2023 Sampling guide: Combining fisheries-independent surveys of the Eastern Bering Sea shelf and slope

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I. Executive Summaries

A. Key Information for FPC/Skipper

- Cruse #: 2023-01 (Same as EBS, tows will be distinguished from standard EBS survey tows by gear code and haul type
- Door code: 115
- Gear code: 172
- Haul type: 20
- Abundance Tows: No
- Towing speed: 2.5 knots (For towing slope net (AK Knight only))
- Tow settings: Dynamic mode (brakes not set)
- Note different scope table for slope net (Appendix A)
- Wire Marking: Need to mark wire out to 525 fathoms on both vessels (towing depth of 400 m)
- Northwest Explorer (with 83-112) will follow standard EBS shelf protocols, Alaska Knight (with Poly Nor' Eastern) will follow standard EBS slope protocols (Appendix A)
- Note: It will likely take longer for the 83-112 to sink to the greater towing depths on the slope

B. Key information for Deck Lead and Crab Lead

- Printed list of length codes for slope species will be provided on both vessels
- If subsampling of catches → sample 100% of core species listed below
- No otolith collections,
- No invertebrate identification, except crabs
- For key species → Arrowtooth flounder (*Atheresthes stomias*), Greenland turbot (*Reinhardtius hippoglossoides*), Kamchatka flounder (*Atheresthes evermanni*), Pacific halibut (*Hippoglossus stenolepis*), Pacific cod (*Gadus macrocephalus*), Sablefish (*Anoplopoma fimbria*), Snow crab (*Chionoecetes opilio*), Walleye pollock (*Gadus chalcogrammus*) → length 100% of catch or up to 500 fish (still only sex up to 100)
- Species not included above, or on the slope length code list do not need to be processed at all (unless called for by another special project).
- For identification of unfamiliar fish species, consult Mecklenburg, Skate ID guide, and Gadids of the eastern North Pacific, or consult with Duane
- A note on lengthening giant Grenadier: Measuring: needs to be consistent on both boats → measure to the beginning of anal fin (Pre-Anal Fin). Place on length board with the ventral surface facing upwards during measurement.

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.

D. Sampling locations:

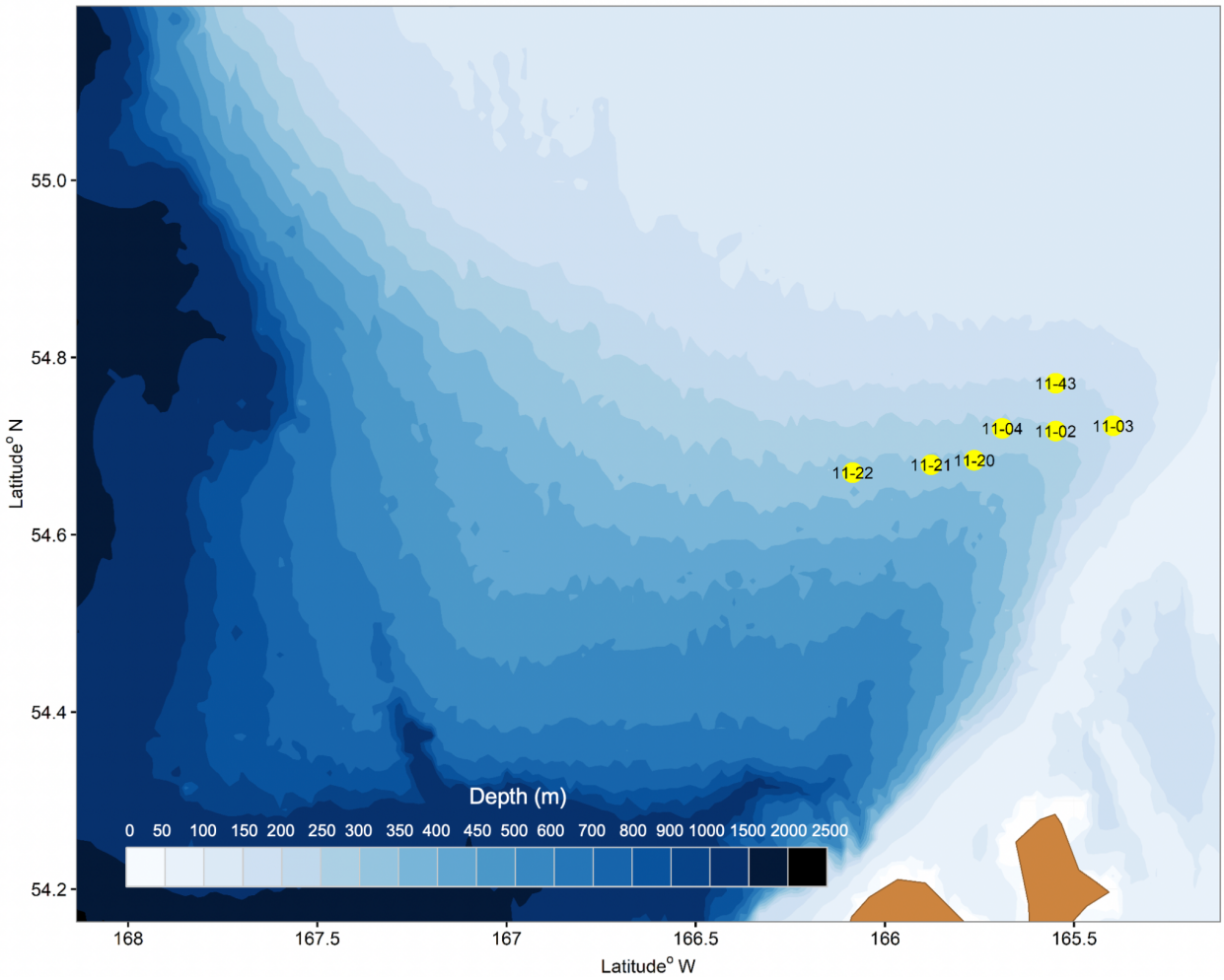


Figure 1. Map of sampling locations for study. Towing will likely proceed from the northeast (*e.g.* beginning with stations 11-43 or 11-03) and proceed southwest (*e.g.* station 11-22).

Table 1. Except from previous EBS slope survey drag logs highlighting relevant information on towing locations for sampling.

station ID	start latitiude	start longitude	end latitude	end longitude	performance	wire (m)	bottom depth
11-02	54.718	-165.551	54.709	-165.513	0	700	256
11-02	54.717	-165.531	54.723	-165.569	0	700	253
11-02	54.707	-165.498	54.717	-165.528	0	700	252
11-02	54.717	-165.549	54.706	-165.517	0	686	257
11-03	54.743	-165.408	54.720	-165.396	0	600	202
11-03	54.743	-165.413	54.724	-165.402	6.12	600	205
11-03	54.749	-165.427	54.730	-165.409	0	640	208
11-03	54.723	-165.397	54.743	-165.410	0	600	204
11-04	54.721	-165.715	54.720	-165.676	0	750	267
11-04	54.722	-165.732	54.717	-165.695	0	700	267
11-04	54.724	-165.740	54.720	-165.703	1.1	750	265
11-04	54.720	-165.668	54.718	-165.702	-3.13	750	270
11-04	54.720	-165.690	54.720	-165.726	0	750	266
11-20	54.693	-165.735	54.690	-165.703	5	799	304
11-20	54.690	-165.780	54.691	-165.820	0	800	306
11-20	54.692	-165.779	54.689	-165.740	0	800	301
11-20	54.684	-165.764	54.684	-165.728	0	777	311
11-21	54.678	-165.911	54.676	-165.948	0	799	316
11-21	54.677	-165.913	54.677	-165.868	0	800	318
11-21	54.679	-165.878	54.678	-165.914	0	800	318
11-22	54.670	-166.118	54.668	-166.157	0	800	315
11-22	54.671	-166.091	54.670	-166.127	0	800	315
11-22	54.672	-166.087	54.670	-166.123	0	777	312
11-22	54.670	-166.085	54.670	-166.122	0	950	316
11-43	54.776	-165.558	54.776	-165.596	0	650	205
11-43	54.775	-165.549	54.771	-165.587	0	594	206

II. Appendices

Appendix A: EBS Slope Towing Protocols (From Stauffer 2003)

A. Scope

The EBSS survey utilizes the following scope ratio table that was empirically established to determine the amount of warp used at each trawling depth when the warps are constructed of 1 inch, die-formed, steel-core wire. When other types or sizes of warps are used, a new table should be re-established. Use warp marks to determine the amount of warp out during trawling operations. To prevent net collapse or door crossing, the warp should be let out evenly in the "free-wheel mode" while maintaining the vessel speed at least 1 knot above the payout rate. Gradually decrease vessel speed and payout rate as the desired amount of wire is approached.

Bottom Depth		Scope	
Minimum (m)	Maximum (m)	Meters	Fathoms
146	176	550	301
177	206	600	328
207	237	650	355
238	267	700	383
269	298	750	410
299	328	800	437
330	358	850	465
360	389	900	492
390	420	950	519
421	450	1000	547
451	481	1050	574
482	511	1100	601
512	542	1150	628
543	572	1200	656
573	603	1250	683
604	633	1300	710
634	664	1350	738
665	694	1400	765
695	725	1450	792
726	755	1500	820
756	786	1550	847
787	816	1600	874
817	847	1650	901
848	877	1700	930
878	908	1750	957
909	938	1800	984
939	969	1850	1012
970	999	1900	1039
1000	1030	1950	1066
1031	1060	2000	1094
1061	1091	2050	1121
1091	1121	2100	1148

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.

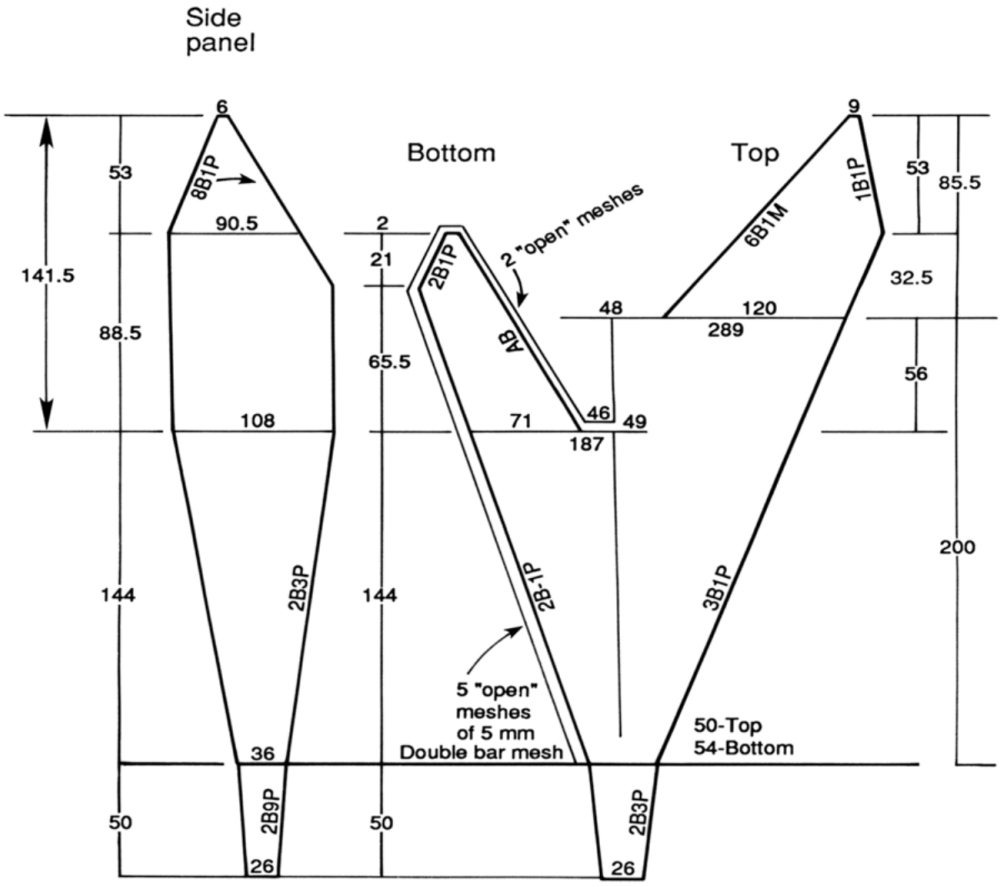
Otoliths (age structures) were collected from commercially and ecologically important

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

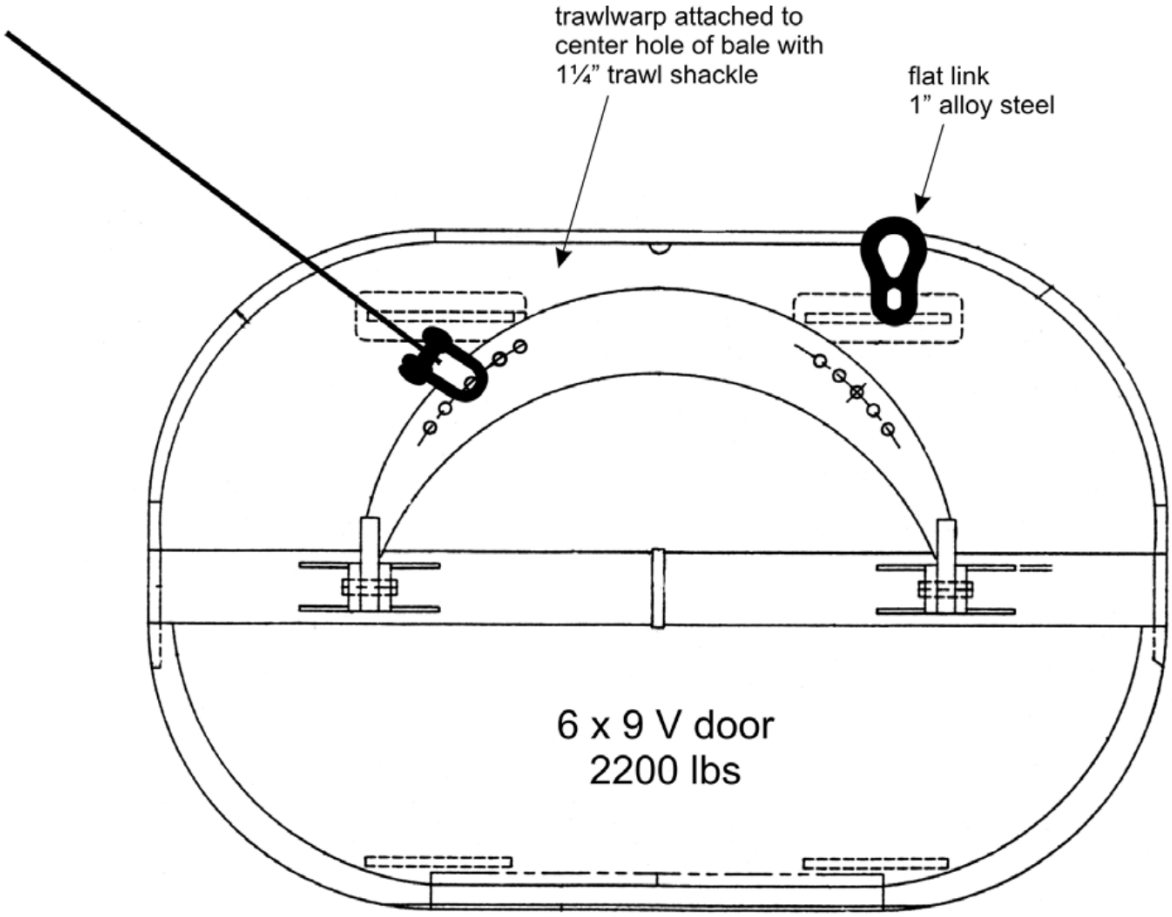
Eastern Bering Sea Slope Bottom Trawl Survey
Net Plan for Poly Nor'Eastern Trawl
("Cut Plan" = Total Mesh Counts)

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

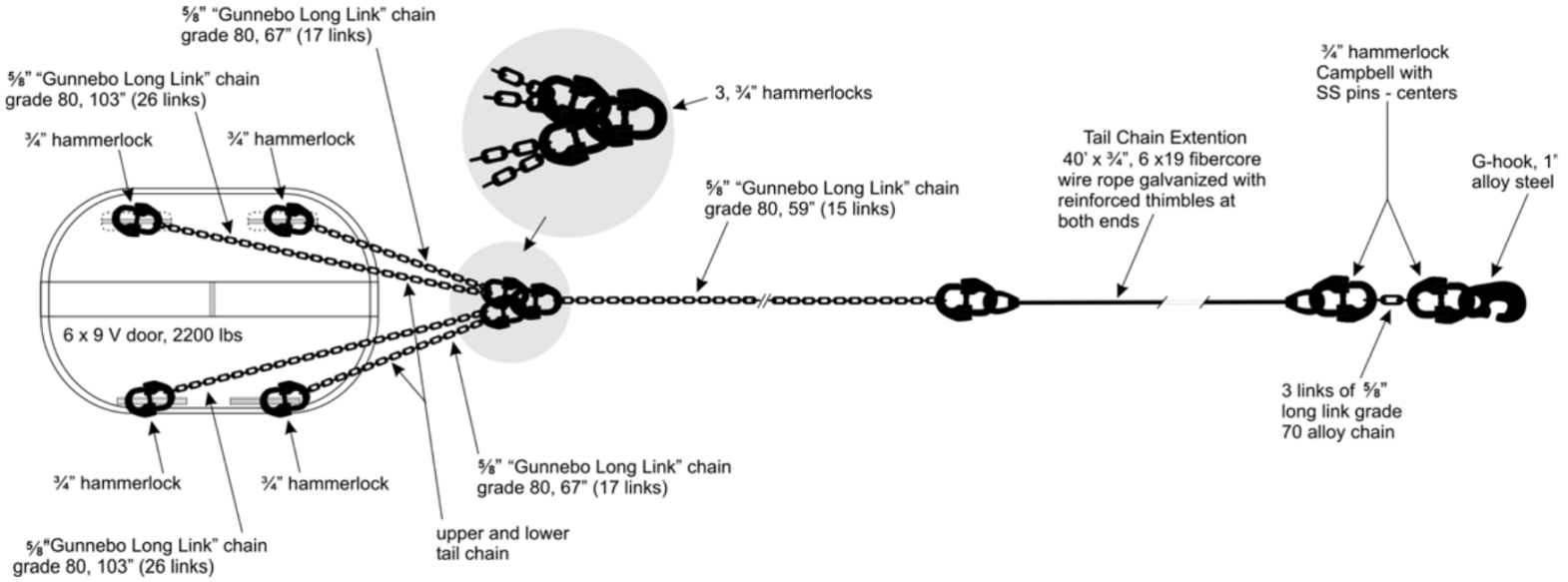


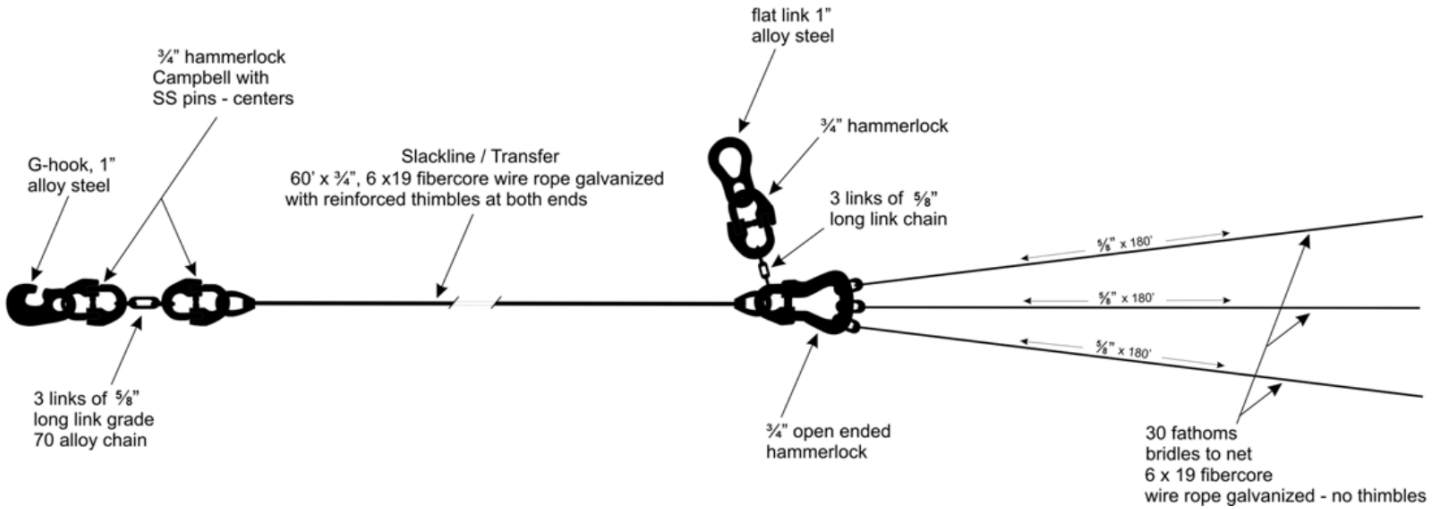
Web: Chaffing strip along inside of Bottom wings and Busom. Cut 8 meshes wide. 5 mm Double Bar mesh, goring 3 meshes on each side (leaving 2 open meshes). Secure 3 mesh of gore on inside (Bar Cut) of Bottom wings, and securing other gore to footrope (Bolsh).

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

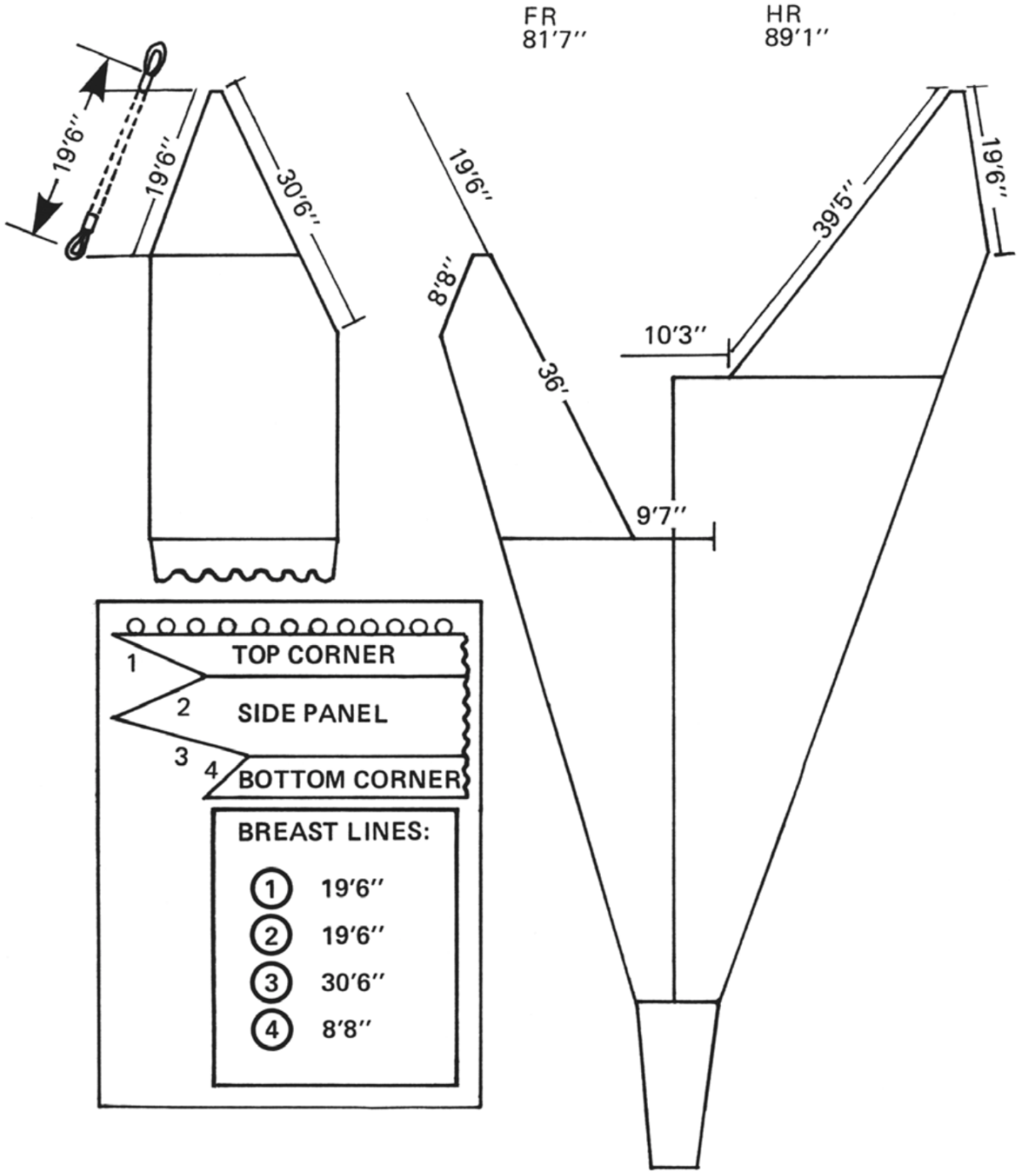


Eastern Bering Sea Slope Bottom Trawl Survey
Trawl Door Rigging Plan for Poly Nor'Eastern Trawl



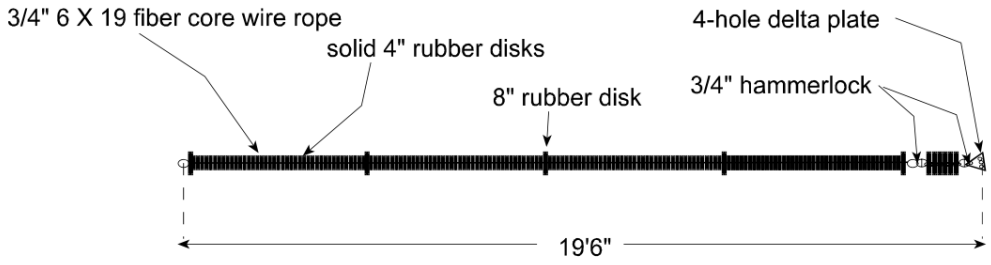


Eastern Bering Sea Slope Bottom Trawl Survey
Framing Lines for Poly Nor'Eastern Trawl

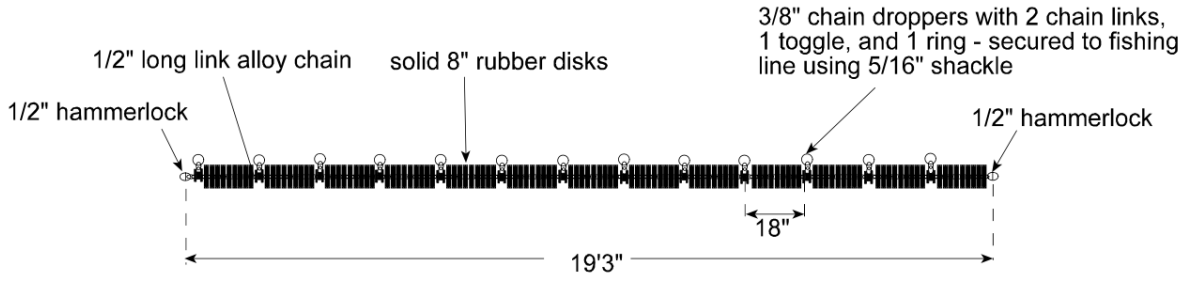


Eastern Bering Sea Slope Bottom Trawl Survey
Groundgear Construction Plan for Poly Nor'Eastern Trawl

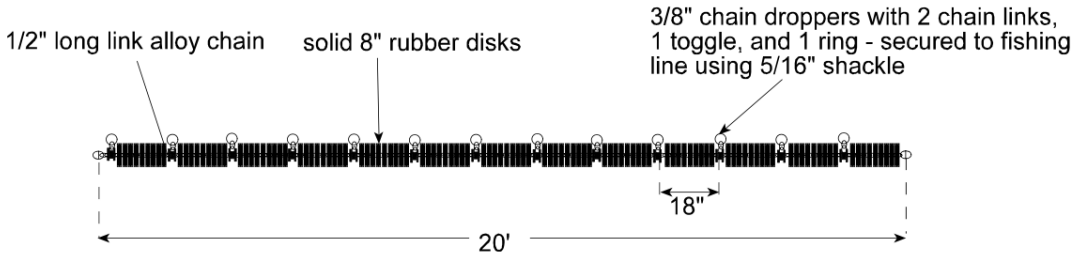
Outboard section



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