NOAA/NMFS Saltonstall-Kennedy Program
Completion Report

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David Chosid[1], Michael Pol[1], Mark Szymanski[1], Luis Ribas[2], and Thomas Moth-Poulsen[3]

[1]Massachusetts Division of Marine Fisheries
1213 Purchase St, 3rd Floor
New Bedford MA 02740
1.508.990.2860 x140
FAX 1.508.990.0449
Mass.gov/fisheries

[2]Barrosa Fishing Corp.
7A Sandy Hill Lane
Provincetown, MA 02657
1.508.487.2777

[3]FAO-SEUR
Benczur utca 34, H-1068
Budapest, Hungary
+39.1.461.2000

Dedication

Scott W. Westcott
Captain, F/V *Mary Elena*
(1963-2005)

This final report is dedicated to the memory of Scott W. Westcott, captain of the F/V *Mary Elena*, who died suddenly in May 2005. Scott's knowledge, patience, curiosity, creativity, attention to detail and sense of humor contributed greatly to the success of this research. His absence was felt during the completion of the study; it continues to be felt.

Abstract

Two innovative species-selective flatfish trawl nets, the Ribas and Topless nets, were designed to maintain catches of legal-sized yellowtail flounder *Limanda ferruginea* while reducing catches of sub-legal yellowtail flounder, Atlantic cod *Gadus morhua*, and other non-target species. The Ribas net uses large mesh panels in its top section; the Topless net is distinguished by the removed top section from the wings back to the belly. These designs function to exploit the behavioral properties of different species and exclude unwanted organisms during the herding process, a process which may show diel variability. The experimental nets were compared against a standard flatfish net using twin and alternate trawling on Georges Bank, USA onboard a commercial fishing vessel working around the clock. Non-parametric paired randomization testing indicates that the Topless net significantly reduced catches of Atlantic cod, legal and sub-legal-sized yellowtail flounder, haddock *Melanogrammus aeglefinus*, monkfish *Lophius americanus*, American plaice *Hippoglossoides platessoides*, grey sole *Glyptocephalus cynoglossus,* winter flounder *Pseudopleuronectes americanus*, and American lobster *Homarus americanus*; the Ribas net showed significant reductions in catches of legal and sub-legal-sized yellowtail flounder, haddock, American plaice, and grey sole. Significant diel differences in the Topless net's catching efficiency for legal and sub-legal yellowtail, grey sole, and winter flounder were found. No diel differences were observed using the Ribas net. Our results imply that light levels affect the behavior and reaction of these species to trawl nets, and that currently permitted use of these nets or a similar design in a 24-hour/day flatfish fishery on Georges Bank should be reinvestigated to determine if Atlantic cod catch rates meet management needs.

Executive Summary

This research investigated two experimental flatfish net designs, the Ribas and Topless nets, primarily intended to maintain catches of legal-sized yellowtail flounder *Limanda ferruginea* while reducing non-target sub-legal yellowtail and Atlantic cod *Gadus morhua*. The Ribas net uses large mesh panels in its top section; the Topless net has the top portion removed from the wings back to the belly. Field observations, experience, and previous work suggested that modifications to the top of a flatfish net could increase escapement of Atlantic cod while maintaining flatfish catches. The present study continues from smaller versions of these net designs used in Massachusetts inshore waters during the day and extends the research offshore to Georges Bank, USA over 24-hour periods, on a larger vessel, and at a greater depth range.

The control and experimental nets were designed and constructed similarly except for the described modifications. The experimental nets were compared using a commercial fishing vessel over three trips (November 2003, March 2004, and December 2006) using twin trawling (two nets towed at the same time) and alternate trawling (control/experimental net singly in a rotation) against a standard control flatfish net; 112 valid tows (56 pairs of tows for control and experimental nets) were completed. Tow pairs where at least one fish of a species was caught in one net were analyzed. Under this criterion, sample sizes were much smaller than 56 pairs partially due to low stock sizes and variation in fish distributions. Catches of Atlantic cod were especially low, but at a level to be expected in a flatfish fishery. Other species were more often caught at commercial quantities. Tows were conducted throughout Georges Bank and were generally not separately analyzed by trip or location due to similarities in length frequencies and small sample sizes.

Catches were sorted separately from each net by species and weighed. In some cases, large catches were grouped into higher taxonomic categories ("Skates NK"), or large catches of non-target species were estimated by counts of filled totes. In some large tows, the entire codend was weighed and the predominant non-target species estimated by subtraction. Commercially important species were also individually measured for fish lengths, or sub-samples of at least 100 individuals were recorded. Data were also collected on tow location, duration, weather, wind speed, temperature, depth, and other factors.

Catch weights and length frequencies were analyzed for sub-legal and legal-sized yellowtail flounder, Atlantic cod, and other commercially important fishes. Normality of count data was assessed with quantile-quantile normal plots and other diagnostics; paired non-parametric randomization testing was conducted following conclusions of non-normality. Catches in pairs of tows were plotted and compared to an equal catch line to support conclusions of randomization testing. Box and whisker plots and histograms of length data were also constructed to assess differences in length distributions by trip, species, net type, depth, and diel category (day and night). Following this analysis, the effects of day or night tows were assessed using the civil twilight definition.

Results from paired randomization testing (using an alpha level of 0.10) showed significant reductions in catch in the Topless net for Atlantic cod, legal and sub-legal-sized yellowtail flounder, American plaice *Hippoglossoides platessoides*, grey sole *Glyptocephalus cynoglossus*, haddock *Melanogrammus aeglefinus*, monkfish *Lophius americanus*, winter flounder *Pseudopleuronectes americanus*, and American lobster *Homarus americanus*. The Topless net results showed that Atlantic cod, American plaice, and haddock were significantly reduced during the day and night; grey sole was only significantly reduced during the day and legal and sub-legal yellowtail flounder and winter flounder were only significantly reduced during the night. The Ribas net significantly reduced legal and sublegal yellowtail flounder, American plaice, grey sole, and haddock catches and no diel effects were seen. Analyses did not detect any substantial length frequency difference between nets; some changes in the size structure of species, particularly haddock and yellowtail flounder, were observed.

Lower catches of Atlantic cod in the Topless net and not with the Ribas net suggest that the presence of any netting in the upper square section inhibited escapement which was independent of diel condition. Haddock were significantly reduced in both experimental designs at either diel period indicating that haddock could perceive and escape through large openings in any light condition. Monkfish and lobster showed significant reductions in only the Topless net during the day and night which may indicate a partial passive escape mechanism due to low resistance in the Topless net's wings and additional escape opportunities than available in the Ribas net. Flatfish results were varied with respect to nets and diel periods and may be due to species, size, ontogenetic, and gender specific behaviors.

The Topless net met the goal of significantly reducing Atlantic cod catches during the day and night. However, legal-sized yellowtail flounder were only adequately retained in this net during the day which emphasizes the importance of diel cycles and/or light levels on the reaction of fish to trawl gear. Failures of the Ribas net to reduce cod catch conflict with the results of the inshore daytime research and may be due to different net sizes, larger vessels, greater geographic and depth ranges, and diel conditions.

A modified Ribas and a Topless design are mandated for use during a 24-hour flatfish fishery on Georges Bank. Observer and other data from this fishery should be examined to see if actual fishery results are consistent with our testing; if they are managers should reexamine the use of the Ribas and the Topless net to reduce Atlantic cod in a flatfish fishery. Additionally, the economic potential and practicality of the Topless net should be examined for applied daytime flatfish fisheries where roundfish reductions are desired.

Purpose

Current U.S. fishery management practices restrict the number of days or hours that can be fished and therefore reward improvements in efficiency and precision by harvesters. The development of fishing gear that is more selective (that is, that more accurately captures the size and species of marine organisms desired) not only can save valuable fishing time, but can also allow access to healthy species or stocks intermingled with fish stocks requiring protection. Access to healthy stocks through more selective fishing gear benefits the fishing industry, seafood consumers, and coastal communities.

Developing gear with improved selective properties is complicated by variations between individual fish as well as species-specific behaviors and distributions. In some cases, species are geospatially separate, allowing selective harvest with traditional gears or selective closure to harvest. Fish themselves, however, are not restricted by boundaries of closure areas. The modification of trawl nets and all fishing gear to improve species selectivity where separation does not exist begins with an understanding of the behavior of fish (Wardle, 1993; Kim and Wardle, 2005). Wardle (1993) described the herding and exhaustion of fish in a trawl net through a series of involuntary optomotor responses by fish to trawl doors, wires, and the front end of the trawl net. As a result of this behavioral work, it has been possible to improve trawl gear by exploiting variation in behavior or physical properties between species or within subsets of species. For example, the use of the Nordmøre grate in shrimp fisheries reduced non-target finfish catch by 90% in some areas (Richards and Hendrickson, 2006). Also, the development of the semi-pelagic raised footrope trawl in Massachusetts reduced catch of flatfish and American lobsters *Homarus americanus* in a silver hake *Merluccius bilinearis* fishery by exploiting behavioral differences in bottom-affinitive fish (McKiernan et al., 1999; Pol, 2004).

From 2000-2002, the Conservation Engineering Program of the Massachusetts Division of Marine Fisheries (DMF) in collaboration with harvester Capt. Luis Ribas, designed and tested the experimental “Topless” and “Ribas” nets to reduce Atlantic cod *Gadus morhua* catch while targeting yellowtail flounder *Limanda ferruginea* (Pol et al., 2003). These nets differed from conventional fishing gear primarily in the webbing in the top half of the net. In the Ribas net, 152 mm (6.0 in) diamond meshes were replaced with 203 mm (8.0 in) square meshes. In the Topless net, based on a Faroese design (Thomsen, 1993), the "square" panel of the net, the top wings, and the top bellies were removed. These modifications were designed to exploit species-specific vertical distributions of fish and the rising behavior of Atlantic cod by easing escape over the top half of the net.

The modifications tested in this study originated from observation and understanding of the reaction of Atlantic cod to pursuit by a trawl net. Prior underwater observations revealed cod rising when herded until inhibited or restricted by the webbing along the top of the net, while flatfish have been observed to predominately pass just under, or just over, the footrope (Walsh and Hickey, 1993; Thomsen, 1993; DMF, unpubl. data). Main and Sangster (1981a; 1982) also found vertical separation during the herding process using a triple codend, dual separator panel net, with most haddock in the topmost codend, cod more likely to be found in a middle codend, and flatfish almost exclusively in the lowest codend.

Pol et al. (2003) found that the Ribas and Topless net designs reduced Atlantic cod catches while maintaining commercially viable catch rates of legal-sized yellowtail flounder (>33 cm (13.0 in)). These nets also showed marked declines in catch rates of sub-legal-sized yellowtail and winter flounder *Pseudopleuronectes americanus*. However, all tows were conducted during the daylight hours on inshore vessels 15.2 – 18.3 m (50-60 ft) in length. Since fish vision is important for reaction to fishing gear and in vertical distribution of fish, the possible effectiveness of a design that may rely on vision, and therefore light levels, during nighttime fishing was questioned (Fridman, 1969). In addition, the ability of this net to maintain its function on a larger size scale suitable to offshore vessels remained unknown.

Light level is a vital component of gear testing, but is difficult to evaluate (Olla et al., 2000). Undersea light levels are influenced by water quality, temperature, depth, cloud cover, moon phase, bioluminescence, anthropogenic sources, and sun position in the sky (U.S. Navy, 1952). Measurement of light is also complicated by multiple dimensions of intensity, wavelength, and polarization. While fish certainly employ senses other than vision to detect fishing gear, incorporation of gear modifications into a round-the-clock fishery should require determining whether the modification is effective at night or under low-light conditions.

Time-of-day is often used as a proxy for in-situ light measurements. Prior work attempting to compensate for a diel factor in groundfish catches indicated very specific situations based on time-of-year, location, light levels, depth, predator and prey densities, and overall stock structures (Lough and Potter, 1993; Casey and Myers, 1998; Adlerstein and Welleman, 2000; Petrakis et al., 2000; Hannah et al., 2005). The protocol for defining the diel cycle or thresholds of light and dark conditions using time varies per author. Some test for day/night difference in catches using sunrise and sunset to define day and night (Bowering, 1979; Petrakis et al., 2000; 2001). Other researchers have omitted any fish captured during a defined buffer time period (Beamish, 1966; Sissenwine and Bowman, 1978; Walsh, 1988; Lough and Potter, 1993; Aglen et al., 1997; Casey and Myers, 1998) while others incorporated events (such as twilight), or continuous light changes or the circadian cycle (Engås and Soldal, 1992; Michalsen et al., 1996; Sangster and Breen, 1998). According to Helfman (1993), twilight periods signify times of behavioral transitions for diurnal species. Hjellvik et al. (1999) further suggests that different diel models may be appropriate for individual stock situations and age classes such as continuous daily light changes, circadian rhythms, or day/night threshold effects. Using this premise, they found that the most suitable models for Atlantic cod in the Barents Sea changed by fish size and season.

In addition to visual perception of fishing gear, fishes' movement patterns or height off the sea bed may alter their vulnerability to a trawl net based on day/night differences in catch rates. Adlerstein and Welleman (2000) present evidence of Atlantic cod in the North Sea performing diel movements based on prey availability. Walsh and Morgan (2004) showed through data tags that adult, Grand Banks yellowtail flounder perform seasonal off-bottom behavior during the night at various times of the year. From work with species such as haddock *Melanogrammus aeglefinus* and dab *Limanda limanda*, Adlerstein and Ehrich (2002) suggest that species with higher night catches are more closely associated with the sea bed while pelagic fish are more likely to be captured during the day by trawl nets

Atlantic cod and yellowtail flounder are caught during day and night in a mixed species trawl fishery on Georges Bank, USA. At the initiation of this study, harvest of Atlantic cod was under tight restrictions and yellowtail flounder harvest was not. While the current stock status does not allow for increased harvest of yellowtail flounder, a trawl net that catches yellowtail similar to standard designs and releases or avoids Atlantic cod, could allow increased access to the yellowtail flounder stocks as fish stocks rebuild and provide a design that could be used worldwide to separate fish species in trawls.

This study was developed to investigate the effectiveness of the Ribas and Topless net designs during day and night, on a larger vessel than previously used, and with larger nets. A lesser goal was to test depth effects, although this was not explicitly incorporated into the statistical design of the study. Although this study focused on reducing Atlantic cod/yellowtail flounder interactions, these nets were expected to also reduce interactions between Atlantic cod and other flatfish such as winter flounder, grey sole *Glyptocephalus cynoglossus*, and American plaice *Hippoglossoides platessoides*.

Goals and Objectives

This project proposed to measure the reduction in Atlantic cod and sub-legal-sized yellowtail flounder catch rates when two experimental designs were compared to a standard net. The proposed testing included comparisons in daylight and nighttime conditions. The testing occurred on a large, offshore vessel using nets larger than previously tested.

Goal: To reduce catch rates of Atlantic cod and sub-legal-sized yellowtail flounder and to maintain catch rates of legal-sized yellowtail flounder on offshore vessels.

> Objective: Develop and test larger scale versions of the Topless and Ribas nets for use on offshore vessels, primarily on Georges Bank.

Objective: Conduct 50 alternate paired tows with each net, comparing each net to a standard net, fishing on a 24-hour schedule, for a total of 100 paired tows, or 200 total tows.

Objective: Determine differences in net performances during day and night. Compare overall results to smaller boat testing.

Objective: Provide information for New England Fisheries Management Council (NEFMC) implementation of net designs.

Approach

The research was conducted from a commercial fishing vessel, the F/V *Mary Elena*, a 27 m (90 ft) LOA, 653 kW (875 hp) Western-rig commercial trawler with Thyboron 4.2 m (96 in) type 4 doors. Testing took place in the Western and Eastern U.S./Canada areas, Georges Bank, USA over three trips: November 6–10, 2003, March 17-22, 2004, and December 8-17, 2006. An exempted fishing permit (EFP# 970254) allowing exemption from the haddock trip limits and cod landing limits was granted by the National Marine Fisheries Service (NMFS) and was valid during the first leg of the research. This EFP was extended for the second trip. An additional EFP was issued on November 29, 2006 for the remaining trip granting an exemption from groundfish trip limits, with restrictions of up to 140 hours of experimental towing time using the experimental and control nets.

The design of the control net was based on industry practice. This net (Figure 1) was constructed with 152 mm (6.0 in) diamond mesh openings[1], 3 mm (0.1 in) diameter polyethylene (PE) throughout, with a codend of 165 cm (6.5 in) black knotless square mesh, 25 meshes wide on the top and bottom and 50 meshes long. The headrope and 7.6 cm (3.0 in) diameter cookie-wrapped footrope lengths were 28.3 m (93 ft) and 33.8 m (111 ft) respectively. The fishing circle in the standard net was 360 meshes. Forty-eight 203 mm (8.0 in) floats were used.

The Topless experimental net (Figure 2) was constructed of PE mesh with 165 mm (6.5 in) black knotless square mesh in the codend, 25 meshes wide on the top and bottom and 100 meshes long. The bottom half of this trawl was comprised of 7.6 cm (3.0 in) cookie-wrapped footrope length of 33.5 m (110 ft) and 152 mm (6.0 in) diamond mesh webbing throughout. It had a fishing circle with 240 meshes and 25 203 mm (8.0 in) floats. The Topless net had no top wings, allowing the headrope to follow a taper of the net's gore, or selvedge, into a modified top belly, reaching a length of 47 m (154.5 ft).

The Ribas net (Figure 3) was identically constructed, except that 152 mm (6.0 in) diamond mesh on most of the top of the net was replaced with 203 mm (8.0 in) square mesh extending from the headrope to just before the codend. The square mesh consisted of several rectangular panels sewn to pieces of diamond mesh along the selvedge. This design had a headrope length of 33.5 m (110 ft).

[1] All mesh measurements are between the knots and nominal.

All three codends had chaffing gear on the bottom half, consisting of unbraided strands of PE twine. Both the control and experimental nets used 73.2 m (240 ft) of 7.6 cm (3.0 in) cookie wrapped ground cable and 36.6 m (120 ft) bridles.

Field Methods

Codend mesh openings were measured following the conclusion of the first two trips. Standard ICES protocol was followed during measurement, including the use of an objective mesh gauge (ICES, 2005).

Twin trawling (one vessel towing two nets side-by-side), using two tow warps and a center sled-design clump, was used on the first trip. On the second trip, a third wire winch was added to the vessel, and a three warp twin trawling method was used. Experimental and control nets were exchanged side-to-side after every tow during twin trawling. Single trawling (one vessel towing one net) was used during the third trip with the control and experimental nets alternating in pairs (alternate tows) in close proximity to one another, although not directly overlapping, in order to reduce the inherent variability that may exist due to a change in location.

Each trip generally concentrated on different areas of the Georges Bank, USA (Figure 4). Trip one occurred south of Closed Area 2; trip two occurred south of Closed Area 2 and south of Closed Area 1; trip three occurred between the northeast corner of Closed Area 1 and the northwestern side of the Haddock Special Access Program (SAP) area. Individual tow locations were based on captains' knowledge of the fishing grounds. However, for the third trip, greater restriction was placed on tow locations to achieve a wider geographic spread. For the first two trips, mixtures of Atlantic cod and yellowtail flounder were sought; the final trip concentrated on finding Atlantic cod with any other flatfish. Each trip was split into two parts. The first half of the trip tested the Ribas net against the control net; the second half tested the Topless net against the same control.

An Mk-9 Wildlife Computers (Redmond, WA) temperature/light/depth probe was mounted onto the headrope of the control net during trip 2, but did not function as anticipated. Nets and doors were equipped with net mensuration sensors and a Tidbit temperature logger (Onset Computer, Inc, USA) in order to estimate environmental conditions and net performances. In trips one and two, proper net configuration was monitoring using Netmind (Northstar Technical, Inc, Newfoundland) door spread and wing spread sensors. Simrad ITI (Kongsberg Maritime AS, Norway) sensors with a hull-mounted transducer were used to monitor door-to-sled and wing spreads; tow warp length was adjusted to maintain appropriate spreads. This system was property of the vessel, and was supplemented by a pair of sensors loaned from the Northeast Fisheries Science Center, NMFS. Due to hardware problems with a Notus Trawlmaster mensuration system (Notus Electronics Ltd, Newfoundland), no net or door geometry measurements were obtained during the third trip. Correct bottom contact, in the latter case, was made by crew estimates and observations of gear wear and the length of warp wire out.

We recorded time, tow duration, total codend catch weight, weather and sea conditions, starting depth, wire out, and the coordinates at the beginning and end of each trawl. The total tow durations varied within and between trips, although generally durations were approximately two hours. Variations in the durations were expected to minimally affect the mean length composition of trawl catches (Godø et al., 1990). Tow speeds were kept at around 1.5 m/s (~3 kt).

Catch composition, species weights, and lengths of selected species were collected for each catch. Codend catches were emptied into a confined space (checker) on the deck of the vessel. During twin trawling, both codends were brought on board and dumped into separate checkers. On the third trip, the nets were also completely shaken down to remove all catch. Pressurized seawater hoses were used to direct most of the catch onto a conveyor. The vessel and scientific crews then sorted the catch into separate containers, usually by species.

For large catches of non-target species, fish totes were filled and counted. Estimates of total catch of these species were obtained by averaging a sub-sample of weighed containers and applying it to the total tote count. The size of the sub-sample was based on the number of species present and time constraints; more totes were sampled in tows with larger species mixes. Extremely large catches of non-target species were not weighed individually and were considered the remaining weight of the full codend (determined using a crane scale, MSI 4300, Measurement Systems International, Seattle, resolution: ± 4.5 kg (10 lbs)) after the other species were weighed). Some large non-target catches were grouped into a "NK" (not known) category such as "Skate NK".

Weights were obtained for commercially and scientifically important species to the closest tenth of a pound using a pre-calibrated MSI CW6000 (Measurement Systems International, Seattle) motion compensated bench scale and Salter scales (Salter Brecknell, Fairmont, MN). Fish lengths were defined as the straight-line distance from the snout to the end of the fish's centerline when the fish was lying on its lateral surface. Sub-samples of lengths of the target fish species were collected from very large catches of those species. No less than 100 individuals were measured whenever possible in order to obtain adequate sample sizes without over-sampling. Samples of catches were expanded to the entire catch.

Analysis Methods

The map showing tow locations was generated with ArcMap GIS (ESRI, Redlands, CA) (Figure 4). Data were entered into a customized relational database included with report, using Microsoft Access. We carried out analyses using Microsoft EXCEL or the R statistical program. Analyses in R were conducted primarily using median values.

We adjusted catch and length-frequency data for each tow by the tow duration. Both lengths and weights were raised to the total amount of catch when sub-sampling occurred. Counts of sub-legal (<33 cm (13.0 in)) and legal-sized yellowtail flounder were derived from the total yellowtail flounder length frequency data and converted into catch weights using weight-at-length data provided by the National Marine Fisheries Service (NMFS).

Paired Analyses

For any given species, pairs of tows that had no catch (zero values) for both control and experimental nets were not included in these statistical tests; only paired tows with at least one fish present in either net were included in analyses for that species.

Absence from both tows of a pair was considered evidence of the absence of that species from the area. No adjustment was used to account for the different fishing techniques between twin and alternate towing, as comparisons centered on complementary pairs of tows.

Scatterplots were constructed for each selected species showing catch weights (kg/hr) for the paired experimental nets with an equal catch line. Data points above the equal catch line show pairs of tows where the catch was higher in the experimental net; data points below the lines show tow pairs where the catch was greater in the control net.

Quantile-quantile normal distribution (Q-Q norm) plots were examined to determine deviations from normality for the difference in paired tows and $\log_2(x+1)$ transformed paired tows for each selected species. As non-normality was apparent in all cases, untransformed and transformed, non-parametric randomization testing was used.

Catch rates of Atlantic cod, yellowtail flounder (total, legal-sized, and sub-legal-sized), American plaice, grey sole, haddock, American lobster, monkfish *Lophius americanus*, and winter flounder were tested for significance using paired non-parametric randomization testing with 1000 iterations ($\alpha = 0.10$). This method preserves the value of pairing that is lost using non-paired randomization testing, such as used by Rago (2004) and Pol (2006). For each analysis, adjusted catch rates of each pair were randomly assigned, without replacement, to one of the two net types, and mean differences were calculated. We compared the observed difference in paired treatments against a distribution of the randomly assigned paired values. The reported probability value is the proportion of the randomly determined differences that are greater than or equal to the actual observed value (Sprent, 1989). Probability values will vary with repeated runs; we report the more likely result.

Differences of paired catch data were assembled into depth groups of 10 fathom increments based on the average start depth of the hauls. Box and whisker plots were constructed for this data.

Diel Analyses

Day was defined as sunup to sunset (when the sun first appears at the horizon until it disappears). Local sunup and sunset times were acquired from the U.S. Naval Observatory (http://aa.usno.navy.mil/) to the closest 30-minute latitude and longitude coordinates and are accurate to the nearest temporal minute. Transitional periods between day and night are referred to as dawn, which ends at sunup, and dusk, which begins at sunset. We considered multiple thresholds that define when dawn begins and when dusk ends (Helfman, 1993). Civil and astronomical twilight represent the extreme sun declinations that define these categories and we ran analyses using both thresholds of twilight. U.S. Naval Observatory computational definitions for sunup, sunset, and twilight periods were used.

We placed tows into the sun cycle categories “dawn”, “day”, “dusk”, or “night” based on the period where the majority of the tow occurred. Tows that occurred primarily during dawn and dusk were removed from the analyses along with the complementary pair. Randomization testing was repeated for each species group of interest, using both definitions of twilight.

Length Distribution Analyses

Adjusted length frequency data were collected for selected commercial species of concern caught throughout the experiment. Only those target species caught in reasonable weights are presented and include Atlantic cod, American plaice, grey sole, haddock, monkfish, winter flounder, and yellowtail flounder. Over the three trips, length data were consistently collected for Atlantic cod, winter flounder, and yellowtail flounder. For other species, length data were not consistently collected. The catch weight data does provide complete species catch information for each haul over all trips (Table 1). Further analyses were completed for American lobster although no length data were recorded.

Length data were examined by net types, trips, and the diel variations using both box and whisker plots (McGill et al., 1978) and length frequency histograms. Boxplots were drawn using the 25th and 75th quantiles as lower and upper limits, with a bar representing the median. The distance between the quantiles is called the interquartile range (IQR); approximately 50% of observed values are within this range. Whiskers extend to at most 1.5 times the IQR and end at an observed value. Points beyond the whiskers are greater than 1.5 times the IQR and can be considered outliers (Sokal and Rohlf, 1995). Box widths are proportional to the square roots of the sample sizes within each grouping. Bins (1 cm) for the histograms were calculated as the range of represented lengths for each species and group. Only histograms of relevance are presented. In order to facilitate analyses using the R statistical package and avoid the R rounding convention, which rounds towards the nearest even integer, the adjusted count data was multiplied by 10 to obtain an even integer. Therefore, relative length frequency data are presented.

Findings/Results

General

One hundred and twelve valid tows were completed during the three trips. Twenty-four twin trawls occurred during the first trip: 12 Ribas/control net pairs and 12 Topless/control net pairs. Sixteen twin trawls were completed during the second trip: 8 Ribas/control net pairs and 8 Topless/control net pairs. The final trip was composed of 16 pairs of alternate hauls; 8 were Ribas/control net pairs and 8 were Topless/control net pairs. Tow locations were dispersed over Georges Bank (Figure 4).

Data on over 74,200 kg (163,582 lbs) of estimated catch including over 50 species or species groups were collected (Table 1 and Appendix 1). Species composition varied over the course of the experiment due in part to the lengthy time frame (2003, 2004, and 2006) and large area (Figure 4). Of the primary species of interest, Atlantic cod were caught, in relatively low weights, on trips two and three only (Table 1). Yellowtail flounder were caught on all three trips; however, the majority of yellowtail were caught during trip one.

Trip-by-trip length frequency distribution plots for all species of concern did not identify any major differences in size structures or net performances (Figures 5-7). Therefore, in order to maximize our sample sizes for later analyses, we combined the data for all trips. For some species, such as Atlantic cod and haddock, observed differences in size structures are partially due to small sample sizes. Results for the sub-legal-sized yellowtail flounder likely indicate an actual change in the size structure within trip three. Trip two is expected to show the greatest difference in size structures due to seasonal differences; trip two occurred in March while trips one and three occurred in November and December respectively. However, the greatest size structure differences occur between trips one and three suggesting that the structures changed over a time series. Further and more detailed analyses in trip variations are completed in the net specific sections below.

Since civil twilight allows for greater sample sizes, randomization results will be discussed using only this definition.

Depth analyses indicated that no trends for differences in paired net efficiencies were evident for most species over 18 m (10 fm) depth ranges. Sub-legal-sized yellowtail flounder in the control/Ribas and control/Topless pairs show some trend towards the control net with decreasing depth although the results are based on small sample sizes for the shallowest and deepest depths. Box and whisker plots for all other species generally show equal efficiencies of experimental and control nets over all depth groups and therefore, the plots are not presented in this paper.

Box and whisker plots revealed that all the net's measured codend meshes had interquantile ranges within 2 cm of each other. Standard deviations for measured codend meshes were not greater than 0.127 cm (0.05 in). This plot is also not presented in this paper.

Ribas Net

Atlantic cod and other roundfish

Catch and randomization results for Atlantic cod, haddock, and monkfish are provided in Tables 1-4 and Figures 8-16.

Randomization tests for Atlantic cod and monkfish catch weights showed no significant differences between the control and Ribas nets (Table 2); however, the Ribas net did significantly reduce catches of haddock. Scatterplots of the tow pairs for Atlantic cod (Figure 8) show approximately equal numbers of pairs above and below the equal catch line, an indication that overall, catch rates were similar in the control and Ribas nets. The monkfish scatterplot shows a slight trend favoring higher catches within the control net. The haddock scatterplot is noticeably different; the catch of haddock in the Ribas net was almost always lower than in the control net.

Diel analyses of both Atlantic cod and monkfish catches revealed no significant differences for catch between the control and Ribas nets during the day or night (Tables 3 and 4). The Atlantic cod diel analyses results are based on limited numbers of pairs: five pairs during the day and six pairs during the night. The difference in haddock catches continued to be significant when examined separately for day and night tows.

Comparison of length distributions of Atlantic cod caught by the Ribas and control nets during the entire experiment showed overlapping interquartile ranges for box and whisker plots, and histograms within and between trips (Figures 9 and 10) and diel periods (Figures 13 and 14) although distribution shapes varied somewhat. However, these differences are likely due to a small number of small fish (one fish each at 22 and 25 cm (8.7 and 9.8 in)) caught in the Ribas net on trip two at night.

Similarly, comparison of haddock length frequency distributions between trips and nets, and for the diel analysis, is difficult because catches were extremely low in the Ribas net (Table 1). Haddock length frequency distributions within trips show overlapping interquartile ranges for fish caught in the control net and Ribas net (Figure 9). Haddock caught on trip one in the Ribas and control net were predominately of similar small size (16-23 cm (6.3-9.0 in)) (Figure 11). The box and whisker plot and histogram for haddock lengths within the control net during the day indicate a bimodal pattern with a smaller length class barely present at night (Figures 13 and 15). The bimodal pattern is also seen in the low Ribas catch. Box and whisker plots and histograms for monkfish are shown to be largely in agreement within and between trips (Figures 9 and 12) and diel periods (Figures 13 and 16).

Yellowtail flounder and other flatfish

Results for yellowtail flounder (grouped by legal, sub-legal, combined), winter flounder, grey sole, and American plaice are provided in Tables 1-4 and Figures 8 and 17-25.

Randomization tests for all flatfish species and groups except for winter flounder showed significant differences in catches between the control and Ribas nets (Table 2). Scatterplots for yellowtail flounder and the other flatfish generally indicate similar catches in Ribas/control pairs for each species except winter flounder (Figure 8). When large catches were encountered, the control net nearly always had a larger catch than the Ribas net, as evidenced by points distant from and below the equal catch line; winter flounder showed slightly larger, but not statistically different catches within the Ribas net (Table 2). Diel analyses comparing these nets also found no significant differences for any flatfish species or group with the exception of sub-legal-sized yellowtail flounder which had significant reductions in the Ribas net during the day (Table 3) and night (Table 4).

Yellowtail flounder length frequency distributions separated by nets indicated that the distributions are mostly similar within trips (Figure 17). During trip three, yellowtail caught in the Ribas net were generally smaller than fish caught in the control net, although the number caught in the Ribas net and trip three overall was small (Table 1). Closer examination of the underlying histogram for both of these cases showed that differences in distributions are small (Figure 18). No major night-and-day differences were seen for lengths of yellowtail flounder (Figures 19 and 20).

Overall within-species length frequency distributions were similar at the trip levels for grey sole and American plaice in both the control and Ribas nets (Figure 21). Winter flounder distributions by trip and nets show some variation although the overall median difference is negligible. Length frequency histograms for all flatfish are not shown since the box and whisker plots suitably explain the distributions. The sizes of flatfish were different between species; winter flounder and grey sole were largest (median: 41-48 cm (16.1-18.9 in) and 41-45 cm (16.1-17.7 in) respectively), and American plaice smallest (median: 31-39 cm (12.2-15.4 in)). No major night-and-day differences were seen for lengths of winter flounder, grey sole, or American plaice (Figure 22-25).

American lobster

The randomization tests showed no significant difference for American lobster using the Ribas/control pairs (Table 2). No differences were seen in lobster catches between nets during the day (Table 3) or night (Table 4). Scatterplots of lobster catches showed no apparent pattern in catch weights between the Ribas and control nets (Figure 8). No length data was collected for American lobster during this study. No box and whisker plots or histograms were generated.

Topless Net

Atlantic cod and other roundfish

Catch and randomization results for Atlantic cod, haddock, and monkfish are provided in Tables 1-4 and Figures 26-34.

Paired randomization tests for Atlantic cod, haddock, and monkfish catch weights showed significant reductions in catch in the Topless net compared to the control net (Table 2). Scatterplots of the tow pairs for Atlantic cod and monkfish show that for the majority of tow pairs, the control nets caught more for each of these species (Figure 26). The catch of haddock in the Topless net was always lower than in the control net. Significant differences between the Topless and control net for all three species were present for daytime and nighttime pairs (Tables 3 and 4).

Length distributions of Atlantic cod were similar between trips and for Topless and control nets (Figures 27 and 28); respective monkfish lengths were also not different (Figure 30). Box and whisker plots of haddock lengths appeared to be somewhat different between the nets and trips (Figure 29); however, these differences are based on very small sample sizes.

Diel comparisons for lengths of Atlantic cod indicated no night and day differences within the Topless and control nets (Figures 31 and 32); no differences were observed between nets as well. No haddock were caught during the day in the Topless net and night tows were comprised of extremely small counts (Figure 33). In the control net, haddock of similar lengths were caught during day and night although the interquartile ranges appear very different which again are affected by small sample sizes in the daytime tows. No difference in length distributions during day and night was found for monkfish in the control net (Figure 34); the topless net shows different interquartile ranges in the diel cycles although this data are based on small counts.

Yellowtail flounder and other flatfish

Results for yellowtail flounder (grouped by legal, sub-legal, combined), winter flounder, grey sole, and American plaice are provided in Tables 1-4 and Figures 26 and 35-43.

Scatterplots for yellowtail flounder and other flatfish show a general trend of larger catches in the control net (Figure 26). We found significant differences between the Topless and control nets using paired randomization tests for catches of legal and sub-legal-sized yellowtail flounder, American plaice, grey sole, and winter flounder (Table 2). Significant reductions also occurred for American plaice and grey sole during the day (Table 3) and for legal and sub-legal yellowtail, American plaice, and winter flounder during the night (Table 4).

Total yellowtail flounder length distributions by trip and net type show two modes and a smaller size group during trip three (Figures 35 and 36). Length frequency distributions of yellowtail flounder are largely similar between day and night (Figures 37 and 38).

Within-species length frequency distributions of American plaice, grey sole, and winter flounder were similar for the Topless and control nets over all trips (Figure 39) and for diel periods (Figures 40-43), although the length ranges and medians were different for different species.

American lobster

The Topless net significantly reduced the lobster catch overall (Table 2) during the day (Table 3), and at night (Table 4) compared to the control net. Scatterplots of lobster catches showed that most tow pairs had greater catch weights in the control net, including some tows with over 27.2 kg/hour (60 lbs/hour) of lobster (Figure 26). As noted earlier, no length data was collected for American lobster during this study. No box and whisker plots or histograms were generated.

Discussion

The primary goal of this project was to reduce Atlantic cod catches while retaining legal-sized yellowtail flounder catches using the Topless and Ribas trawl nets. Both nets were designed to exploit natural stratification and behavior under pursuit and encourage escapement by or avoidance of Atlantic cod. The original study on inshore vessels using a smaller version of the net during the day showed success at decreasing Atlantic cod catches with both designs (Pol et al., 2003). The current research, conducted over a large offshore area during all hours, showed that the Topless net met the goal of reducing catch rates of Atlantic cod which occurred during daytime and nighttime tows, and sub-legal-sized yellowtail, but only during nighttime tows (Tables 2-4). Unfortunately, legal-sized yellowtail flounder were also significantly reduced during the night. Additional significant reductions were found in American plaice, grey sole, haddock, lobster, monkfish, and winter flounder as compared to the control net. The Ribas design did not meet the goals of significantly reducing catches of Atlantic cod and maintaining legal-sized yellowtail flounder. Sub-legal yellowtail were significantly reduced during both time periods; American plaice, grey sole, and haddock were also significantly reduced in the Ribas net while winter flounder, monkfish, and lobster were not.

Escape of Atlantic cod upward in the Topless net is consistent with results of earlier work by Pol et al. (2003) and Madsen et al. (2006). The reduction in the Topless net occurred during the day and at night (Tables 3 and 4), suggesting that Atlantic cod could perceive the top exit and avoid capture under all light conditions. This upward escape behavior appeared to occur in our study despite other research describing a tendency to stay close to the sea bed, especially during the day (Main and Sangster, 1982; Ferro et al., 2007). Madsen et al. (2006) tested a flatfish net design similar to the Ribas net with 400 mm (15.7 in) meshes in the square and first belly section, which are larger meshes than in the Ribas design. Their results showed a significant reduction in cod catch compared to a standard flatfish net, a result similar to the smaller Ribas net used by Pol et al. (2003) but unlike the larger Ribas net results of this study. The overall net design used by Madsen et al. (2006) could be described as intermediate between the Ribas and Topless net. Their net's ability and the Topless net's ability to reduce cod catch suggests that the mesh sizes in the top of the Ribas net were not large enough to allow Atlantic cod to escape, either due to a visual stimulus or mechanical blockage of upward swimming. Observation of nighttime contact between top meshes and Atlantic cod could verify this theory.

Both nets reduced catches of haddock (Table 2). Haddock have been observed to swim upward when herded (Main and Sangster, 1981b; pers. comm., P. He, University of New Hampshire), and in numerous studies, have been caught in the upper half of separator trawls (for example, Main and Sangster, 1982; La Valley, 2007). The use of large meshes in the top portions of a net has been found to allow haddock escapement. The escape of haddock through square mesh panels is also consistent with findings by Engås et al. (1998) who used a square mesh panel within a groundfish net round the clock. Based on the work by Pol et al. (2003) and contemporaneous research with the Ribas and Topless nets, we conclude haddock most likely escaped over the top of the net. This escape occurred during both day and night tows which suggest haddock could perceive and exit the openings under all light conditions (Tables 3 and 4). Differences in the headrope heights between the control and Ribas net (the Topless net did not have a traditional headrope) could partially account for a difference in escapes. However, due to monitoring of the nets during the study, and similar footrope/headrope designs, this factor was discounted as an explanation for the catch differences.

Monkfish showed significantly decreased catches in the Topless net pairs and did not show diel differences (Tables 2-4). These fish have been observed to show no directed swimming or response to trawl presence or contact (Reid et al., 2007). Hannah et al. (2005), while testing a design similar to the Topless net, noted that lower wings and the absence of webbing facilitate fish escape and also allow more time for escape to happen. Testing of an unscaled Topless net model in a flume tank (Winger et al., 2006) suggested that the wings had low resistance to contact (DMF, unpubl. data). Thus, the escape of monkfish may have been due (or partially due) to passive tumbling over the top of the wings. This behavior is probably not conditioned by light, and thus is consistent with our observations and with those of Reid et al. (2007). Other possibilities, such as changes in selectivity of codends due to changes in catch volumes or the footrope not making bottom contact are unlikely since similar length frequency distributions were generally seen within all nets (Figures 9 and 27) at each diel period (Figures 13 and 31).

The Topless and Ribas nets showed a significant reduction in catches compared to the control net for legal and sub-legal-sized yellowtail flounder, American plaice, and grey sole; winter flounder were only significantly reduced in the Topless net (Table 2). Significant diel differences in catches within flatfish species for both nets were found (Tables 3-4). Explanations of flatfish behavior in trawl capture have typically treated all flatfish as if their reactions were similar (Walsh and Hickey, 1993; Bublitz, 1996; Winger et al., 2004). Interspecies differences in flatfish behavior during trawling are difficult to study due in part to low light levels, water clarity, and camera sensitivities. Our extensive filming of trawls has rarely allowed identification of any one of the more than ten species of flatfish present locally (DMF, unpubl. data). Catch results from this study suggest that significant differences in behavior or orientation that affect trawl capture exist among flatfish species. The experience of the authors and of others (Bublitz, 1996;

He, 2003) indicates that flatfish rarely venture off bottom when pursued by trawl nets, and thus changes to the tops of nets should not affect catchability. However, Bublitz (1996) observed two types of behavioral reactions by unspecified flatfish. The first is consistent with our experience; flatfish pass into the net just over the footrope. In the second, flatfish rose slowly to heights above 37 cm (14.6 in) and either swam in the tow direction or turned and swam into the net. Greenland halibut have been observed to express vertical swimming behavior to escape from the sea floor to over the headrope (Albert et al., 2003). Off-bottom behavior of yellowtail flounder has been observed with increased height at night (Sissenwine and Bowman, 1978; Cadrin and Westwood, 2004; Walsh and Morgan, 2004; Ferro et al., 2007). Ryer and Barnett (2006) identified four categories of immature flatfish response to disturbance, two of which involved vertical movement that may have been adequate to avoid capture by a low-rise trawl. Vertical responses were more common during low light conditions. Any of the flatfish reductions we observed could be due to these types of reactions, which might allow sufficient height to escape over wings or headrope.

Our observations of size-related differences in yellowtail flounder behavior are partially consistent with earlier work. Beamish (1966) and Walsh (1988) found diel differences in catches of yellowtail flounder <22 cm (8.7 in), somewhat smaller than our sub-legal yellowtail (<33 cm (13.0 in)). Behavioral differences between yellowtail >22 cm (8.7 in) and <22 cm (8.7 in) might be ontological as yellowtail flounder typically mature only at 20 cm (7.9 in) (Collette and Klein-MacPhee, 2002). While sub-legal (<33 cm (13.0 in)) yellowtail are fully mature (O'Brien et al., 1993), and thus ontological differences probably do not apply in this case, some species of flatfish show size differences in swimming strategies (Winger et al., 1999; 2004). Georges Bank yellowtail flounder show sex-related length differences, with males maturing earlier at shorter length (O'Brien et al., 1993). Males and females can segregate (DMF, unpubl. data). Therefore, differences in catch rates related to size may also be related to gender. We did not collect data on fish gender during this study.

American lobster catches were significantly reduced in the Topless net but not the Ribas net; these results were unaffected by day or night periods. Observations of Norway lobster *Nephrops norvegicus* by Newland et al. (1992) demonstrate that trawl gear induces particular escape behaviors dependent upon the lobsters' initial orientation. Those facing away from the approaching gear perform an escape behavior upwards and backwards into the water column, once stimulated; those facing towards the approaching trawl swim in the opposite direction. Once stimulated, the Norway lobster will begin to orientate itself perpendicular to the approaching gear or continue to perform the escape reaction. An upward movement would likely favor escapement of American lobster, a similar species to the Norway lobster, from the Topless net rather than the control or Ribas nets since additional opportunities exist to clear the effective fishing area, especially over the wing sections.

It was not within the scope of this study to examine day-night differences within the control net catch or the combined catch in control and experimental nets; that is, we did not examine whether some species showed changes in their availability to trawl gear in general during day and night, although such differences have been found for trawl survey gear (Walsh, 1988). However, other gear research did not find these differences (Sangster and Breen, 1998). We did discover that winter flounder catches in the

Ribas/control pairs during the night were extremely low (n=4); the lack of data do suggest that winter flounder are less vulnerable in general to flatfish trawls at night.

Day-night differences in fish avoidance observed in this study are partially consistent with previous work (Glass and Wardle, 1989; Glass et al., 2004) suggesting that some light is necessary for fish to react to trawl gear. The collection of information on light levels during tows has long been advocated by gear researchers to fully understand the fish capture process. Our experiences with this study reinforce this position on light importance by establishing that diel differences exist but is confounded by complex factors to record such as celestial and atmospheric conditions. Additionally, an analyst must choose among multiple definitions of twilight, and amongst models of fish reaction (as described in Hjellvik et al., 1999). Even with knowledge of these factors, the light level on bottom is difficult to know. Jamieson et al. (2006) suggests that bioluminescence generated by the trawl itself while fishing may provide adequate light to stimulate a fish escape response. Walsh and Hickey (1993) showed that the presence of artificial light using light sticks on a trawl net at night did not change escape responses (during darkness) for Atlantic cod, haddock, other roundfish, and unknown flatfish. However, this may have been due to the fishes lack of acclimation time to the new light conditions.

Comparative field experiments of two nets at similar light levels are likely only reasonable or possible using twin trawling. Our limited success with the twin trawling technique in this experiment was heavily reliant on the skill of the vessel captain and the availability of suitable ground for twin trawling.

Despite strong efforts to find appropriate mixtures of species to test our main hypotheses, our success was limited by the low stock sizes of both yellowtail flounder and Atlantic cod during most of the study. We were also reliant on the traditional ecological knowledge of our industry partners, which varied during the study, to locate appropriate times and places to find species mixes. Actual pairs of tows where a species was caught in one of the paired tows were far fewer than 56 (the total pairs conducted). For example, only 14 pairs of tows out of 23 completed with the Ribas and control nets had Atlantic cod catches in one or both of the two net pairs. This quantity of pairs is a disappointment for the project. The amount of Atlantic cod was also low within each haul; the maximum catch in the control net was less than 27.2 kg/hour (60 lbs/hour), despite our attempts to concentrate on catching Atlantic cod in our third trip. However, as Atlantic cod is a non-target species in the flatfish fishery, we consider conclusions based on this number of pairs and amounts to be valid and useful. Catches of other commercially important species approached or met commercial quantities on some tows.

Possible compromises in the integrity of the nets as they fished were unlikely to have impacted catches in the valid tows. Although net mensuration data were sparse and overall unreliable, correct door spreads and known net geometries while fishing, evidence of similar length frequency distributions of fish stocks within pairs, and the experience of the vessel captains leads us to believe that all nets fished as intended.

Observed differences between trips or nets in length frequency distributions, such as with haddock, are likely due, in some cases, to small sample sizes, changes in the length structure of the population, different fishing areas (even though it is considered the same stock), or a difference in performance of fishing technique (twin trawling vs. alternate trawling). Sangster and Breen (1998) found no significant difference for haddock, plaice *Pleuronectes platessa*, and anglerfish *Lophius piscatorius* in twin and alternate trawls; significant differences were detected, however, for Atlantic cod and *Nephrops norvegicus*.

Concerns over catches of Atlantic cod in flatfish fisheries on eastern Georges Bank, USA, led to the creation of a special access program. Fishermen may currently fish for flatfish in this area (the Eastern U.S./Canada Area (EUSCA)) if they use a two seam, low-rise trawl net either with a maximum footrope length not greater than 105 ft (32.0 m) and a headrope is at least 30 percent longer than the footrope, measured from the forward wing end; or with the top panel of the net containing a section of mesh at least 10 ft (3.05 m) long, stretching from selvedge to selvedge, composed of at least 12–in (30.5–cm) mesh that is inserted no farther than 4.5 meshes behind the headrope (50 CFR 649.85 (3)(iii)(B)(1) and (2)). The first design describes a Topless-style net; the second is similar to the Ribas design, but with a larger mesh on top. The fishery where these nets must be used is a 24-hr fishery.

Our new results establish that the Topless net design is effective for avoiding Atlantic cod. The Ribas net did not significantly reduce Atlantic cod catch during day or night. The difference in results between Pol et al. (2003) and this study indicate that one, some, or all of the factors of larger net size, deeper depths, larger vessels, or day and night conditions impact the ability of these nets to avoid cod. Cod catch data from the 24-hr EUSCA fishery should be evaluated to determine if the commercial implementation of this design has been sufficiently effective. These results also establish that the catch efficiency for legal-sized yellowtail flounder was reduced by the Topless design during nighttime tows. This loss of efficiency should be of interest to the commercial fleet and influence their use of this design in the fishery.

Overall reductions for all commercially important species in the Topless design suggest it may not be economically sustainable on its own within a dedicated flatfish fishery. However, as a supplementary special access program which does not utilize regular allotted fishing days, the reduction in catch may be acceptable to the fishing community. Also, weak stock management may dictate the future of this fishery and necessitate available options such as the Topless net.

The Topless design can easily be replicated and applied to daytime flatfish fisheries around the globe where roundfish reductions are desired. Also, this gear is comparatively easy to define in legislation. This study emphasizes the importance of diel cycles and/or light levels on the reaction of fish to gear modifications. Future gear innovations must consider the impact of light levels during design, testing, and implementation on a regional basis. Twin trawling is a valuable method which removes some of the problems associated with comparing paired samples during a changing diel cycle. Our results also establish differences between flatfish species behaviors in a trawl net. The advancement of technology, including lower light, higher resolution cameras, and advanced sensors, should aid researchers attempting to define and describe differences in species behaviors.

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Media

Photographs

Digital photographs of field research are provided on DVD along with this report. The photographs are indexed by file name, size, captions, and keywords in Appendix 2.

Video

Videos showing field research are provided on DVD along with this report. The videos are indexed by the DMF tape ID, film title, description, and the original recorded medium in Appendix 3.

Data

A customized relational database developed for the project containing all catch data is included with the report on a CD.

Acknowledgements

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Author Responsibilities

David Chosid sea-sampled, assisted design and construction of the project database, entered data, conducted most of the data analysis, conducted purchasing, wrote interim reports and wrote the majority of the final report. Michael Pol contributed to the proposal, sea-sampled, conducted purchasing, assisted design and construction of the project database, entered data, wrote interim reports, contributed to the writing of the final report, and provided overall supervision. Mark Szymanski sea-sampled, managed equipment and purchases, and contributed to the final report. Luis Ribas developed and constructed the nets used in the study, provided input in sampling times and locations, and provided editorial input. Thomas Moth-Poulsen revised the sampling design, sea-sampled, contributed to project management, and provided editorial input.

Table 1: Total catch by weight and number of tows over all three trips for each species. The species of concern in this paper are presented in the top section. Species whose total over all three trips were less than 45.3 kg (100 lbs) and weights of sea stars, snails, and sponges are not displayed. Scientific and common names for all species are presented in Appendix 1.

	Trip 1			Trip 2			Trip 3		
Species	Control	Ribas	Topless	Control	Ribas	Topless	Control	Ribas	Topless
Valid tows (number)	24	12	12	16	8	8	16	8	8
Flounder, Yellowtail	6367.4	1936.0	1563.9	347.0	95.9	100.7	183.7	7.7	71.6
Monkfish (Angler, Goosefish)	1572.1	681.9	227.8	319.1	204.5	48.5	426.9	243.6	55.5
Haddock	6.7	0.1	0.0	69.3	3.0	16.2	1322.3	15.4	16.8
Lobster, American	291.1	106.0	49.6	5.2	5.6	0.0	514.7	275.2	88.1
Flounder, American Plaice (Dab)	0.7	0.0	0.0	19.3	0.5	3.2	836.4	308.2	158.6
Flounder, Witch (Grey Sole)	6.3	2.8	0.5	345.1	208.1	52.5	258.0	124.2	78.2
Cod, Atlantic	0.0	0.0	0.0	121.9	5.3	55.2	287.9	72.1	62.5
Flounder, Winter (Blackback)	300.2	86.5	81.2	40.9	11.8	13.9	15.6	2.3	3.4
Skate, Winter (Big)	0.0	0.0	0.0	7460.9	2121.4	3573.3	4581.9	211.1	882.3
Skate, Little	0.0	0.0	0.0	1865.9	513.7	802.7	7881.6	1595.6	2714.6
Skate, Nk	6944.6	4202.1	1370.3	0.0	0.0	0.0	43.0	0.0	579.8
Skate, Barndoor	77.0	25.2	0.0	107.2	33.5	19.9	703.6	338.3	72.0
Scallop, Sea	582.4	624.7	1.7	3.5	1.6	2.4	15.9	6.5	42.6
Flounder, Sand Dab (Windowpane)	0.0	0.7	0.5	572.5	53.5	227.7	44.6	1.8	26.7
Raven, Sea	0.5	3.4	0.0	137.7	31.9	38.5	100.3	7.7	20.2
Flounder, Fourspot	118.8	35.7	4.9	3.2	3.1	0.0	47.7	22.9	17.3
Sculpin, Longhorn	94.3	36.8	7.7	10.4	0.0	2.3	69.4	2.9	1.4
Flounder, Summer (Fluke)	2.7	4.3	0.0	80.5	23.5	31.3	8.4	0.0	4.1
Skate, Smooth	0.0	0.0	0.0	0.0	0.0	0.0	119.4	28.5	5.7
Pollock	0.0	0.0	0.0	3.6	0.0	0.0	119.1	10.0	3.4
Crab, Jonah	0.0	0.0	0.0	0.1	1.5	0.2	32.3	56.9	16.5
Skate, Thorny	0.0	0.0	0.0	1.8	0.0	1.1	44.8	36.0	16.8
Hake, Silver (Whiting)	1.0	0.5	0.0	0.0	0.0	0.0	69.7	2.9	3.3
Skate, Clearnose	0.0	0.0	0.0	0.0	0.0	0.0	60.7	15.4	0.0

Table 2: Results from randomization tests for various species and groups divided into Ribas/control paired tows and Topless/control net paired tows. “n” is the sample count. The sample mean and variance are derived from the actual differences in paired catch weight per hour (kg/hr) samples (control – experimental). Probability values below α = 0.10 are in bold.

	Ribas / control pairs				Topless / control pairs			
Species	n	sample mean	sample variance	probability	n	sample mean	sample variance	probability
Atlantic cod	14	2.7	62.0	0.12	19	4.2	47.4	**<0.01**
yellowtail flounder	21	43.2	19470.8	**0.09**	22	16.3	1752.4	**0.04**
legal yellowtail flounder	21	46.1	22725.0	**0.07**	22	15.4	1646.0	**0.05**
sub-legal yellowtail flounder	18	1.0	2.9	**<0.01**	19	1.8	16.9	**0.01**
American plaice	15	9.6	574.7	**0.04**	20	5.9	55.8	**<0.01**
grey sole	22	2.0	26.1	**0.05**	21	2.1	24.4	**0.02**
haddock	21	10.2	249.0	**<0.01**	15	31.6	10117.6	**<0.01**
lobster	21	2.3	102.8	0.17	21	4.9	62.3	**<0.01**
monkfish	28	3.1	150.1	0.10	27	9.7	107.4	**<0.01**
winter flounder	10	-0.4	11.0	0.66	17	3.5	40.9	**0.01**

Table 3: Results from randomization tests for various species and groups during the day defined by civil twilight divided into Ribas/control paired tows and Topless/control net paired tows. “n” is the sample count. The sample mean and variance are derived from the actual differences in paired catch weight per hour (kg/hr) samples (control – experimental). Probability values below $\alpha = 0.10$ are in bold.

	day tows (civil twilight)							
	Ribas / control pairs				Topless / control pairs			
Species	n	sample mean	Sample variance	probability	n	sample mean	sample variance	probability
Atlantic cod	5	1.4	27.9	0.31	9	2.8	28.6	**0.07**
yellowtail flounder	10	58.4	34124.3	0.25	13	8.5	1648.1	0.32
legal yellowtail flounder	10	64.1	40810.3	0.24	12	9.8	1727.0	0.30
sub-legal yellowtail flounder	8	1.3	5.4	**<0.01**	10	0.2	0.5	0.16
American plaice	6	14.8	1318.8	0.21	10	6.8	75.8	**<0.01**
grey sole	10	0.7	17.9	0.34	10	2.5	12.8	**0.04**
haddock	10	7.7	79.6	**<0.01**	5	1.7	0.4	**0.02**
lobster	8	3.6	99.1	0.20	11	5.2	66.3	**0.03**
monkfish	13	3.2	235.3	0.30	15	8.2	78.8	**<0.01**
winter flounder	6	-1.0	15.2	0.75	10	2.1	42.0	0.22

Table 4: Results from randomization tests for various species and groups during the night defined by civil twilight divided into Ribas/control paired tows and Topless/control net paired tows. “n” is the sample count. The sample mean and variance are derived from the actual differences in paired catch weight per hour (kg/hr) samples (control – experimental). Probability values below α = 0.10 are in bold.

	night tows (civil twilight)							
	Ribas / control pairs				Topless / control pairs			
Species	n	sample mean	sample variance	probability	n	sample mean	sample variance	probability
Atlantic cod	6	2.9	28.4	0.17	7	3.6	8.6	**0.02**
yellowtail flounder	10	32.1	8566.5	0.15	8	30.3	2081.2	**<0.01**
legal yellowtail flounder	10	32.4	8909.1	0.15	8	27.6	1936.7	**<0.01**
sub-legal yellowtail flounder	7	0.7	1.4	**0.07**	8	3.6	34.8	**0.02**
American plaice	6	2.0	62.9	0.37	7	1.3	1.2	**0.03**
grey sole	10	3.0	37.8	0.11	8	2.4	49.5	0.31
haddock	8	11.1	420.0	**0.03**	7	63.8	21311.7	**0.01**
lobster	10	3.8	94.8	0.11	7	6.2	82.0	**0.02**
monkfish	12	3.0	99.2	0.16	9	12.6	188.4	**<0.01**
winter flounder	4	0.4	6.1	0.50	7	5.6	37.5	**0.01**

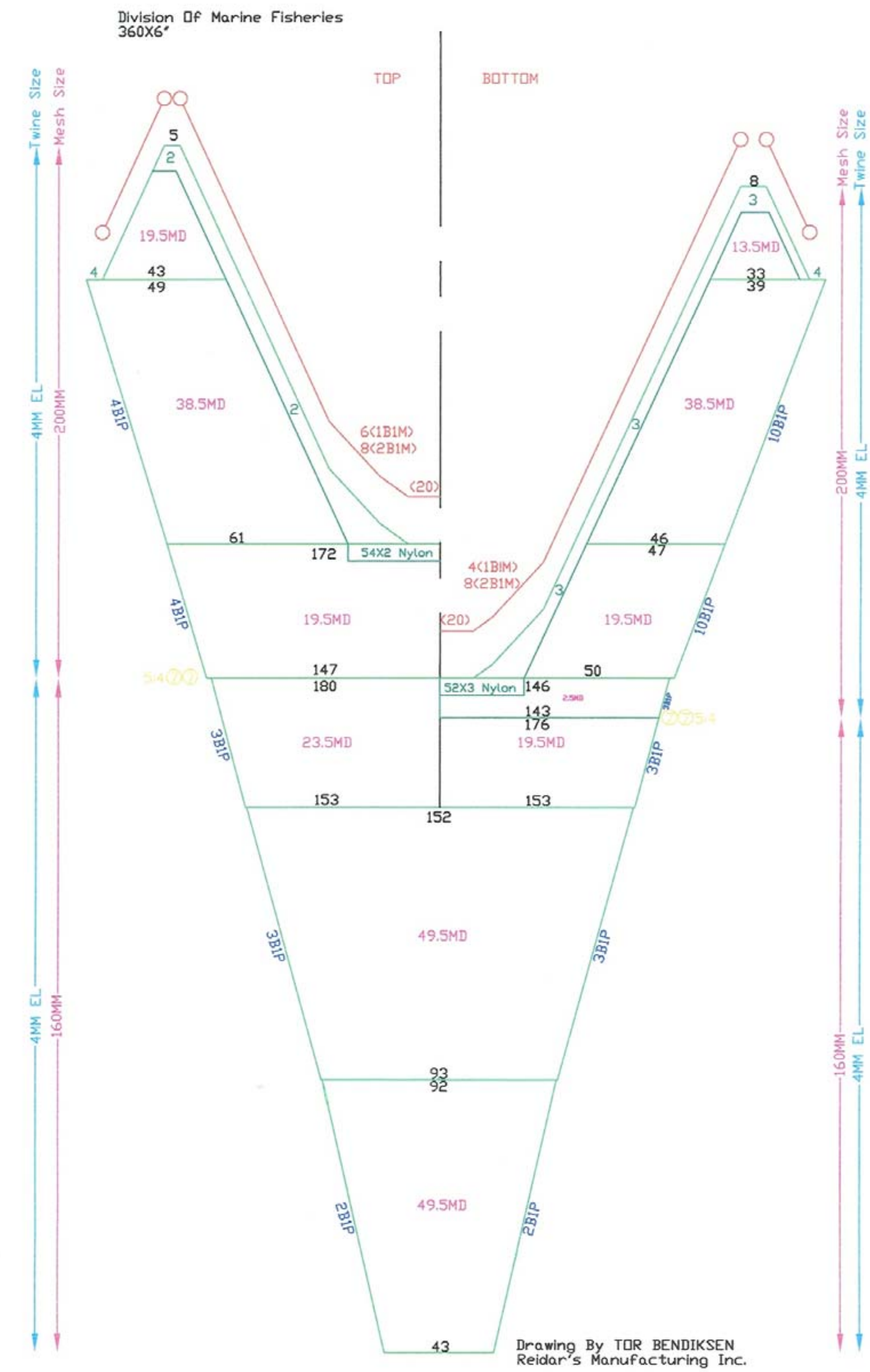

Figure 1: Diagram of the standard flatfish control net.

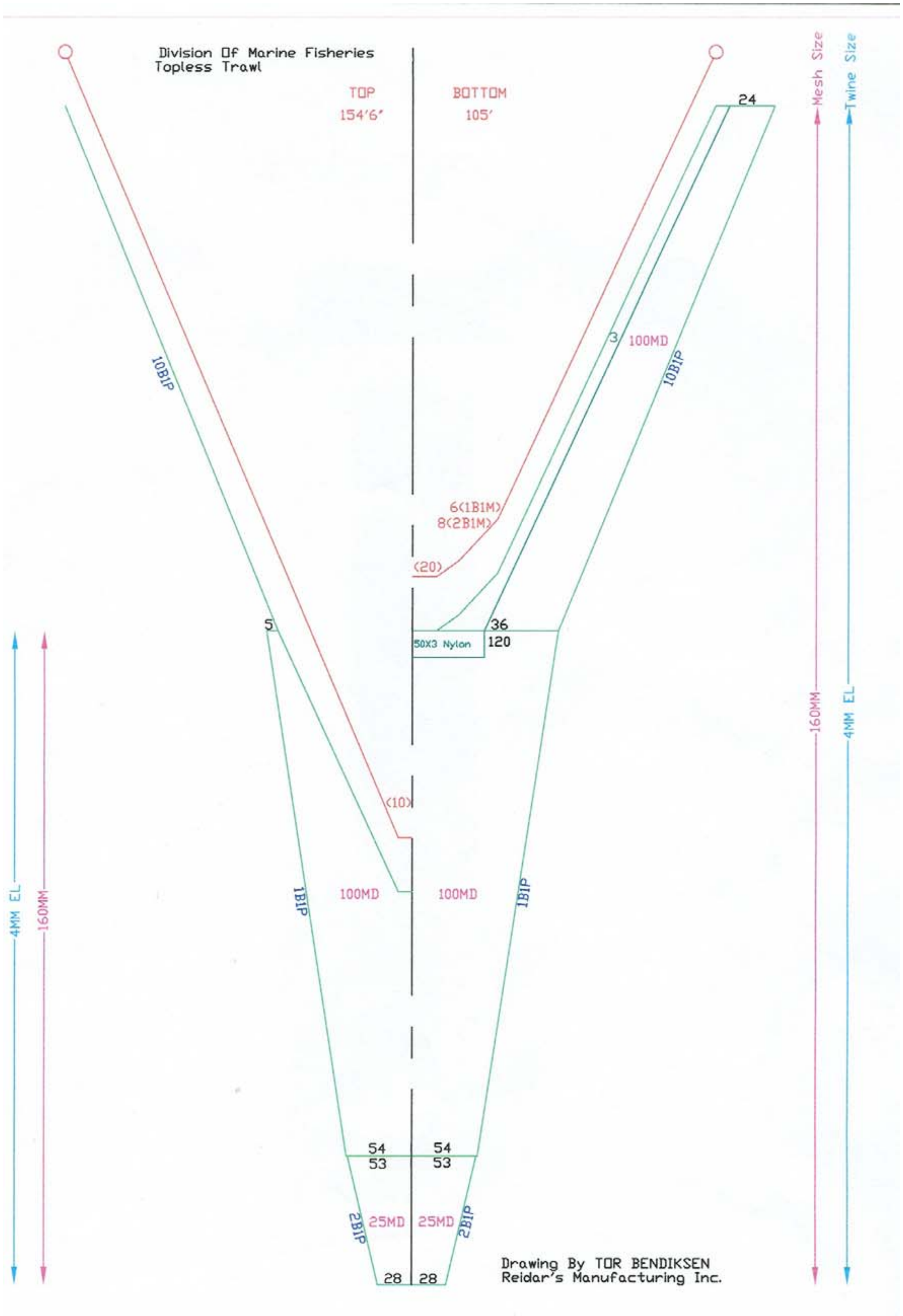

Figure 2: Diagram of the Topless net.

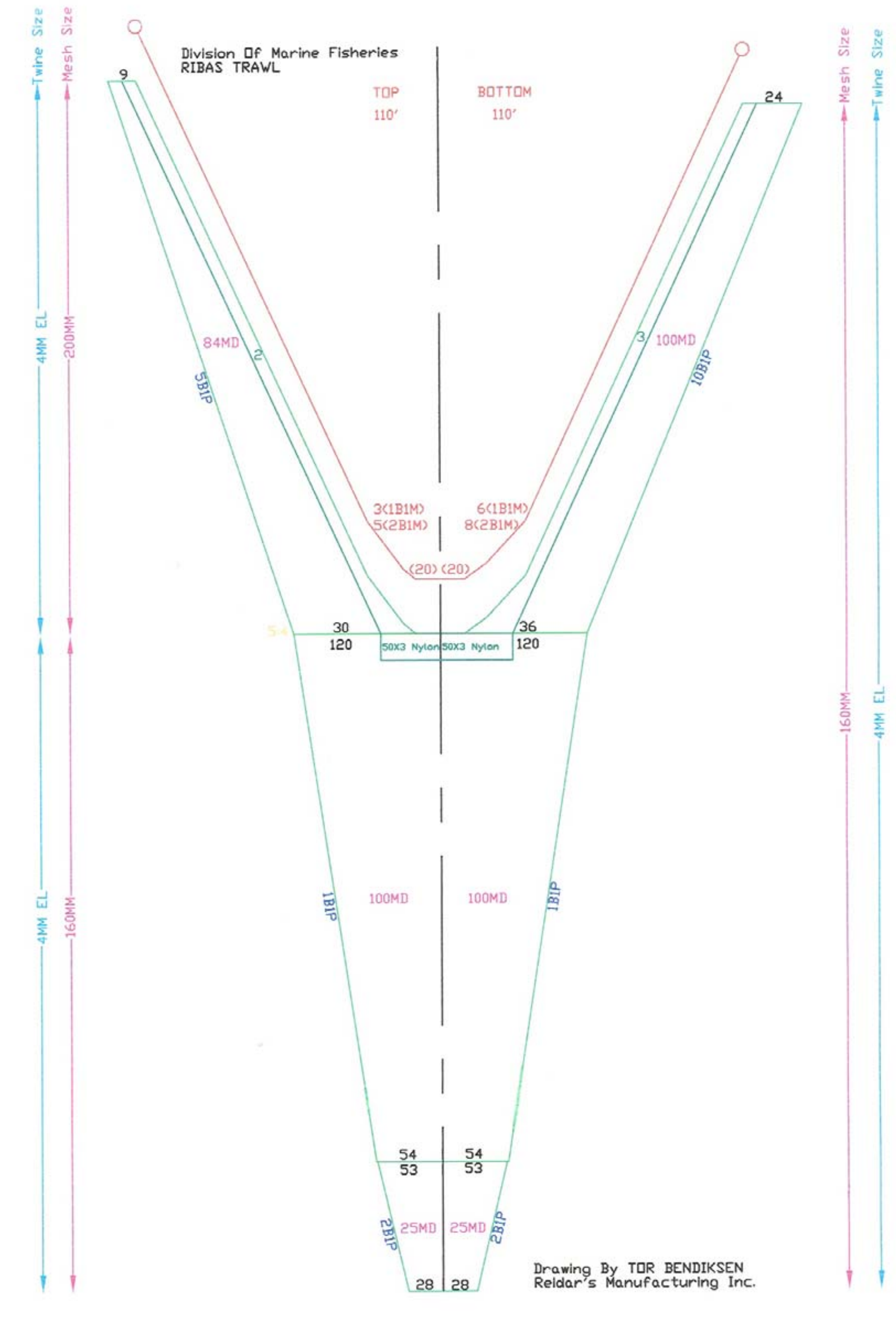

Figure 3: Diagram of the Ribas net.

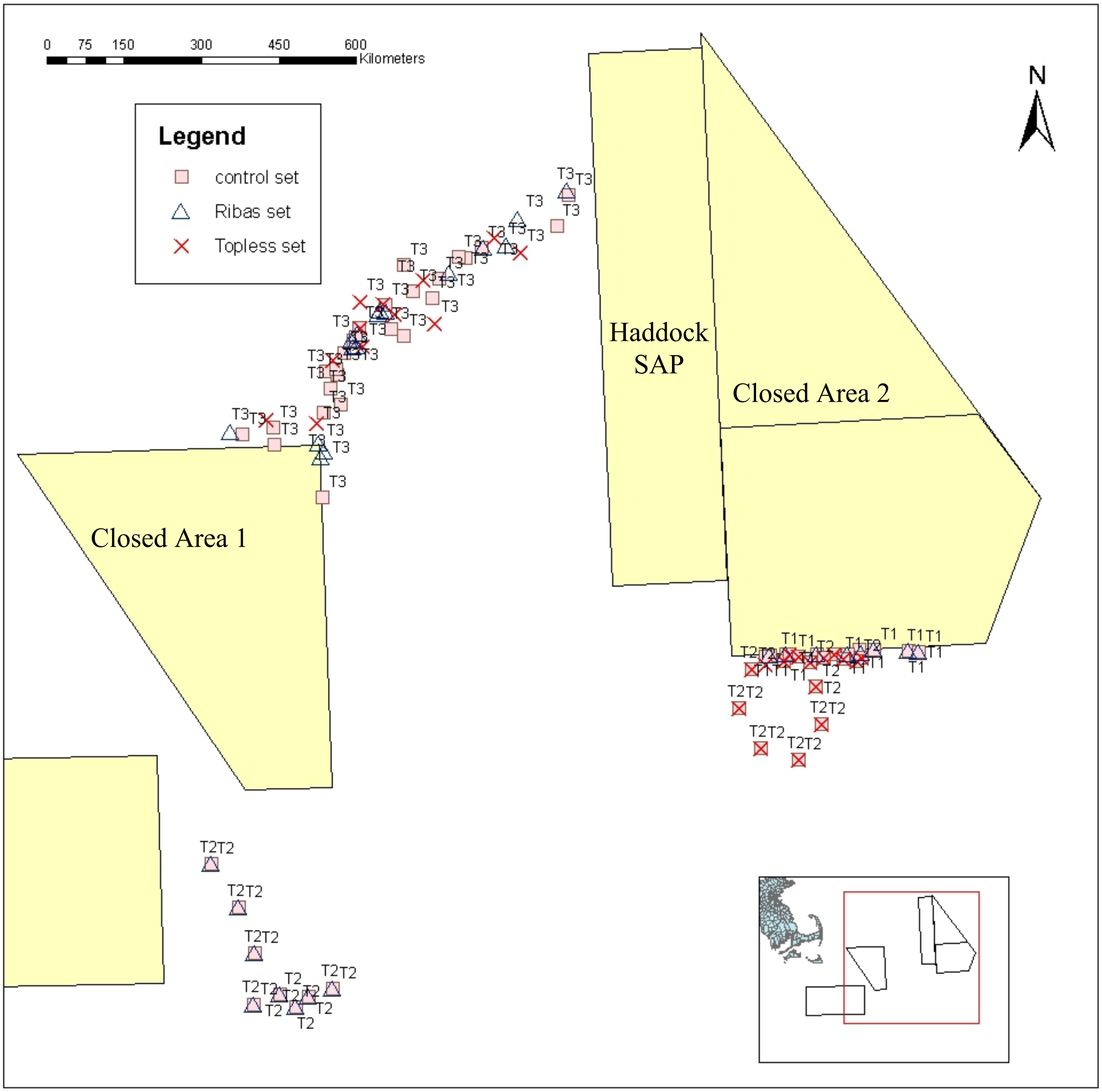

Figure 4: Location of start of tows on Georges Bank, USA. "T1" represents tows from trip 1. "T2" represents tows from trip 2. "T3" represents tows from trip 3. Marked areas are regulated Closed Areas or Special Access Program (SAP) areas. The window in the bottom right shows the greater area including coastal Massachusetts.

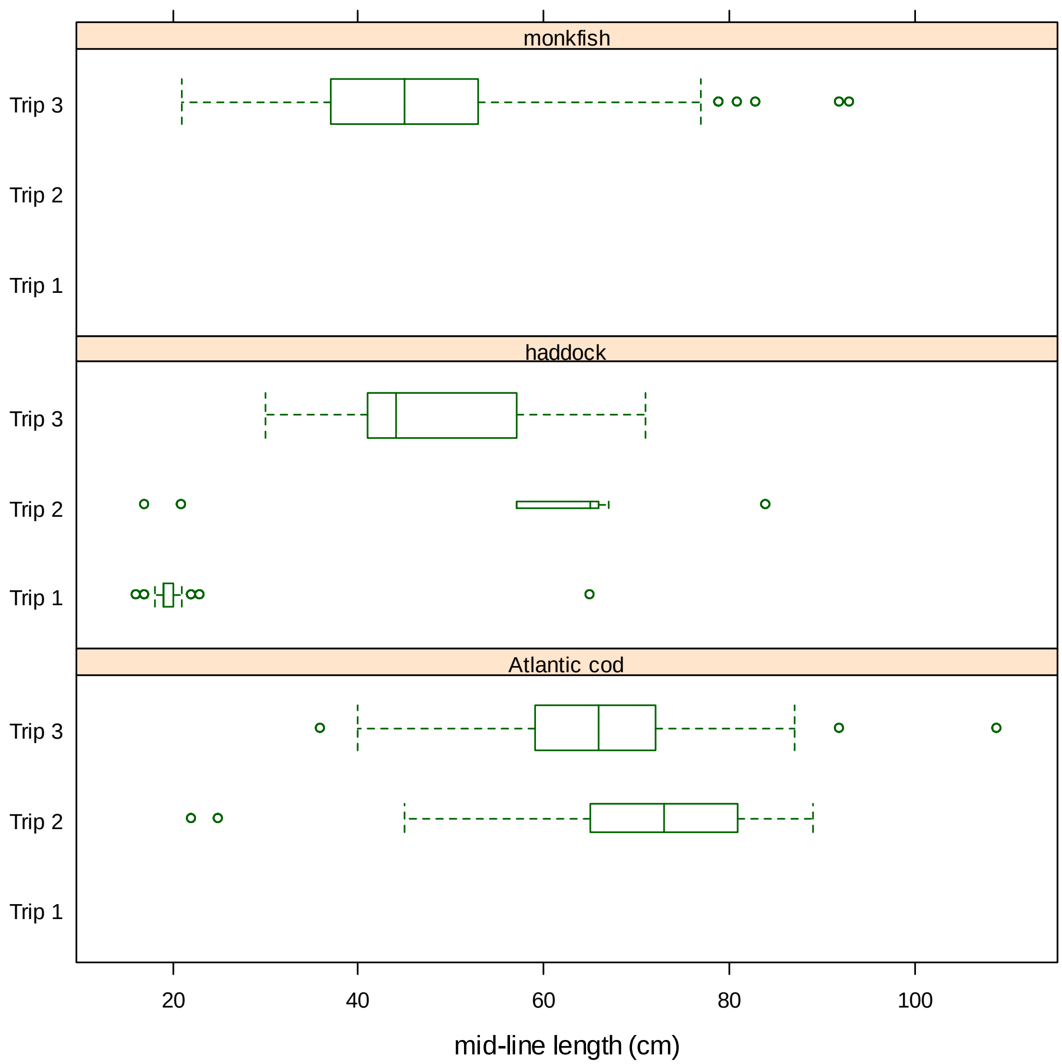

Figure 5: Box and whisker plots of length frequency distributions for major roundfish species comparing trips.

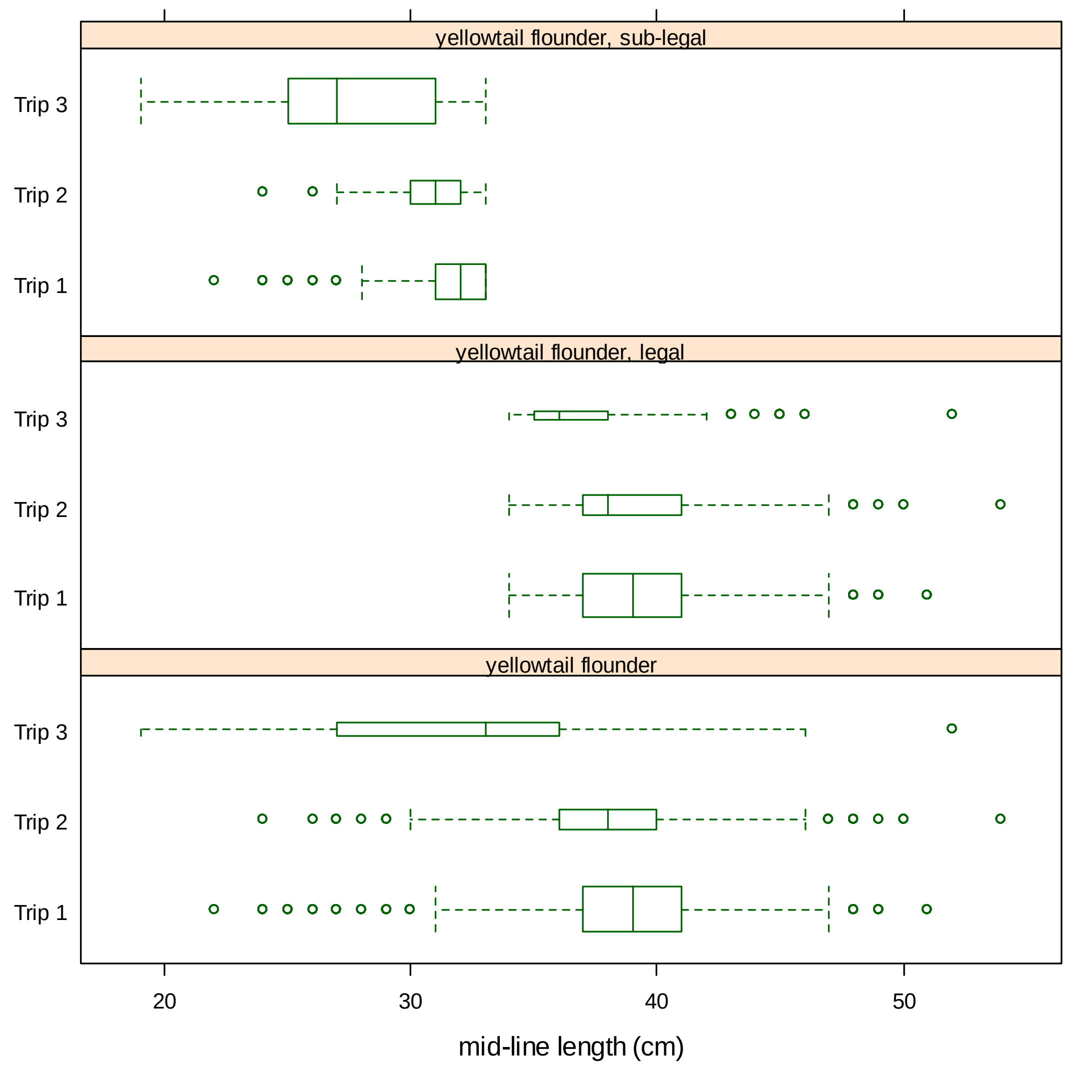

Figure 6: Box and whisker plots of length frequency distributions for yellowtail flounder size categories, comparing trips.

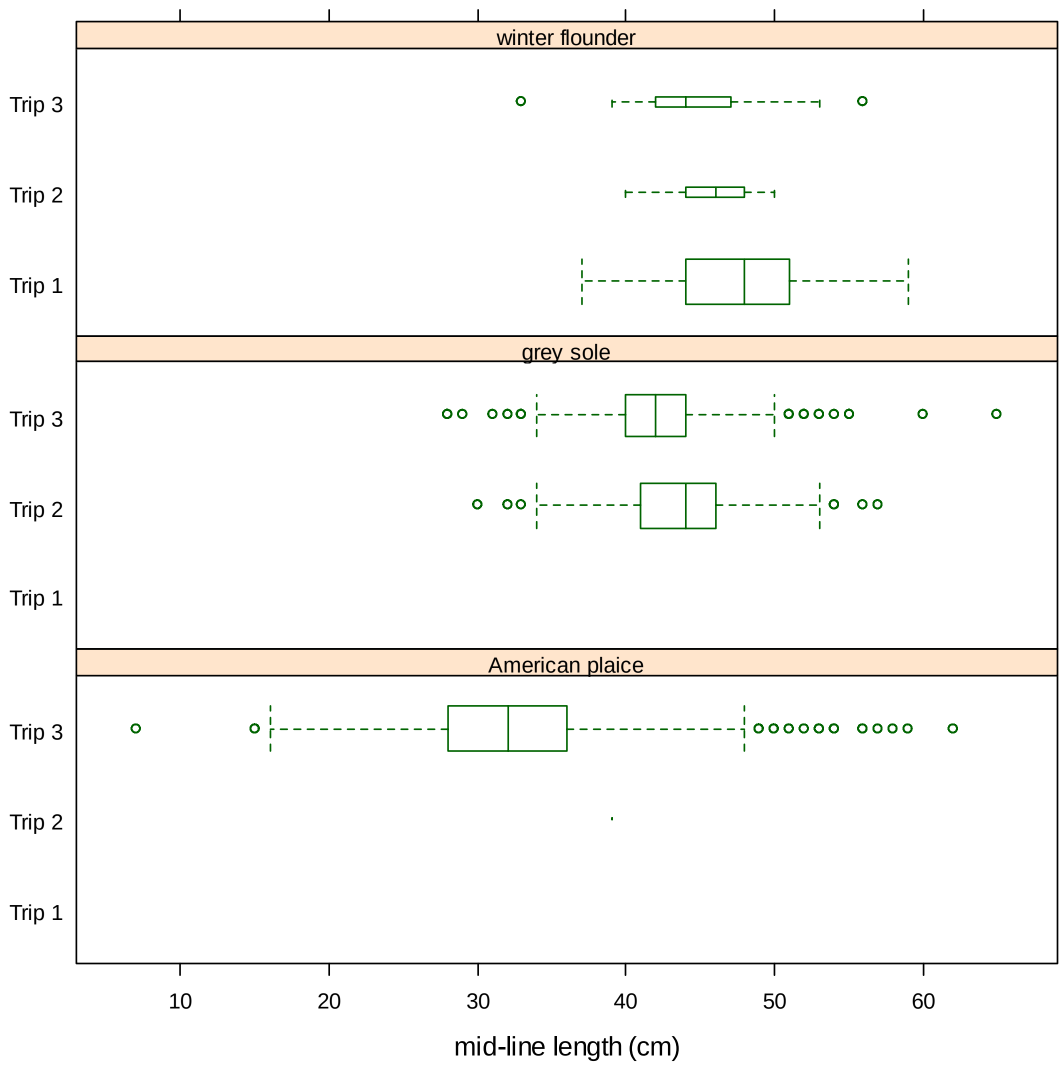

Figure 7: Box and whisker plots of length frequency distributions for major flatfish species, excluding yellowtail flounder, comparing trips.

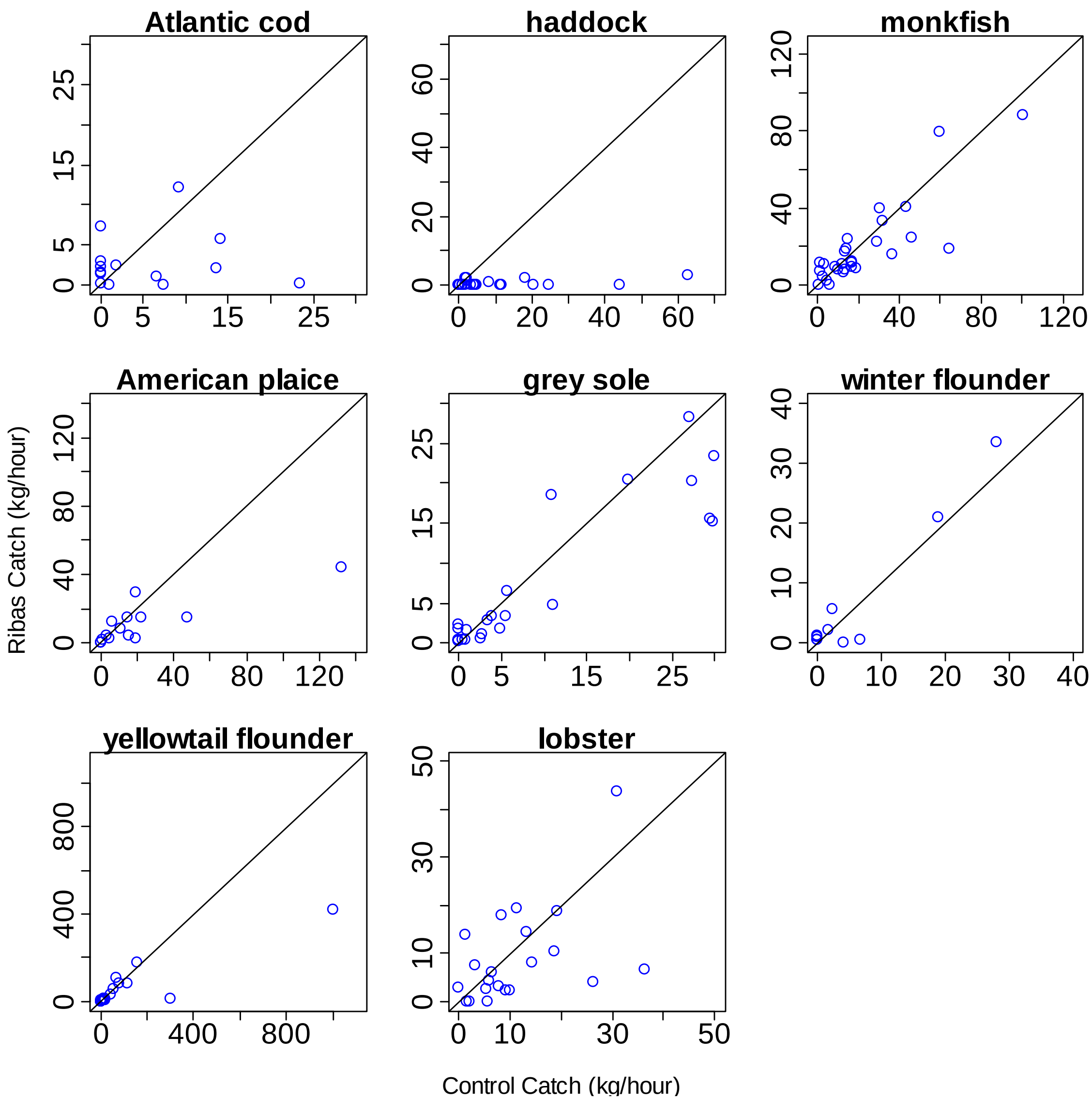

Figure 8: Paired catch data (kg/hr) for all major species for the Ribas and control tows with an equal catch line.

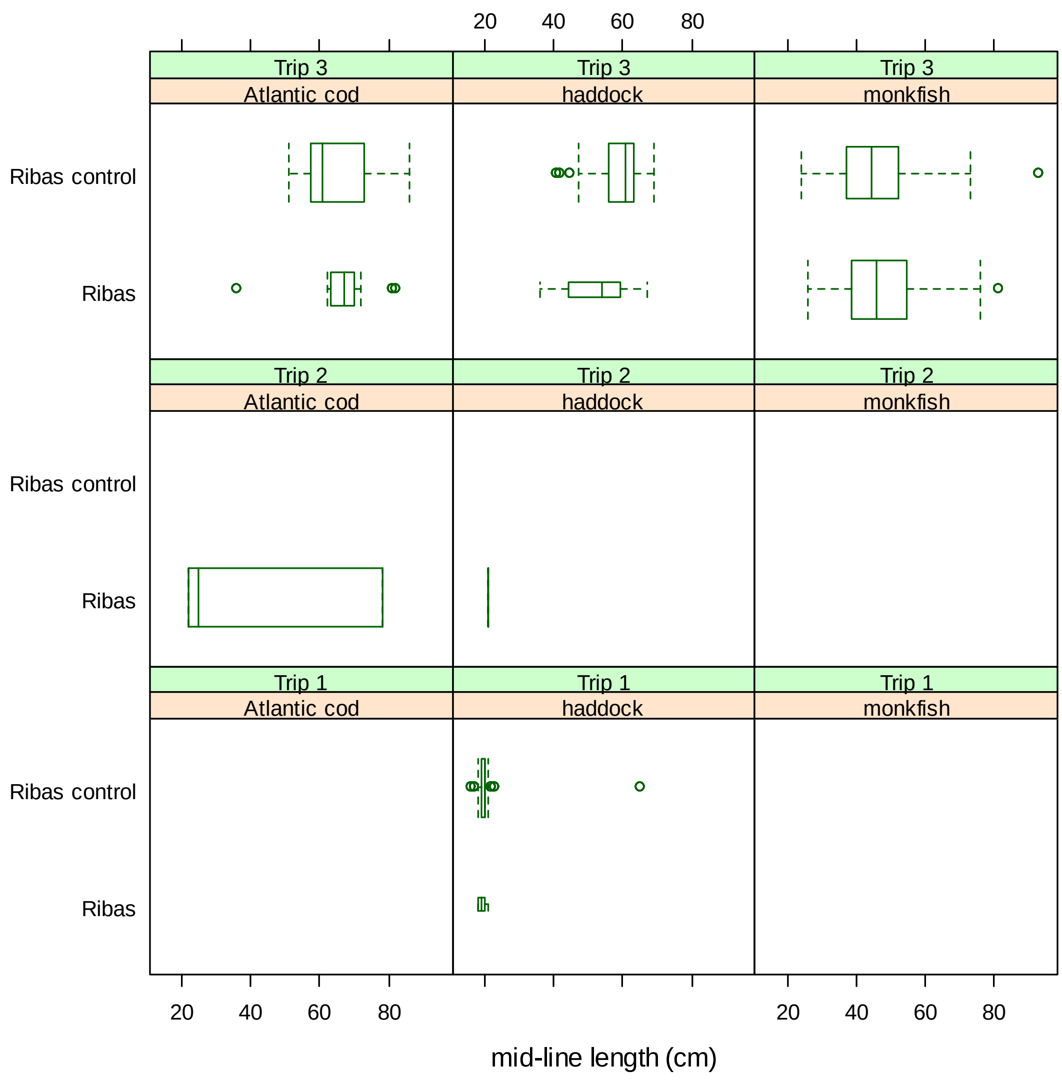

Figure 9: Box and whisker plots of length frequency distributions for major roundfish species (columns) comparing each trip (rows) and Ribas and paired control nets (y-axis).

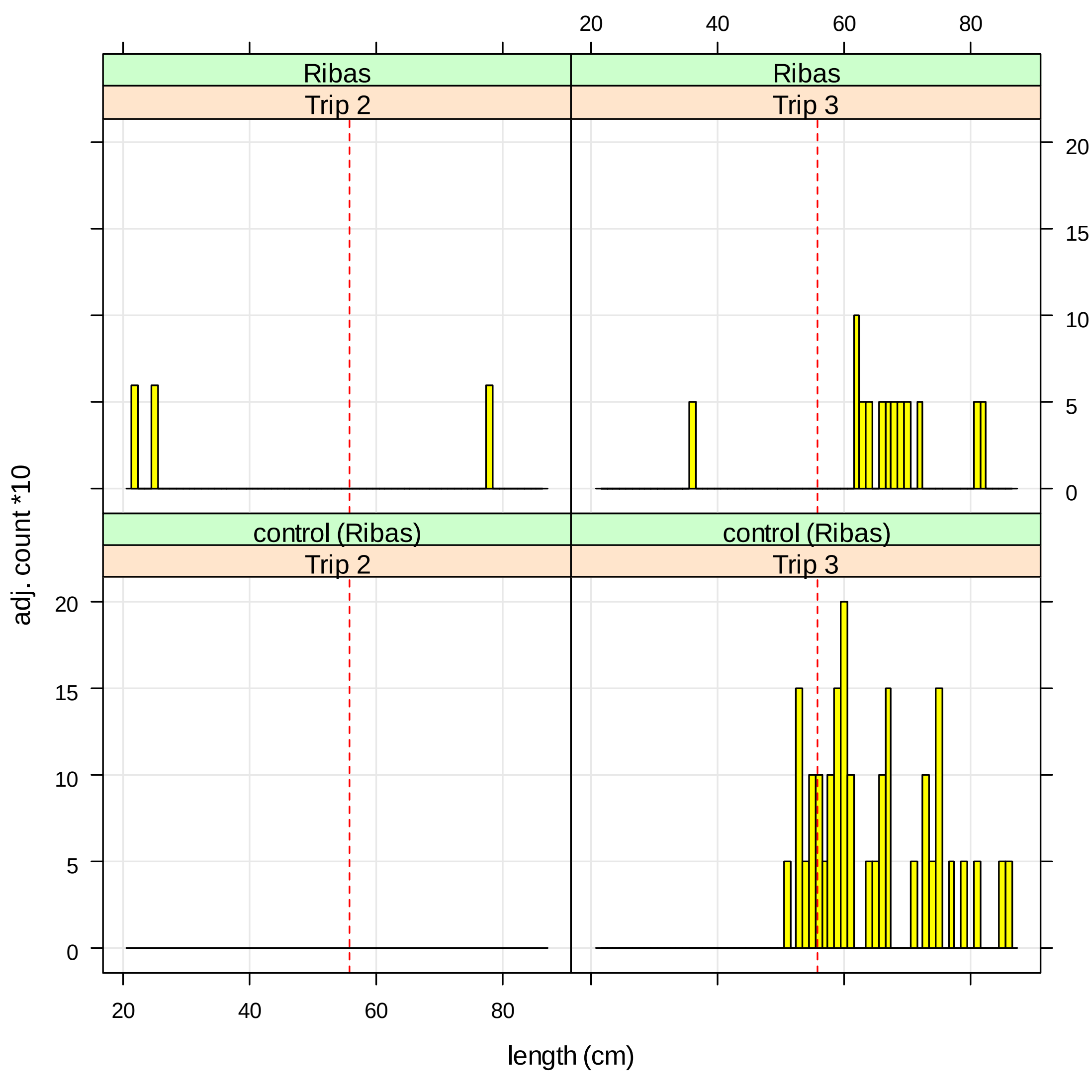

Figure 10: Ribas and paired control net length frequency distributions for Atlantic cod comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

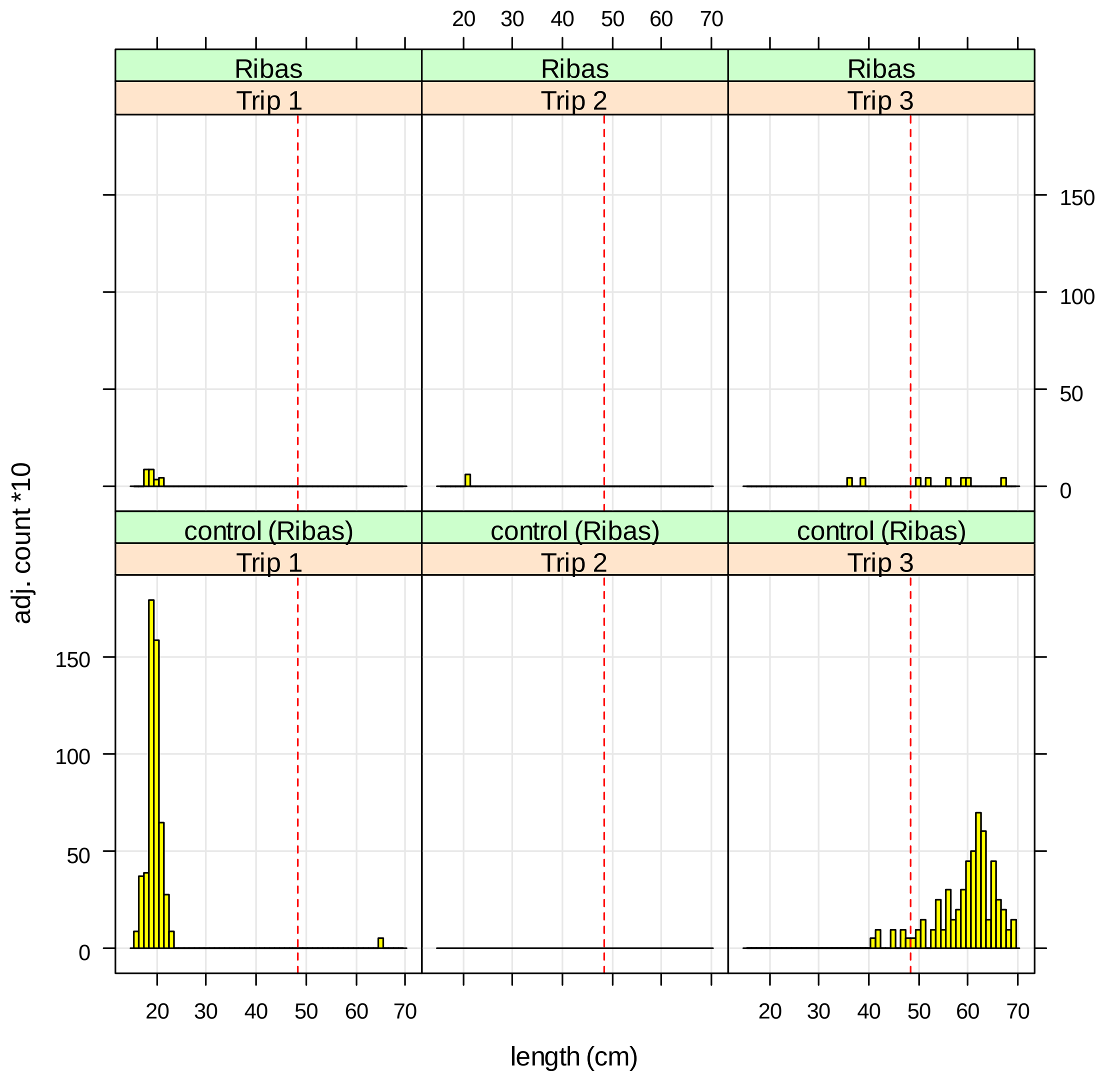

Figure 11: Ribas and paired control net length frequency distributions for haddock comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

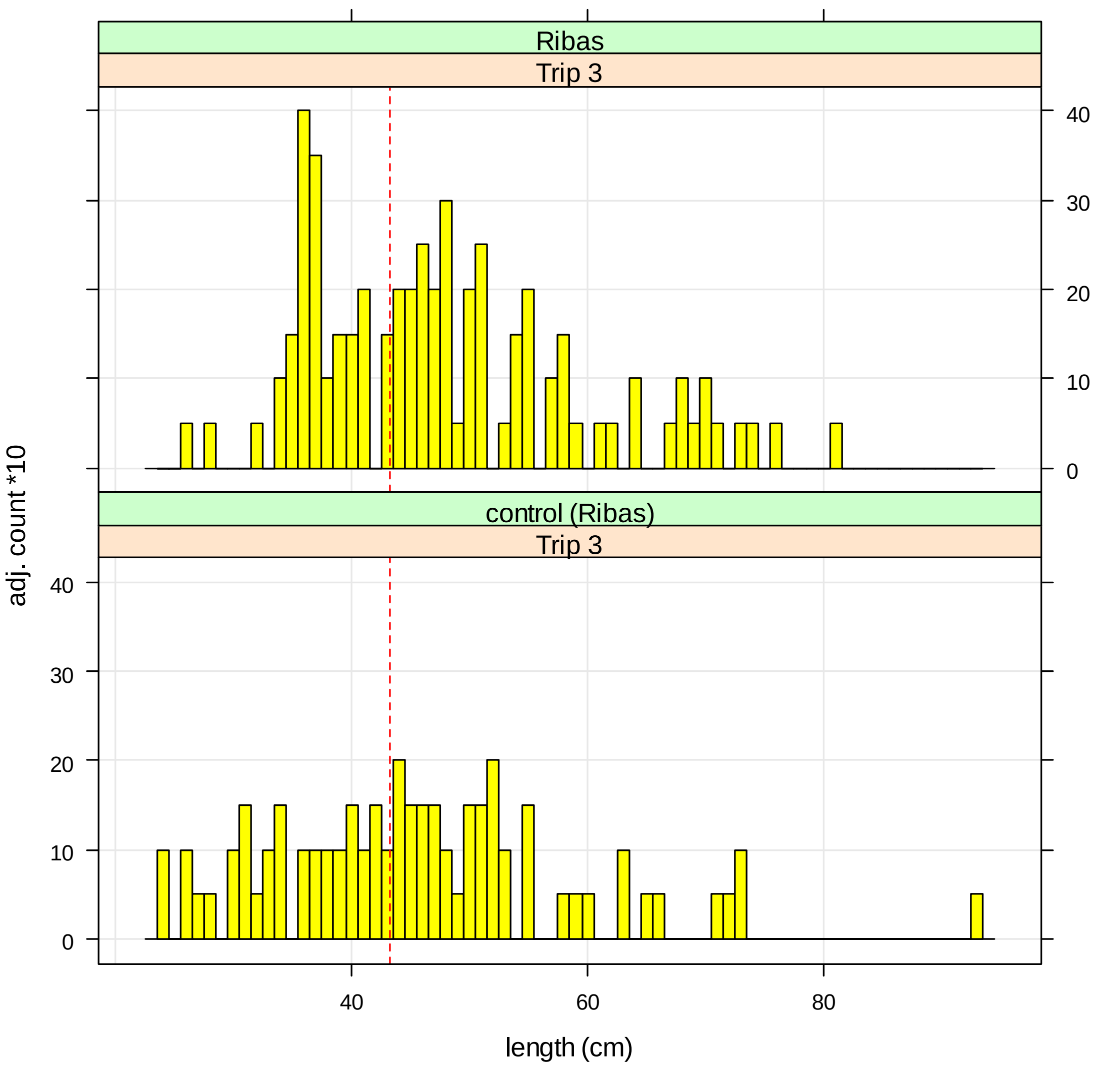

Figure 12: Ribas and paired control net length frequency distributions for monkfish comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

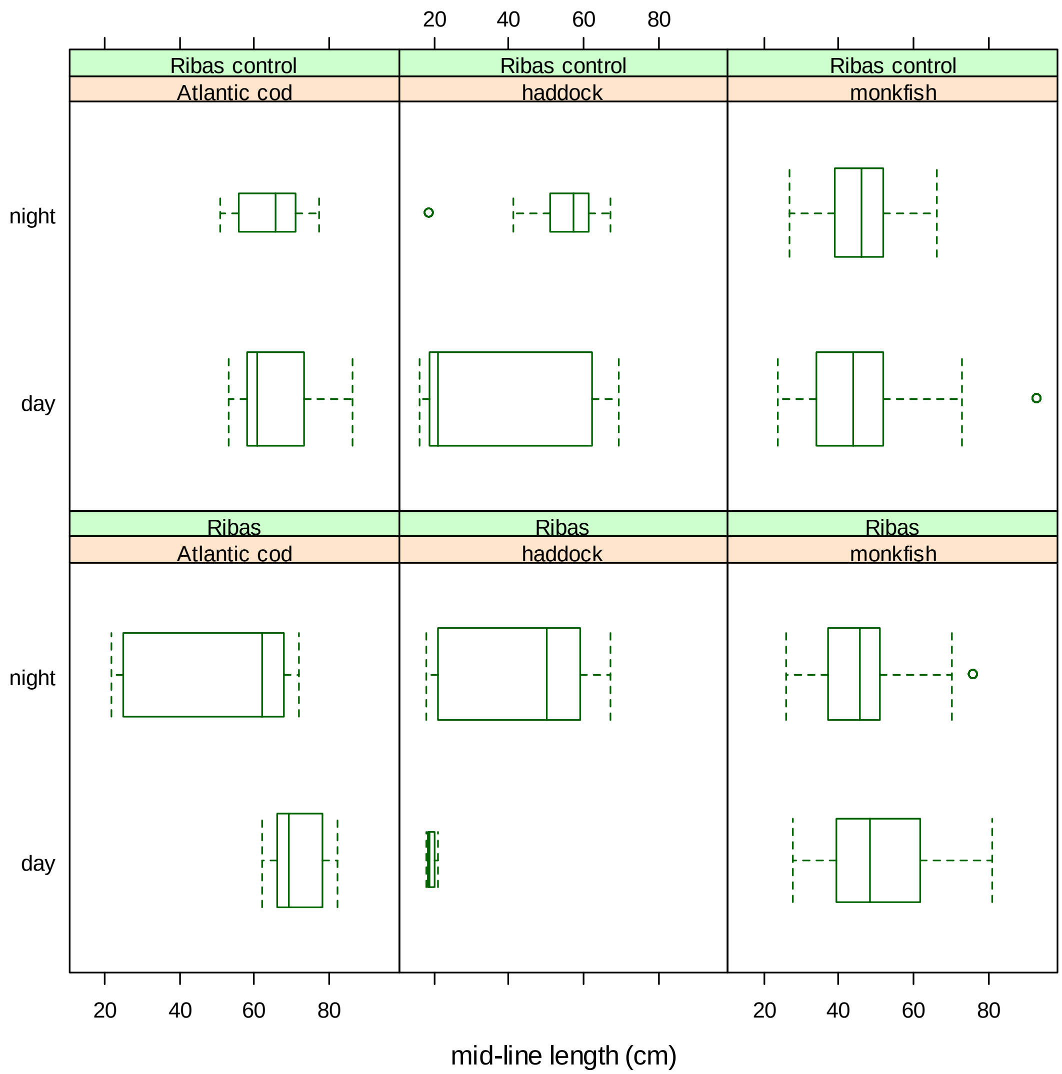

Figure 13: Box and whisker plots of length frequency distributions for major roundfish species (columns) comparing Ribas and paired control nets (rows) and diel period (y-axis).

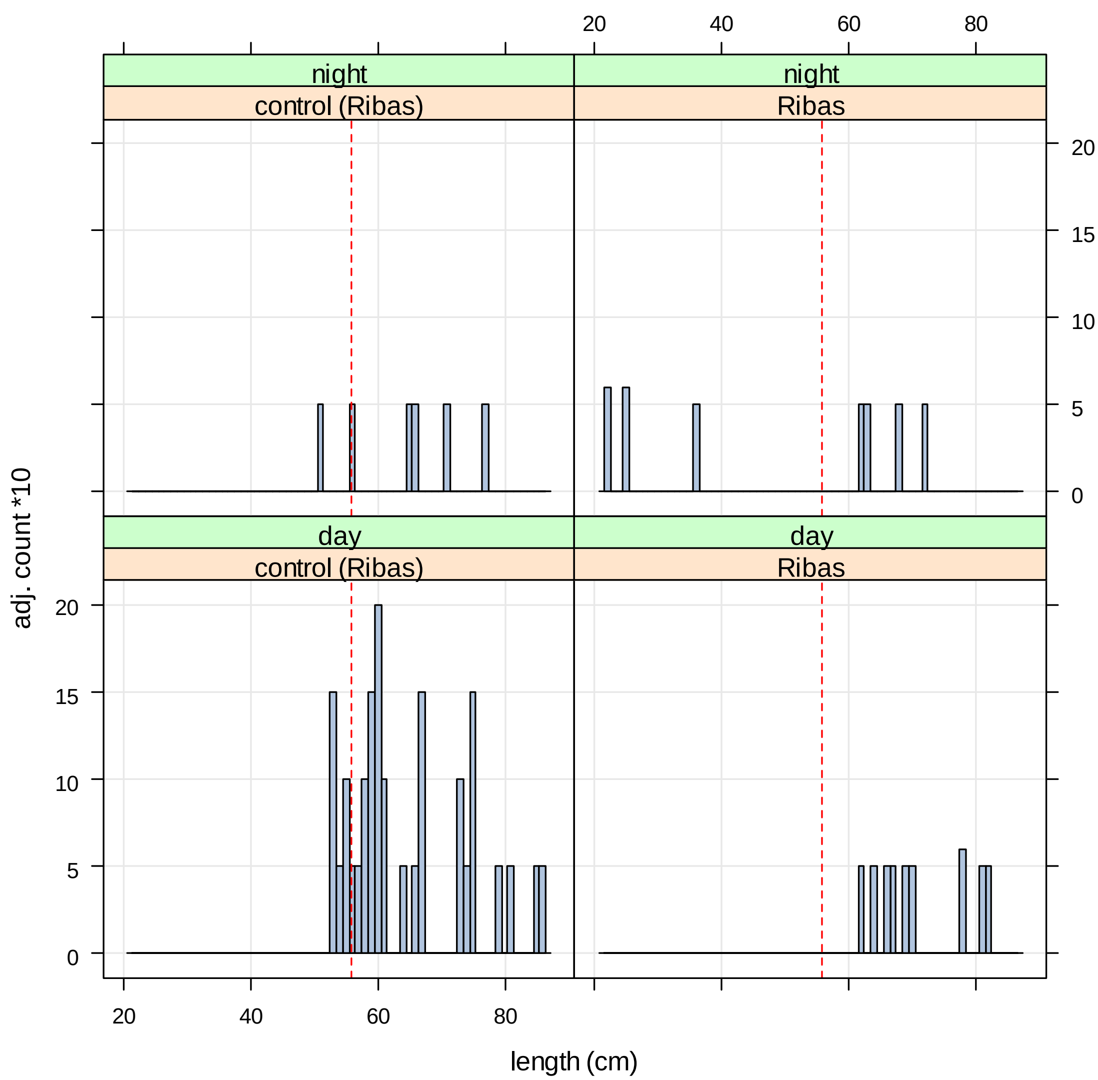

Figure 14: Ribas and paired control net length frequency distributions for Atlantic cod comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

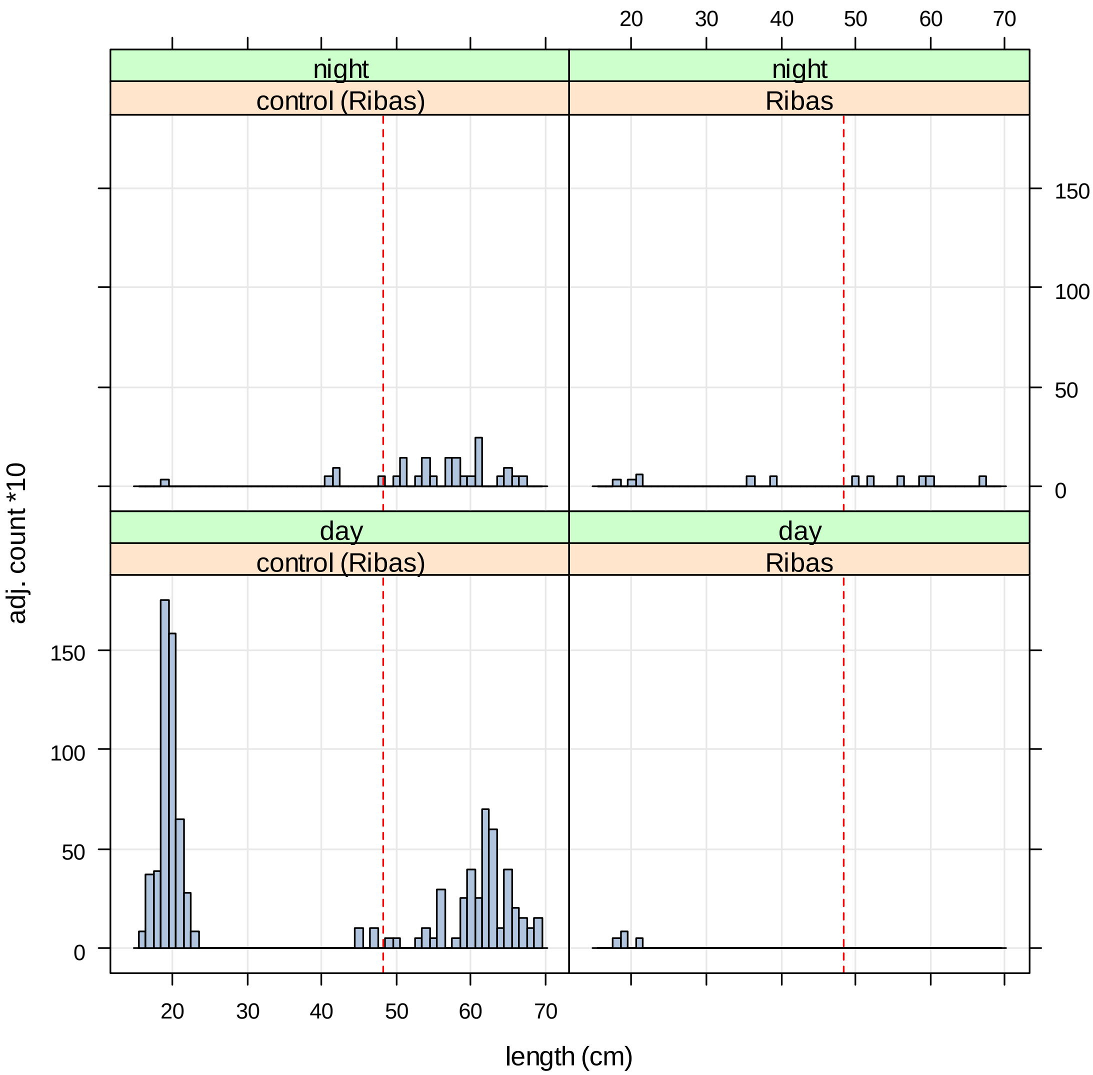

Figure 15: Ribas and paired control net length frequency distributions for haddock comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

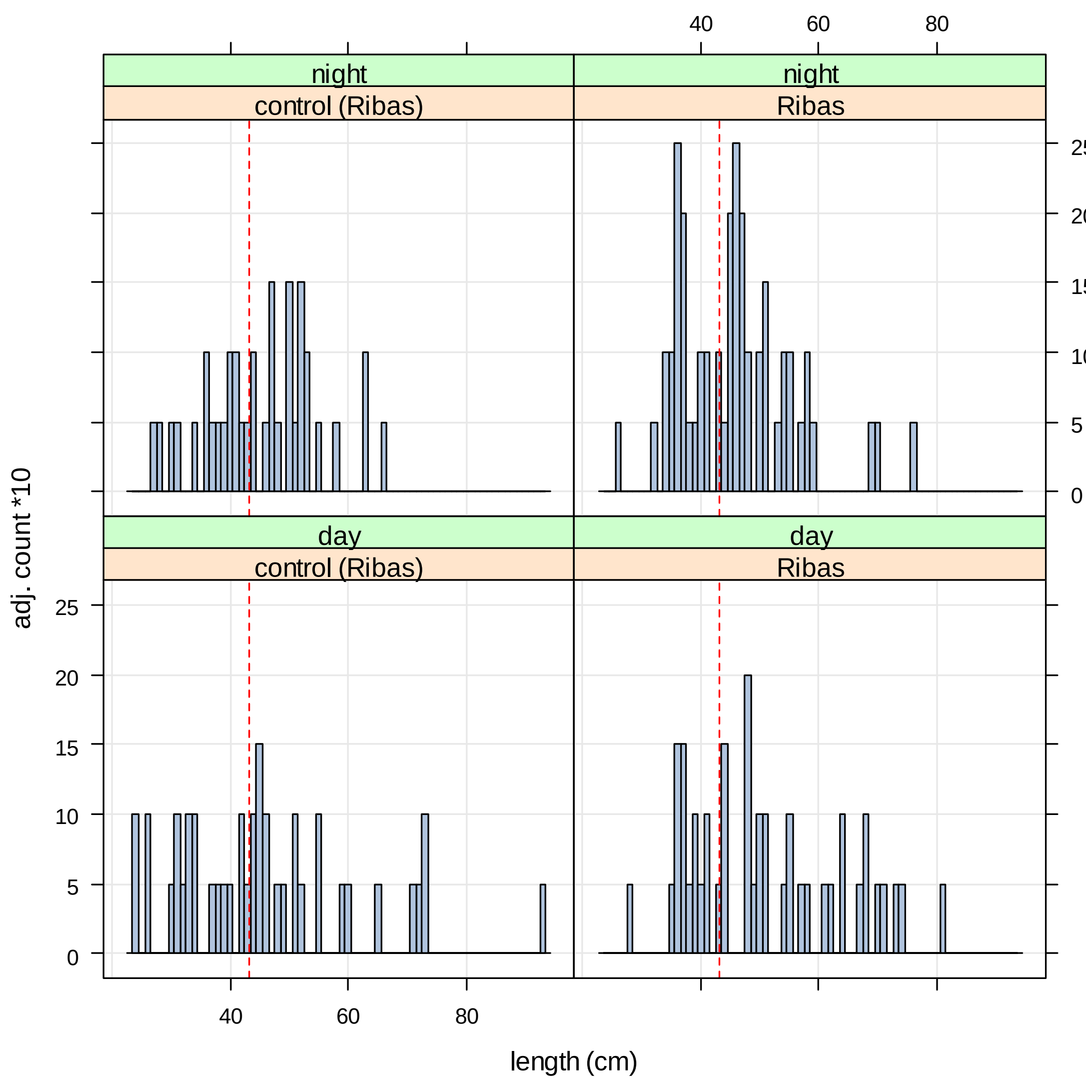

Figure 16: Ribas and paired control net length frequency distributions for monkfish comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

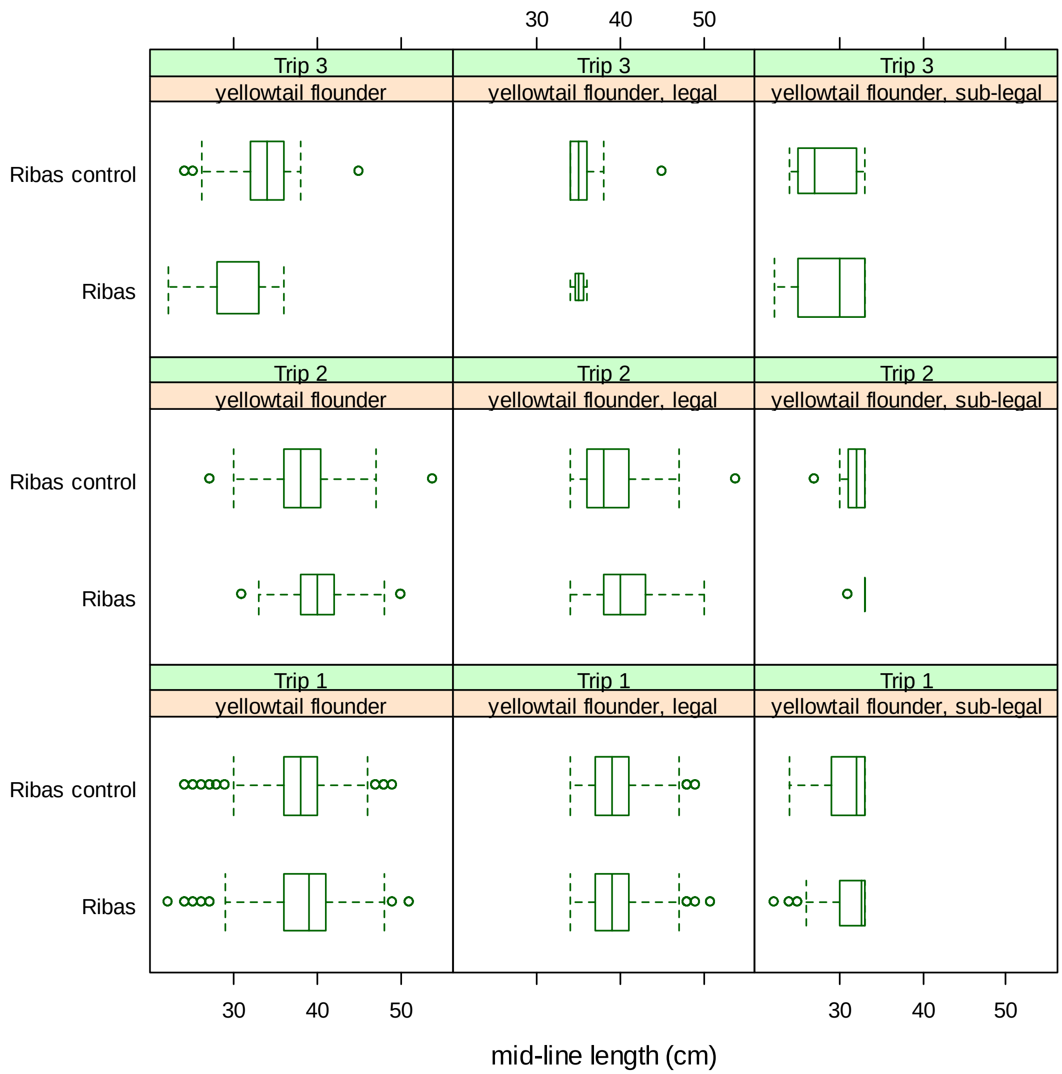

Figure 17: Box and whisker plots of length frequency distributions for yellowtail flounder categories (columns) comparing each trip (rows) and Ribas and paired control nets (y-axis).

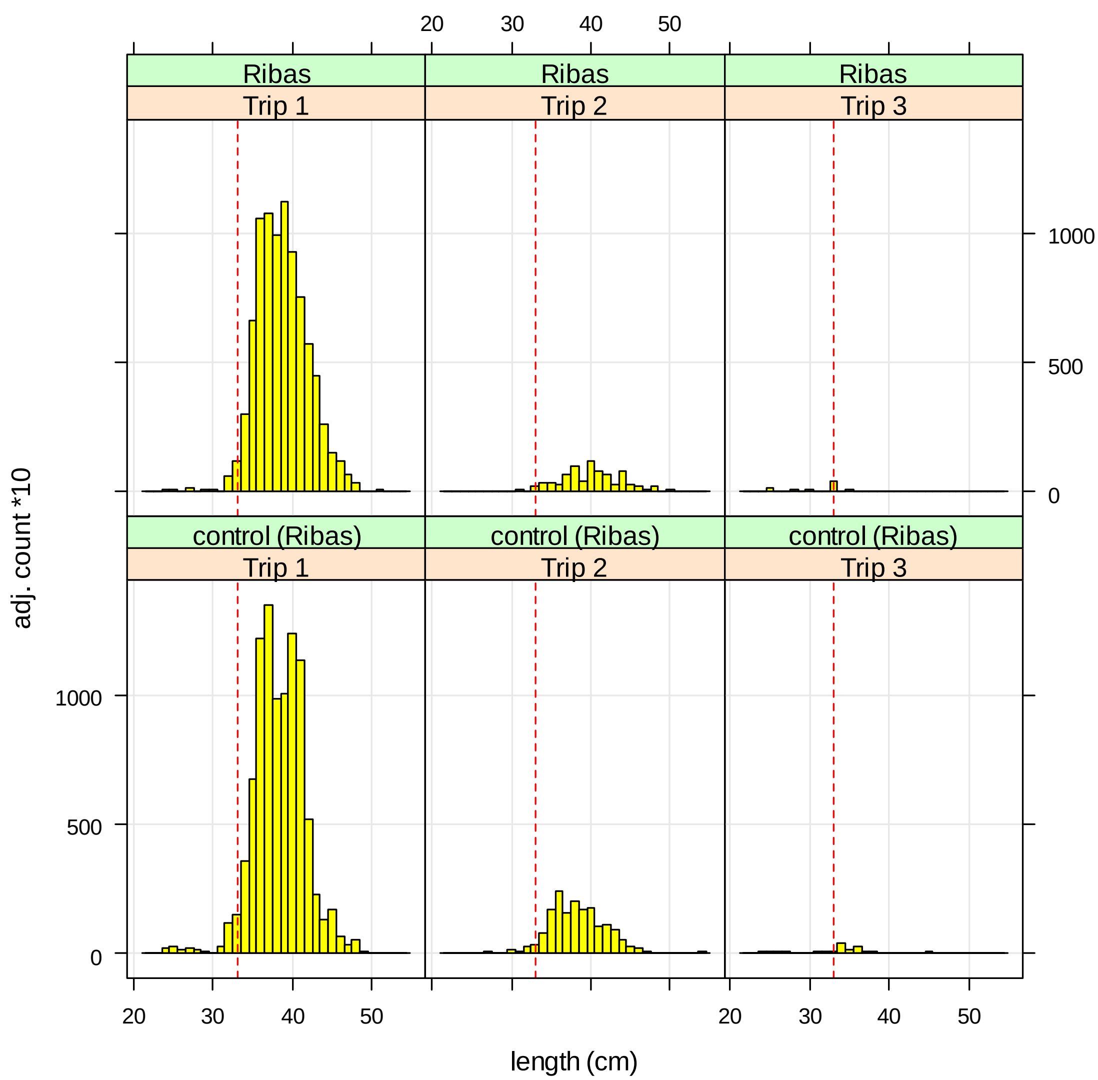

Figure 18: Ribas and paired control net length frequency distributions for yellowtail flounder comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

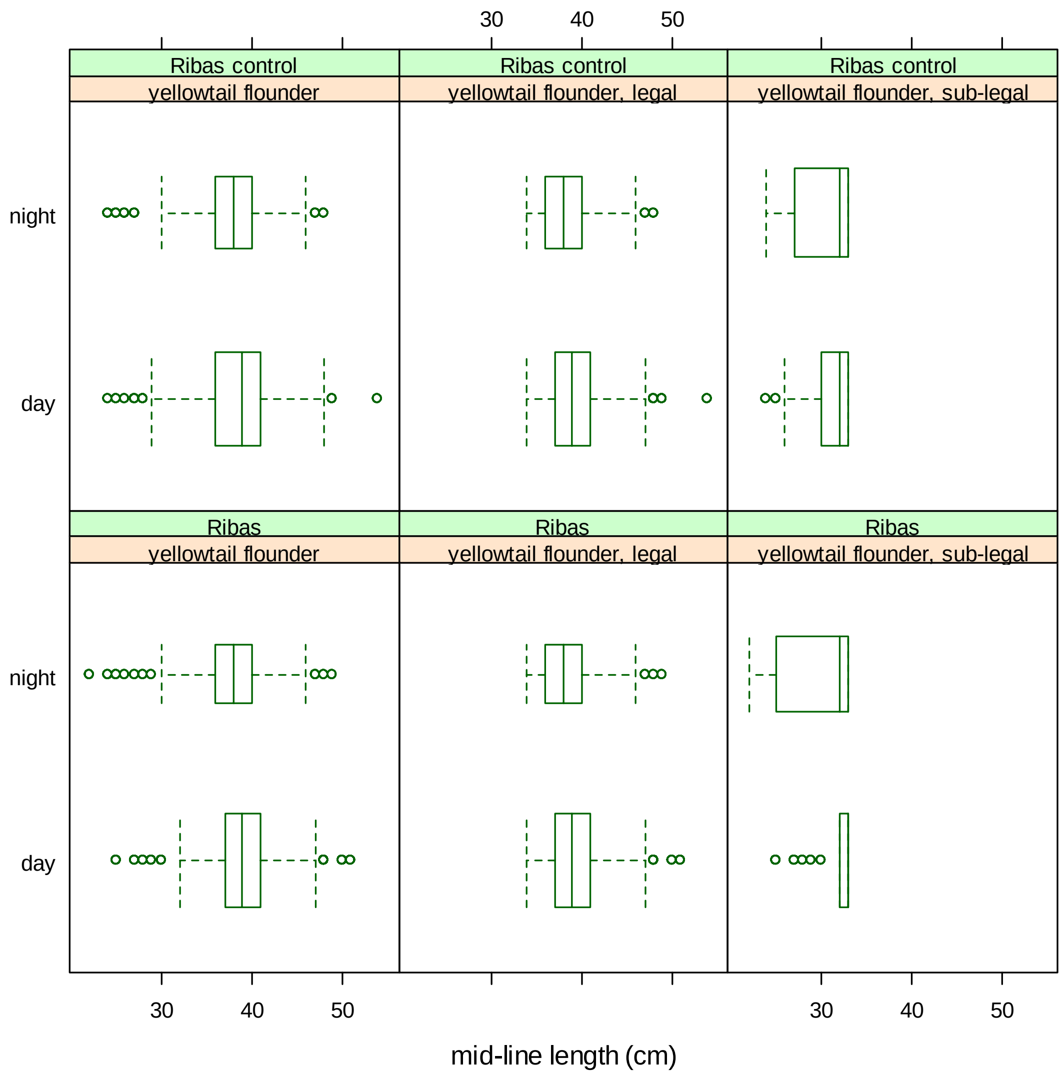

Figure 19: Box and whisker plots of length frequency distributions for yellowtail flounder categories (columns) comparing Ribas and paired control nets (rows) and diel period (y-axis).

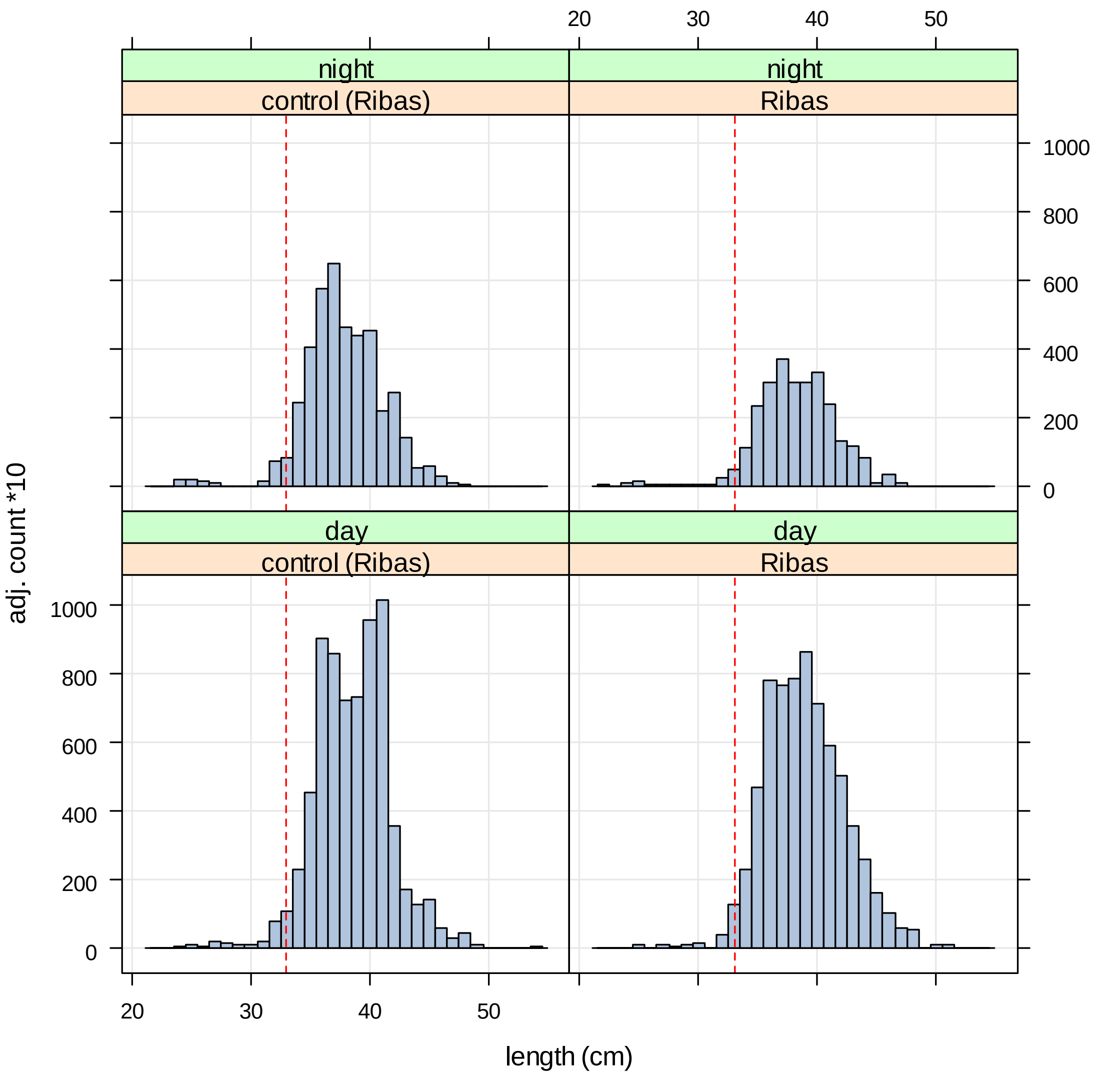

Figure 20: Ribas and paired control net length frequency distributions for yellowtail flounder comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

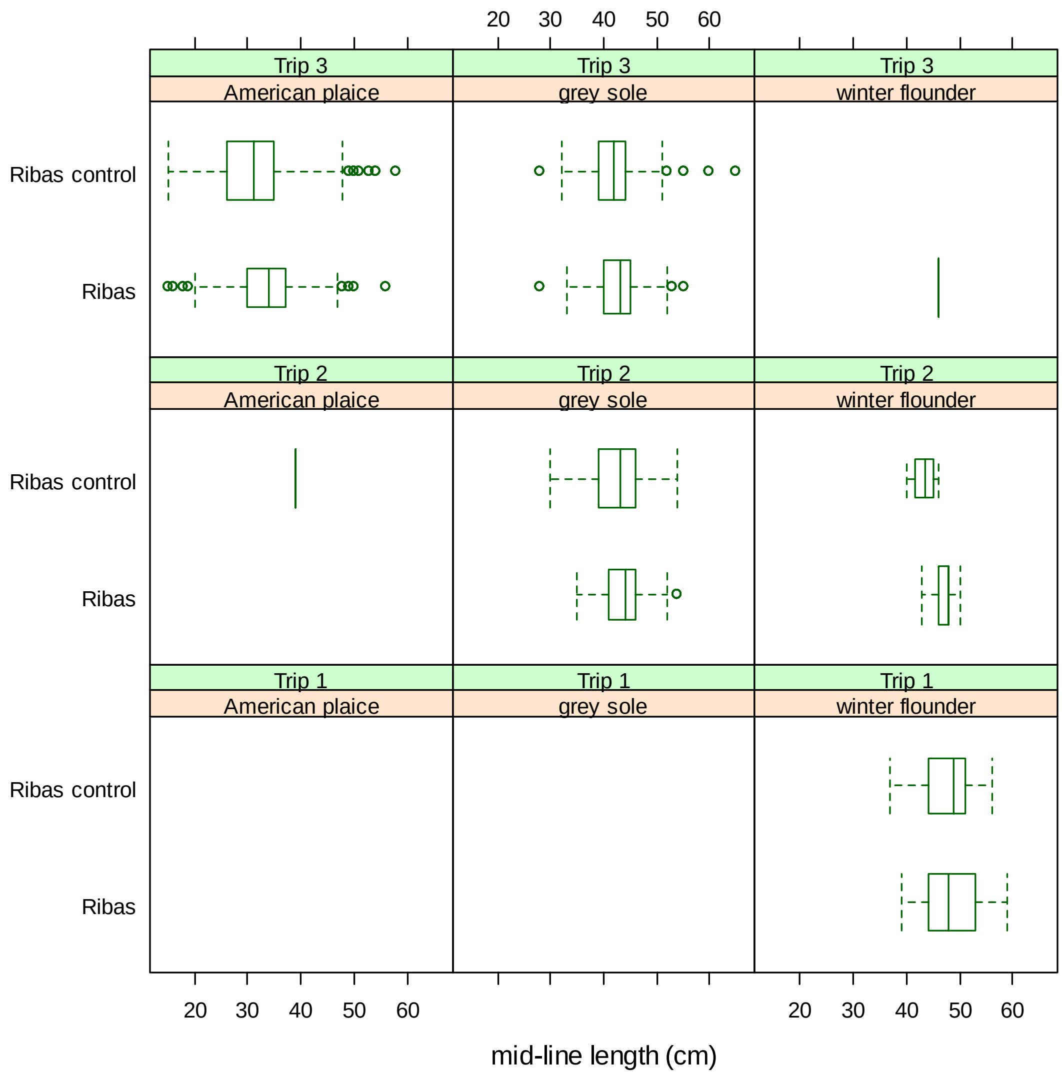

Figure 21: Box and whisker plots of length frequency distributions for major flatfish species (columns), excluding yellowtail flounder, comparing each trip (rows) and Ribas and paired control nets (y-axis).

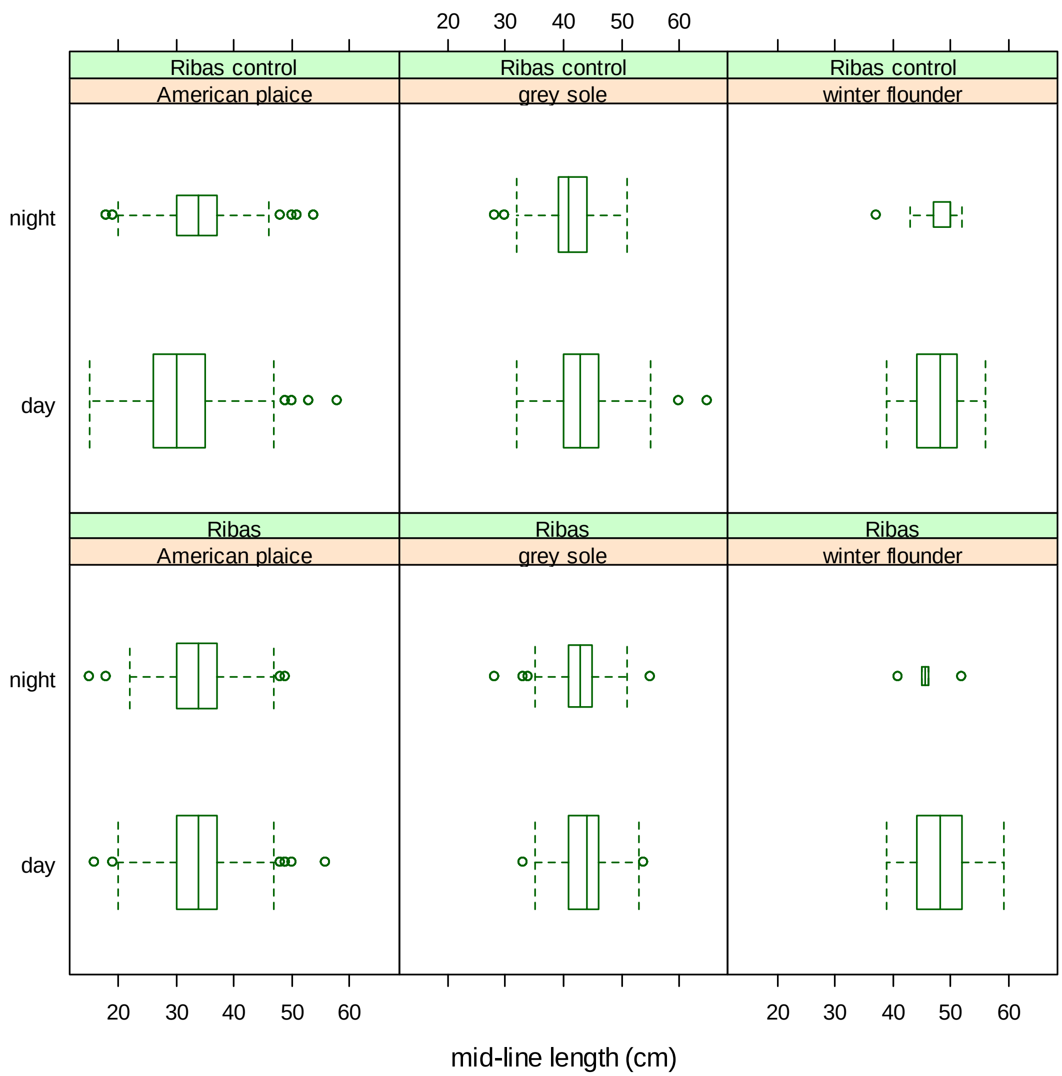

Figure 22: Box and whisker plots of length frequency distributions for major flatfish species (columns), excluding yellowtail flounder, comparing each comparing Ribas and paired control nets (rows) and diel period (y-axis).

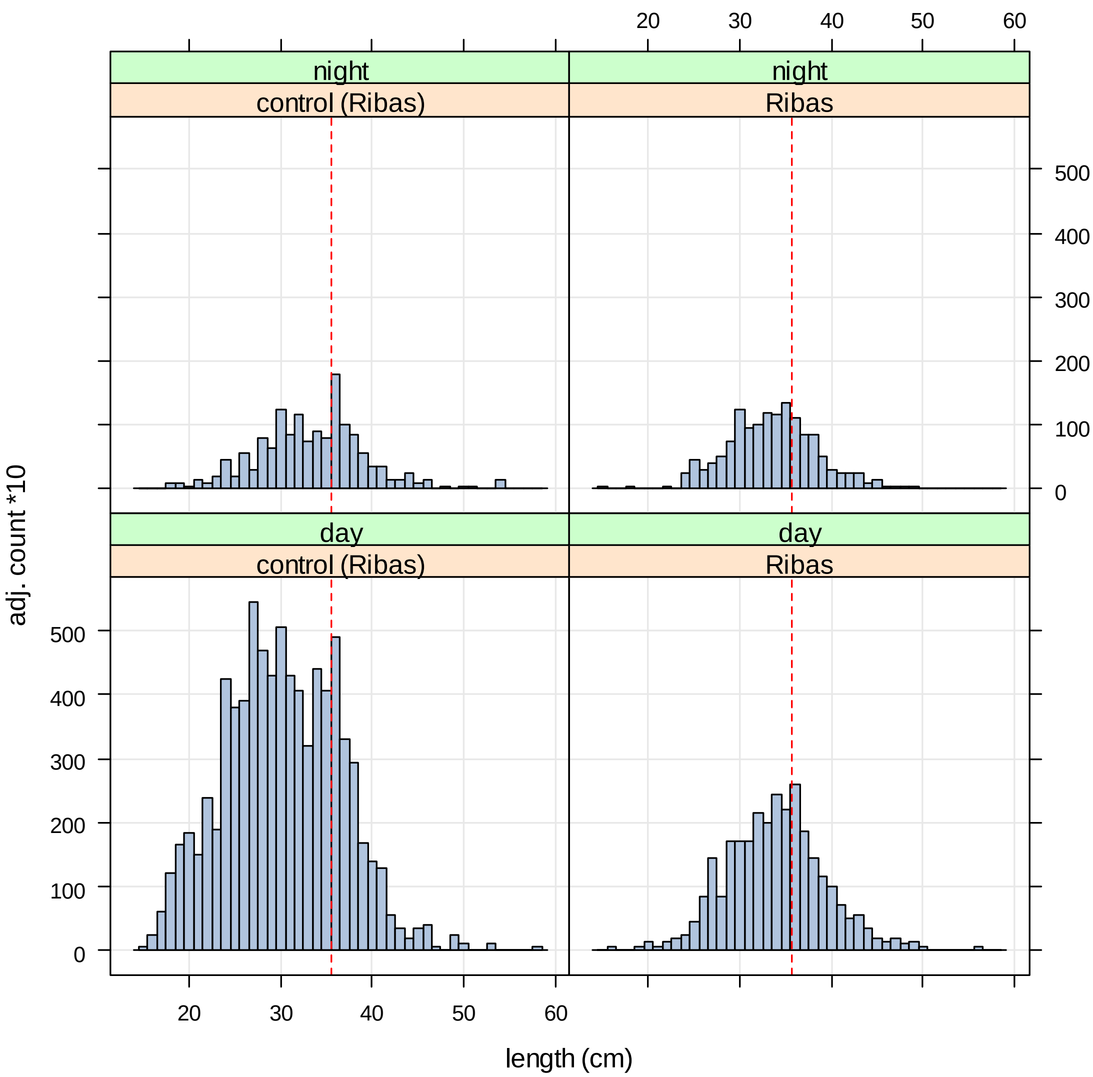

Figure 23: Ribas and paired control net length frequency distributions for American plaice comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

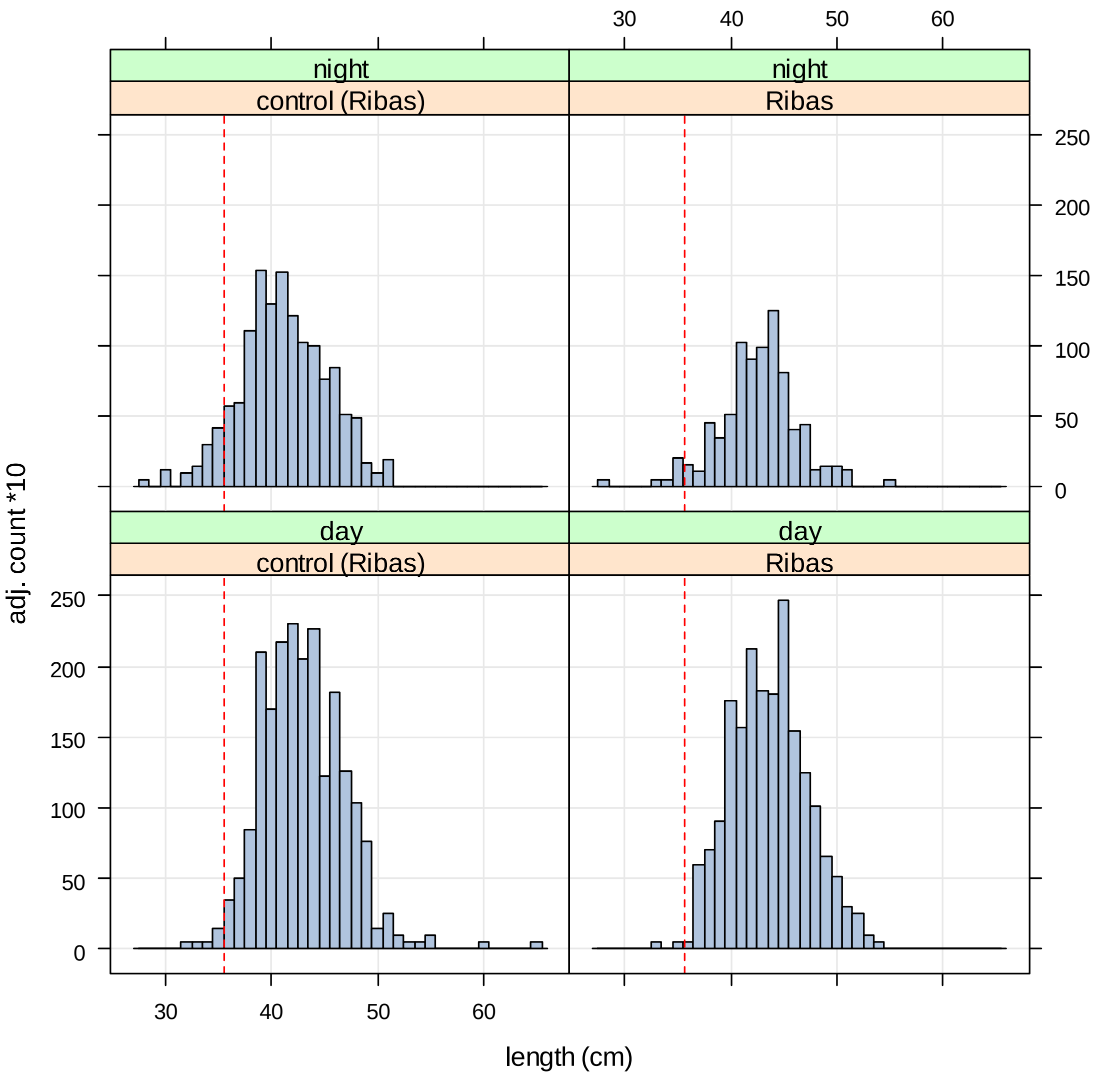

Figure 24: Ribas and paired control net length frequency distributions for grey sole comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

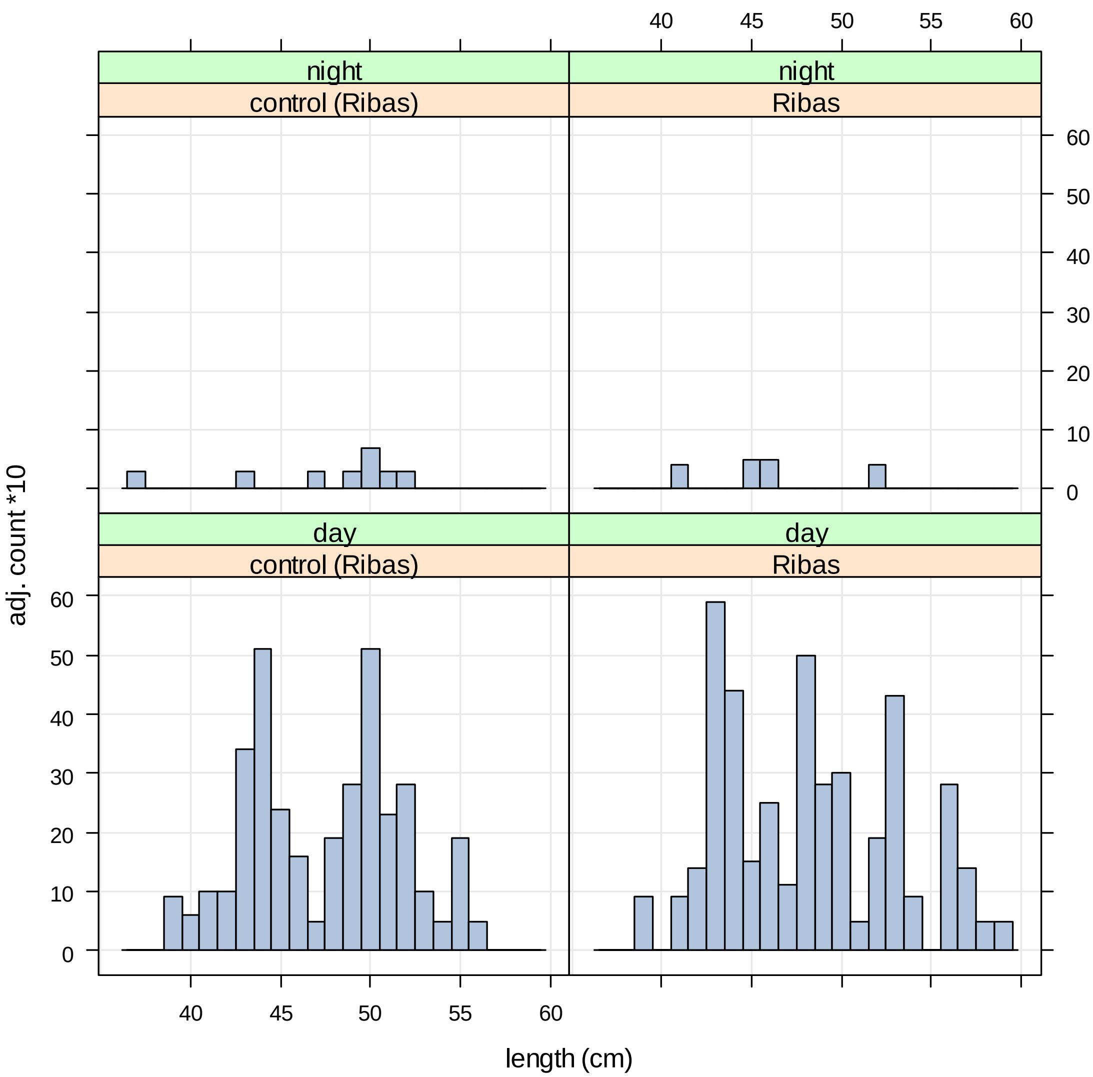

Figure 25: Ribas and paired control net length frequency distributions for winter flounder comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

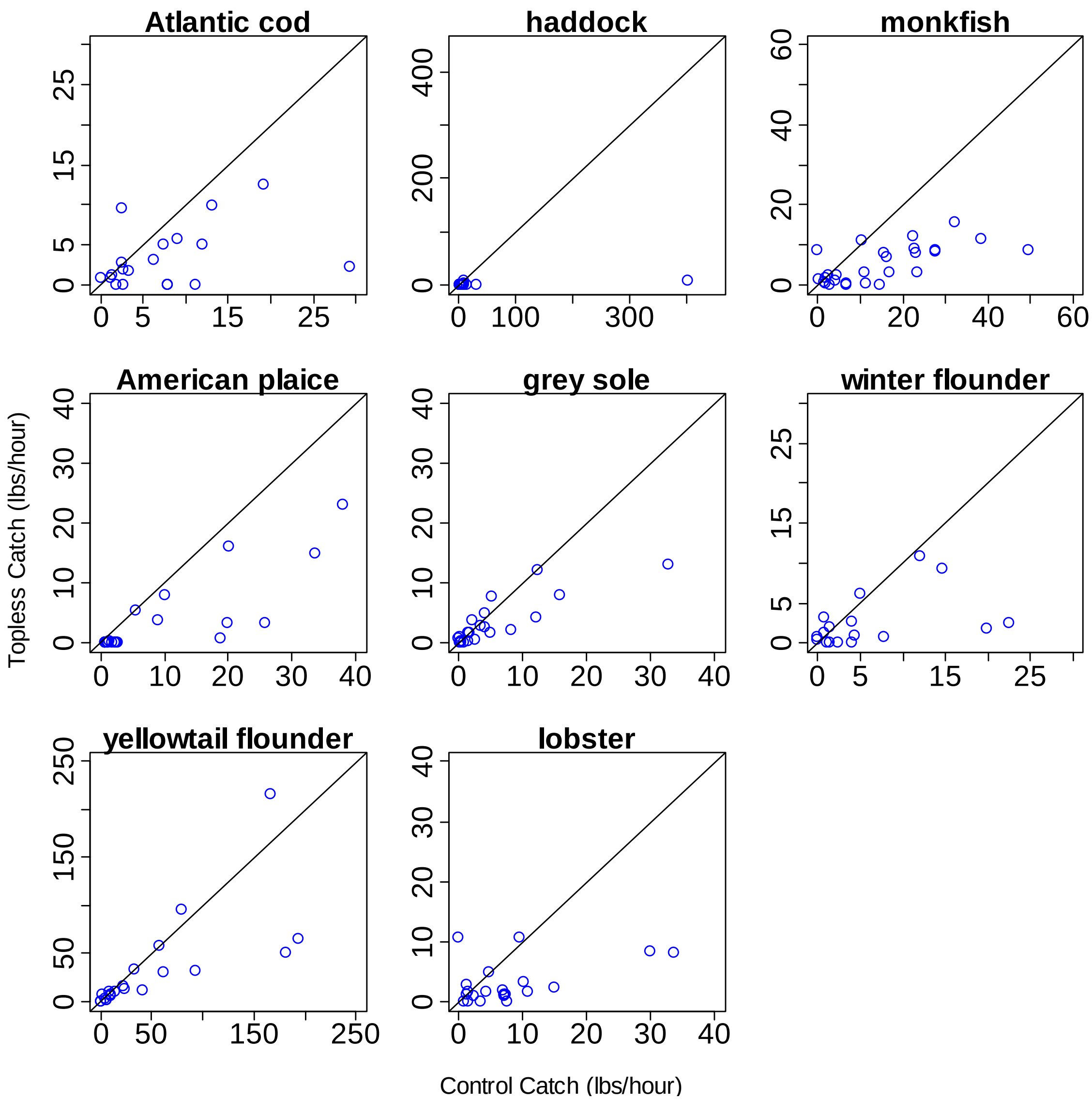

Figure 26: Paired catch data (kg/hr) for all major species for the Topless and control tows with an equal catch line.

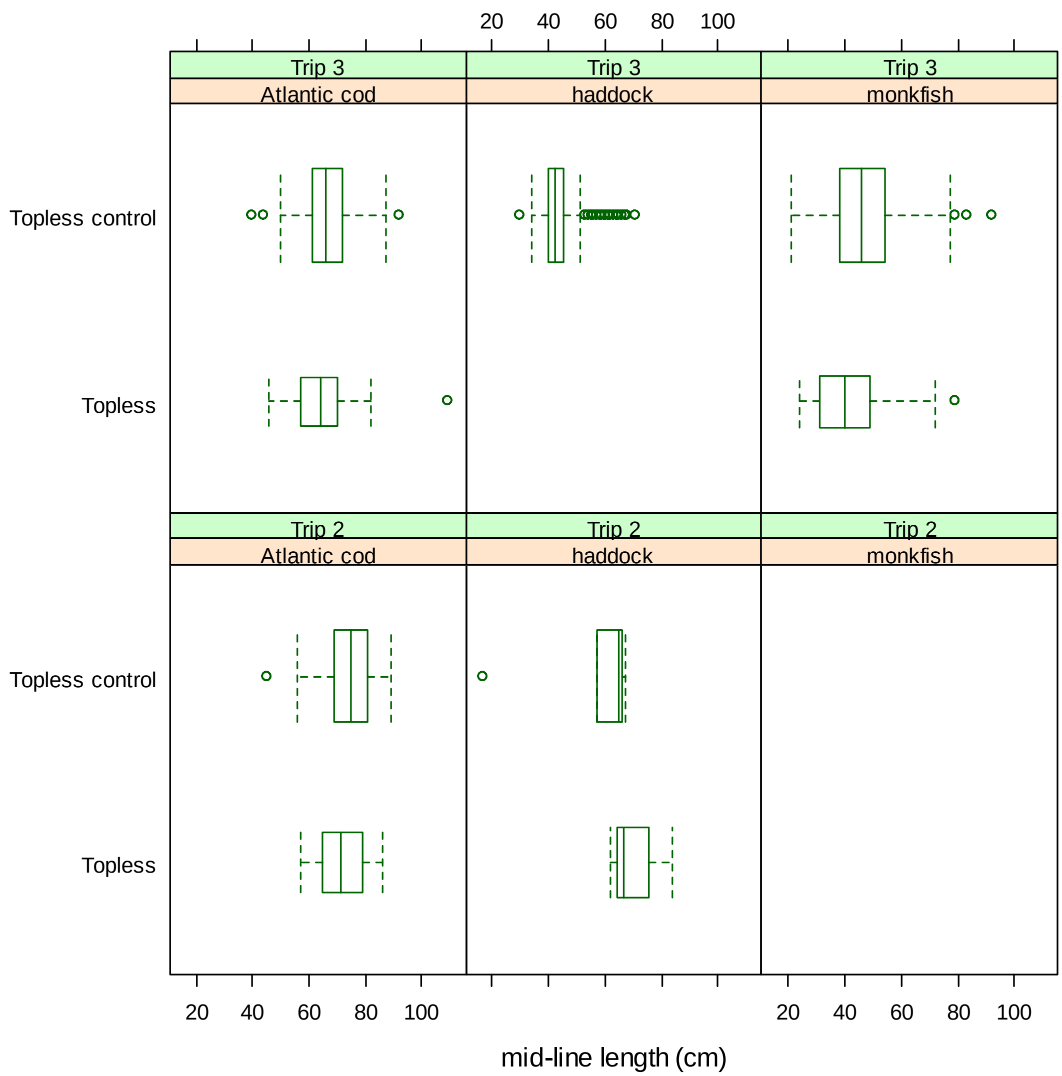

Figure 27: Box and whisker plots of length frequency distributions for major roundfish species (columns) comparing each trip (rows) and Topless and paired control nets (y-axis).

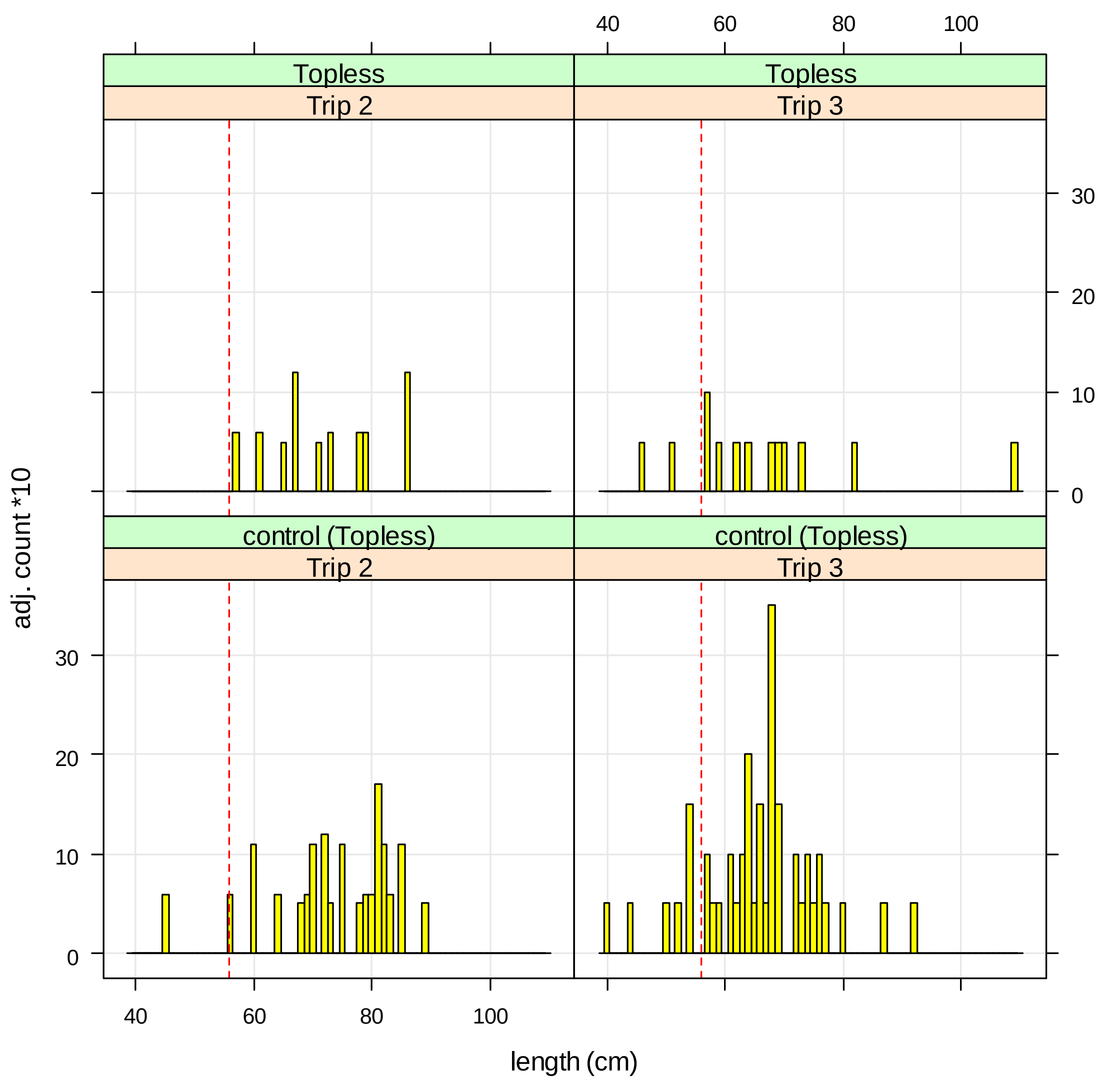

Figure 28: Topless and paired control net length frequency distributions for Atlantic cod comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

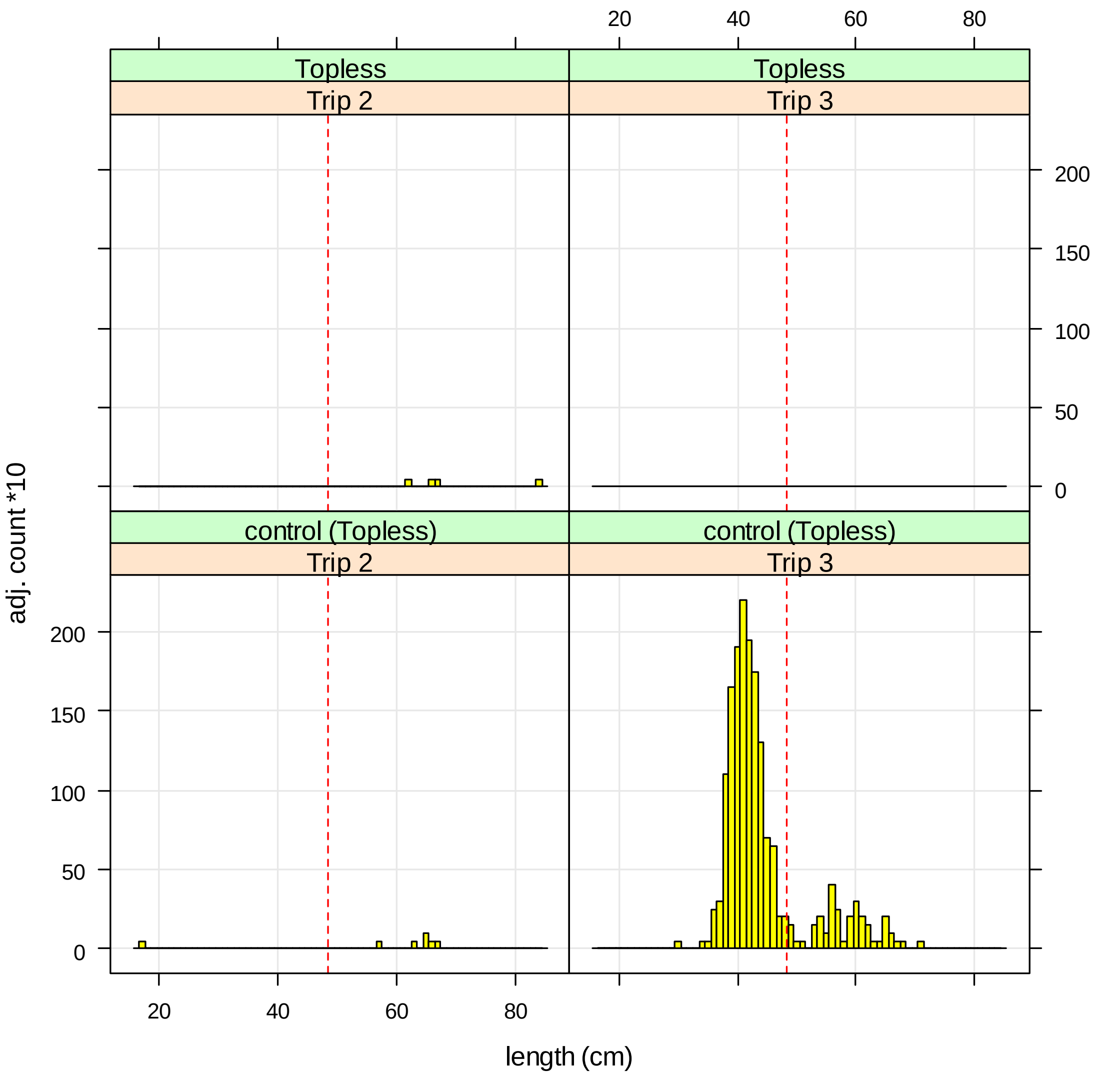

Figure 29: Topless and paired control net length frequency distributions for haddock comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

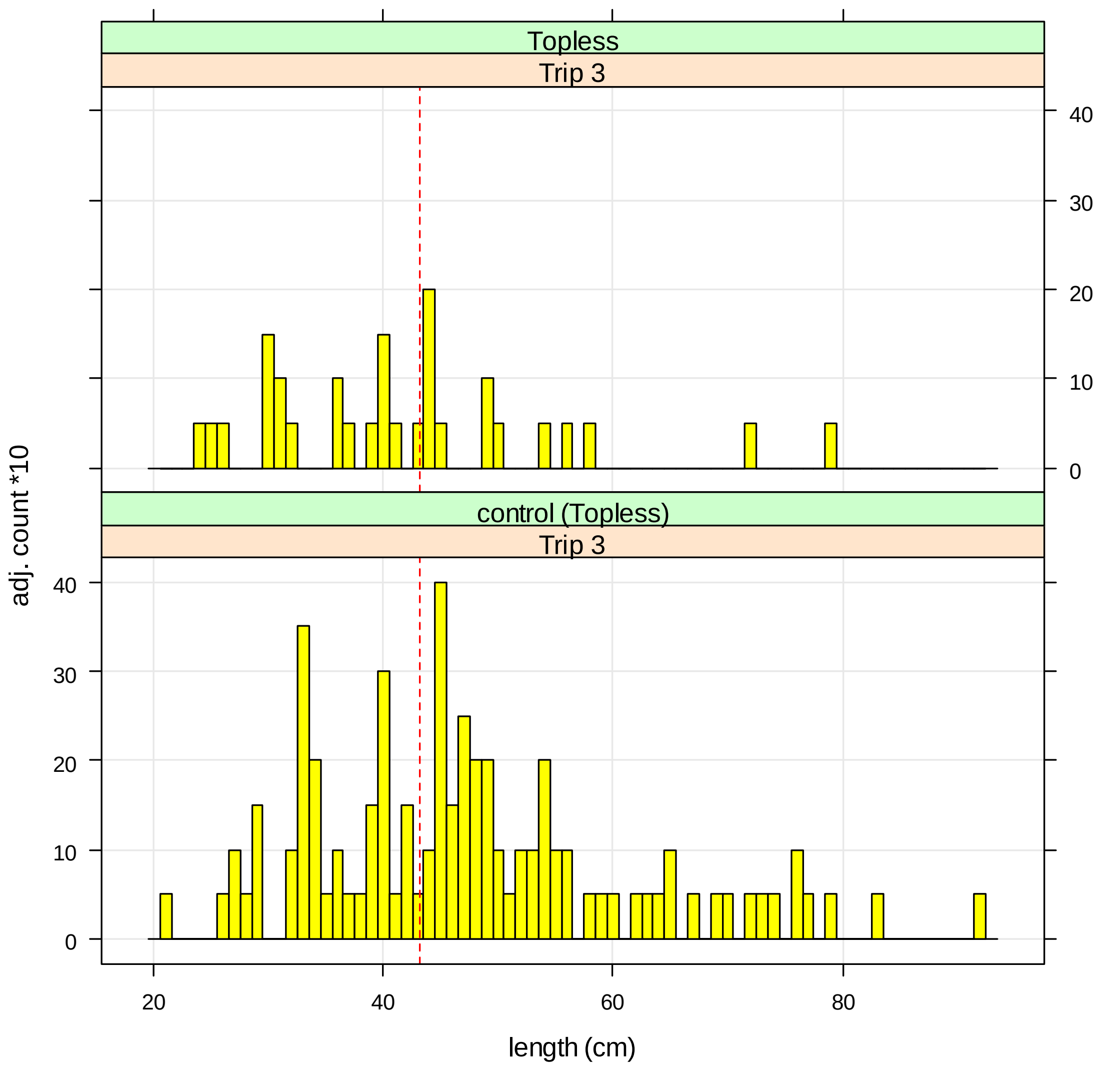

Figure 30: Topless and paired control net length frequency distributions for monkfish comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

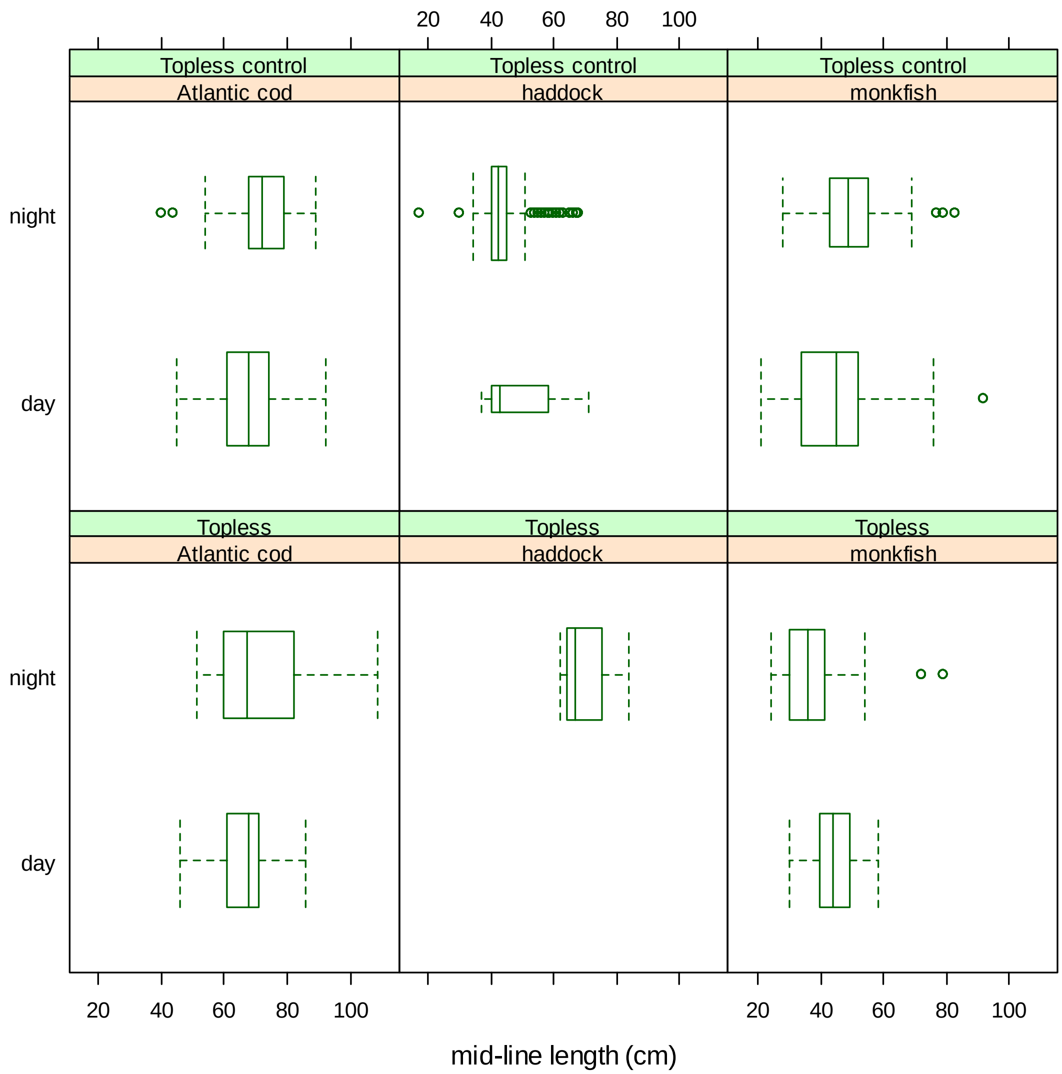

Figure 31: Box and whisker plots of length frequency distributions for major roundfish species (columns) comparing Topless and paired control nets (rows) and diel period (y-axis).

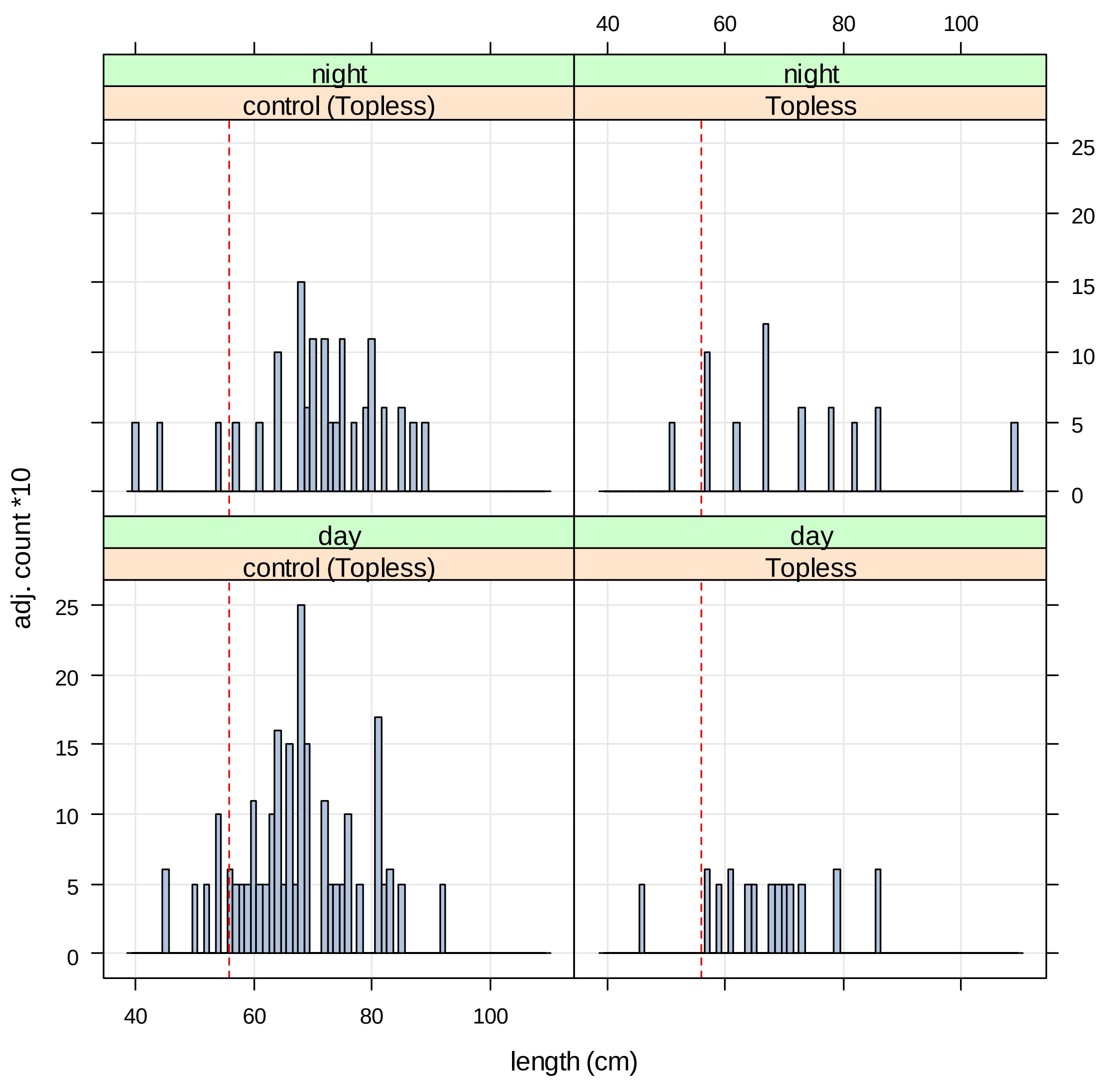

Figure 32: Topless and paired control net length frequency distributions for Atlantic cod comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

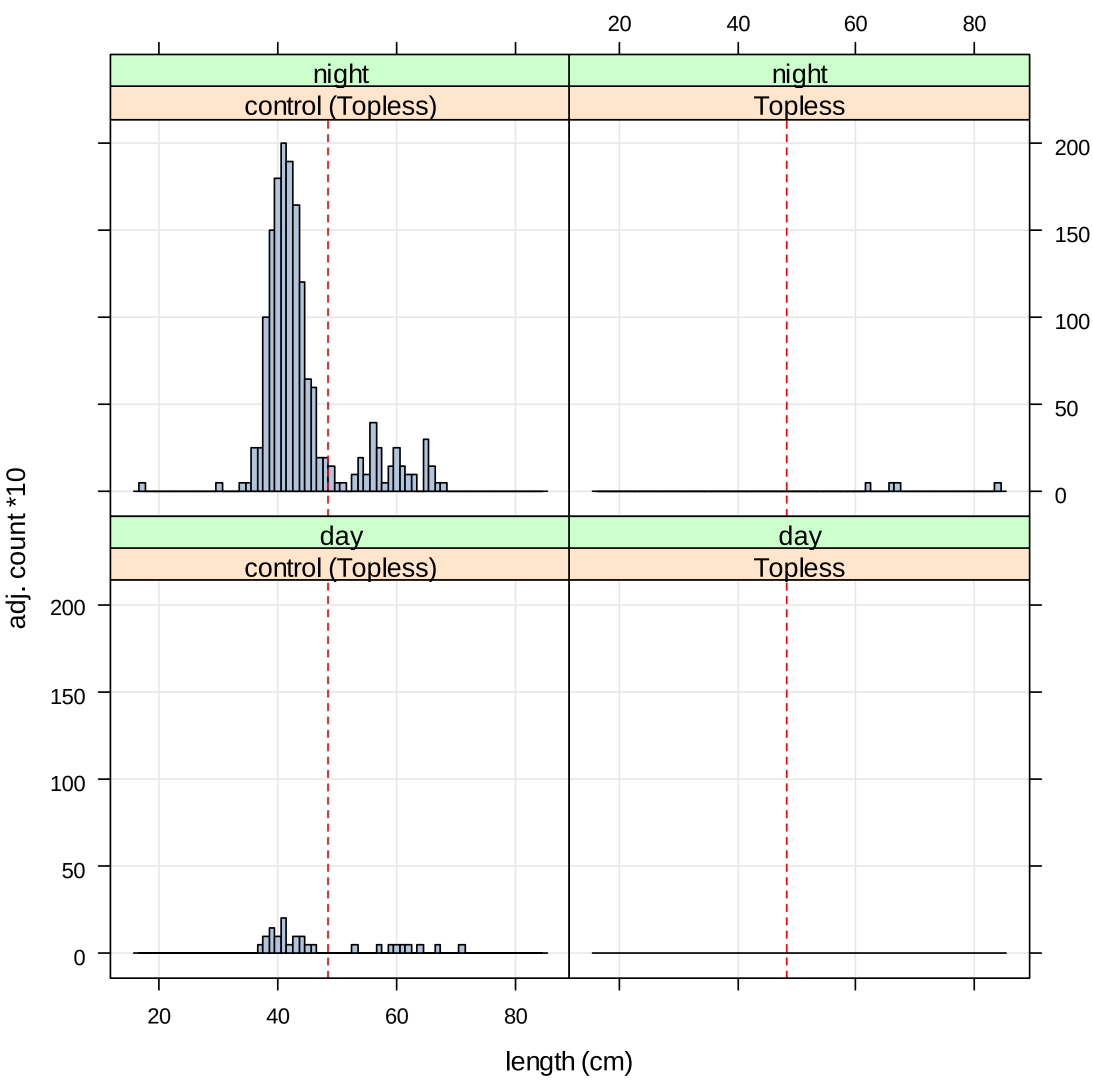

Figure 33: Topless and paired control net length frequency distributions for haddock comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

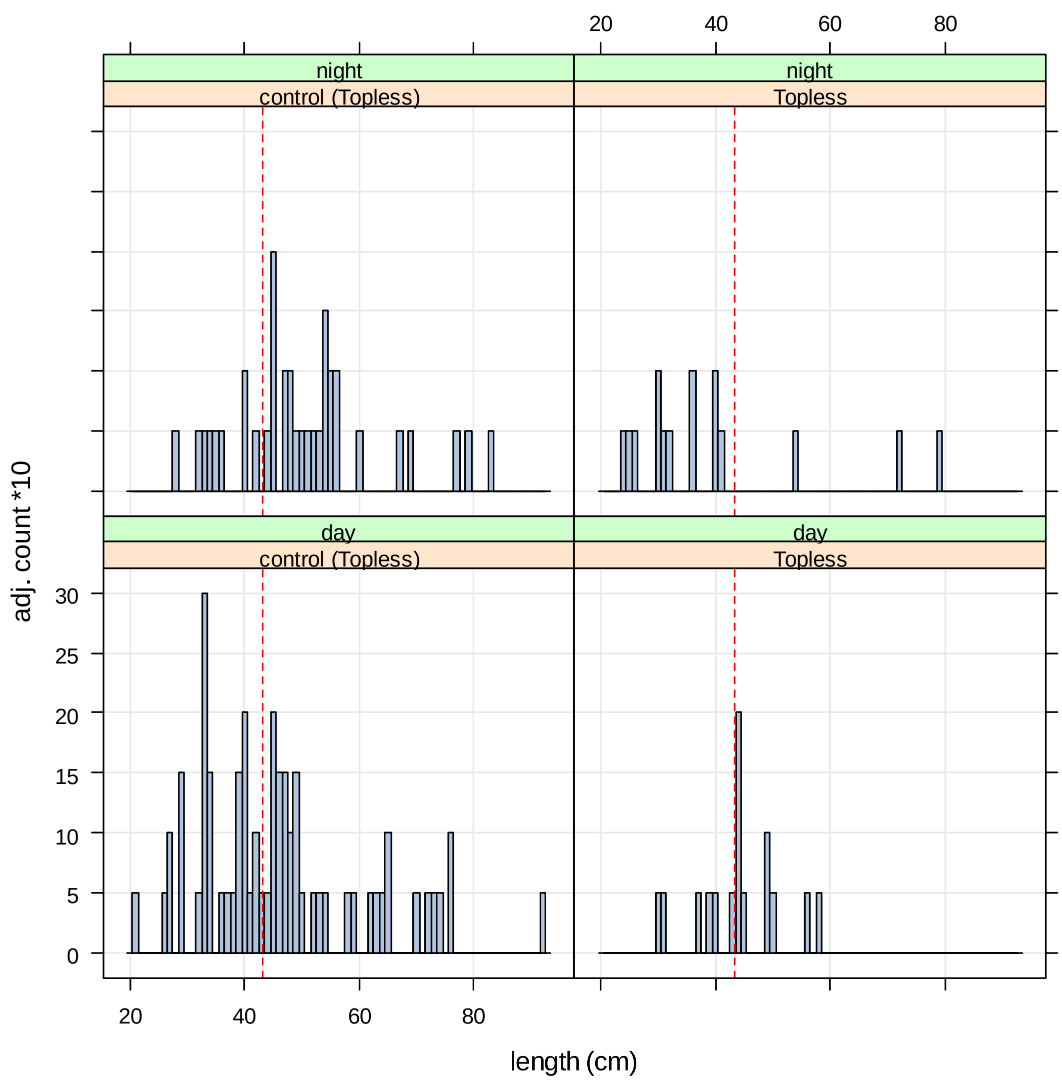

Figure 34: Topless and paired control net length frequency distributions for monkfish comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

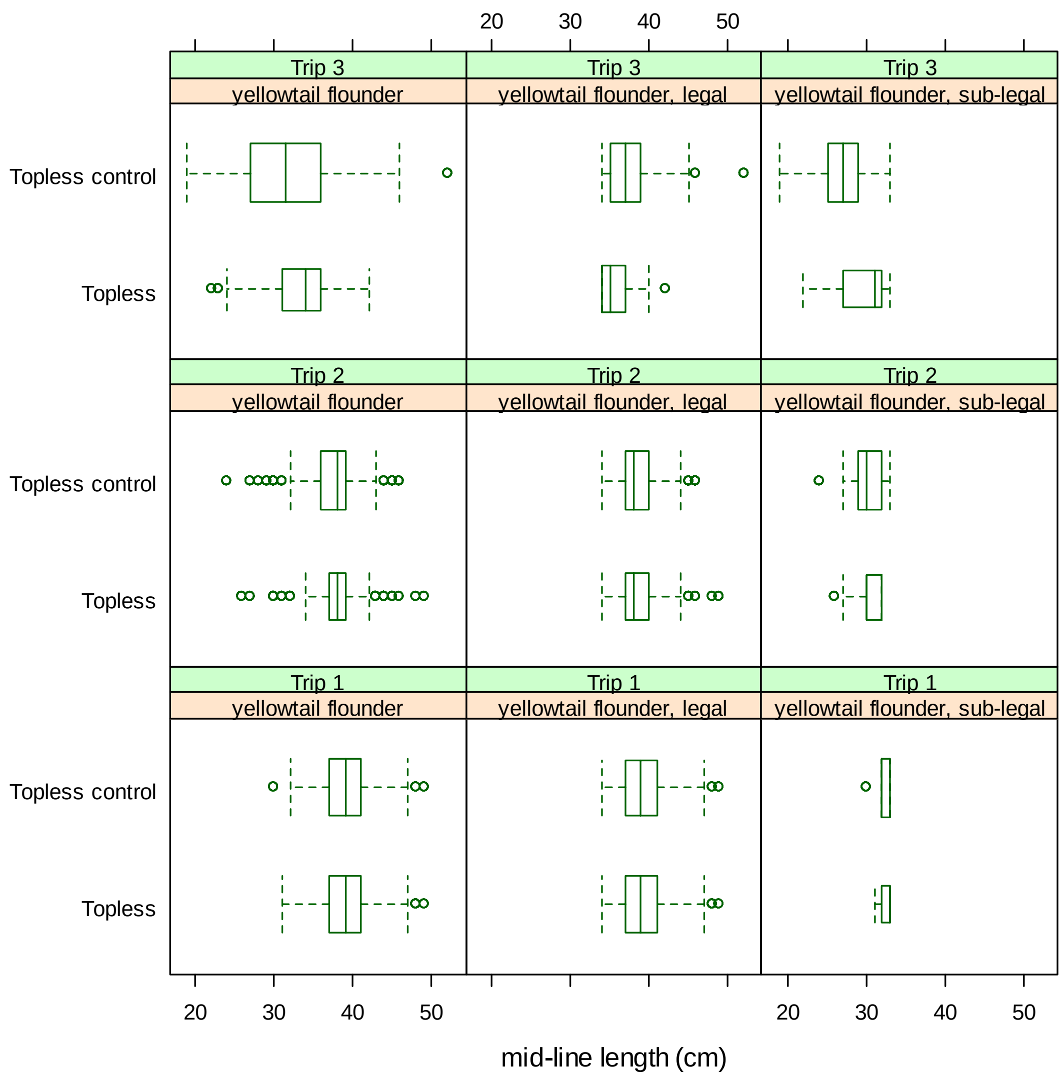

Figure 35: Box and whisker plots of length frequency distributions for yellowtail flounder categories (columns) comparing each trip (rows) and Topless and paired control nets (y-axis).

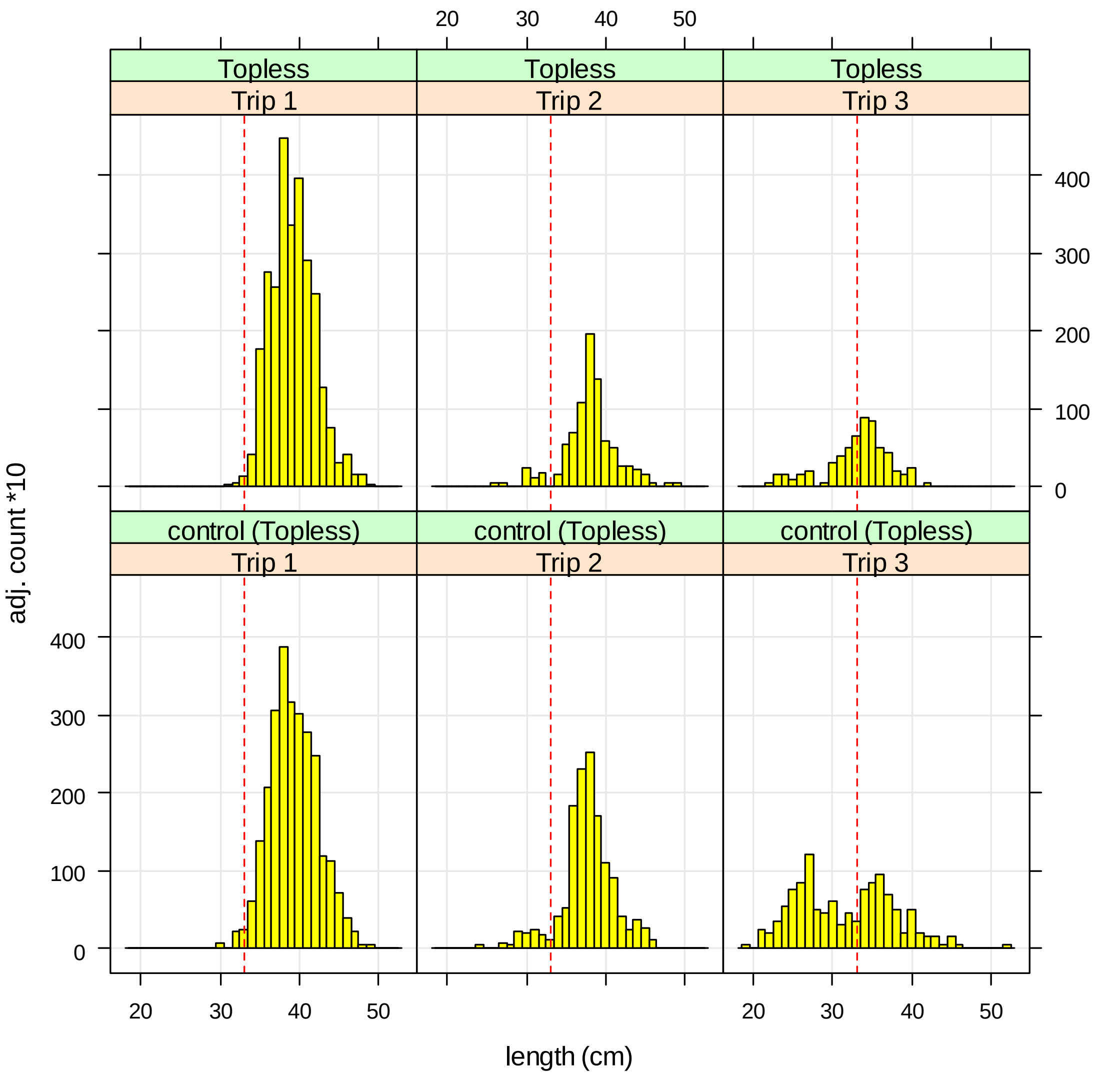

Figure 36: Topless and paired control net length frequency distributions for yellowtail flounder comparing trips (columns) and nets (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

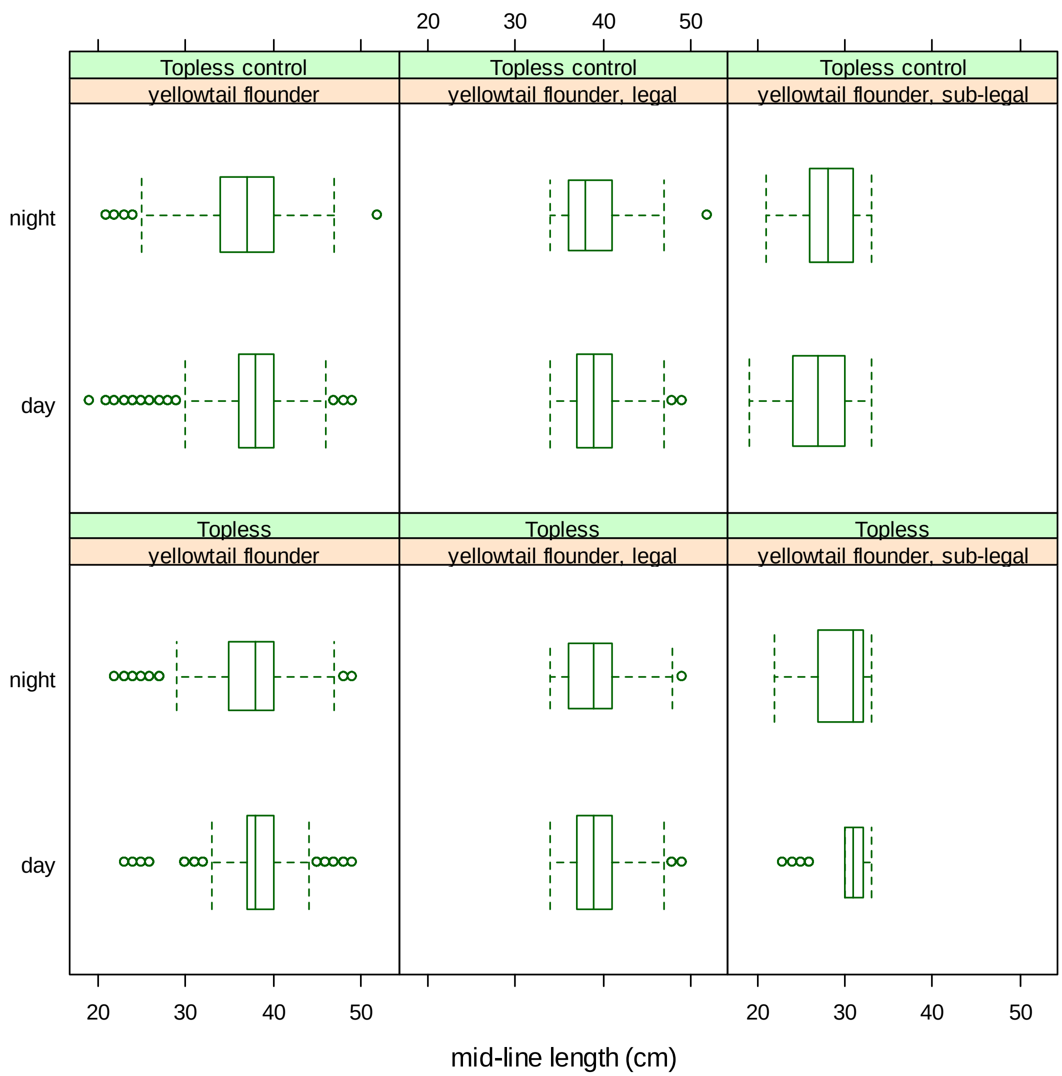

Figure 37: Box and whisker plots of length frequency distributions for yellowtail flounder categories (columns) comparing Topless and paired control nets (rows) and diel period (y-axis).

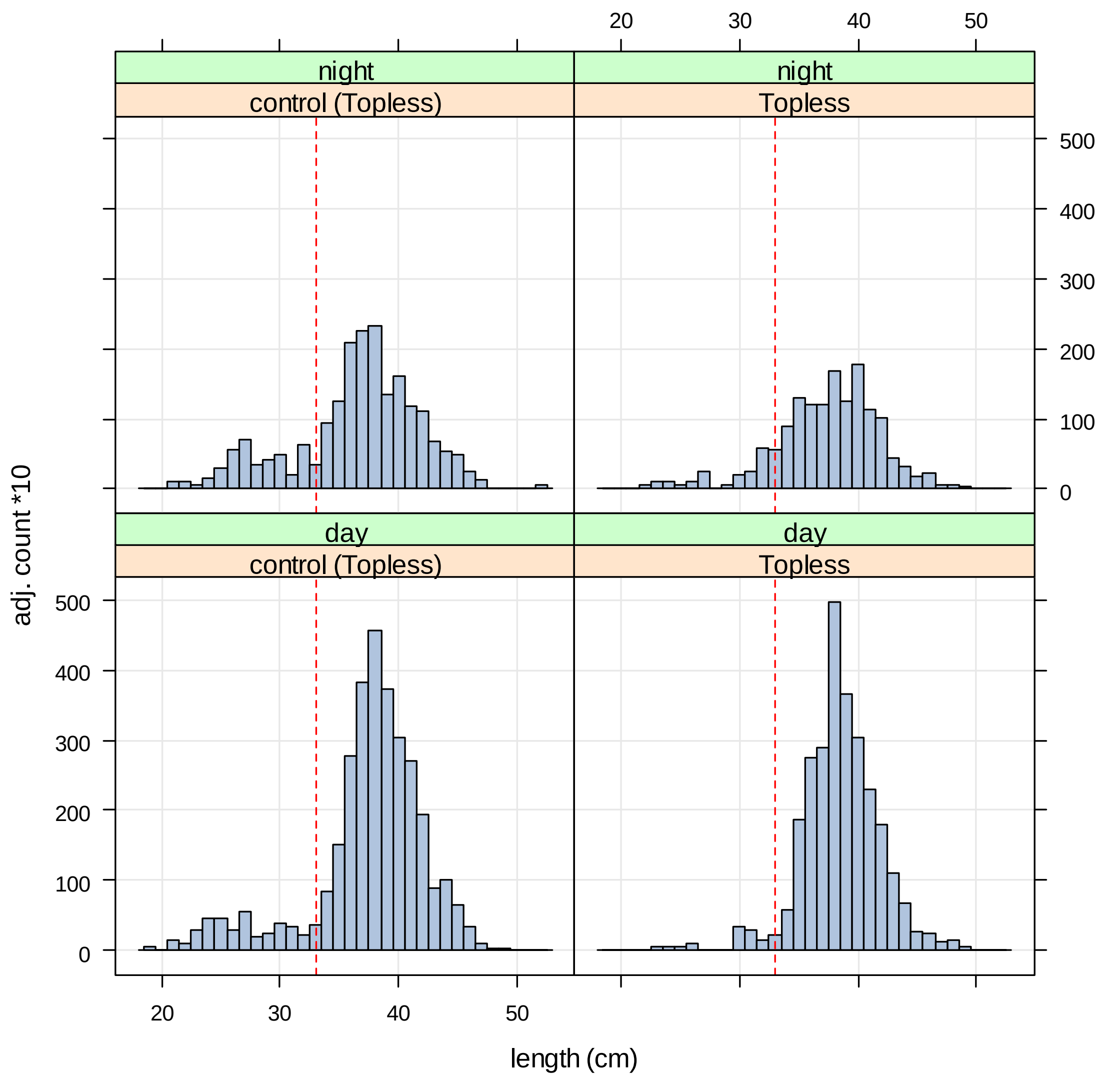

Figure 38: Topless and paired control net length frequency distributions for yellowtail flounder comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

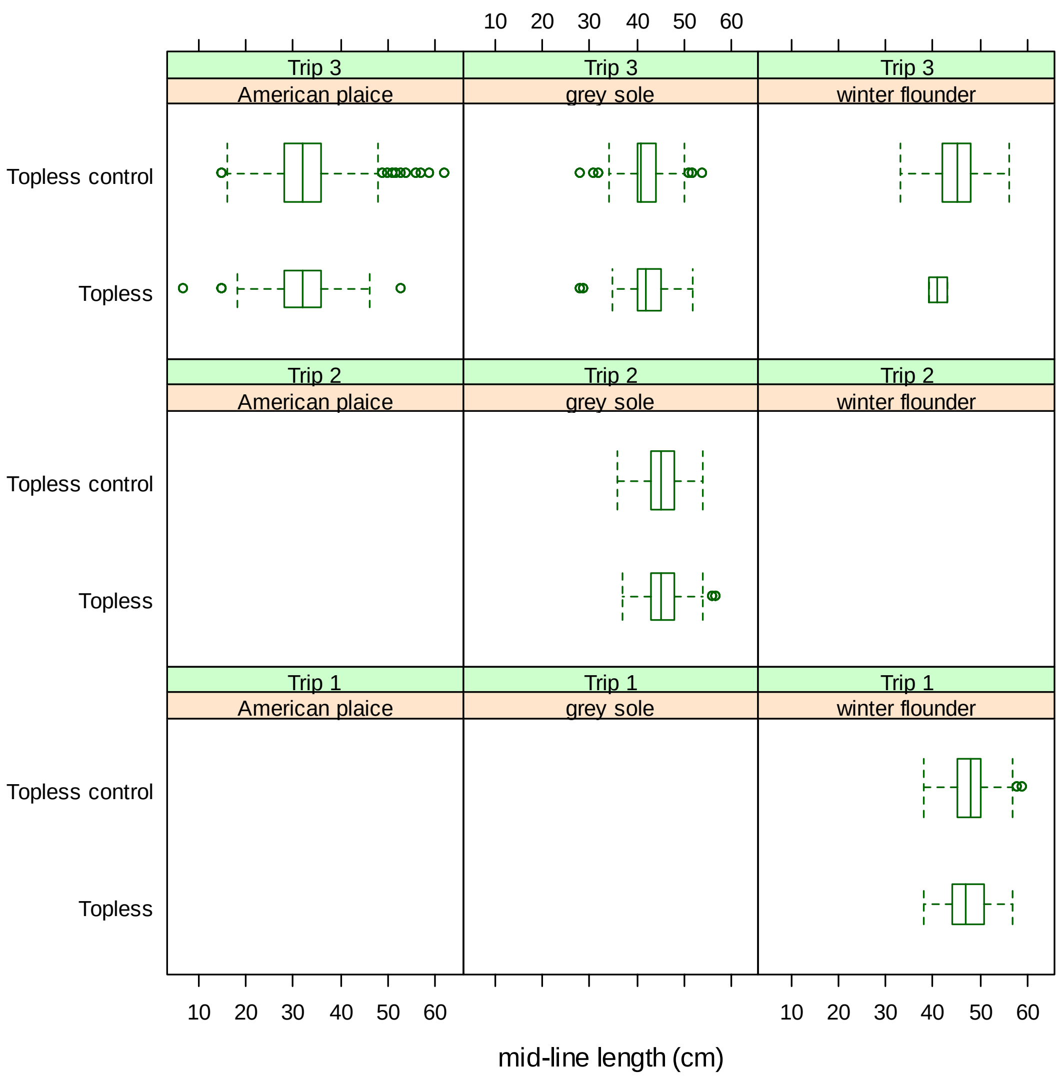

Figure 39: Box and whisker plots of length frequency distributions for major flatfish species (columns), excluding yellowtail flounder, comparing each trip (rows) and Topless and paired control nets (y-axis).

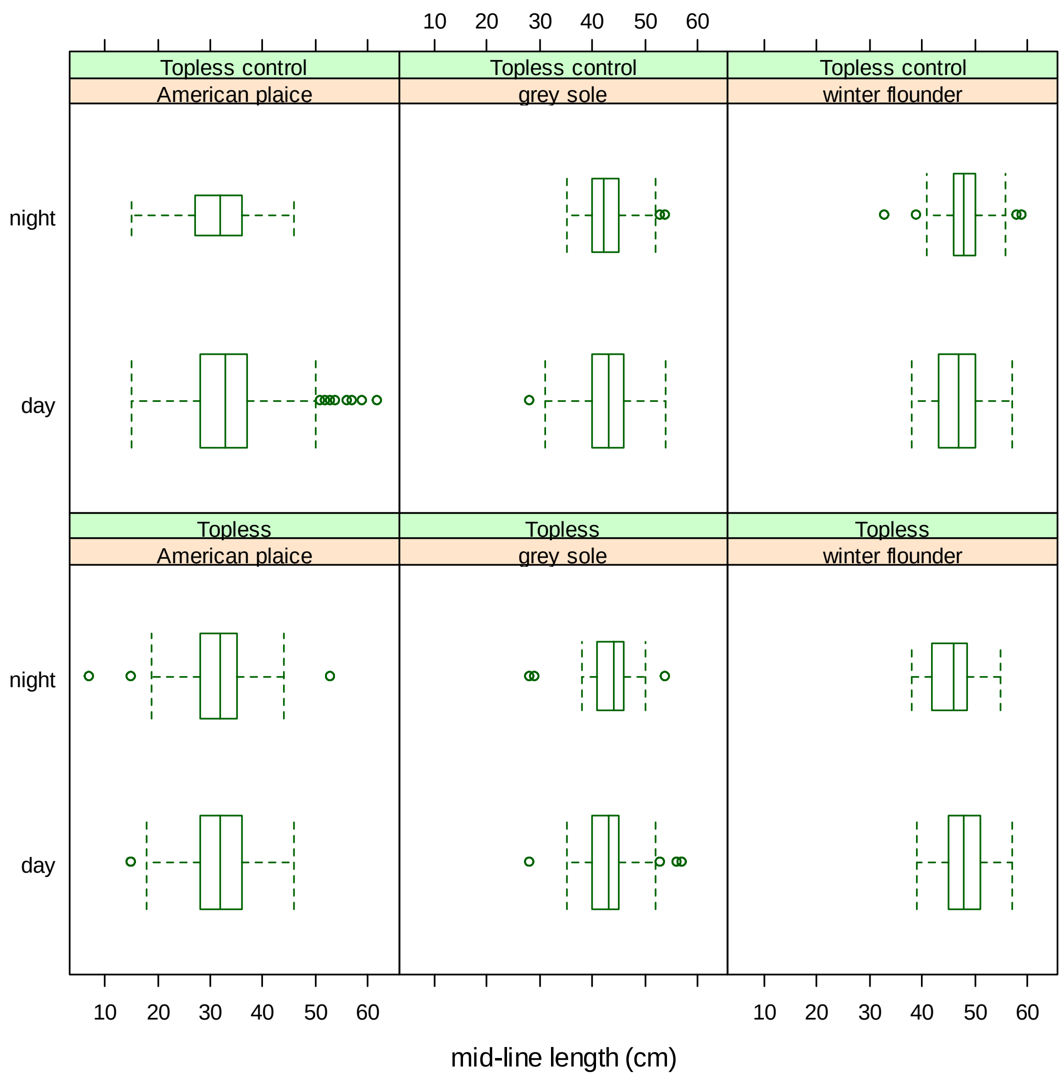

Figure 40: Box and whisker plots of length frequency distributions for major flatfish species (columns), excluding yellowtail flounder, comparing each comparing Topless and paired control nets (rows) and diel period (y-axis).

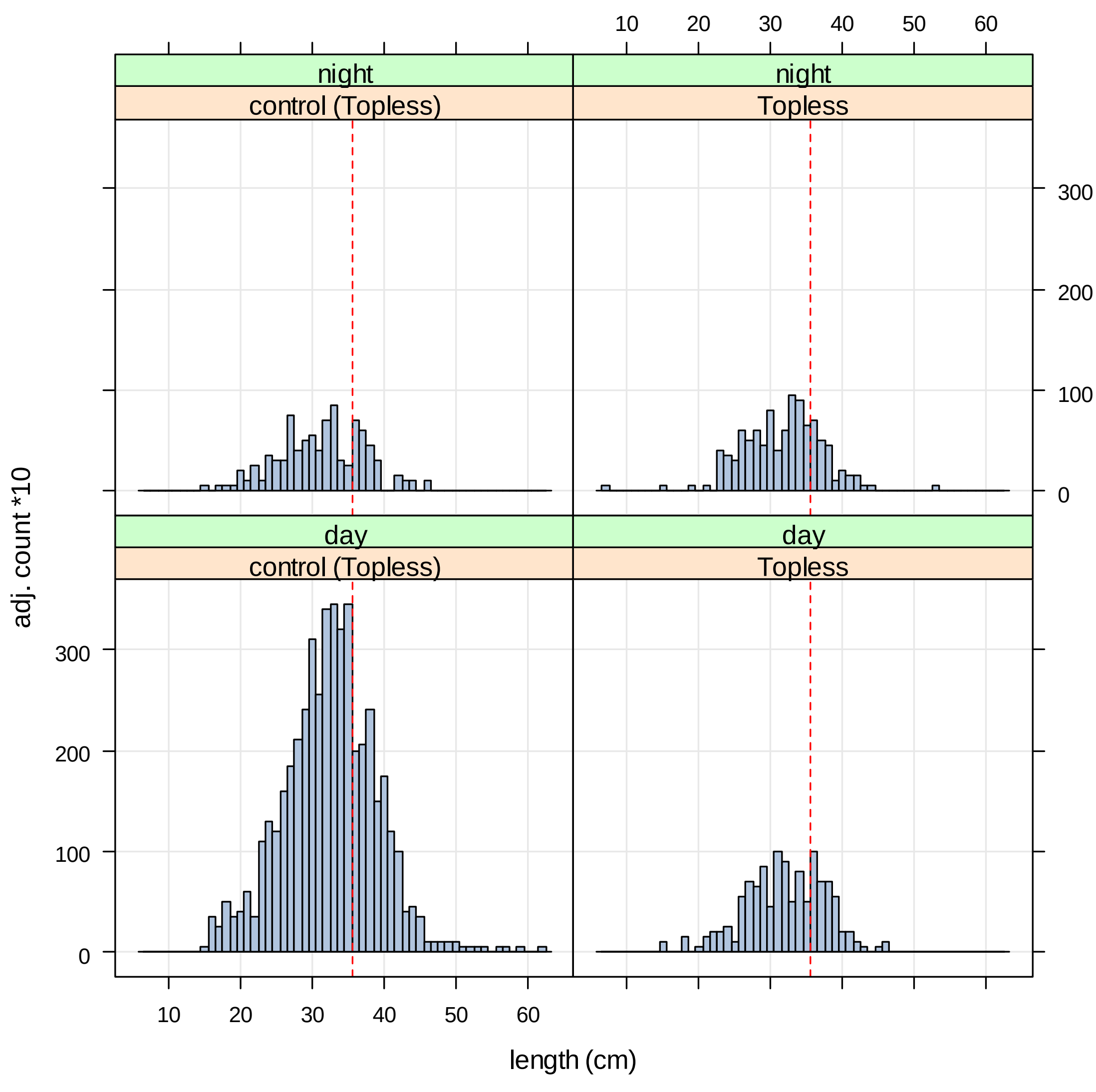

Figure 41: Topless and paired control net length frequency distributions for American plaice comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

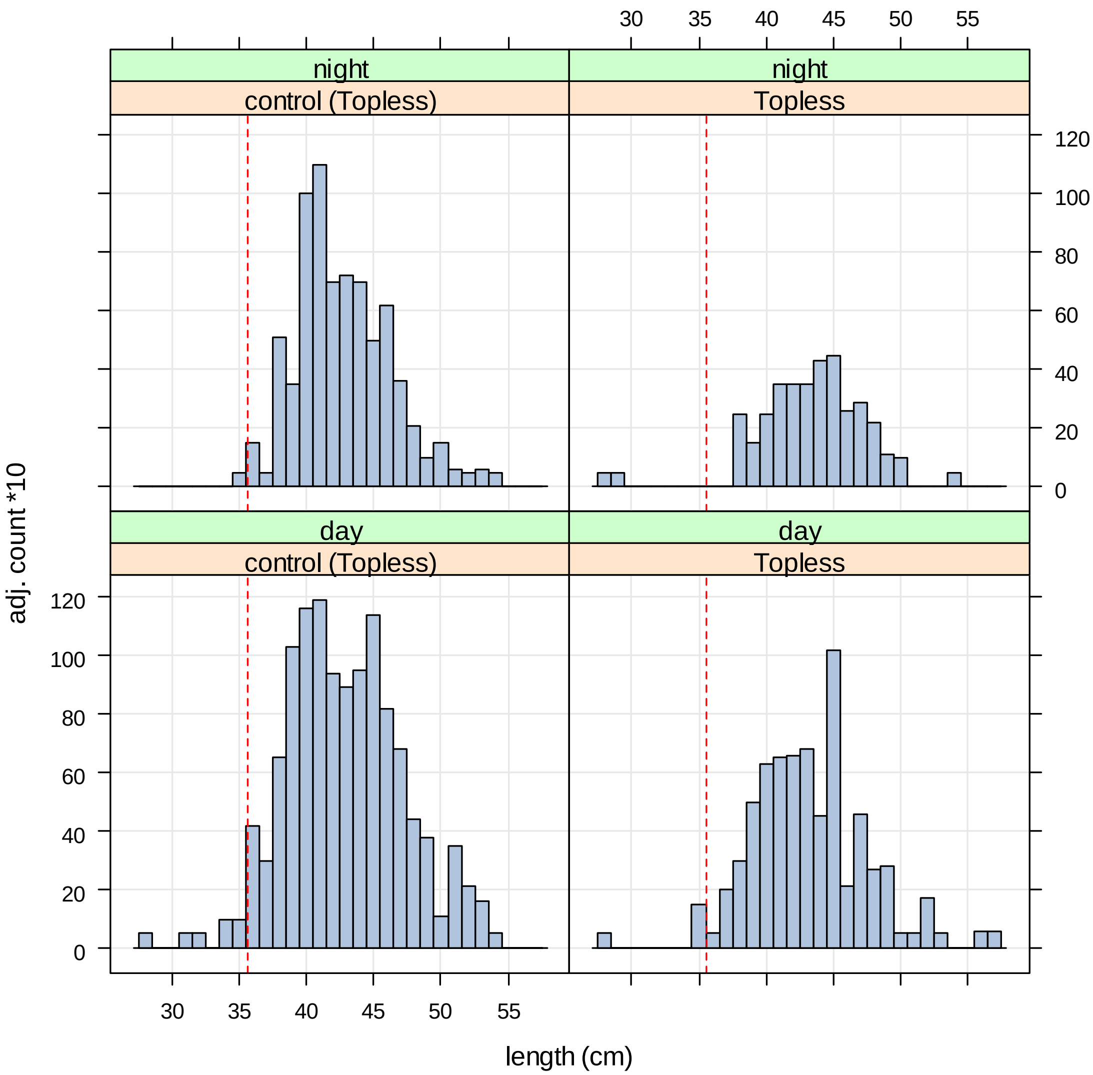

Figure 42: Topless and paired control net length frequency distributions for grey sole comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

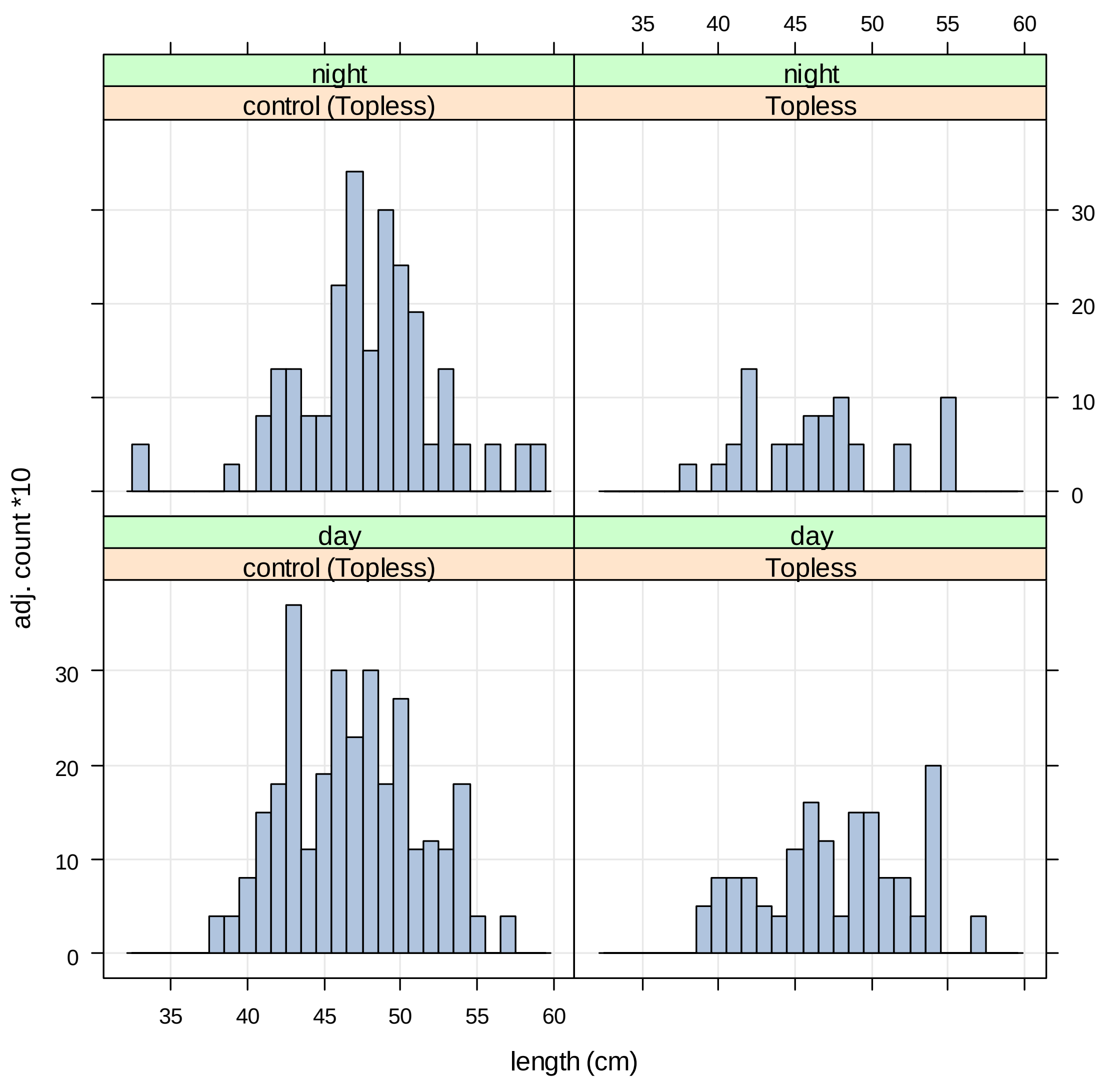

Figure 43: Topless and paired control net length frequency distributions for winter flounder comparing nets (columns) and diel period (rows). The dotted line represents the minimum legal landing size for that species at the time of the study. The adjusted count is multiplied by ten.

Appendix 1: Common and scientific names for encountered species. "Nk" (not known) refers to organisms identified to the genus.

Common Name	Scientific Name
Butterfish	*Peprilus triacanthus*
Cod, Atlantic	*Gadus morhua*
Crab, Cancer, Nk	*Cancer sp*
Crab, Deepsea, Red	*Geryon quinquedens*
Crab, Hermit, Nk	*Paguroidea sp*
Crab, Jonah	*Cancer borealis*
Crab, Rock	*Cancer irroratus*
Cusk	*Brosme brosme*
Dogfish, Spiny	*Squalus acanthias*
Flounder, American Plaice (Dab)	*Hippoglossoides platessoides*
Flounder, Fourspot	*Paralichthys oblongus*
Flounder, Gulfstream	*Citharichthys arctifrons*
Flounder, Sand Dab (Windowpane)	*Scophthalmus aquosus*
Flounder, Summer (Fluke)	*Paralichthys dentatus*
Flounder, Winter (Blackback)	*Pseudopleuronectes americanus*
Flounder, Witch (Grey Sole)	*Glyptocephalus cynoglossus*
Flounder, Yellowtail	*Limanda ferruginea*
Haddock	*Melanogrammus aeglefinus*
Hagfish, Atlantic	*Myxine glutinosa*
Hake, Red (Ling)	*Urophycis chuss*
Hake, Silver (Whiting)	*Merluccius bilinearis*
Hake, White	*Urophycis tenuis*
Halibut, Atlantic	*Hippoglossus hippoglossus*
Halibut, Greenland	*Reinhardtius hippoglossoides*
Herring, Atlantic	*Clupea harengus*
Lobster, American	*Homarus americanus*
Lumpfish	*Cyclopterus lumpus*
Mackerel, Atlantic	*Scomber scombrus*
Monkfish (Angler, Goosefish)	*Lophius americanus*
Ocean Pout	*Macrozoarces americanus*
Pollock	*Pollachius virens*
Raven, Sea	*Hemitripterus americanus*
Ray, Torpedo	*Torpedo nobiliana*
Scallop, Sea	*Placopecten magellanicus*
Sculpin, Longhorn	*Myoxocephalus octodecemspinosus*
Skate, Barndoor	*Raja laevis*
Skate, Clearnose	*Raja eglanteria*
Skate, Little	*Raja erinacea*
Skate, Nk	*Rajidae*
Skate, Smooth	*Raja senta*
Skate, Thorny	*Raja radiata*
Skate, Winter (Big)	*Raja ocellata*

Common Name	Scientific Name
Snail, Moonshell, Nk	*Naticidae*
Snail, Nk	*Gastropoda*
Sponge, Nk	*Porifera*
Squid, Atlantic Long-Fin (Loligo)	*Loligo pealeii*
Squid, Short-Fin (Illex)	*Illex illecebrosus*
Starfish, Brittle,Nk	*Ophiuroidea*
Starfish, Seastar,Nk	*Asteroidea*
Wrymouth	*Cryptacanthodes maculatus*

Appendix 2: JPG picture file listing of pictures taken during this study. Names, keywords, size and a caption are provided for each image. Pictures are included separately on DVD.

Filename	Size (KB)	Caption	Keywords
BoatCrew	278 KB	The catch is dumped on deck.	Offshore SK '03 Fieldwork
DSC00001	247 KB	Big lobster in a tote.	Offshore SK '03 Fieldwork
DSC00002	317 KB	Thomas looks at the catch on deck of the F/V Mary Elena.	Offshore SK '03 Fieldwork
DSC00004	297 KB	Measuring and weighing the catch.	Offshore SK '03 Fieldwork
DSC00005	279 KB	Mark records the information.	Offshore SK '03 Fieldwork
DSC00006	273 KB	Mark records the information.	Offshore SK '03 Fieldwork
fishmeasure	280 KB	Mark records while boat crewman and Thomas measure fish.	Offshore SK '03 Fieldwork
Goodcatch	296 KB	Large bag of flats.	Offshore SK '03 Fieldwork
IMG_0786	3,435 KB	Winch controls.	Offshore SK '04 Fieldwork
IMG_0787	3,116 KB	Observer Dave Gallagher.	Offshore SK '04 Fieldwork
IMG_0790	2,919 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0791	2,778 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0793	3,298 KB	Hydrophone wire for Netmind.	Offshore SK '04 Fieldwork
IMG_0794	2,886 KB	Hydrophone wire for Netmind.	Offshore SK '04 Fieldwork
IMG_0795	3,209 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0796	3,078 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0797	3,487 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0798	3,675 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0799	2,898 KB	Mary Elena crewmember.	Offshore SK '04 Fieldwork
IMG_0800	2,756 KB	Misc boats.	Offshore SK '04 Fieldwork
IMG_0801	3,330 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0802	3,381 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0803	3,757 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0804	2,921 KB	Misc boats.	Offshore SK '04 Fieldwork
IMG_0805	3,083 KB	Misc boats.	Offshore SK '04 Fieldwork
IMG_0806	3,962 KB	Misc boats.	Offshore SK '04 Fieldwork
IMG_0807	3,781 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0808	3,618 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0809	3,623 KB	Mary Elena crewmember.	Offshore SK '04 Fieldwork
IMG_0810	3,081 KB	Mary Elena crewmember.	Offshore SK '04 Fieldwork
IMG_0813	3,099 KB	Observer recording sheet.	Offshore SK '04 Fieldwork
IMG_0814	4,040 KB	Yellowtails in totes.	Offshore SK '04 Fieldwork
IMG_0815	3,223 KB	Haddock in a tote.	Offshore SK '04 Fieldwork
IMG_0816	3,594 KB	Mary Elena crewmembers.	Offshore SK '04 Fieldwork
IMG_0817	3,695 KB	Fish in a tote.	Offshore SK '04 Fieldwork
IMG_0818	3,852 KB	Monkfish in a basket.	Offshore SK '04 Fieldwork
IMG_0819	3,067 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0820	3,072 KB	Haddock in totes.	Offshore SK '04 Fieldwork
IMG_0821	3,083 KB	Observer William Duffy.	Offshore SK '04 Fieldwork
IMG_0822	3,563 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0823	4,342 KB	Tow being dumped on deck.	Offshore SK '04 Fieldwork
IMG_0824	3,610 KB	Mixed catch of fish.	Offshore SK '04 Fieldwork

IMG_0825	4,076 KB	Grey Sole in a tote.	Offshore SK '04 Fieldwork
IMG_0826	2,914 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0827	3,720 KB	Tow being dumped on deck.	Offshore SK '04 Fieldwork
IMG_0828	3,750 KB	Tow being dumped on deck.	Offshore SK '04 Fieldwork
IMG_0829	3,463 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0830	3,657 KB	the codend	Offshore SK '04 Fieldwork
IMG_0831	4,175 KB	the codend	Offshore SK '04 Fieldwork
IMG_0832	2,810 KB	Fisherman	Offshore SK '04 Fieldwork
IMG_0833	3,872 KB	deck work	Offshore SK '04 Fieldwork
IMG_0834	3,220 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0835	4,064 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0836	2,925 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0837	2,979 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0839	3,652 KB	Deck shots.	Offshore SK '04 Fieldwork
IMG_0840	3,620 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0841	4,646 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0843	3,540 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0844	3,636 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0845	3,592 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0846	3,825 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0847	4,358 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0848	4,346 KB	Sorting the catch.	Offshore SK '04 Fieldwork
IMG_0849	3,167 KB		Offshore SK '04 Fieldwork
IMG_0850	4,058 KB	Observer William Duffy.	Offshore SK '04 Fieldwork
IMG_0851	4,025 KB	Observer William Duffy.	Offshore SK '04 Fieldwork
IMG_0852	4,029 KB	Mary Elena crewmember.	Offshore SK '04 Fieldwork
IMG_0853	3,325 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0854	3,846 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0855	3,118 KB	Observer William Duffy.	Offshore SK '04 Fieldwork
IMG_0856	2,995 KB	Observer William Duffy.	Offshore SK '04 Fieldwork
IMG_0857	2,732 KB	Atlantic cod getting ready to be measured.	Offshore SK '04 Fieldwork
IMG_0858	2,917 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0859	2,406 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0861	2,992 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0862	3,679 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMG_0863	2,778 KB	Measuring and recording the catch.	Offshore SK '04 Fieldwork
IMGP1398	3,440 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1399	3,567 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1400	3,718 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1401	3,467 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1402	4,740 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1403	5,516 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1404	4,365 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1405	5,319 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork

IMGP1406	4,070 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1407	5,177 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1408	4,991 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1409	5,189 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1410	5,169 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1411	3,605 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1412	3,649 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1413	3,472 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1414	3,920 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1415	3,963 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1416	4,036 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1417	3,534 KB	Inspection of nets at parking area in Pt. Judith, RI.	Offshore SK '06 Fieldwork
IMGP1418	3,557 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1419	3,803 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1420	3,550 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1421	3,750 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1422	3,667 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1423	3,748 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1424	3,958 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1425	3,417 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1426	4,057 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1427	3,798 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1428	3,893 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1429	3,338 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1430	3,862 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1431	3,954 KB	Set-up of the Notus sensors on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1432	3,908 KB	Preparations of the gear for test day.	Offshore SK '06 Fieldwork
IMGP1433	3,667 KB	Misc boat photo.	Offshore SK '06 Fieldwork
IMGP1434	3,372 KB	F/V Mary Elena underway for test run of Notus system.	Offshore SK '06 Fieldwork

IMGP1435	4,745 KB	Preparations of the gear for test day.	Offshore SK '06 Fieldwork
IMGP1436	3,819 KB	Notus sensors in a fish tote.	Offshore SK '06 Fieldwork
IMGP1437	3,803 KB	Positioning of the Notus sensors on the net.	Offshore SK '06 Fieldwork
IMGP1438	4,367 KB	Positioning of the Notus sensors on the net.	Offshore SK '06 Fieldwork
IMGP1439	4,000 KB	Positioning of the Notus sensors on the net.	Offshore SK '06 Fieldwork
IMGP1440	4,635 KB	Positioning of the Notus sensors on the net.	Offshore SK '06 Fieldwork
IMGP1441	4,218 KB	Deck shot from the wheelhouse.	Offshore SK '06 Fieldwork
IMGP1442	4,127 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1443	4,102 KB	Checking the net	Offshore SK '06 Fieldwork
IMGP1444	3,424 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1445	3,760 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1446	3,769 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1447	3,994 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1448	3,655 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1449	3,024 KB	The Notus hydrophone on the stabilizer.	Offshore SK '06 Fieldwork
IMGP1450	2,151 KB	The Notus hydrophone gets placed on the stabilizer.	Offshore SK '06 Fieldwork
IMGP1451	3,406 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1452	3,611 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1453	3,866 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1454	3,431 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1455	3,427 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1456	3,498 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1457	3,206 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1458	3,361 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1459	3,541 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1460	3,261 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1461	3,234 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1462	3,411 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1463	3,188 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1464	3,308 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1465	3,217 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1466	3,226 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork

IMGP1467	3,805 KB	Set-up of the Notus hydrophone on the boat prior to the third trip.	Offshore SK '06 Fieldwork
IMGP1468	4,018 KB	Dave Chosid (MADMF) holds up a George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1469	4,021 KB	Dave Chosid (MADMF) looks at a George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1470	3,931 KB	Mark Szymanski (MADMF) holds up a George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1471	2,700 KB	Mark Szymanski (MADMF) holds up a George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1472	4,570 KB	Dave gets frustrated over the bench scale.	Offshore SK '06 Fieldwork
IMGP1473	4,533 KB	George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1474	4,491 KB	George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1475	4,046 KB	Mark Szymanski (MADMF) holds up a George's Bank lobster.	Offshore SK '06 Fieldwork
IMGP1476	4,220 KB	Net contents are being shaken down by vessel crew.	Offshore SK '06 Fieldwork
IMGP1477	4,087 KB	Net contents are being shaken down by vessel crew.	Offshore SK '06 Fieldwork
IMGP1478	4,096 KB	Minor net repairs being made by vessel crew.	Offshore SK '06 Fieldwork
IMGP1479	4,071 KB	Minor net repairs being made by vessel crew.	Offshore SK '06 Fieldwork
IMGP1480	4,073 KB	Minor net repairs being made by vessel crew.	Offshore SK '06 Fieldwork
IMGP1481	4,110 KB	Net contents are being shaken down by vessel crew.	Offshore SK '06 Fieldwork
IMGP1482	3,876 KB	Catch is finally dumped out on deck to be sorted.	Offshore SK '06 Fieldwork
IMGP1483	4,080 KB	Catch is finally dumped out on deck to be sorted.	Offshore SK '06 Fieldwork
IMGP1484	4,104 KB	Mike Pol (MADMF) holds up a big pollock.	Offshore SK '06 Fieldwork
IMGP1485	3,589 KB	Mark Szymanski (MADMF) waits to finish recording the catch.	Offshore SK '06 Fieldwork
IMGP1486	4,276 KB	Big pollock in a tote.	Offshore SK '06 Fieldwork
IMGP1487	3,716 KB	Greenland halibut on the measuring table.	Offshore SK '06 Fieldwork
IMGP1488	3,836 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1489	4,002 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1490	3,899 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1491	3,523 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1492	3,512 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1493	3,715 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1494	3,425 KB	Mark Szymanski and Mike Pol measuring and recording the catch.	Offshore SK '06 Fieldwork
IMGP1495	3,744 KB	Big monkfish and pollock in totes.	Offshore SK '06 Fieldwork
IMGP1496	3,889 KB	Deck shot of net being hauled in.	Offshore SK '06 Fieldwork
IMGP1497	3,360 KB	Deck shot of net being hauled in.	Offshore SK '06 Fieldwork
IMGP1498	3,957 KB	Deck shot of net being hauled in.	Offshore SK '06 Fieldwork
IMGP1499	4,048 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1500	3,864 KB	Scenery shots.	Offshore SK '06 Fieldwork

IMGP1501	3,806 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1502	3,882 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1503	3,859 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1504	3,406 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1505	3,947 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1506	4,327 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1507	3,751 KB	Different skate species displayed.	Offshore SK '06 Fieldwork
IMGP1508	3,759 KB	Different skate species displayed.	Offshore SK '06 Fieldwork
IMGP1509	3,253 KB	Sunset on the water.	Offshore SK '06 Fieldwork
IMGP1510	3,639 KB	Sunset on the water.	Offshore SK '06 Fieldwork
IMGP1511	3,709 KB	Sunset on the water.	Offshore SK '06 Fieldwork
IMGP1512	3,487 KB	Sunset on the water.	Offshore SK '06 Fieldwork
IMGP1513	3,430 KB	Sunset on the water.	Offshore SK '06 Fieldwork
IMGP1514	4,284 KB	The net is hauled in at night.	Offshore SK '06 Fieldwork
IMGP1515	4,395 KB	Nighttime haul dumped on deck.	Offshore SK '06 Fieldwork
IMGP1516	4,213 KB	Nighttime haul dumped on deck.	Offshore SK '06 Fieldwork
IMGP1517	4,195 KB	Nighttime haul dumped on deck.	Offshore SK '06 Fieldwork
IMGP1518	4,010 KB	Dave Chosid (MADMF) holds up a George's Bank codfish.	Offshore SK '06 Fieldwork
IMGP1519	3,131 KB	Dave Chosid (MADMF) holds up a George's Bank codfish.	Offshore SK '06 Fieldwork
IMGP1520	4,350 KB	Fish in baskets wait to be weighed.	Offshore SK '06 Fieldwork
IMGP1521	4,424 KB	Fish in baskets wait to be weighed.	Offshore SK '06 Fieldwork
IMGP1522	3,525 KB	The net is hauled in.	Offshore SK '06 Fieldwork
IMGP1523	3,737 KB	The net is hauled in.	Offshore SK '06 Fieldwork
IMGP1524	3,493 KB	The net is hauled in.	Offshore SK '06 Fieldwork
IMGP1525	3,558 KB	Shots of seagulls.	Offshore SK '06 Fieldwork
IMGP1526	3,660 KB	Shots of seagulls.	Offshore SK '06 Fieldwork
IMGP1527	3,674 KB	Red crab.	Offshore SK '06 Fieldwork
IMGP1528	4,383 KB	Ghost lobster pot is stuck in net.	Offshore SK '06 Fieldwork
IMGP1529	4,259 KB	Boat crew removes ghost lobster pot.	Offshore SK '06 Fieldwork
IMGP1530	3,655 KB	Net contents are shaken down.	Offshore SK '06 Fieldwork
IMGP1531	4,197 KB	The catch is ready to be dumped on deck.	Offshore SK '06 Fieldwork
IMGP1532	4,306 KB	The catch is being dumped on deck.	Offshore SK '06 Fieldwork
IMGP1533	4,113 KB	The catch is being dumped on deck.	Offshore SK '06 Fieldwork
IMGP1534	4,179 KB	The catch is being dumped on deck.	Offshore SK '06 Fieldwork
IMGP1535	3,384 KB	Mike Pol (MADMF) points to something in the water next to the boat.	Offshore SK '06 Fieldwork
IMGP1536	3,732 KB	Shot of marine mammal near boat.	Offshore SK '06 Fieldwork
IMGP1537	3,722 KB	Shot of marine mammal near boat.	Offshore SK '06 Fieldwork
IMGP1538	3,359 KB	Deck shot of net ramp.	Offshore SK '06 Fieldwork
IMGP1539	3,318 KB	Deck shot of net ramp.	Offshore SK '06 Fieldwork
IMGP1540	4,357 KB	Cusk gets measured.	Offshore SK '06 Fieldwork
IMGP1541	4,316 KB	Cusk gets measured.	Offshore SK '06 Fieldwork
IMGP1542	3,924 KB	Cusk gets measured.	Offshore SK '06 Fieldwork
IMGP1543	4,296 KB	Cusk gets measured.	Offshore SK '06 Fieldwork
IMGP1544	4,261 KB	Cusk gets measured.	Offshore SK '06 Fieldwork
IMGP1545	4,475 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1546	4,419 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1547	4,509 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1548	4,163 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork

IMGP1549	3,978 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1550	4,353 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1551	4,242 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1552	3,843 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1553	3,962 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1554	3,918 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1555	2,596 KB	Crane scale is used to weigh the entire catch.	Offshore SK '06 Fieldwork
IMGP1556	3,964 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1557	3,956 KB	Nighttime haul with a large catch.	Offshore SK '06 Fieldwork
IMGP1558	4,036 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1559	3,880 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1560	4,085 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1561	4,076 KB	The catch is dumped on deck.	Offshore SK '06 Fieldwork
IMGP1562	3,548 KB	Large rock in net.	Offshore SK '06 Fieldwork
IMGP1563	4,161 KB	Large rock in net.	Offshore SK '06 Fieldwork
IMGP1564	4,114 KB	Large rock in net.	Offshore SK '06 Fieldwork
IMGP1565	4,274 KB	Large rock in net.	Offshore SK '06 Fieldwork
IMGP1566	3,773 KB	Dave Chosid (MADMF) looks over the catch.	Offshore SK '06 Fieldwork
IMGP1567	3,618 KB	Dave Chosid (MADMF) looks over the catch.	Offshore SK '06 Fieldwork
IMGP1568	3,677 KB	The net gets stuck around the net drum.	Offshore SK '06 Fieldwork
IMGP1569	3,498 KB	The net gets stuck around the net drum.	Offshore SK '06 Fieldwork
IMGP1570	3,519 KB	Shot of the Onset tidbit on the door.	Offshore SK '06 Fieldwork
IMGP1571	3,277 KB	The net is being hauled.	Offshore SK '06 Fieldwork
IMGP1572	3,827 KB	Shot of the port door.	Offshore SK '06 Fieldwork
IMGP1573	3,552 KB	The net is being hauled.	Offshore SK '06 Fieldwork
IMGP1574	3,576 KB	The net is being hauled.	Offshore SK '06 Fieldwork
IMGP1575	3,160 KB	Dave Chosid poses for the camera.	Offshore SK '06 Fieldwork
IMGP1576	3,390 KB	Dave Chosid poses for the camera.	Offshore SK '06 Fieldwork
IMGP1577	3,837 KB	The sun sets over the water.	Offshore SK '06 Fieldwork
IMGP1578	4,145 KB	Dave Chosid poses for the camera.	Offshore SK '06 Fieldwork
IMGP1579	3,698 KB	Dave Chosid poses for the camera.	Offshore SK '06 Fieldwork
IMGP1580	4,018 KB	Mark Szymanski poses for the camera.	Offshore SK '06 Fieldwork
IMGP1581	3,957 KB	Mark Szymanski poses for the camera.	Offshore SK '06 Fieldwork
IMGP1582	3,926 KB	Dave Chosid hugs the big lobster.	Offshore SK '06 Fieldwork
IMGP1583	3,939 KB	Mike Pol looks at the catch.	Offshore SK '06 Fieldwork
IMGP1584	4,126 KB	Mike Pol looks at the catch.	Offshore SK '06 Fieldwork
IMGP1585	3,645 KB	Large lobster.	Offshore SK '06 Fieldwork
IMGP1586	4,164 KB	Mark Szymanski poses for the camera.	Offshore SK '06 Fieldwork
IMGP1587	3,705 KB	Mike Pol looks at the catch.	Offshore SK '06 Fieldwork
IMGP1588	4,062 KB	The net is being dumped on deck.	Offshore SK '06 Fieldwork
IMGP1589	3,807 KB	Seagulls over head wait for a free meal.	Offshore SK '06 Fieldwork
IMGP1590	4,146 KB	Mark Szymanski looks at the catch.	Offshore SK '06 Fieldwork
IMGP1591	4,001 KB	Loligo squid on the measuring table.	Offshore SK '06 Fieldwork
IMGP1592	3,880 KB	Mike Pol looks hungrily at the big loligo squid on the measuring table.	Offshore SK '06 Fieldwork
IMGP1593	4,345 KB	Mike Pol cuts up some loligo.	Offshore SK '06 Fieldwork
IMGP1594	4,014 KB	Mike Pol cuts up some loligo.	Offshore SK '06 Fieldwork
IMGP1596	4,306 KB	Mike Pol cuts up some loligo.	Offshore SK '06 Fieldwork
IMGP1597	3,513 KB	Everyone posed for a picture after a successful trip back at the dock.	Offshore SK '06 Fieldwork

IMGP1598	3,495 KB	Everyone posed for a picture after a successful trip back at the dock.	Offshore SK '06 Fieldwork
IMGP1728	3,818 KB	Mark and Dave talk about life.	Weighing Codend at SMAST
IMGP1729	3,704 KB	Soaking the codend.	Weighing Codend at SMAST
IMGP1730	3,859 KB	Mark Szymanski (MADMF) and David Martins (SMAST) prepare to lift grates.	Weighing Codend at SMAST
IMGP1731	3,587 KB	Hanging the codend.	Weighing Codend at SMAST
IMGP1732	3,620 KB	Mark waves to camera.	Weighing Codend at SMAST
measuring	294 KB	Mark records while crewman and Thomas measure.	Offshore SK '03 Fieldwork
P1010002	2,117 KB	Thomas Moth-Poulsen and Scott Wescott talk about the clump.	Offshore SK '03 Dockside
P1010003	2,263 KB	Scott Wescott shows Thomas Moth-Poulsen the clump.	Offshore SK '03 Dockside
P1010004	2,228 KB	Thomas Moth-Poulsen and Scott Wescott talk about the clump.	Offshore SK '03 Dockside
P1010009	2,541 KB	Deck shot of the Mary Elena.	Offshore SK '03 Dockside
P1010011	2,247 KB	Thomas Moth-Poulsen and Mark Szymanski pose for picture in front of the Mary Elena	Offshore SK '03 Dockside
snowcrop	2,053 KB	Misc boats.	Offshore SK '04 Fieldwork
Thomaslooksat catch_2	303 KB	Thomas looks over the catch.	Offshore SK '03 Fieldwork

Appendix 3: Video file listing. Video identifications, titles, descriptions, and the original recorded mediums are provided for each video. Videos are included separately on DVDs.

Video ID	Title	Description	Medium
03MADMF847	Film of SK Nets	Net inspections and discussion with partners.	Mini DV
03MADMF848	Deck Footage	Trip one field research and gear tests.	Mini DV
06MADMF951	OffshoreSK #1	Trip three field research.	Mini DV
06MADMF952	OffshoreSK #2	Trip three field research.	Mini DV