Sampling protocols for shelf/slope catch comparison tows in 2024

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Overview

This project will compare catchability and selectivity between the EBS shelf and EBS slope bottom trawl survey gear and towing protocol by conducting side-by-side paired tows on the upper continental slope (200 to 400 m depth) and outer continental shelf. The results of this study will be used to develop calibration factors between EBS shelf and slope gears, as a step towards combining EBS shelf and slope indices of abundance and extending the EBS shelf survey to the upper continental slope.

Sample allocation

Paired side-by-side tows between the 83-112 eastern trawl and Poly Nor'eastern (PNE) will be allocated among ~46 stations in four zones (Figure 1; Table 1). Station allocation within each sample zone is provided below.

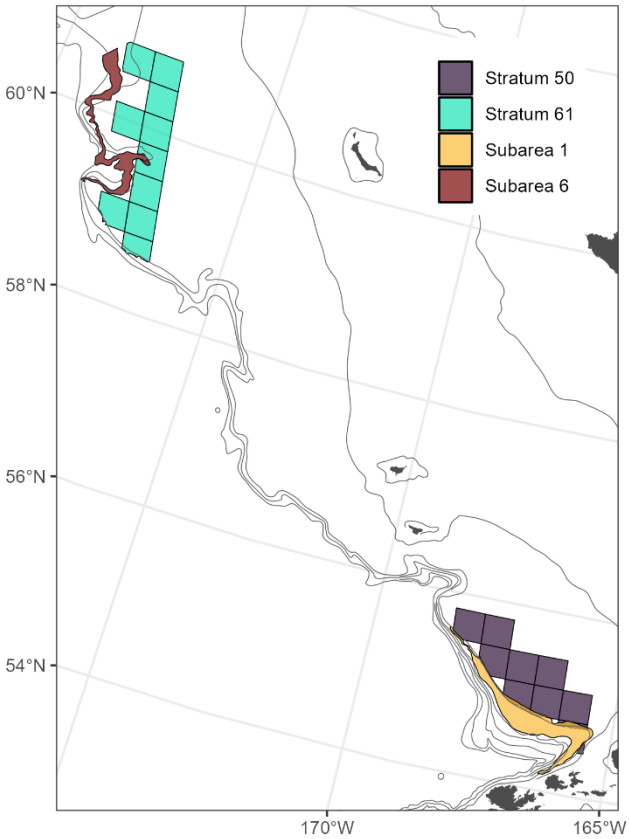


Figure 1. Sample zones (strata and subarea) on the EBS shelf and EBS slope.

Table 1. Sample areas and projected number of stations to be sampled, by leg.

Area	Leg	Stns (#)	Timing and coordination
Subarea 1	1	12-15	Slope stations to be sampled at the beginning of the survey.
Stratum 50	2	6 or 7	Shelf stations along the edge of the survey area. Tows with the 83-112 net will be the standard index station tow. FPCs need to coordinate to ensure both vessels are in the sampling zone at the same time.
Stratum 61	4	6	Shelf stations along the edge of the survey area. Leave these stations for the end of the standard EBS shelf survey. Tows with the 83-112 net will be the standard index station tow. FPCs need to coordinate to ensure both vessels are in the sampling zone at the same time.
Subarea 6	4	13	Slope stations to be sampled immediately after completing the final shelf survey tows in Shelf Stratum 60.

Towing protocols for side-by-side tows

Vessels will conduct pairs of side-by-side tows in four sampling zones. During each paired tow, the Alaska Knight will conduct a 30-minute tow with the PNE following slope survey protocols, except with a Modified EBS Slope Scope Table that includes shelf depths. The Northwest Explorer will simultaneously conduct a 30-minute tow with the 83-112 following shelf survey protocols with an Extended EBS Shelf Scope Table that includes slope depths. Modified and extended scope tables are provided in Appendix A: Modified and Extended Scope Tables.

Haul coding for Wheelhouse/Calypso and towing protocols are summarized on pages 4–7.

Standard Slope survey protocols are summarized in Appendix B: EBS Slope Tows Guide.

Catch processing and sampling

Catch processing and sampling will follow standard survey protocols for splitting and subsampling (Table 2). Collect weights, lengths, and sexes following standard protocols. Identify species following minimum ID standards and collect voucher samples when needed. Do not collect otoliths or biological samples for scientific collections from tows that are not standard EBS shelf index station hauls.

Table 2. Catch sampling protocols by gear type.

	83-112	**PNE**
Target sexes per species per haul (#)	100 individuals	100 individuals
Target lengths per species per haul (#)	100 individuals	500 individuals: - arrowtooth flounder - Greenland turbot - Kamchatka flounder - Pacific halibut - Pacific cod - walleye pollock - snow crab 100 fish: - Everything else
Minimum ID Standard	Survey standard	Survey standard
Special collections?	Only at shelf index stations	No
Collect otoliths?	Only at shelf index stations	No
Deploy CTD?	Yes	Yes
Deploy light meter?	Yes	Yes

Between legs: Storing gear at OSI

This project requires two more nets than our survey vessels can carry. Therefore, either two EBS slope nets or two 83-112 nets that are damaged beyond repair should be offloaded at OSI between legs 2 and 3 and replaced with two new 83-112 nets. Between legs 3 and 4, the EBS slope nets should be transferred back onto the vessel, replacing two 83-112 nets. Leg 4 FPCs, please coordinate with Shawn Russell/AFSC Net Loft to ensure that any stored 83-112 nets are loaded on flatbeds for southbound transport at the end of the survey.

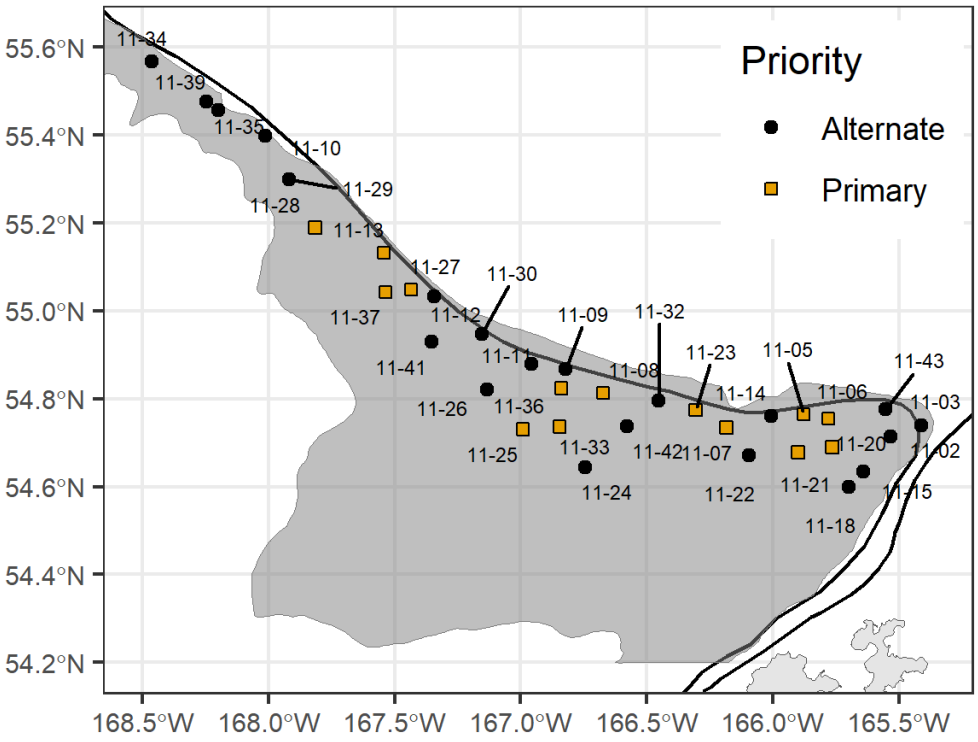
Between legs: Check for changes to sample allocation

Tow allocation may change based on the overall progression of the survey. During leg changes, outgoing and incoming FPCs should check with the project leads and/or Duane Stevenson to determine whether the planned sample allocation has changed.

Quick Reference: Leg 1 - Subarea 1

Tows will be conducted at slope survey stations in subarea 1. Stations in the area have been ranked by sampling priority (Primary or Alternate). Primary stations should be prioritized for sampling but FPCs may opt to replace Primary stations with Alternate stations for logistical reasons (e.g. avoid unreasonably long transit times).

	83-112	**PNE**
Haul type	20	20
Gear code	44	172
Accessory code	15	115
Tow speed (knots)	3 (2.8-3.2 acceptable)	2.5 (2.2-2.8 acceptable)
Scope table	Extended Shelf	Modified Slope
Towing mode	Brake set	Dynamic (brakes not set)
Bad tow?	Move on	Move on

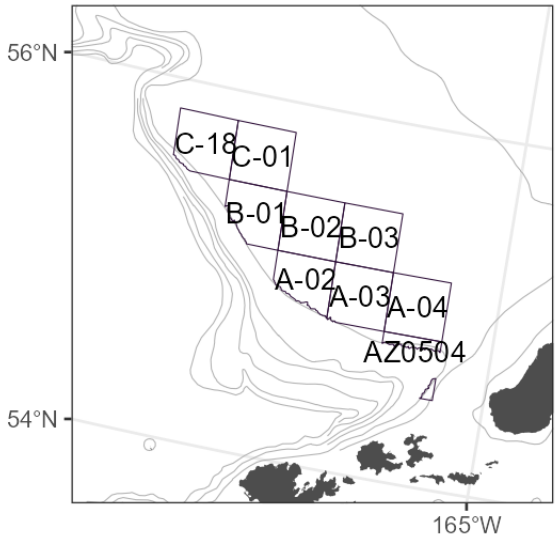


Primary and alternate stations in subarea 1.

Quick Reference: Stratum 50 (Leg 2)

Conduct PNE tows alongside standard index station tows. Tows can be conducted at any time during the leg. FPCs should coordinate to select stations to sample within zone. Tows with the 83-112 will follow standard towing protocols for the EBS shelf survey. PNE tows will follow EBS slope survey protocols, except with wire out from the shelf survey scope table.

	83-112	**PNE**
Haul type	3	20
Gear code	44	172
Accessory code	15	115
Tow speed (knots)	3 (2.8-3.2 acceptable)	2.5 (2.2-2.8 acceptable)
Scope table	Standard Shelf	Modified Slope
Towing mode	Brake set	Dynamic (brakes not set)
Bad tow?	Retow	Move on

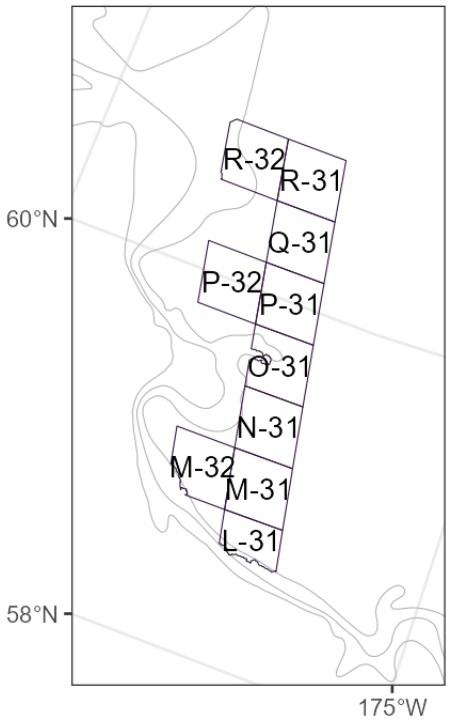


Target stations in Stratum 50. FPCs should coordinate to pick 6 to 7 stations to sample over two days.

Quick Reference: Stratum 61 (Leg 3 or 4)

Conduct PNE tows alongside standard index station tows. These tows should be the last ones conducted during the standard EBS shelf survey and FPCs should coordinate to select stations to sample within the zone. Tows with the 83-112 will follow standard towing protocols for the EBS shelf survey. PNE tows will follow EBS slope survey protocols, except with wire out from the shelf survey scope table.

	83-112	**PNE**
Haul type	3	20
Gear code	44	172
Accessory code	15	115
Tow speed (knots)	3 (2.8-3.2 acceptable)	2.5 (2.2-2.8 acceptable)
Scope table	Standard Shelf	Modified Slope
Towing mode	Brake set	Dynamic (brakes not set)
Bad tow?	Retow	Move on

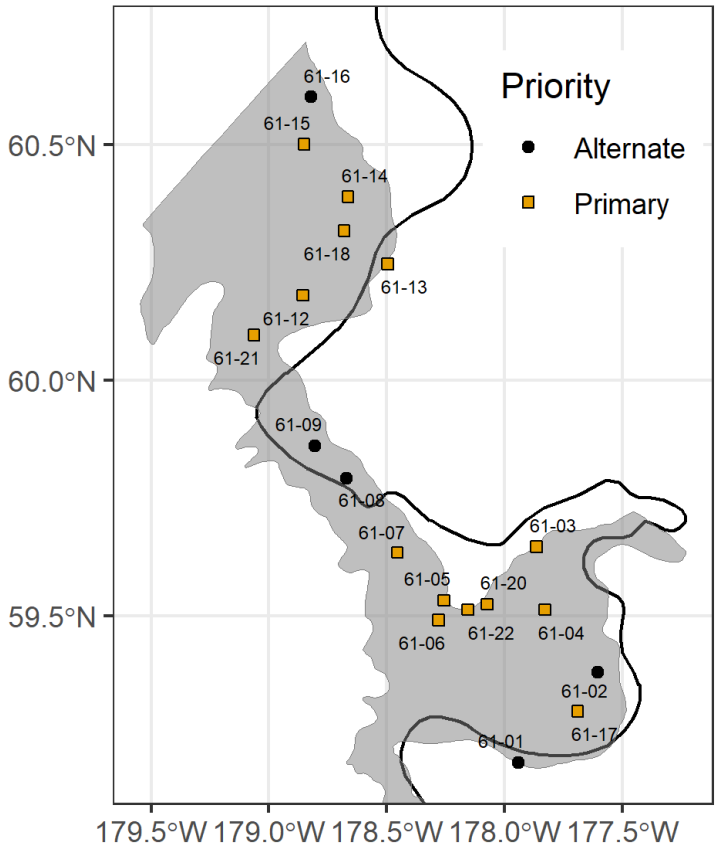


Target stations in Stratum 61. FPCs should coordinate to pick 6 of these stations to sample.

Quick Reference: Subarea 6 (Leg 4)

Tows will be conducted at slope survey stations that have been selected for sampling. Tows in the zone will start immediately after the final tows in EBS shelf stratum 60. Selected stations in subarea 6 are ranked by sampling priority (Primary or Alternate). Primary stations should be prioritized for sampling but FPCs may opt to replace Primary stations with Alternate stations for logistical reasons (e.g. avoid unreasonably long transit times).

	83-112	**PNE**
Haul type	20	20
Gear code	44	172
Accessory code	15	115
Tow speed (knots)	3 (2.8-3.2 acceptable)	2.5 (2.2-2.8 acceptable)
Scope table	Extended Shelf	Modified Slope
Towing mode	Brake set	Dynamic (brakes not set)
Bad tow?	Move on	Move on



Primary and alternate stations in subarea 6.

Appendix A: Modified and Extended Scope Tables

Modified EBS Slope Scope Table

Fathoms			Meters	
Depth Range	Wire Out		Depth Range	Wire Out
1 to 21	75		1 to 38	137
22 to 29	100		39 to 53	183
30 to 38	125		54 to 69	229
39 to 47	150		70 to 86	274
48 to 57	175		87 to 104	320
58 to 67	200		105 to 123	366
68 to 79	225		124 to 145	411
80 to 94	300		146 to 173	549
95 to 110	325		174 to 201	594
110 to 125	350		202 to 229	640
126 to 140	375		230 to 257	686
141 to 156	400		258 to 284	732
157 to 171	425		285 to 312	777
172 to 186	450		313 to 341	823
187 to 201	475		342 to 368	869
202 to 217	500		369 to 396	914
218 to 232	525		397 to 425	960
233 to 248	550		426 to 454	1006
249 to 263	575		455 to 480	1052
264 to 278	600		481 to 508	1097

Extended EBS Shelf Scope Table

Fathoms			Meters	
Depth Range	Wire Out		Depth Range	Wire Out
1 to 21	75		1 to 38	137
22 to 29	100		39 to 53	183
30 to 38	125		54 to 69	229
39 to 47	150		70 to 86	274
48 to 57	175		87 to 104	320
58 to 67	200		105 to 123	366
68 to 78	225		124 to 143	411
79 to 90	250		144 to 165	457
91 to 102	275		166 to 187	503
103 to 114	300		188 to 208	549
115 to 128	325		209 to 234	594
129 to 140	375		235 to 257	686
141 to 156	400		258 to 284	732
157 to 171	425		285 to 312	777
172 to 186	450		313 to 341	823
187 to 201	475		342 to 368	869
202 to 217	500		369 to 396	914
218 to 232	525		397 to 425	960
233 to 248	550		426 to 454	1006
249 to 263	575		455 to 480	1052
264 to 278	600		481 to 508	1097

Appendix B: EBS Slope Towing Protocols

B. Speed of tow

The EBSS survey targets an average towing speed over ground of 2.5 knots with an acceptable range of momentary towing speed between 2.2 knots and 2.8 knots when the net is in contact with the bottom and in fishing configuration. It is important to keep the vessel speed as constant as possible and near 2.5 knots when the net is fishing on bottom. After brake-set, vessel speed can be used to regulate sink time of the trawl, however vessel speed should be as close to 2.5 knots as possible when the net reaches the bottom. Monitor vessel speed frequently during a tow using the NOAA supplied GPS unit.

C. Duration and distance of tow and use of trawl mensuration / performance monitoring instrumentation

The performance and geometry of the trawl are measured using several sensors. Net height and width is measured in real time using SCANMAR sensors mounted on the center of the headrope and on the upper bridle just forward of the wingtips. Depth and temperature data is measured using a self-contained bathythermograph mounted near the center of the headrope. Bottom contact information will be measured with a self-contained Bottom Contact Sensor (BCS) mounted at the center of the footrope. Detailed descriptions of the rigging for each of these sensors is provided in the AFSC Net Mensuration Manual, which is carried aboard all survey vessels. Annual training is mandatory for all staff operating net mensuration and monitoring instruments and interpreting the data collected with them.

Target tow duration is 30 minutes, which equates to approximately 1.3 nmi or 2.4 km at the standard towing speed of **2.5 knots**. The start of the 30 minute towing period is determined from the net height data and is defined as when the height decreases to 8 m. Winches are engaged and haulback begins 30 minutes later. Tows may be shortened due to obstructions, inability to follow a depth contour, hangups, gear problems, or extremely large catches which affect the efficiency of the trawl.

After a haul is completed, data from each of the sensors will be synchronized with the GPS data and displayed simultaneously using custom designed software (ScanPlot). Using this software, the operator will determine the precise moments that the footrope initially contacts (On-Bottom) and leaves bottom (Off-Bottom) and calculate the duration, distance fished, and average net spread and height during each tow. The trace of the BCS data is the most useful tool for determining the On- and Off-Bottom times. The transition between when the net is on or off bottom is usually clearly signaled by an abrupt change in readings from around 40 degrees to around 60 degrees (vice versa when leaving bottom). Distance fished is determined from the vessel track between the On- and Off-Bottom positions.

D. Direction of tow

On the EBSS survey, the towing direction is dictated by bottom topography, current direction, wind speed and direction, and wave height and direction. Bottom topography often precludes all but a single towing direction to complete a tow successfully because of the need to follow a depth contour. In strong current, the tow is directed up-stream to prevent net distortion. In strong winds, the trawl is directed up-wind to allow the skipper better control of vessel direction and towing speed. In summary, tow direction is not a random variable, but it is not always predictable because of variation in wind and current.

E. Location of suitable sampling sites

The EBSS survey uses random sampling within strata defined by depth and sub-area. To minimize lost time in transit, stations should be completed in the order of proximity, proceeding from one station to the next closest station. Prior to trawling, each station should be surveyed, using a depth sounder, to determine if it is in the correct depth stratum and trawlable. Unfortunately the best available bathymetry data is poor and the actual station location and depth must be changed from the redetermined stations. A successful sampling area with a good potential for success is characterized by relatively low relief substrate with at least 1.5 nmi of trawlable bottom within the depth stratum boundaries. If trawlable ground is not found at the predetermined site, a search should be conducted within the same sub-area and depth stratum to locate another site as close to the original site as possible. A site is designated as untrawlable if the skipper and/or FPC determine that the bottom topography precludes a successful tow due to potential net damage, insufficient distance, widely changing depth range, and obstruction in the tow path. Trawlable ground decisions are governed by the skipper and FPC's experience with the net and its ability to perform given the bottom topography.

F. Successful tow criteria

The success of a tow should be assessed considering events during the trawl operation as well as examination of data after the tow is completed. Attention to the net mensuration monitor may indicate a tear-up or obstruction causing the net to deviate from normal dimensions. Under some conditions it may be impossible to maintain proper speed during the tow. After the tow, examination of the net for evidence of damage and examination of the trawl mensuration data, bottom contact data and depth data are used to assess trawl performance. The following are minimal criteria which must be met to consider a haul satisfactory:

1. The BCS tilt angle should indicate proper footrope bottom contact (variable footrope contact indicates poor performance).

2. Net mensuration data should indicate the net dimensions are within those expected for the towing depth.

3. Trawl time should be > 15 minutes and < 35 minutes.

If the tow is deemed unsuccessful then a second attempt is made at the same location, or another location is found in the same depth and sub-area, to replace the unsuccessful tow. At the end of the survey, mensuration data is reviewed by another party and any differences in opinion are discussed. The FPC has the final determination.

G. Vessel and winch operations

During trawl deployment, vessel speed should be maintained at least 1 knot faster than the net pay out rate (up to brake-set). Deploy the wire to the prescribed length using the painted marks on the wires. Set the brakes at the determined warp length and adjust the vessel speed to 2.5 knots as soon as possible. Use vessel speed to regulate settling rate of the trawl. Vessel speed should be as close to 2.5 knots as possible when the net is on the bottom. Speeds between 1 and 2 knots can be used to increase sink rate and speeds up to 3.5 knots can be used to decrease the sink rate. The auto-trawl system should be ON during the tow to avoid net damage if there should be a hang-up or a large catch. The skipper should haul back the trawl and end the tow by "popping" the net off the bottom as quickly as possible. This is accomplished in most cases by increasing engine RPM when starting the winches. Use net mensuration data to verify that the skipper is quickly lifting the trawl net off bottom.

Appendix B. Catch Processing and Collection of Biological Data (From Hoff, 2016)

Catches were sorted, weighed, and enumerated for all species of fishes and invertebrates. The catch was processed in one of two ways: either by sorting the entire catch and weighing each species in aggregate or by weighing the net codend and discarding the predominant species (except for a weighed and sexed random length frequency sample) and the rest of the catch sorted and weighed by species. Random samples of species that were designated for biological data collection were set aside after weighing. Total weight and numbers for each species were recorded onto a paper on-deck catch form. In cases where individuals could not be reasonably enumerated (i.e., corals, sponges, bryozoans, ascidians), only total weight was recorded. For large numbers of an individual species in a single haul, the total number was extrapolated from subsample weight and count of 50-200 individuals. In most cases fish length frequency subsamples were used for extrapolation of the total haul count for individual species.

A random subsample of 100-150 fish, depending on the size range for the species, was selected for length frequency measurements. The sex of each individual was determined by internal examination of the gonads or by external characters (e.g., claspers for elasmobranchs), and specimens were sorted into baskets of males, females, or undetermined sex. Fork length (FL) was measured for most fishes, except for elasmobranchs which were measured to total length (TL) and macrourids to preanal-fin length (PAFL). Fishes and cephalopods were measured to the nearest centimeter on an in-line bar-coded length board using a Nexus Android tablet with an inhouse

developed application, which uses a bar-code reader wand and species-specific numerical codes. Length data were downloaded into a database, examined for accuracy, and paper copies printed. All crab species were measured to the nearest 1.0 mm using vernier calipers and recorded to a Logic Instrument Android tablet and an in-house developed application program.

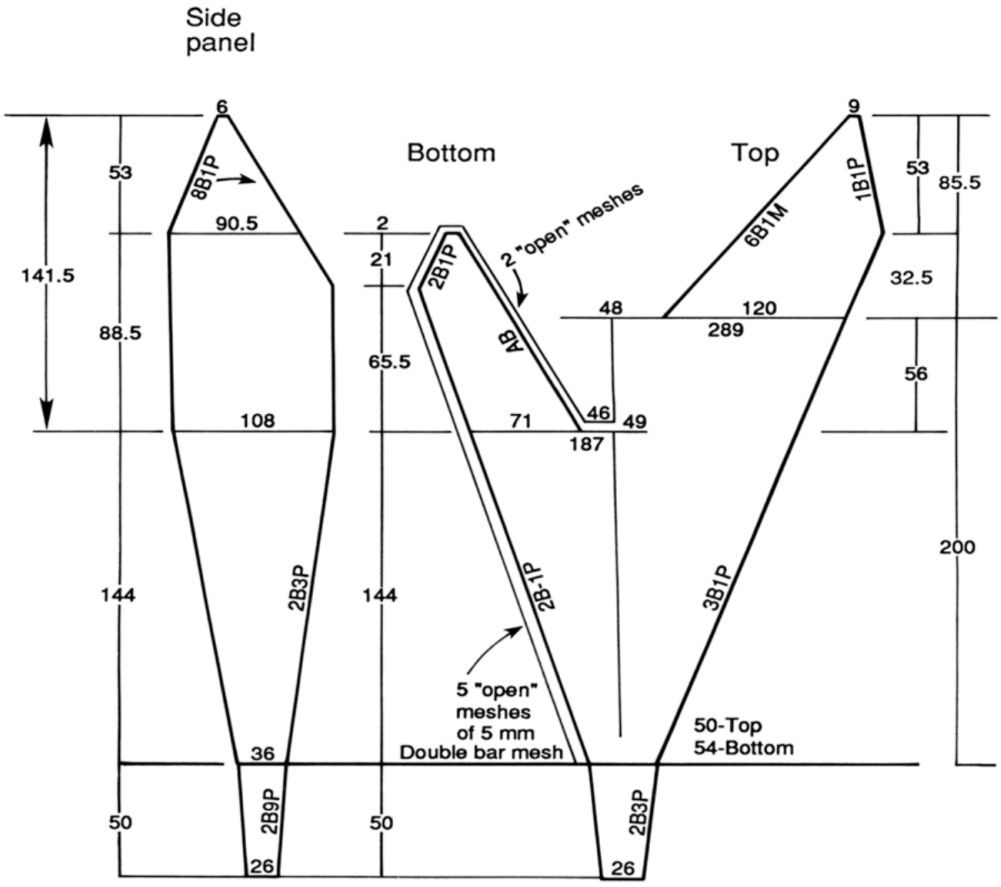
Otoliths (age structures) were collected from commercially and ecologically important

fish species utilizing a stratified sampling regime based on geographic subarea and length. Otoliths of each species were collected from 1 to 3 specimens/cm/sex/subarea with the exception of rougheye rockfish (S. aleutianus) and blackspotted rockfish (S. melanostictus), for which there was an attempt to collect otoliths from all fish encountered. At the time of otolith collection, the sex, fork length (cm) or pre-anal fin length (PAFL), and weight (kg) of each specimen were recorded on paper forms.

Appendix C. Trawl Diagrams

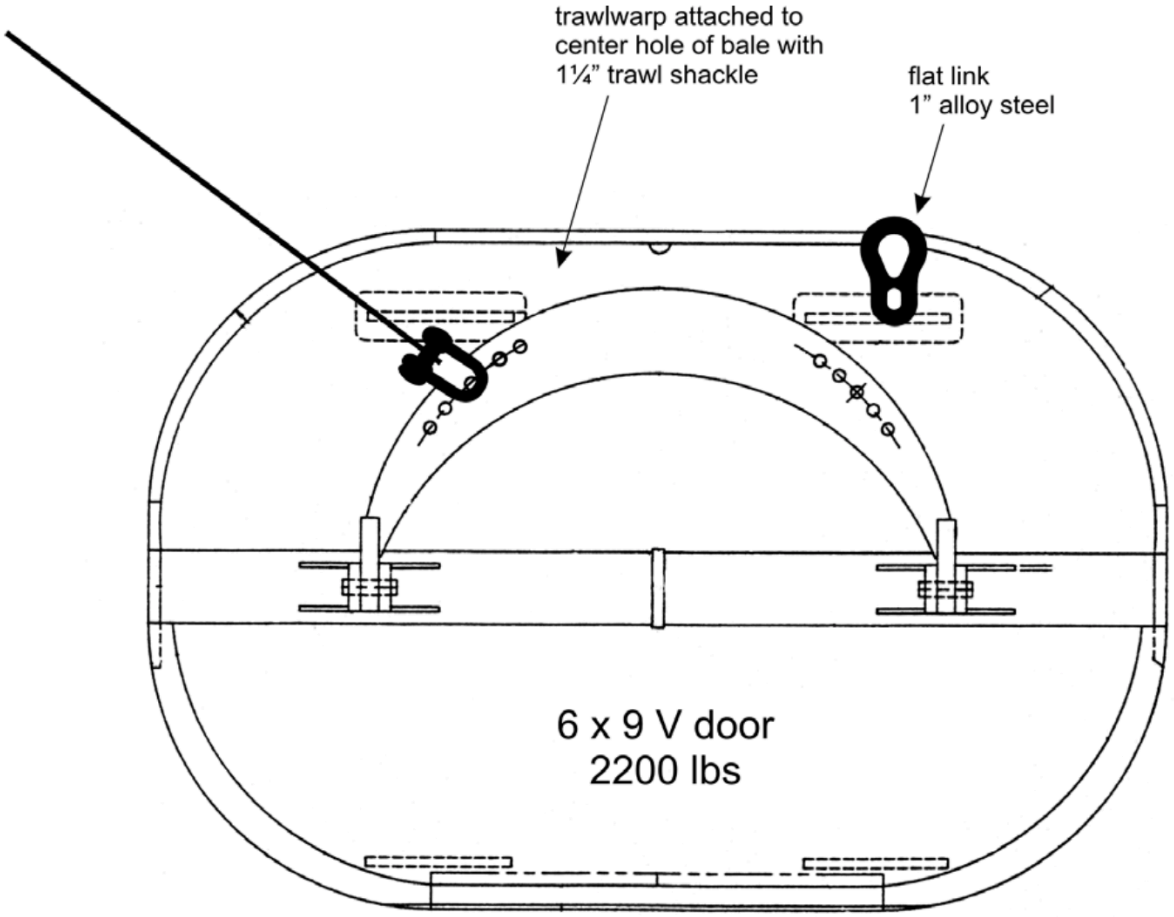
Eastern Bering Sea Slope Bottom Trawl Survey
Net Plan for Poly Nor'Eastern Trawl
("Cut Plan" = Total Mesh Counts)

Twine Sizes: top and sides 4 mm
bottom and intermediate 5 mm

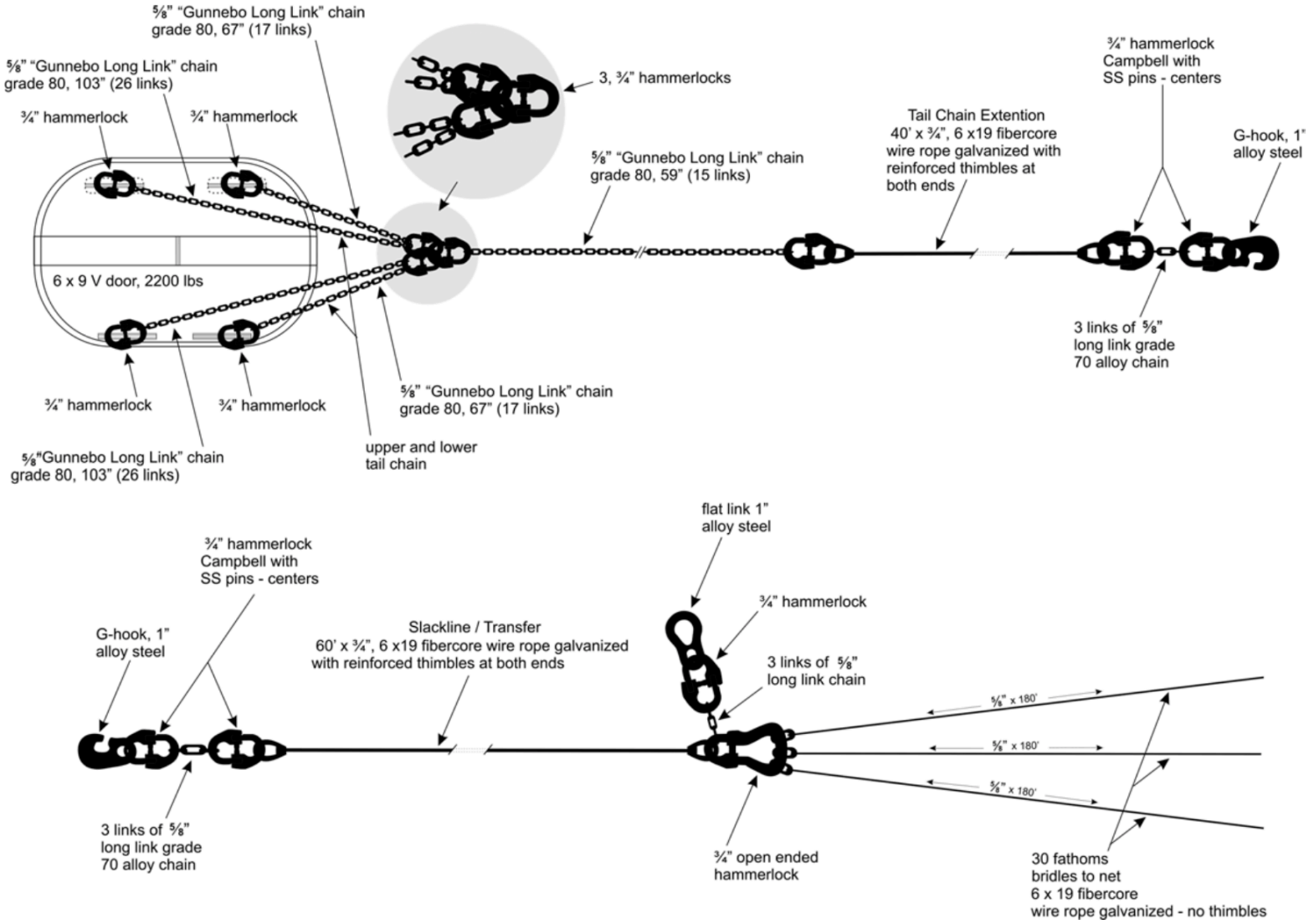


Web: Chaffing strip along inside of Bottom wings and Busom. Cut 8 meshes wide. 5 mm Double Bar mesh, goring 3 meshes on each side (leaving 2 open meshes). Secure 3 mesh of gore on inside (Bar Cut) of Bottom wings, and securing other gore to footrope (Bolsh).

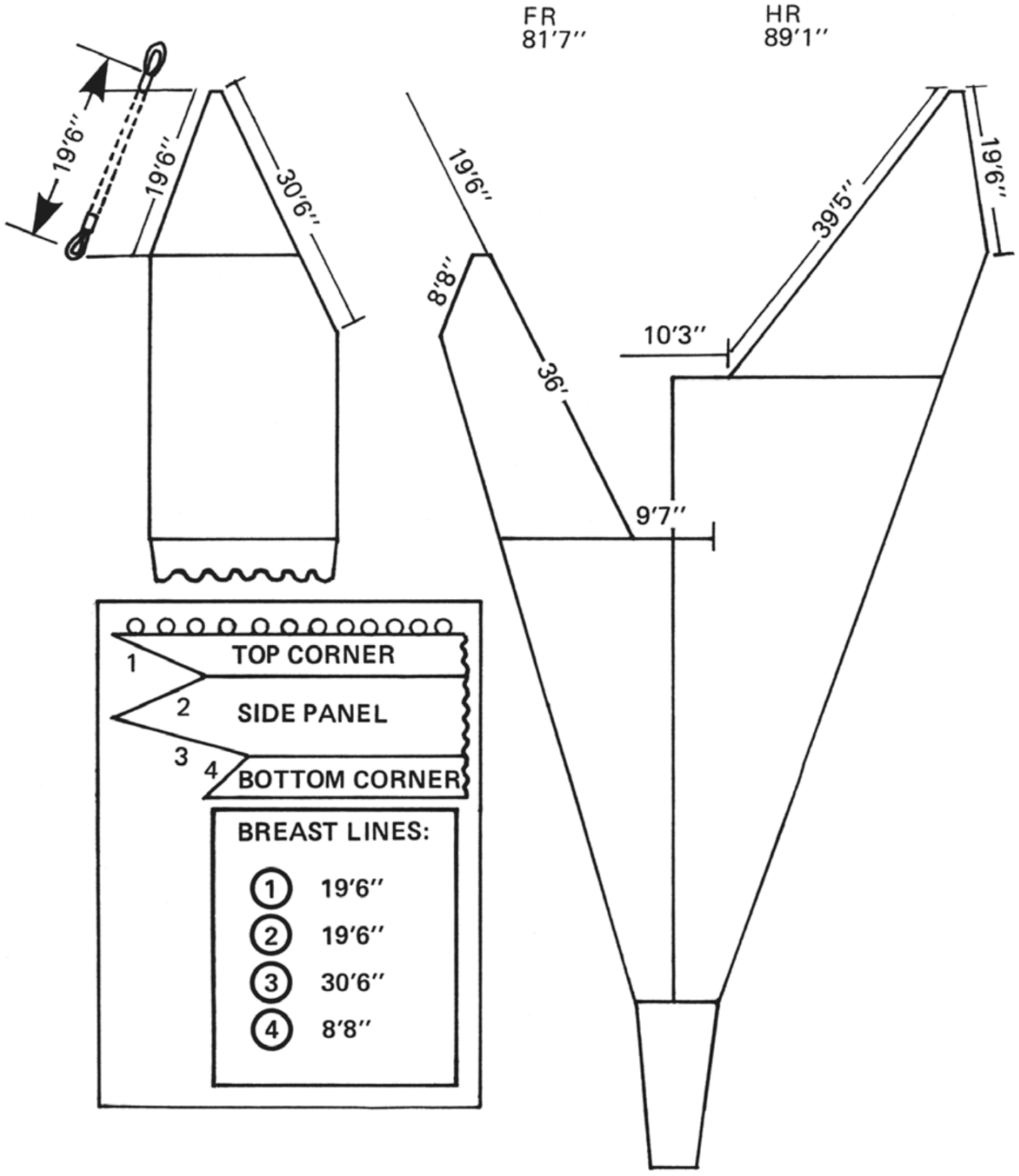
Eastern Bering Sea Slope Bottom Trawl Survey
Trawl Door Rigging Plan Detail for Poly Nor'Eastern Trawl
Sole Manufacturer NET Systems, Inc., Bainbridge Island, WA



Eastern Bering Sea Slope Bottom Trawl Survey
Trawl Door Rigging Plan for Poly Nor'Eastern Trawl

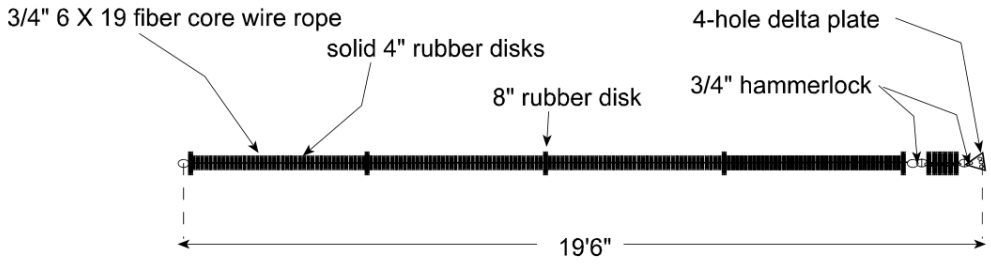


Eastern Bering Sea Slope Bottom Trawl Survey
Framing Lines for Poly Nor'Eastern Trawl

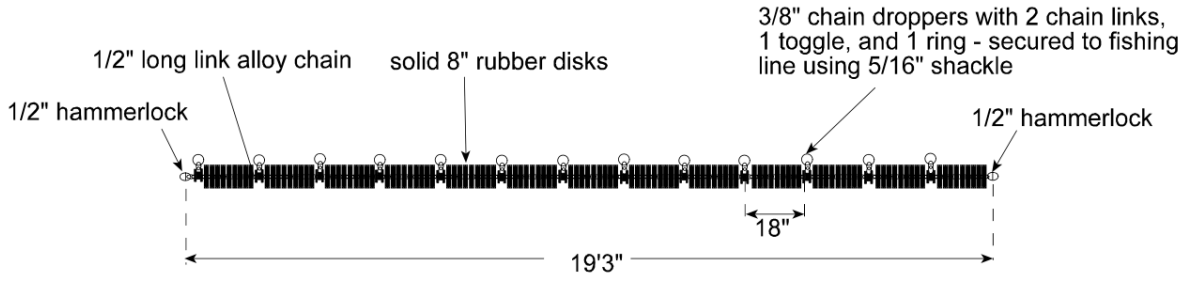


Eastern Bering Sea Slope Bottom Trawl Survey
Groundgear Construction Plan for Poly Nor'Eastern Trawl

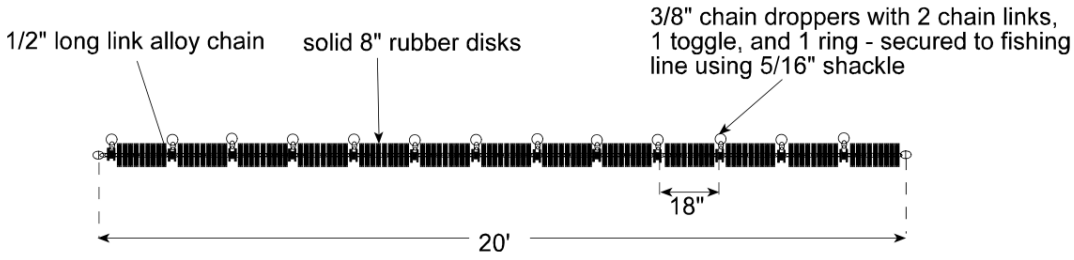
Outboard section



Middle section

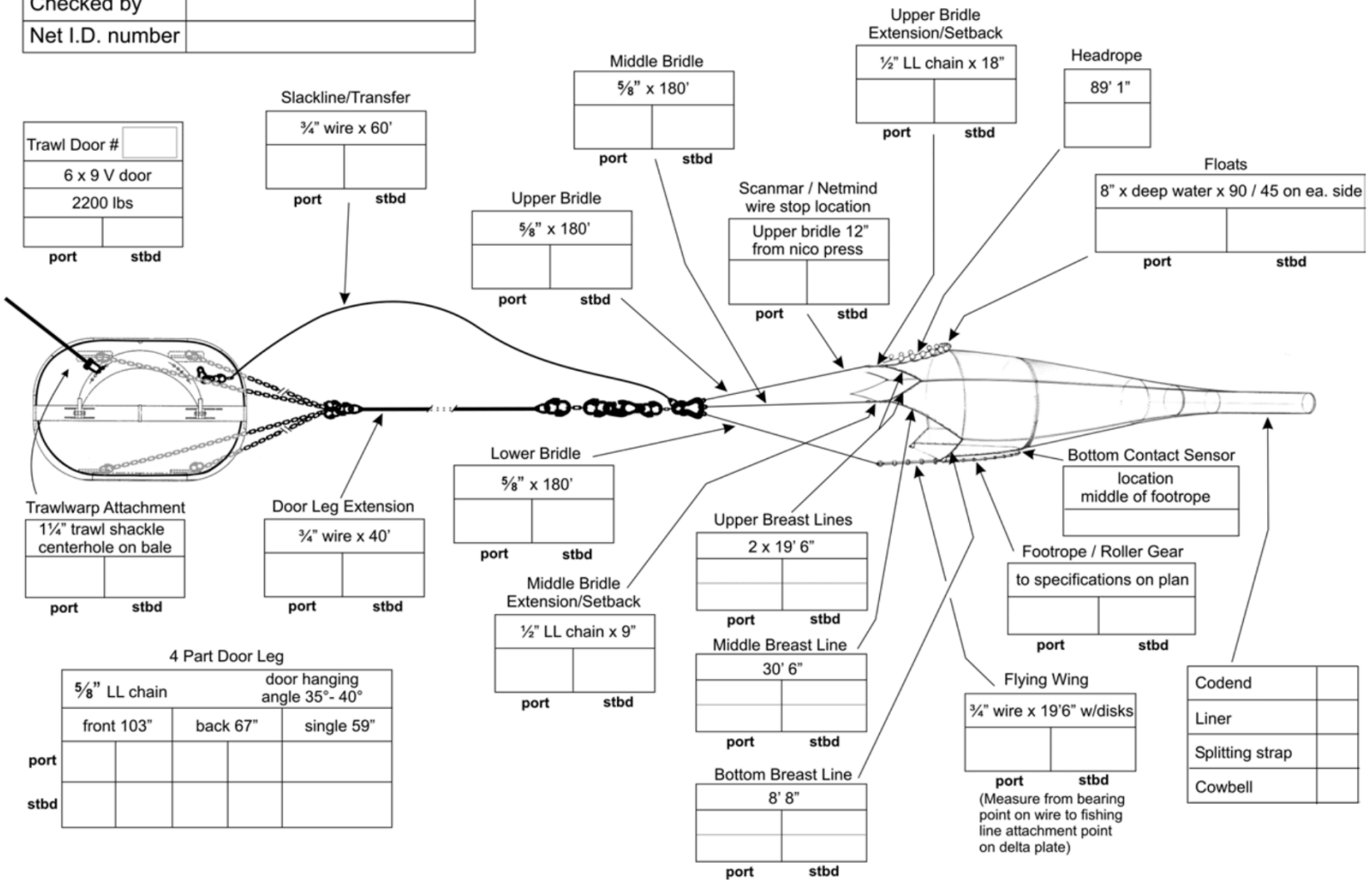


Inboard section



Survey Trawl Check List
Eastern Bering Sea Slope Bottom Trawl Survey
Poly Nor'Eastern Trawl

Vessel	
Cruise	
Date	
Checked by	
Checked by	
Net I.D. number	



4 Part Door Leg

	⅝" LL chain				door hanging angle 35°- 40°
	front 103"		back 67"		single 59"
port					
stbd					

Appendix C: Inventory

- EBS slope survey polycorder code/length code species list (both vessels)
- Standard 83-112 trawl/door configuration (Northwest Explorer)
- Standard EBS slope Poly Nor'Eastern trawl/door configuration:

Key points:

- Modified trawl doors
- Poly Nor'Eastern net
- 4-point Bridles
- Slope-specific bottom contact sensor

Complete specifications:

- **Netting:** Polyethylene, 5" stretch measure - 4 mm top and sides, 5 mm bottom and intermediate.
- **Headrope:** 89' 1" of 1⁄2" (6×19) galvanized wire rope wrapped with d" polypropylene rope. Both eyes have 1⁄2" gusseted thimble; 89' 1" doesn't include the length of either eye. Headrope length is measure from the top of the nicro sleeve to the top of the nicro at other end.Top wing is hung over 16.31" per taper combination. Headrope setback - 18" of 1⁄2" long link galvanized alloy chain and connecting hardware.
- **Bolsh Line:** 81' 7" plus thimbled eyes of d" (6×19) galvanized wire rope, wrapped with d" polypropylene rope.
- **Fishing Line:** 81' of 1⁄2" long link galvanized alloy chain. Safe working load of 11,300 lbs.
- **Breastlines:** 1⁄2" (6×19) galvanized wire rope wrapped with d" polypropylene rope. Top corner 19' 6", bottom corner 8' 8", bottom side panel 30' 6". All lengths are measured from the top of nicro sleeve at wing tip and including thimbled eye at ribline.
- **Riblines:** 3⁄4" Samson 2in1® Duralon braided trawl rope. Riblines are hung at 98% of stretch measure of gored seam. All measurements are made with 400 lbs of tension on rope. Gored seams are attached to the ribline using white untreated 60 T braided nylon hanging twine used to tie a benzel every 16".
- **Groundgear:** 8" rubber discs strung on 1⁄2" galvanized, long link marine deck lashing chain, grade 70, 79' 6" bearing to bearing (eye to eye). "Flying wing" outboard sections, 4" rubber discs strung on 3⁄4" (6×19) fiber core wire rope.
- **Side Seams:** Side seams are laced in each panel individually. Seams are made by gathering 3 meshes (4 knots) and lacing them together using white, double 21 thread perma-grip® (or like kind) nylon, three- strand twine. Individual panels are laced together using green, double 21 thread perma- grip® nylon, three-strand twine. Panels which are secured to framing lines have selvage edge created by gathering 3 meshes as described above. These selvage edges are hung tight to framing lines using 60 T braided nylon hanging twine.

- **Flotation:** Ninety 8" side lug deep-water trawl floats (5.4 lbs of buoyancy each) hung evenly to headrope starting 1' from wing tip, leaving 3' open in the center of the headrope. Total buoyancy - 486 lbs.
- **Splitting Gear:** 3⁄4" Spectra® rope spliced 21' with eyes in each end. The rope is passed through four galvanized rings secured to each ribline 18 meshes from the bottom. A second identical splitting strap is located 38 meshes from the bottom.
- **Codend:** 31⁄2" stretched measure (including 1 knot) polyethelene 4 mm double bar mesh. Four panels cut 30 meshes long by 100 meshes deep. Two meshes in a gored seam each side, leaving 26 open meshes per panel. Gored seams are laced together using double 21 T nylon twine. Riblines in codend are 3⁄4" 2in1® Duralon braided trawl rope, hung at 90% of the stretch measure of the gored seams.Codend is closed at terminal end using 25 21⁄2" X 1⁄4" galvanized steel rings. A 1⁄4" Duralon rope is passed through the selvage mesh and a ring is attached to the rope using a cow hitch every 12", with five open meshes between each ring. The bag is then closed using a e"-3⁄4" hauling clip.