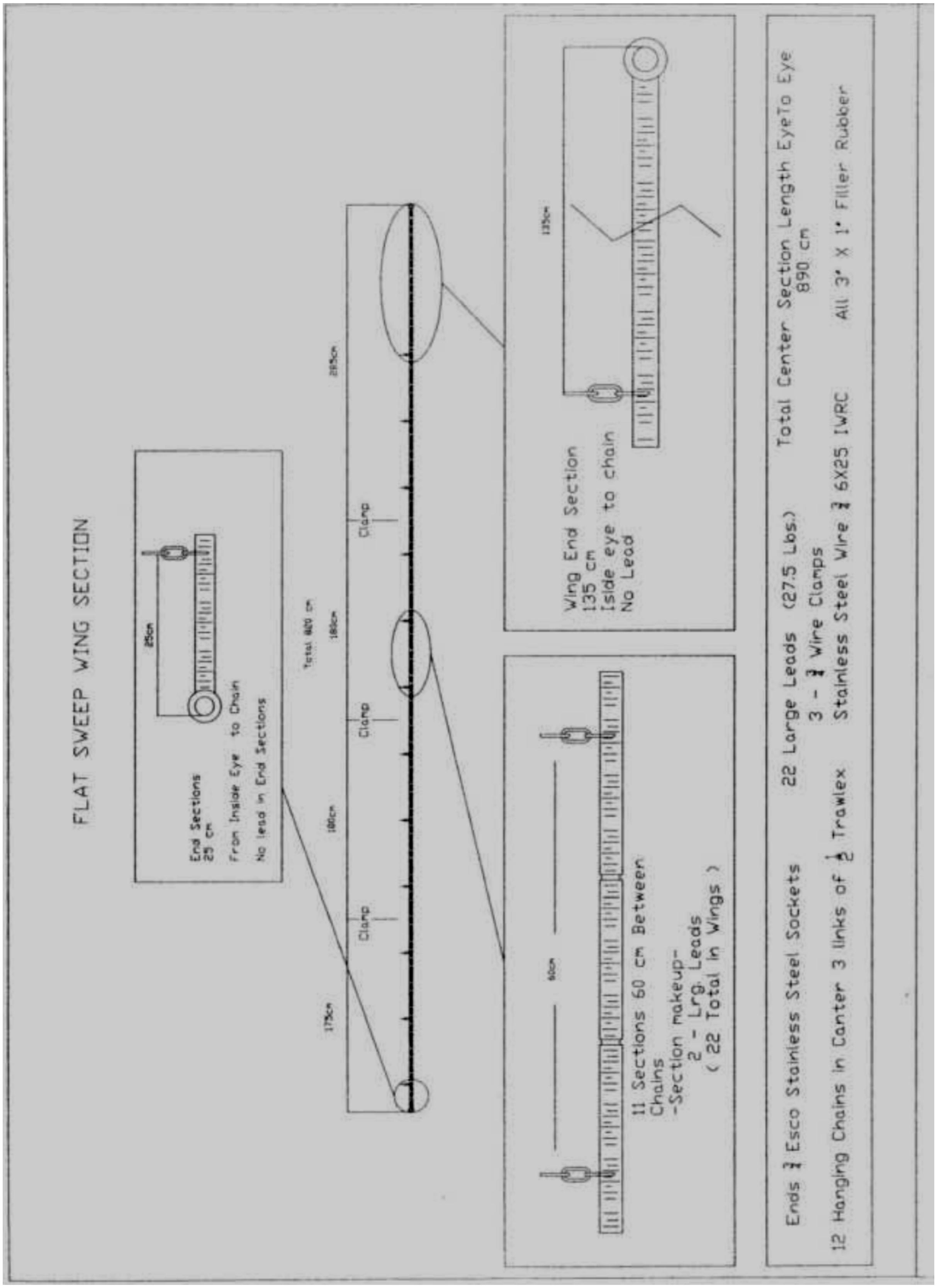


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

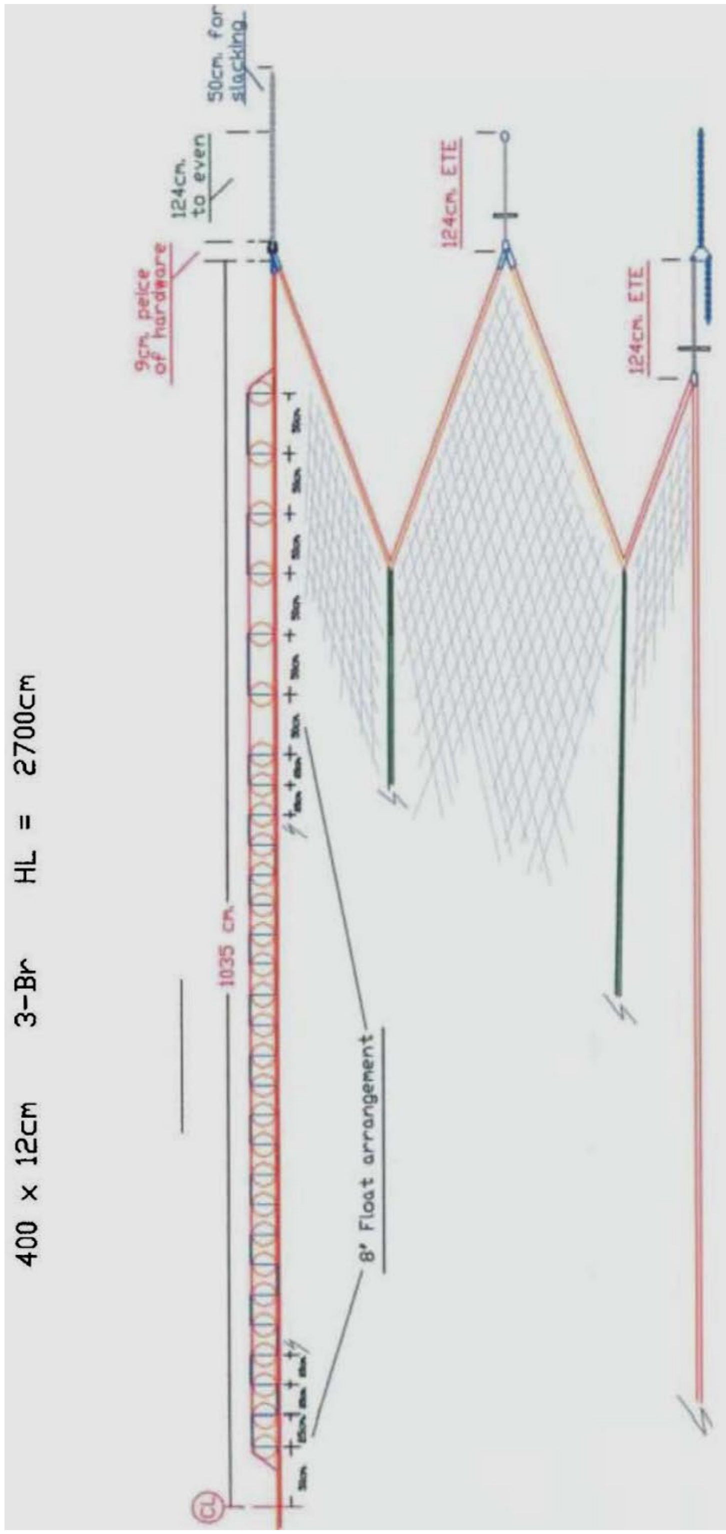


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008).

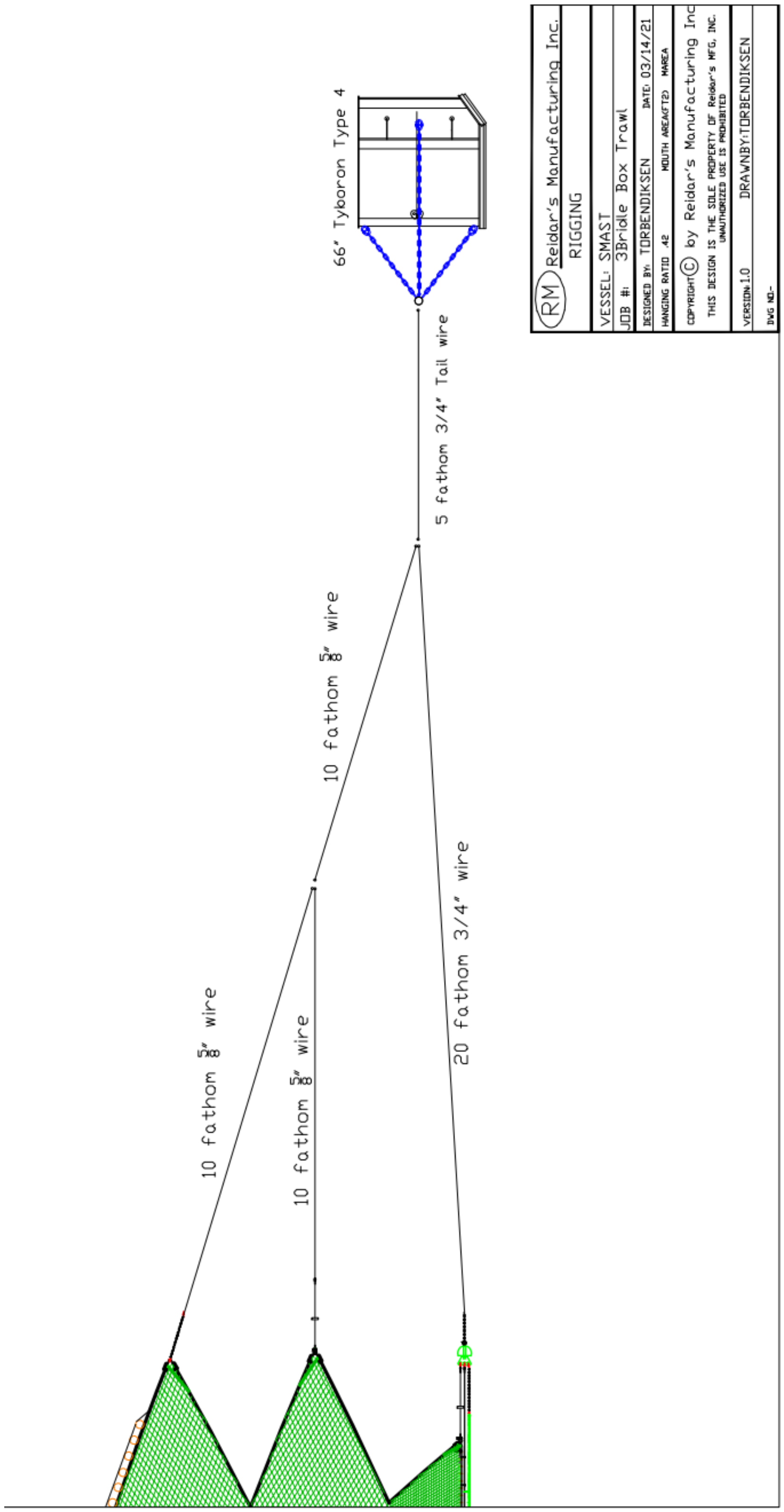


Figure 6: Bridle and door rigging schematic for the survey trawl (Courtesy of Reidar's Manufacturing Inc.).

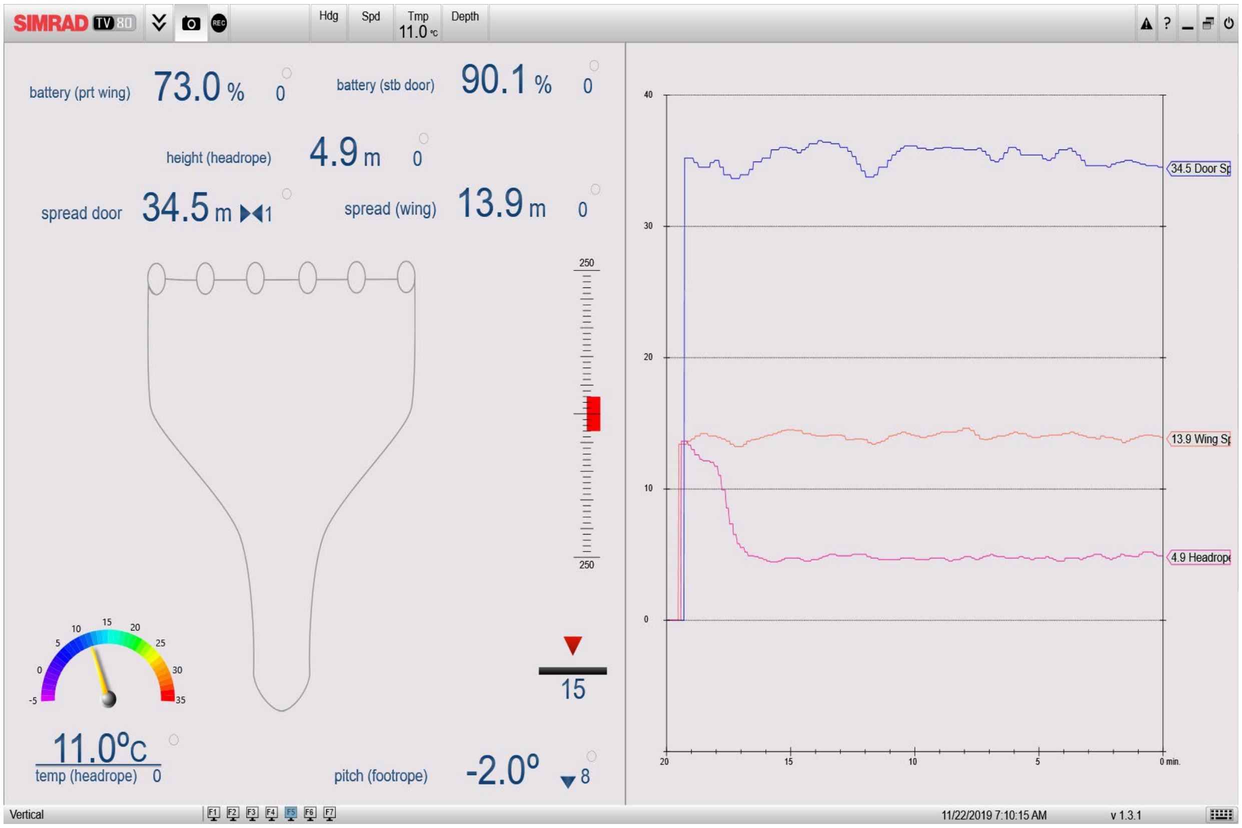


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.

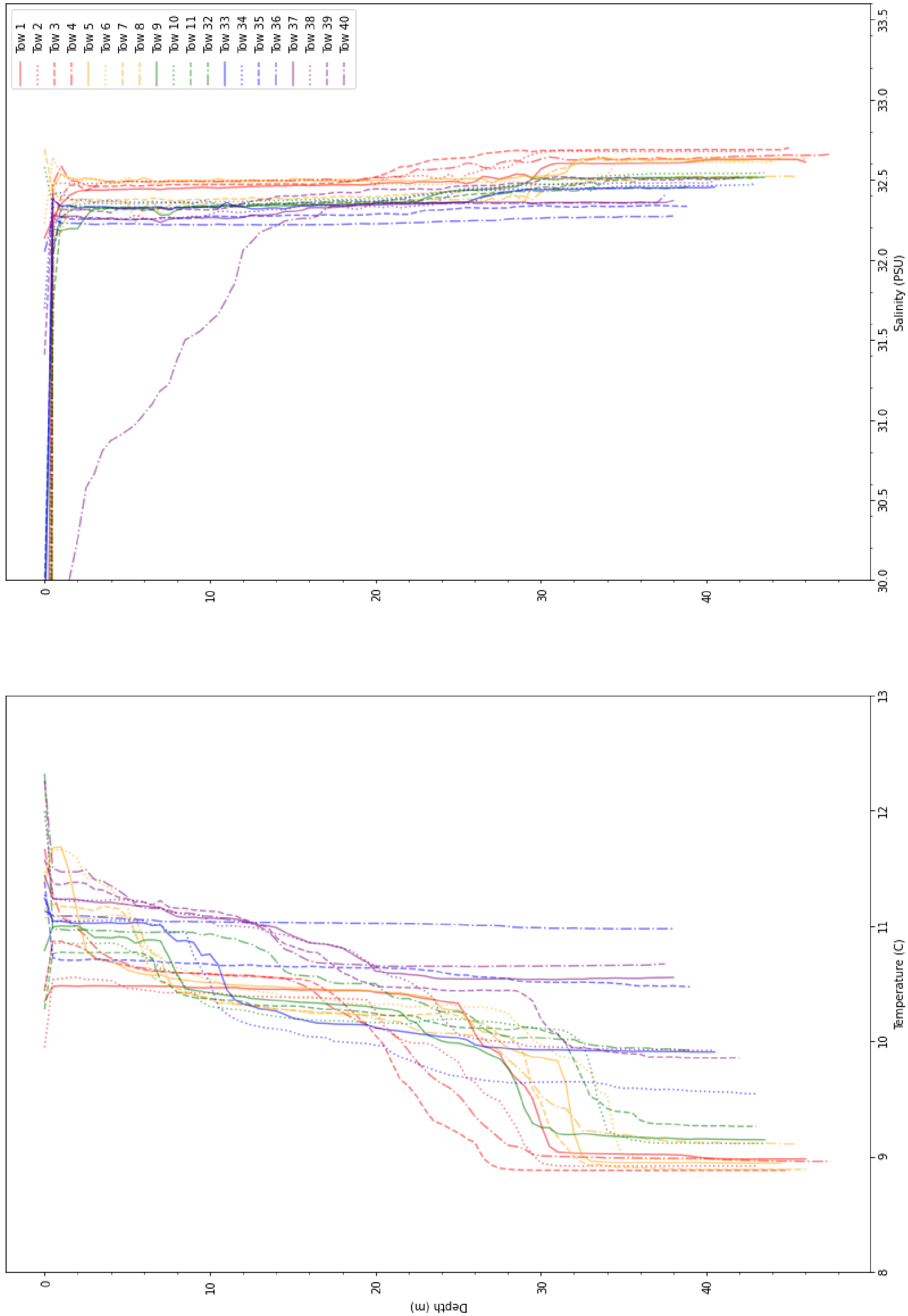
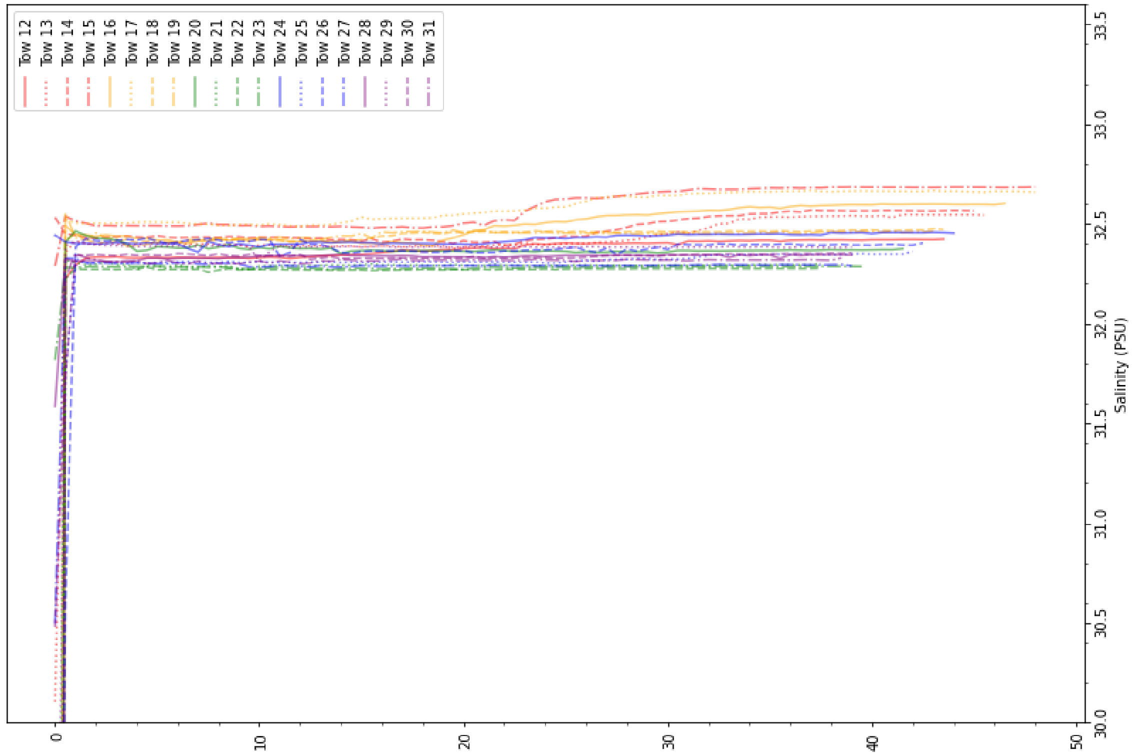


Figure 8: CTD sonde downcast profiles from the VW1 Study Area.



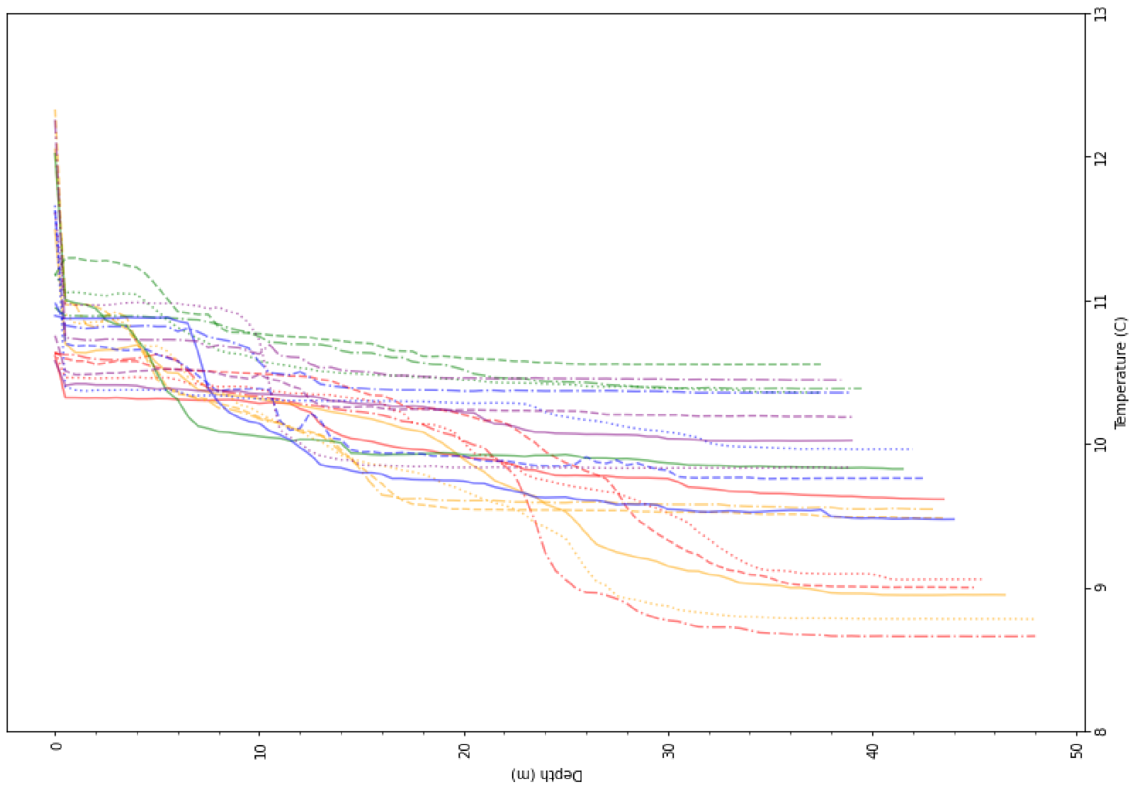
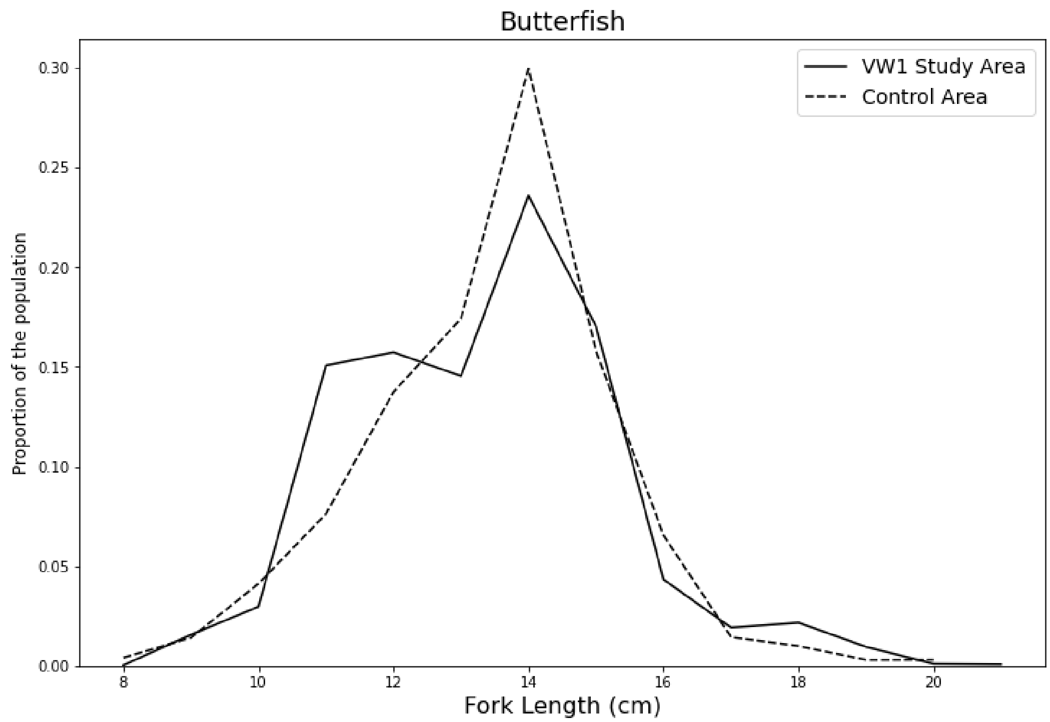


Figure 9: CTD conde downcast profiles from the Control Area.



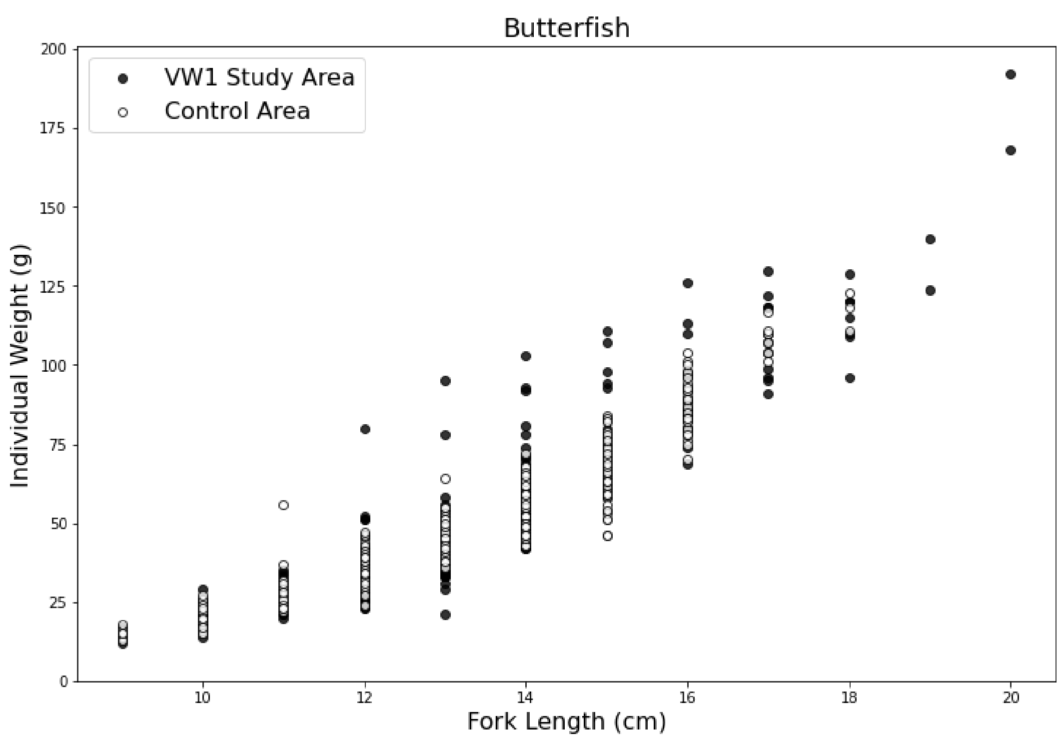


Figure 10: Population structure of butterfish in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

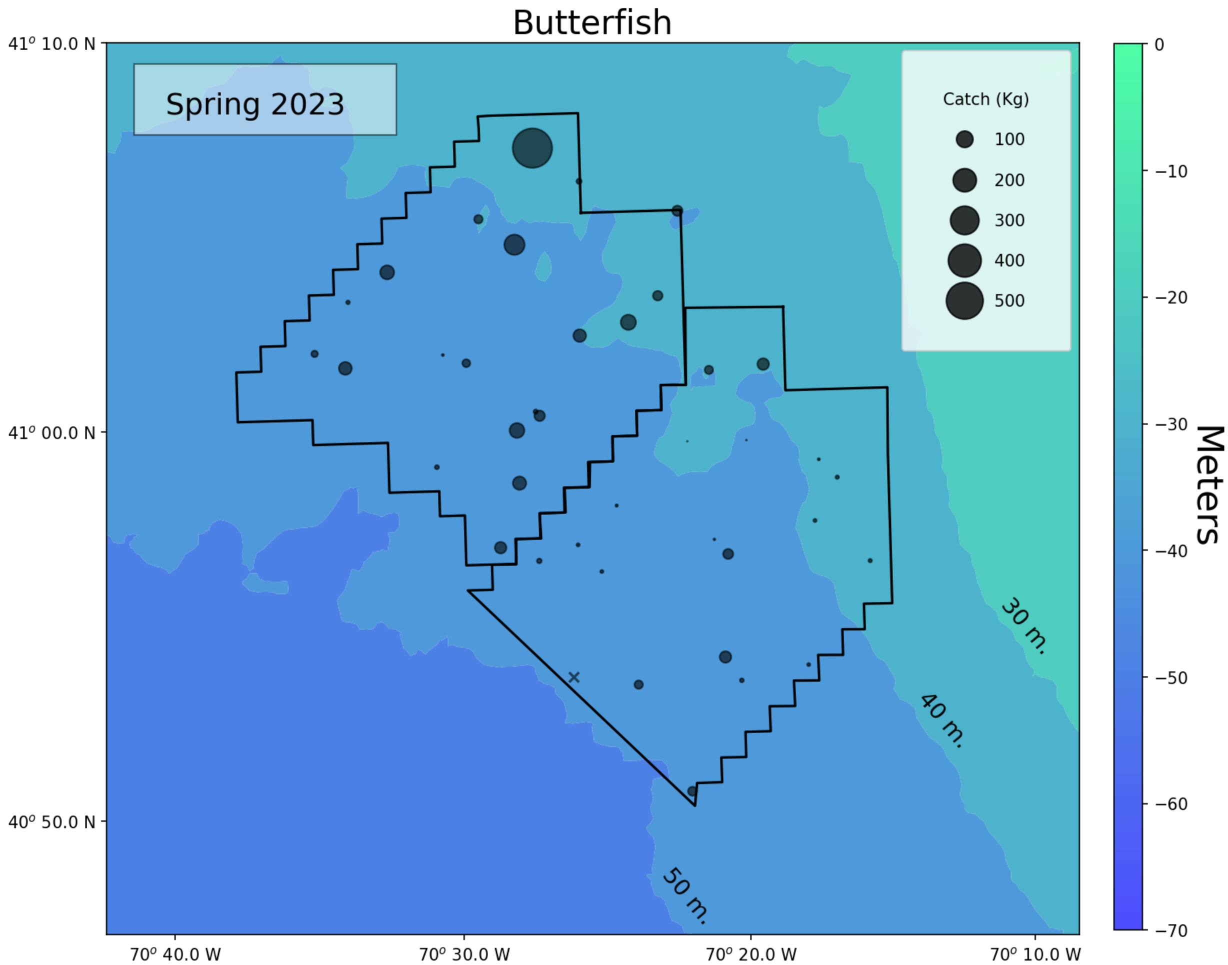
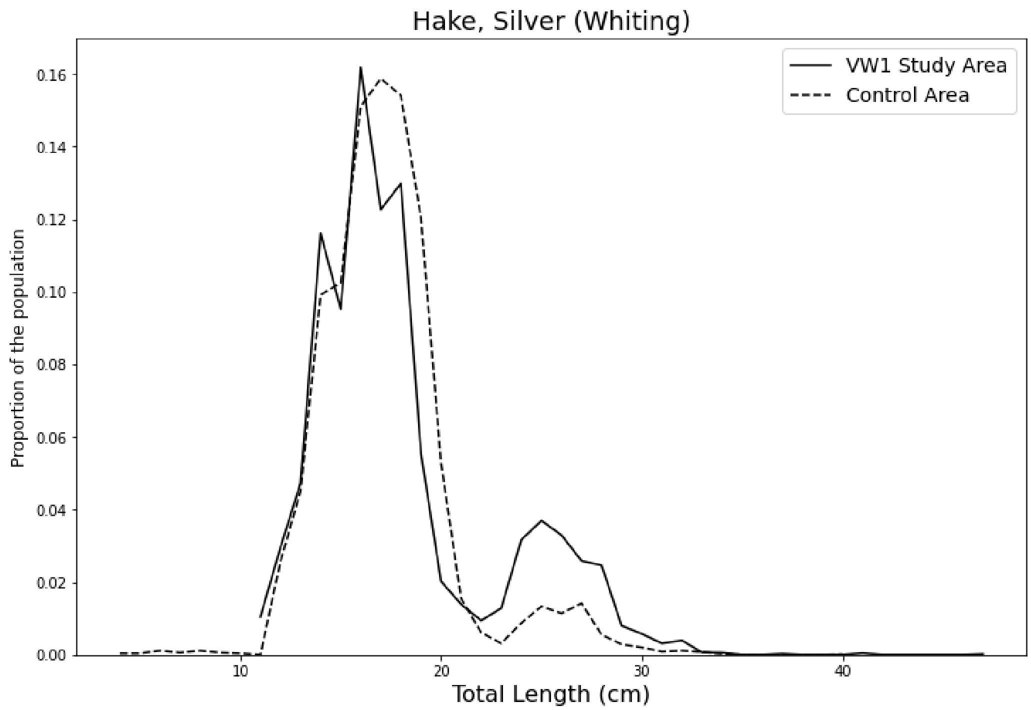


Figure 11: Distribution of the catch of butterfish in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



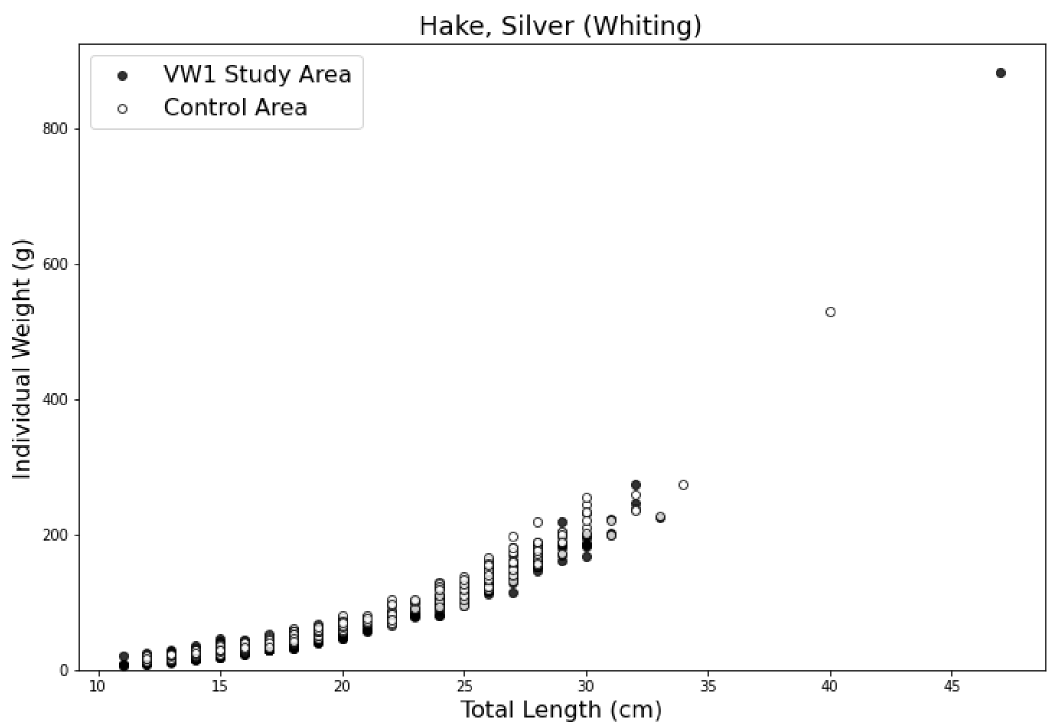


Figure 12: Population structure of silver hake in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

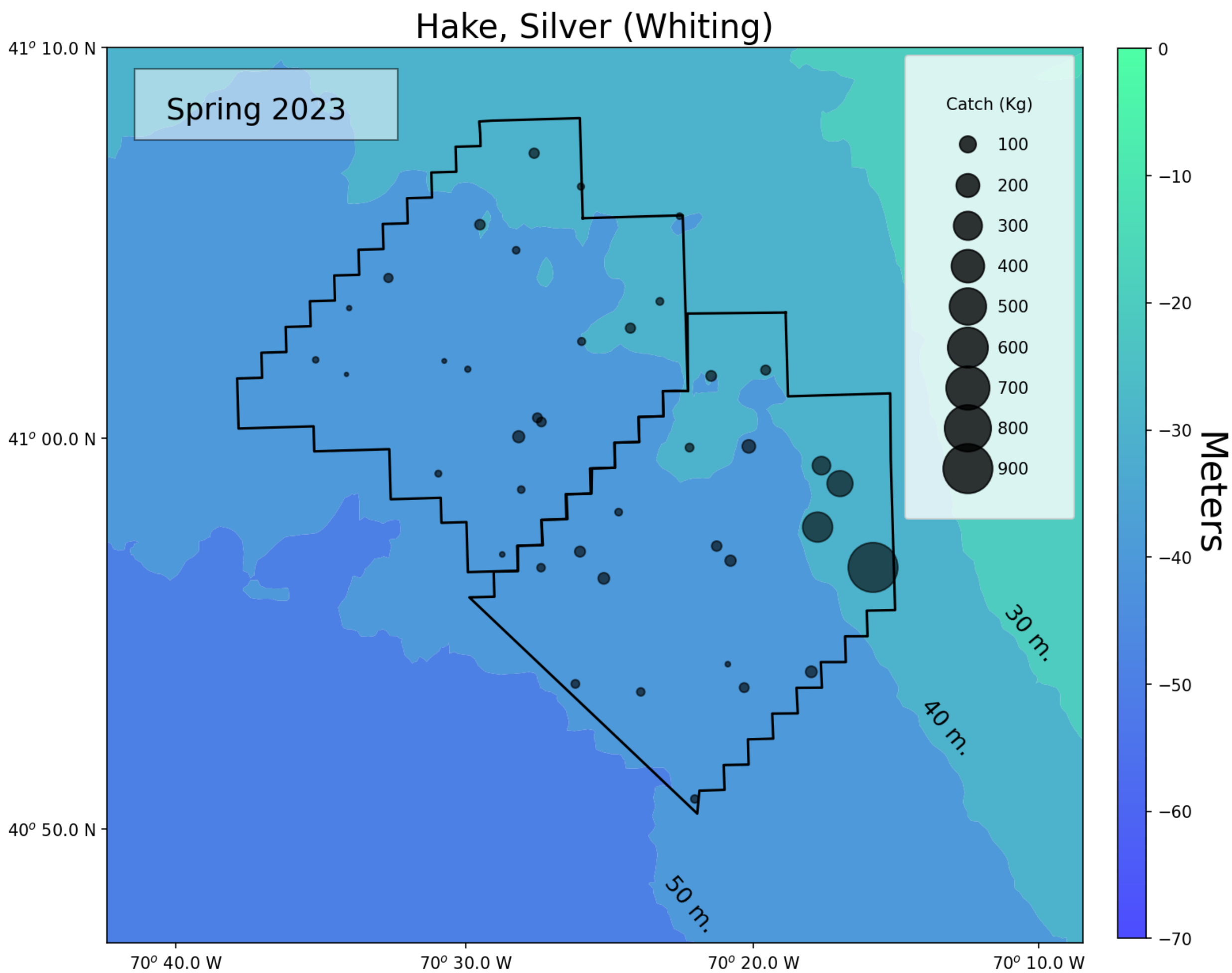
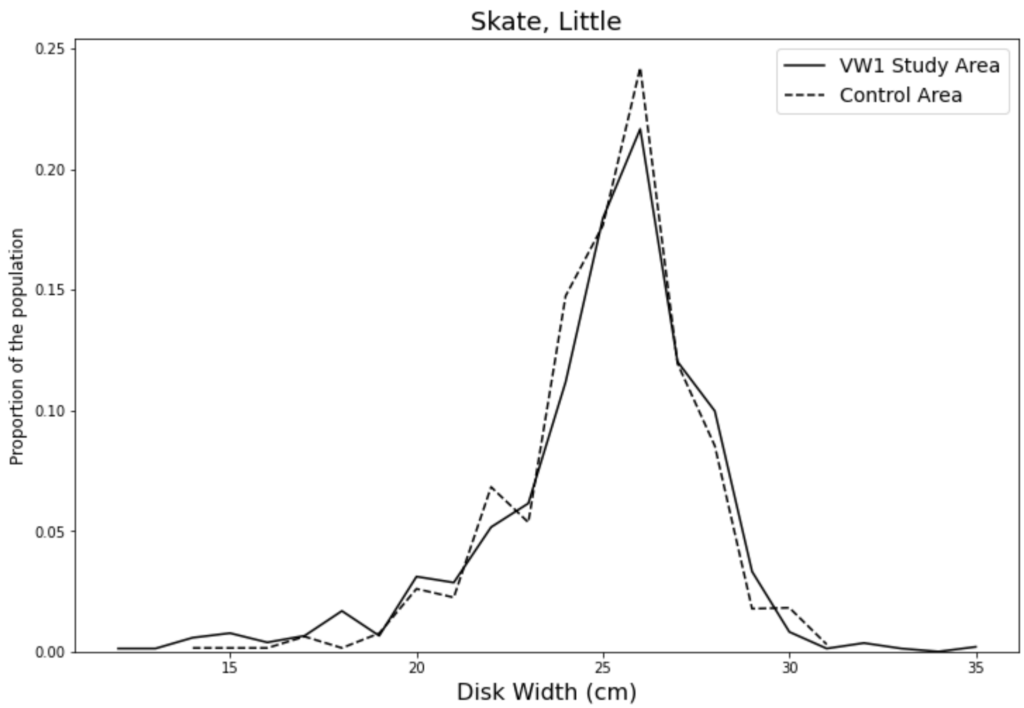


Figure 13: Distribution of the catch of silver hake in the VW1 Study Area (left) and Control Area (right).



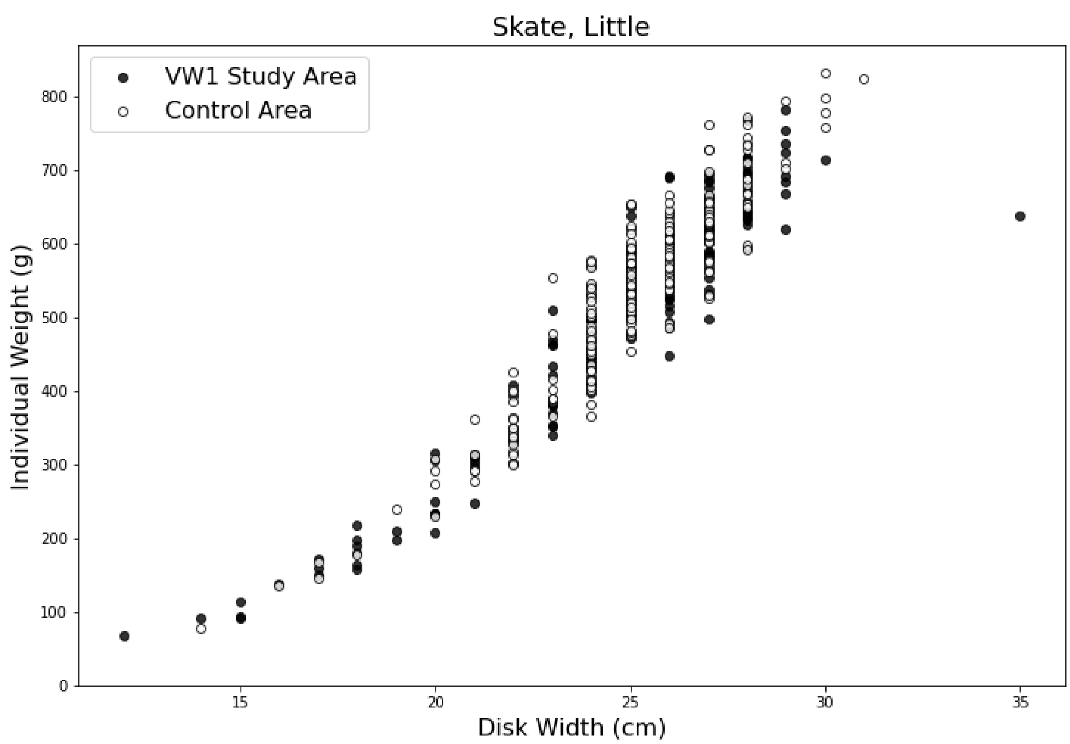


Figure 14: Population structure of little skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

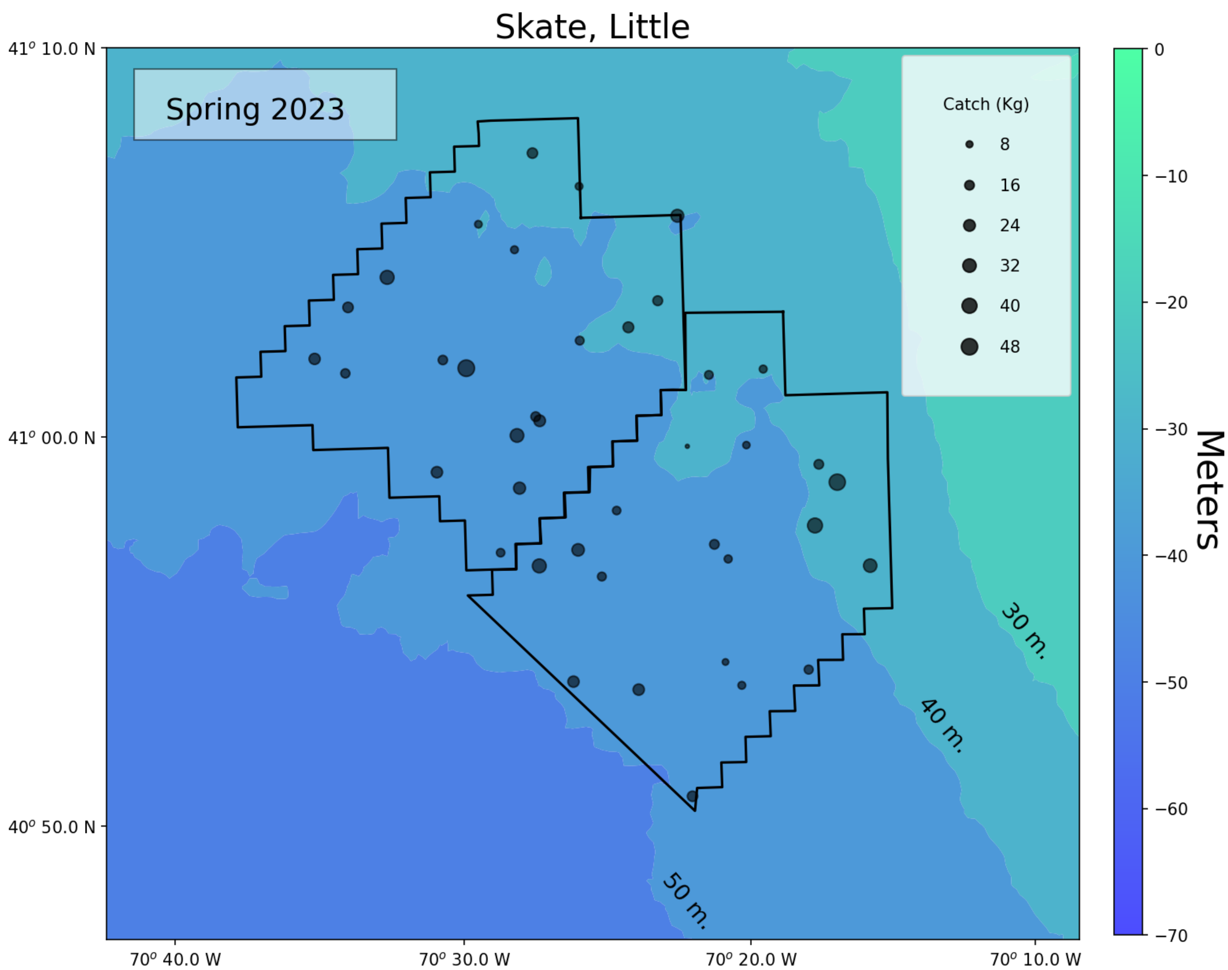
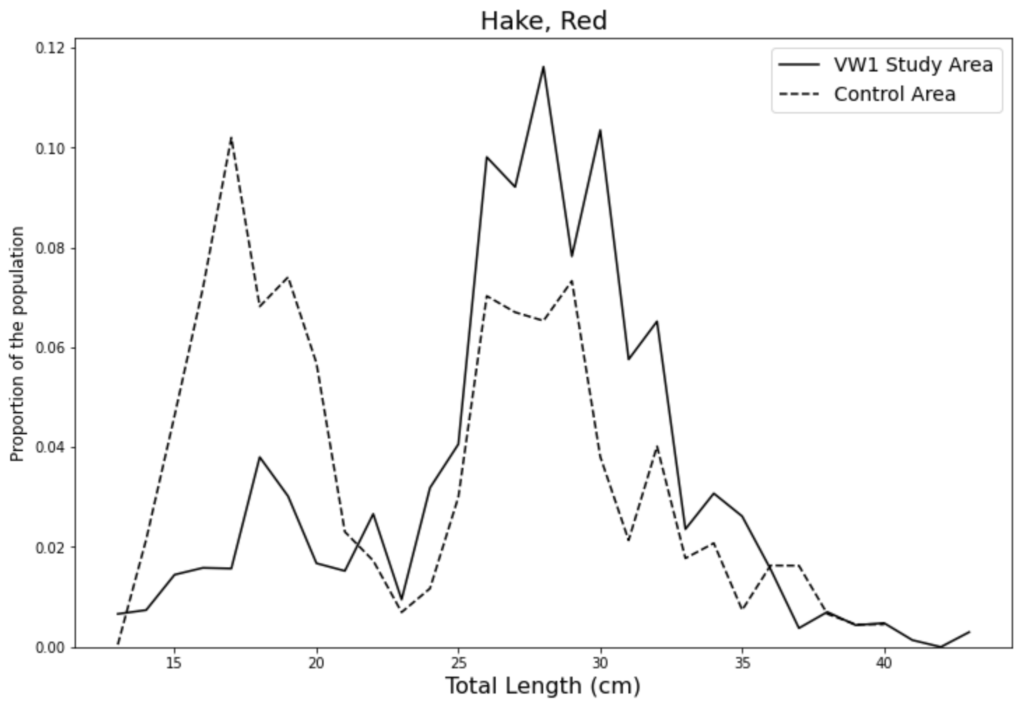


Figure 15: Distribution of the catch of little skate in the VW1 Study Area (left) and Control Area (right).



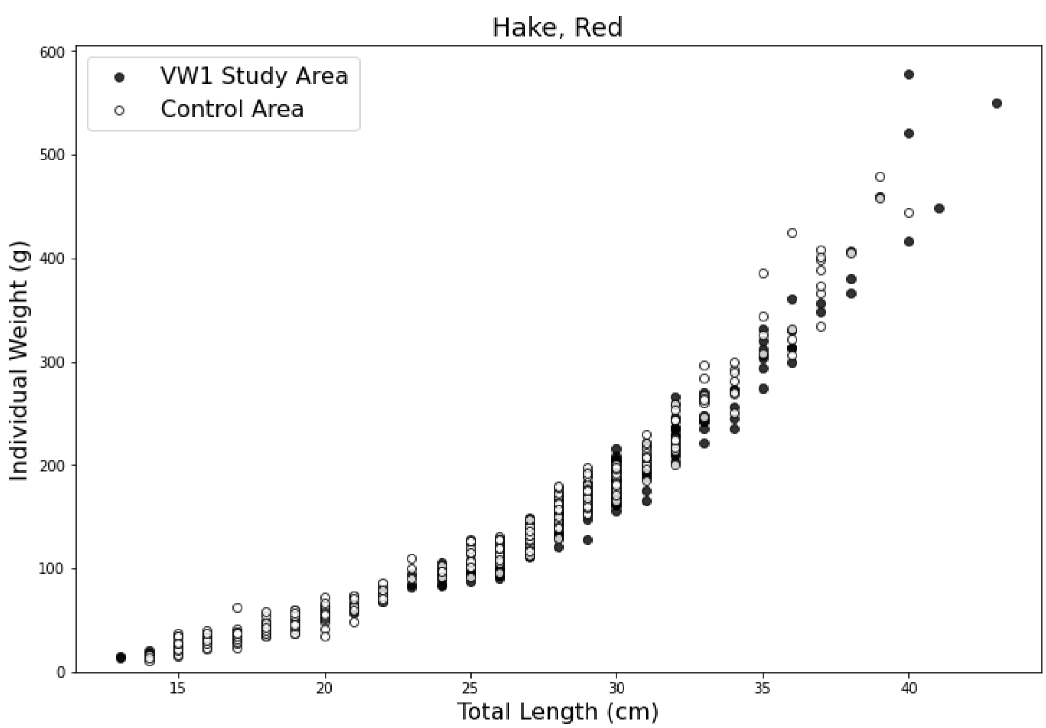


Figure 16: Population structure of red hake in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

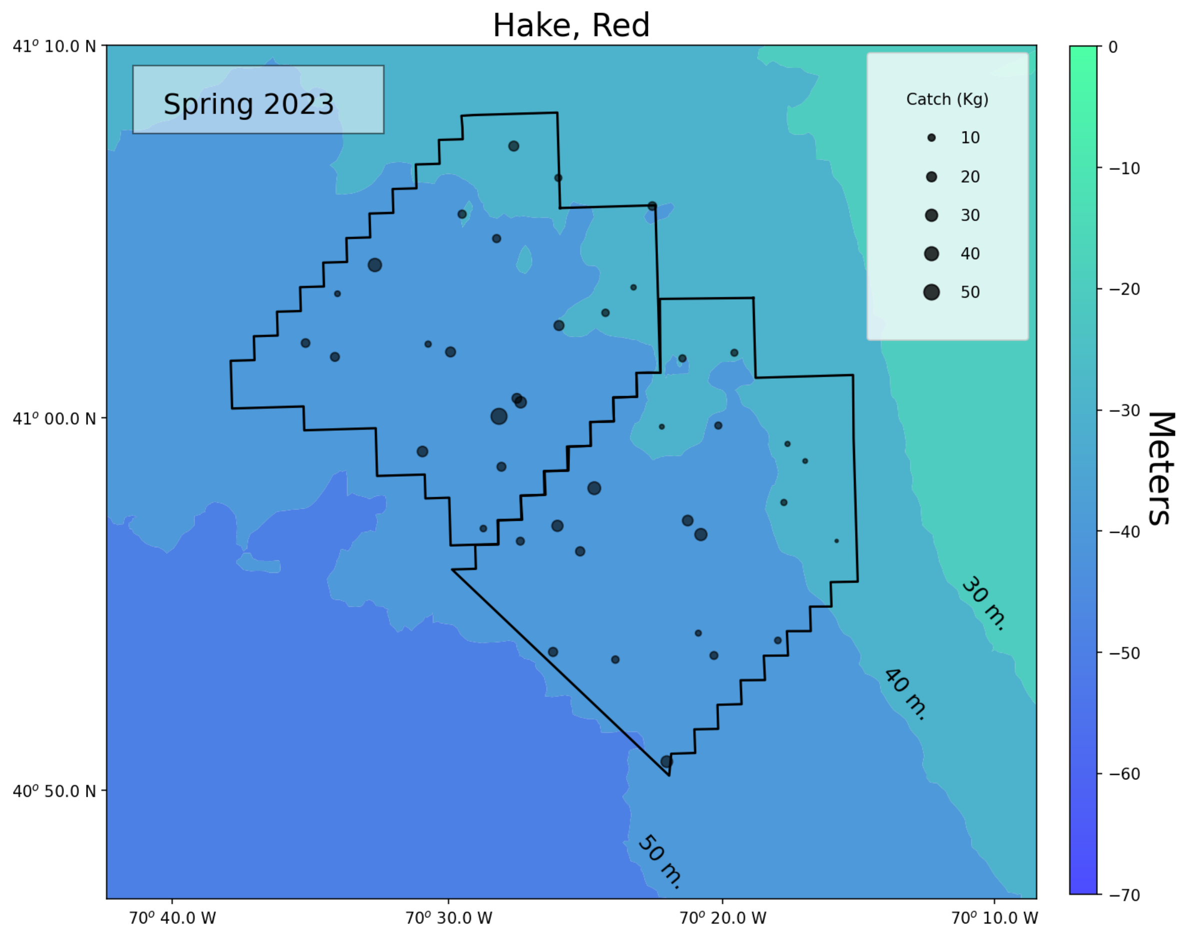
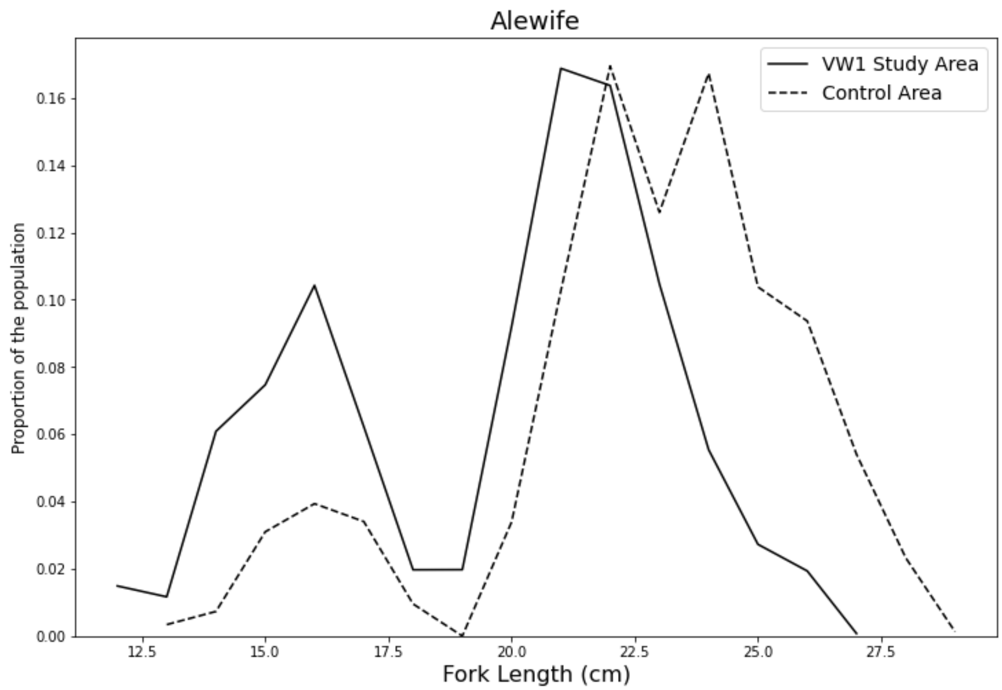


Figure 17: Distribution of the catch of red hake in the VW1 Study Area (left) and Control Area (right).



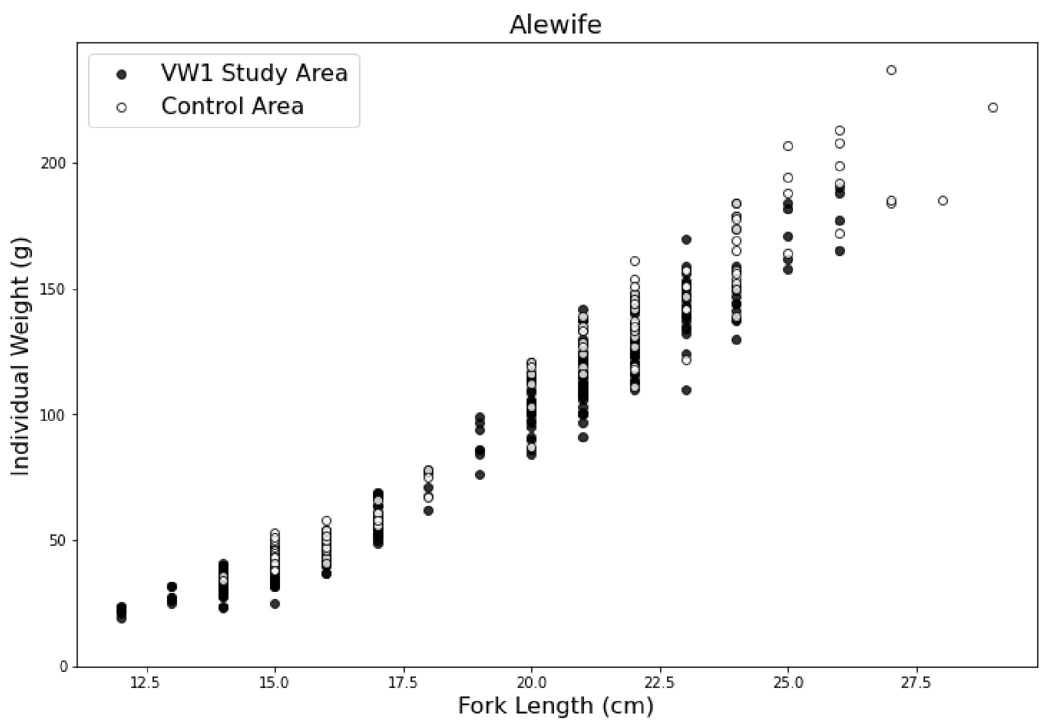


Figure 18: Population structure of alewife in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

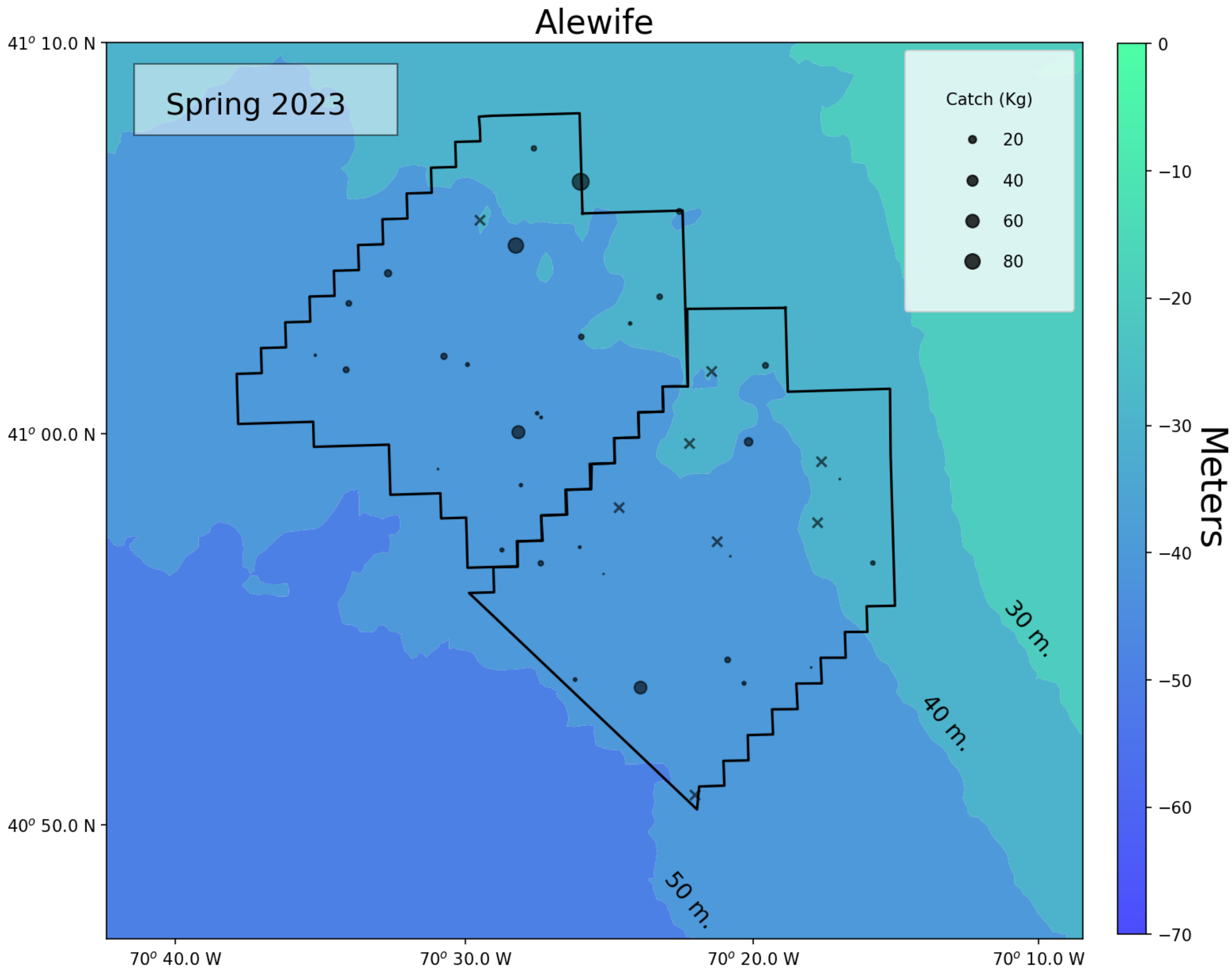
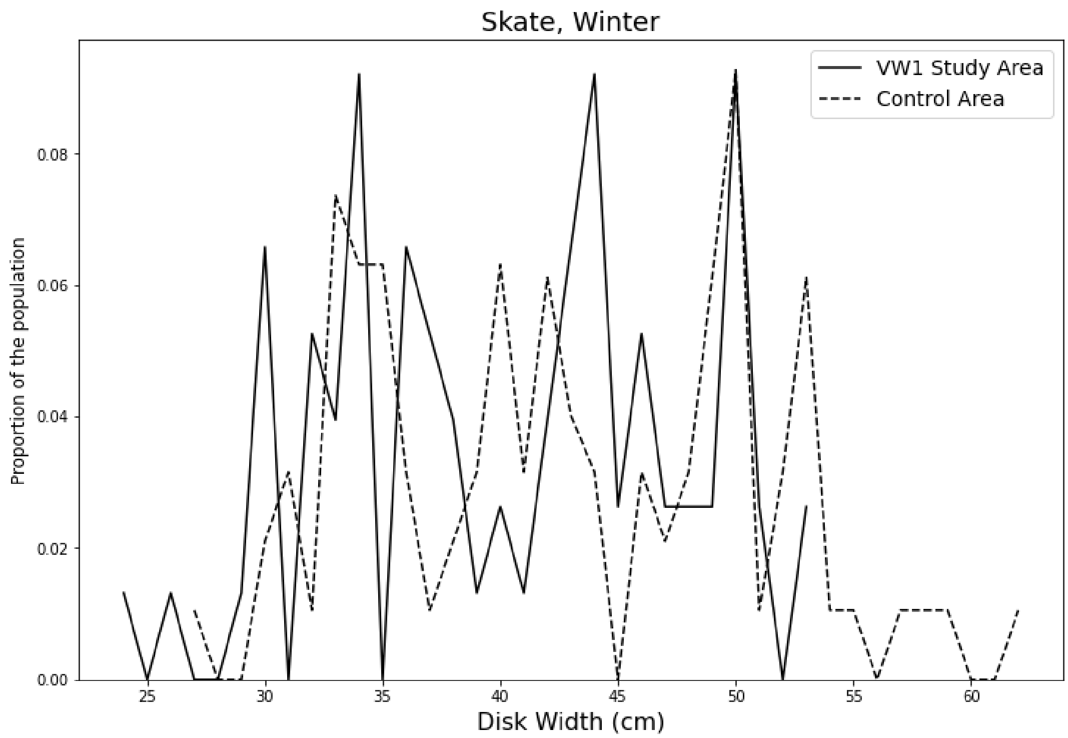


Figure 19: Distribution of the catch of alewife in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



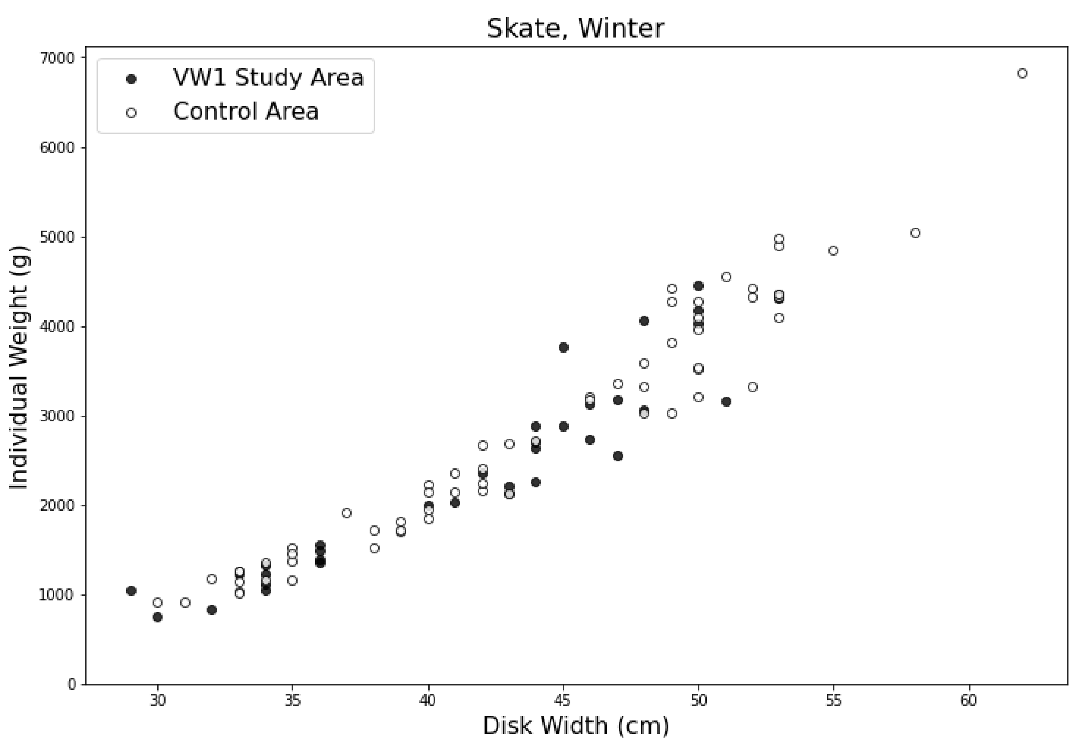


Figure 20: Population structure of winter skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

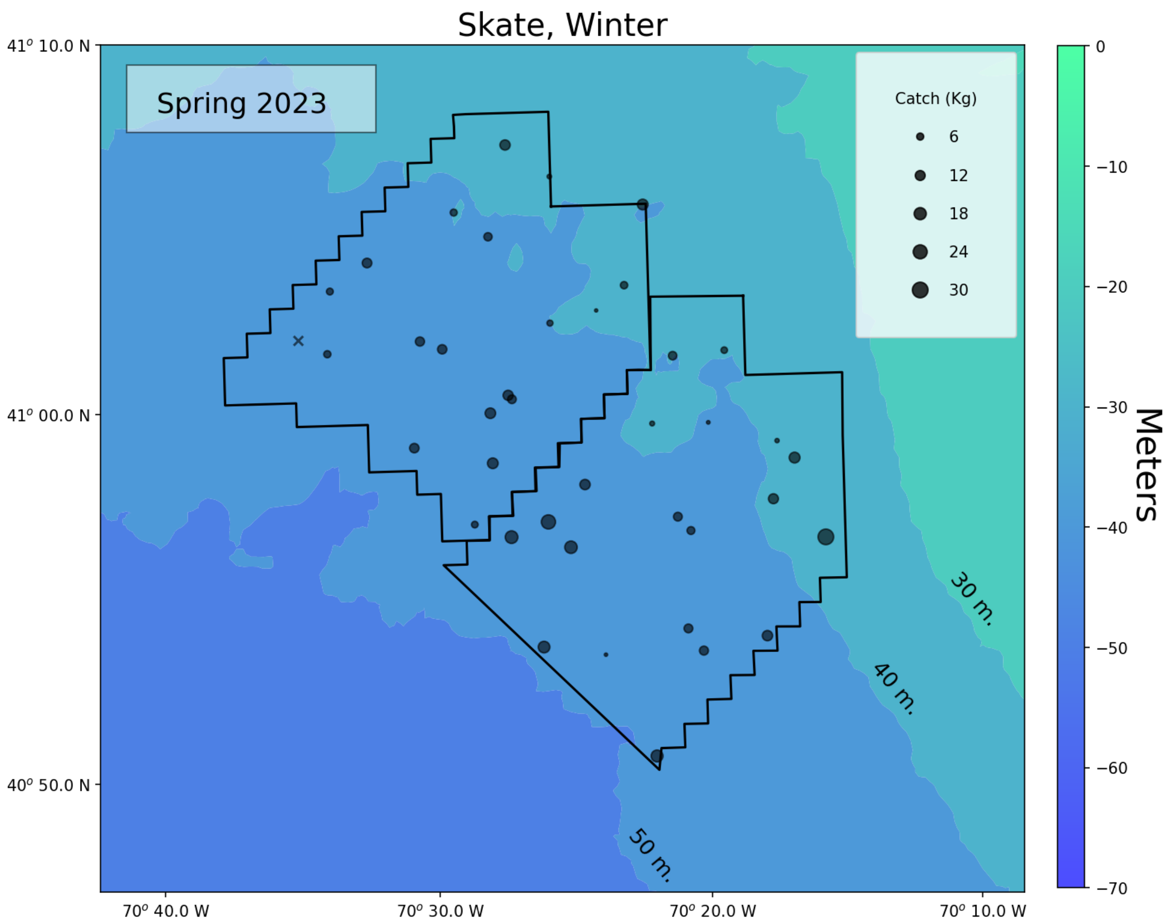
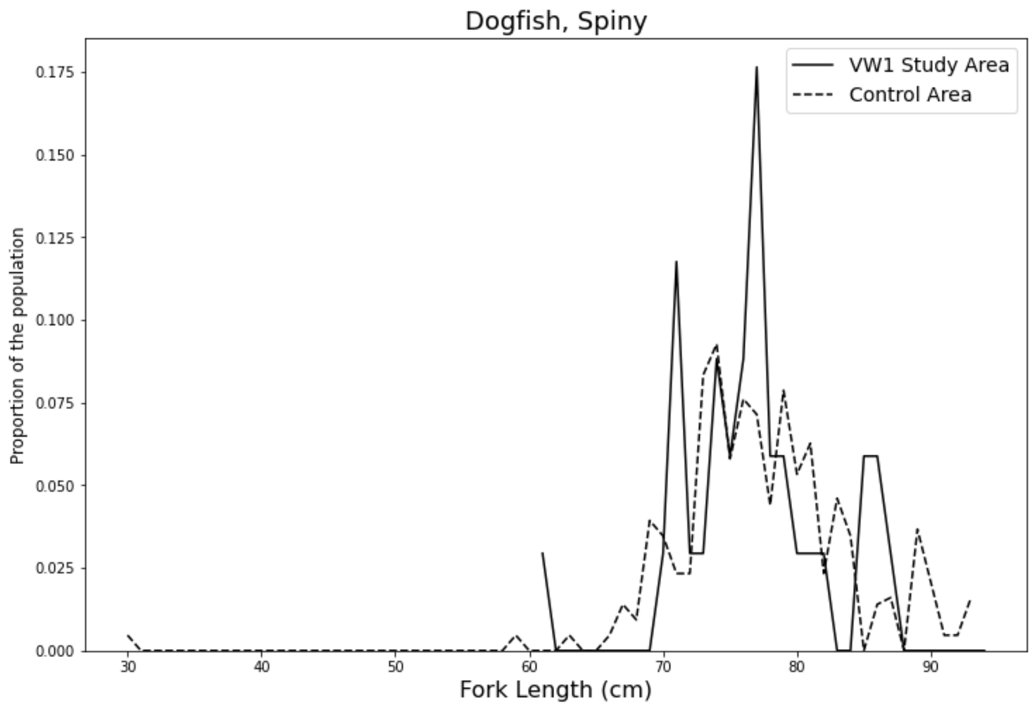


Figure 21: Distribution of the catch of winter skate in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



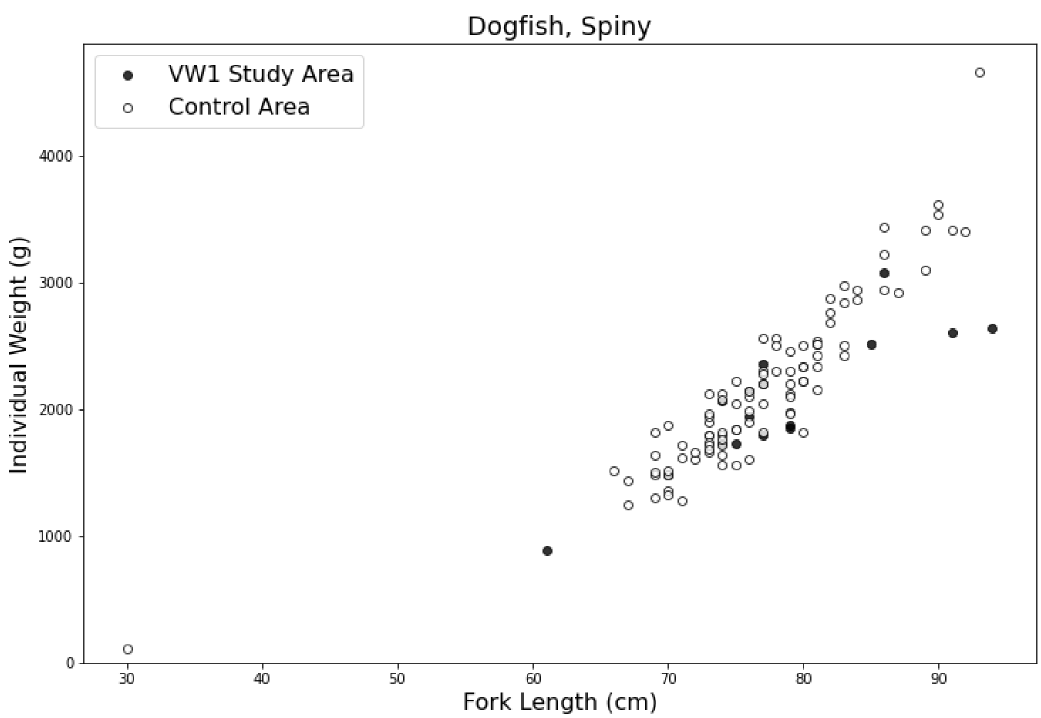


Figure 22: Population structure of spiny dogfish in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

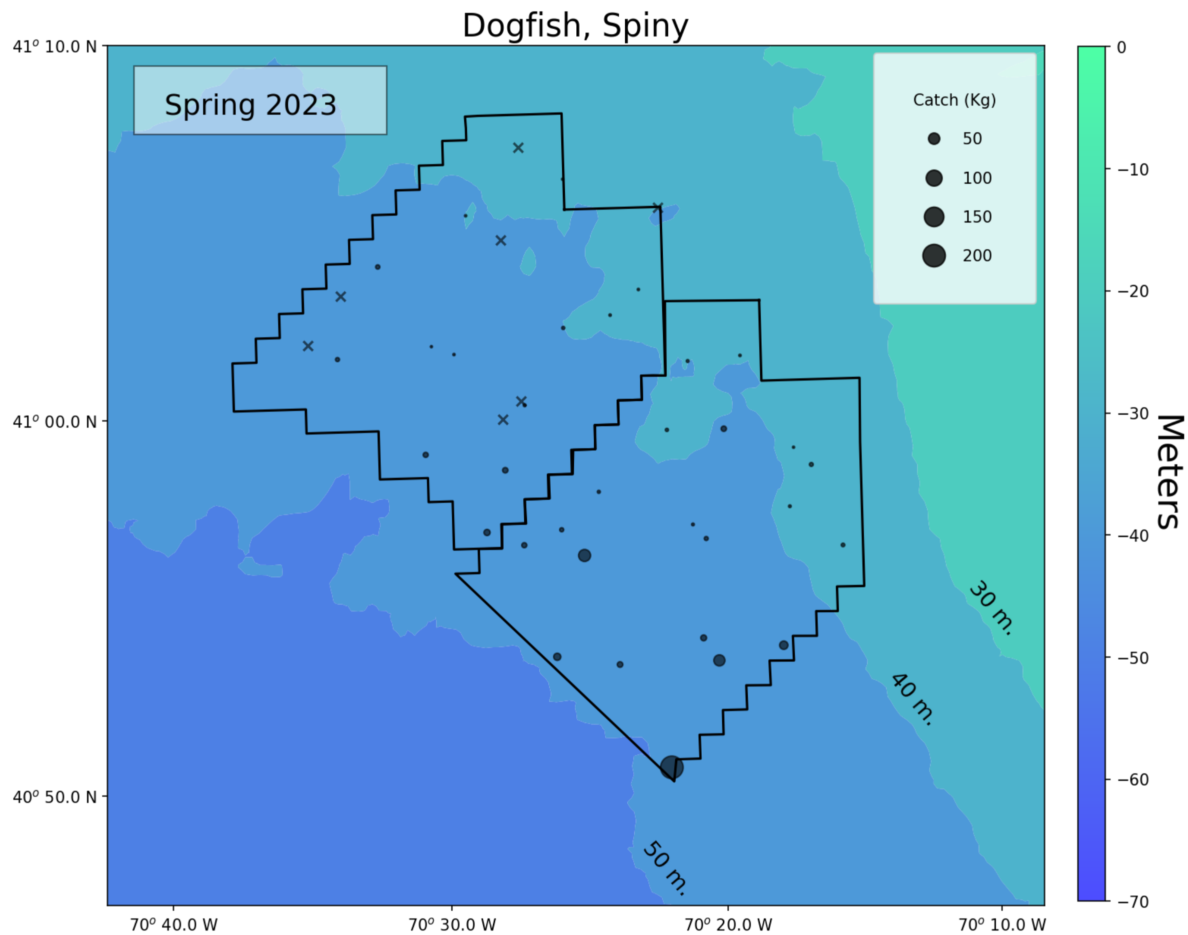
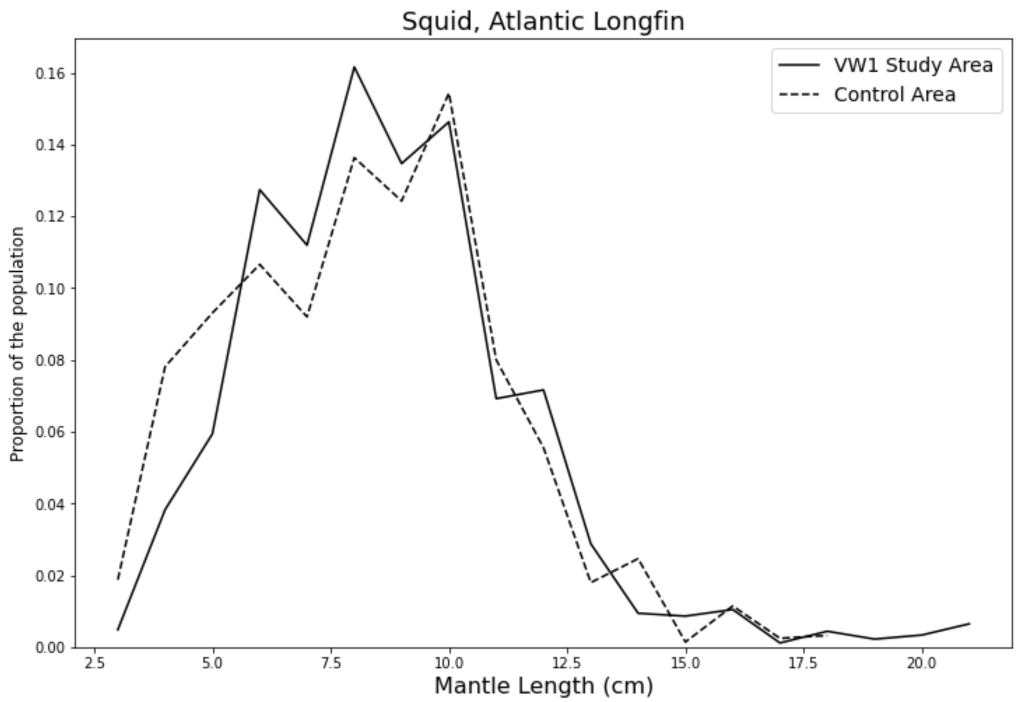


Figure 23: Distribution of the catch of spiny dogfish in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



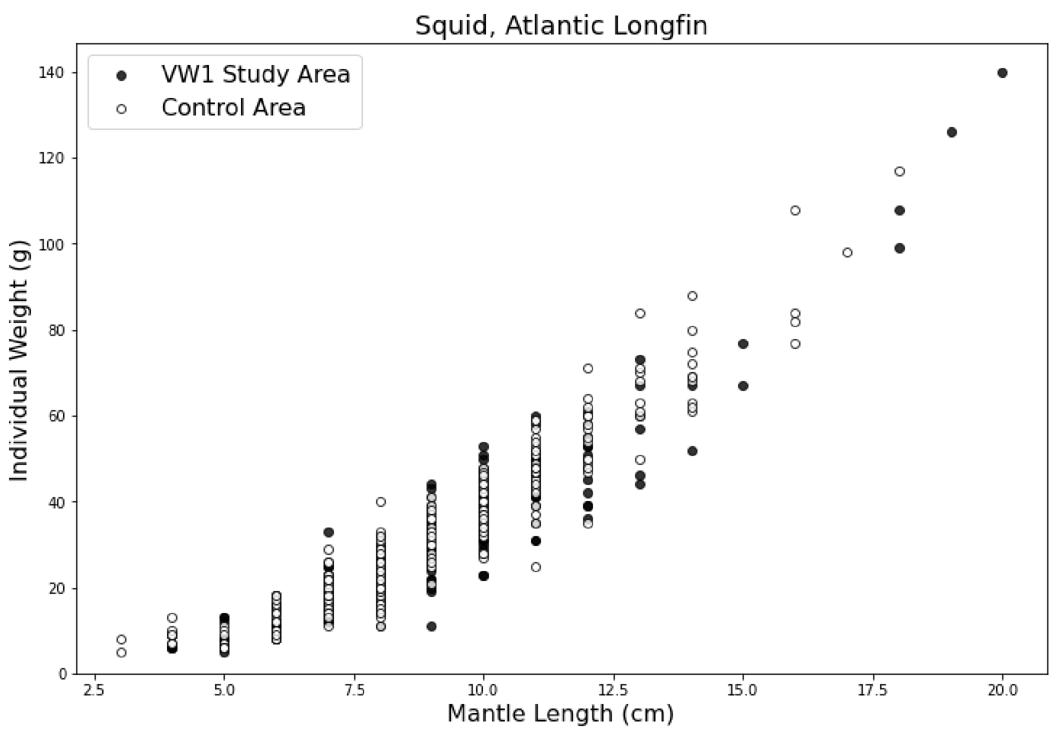


Figure 24: Population structure of Atlantic longfin squid in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

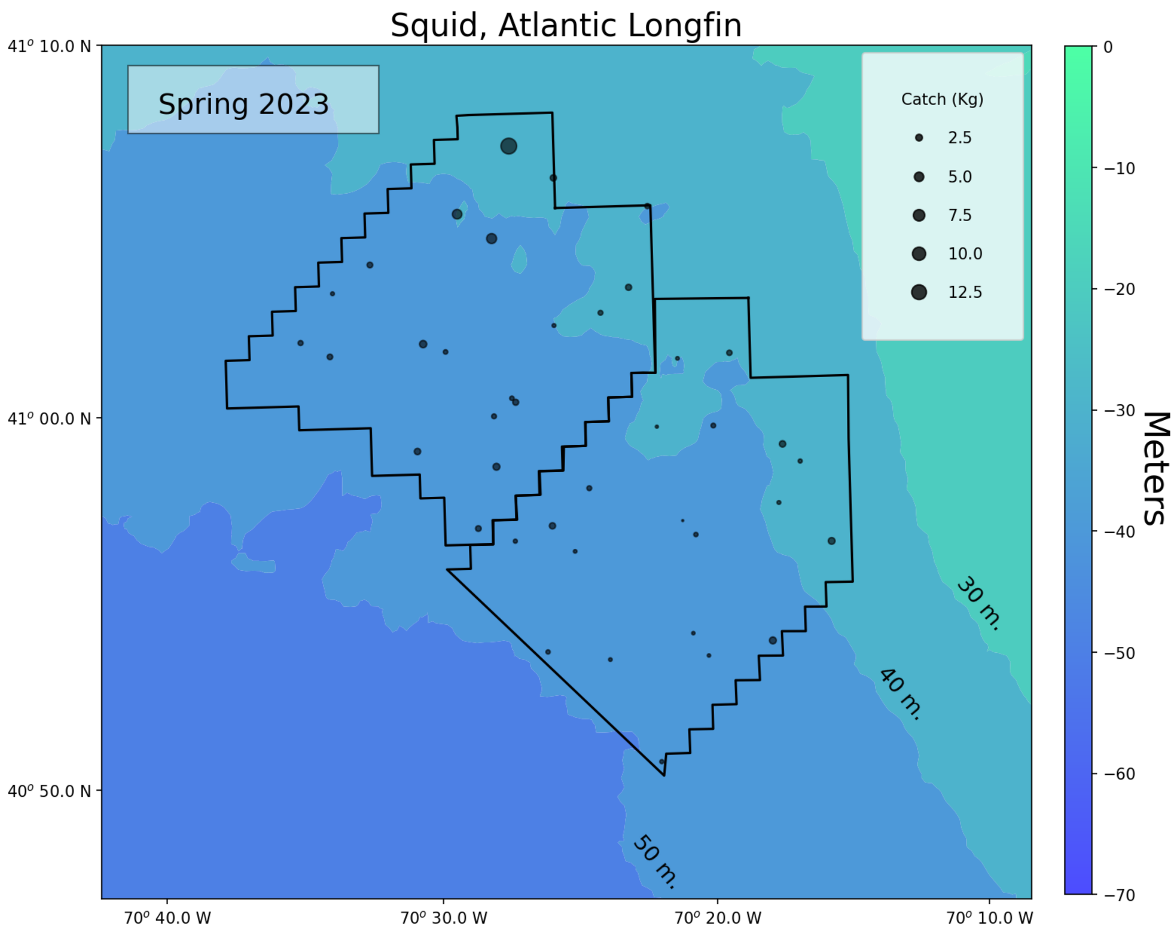
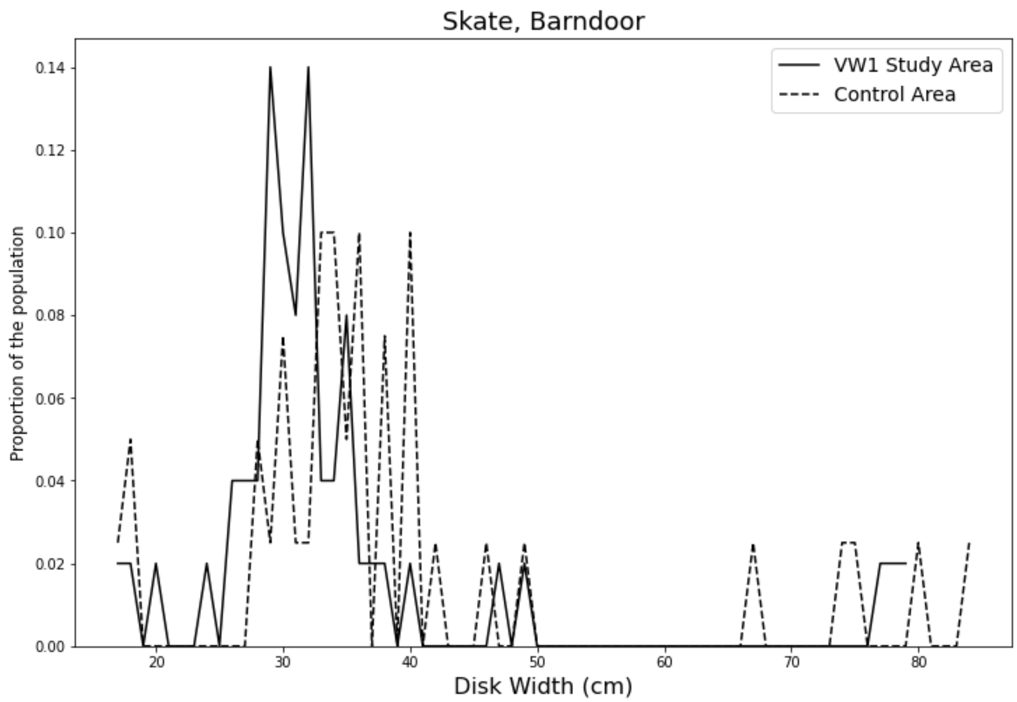


Figure 25: Distribution of the catch of Atlantic longfin squid in the VW1 Study Area (left) and Control Area (right).



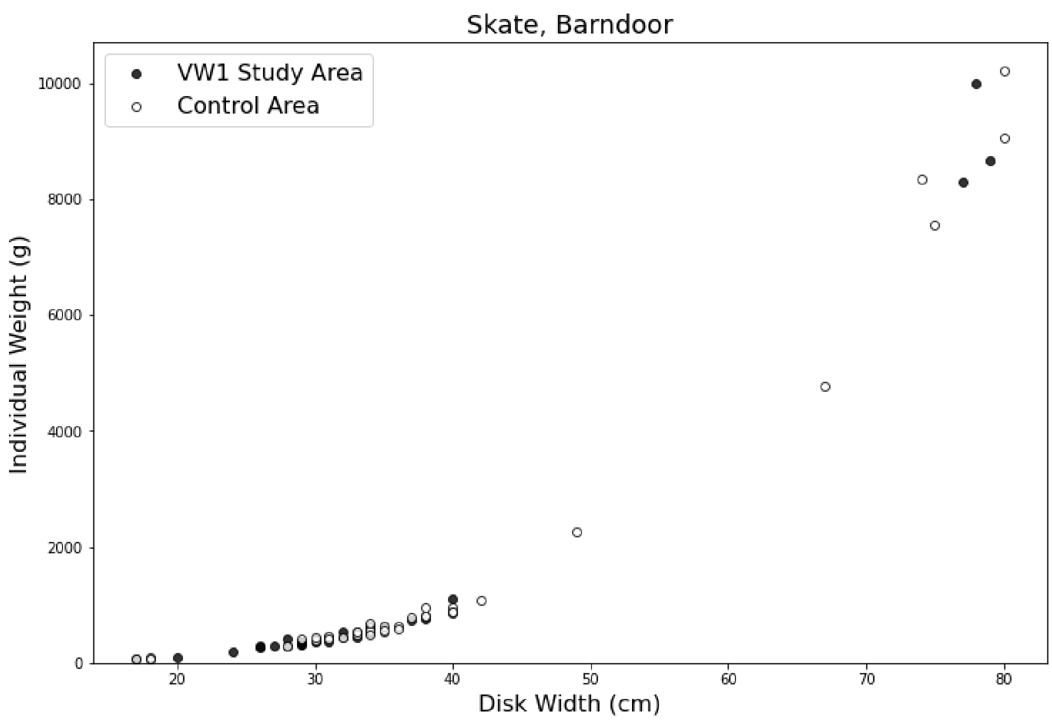


Figure 26: Population structure of barndoor skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

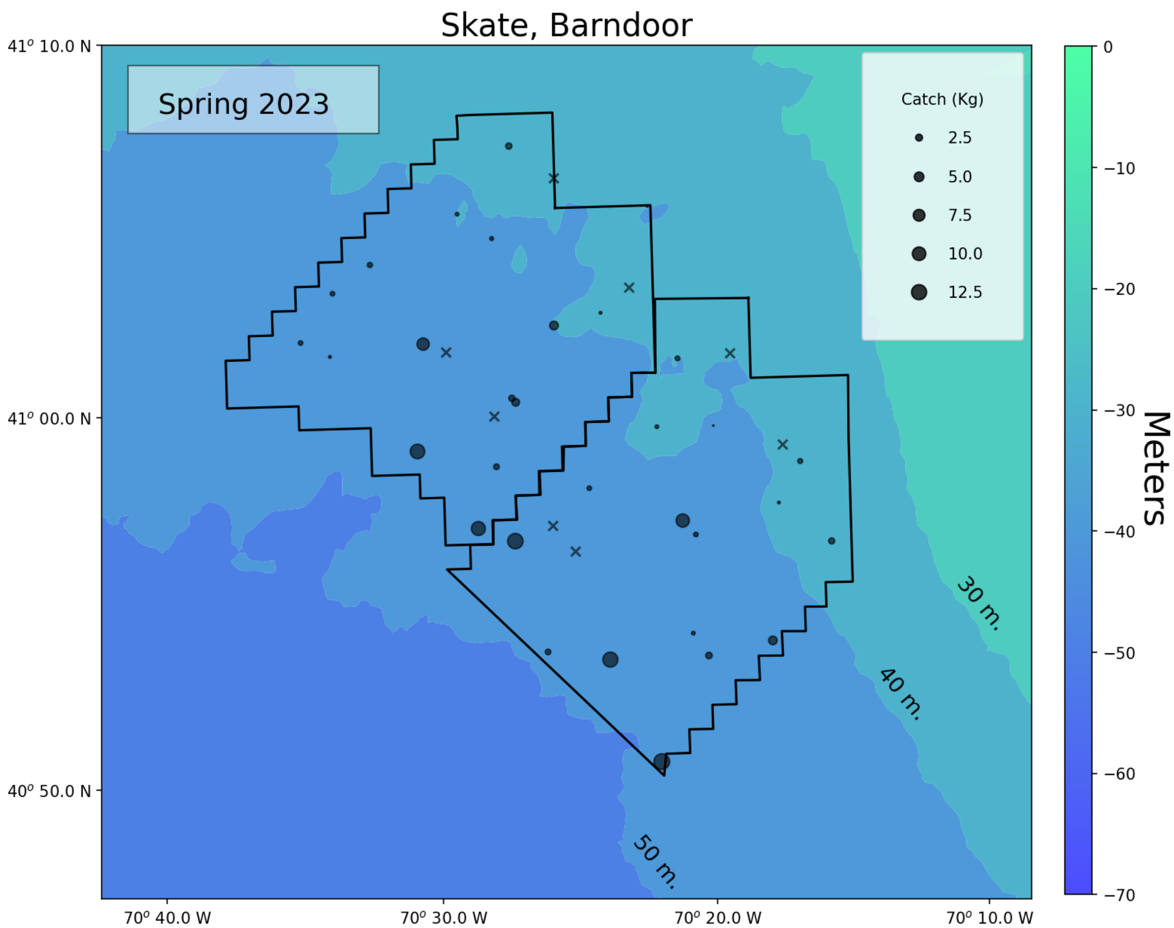
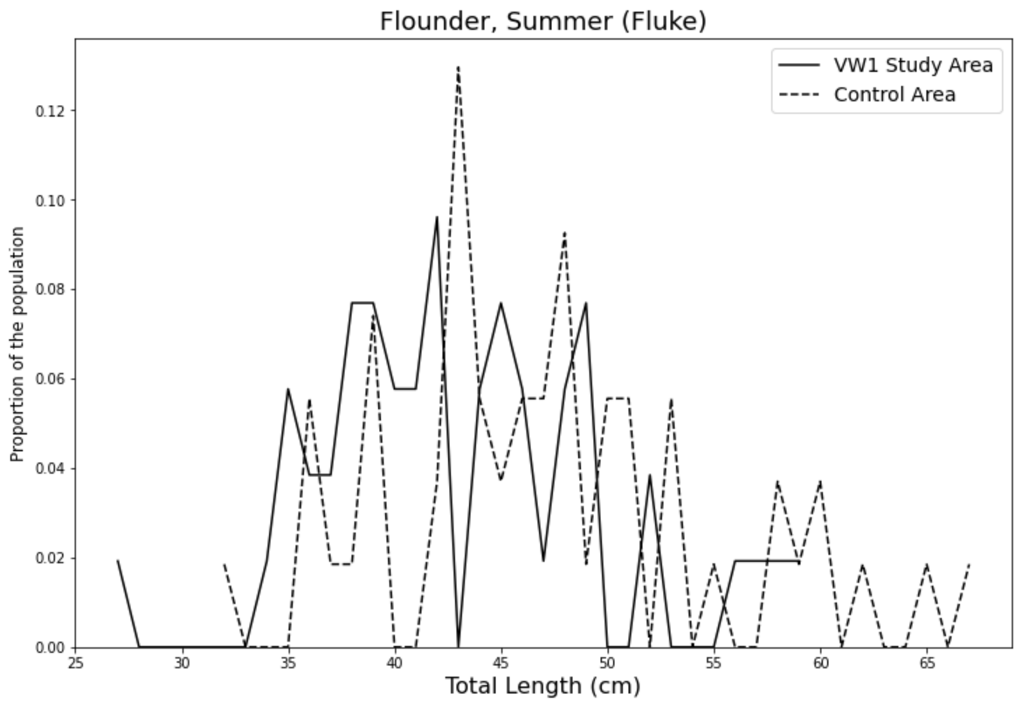


Figure 27: Distribution of the catch of barndoor skate in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



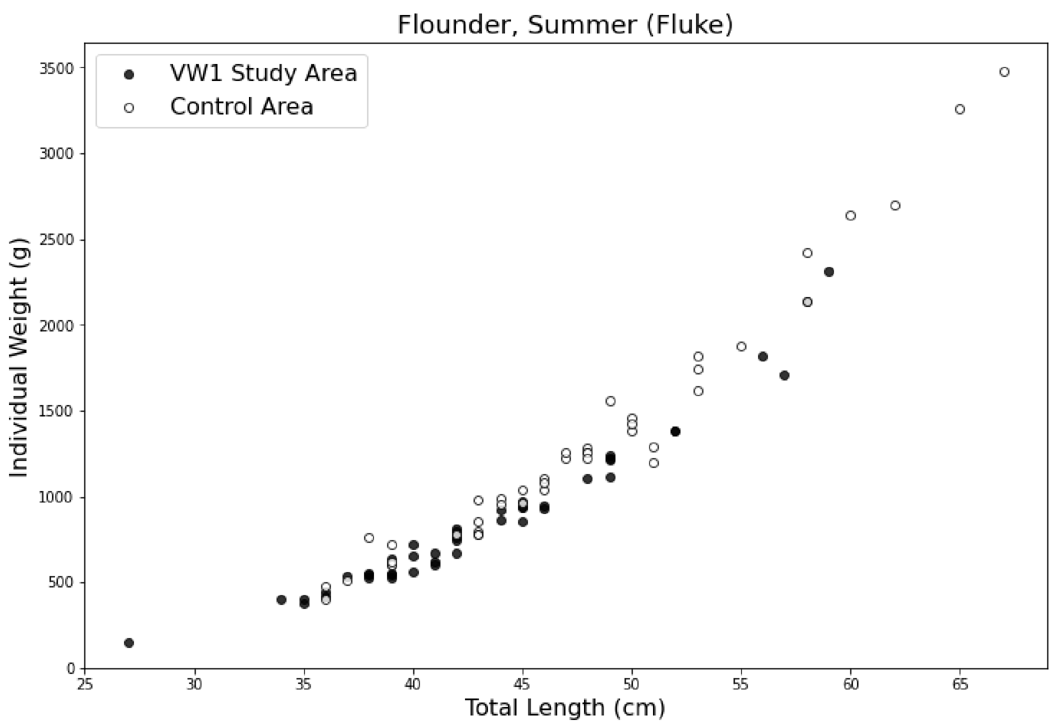


Figure 28: Population structure of summer flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

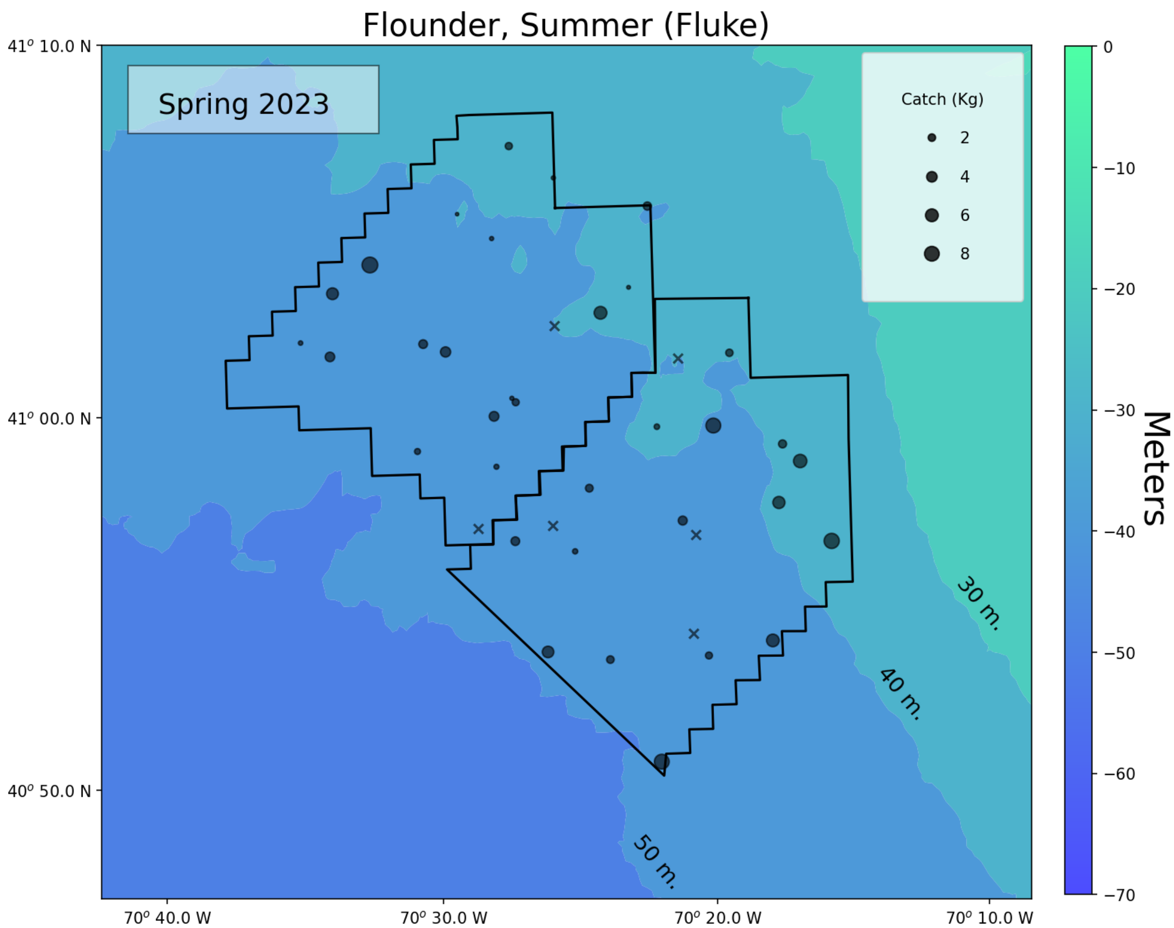
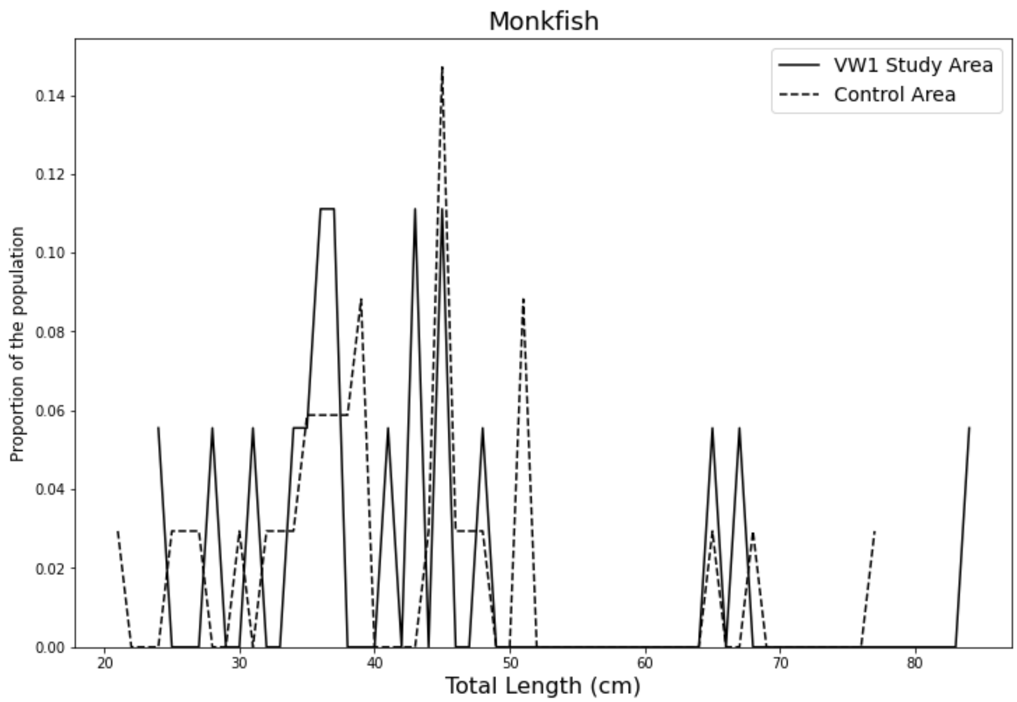


Figure 29: Distribution of the catch of summer flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



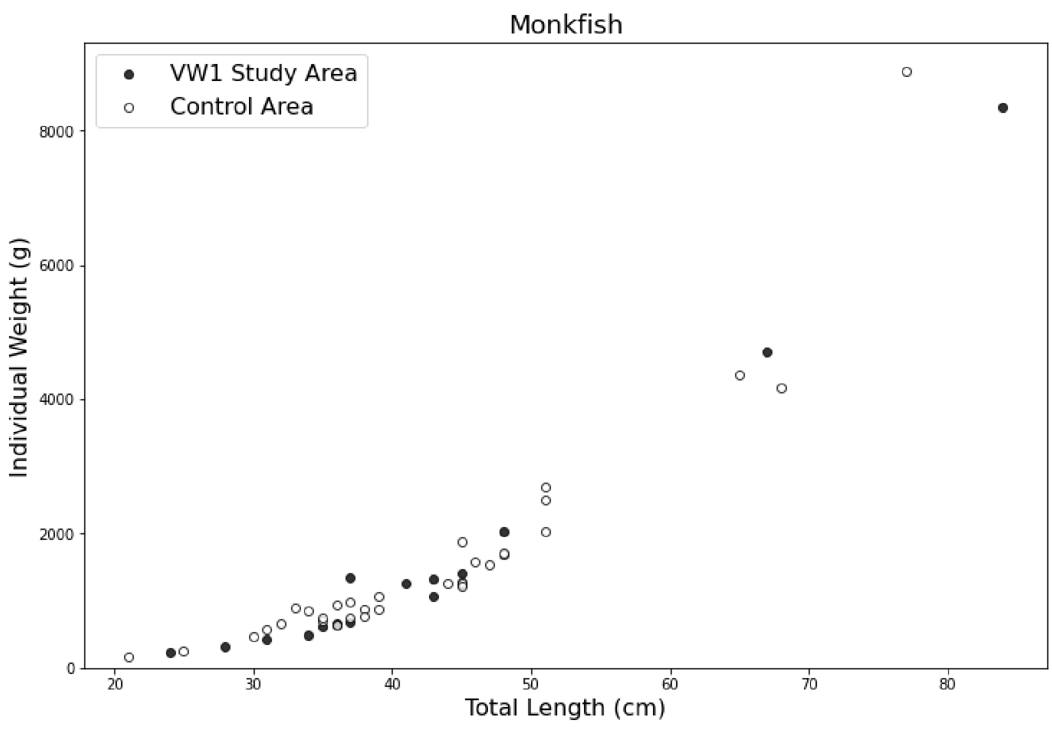


Figure 30: Population structure of monkfish in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

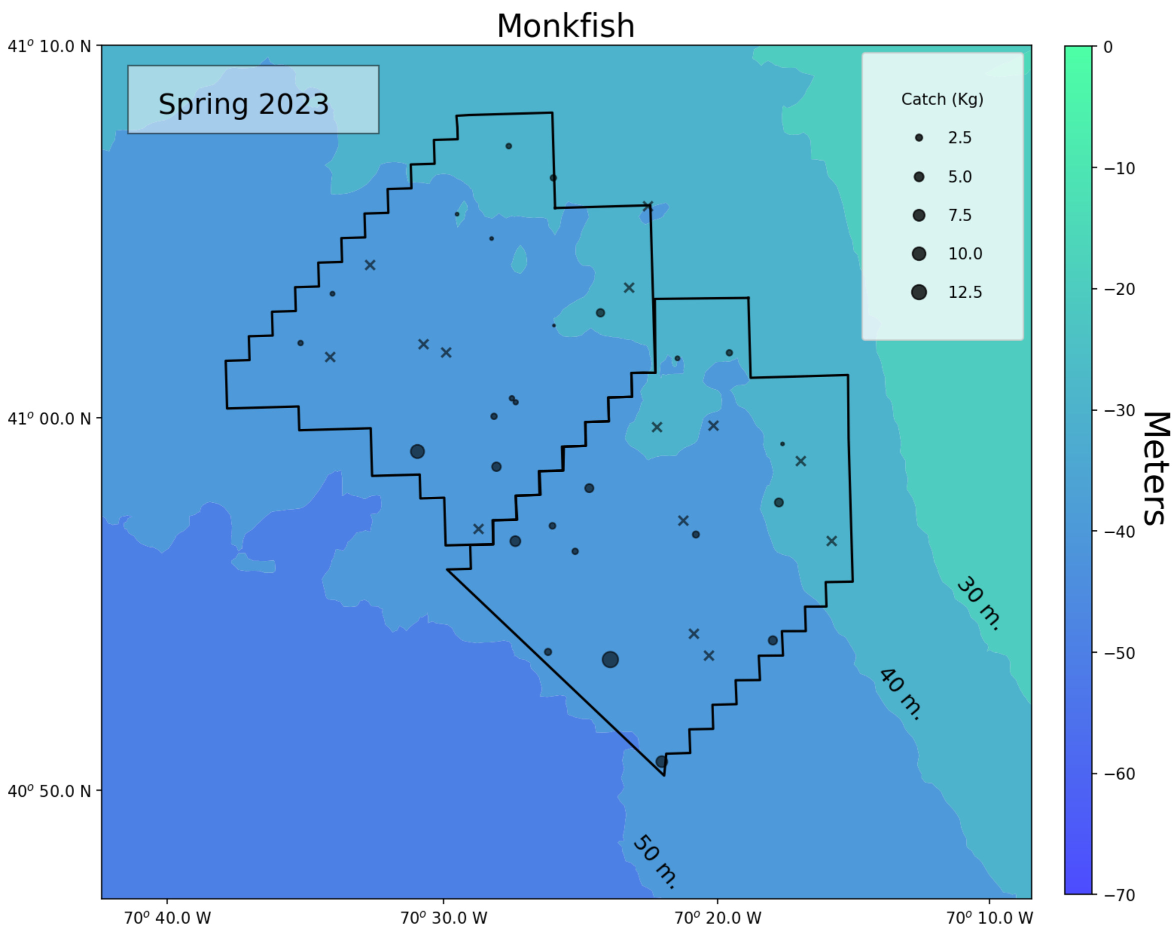
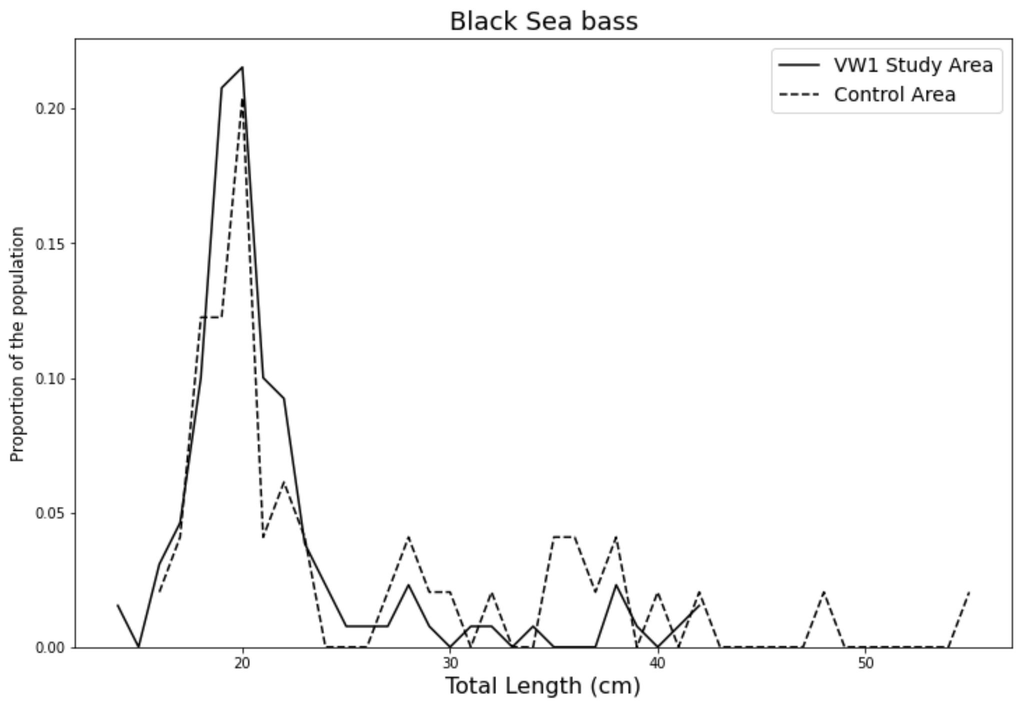


Figure 31: Distribution of the catch of monkfish in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



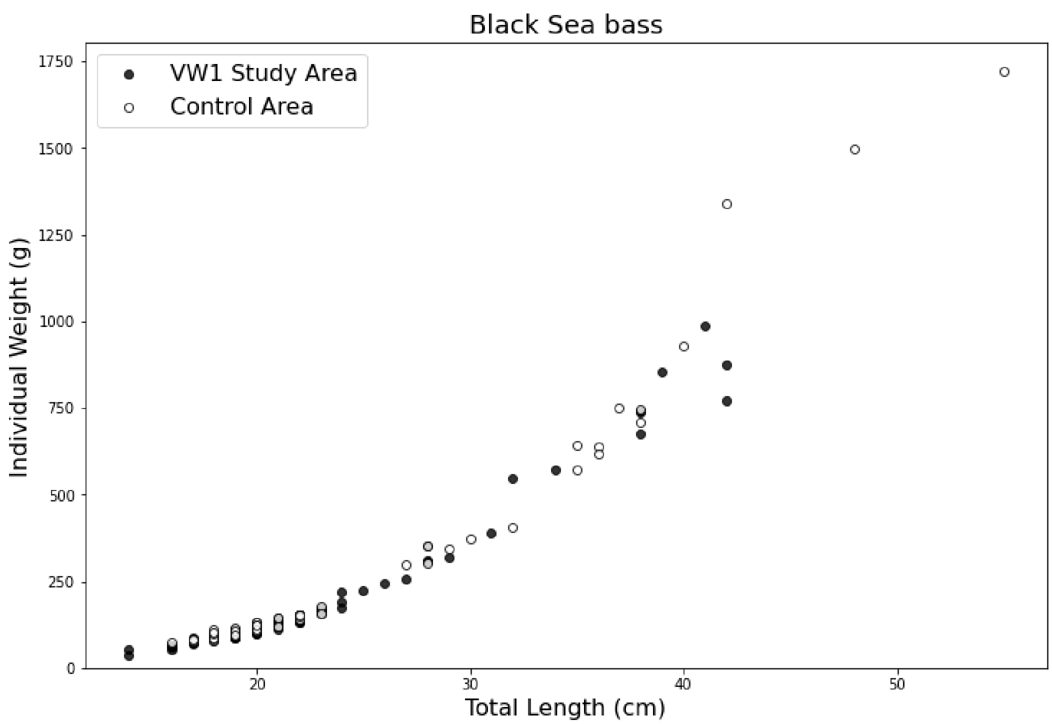


Figure 32: Population structure of black sea bass in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

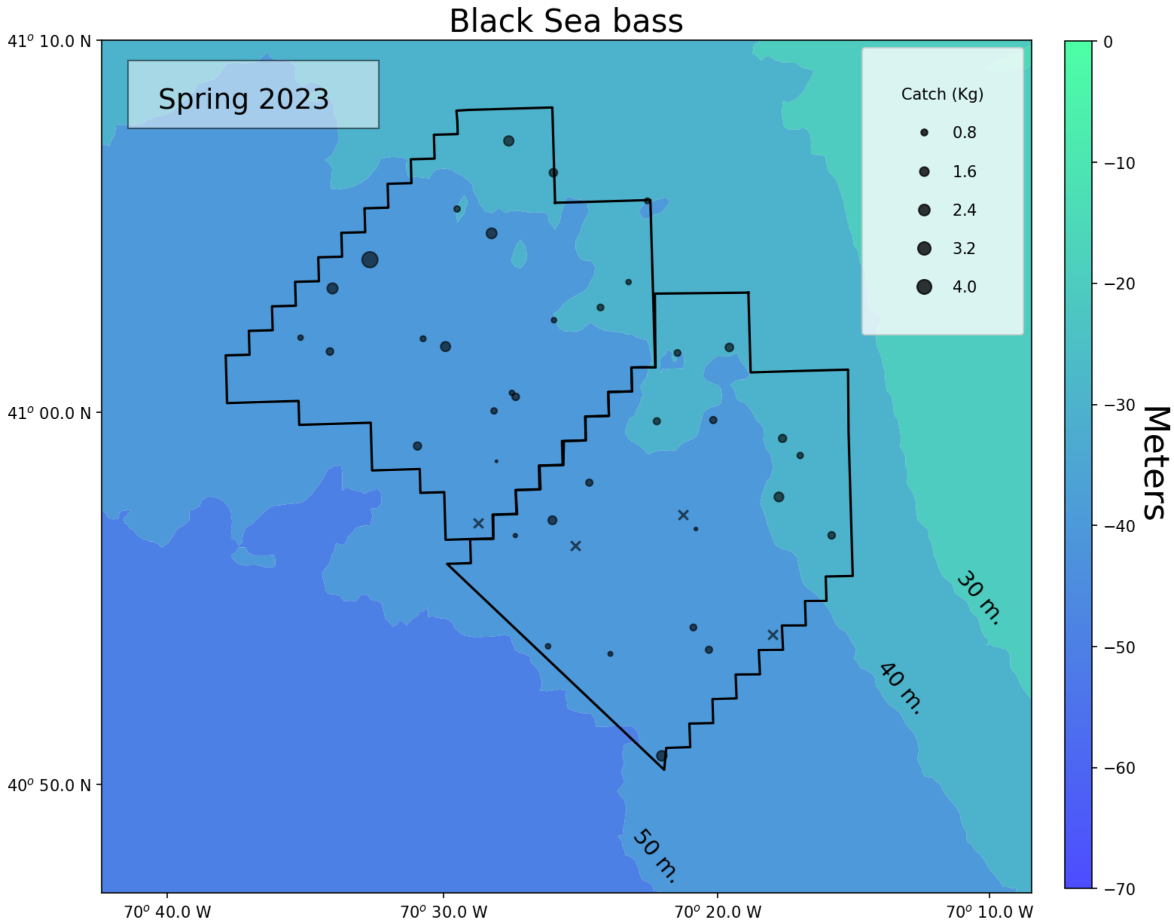
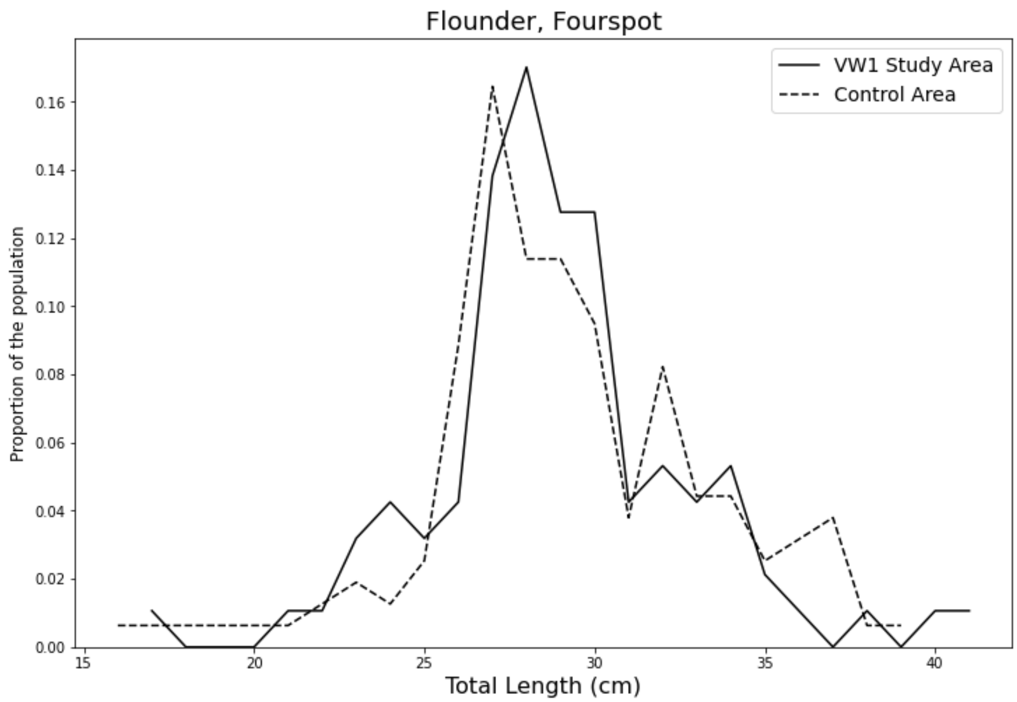


Figure 33: Distribution of the catch of black sea bass in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



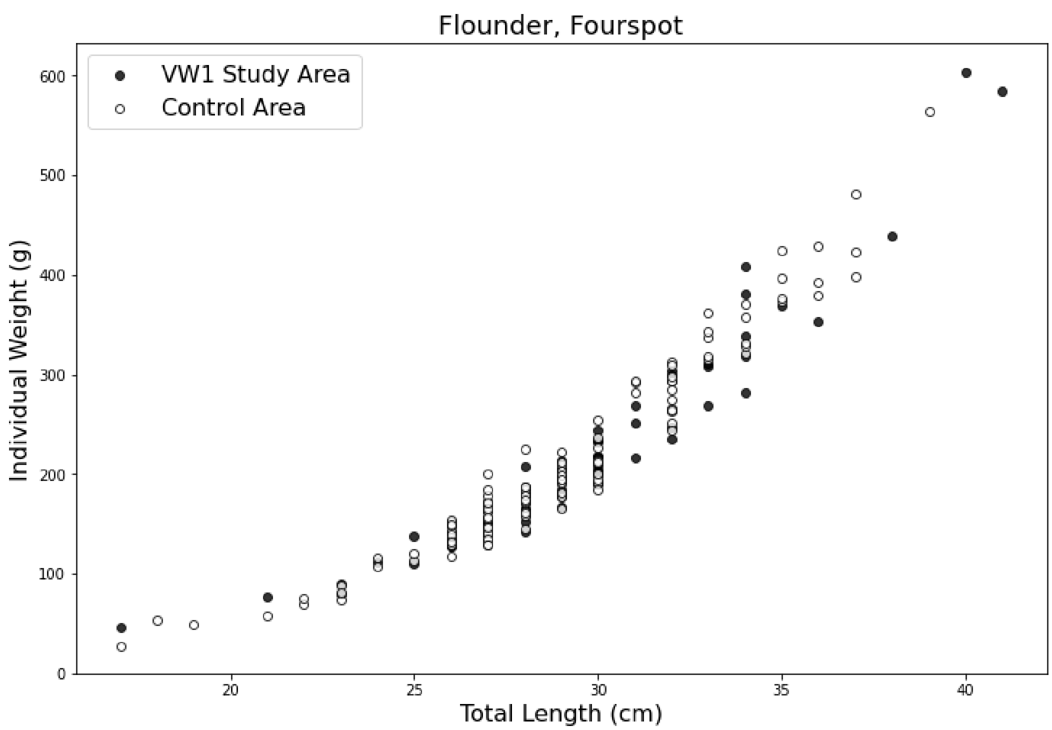


Figure 34: Population structure of fourspot flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

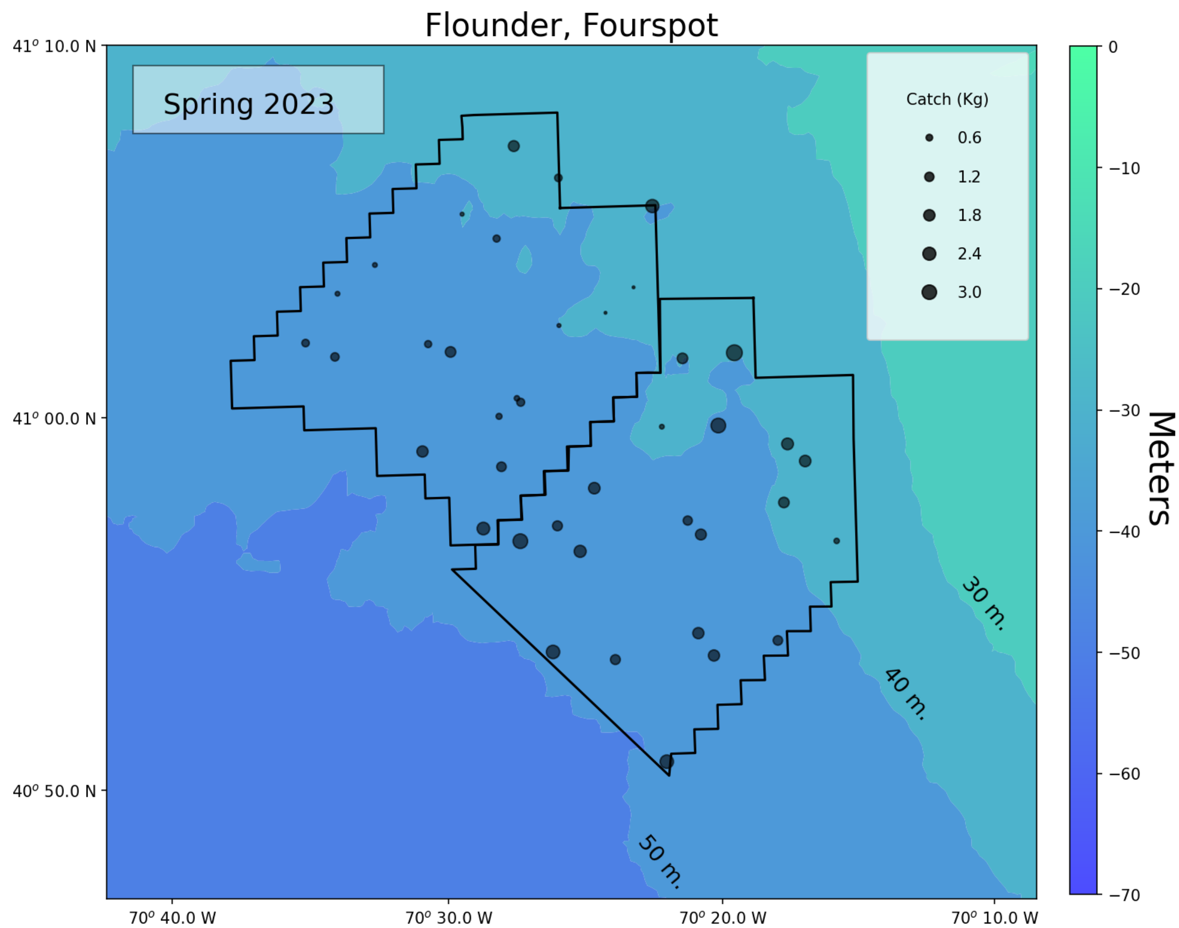
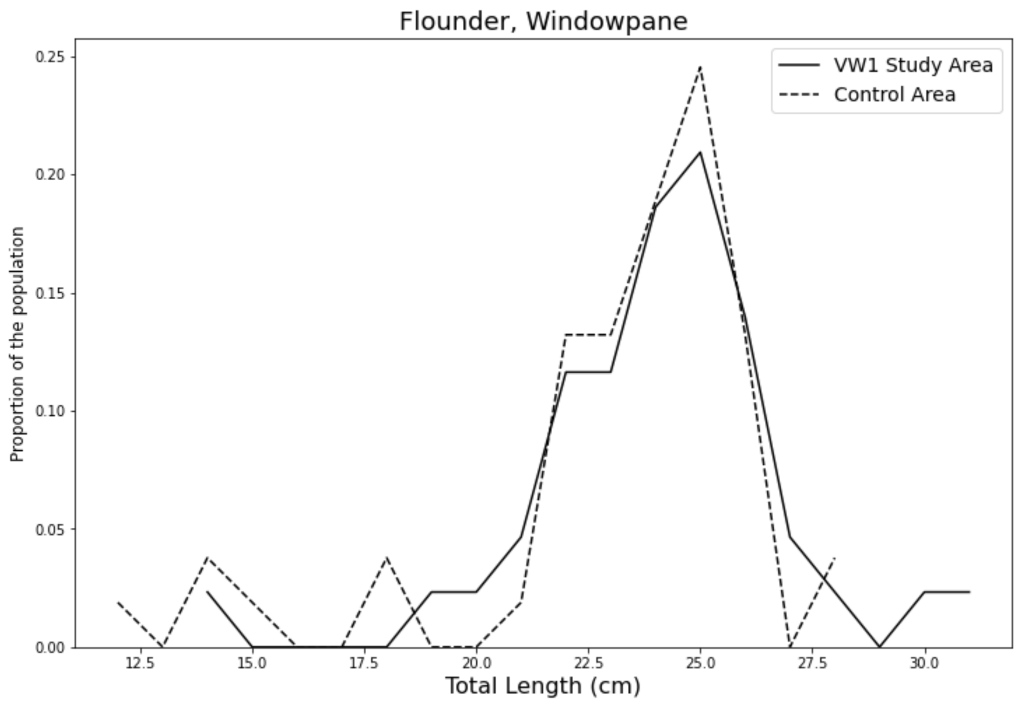


Figure 35: Distribution of the catch of fourspot flounder in the VW1 Study Area (left) and Control Area (right).



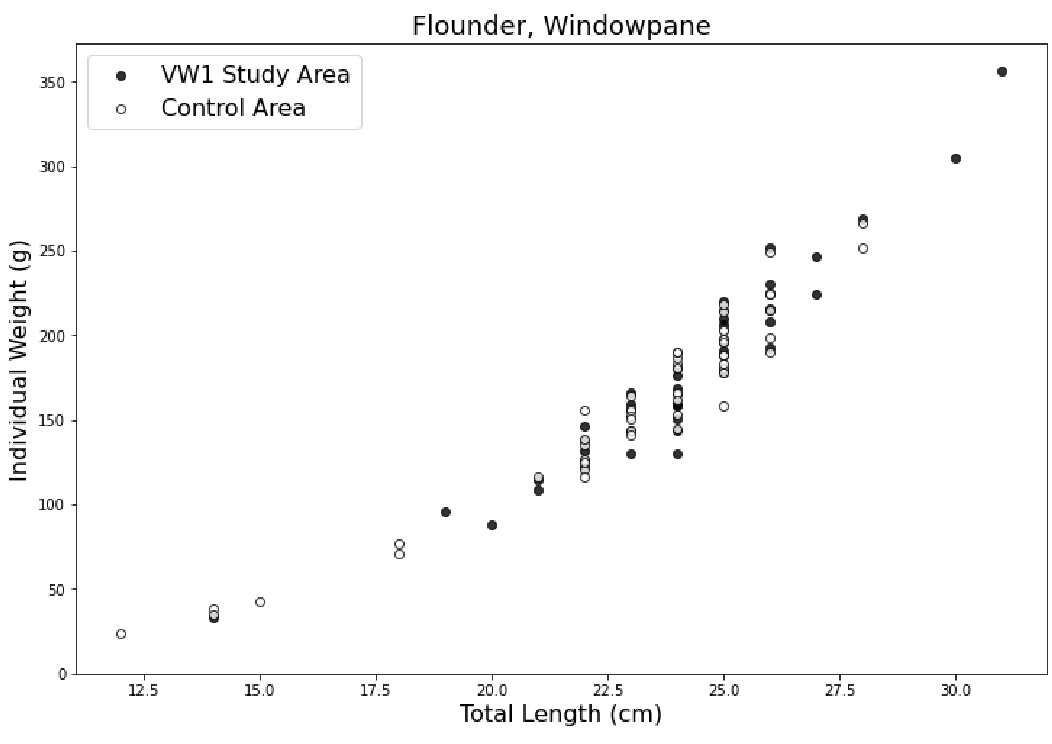


Figure 36: Population structure of windowpane flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

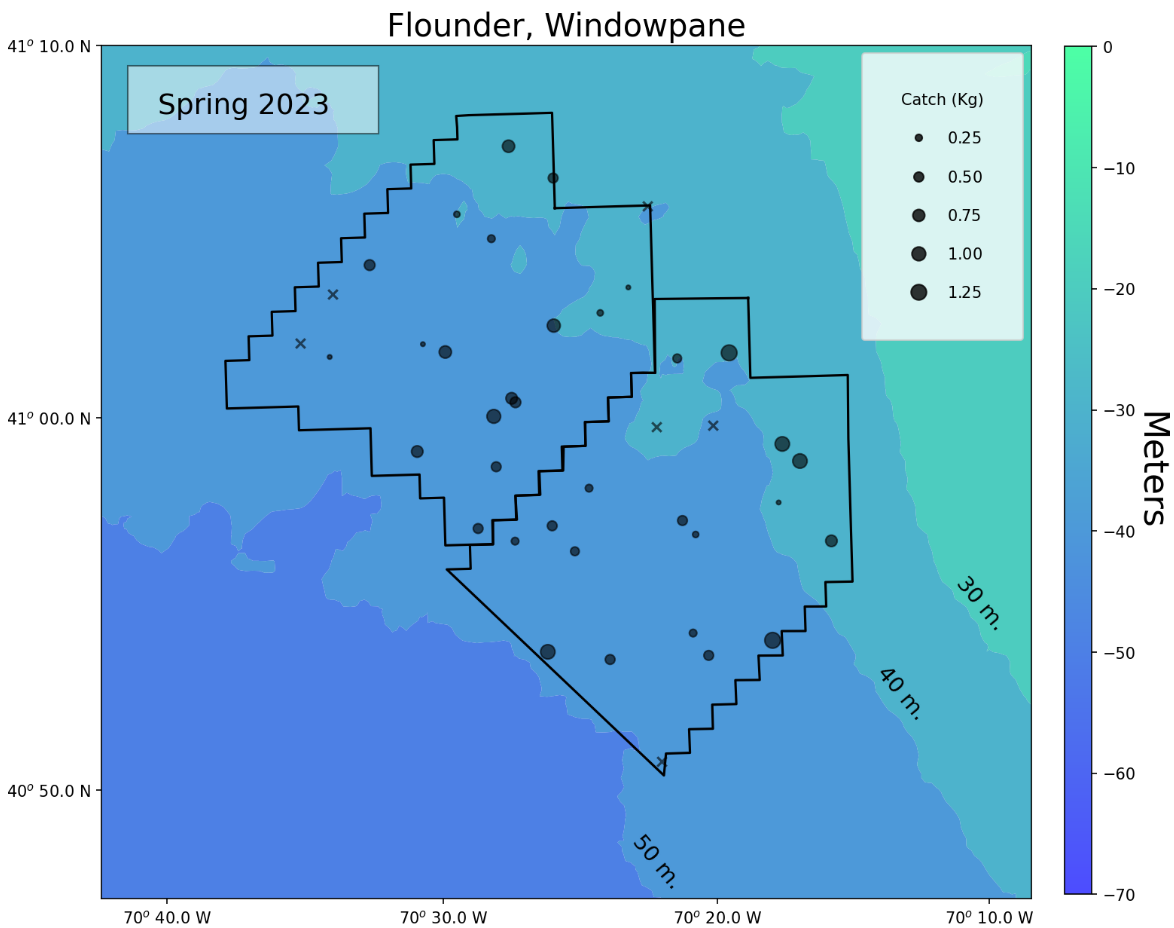


Figure 37: Distribution of the catch of windowpane flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.