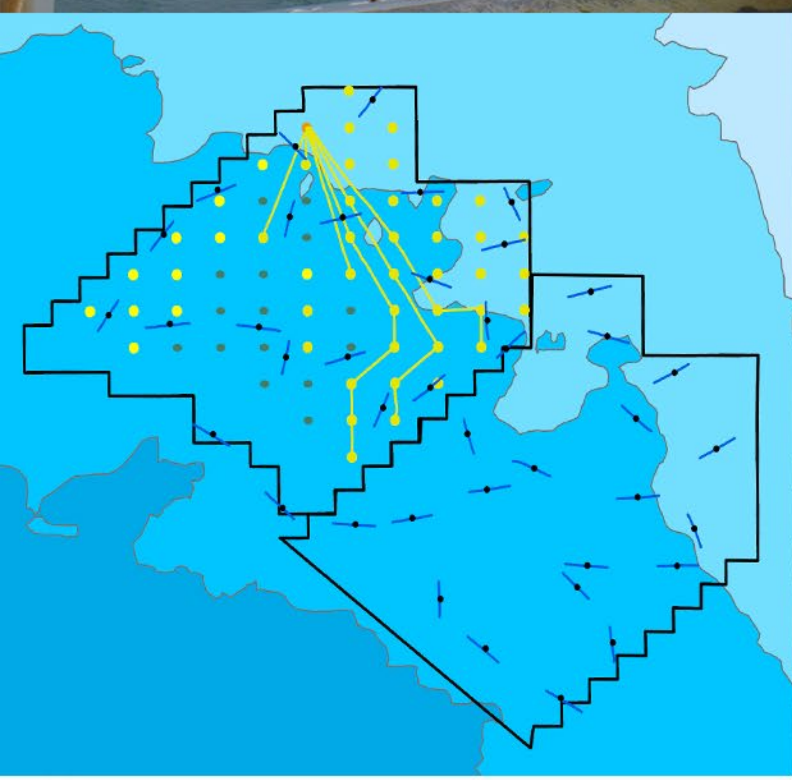
Vineyard Wind 1 Demersal Trawl Survey



Vineyard Wind 1 Study Area

Quarterly Report

Winter 2024 (January - March)

VINEYARD WIND 1 DEMERSAL TRAWL SURVEY

Winter 2024 Seasonal Report

Vineyard Wind 1 Study Area

February 2024

Prepared for Vineyard Wind 1 LLC

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Vineyard Wind 1 Demersal Trawl Survey Winter 2024 Seasonal Report

Vineyard Wind 1 Study Area

Progress Report #15

January 1 – March 31, 2024

Project title: Vineyard Wind 1 Demersal Trawl Survey Winter 2024 Seasonal Report – Vineyard Wind 1 Study Area

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SMAST-CE-REP-2024-122

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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. This includes 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 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 winter of 2024.

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 all wind turbine locations. Scour protection consists of stone and rock material (~10-30 centimeter [cm] diameter) placed around the wind turbine's foundation to minimize the removal of sediment by hydrodynamic forces. The scour protection layer was ~50 meters (m) in diameter from the center of the foundation, which makes the area untrawlable with demersal trawls. Additionally, the installation of several wind turbine foundations was underway. To address these untowable areas, alternative tow locations were created for each sub-area. If the primary tow location was located within an area with scour protection or a wind turbine foundation, 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.

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 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 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 between January 30 and February 3, 2024. 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. As previously mentioned, this survey occurred during the Vineyard Wind 1 construction phase. Prior to this survey, all the scour protection had been deposited on the seafloor for the project's wind turbines and the electrical service platform had been installed. Forty-three wind turbine foundations had been installed in Lease Area OCS-A 0501 using pile driving before this survey. Foundation installation stopped on December 16th, 2023. No additional foundations were installed during the survey. Additionally, eighteen inter-array cables had been laid and buried in the seafloor prior to the start of the survey.

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 20.0 ± 0.05 minutes (mean ± one standard deviation) in the VW1 Study Area and 19.9 ± 0.18 minutes in the Control Area. Tow distances averaged 0.97 ± 0.03 nautical miles (nmi) in the VW1 Study Area giving an average tow speed of 2.9 ± 0.08 knots. Similarly, tow distance averaged 0.97 ± 0.02 nmi in the Control Area giving an average tow speed of 2.9 ± 0.07 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 34.9 ± 0.5 m (range: 33.9 – 35.9 m) for tows in the VW1 Study Area and 34.8 ± 1.2 (range: 31.1 – 36.0 m) in the Control Area. Wing spread averaged 14.2 ± 0.3 m for tows in the

VW1 Study Area (range: 13.8 – 14.8 m) and 14.2 ± 0.4 m for tows in the Control Area (range: 13.5 – 14.9 m). Headline height averaged 5.5 ± 0.1 m for tows in the VW1 Study Area (range: 5.4 – 5.9 m) and 5.6 ± 0.2 m for tows in the Control Area (range: 5.2 – 6.0 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. Small variations in bottom water temperature were observed to vary with depth. Bottom water temperature was 5.1 – 5.3°C [41.1 – 41.5°F] in deeper tows (23 – 25 fathoms [fm] [42 – 46 m]. Slightly colder water, 4.0 – 4.2°C [39.2 – 39.6°F], was recorded in shallower tows (20 – 21 fm [37 – 38 m]). Due to technical issues with the CTD sonde on the first day of the survey, 13 cast were not collected. Subsequently, 10 casts were successfully collected in the VW1 Study Area, and 17 casts were collected in the Control Area. No thermocline was observed in the in the VW1 Study Area (Figure 8) or the Control Area (Figure 9).

3.2 Catch Data

3.2.1 VW1 Study Area

In the VW1 Study Area, a total of 23 species were caught over the duration of the survey (Table 3). Catch volume ranged from 18.6 to 222.7 kilograms per tow (kg/tow) with an average of 52.7 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. Silver hake and Atlantic herring accounted for 92.8% of the total catch weight. Data collected from this area included the catch of both adults and juveniles of most species observed.

Silver hake is a commercially important species also commonly referred to as whiting. Silver hake was the most abundant species, accounting for 49.4% of the total catch weight. Individuals ranged in length from 8 to 32 cm. Silver hake had a unimodal size distribution consisting of a peak at 14 cm (Figure 10). Silver hake were observed in all 20 tows at an average catch rate of 26.3 ± 4.3 kg/tow (mean ± Standard Error of the Mean [SEM], range: 1.1 – 84.3 kg/tow). The catch of silver hake was distributed across the VW1 Study Area (Figure 11).

Atlantic herring (*Clupea harengus*) was the second most abundant species, accounting for 43.4% of the total catch weight. Individuals ranged in length from 16 to 26 cm with a unimodal size distribution consisting of a peak at 22 cm (Figure 12). Atlantic herring were observed in 18 of the

20 tows at an average catch rate of 22.6 ± 11.5 kg/tow (range: 0 – 217.6 kg/tow). Atlantic herring were caught throughout the VW1 Study Area with the majority of the catch occurring in the northern half of the study area (Figure 13).

Longhorn sculpin (*Myoxocephalus octodecimspinosus*) was the third most abundant species caught in the VW1 Study Area. Individuals ranged in length from 22 to 36 cm with a unimodal peak between 26 and 28 cm (Figure 14). Longhorn sculpin were observed in all 20 tows at an average catch rate of 1.3 ± 0.2 kg/tow (range: 0.2 – 4.2 kg/tow). Longhorn sculpin were observed throughout the VW1 Study Area (Figure 15).

Little skate were commonly observed in the VW1 Study Area. Individuals ranged in size from 9 to 28 cm (disk width) with a unimodal size distribution consisting of a peak at 16 cm (Figure 16). Little skate were observed in 15 of the 20 tows. Catch rates averaged 0.7 ± 0.2 kg/tow (range: 0 – 3.0 kg/tow). Little skate were observed throughout the VW1 Study Area (Figure 17).

Atlantic mackerel (*Scomber scombrus*) were frequently observed in the VW1 Study Area. Individuals ranged in length from 16 to 32 cm with a unimodal size distribution peaking at 18 cm (Figure 18). Atlantic mackerel were observed in nine of the 20 tows. Catch rates averaged 0.4 ± 0.2 kg/tow (range: 0 – 2.7 kg/tow). Atlantic mackerel were primarily observed in the northern half of the VW1 Study Area (Figure 19).

Windowpane flounder is a federally regulated flatfish species frequently observed in the VW1 Study Area. Individuals ranged in length from 13 to 28 cm with a unimodal size distribution peaking at 22 cm (Figure 20). Windowpane flounder were observed in 12 of the 20 tows at an average catch rate of 0.3 ± 0.1 kg/tow (range: 0 – 1.8 kg/tow). Windowpane flounder were primarily caught in the southern half of the study area with the highest catches observed along the southern boundary (Figure 21).

Less common recreational and commercial species observed included seven individuals of monkfish (size: 14 – 21 cm), four individuals of Atlantic cod (*Gadus morhua*, size: 44 – 61 cm), three individuals of summer flounder (size: 24 – 31 cm), one individual yellowtail flounder (size: 29 cm), one individual American lobster (*Homarus americanus*), and one individual Atlantic sea scallop (*Placopecten magellanicus*).

3.2.2 Control Area

In the Control Area, a total of 25 species were caught over the duration of the survey (Table 4). Catch volume ranged from 6.6 to 143.2 kg/tow with an average of 38.6 kg/tow. The majority of the catch was primarily comprised of a small subset of the observed species. Silver hake and Atlantic herring accounted for 87.8% 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 47.8% of the total catch weight. Individuals ranged in length from 8 to 34 cm. Silver hake had a unimodal size distribution consisting of a peak at 14 cm (Figure 10). Silver hake were observed in all 20 tows at an average catch rate of 18.5 ± 3.0 kg/tow (range: 2.3 – 54.9 kg/tow). The catch of silver hake was distributed across the Control Area (Figure 11).

Atlantic herring was the second most abundant species, accounting for 40% of the total catch weight. Individuals ranged in length from 18 to 27 cm with a unimodal size distribution consisting of a peak at 21 cm (Figure 12). Atlantic herring were observed in all 20 tows at an average catch rate of 15.3 ± 8.2 kg/tow (range: 0.1 – 133.6 kg/tow). Atlantic herring were caught at low densities throughout the Control Area with two large catches observed along the northern boundary (Figure 13).

Longhorn sculpin was the third most abundant species caught in the Control Area. Individuals ranged in length from 18 to 35 cm with a unimodal peak between 26 and 28 cm (Figure 14). Longhorn sculpin were observed in 19 of the 20 tows at an average catch rate of 1.5 ± 0.2 kg/tow (range: 0 – 3.1 kg/tow). Longhorn sculpin were observed throughout the Control Area (Figure 15).

Little skate were commonly observed in the Control Area. Individuals ranged in size from 9 to 26 cm (disk width) with a wide size distribution (Figure 16). Little skate were observed in 17 of the 20 tows. Catch rates averaged 0.8 ± 0.2 kg/tow (range: 0 – 3.4 kg/tow). Little skate were observed throughout the Control Area (Figure 17).

Atlantic mackerel was frequently observed in the Control Area. Individuals ranged in length from 15 to 30 cm with a unimodal size distribution peaking at 18 cm (Figure 18). Atlantic mackerel were observed in 17 of the 20 tows. Catch rates averaged 0.8 ± 0.2 kg/tow (range: 0 – 2.4 kg/tow). Atlantic mackerel were observed to be distributed across the Control Area (Figure 19).

Windowpane flounder were frequently observed in the Control Area. Individuals ranged in length from 18 to 34 cm with a unimodal size distribution peaking at 22 cm (Figure 20). Windowpane flounder were observed in 12 of the 20 tows at an average catch rate of 0.4 ± 0.1 kg/tow (range: 0 – 1.6 kg/tow). Windowpane flounder were primarily caught in the southern half of the Control Area (Figure 21).

Less common recreational and commercial species observed included thirteen individuals of Atlantic cod (size: 20 – 45 cm), six individuals of monkfish (size: 18 – 24 cm), three individuals of summer flounder (size: 22 – 27 cm), two individuals of winter flounder (size: 30 – 35 cm), two individuals of Atlantic sea scallop, one individual yellowtail flounder (size: 35 cm), and one individual American lobster.

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	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	7:12	N° 41 07.051	W° 70 30.915	20	7:32	N° 41 06.346	W° 70 29.117	22	4.1	95
2	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	8:06	N° 41 05.627	W° 70 31.246	21	8:26	N° 41 05.171	W° 70 32.424	22	4.3	95
3	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	8:51	N° 41 04.593	W° 70 33.131	20	9:11	N° 41 03.806	W° 70 33.805	22	4.4	100
4	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	9:38	N° 41 02.406	W° 70 34.752	23	9:58	N° 41 01.578	W° 70 35.388	24	4.7	100
5	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	10:27	N° 41 01.691	W° 70 34.915	24	10:47	N° 41 01.817	W° 70 32.615	24	4.8	100
6	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	11:12	N° 41 01.790	W° 70 31.145	25	11:32	N° 41 01.638	W° 70 29.846	24	4.8	100
7	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	11:51	N° 41 01.360	W° 70 29.573	23	12:11	N° 41 00.455	W° 70 29.772	25	5.0	100
8	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	12:34	N° 41 00.745	W° 70 28.435	23	12:54	N° 41 01.088	W° 70 27.251	22	5.0	100
9	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	13:19	N° 40 59.949	W° 70 26.949	22	13:39	N° 40 59.060	W° 70 26.949	23	5.1	100
10	VW1	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	14:07	N° 40 59.776	W° 70 25.776	23	14:27	N° 41 00.479	W° 70 24.818	22	5.1	100
11	Control	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	14:56	N° 40 59.259	W° 70 24.216	22	15:16	N° 40 58.342	W° 70 23.905	22	5.1	100
12	Control	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	15:41	N° 40 58.145	W° 70 22.687	22	16:01	N° 40 57.745	W° 70 21.578	22	5.1	100
13	Control	1/31/2024	Mostly Cloudy	3-6	N	0.5-1.25	16:23	N° 40 57.467	W° 70 22.820	23	16:43	N° 40 57.283	W° 70 24.038	23	5.2	100
14	VW1	2/1/2024	Mostly Cloudy	3-6	SW	0.5-1.25	7:07	N° 40 58.481	W° 70 31.364	24	7:27	N° 40 59.043	W° 70 32.433	26	4.8	100
15	VW1	2/1/2024	Mostly Cloudy	3-6	SW	0.5-1.25	8:01	N° 40 57.201	W° 70 30.214	25	8:21	N° 40 56.491	W° 70 29.353	24	4.9	100
16	Control	2/1/2024	Mostly Cloudy	3-6	SW	0.5-1.25	8:41	N° 40 56.382	W° 70 28.141	24	9:01	N° 40 56.331	W° 70 26.883	24		100
17	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	9:28	N° 40 56.434	W° 70 26.341	24	9:48	N° 40 56.641	W° 70 25.151	23	5.1	100
18	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	10:19	N° 40 54.811	W° 70 24.932	24	10:39	N° 40 53.858	W° 70 24.892	25	5.2	100
19	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	11:09	N° 40 53.322	W° 70 24.015	25	11:29	N° 40 52.642	W° 70 23.095	25	5.2	100
20	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	11:59	N° 40 52.865	W° 70 21.606	25	12:19	N° 40 51.304	W° 70 20.527	25	5.3	100
21	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	12:47	N° 40 52.685	W° 70 19.569	24	13:07	N° 40 53.645	W° 70 19.711	23	5.3	100
22	Control	2/1/2024	Mostly Cloudy	7-10	SW	0.5-1.25	13:30	N° 40 54.403	W° 70 20.372	23	13:50	N° 40 55.101	W° 70 21.162	23	5.2	100
23	Control	2/1/2024	Mostly Cloudy	11-15	SW	0.5-1.25	14:11	N° 40 55.348	W° 70 21.075	22	14:31	N° 40 55.267	W° 70 19.803	22	5.2	100
24	Control	2/1/2024	Mostly Cloudy	11-15	SW	0.5-1.25	14:51	N° 40 55.318	W° 70 18.256	22	15:11	N° 40 55.347	W° 70 17.052	21	5.1	100
25	Control	2/1/2024	Mostly Cloudy	11-15	SW	0.5-1.25	15:29	N° 40 55.853	W° 70 16.972	20	15:49	N° 40 56.734	W° 70.17.378	20	5.1	95
26	Control	2/1/2024	Mostly Cloudy	11-15	SW	0.5-1.25	16:07	N° 40 57.247	W° 70 18.266	20	16:27	N° 40 57.148	W° 70.19.541	22	5.1	95
27	Control	2/2/2024	Overcast	3-6	NW	0.5-1.25	7:07	N° 40 58.834	W° 70 15.984	18	7:27	N° 40 58.288	W° 70.16.031	20	4.8	75
28	Control	2/2/2024	Overcast	3-6	NW	0.5-1.25	7:52	N° 40 59.101	W° 70 18.520	21	8:12	N° 40 59.693	W° 70.14.419	22	4.8	95
29	Control	2/2/2024	Overcast	3-6	NW	0.5-1.25	8:35	N° 41 00.330	W° 70 18.445	20	8:55	N° 41 00.854	W° 70.17.397	19	4.8	95
30	Control	2/2/2024	Overcast	3-6	NW	0.5-1.25	9:22	N° 41 01.419	W° 70 19.275	21	9:42	N° 41 01.723	W° 70.20.458	20	4.5	95
31	Control	2/2/2024	Rain	3-6	NW	0.5-1.25	10:13	N° 41 02.966	W° 70 19.804	20	10:33	N° 41 02.655	W° 70.21.088	21	4.4	95
32	Control	2/2/2024	Rain	3-6	NW	0.5-1.25	10:59	N° 41 01.695	W° 70 22.403	20	11:19	N° 41 00.963	W° 70.23.244	21	4.4	95
33	VW1	2/2/2024	Mostly Cloudy	3-6	NW	0.5-1.25	11:40	N° 41 01.482	W° 70 23.501	20	12:00	N° 41 02.485	W° 70.23.593	21	4.4	95
34	VW1	2/2/2024	Mostly Cloudy	3-6	NW	0.5-1.25	12:19	N° 41 02.892	W° 70 24.685	21	12:39	N° 41 03.257	W° 70.25.857	23	4.4	95
35	VW1	2/2/2024	Mostly Cloudy	3-6	NW	0.5-1.25	13:02	N° 41 03.915	W° 70 23.702	21	13:22	N° 41 04.206	W° 70.22.425	21	4.1	95
36	VW1	2/2/2024	Mostly Cloudy	3-6	NW	0.5-1.25	13:39	N° 41 04.754	W° 70 22.591	20	13:59	N° 41 05.616	W° 70.23.063	20	4.2	95
37	VW1	2/2/2024	Mostly Cloudy	3-6	NW	0.5-1.25	14:20	N° 41 05.498	W° 70 24.930	21	14:40	N° 41 05.451	W° 70.26.186	21	4.1	95
38	VW1	2/2/2024	Mostly Cloudy	7-10	NW	0.5-1.25	15:01	N° 41 04.870	W° 70 27.438	21	15:21	N° 41 04.594	W° 70.28.594	21	4.6	95
39	VW1	2/2/2024	Mostly Cloudy	11-15	NW	0.5-1.25	15:42	N° 41 04.251	W° 70 29.719	22	16:02	N° 41 05.189	W° 70.29.453	21	4.7	100
40	VW1	2/2/2024	Mostly Cloudy	11-15	NW	0.5-1.25	16:35	N° 41 07.533	W° 70 27.512	21	16:55	N° 41 08.332	W° 70.26.838	20	4.0	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	20.0	0.94	2.8	20	4.1	95	5.6	14.2	35.4
2	VW1	20.2	0.98	2.9	21	4.3	95	5.5	14.0	34.9
3	VW1	20.0	0.94	2.8	20	4.4	100	5.6	14.0	35.0
4	VW1	20.0	0.96	2.9	23	4.7	100	5.5	14.1	35.4
5	VW1	20.1	1.00	3.0	24	4.8	100	5.5	14.1	35.9
6	VW1	20.1	1.01	3.0	25	4.8	100	5.6	14.1	35.4
7	VW1	20.0	0.92	2.8	23	5.0	100	5.6	13.9	34.8
8	VW1	20.0	0.97	2.9	23	5.0	100	5.9	13.8	33.9
9	VW1	20.0	0.96	2.9	22	5.1	100	5.4	14.0	35.2
10	VW1	20.0	1.00	3.0	23	5.1	100	5.5	14.0	35.0
11	Control	19.5	0.96	3.0	22	5.1	100	5.6	14.6	34.9
12	Control	20.0	0.95	2.8	22	5.1	100	5.7	14.9	34.5
13	Control	20.0	0.96	2.9	23	5.2	100	5.7	14.3	34.7
14	VW1	20.0	0.99	3.0	24	4.8	100	5.5	14.8	35.4
15	VW1	20.0	0.98	2.9	25	4.9	100	5.5	14.3	35.8
16	Control	20.0	0.97	2.9	24		100	5.2	14.3	35.8
17	Control	20.0	0.94	2.8	24	5.1	100	5.6	14.1	35.5
18	Control	20.0	0.96	2.9	24	5.2	100	5.5	14.3	35.7
19	Control	20.0	0.99	3.0	25	5.2	100	5.6	14.2	35.7
20	Control	20.0	1.00	3.0	25	5.3	100	5.6	14.2	36.0
21	Control	20.0	0.97	2.9	24	5.3	100	5.4	14.1	35.6
22	Control	20.0	0.93	2.8	23	5.2	100	5.4	14.0	35.6
23	Control	20.0	0.98	2.9	22	5.2	100	5.8	13.9	34.6
24	Control	19.5	0.94	2.9	22	5.1	100	5.8	13.7	34.3
25	Control	19.5	0.94	2.9	20	5.1	95	5.3		35.7
26	Control	20.0	0.98	2.9	20	5.1	95	5.5	14.4	35.1
27	Control	20.0	0.97	2.9	18	4.8	75	6.0	13.5	32.8
28	Control	20.0	0.98	2.9	21	4.8	95	5.5	13.7	34.5
29	Control	20.0	0.95	2.9	20	4.8	95	5.4	14.3	35.0
30	Control	20.0	0.97	2.9	21	4.5	95	5.7	14.1	33.8
31	Control	20.0	1.03	3.1	20	4.4	95	5.8	13.6	31.1
32	Control	20.0	0.97	2.9	20	4.4	95	5.5	14.6	34.7
33	VW1	20.0	1.01	3.0	20	4.4	95	5.5	14.6	34.5
34	VW1	20.0	0.97	2.9	21	4.4	95	5.4	14.3	34.5
35	VW1	20.0	1.02	3.1	21	4.1	95	5.6	14.6	34.6
36	VW1	20.0	0.95	2.9	20	4.2	95	5.4	14.5	33.9
37	VW1	20.0	0.96	2.9	21	4.1	95	5.4	14.4	34.7
38	VW1	19.9	0.97	2.9	21	4.6	95	5.4	14.5	34.7
39	VW1	20.0	0.98	2.9	22	4.7	100	5.5	14.7	34.9
40	VW1	20.0	0.95	2.9	21	4.0	95	5.5	13.9	34.9
Summary Statistics										
Control	Minimum	19.5	0.93	2.8	18.0	4.4	75.0	5.2	13.5	31.1
	Maximum	20.0	1.03	3.1	25.0	5.3	100.0	6.0	14.9	36.0
	Average	19.9	0.97	2.9	22.0	5.0	97.0	5.6	14.2	34.8
	St. Dev	0.18	0.02	0.07	2.0	0.3	5.7	0.2	0.4	1.2
VW1	Minimum	19.9	0.92	2.8	20.0	4.0	95.0	5.4	13.8	33.9
	Maximum	20.2	1.02	3.1	25.0	5.1	100.0	5.9	14.8	35.9
	Average	20.0	0.97	2.9	22.0	4.6	97.8	5.5	14.2	34.9
	St. Dev.	0.05	0.03	0.08	1.7	0.4	2.6	0.1	0.3	0.5

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*		
Hake, Silver (Whiting)	*Merluccius bilinearis*	535.0	26.3	4.3	49.4	20
Herring, Atlantic	*Clupea harengus*	469.2	22.6	11.5	43.4	18
Sculpin, Longhorn	*Myoxocephalus octodecimspinosus*	25.8	1.3	0.2	2.4	20
Skate, Little	*Leucoraja erinacea*	14.1	0.7	0.2	1.3	15
Mackerel, Atlantic	*Scomber scombrus*	8.2	0.4	0.2	0.8	9
Flounder, Windowpane	*Scophtalmus aquosus*	6.7	0.3	0.1	0.6	12
Atlantic Cod	*Gadus morhua*	5.4	0.3	0.2	0.5	3
Herring, Blueback	*Alosa aestivalis*	3.5	0.2	0.1	0.3	11
Alewife	*Alosa pseudoharengus*	2.3	0.1	0.0	0.2	11
Hake, Spotted	*Urophycis regia*	2.0	0.1	0.0	0.2	7
Monkfish	*Lophius americanus*	1.8	0.1	0.0	0.2	6
Crab, Rock	*Cancer irroratus*	1.7	0.1	0.0	0.2	6
Dogfish, Spiny	*Squalus acanthias*	1.6	0.1	0.1	0.1	1
Shad, American	*Alosa sapidissima*	1.2	0.1	0.02	0.1	7
Lobster, American	*Homarus americanus*	0.9	0.05	0.05	0.1	1
Flounder, Summer (Fluke)	*Paralichthys dentatus*	0.8	0.04	0.02	0.1	3
Hake, Red	*Urophycis chuss*	0.6	0.03	0.01	0.1	6
Butterfish	*Peprilus triacanthus*	0.3	0.02	0.01	0.03	3
Flounder, Gulfstream	*Citharichthys arctifrons*	0.3	0.01	0.01	0.03	3
Flounder, Yellowtail	*Pleuronectes ferrugineus*	0.3	0.01	0.01	0.03	1
Ocean Pout	*Zoarces americanus*	0.2	0.01	0.01	0.02	1
Menhaden, Atlantic	*Brevoortia tyrannus*	0.1	0.005	0.005	0.01	1
Sea Scallop, Atlantic	*Placopecten magellanicus*	0.1	0.00	0.01	0.01	1
Total		1082.1				

*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	375.7	18.5	3.0	47.8	20
Herring, Atlantic	Clupea harengus	314.6	15.3	8.2	40.0	20
Sculpin, Longhorn	Myoxocephalus octodecimspinosus	30.1	1.5	0.2	3.8	19
Skate, Little	Leucoraja erinacea	16.4	0.8	0.2	2.1	17
Mackerel, Atlantic	Scomber scombrus	15.9	0.8	0.2	2.0	17
Flounder, Windowpane	Scophtalmus aquosus	8.3	0.4	0.1	1.1	12
Herring, Blueback	Alosa aestivalis	7.4	0.4	0.1	0.9	13
Atlantic Cod	Gadus morhua	5.5	0.3	0.1	0.7	8
Monkfish	Lophius americanus	2.7	0.1	0.1	0.3	8
Alewife	Alosa pseudoharengus	2.5	0.1	0.0	0.3	10
Dogfish, Spiny	Squalus acanthias	2.2	0.1	0.1	0.3	1
Flounder, Winter	Pleuronectes americanus	1.0	0.05	0.03	0.1	2
Butterfish	Peprilus triacanthus	0.6	0.03	0.01	0.1	5
Hake, Spotted	Urophycis regia	0.5	0.02	0.01	0.1	3
Menhaden, Atlantic	Brevoortia tyrannus	0.5	0.02	0.02	0.1	2
Shad, American	Alosa sapidissima	0.5	0.02	0.01	0.1	4
Hake, Red	Urophycis chuss	0.5	0.02	0.01	0.1	4
Sea Raven	Hemitripterus americanus	0.4	0.02	0.02	0.1	1
Flounder, Summer (Fluke)	Paralichthys dentatus	0.4	0.02	0.01	0.1	3
Flounder, Yellowtail	Pleuronectes ferrugineus	0.3	0.01	0.01	0.04	1
Sea Scallop, Atlantic	Placopecten magellanicus	0.2	0.01	0.01	0.03	2
Squid, Atlantic Longfin	Dorytheuthis pealei	0.2	0.01	0.01	0.03	1
Crab, Rock	Cancer irroratus	0.2	0.01	0.01	0.03	2
Lobster, American	Homarus americanus	0.1	0.005	0.01	0.01	1
Flounder, Gulfstream	Citharichthys arctifrons	0.1	0.005	0.01	0.01	1
Total		786.8				

*SEM - Standard Error of the Mean

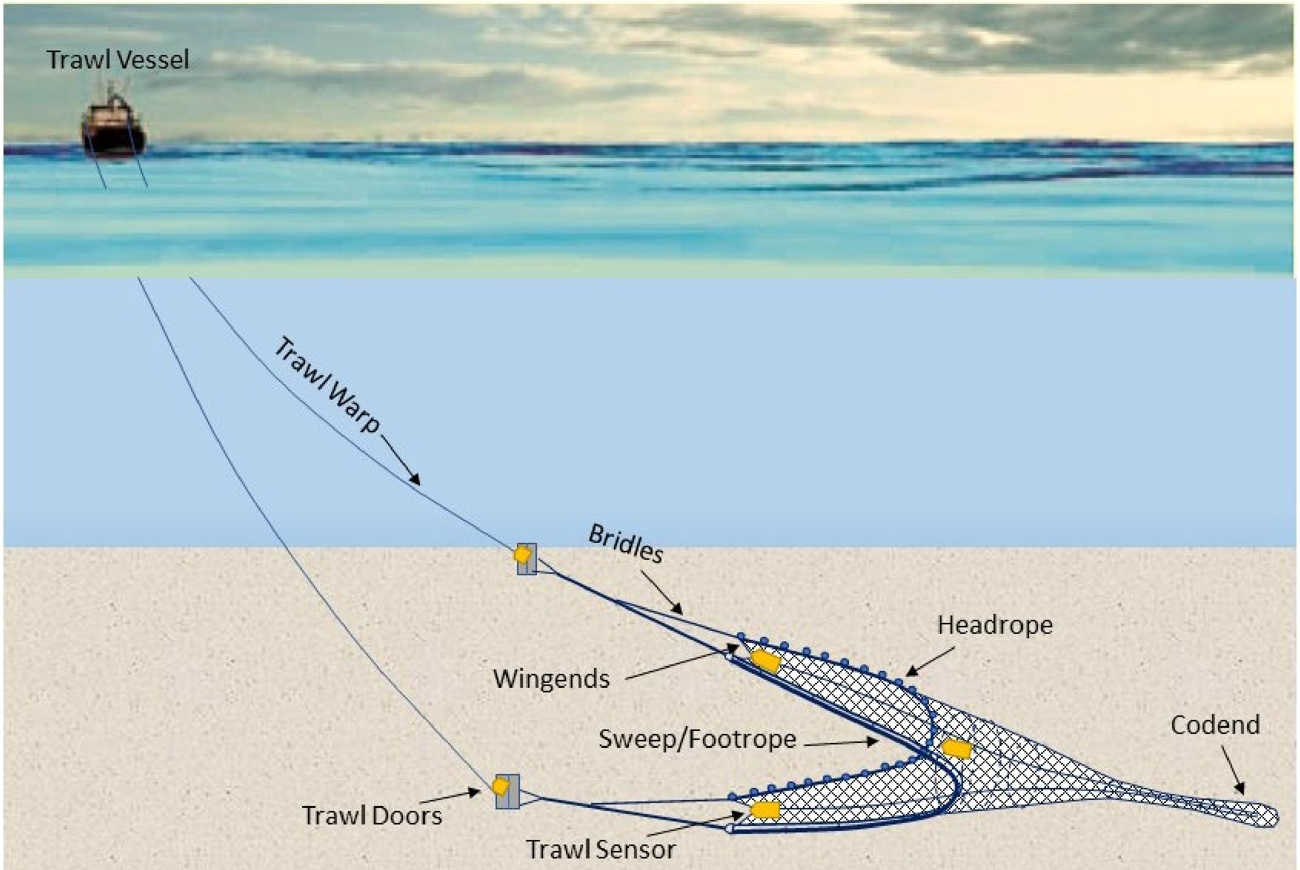


Figure 1: General schematic (not to scale) of a demersal otter trawl. Yellow rectangles indicate Simrad PX trawl geometry sensors.

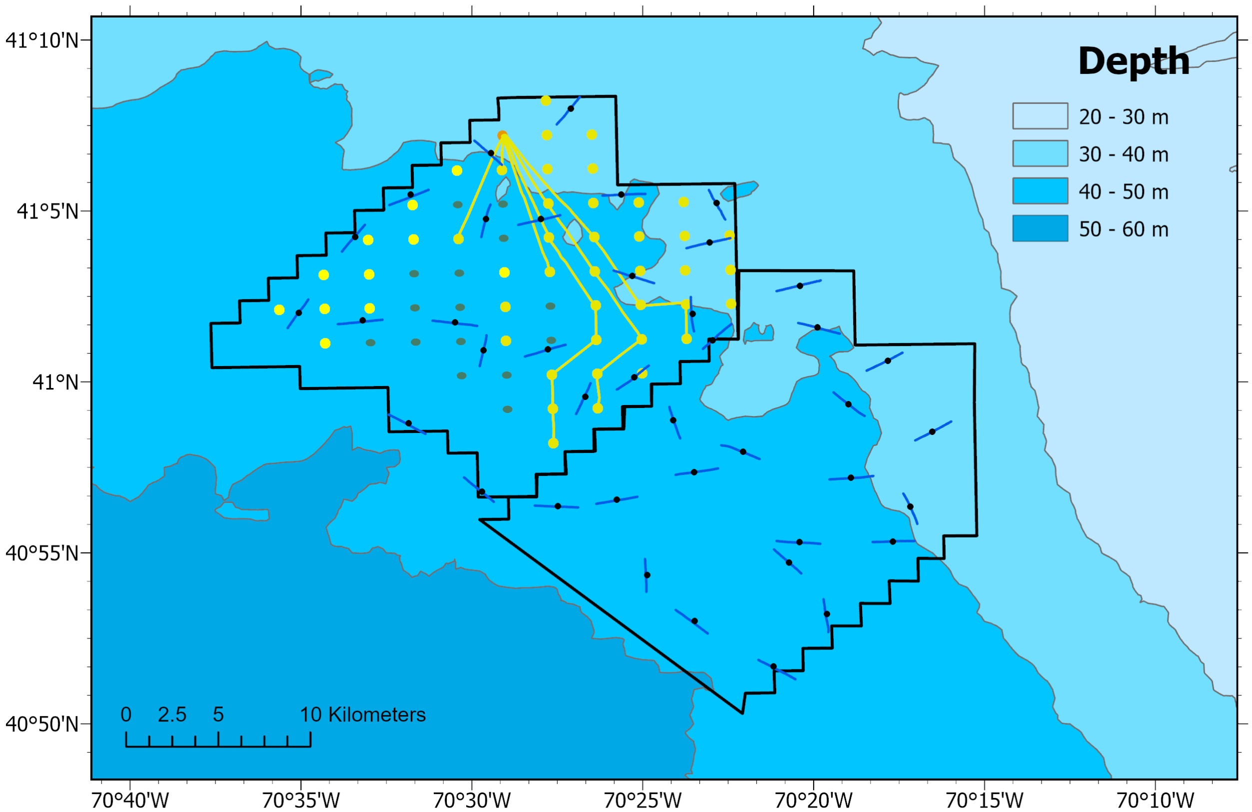


Figure 2: Tow locations (black dots) and trawl tracks (blue lines) from the VW1 Study Area (left) and the Control Area (right). Prior to the start of the survey, scour protection (gray dots) had been installed in all wind turbine locations. The electrical service platform (orange dot) in addition to select wind turbine foundations (yellow dots) and inter-array cables (yellow lines) had been installed.

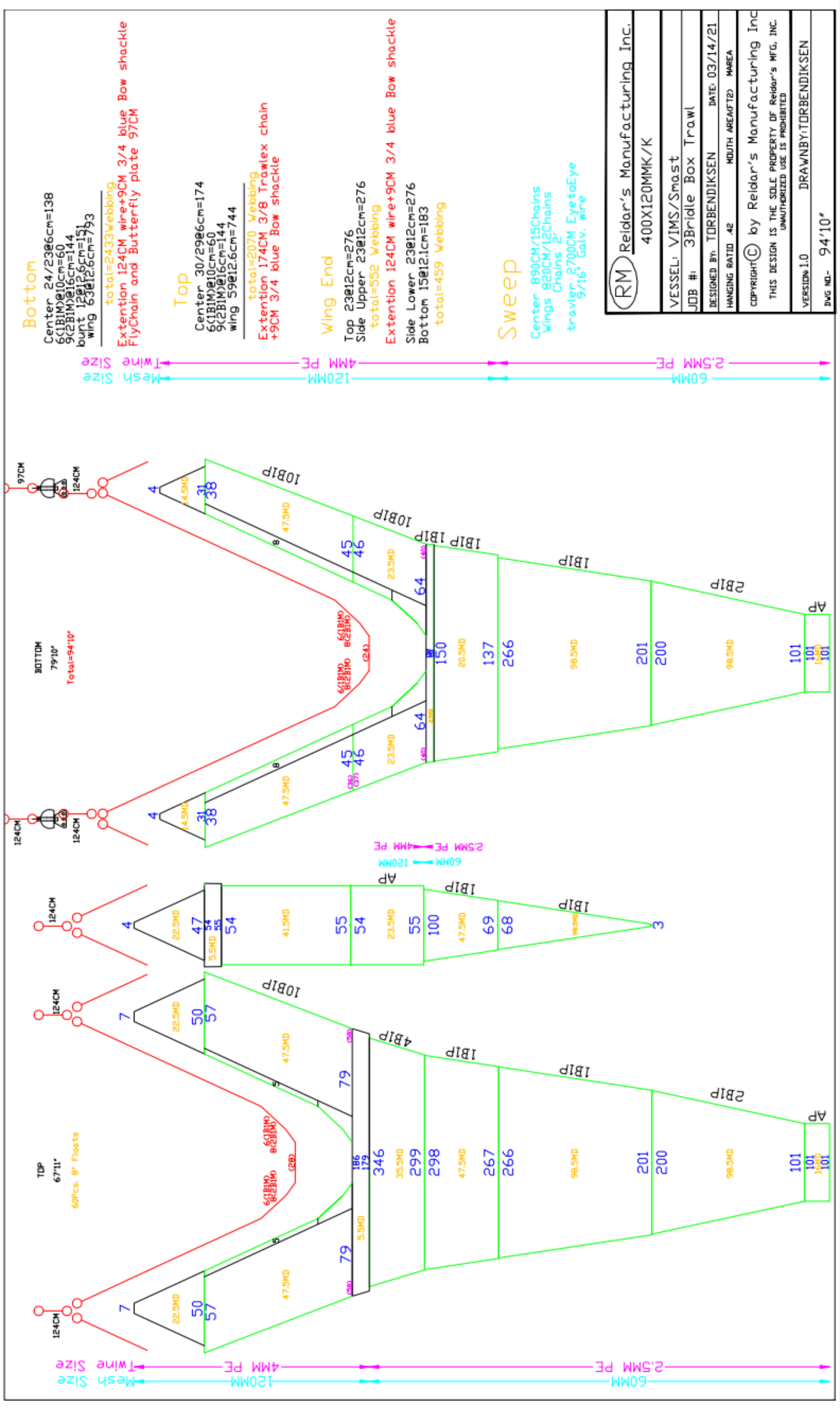


Figure 3: Schematic net plan for the NEAMAP trawl (Courtesy of Reidar's Manufacturing Inc.).

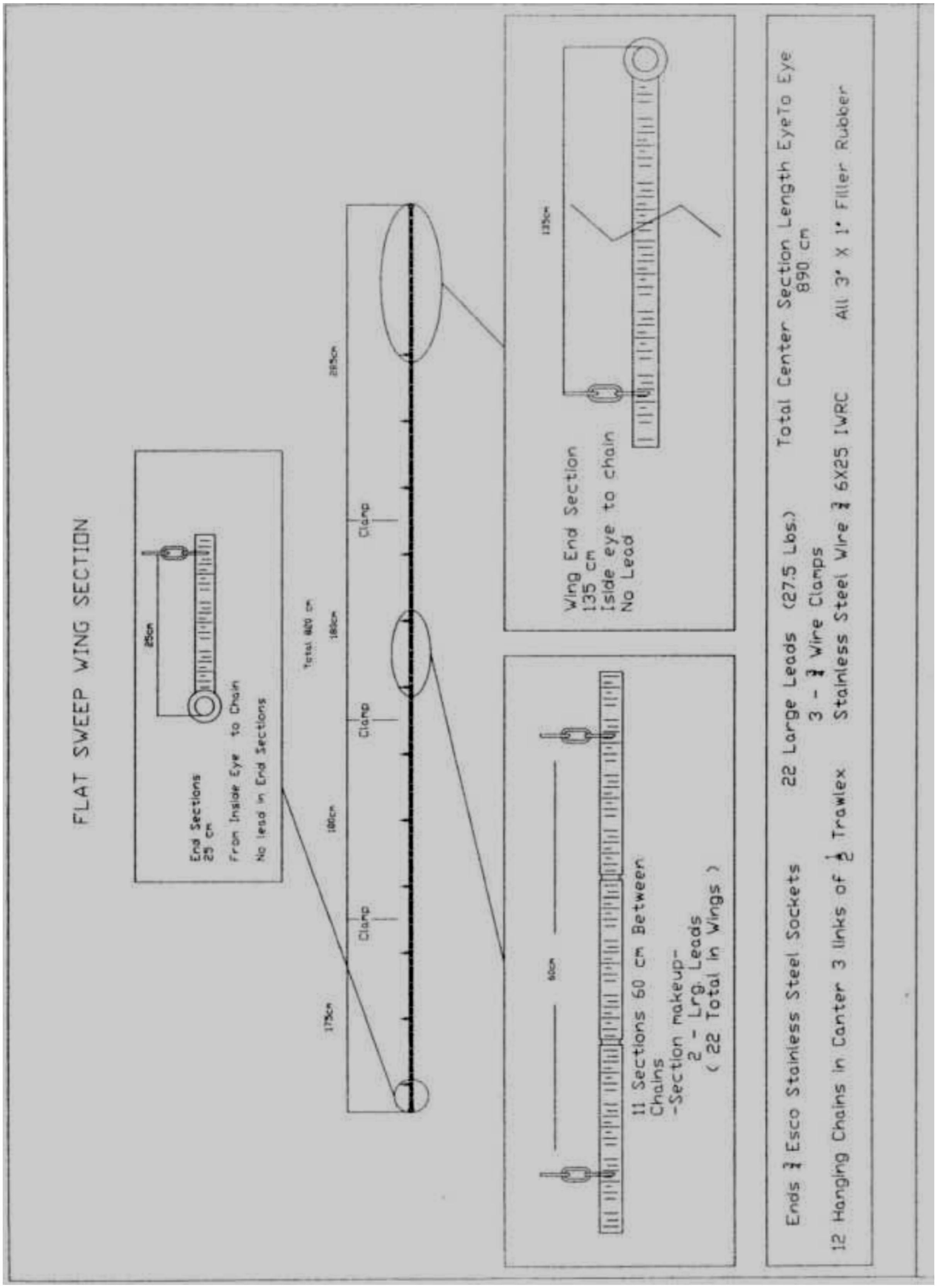


Figure 4: Sweep diagram for the survey trawl (Bonzek et al., 2008).

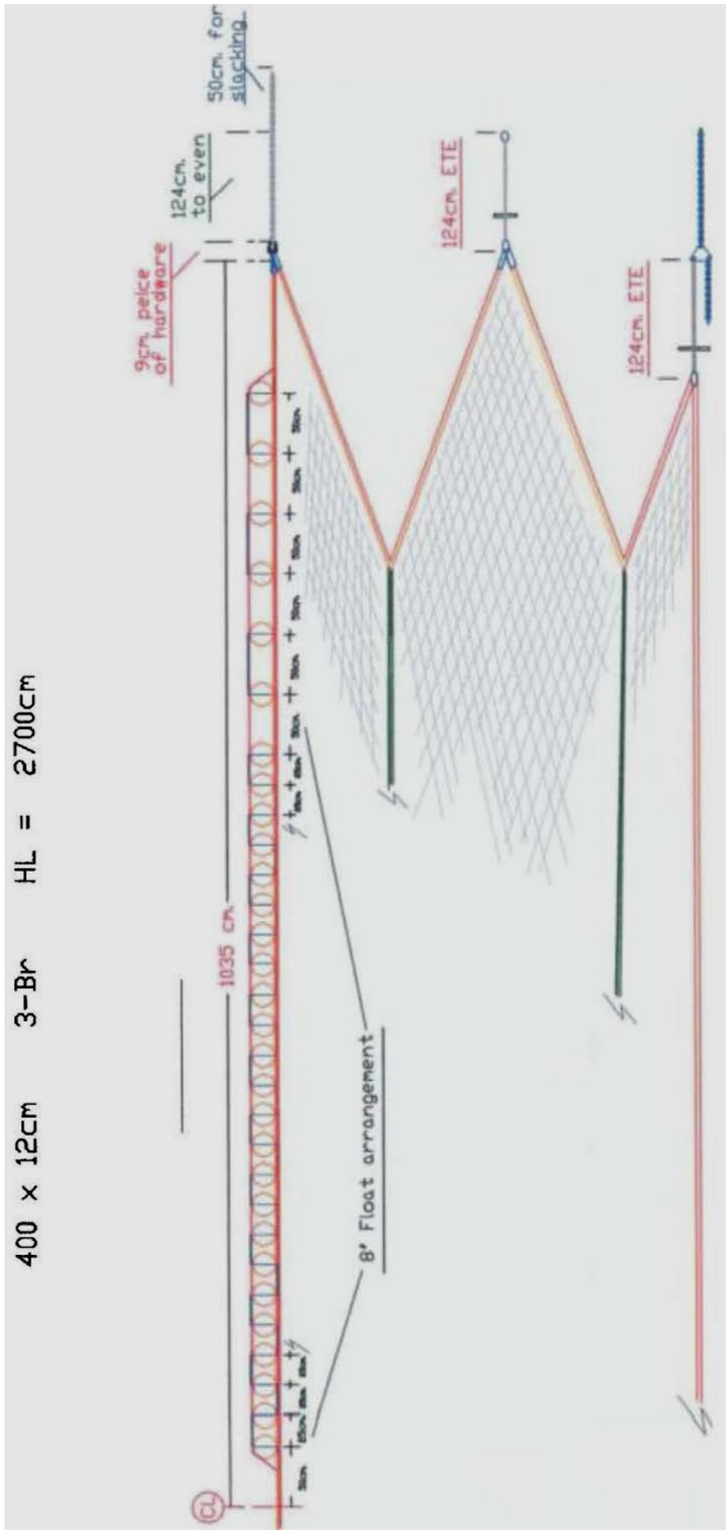


Figure 5: Headrope and rigging plan for the survey trawl (Bonzek et al., 2008).

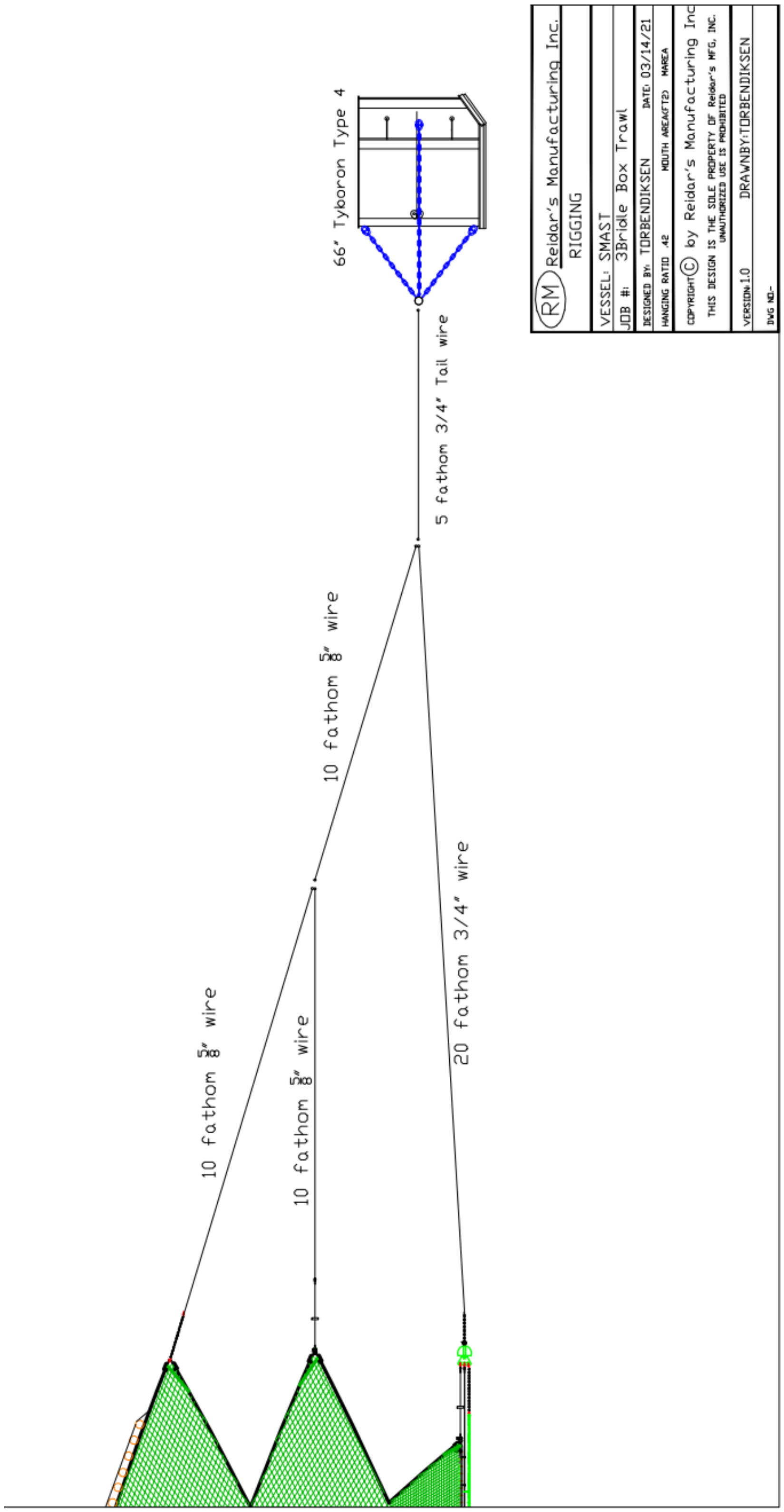


Figure 6: Bridle and door rigging schematic for the survey trawl (Courtesy of Reidar’s Manufacturing Inc.).

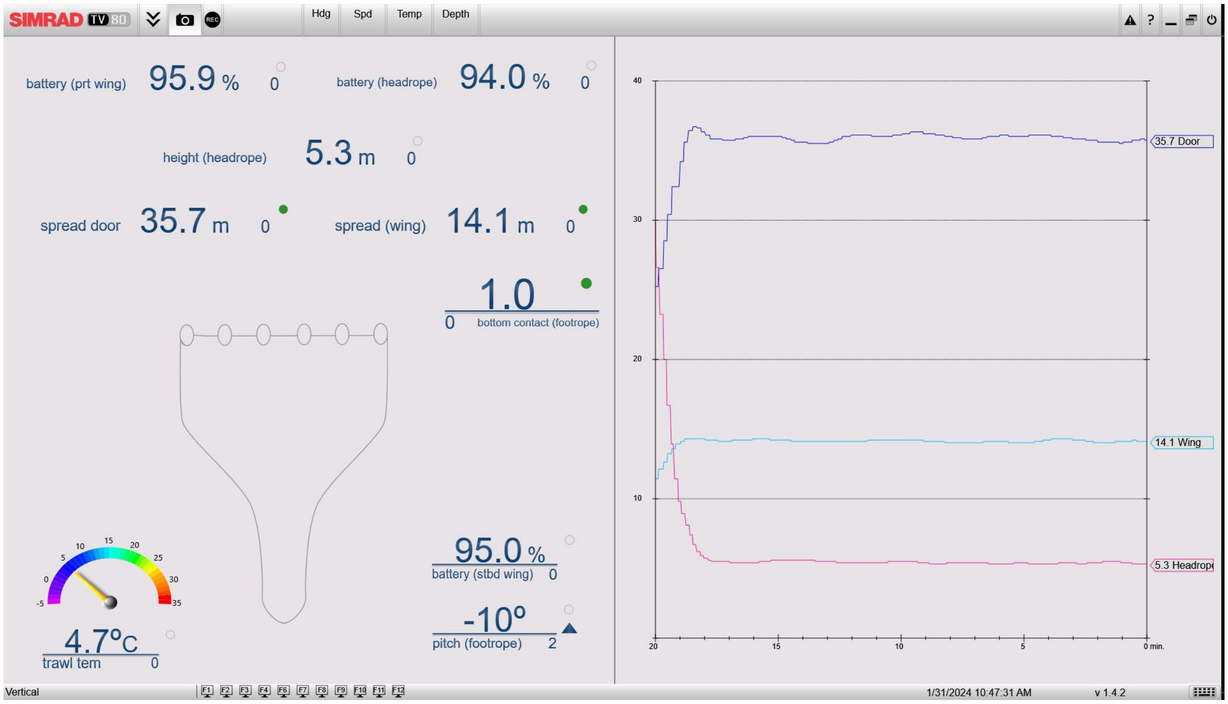


Figure 7: Screenshot of the SIMRAD TV80 software monitoring the trawl parameters.

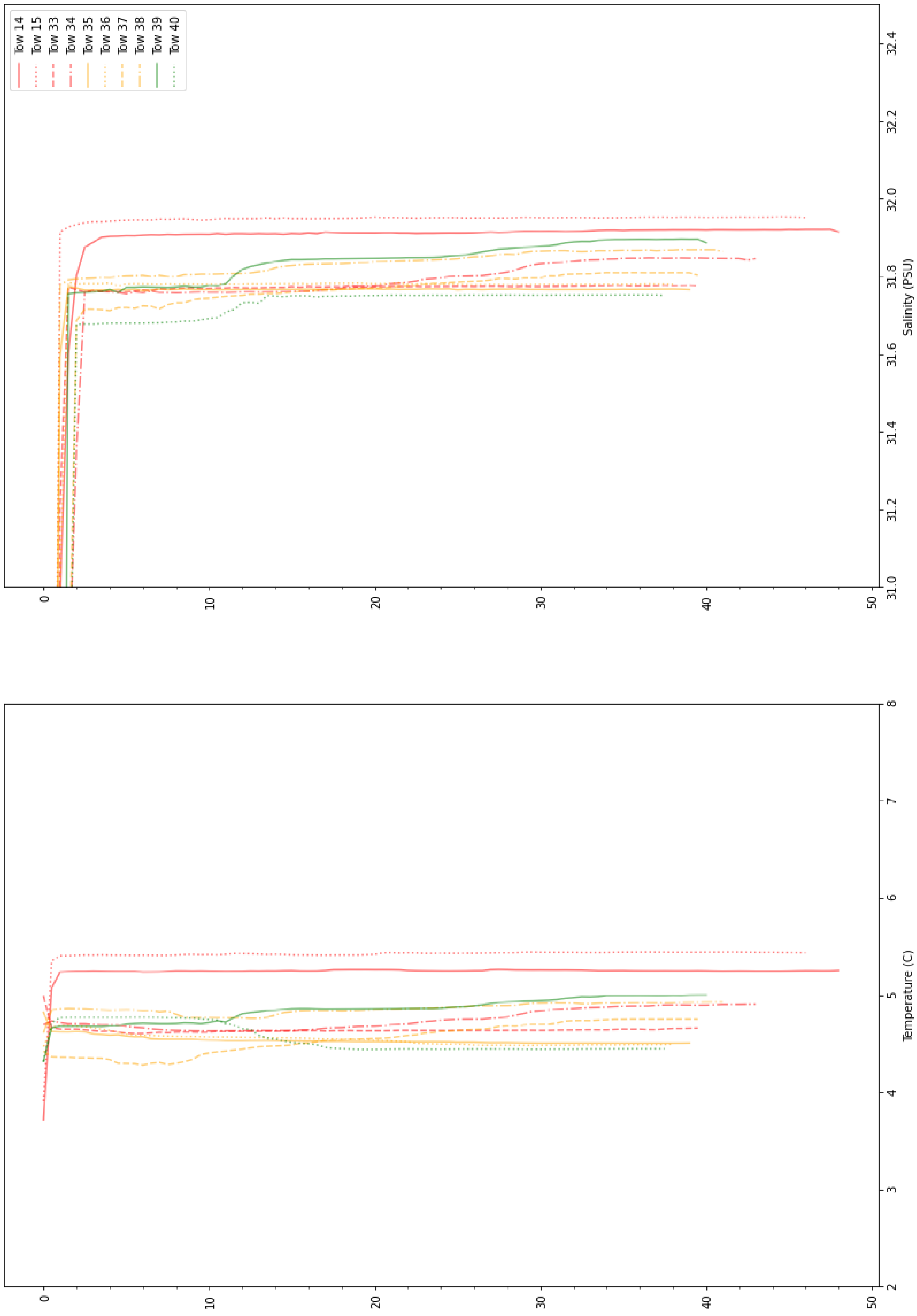
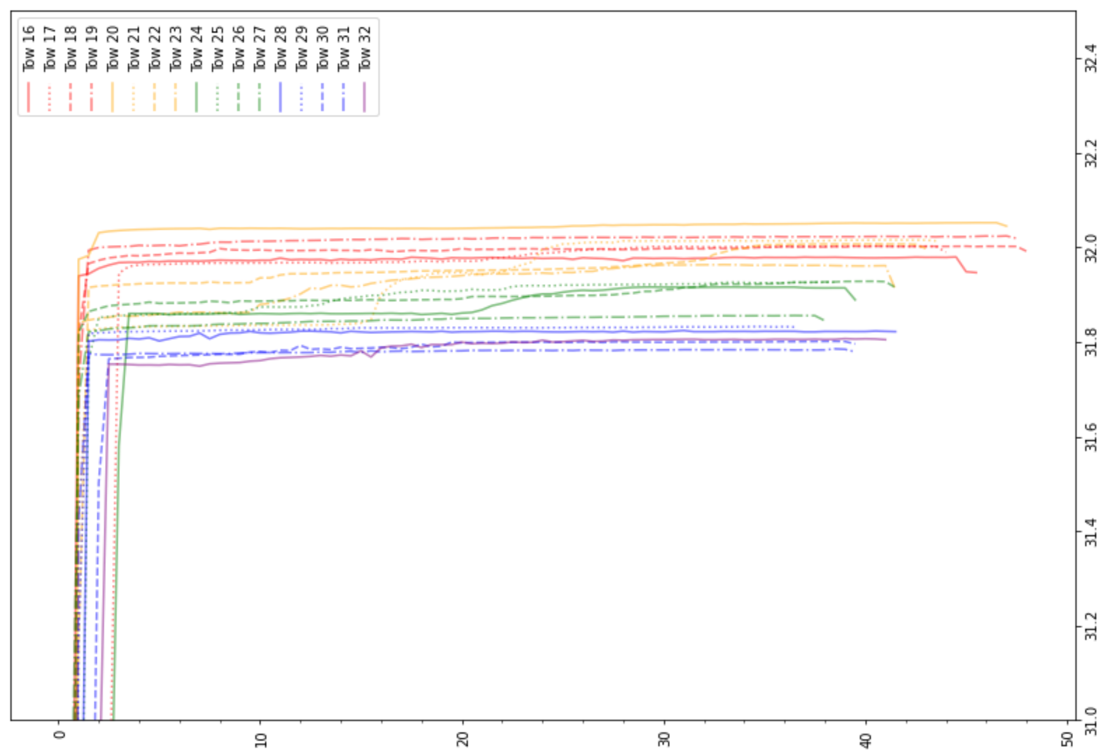


Figure 8: CTD sonde downcast profiles from the VW1 Study Area.



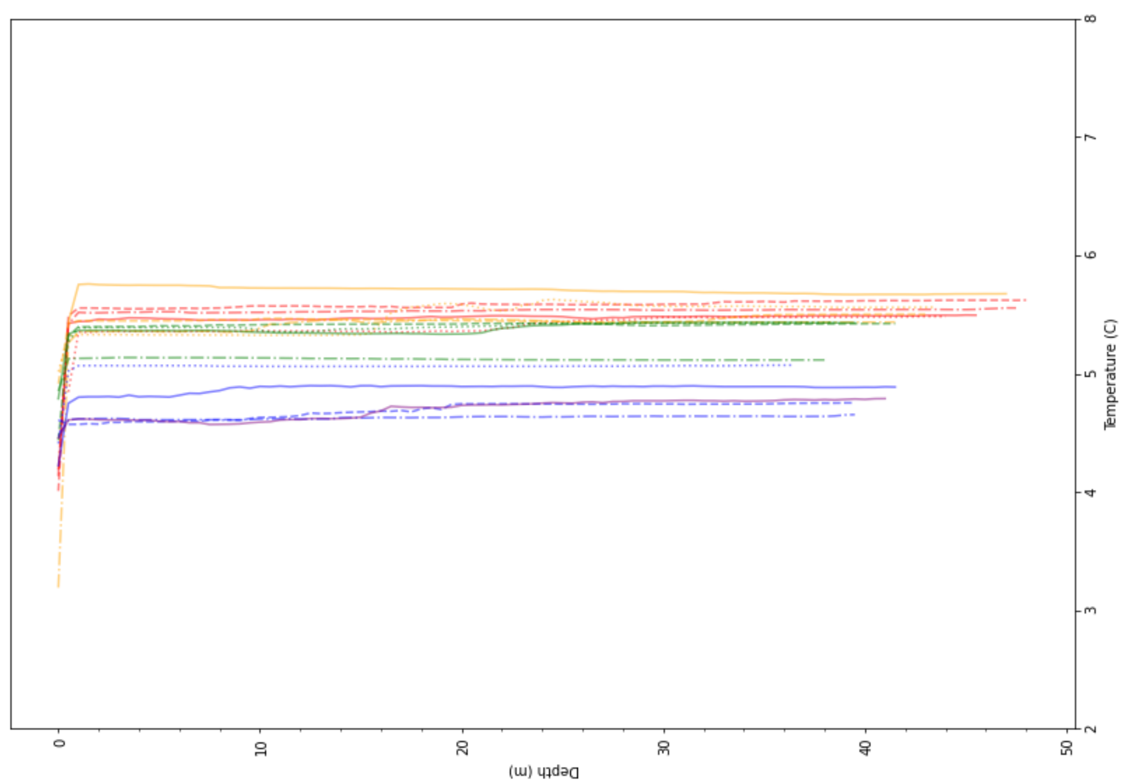


Figure 9: CTD sonde downcast profiles from the Control Area.

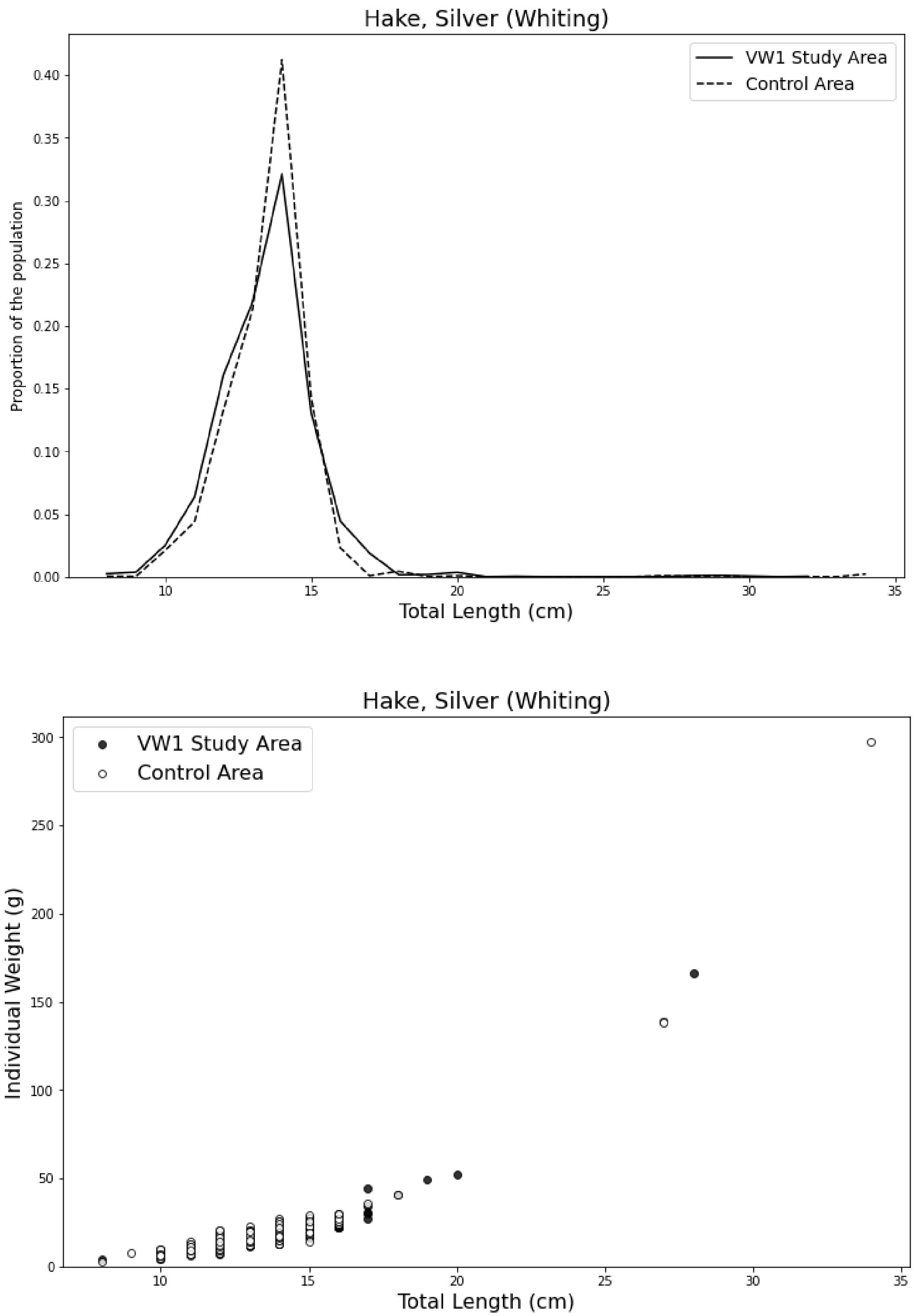


Figure 10: Population structure of silver hake in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

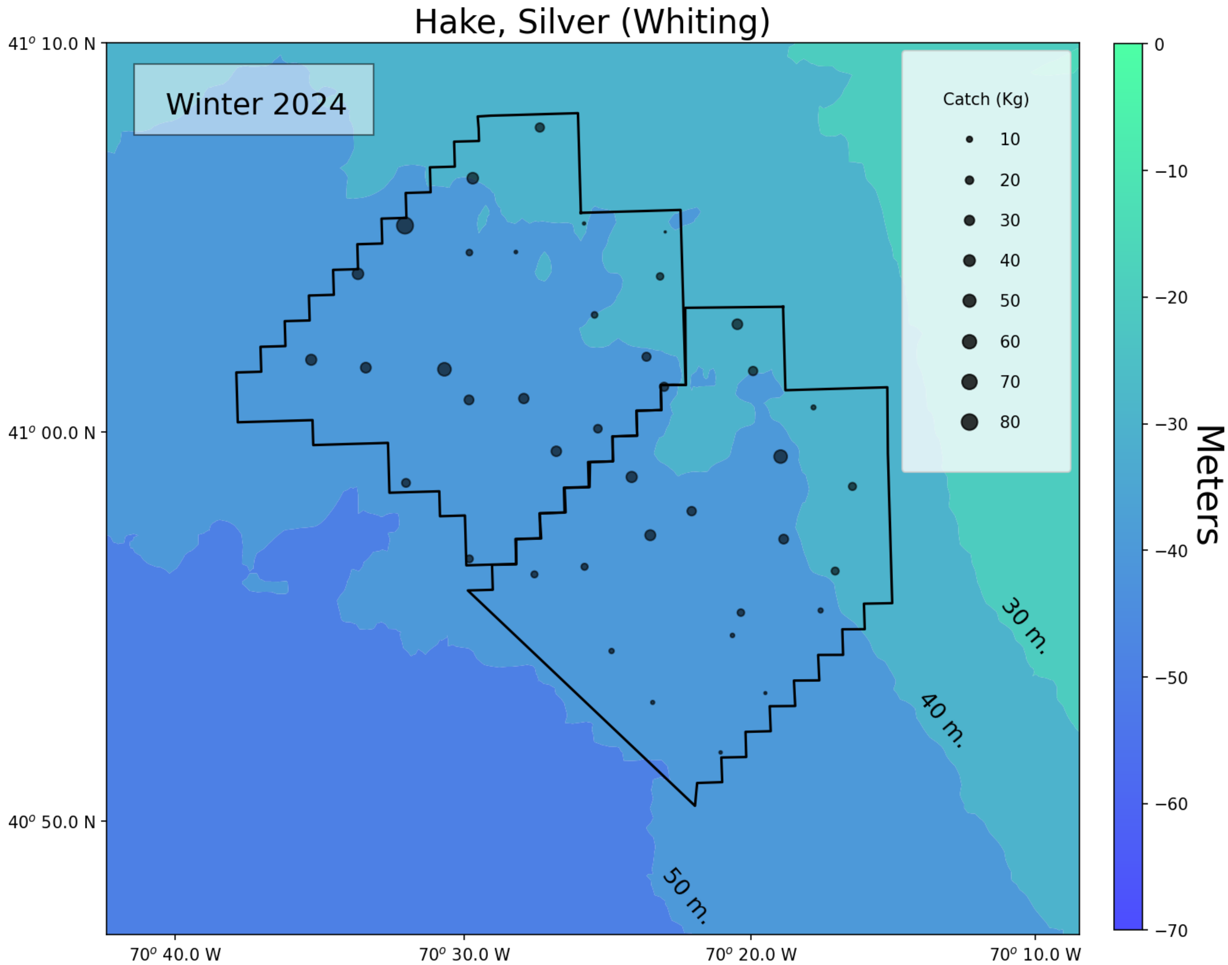


Figure 11: Distribution of the catch of silver hake in the VW1 Study Area (left) and Control Area (right).

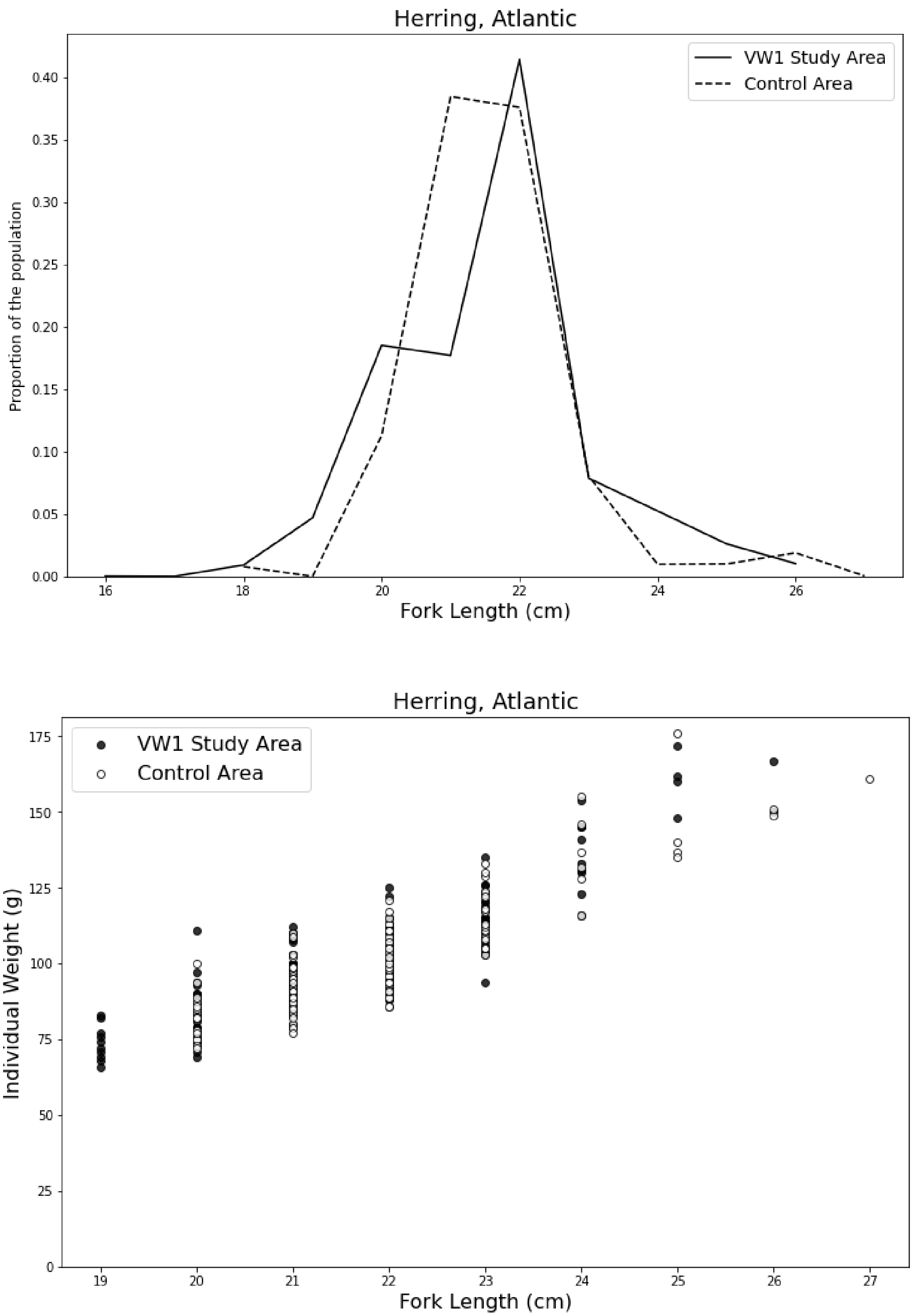


Figure 12: Population structure of Atlantic herring in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

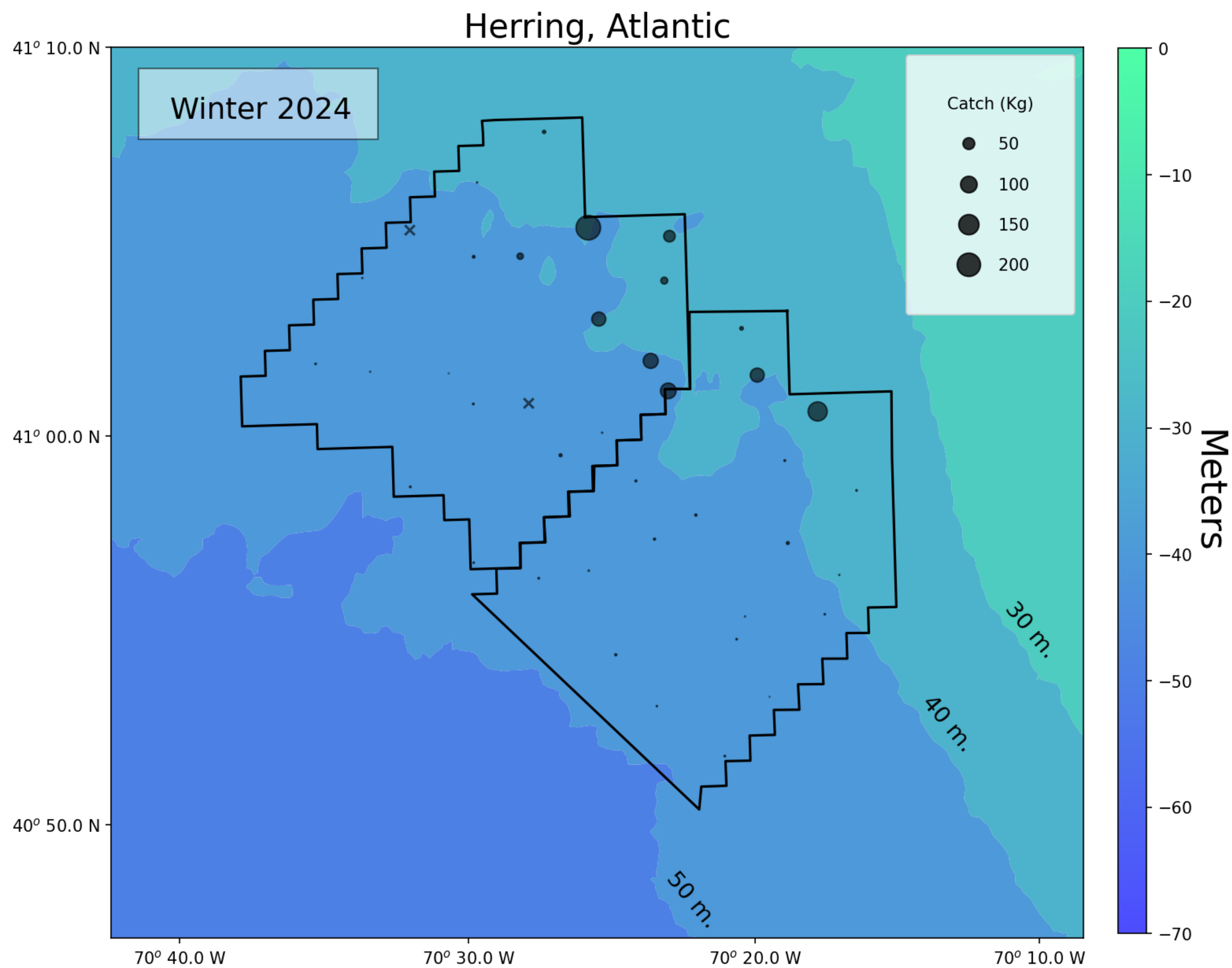


Figure 13: Distribution of the catch of Atlantic herring in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.

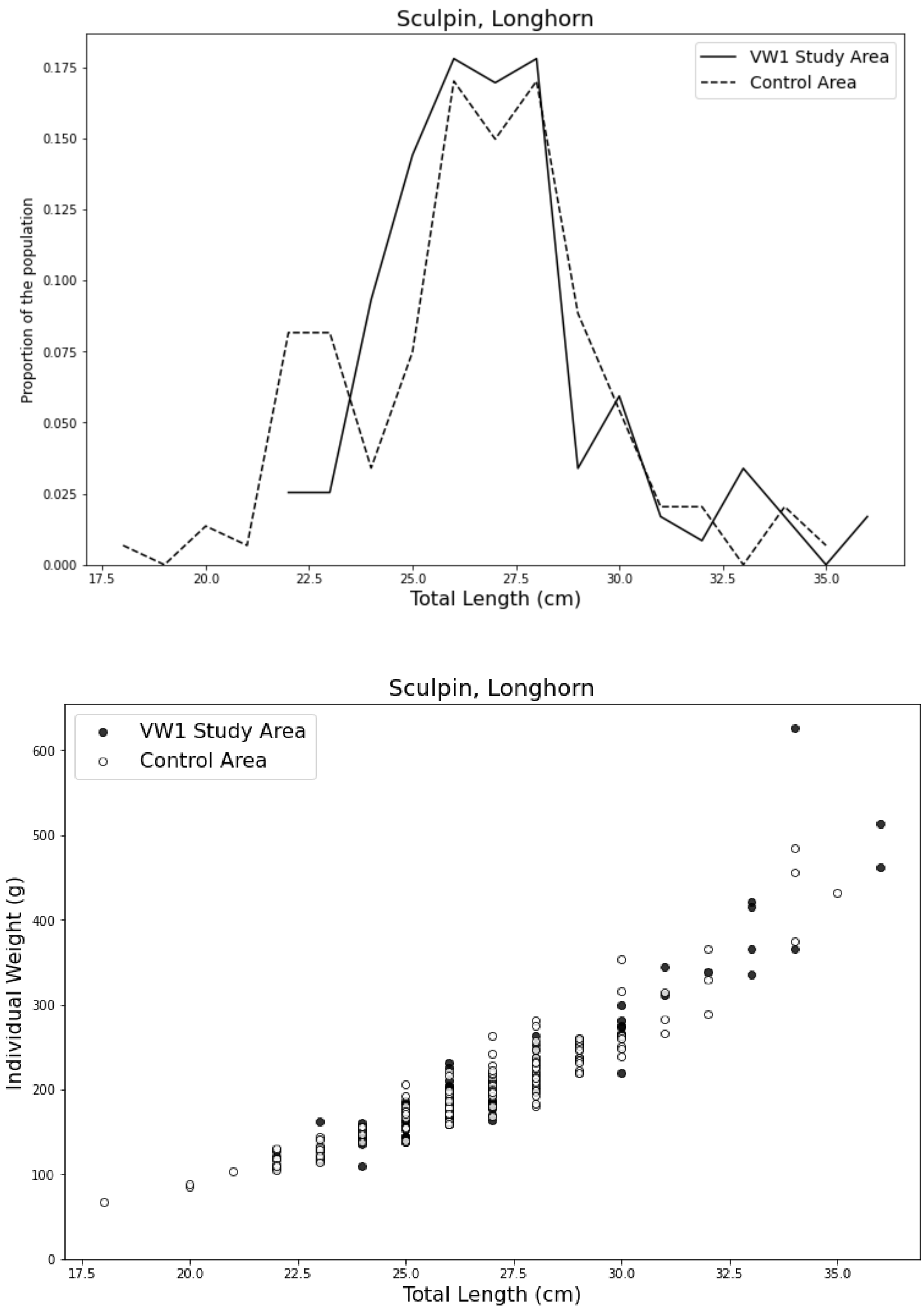


Figure 14: Population structure of longhorn sculpin in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

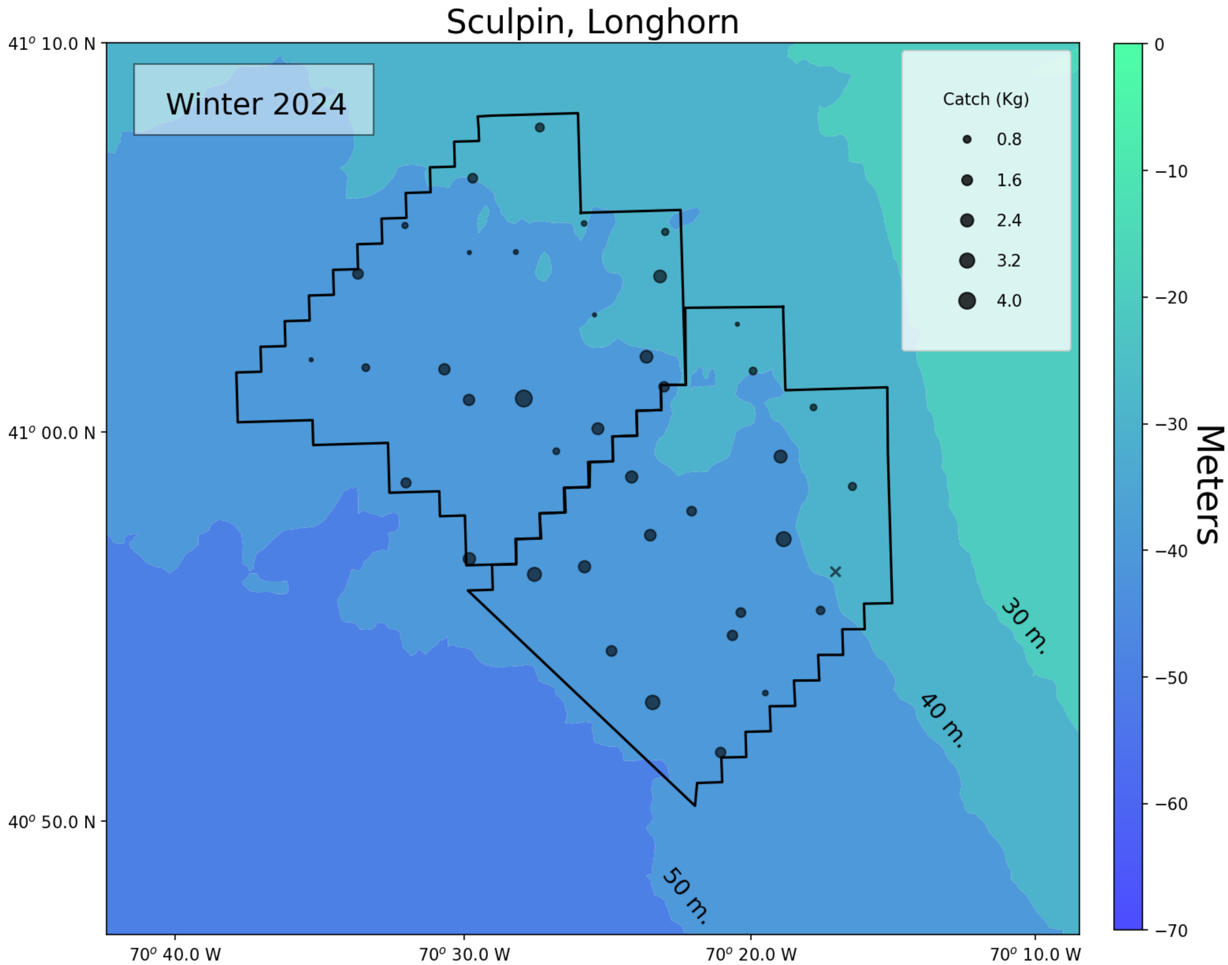
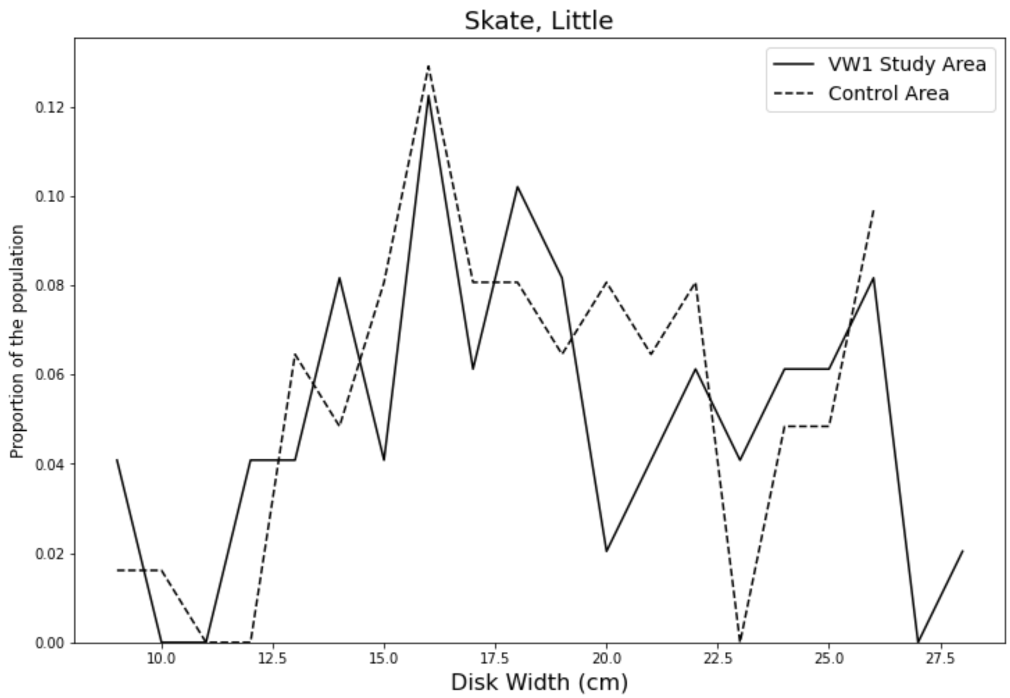


Figure 15: Distribution of the catch of longhorn sculpin in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



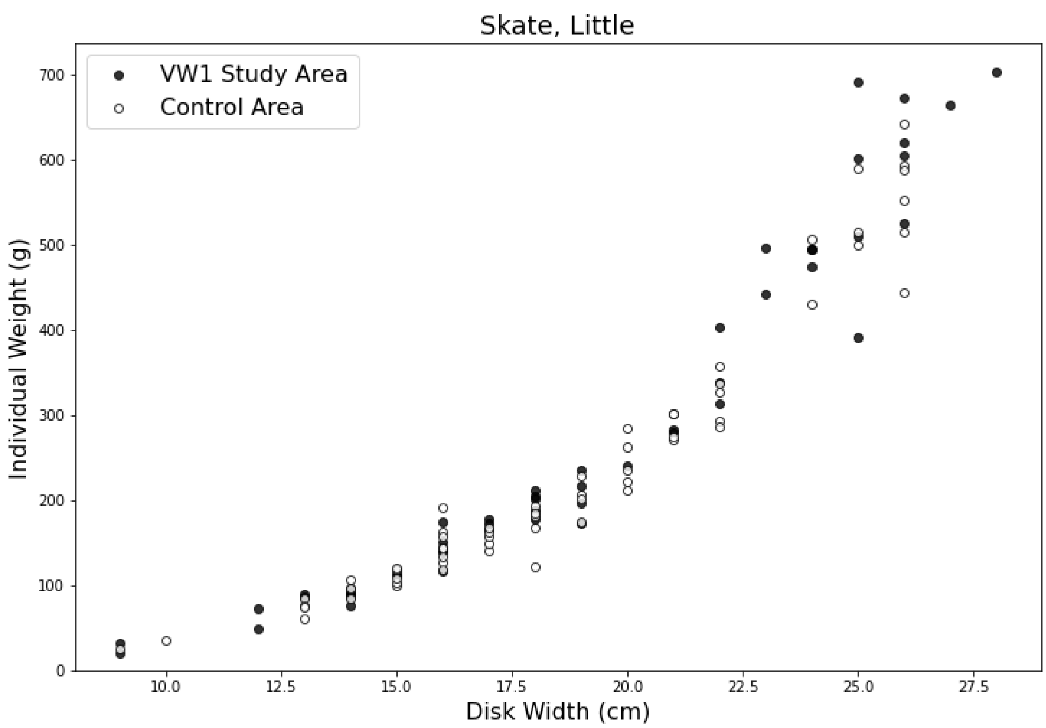


Figure 16: Population structure of little skate in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

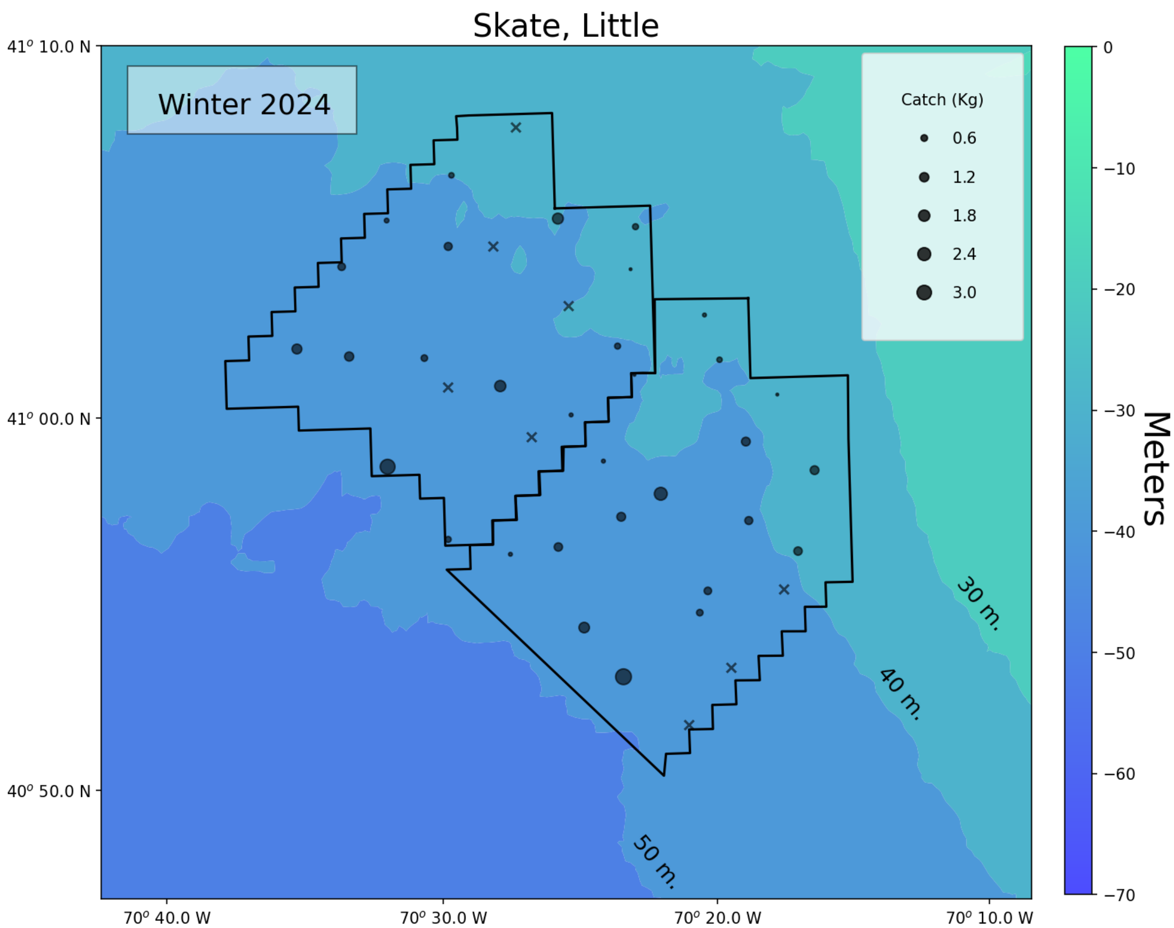
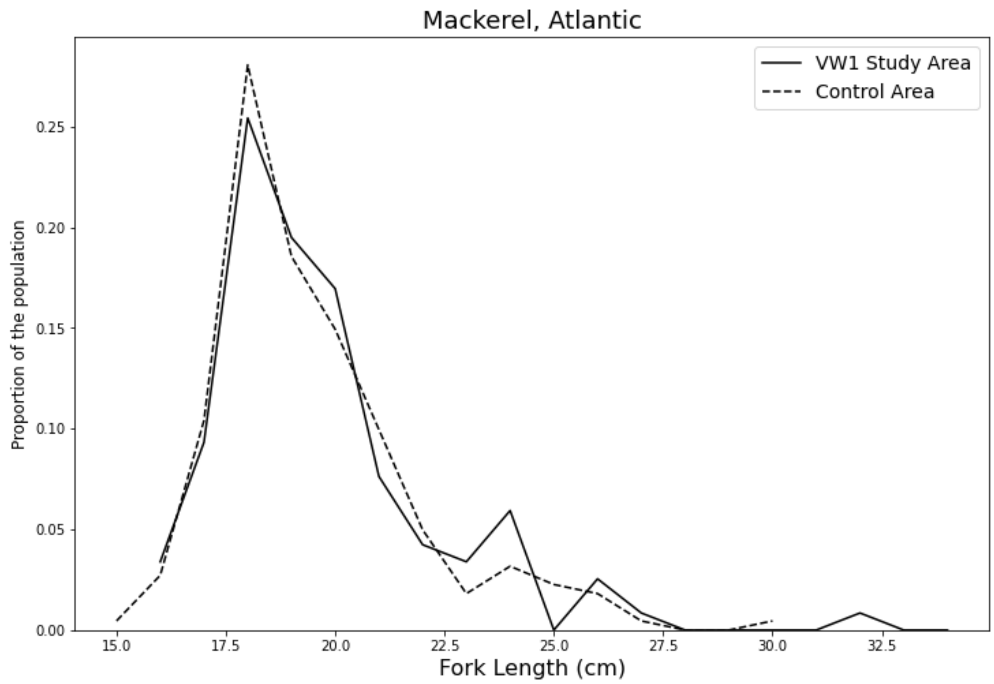


Figure 17: Distribution of the catch of little skate in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.



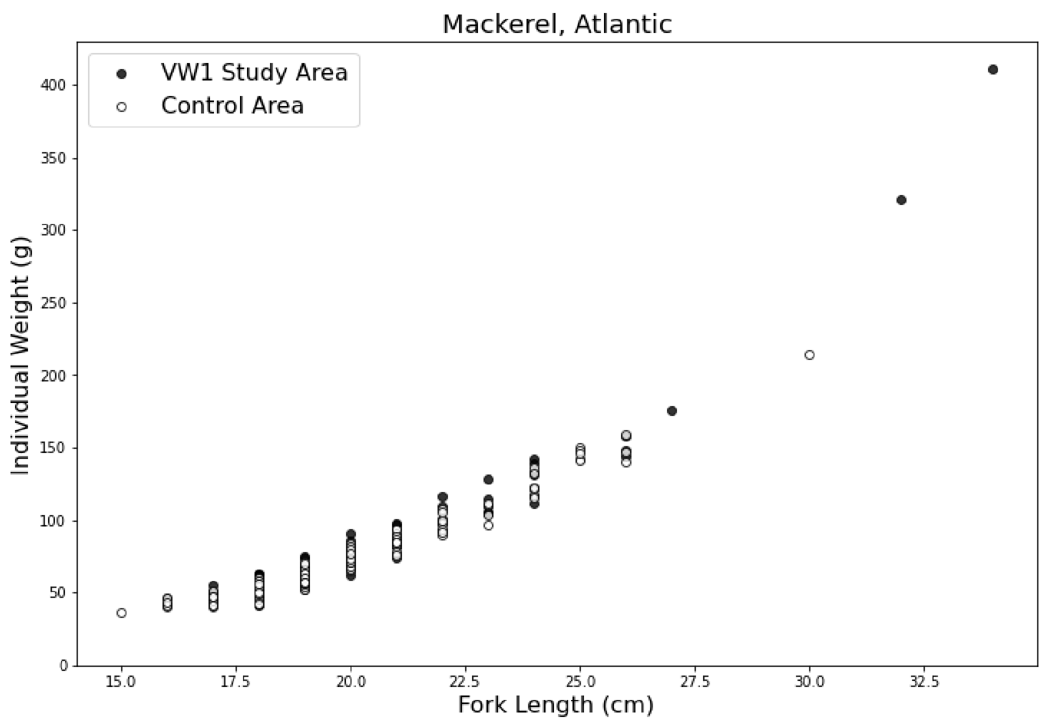


Figure 18: Population structure of Atlantic mackerel in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

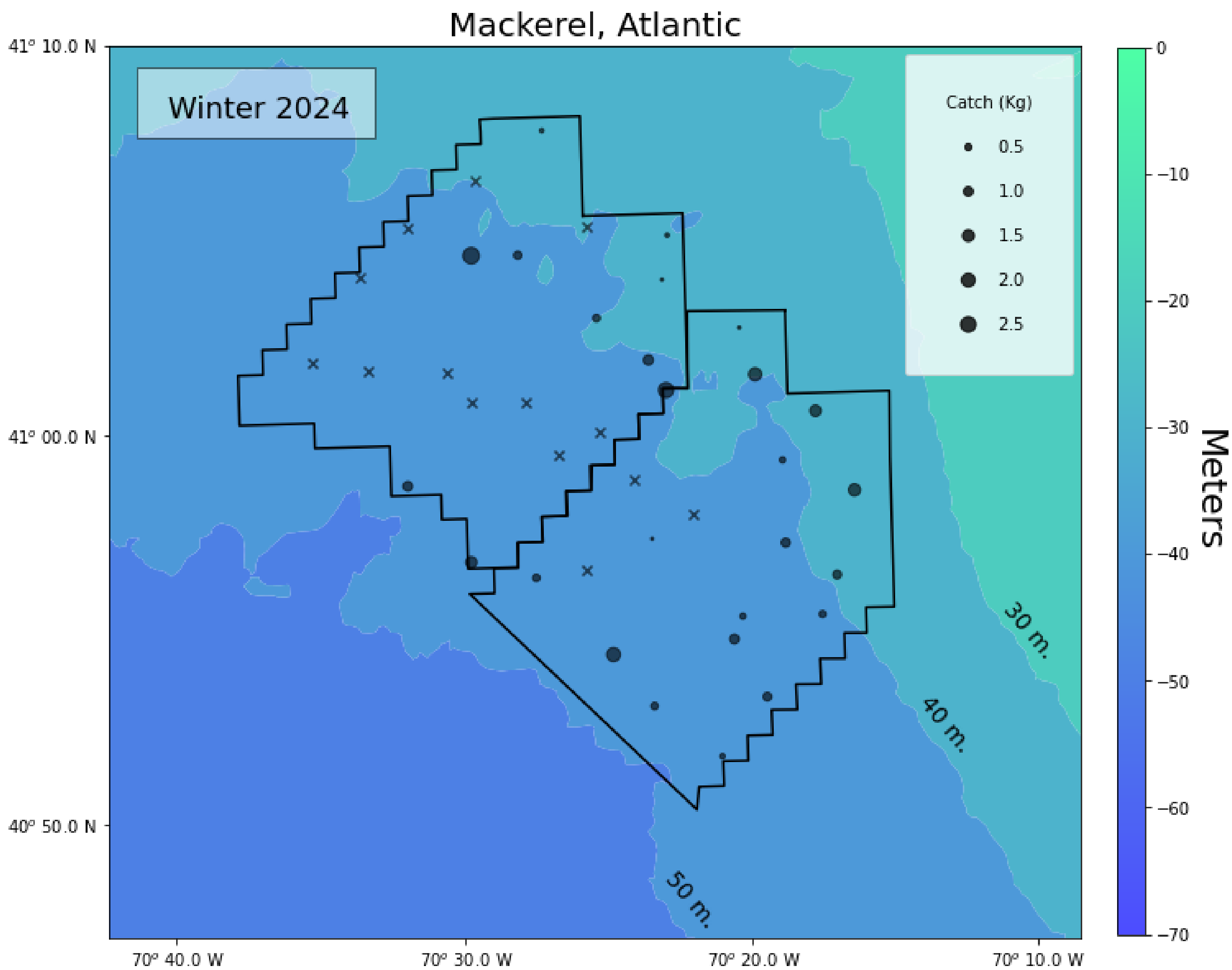


Figure 19: Distribution of the catch of Atlantic mackerel in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.

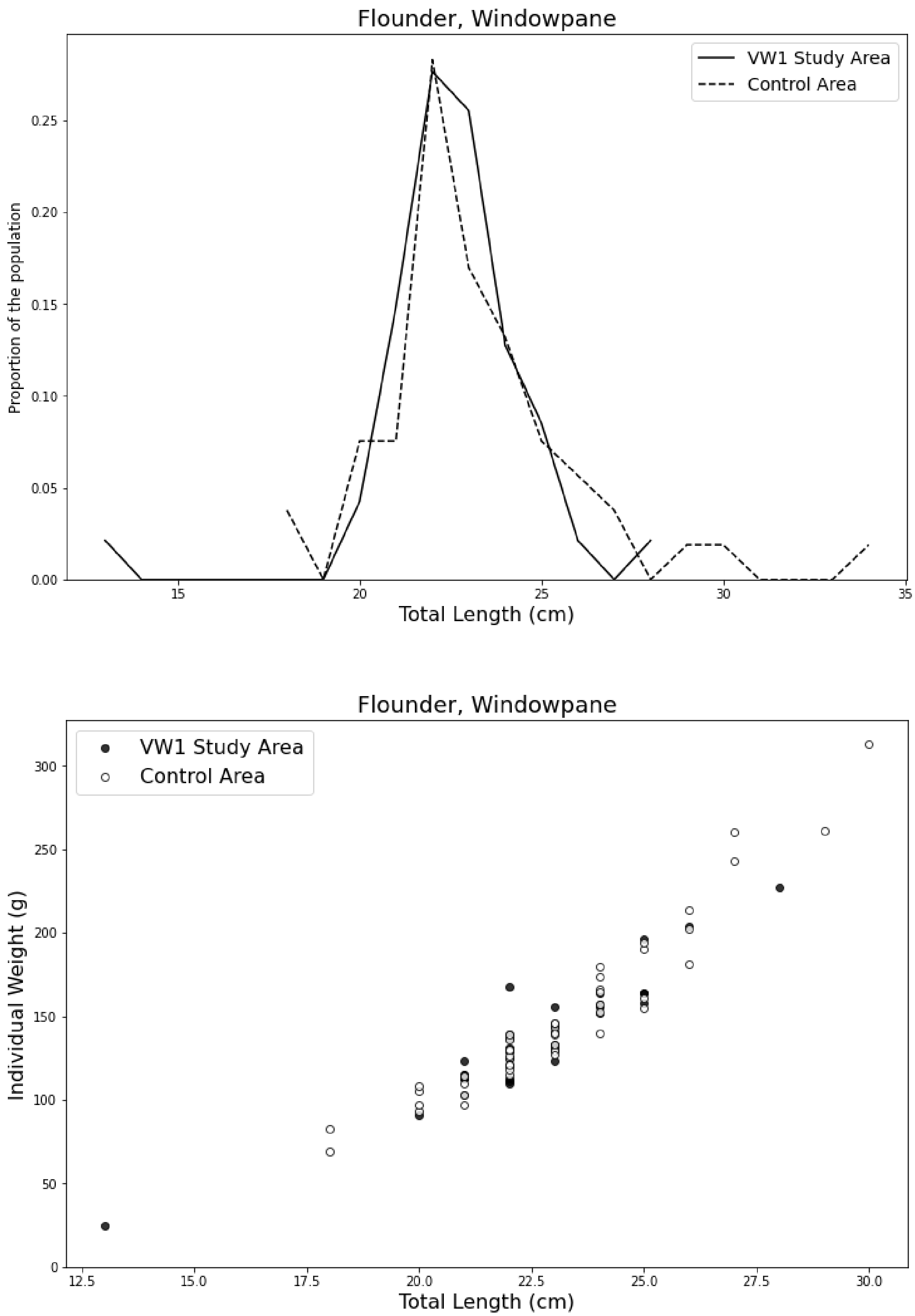


Figure 20: Population structure of windowpane flounder in the VW1 Study Area and Control Area as determined by the length-frequency data (top) and length-weight relationships (bottom).

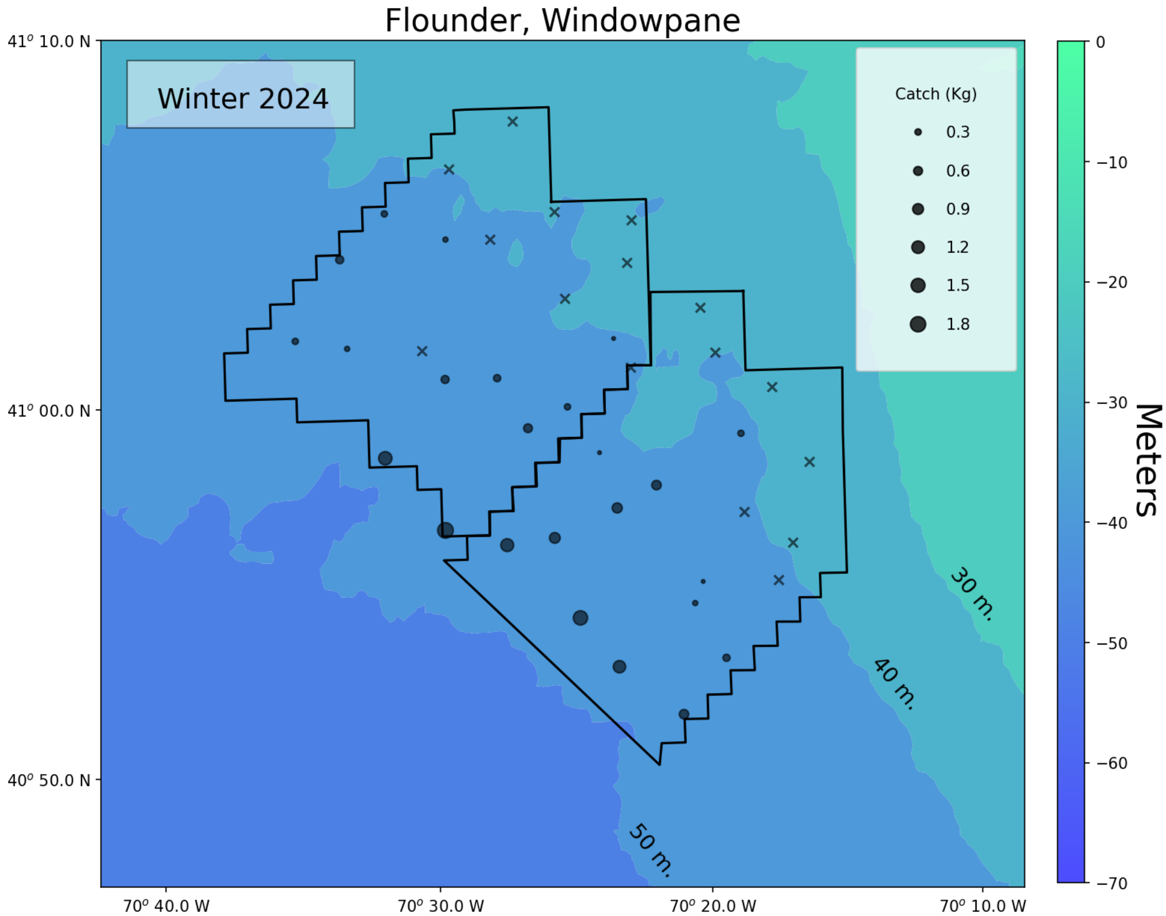


Figure 21: Distribution of the catch of windowpane flounder in the VW1 Study Area (left) and Control Area (right). Tows with zero catch are denoted with an x.