Fishing gear parameters for the Alaska effects-of-fishing model

To convert the distances fished by different fishing gears to areas of seafloor contact, it was necessary to estimate both the width of these gears as they are operating and the proportion of that gear that can affect benthic habitats, starting with the proportion of direct contact. Both the variability of these parameters and the data available to support estimates differ considerably between fishing gears. This document describes the estimation of gear widths and contact proportions for the 2016 Alaska EFH fishing effects model.

Bering Sea pelagic trawls - By far the most complex fisheries for estimating gear width and contact parameters are those using pelagic trawls. In Alaska fisheries, pelagic trawls are defined by specific gear characteristics, not by whether or not they are fished in midwater. Particularly when fished for pollock in the Bering Sea, these trawls contact the seafloor to varying degrees, largely depending on the distribution of pollock relative to the seafloor. That distribution is in turn affected by a number of factors, including season, time of day, and depth. Widths of trawls during fishing are also affected by many of the same factors, as well as vessel size, sea state, and bottom contact. There are two major fleets that fish for pollock in the Bering Sea, catcher processors (CP), that process the catch onboard, and catcher vessels (CV), that deliver whole fish to shore plants or motherships. Representatives of both fleets were asked for estimates of the operating widths of their trawls and the proportions of that swept width that included bottom contact. While the CV fleet did not respond in time for initial model runs, CP representatives provided a range of trawl widths and descriptions of which factors are associated with greater and lesser gear widths and seafloor contact. Additional information collected to support estimates included, gear and bottom depths reported for each observed haul in the observer database, the presence or absence of benthic species in observer samples, trawl design widths by horsepower from three major trawl manufacturers, and horsepower ranges for different length classes of pelagic trawlers.

Information from the CP fleet included the following.

1. A range of wing-tip to wing-tip trawl-net spreads from 55-100 fathoms was reported.
2. Trawl-net spreads were reported to be wider when fishing during the B-season, and narrower when fishing during the A-season. Spreads were reported wider when fishing in the deep, and narrower when fishing up shallow.
3. The fraction of pelagic trawls when a portion of the trawl is likely to be in contact with the bottom is reported to be higher when fishing up shallow, and lower when fishing in the deep. Similarly, the fraction of trawls where a portion of the trawl is likely to be in contact with the bottom is reported to be higher during the day and lower during the night.
4. The width of the on-bottom trawl path was reported to be smaller than the wing-tip spread because only a fraction of the footrope is thought to be on bottom when the trawl is on the bottom. Thus, the on-bottom trawl “path” depends on the trawl spread and the fraction of the footrope thought to be in contact with the bottom. Looking fleet-wide, the average width of the on-bottom trawl path is reported wider when fishing during the day and narrower when

fishing at night. Similarly, the width is reported to be wider when fishing during the B-season in the deep, and narrower when fishing during the A-season and up shallow.

<u>Trawl width values</u>

To produce a set of nominal widths values covering the provided range and consistent with effects of the indicated factors, the following adjustments were made relative to the maximum width (100 fm, 183 m, used for daytime fishing during B season, deeper than 90 fm).
1) A 5% width reduction was applied to hauls in depths between 60 and 90 fm, while a 15% reduction was used for those shallower than 60 fm.
2) Trawl widths during A season were reduced 15% relative to those during B season.
3) Trawl widths at night were reduced 15% relative to daytime.
This resulted in the 55 – 100 fathom width range across the variety of conditions. As dividing actual towing times between night and day could not be easily accomplished, widths for A and B season were calculated by averaging night and day values, weighted 50% - 50% for A season and 70% day 30% night for B season. Weighting was estimated from the proportions of daylight based on civil twilight times in the Bering Sea from January 20 – March 31 and June 10 – October 15. The same proportional adjustments were applied to CV trawl widths. As CV vessels span a much wider range of towing capabilities, they were divided into 3 size classes, based on vessel length, < 125 ft, 125 – 150 ft and >150 ft. Maximum widths for each class were estimated based on the proportion of design widths of trawls for each class relative to design widths for the CP class, as reported by trawl manufacturers.

Bycatch data

Three classes of pelagic trawl bycatch, with differing association with the seafloor, were examined for frequency of presence in catches. The first, non-swimmers, included animals such as crabs, anemones and sea whips that would not be expected to leave the seafloor. The second group included the first group and added fish that feed on infauna and epifauna (e.g., rock sole and yellowfin sole) and would be expected to leave the seafloor only rarely. The third group included the first two groups and added piscivorous flatfish (e.g., halibut and arrowtooth flounder) that would be mostly associated with the seafloor, but would leave it more frequently than the second group. Expected likelihood of presence in trawl hauls with no seafloor contact could be described as very unlikely for group 1, rarely for group 2 and infrequently for group 3.

Trawl heights

Trawl heights were calculated as the difference between the gear depth and the bottom depth as reported in the observer data. This data is initially recorded by bridge personnel in the fishing log after completion of each trawl haul, based on recollection of readings from the vessel's echo sounder and trawl sonar. These are then transcribed by the observer. Gear depth is generally measured at the headrope (top of the trawl mouth), so trawl heights exceeding the maximum vertical opening of the trawl itself should indicate separation from the seafloor.

However, as only a single report is made for each haul and reporting practices may vary, these are only general indications and higher trawl heights do not preclude any contact.

Contact Proportion Values

Reductions from complete contact across the width of a pelagic trawl include full hauls with no contact, intermittent contact during a haul, and partial contact across the trawl's footrope. On most pelagic trawls, the center of the footrope hangs lower than the sides, so contact width increases as the height of the trawl mouth is reduced.

There is no direct measurement of contact width during fishing operations, so; while the general principles are understood, no specific measurements are available. Industry summaries, bycatch presence and trawl height reports are all very imprecise measures of the proportion of pelagic trawl widths contacting the seafloor. Nevertheless, these sources did provide a broadly consistent picture of contact variability. Generally, bycatch of all classes increased and trawl height decreased from night to day, A season to B season, and as depth increased, validating the description provided by the CP fleet. One discrepancy between bycatch and trawl height indications was that, while CV and CP fleets had similar patterns in trawl height, rates of detected bycatch presence were much lower for the CV fleet. As the catch sampling situations differ considerably between the two vessel types, we could not rule out the greater bycatch in the CP fleet being an artifact of larger or more easily obtained catch samples. One indicator of this possibility was that CV catches delivered to motherships (with sampling arrangements more similar to CPs) had higher bycatch rates than CV delivering to shore plants. Therefore, we have not assigned lower contact rates to the CV fleet in spite of the bycatch difference. Within CV and CP fleets, bycatch observations did indicate that trawl height was related to bottom contact. As trawl heights increased above the operating opening of the trawl, bycatch rates generally went down.

Trawl height data was therefore used in estimating trawl contact proportions. Cumulative frequencies of trawl heights increased rapidly between zero and the maximum vertical operating openings of 0 – 16 fm for CVs and 0 – 20 fm for CPs , with most rapid increase near 10 fm for CVs and 12 for CPs. Expecting that full width contact only occurs in the lower parts of those ranges and minimal contact occurs at the higher ends, we selected three height values from each distribution (10, 12, 14 CV and 12, 15, 18 CP) to represent low, medium, and high contact estimates. The proportion of tows with heights below each of those points was used to estimate the proportion of contact. While a knife-edge cutoff of all tows below each of these heights being 100% and all above 0% is indeed unrealistic, the contact values associated with each height would represent a mix of partial contacts below and above that average out the same. These contact values were applied for each combination of CV or CP sector, depth range and season. While this procedure certainly represents a considerable simplification, it does provide ranges of values consistent with the available information as needed in the effects-of-fishing model.

Gulf of Alaska and Aleutians Pelagic Trawls – In both the Gulf of Alaska (GOA) and Aleutian Islands (AI), fishing pelagic trawls on the seafloor is much less common, due to both rougher seafloors and different regulations. This is particularly true for pelagic trawls used to target rockfish in the GOA, where rockfish move off of the seafloor during the day. Trawl widths for these fisheries were estimated from trawl manufacturer design widths for the appropriate vessel sizes. Seafloor contact values were set at a low range of 0, 10 and 20 % for pollock fishing and 0% for rockfish fishing.

Non-pelagic (bottom) trawls – Non-pelagic trawls are designed to fish in continuous contact with the seafloor throughout each haul. Widths of these trawls include both cables ahead of the trawl (sweeps) as well as the width of the trawl itself. Lengths of sweeps, and hence trawl widths, vary considerably between fisheries. Flatfish fisheries use very long sweeps, while rockfish and cod fisheries use shorter sweeps. These differences were considered in setting each overall trawl width, based on information from the fishing industry. Most non-pelagic trawling in Alaska is now done with off-bottom doors. This practice is not expected to substantially change the potential seafloor contact width of trawls, but it does remove the portion of that width with the most noticeable seafloor impacts. (Note that those impacts are were likely included in the literature used by the model to estimate trawl effects, as off-bottom doors are a fairly recent innovation).

Contact with the seafloor across the width of a non-pelagic trawl has generally been treated as continuous. The most prominent departure from this assumption for Alaska trawling has been the implementation (2011 in Bering Sea, 2014 in GOA) of raised sweeps for all flatfish fishing (the largest bottom trawl fisheries that also use the longest sweeps). This modification greatly reduces direct seafloor contact across the largest portion of the trawl width by replacing 90-foot sections of continuous contact with contact only by 10-inch diameter bobbins (Rose et al. 2010). Research showed that it also reduces mortality to mobile epifauna (commercial crabs, 78% lower mortality, Rose et al. 2013, Hammond et al. 2013) and structure-forming benthos (sea whips, 31% fewer damaged, Rose et al., 2012). These reductions were applied to the portion of the trawl widths covered by sweeps for each trawler class to estimate smaller effect swaths that reflect lower impacts to each type of habitat features. Another departure from the assumed continuous contact comes from the footropes designs used on the trawl nets themselves. Alaska trawl footropes mostly use 12- to 30-inch diameter bobbins at spacings of 12 to 48 inches. These limit direct seafloor contact to the footprint of the bobbins themselves, though taller structures can still contact components between the bobbins. Alaska bottom trawlers, particularly in the Bering Sea, have used taller bobbins, wider spacings, and less footrope weight over time. Hammond et al. (2013) found these to reduce mortality to crabs passing under these footropes. No adjustments were made to the model for bobbins footropes or changes to them over time.

Longlines – Longlines interact with the seafloor differently than towed fishing gears. Lines are laid out across the seafloor and retrieved. Beyond the very narrow footprint of the line itself, an opportunity for additional seafloor contact could occur as the line is retrieved from the seafloor. If the towing vessel is not directly above the track of the line, currents pull the line to the side between the seafloor and the vessel, or captured fish pull the line sideways while struggling, the line may contact more seafloor. Bycatch of sessile benthos indicates that seafloor interactions do occur. However, no data are available to estimate the contact amounts. Therefore, contact widths of 0, 1 and 2 meters were used in the model to represent a range of possible interactions.

Pots – Pots also should not move across the seafloor during fishing, but have the potential for movement during retrieval. Areas affected by pots used in the model ranged from the footprint of the pots on the seafloor to two times that area.

Jigs – The only bottom contact expected during jigging is occasional contact of the bottom weight with the seafloor. While actual contact is likely very minimal, a value of 0.1 was used in the model for jig effort, allowing the presence of that effort to be tracked.