NATIONAL MARINE FISHERIES SERVICE REPORT: ANALYSIS OF SEAFLOOR CONTACT IN MIDWATER TRAWLS ENGAGED IN THE US WEST COAST PACIFIC HAKE FISHERY

Purpose

The purpose of this report is to provide additional information about and depth to an analysis that NOAA Fisheries presented to the Council, in response to questions raised at the Sept. 2014 meeting. In this report we address the following: 1. Do midwater trawlers participating in Pacific Coast hake fisheries contact the seafloor during fishing? 2. How often do trawls contact the seafloor inside and outside of groundfish EFH Conservation Areas?

Background

At the September 2014 Council Meeting, NOAA Fisheries provided a Supplemental Report in response to March 2014 Council questions concerning the effectiveness, accuracy, and completeness of Pacific Coast Groundfish EFH. In that report, the Northwest and Southwest Fisheries Science Centers, and West Coast Region staff presented information that was requested by the Council to inform discussions surrounding competing proposals to modify groundfish EFH. The report included an analysis of data on whiting midwater trawl effort within and outside of groundfish EFH conservation areas (EFHCA) for seafloor contact. The At Sea Hake and Shore-Side Hake fisheries were treated separately in the analysis. At the September Council meeting, interest was expressed by stakeholders in having further discussions on midwater trawl seafloor contact. In response, NMFS provided two informational sessions on seafloor contact in midwater trawls (November 2014 Council Meeting in Costa Mesa, CA and December 2014 NWFSC Montlake Laboratory in Seattle). Those informational sessions included a detailed PowerPoint presentation (see Appendix D). The following report is a more thorough presentation of the available information on seafloor contact in midwater trawls engaged in the Pacific Coast At Sea Hake Fishery and focuses on the following questions:

1. What is the basis for the benthic organism index of possible seafloor contact?
2. How do our methods of determining the location of towlines influence the proportion of tows inside of and outside of EFHCAs?
3. Has there been a temporal change in the distribution of hauls inside the EFHCAs?
4. What is the effect of separating the hauls according to individual EFHCAs?
5. How does changing an organism's affinity for the seafloor affect midwater trawl possible seafloor contact?

6. How does setting a threshold by numbers or weight affect the midwater trawl possible seafloor contact?
7. What is the effect of separating midwater trawl hauls by type of seafloor?

Overview of Using Benthic Taxa as a Proxy for Midwater Trawl Seafloor Contact

Midwater trawls are designed to fish in the water column above the seafloor, however, it is possible for parts of a midwater trawl (e.g., footrope, doors, bridles, tom weights, chains) to contact the seafloor during fishing operations. Currently, midwater trawls used in Pacific Coast fisheries are not outfitted with sensors that directly measure seafloor contact (e.g., foot rope mounted high-resolution altimeters and bottom contact sensors). Without a direct measure for seafloor contact, we used an index of possible seafloor contact defined as the presence of benthic or demersal fish and invertebrate taxa in the catch. There were a total of 194 bycatch taxa observed in the 22,823 midwater hauls engaged in the At Sea Hake Fishery and used in the current analysis. From these taxa, we developed a list of organisms that typically live in contact with the seafloor to within two meters of the seafloor. The list was determined by an expert group of ichthyologists and fisheries biologists who categorized which taxa were suitable to serve as proxies for possible seafloor contact (Appendix A). The classification was based on published information and expert knowledge on the life histories of the organisms, including their physiology, food habits, vertical distributions, habitat associations, as well as extensive at-sea observations.

Factors that could contribute to either an over- or underestimate of seafloor contact within the EFHCAs

For our analyses there were a number of factors that could contribute to either an over- or underestimate of seafloor contact within the EFHCAs. These factors include two general categories: those relating to the life history of benthic organism and how that influences their availability to capture and retention in midwater trawls and those relating to uncertainty in the location of midwater trawl hauls.

Misjudging the degree to which a given taxa is benthic has received considerable debate during recent discussions on the topic of midwater trawl seafloor contact. If an organism is more benthopelagic or pelagic than the current science supports (i.e., regular excursions into the water column of > 2 meters), then seafloor contact associated with that taxa will be overestimated. It is important to note that only five benthic taxa (thornyheads, rex sole, lingcod, Dover sole, eelpouts, snailfishes occurred in > 1% of the hauls, and only two taxa occurred in > 10% of the midwater trawl hauls (thornyheads and rex sole). Another factor is the effect of setting thresholds for numbers and biomass of organisms when determining possible seafloor contact. Our analyses shows that a low threshold, could overestimate contact especially as it relates to between-tow contamination since records of benthic species in subsequent tows could be erroneous. Escapement is a significant feature in the trawl capture process, and one should consider the contribution of escapement of organisms, especially along the length of the trawl between the footrope and the codend, to an underestimate of seafloor contact. Midwater trawls are four panel nets, large in dimension when compared to a bottom trawls, constructed with a considerable distance between the footrope and codend, and tapering large mesh sizes along much that distance.

There are a number of factors that could contribute to haul location uncertainty, inside vs. outside of EFHCAs (Table 1), including the assumption of a straight towline between observer recorded start and end points, potential offset between trawl and vessel locations, the effect of using differing towline length proportions to assess whether a tow is inside or outside of an EFHCA (e.g., >0, 10%, 50%, 90%), the location where organisms were captured along the length of the towline (inside vs. outside of EFHCAs).

Factors that could contribute to either an over- or underestimate of seafloor contact within the EFHCAs and related questions are addressed in the following seven sections.

Table 1. Factors that could contribute to either an over- or underestimate of possible seafloor contact in midwater trawls, and whether or not a given trawl occurred within a groundfish EFHCAs.

Factor	Overestimating Seafloor Contact	Underestimating Seafloor Contact
"Benthicness" – misjudging the degree to which a given taxa is benthic	X	X
Escapement of organism, especially along the length of the trawl between footrope and the codend		X
Between tow catch contamination	X	
Errors in identification or recording of taxa and errors in counts of organisms	If pelagic organisms were misidentified or incorrectly recorded as benthic taxa	If benthic organisms were misidentified or recorded incorrectly as pelagic taxa
Haul location uncertainty (inside vs. outside of EFHCA) - straight towline assumption vs. actual tow location	The assumption of a straight towline between start and end points can lead to an overestimate if the true trajectory of the towline was curvilinear tending inside an EFHCA	The assumption of a straight towline between start and end points can lead to an underestimate if the true trajectory of the towline was curvilinear tending outside an EFHCA
Haul location uncertainty (inside vs. outside of EFHCA): offset between trawl and vessel location	If a vessel is towing close to an EFHCA boundary and the vessel is inside of the boundary while the trawl is outside of the boundary this would cause an overestimate.	If a vessel is towing close to an EFHCA boundary and the vessel is outside of the boundary while the trawl is inside of the boundary this would cause an underestimate.
Haul location uncertainty (inside vs. outside of EFHCA): towline length proportion used (e.g., >0, 10%, 50%, 90%)	Decreasing towline length proportion would tend to overestimate seafloor contact within EFHCAs	Increasing towline length proportion would tend to underestimate seafloor contact within EFHCAs
Seafloor location where organisms were captured along the length of the tow (inside vs. outside of EFHCA):	Assuming the use of some towline length proportion, if a benthic organism is captured during the portion of the tow outside of an EFHCA boundary, then this would result in an overestimate. of seafloor contact inside the EFHCA	If a benthic organism is captured during a portion of the tow inside EFHCA but only a small portion of the tow occurred inside the EFHCA, then this would tend to underestimate seafloor contact inside the EFHCA.
Seafloor contact by MWT gear other than the trawl net (e.g., footrope, doors, bridles, tom weights, chains)		X
Threshold for numbers and biomass of organisms when determining probable seafloor contact	If threshold is low, could overestimate (related to between-tow contamination, above)	

1. What is the basis for the benthic organism index of possible seafloor contact?

The expert group of ichthyologists and fisheries biologists discussed above determined that 53 of the 194 bycatch taxa were suitable as proxies for possible seafloor contact (Table 2). A number of rockfishes (18) and flatfishes (3) were excluded from the list of proxy taxa for possible seafloor contact. We have categorized the 53 taxa into seven functional groups, and by general degree of affinity for inhabiting the seafloor (Table 2). We provide further categorizations and summary statistics for the haul by haul occurrence of the benthic taxa. The extent of occurrence of benthic taxa by frequency, counts and weight is further summarized in Appendix B. These summaries are tabulated for all hauls, for hauls outside of EFHCAs, for hauls with at least 50% of their length inside EFHCAs, and for hauls with either deploy, retrieve or both points inside EFHCAs. It is important to note that only five benthic proxy taxa (thornyheads, rex sole, lingcod, Dover sole, eelpouts, snailfishes occurred in > 1% of the hauls, and only two taxa occurred in > 10% of the hauls (thornyheads and rex sole). Therefore, thornyheads and rex sole have the greatest impact on the proportion of tows that are identified as having possible seafloor contact. Lingcod is the only other organism with an appreciable impact on whether or not a given haul is classified as possibly contacting the seafloor.

Table 2. List of 53 benthic taxa out of a total of 194 taxa observed in midwater trawl catches categorized by functional groups, and general degree of affinity for seafloor habitation, with 1 being the most benthic (depth in meters).

Taxon	Taxon Group	Group Name	Benthic Rank	Min depth (absolute)	Min depth (common)	Max depth (common)	Max depth (absolute)
Anemones	A	invertebrates	1	0			>2000
barnacles	A	invertebrates	1	0			>2000
basket star	A	invertebrates	1	0			2000
brittle stars	A	invertebrates	1	0			>2000
corals-bryozoans	A	invertebrates	1	0			>2000
Crabs	A	invertebrates	1	0			>2000
Dungeness crab	A	invertebrates	1	0	0	90	230
hermit crabs	A	invertebrates	1	0			>2000
lamp shells	A	invertebrates	1	0			>2000
sea cucumbers	A	invertebrates	1	0			>2000
sea pen-sea whip	A	invertebrates	1	0			>2000
sea stars	A	invertebrates	1	0			>2000
snail eggs	A	invertebrates	1	0			>2000
snail shells	A	invertebrates	1	0			>2000
snails	A	invertebrates	1	0			>2000
sponges	A	invertebrates	1	0			>2000
Aleutian skate	B	flatfishes	1	15			1602
butter sole	B	flatfishes	1	0	2	150	425
Dover sole	B	flatfishes	1	80	200	500	1200
English sole	B	flatfishes	1	0	0	250	550
flathead sole	B	flatfishes	3	0	0	366	1050
petrale sole	B	flatfishes	2	0	50	300	550
rex sole	B	flatfishes	1	0	50	450	850
slender sole	B	flatfishes	2	9	90	350	1145

Taxon	Taxon Group	Group Name	Benthic Rank	Min depth (absolute)	Min depth (common)	Max depth (common)	Max depth (absolute)
turbot (greenland)	B	flatfishes	3	14	300	1000	2000
lingcod	C	lingcod	3	0	100	150	475
black eelpout	D	other demersal fishes	1	13	146	844	1300
blacktail snailfish group	D	other demersal fishes	1	61	400	2286	2286
eelpouts	D	other demersal fishes	1	0			>2000
pacific flatnose	D	other demersal fishes	1	350	500	950	3050
poachers	D	other demersal fishes	1	0	0	300	1300
pricklebacks	D	other demersal fishes	1	0			1195
quillfish	D	other demersal fishes	1	0			360
ronquils	D	other demersal fishes	1	0			825
slender codling	D	other demersal fishes	3	500			1967
snailfishes	D	other demersal fishes	1	0	0	>2000	>2000
wolf-eel	D	other demersal fishes	3	0			355
aurora rockfish	E	rockfishes	1	81	300	500	893
bank rockfish	E	rockfishes	2	31	100	270	500
blackgill rockfish	E	rockfishes	1	125	250	600	768
greenstriped rockfish	E	rockfishes	1	52	100	250	828
harlequin rockfish	E	rockfishes	1	49	100	350	558
quillback rockfish	E	rockfishes	1	3	9	147	275
red banded rockfish	E	rockfishes	1	49	150	450	625
rosethorn rockfish	E	rockfishes	1	25	100	350	550
sharpchin rockfish	E	rockfishes	1	25	100	350	475
stripetail rockfish	E	rockfishes	2	10	10	350	547
tiger rockfish	E	rockfishes	1	3	55	274	274
yelloweye rockfish	E	rockfishes	1	25	91	180	475
longspine thornyhead	F	thornyheads	1	400	500	1300	1755

Taxon	Taxon Group	Group Name	Benthic Rank	Min depth (absolute)	Min depth (common)	Max depth (common)	Max depth (absolute)
shortspine thornyhead	F	thornyheads	1	100	100	850	1524
unident. thornyhead	F	thornyheads	1	100	100	850	1524
sandpaper skate	G	skates	1	18	200	500	1050

2. How do our methods of determining the location of towlines influence the proportion of tows inside of and outside of EFHCAs?

To ascertain how our methods of determining the location of towlines influence the proportion of possible seafloor contact inside of and outside of EFHCAs, we developed a series of comparisons using different haul start and end point intersections (Table 3), and a range of towline length proportions (Table 4).). For this analysis we used all hauls *regardless of whether or not they showed possible seafloor contact*. As one would expect, as the threshold for meeting the definition for being inside an EFHCA is more constrained (i.e., line length proportion inside EFHCAs increases), the number of hauls meeting those criteria decreases. The comparison of haul end points either inside or outside EFHCAs, based on analyses of four different haul point intersection scenarios ranged from 2.4 to 9.4%. The comparison of number of hauls intersecting EFHCAs, based on a range of several towline length proportions ranged from 3.7 % to 11.9% for towline proportions of >0 to 100 %, respectively. See Appendix C for a complementary figure showing the relationship between towline length proportion and number of hauls intersecting EFHCAs.

Table 3. Comparison of haul end points either inside or outside EFHCAs, based on analysis of four different haul point intersection scenarios. The second table further breaks down the scenario where both deploy and retrieve points are either in the same (=) or different (≠) EFHCAs. This analysis includes all hauls regardless of whether or not they showed possible seafloor contact.

Haul Points	# Hauls	% Total
Either	2,150	9.4%
Deploy	596	2.6%
Retrieve	557	2.4%
Both	997	4.4%
Neither	20,673	90.6%
Grand Total	**22,823**	**100.0%**

Haul Points	# Hauls	% Total
Either	2,150	9.4%
Deploy	596	2.6%
Retrieve	557	2.4%
Both	997	4.4%
deploy = retrieve	914	4.0%
deploy ≠ retrieve	83	0.4%
Neither	20,673	90.6%
Grand Total	**22,823**	**100.0%**

Table 4. Comparison of number of hauls intersecting EFHCAs, depending on proportion of towline within the EFHCAs. This analysis includes all hauls regardless of whether or not they showed possible seafloor contact.

Towline Length Proportion	# Hauls	% Total
(outside) =0%	20,112	88.1%
>0%	2,711	11.9%
>=10%	2,345	10.3%
>=20%	2,033	8.9%
>=40%	1,561	6.8%
>=50%	1,411	6.2%
>=60%	1,265	5.5%
>=80%	1,096	4.8%
>=90%	1,007	4.4%
=100%	846	3.7%

3. Has there been a temporal change in the distribution of hauls inside the EFHCAs?

We examined whether there was a temporal pattern in the distribution of hauls occurring inside of the EFHCAs, based on either deploy, retrieve or both haul points being inside EFHCAs (Table 5 and Figure 1). As in Section 2 above, this analysis includes all hauls *regardless of whether or not they showed possible seafloor contact*. The frequency of hauls inside the EFHCAs has declined between 2007 and 2013, but then spiked upward in 2014. The 2014 spike can be explained by the fact that a portion of the At Sea Hake fishery moved offshore and to the south in 2014 to reduce bycatch placing a substantial number of tows in deep water overlying the EFHCA seaward of the 700-ftm contour.

Table 5. Temporal distribution of hauls inside EFHCAs, based on either deploy, retrieve or both haul points being inside EFHCAs. Percentage columns represent proportion of total hauls inside EFHCAs for all years and sectors combined.

	Non-Tribal		Tribal		Combined	
YEAR	**# Hauls**	**%**	**# Hauls**	**%**	**# Hauls**	**%**
2006	26	1.2%	81	3.8%	107	5.0%
2007	325	15.1%	103	4.8%	428	19.9%
2008	218	10.1%	64	3.0%	282	13.1%
2009	103	4.8%	78	3.6%	181	8.4%
2010	106	4.9%	166	7.7%	272	12.7%
2011	97	4.5%	79	3.7%	176	8.2%
2012	39	1.8%	-	-	39	1.8%
2013	78	3.6%	-	-	78	3.6%
2014	587	27.3%	-	-	587	27.3%
All Years	**1,579**	**73.4%**	**571**	**26.6%**	**2,150**	**100.0%**

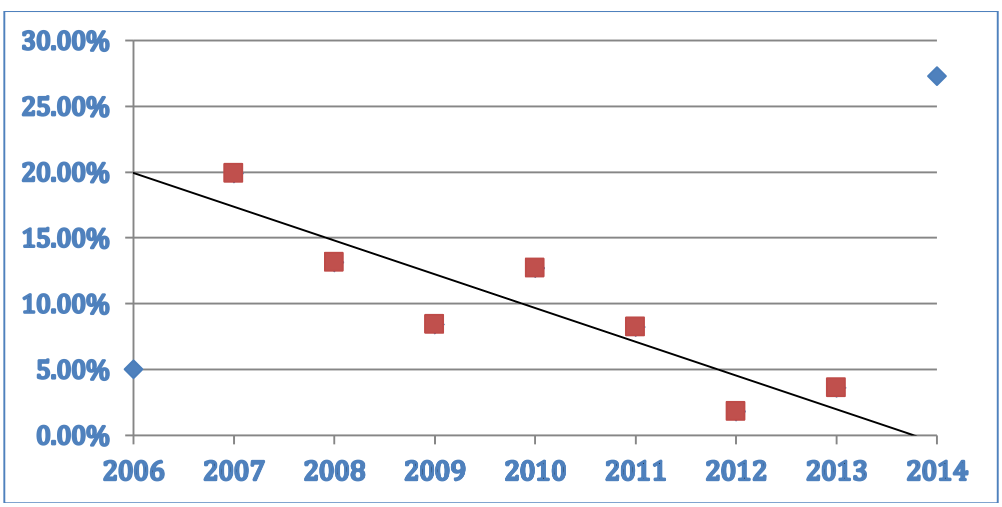

Figure 2. Temporal distribution of hauls inside EFHCAs, based on either deploy, retrieve or both haul points being inside EFHCAs. Percentages represent proportion of total hauls inside EFHCAs for all years and sectors combined. The trend line does not include the years 2006 and 2014 (blue diamonds) because 2006 represents a fraction of the year's potential hauls and 2014 represents a spike in hauls (see text for discussion of 2014).

4. What is the effect of separating the hauls according to individual EFHCAs?

To examine the effect of separating the hauls according to individual EFHCAs, we constructed tabular summaries of the number of hauls that intersect each of the 15 conservations areas through a geographical comparison of the recorded deploy and retrieve points, considering the three possible manners of intersection (Tables 6-8). Percentages of midwater trawl hauls within each of the 15 EFHCAs showing possible seafloor contact (at least one benthic taxa) are shown in Figure 2. There were 2,150 tows where at least one end point was inside an EFHCA, 596 were deploy points only and 557 were retrieve points only (Tables 6 and 7). Out of the remaining 997 tows where both haul points were inside an EFHCA, 914 of those tows had both points inside the same EFHCA, while 83 tows had points in different EFHCAs (Table 8). Not considering catch of benthic indicator species, the top three EFHCAs in terms of haul intersections were: Seaward of the 700-ftm contour, Olympic 2, and Biogenic 1. When considering catch of benthic indicator species, 'Olympic 2' shows the largest number of haul intersections. If one considers, in contrast, the proportion of hauls with benthic indicator species for hauls where both deploy and retrieve points were inside the same EFHCA, the top three are as follows: Daisy Bank/Nelson Island (33.3%), Bandon High Spot (18.8%), and Olympic 2 (16.1%).

The proportion of hauls with benthic indicator species (ranks 1, 2 or 3) for all EFHCAs combined is somewhere between 16% (deploy) and 19% (retrieve) when considering either end point, and decreases to 7% when both end points intersect an EFHCA.

Table 6. Table summarizing proportion of hauls with benthic indicator species (Rank 1, 2 or 3) and inside (based on deploy point only) in each of 15 different EFHCAs. The last row summarizes the proportion of hauls with benthic indicator species within all 15 EFHCAs combined.

EFHCA	# Hauls Inside	# Hauls w/ Taxa	%
Olympic 2	133	32	24.1%
Biogenic 1	130	1	0.8%
Biogenic 2	25	2	8.0%
Grays Canyon	77	14	18.2%
Biogenic 3	1	0	0.0%
Nehalem Bank/Shale Pile	0	0	NA
Astoria Canyon	0	0	NA
Siletz Deepwater	12	0	0.0%
Daisy Bank/Nelson Island	14	3	21.4%
Newport Rockpile/Stonewall Bank	1	0	0.0%
Heceta Bank	2	2	100.0%
Deepwater off Coos Bay	0	0	NA
Bandon High Spot	113	58	51.3%
Rogue Canyon	18	0	0.0%
Seaward of the 700-fm contour	70	2	2.9%
ALL EFHCAs combined	**596**	**114**	**19.1%**

Table 7. Table summarizing proportion of hauls with benthic indicator species (Rank 1, 2 or 3) and inside (based on retrieve point only) in each of 15 different EFHCAs. The last row summarizes the proportion of hauls with benthic indicator species within all 15 EFHCAs combined.

EFHCA	# Hauls Inside	# Hauls w/ Taxa	%
Olympic 2	139	25	18.0%
Biogenic 1	110	2	1.8%
Biogenic 2	32	3	9.4%
Grays Canyon	48	11	22.9%
Biogenic 3	0	0	NA
Nehalem Bank/Shale Pile	1	0	0.0%
Astoria Canyon	3	0	0.0%
Siletz Deepwater	9	1	11.1%
Daisy Bank/Nelson Island	5	1	20.0%
Newport Rockpile/Stonewall Bank	0	0	NA
Heceta Bank	3	0	0.0%
Deepwater off Coos Bay	0	0	NA
Bandon High Spot	99	44	44.4%
Rogue Canyon	20	1	5.0%
Seaward of the 700-fm contour	88	3	3.4%
ALL EFHCAs combined	**557**	**91**	**16.3%**

Table 8. Table summarizing proportion of hauls with benthic indicator species (Rank 1, 2 or 3) and inside (based on both deploy and retrieve points) in each of 15 different EFHCAs. The last row summarizes the proportion of hauls with benthic indicator species within all 15 EFHCAs combined.

EFHCA	# Hauls Inside	# Hauls w/ Taxa	%
Olympic 2	299	48	16.1%
Biogenic 1	155	2	1.3%
Biogenic 2	26	2	7.7%
Grays Canyon	29	3	10.3%
Biogenic 3	0	0	NA
Nehalem Bank/Shale Pile	0	0	NA
Astoria Canyon	1	0	0.0%
Siletz Deepwater	7	0	0.0%
Daisy Bank/Nelson Island	3	1	33.3%
Newport Rockpile/Stonewall Bank	0	0	NA
Heceta Bank	0	0	NA
Deepwater off Coos Bay	0	0	NA
Bandon High Spot	16	3	18.8%
Rogue Canyon	38	1	2.6%
Seaward of the 700-fm contour	340	7	2.1%
ALL EFHCAs combined	**914**	**67**	**7.3%**

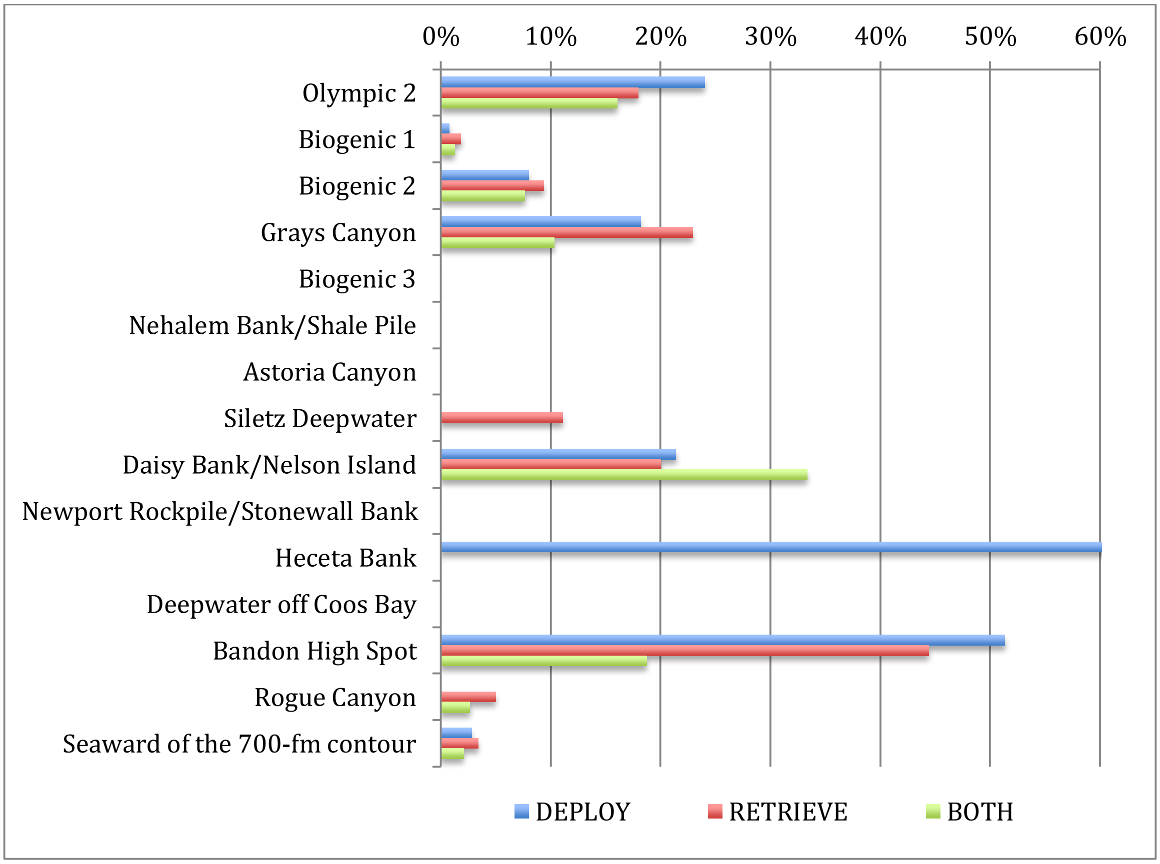

Figure 2. Chart summarizing proportion of midwater trawl hauls (based on deploy, retrieve, or both haul points) with benthic indicator species (Rank 1, 2 or 3) in each of 15 different EFHCAs. EFHCAs are listed generally from north to south (top to bottom). Heceta Bank proportion = 100%.

5. *How does changing an organism's affinity for the seafloor affect midwater trawl possible seafloor contact?*

To examine the effect of "benthicness" on midwater trawl seafloor contact, we grouped hauls according to three levels of taxon affinities for the seafloor, with "1" being the most benthic. Hauls were first summarized without regard to the quantity (by weight or number) of each benthic taxa (Table 9). This analysis also included a range of geospatial considerations for a haul being inside EFHCAs. Not surprisingly, reducing the number of benthic species and increasing the threshold for inclusion reduced the number hauls possibly contacting the seafloor. Removing level 2 and 3 benthic species reduced the number of hauls contacting the seafloor by 19%. The reduction was proportionally greatest when removing the level 3 taxa which included lingcod (942 hauls), flathead sole (20 hauls), turbot (2 hauls), slender codling (1 haul), and wolf eel (1 haul). Removing lingcod, a fish assigned a seafloor affinity of 3, had the largest impact.

Table 9. Summary of number of hauls with various groupings of potentially benthic taxa (see Table 1), categorized by various geospatial methods for a haul being inside EFHCAs. Numbers 1, 2 and 3 represent categories of taxon affinities for the seafloor, with 1 being the most benthic. Last row summarizes number of hauls with potentially benthic taxa, regardless of haul location.

Geospatial Method	1	1 + 2	1 + 2 + 3
>0%	422	440	522
>=10%	306	322	399
>=50%	66	66	121
>=90%	34	34	68
=100%	25	25	52
Deploy OR Retrieve	155	161	205
Deploy AND Retrieve	34	34	67
Combined (Inside OR Outside)	**4,311**	**4,412**	**5,246**

6. *How does setting a threshold by numbers or weight affect midwater trawl possible seafloor contact?*

Hauls were summarized with a threshold set for those hauls with any benthic invertebrates and at least 10 kg and 5 individuals of any given demersal fish taxa recorded in the catch (Table 10). Similar to the analysis on benthic affinities, this analysis included a range of geospatial considerations for a haul being inside EFHCAs. Comparing Tables 9 and 10, setting thresholds substantially reduced the incidence of possible seafloor contact.

Table 10. Summary of number of hauls with various groupings of potentially benthic taxa (see Table 1), categorized by various geospatial methods for a haul being inside EFHCAs. Haul counts are for those hauls with any benthic invertebrates and at least 10 kg and 5 individuals of any given demersal fish taxa recorded in the catch. Numbers 1, 2 and 3 represent categories of taxon affinities for the seafloor, with 1 being the most benthic. Last row summarizes number of hauls with potentially benthic taxa with the same number and biomass thresholds, regardless of haul location.

Geospatial Method	1	1 + 2	1 + 2 + 3
>0%	117	117	152
>=10%	81	81	114
>=50%	13	13	38
>=90%	7	7	22
=100%	4	4	16
Deploy OR Retrieve	34	34	52
Deploy AND Retrieve	7	7	22
Combined (Inside OR Outside)	**1,307**	**1,312**	**1,549**

7. *What is the effect of separating midwater trawl hauls by type of seafloor?*

We examined the effect of separating midwater trawl hauls by the underlying seafloor type (induration) for hauls inside and outside EFHCAs (Table 11 and Figure 2). We used the most recent map of seafloor type for the Pacific Coast (Goldfinger et al. 2014) where the seafloor is classified into three types: soft, mixed and hard substrata. Due to limited coverage of benthic habitat data in deeper water, hauls occurring within the “Seaward of the 700-ftm contour EFHCA” were not included in the inside EFHCAs category. Hauls were plotted as straight lines between recorded deployment and retrieval points. Those portions of hauls that occurred over EFHCAs were defined as “inside” so individual hauls could have portions both “inside” and “outside” EFHCAs. For hauls portions inside EFHCAs, the proportion of the tows that occurred over mixed and hard substrata were slightly higher than for haul portions outside EFHCAs, 8.9% vs. 5.3% and 0.9% vs. 0.3%, respectively. The vast majority of tows occurred over soft substratum (89.7% inside and 94.4% outside the EFHCAs, respectively). The risk of impacts to benthic habitats from mobile seafloor tending fishing gear is much less for soft substratum as compared to hard substratum. Within the subregion of the northern California Current (north of 40°10' N. Lat.), hard and mixed substrata are relatively rare (4.3% and 3.1%, respectively) when compared to soft substratum (92.6%). Within that same subregion, 32% of hard and mixed substrata are protected from bottom trawling by EFH conservation areas (NMFS 2013).

Table 11. Proportion of underlying seafloor types or lithologies for hauls inside and outside EFHCAs. Due to limited benthic habitat data coverage in deeper water, hauls occurring within the “seaward of the 700-ftm contour EFHCA” were not included in the inside EFHCAs category. Surficial geological habitat data source: Goldfinger et al. 2014.

	soft	mixed	hard	unknown
inside	89.7%	8.9%	0.9%	0.4%
outside	94.4%	5.3%	0.3%	0.0%

Figure 3. Proportion of underlying seafloor types or lithologies for haul portions inside and outside EFHCAs. Due to limited benthic habitat data coverage in deeper water, hauls occurring within the “seaward of the 700-ftm contour EFHCA” were not included in the inside EFHCAs category. The lower plot shows the distribution scaled between 0 and 100%, while the upper plot highlights the upper 20% of the range. Surficial geological habitat data source: Goldfinger et al. 2014.

References

Goldfinger C, Henkel, SK, et al. 2014. Benthic Habitat Characterization Offshore the Pacific Northwest Volume 1: Evaluation of Continental Shelf Geology. US Dept. of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region. OCS Study BOEM 2014-662. 161 pp.

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Appendix A.

Expert group ichthyologists and fisheries biologists who provided information used to identify organisms that typically live in contact with the seafloor or within two meters of the seafloor.

Waldo Wakefield, NOAA NMFS NWFSC, Newport, OR
Mary Yoklavich, NOAA NMFS SWFSC, Santa Cruz, CA
Milton Love, University of California Santa Barbara, Santa Barbara, CA
Joseph Bizzarro, University of Washington, Seattle, WA
Vanessa Tuttle, NOAA NMFS NWFSC, Seattle, WA

Overview of Methods.

- Possible seafloor contact was estimated for midwater trawl gear in the Pacific Coast At-Sea Hake Fishery
- We used an index of possible seafloor contact defined as the presence of benthic or demersal fish and invertebrate taxa in the catch. There were a total of 194 bycatch taxa observed in the 22,823 midwater trawl hauls engaged in the At Sea Hake Fishery and used in the current analysis. From these taxa, we developed a list of 53 taxa that served as a proxy for possible seafloor contact, taxa that typically live in contact with the seafloor or within two meters of the seafloor.
- Seafloor contact is reported as frequency of hauls both coastwide and within existing groundfish EFH conservation areas.
- We examined a number of geospatial models for assessing whether or not a midwater towline was inside an EFH conservation area.
- Data sources: At-Sea Hake Observer Program (at-sea sector; 12 Jun 2006 – 31 Dec 2014).

Appendix B

What is the basis for the benthic organism index of seafloor contact?

In this Appendix, we provide further categorizations and summary statistics for the haul by haul occurrence of the benthic taxa. The extent of occurrence of the 53 benthic taxa by frequency, counts and weight is summarized here in Appendix B, Tables 1-4. These summaries are tabulated for all hauls combined (Appendix B, Table 1), for hauls outside of EFHCAs (Appendix B, Table 2), for hauls with at least 50% of their length inside EFHCAs (Appendix B, Table 3), and for hauls with either deploy, retrieve or both points inside EFHCAs (Appendix B, Table 4).

Appendix B, Table 1. Summary statistics for all potentially benthic taxa for all hauls combined (weight in kg).

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
invertebrates	anemones	18	1	2.6	10	46	0.0	0.3	1.2	4.6
	barnacles	1	2	2.0	2	2	0.6	0.6	0.6	0.6
	basket star	4	1	2.0	3	8	0.0	0.1	0.1	0.2
	brittle stars	3	0	2.0	4	6	0.0	0.0	0.0	0.1
	corals-bryozoans	4	2	2.0	2	8	0.0	0.1	0.2	0.4
	crabs	4	0	0.5	2	2	0.0	0.0	0.1	0.1
	Dungeness crab	28	1	4.9	54	136	0.3	2.4	36.1	66.8
	hermit crabs	1	2	2.0	2	2	0.0	0.0	0.0	0.0
	lamp shells	1	3	3.0	3	3	0.1	0.1	0.1	0.1
	sea cucumbers	7	2	2.9	4	20	0.0	0.1	0.3	0.8
	sea pen-sea whip	37	1	9.3	98	343	0.0	0.3	3.5	11.8
	sea stars	38	0	2.7	10	104	0.0	0.2	4.5	7.7
	snail eggs	3	3	8.7	13	26	0.5	1.4	1.8	4.2
	snail shells	2	2	2.0	2	4	0.0	0.0	0.0	0.0
	snails	1	3	3.0	3	3	0.1	0.1	0.1	0.1
	sponges	1	2	2.0	2	2	0.0	0.0	0.0	0.0
flatfishes	Aleutian skate	2	2	2.0	2	4	0.9	0.9	0.9	1.9
	butter sole	1	3	3.0	3	3	0.7	0.7	0.7	0.7
	Dover sole	862	1	19.5	735	16,823	0.2	7.3	272.6	6,333.2
	English sole	98	1	7.0	75	684	0.2	2.5	26.4	241.5
	flathead sole	20	1	7.0	56	139	0.0	2.0	18.9	40.3
	petrale sole	3	2	5.0	11	15	0.5	2.0	4.5	5.9
	rex sole	2,418	0	83.4	8,838	201,723	0.0	16.9	1,620.4	40,803.9
	slender sole	92	1	6.2	149	571	0.0	0.7	12.3	63.6
	turbot (greenland)	2	1	1.5	2	3	1.1	1.9	2.8	3.9
lingcod	lingcod	942	1	4.4	82	4,154	0.5	20.1	447.2	18,903.3
other demersal fishes	black eelpout	1	2	2.0	2	2	0.2	0.2	0.2	0.2

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
	blacktail snailfish group	2	2	2.0	2	4	0.3	0.3	0.3	0.6
	eelpouts	428	1	8.5	188	3,626	0.0	1.0	54.7	415.2
	Pacific flatnose	6	2	2.3	4	14	0.2	0.5	0.9	3.0
	poachers	4	2	10.3	31	41	0.0	3.8	15.2	15.3
	pricklebacks	7	2	3.3	7	23	0.0	0.0	0.1	0.3
	quillfish	4	2	3.8	6	15	0.0	0.1	0.2	0.4
	ronquils	6	2	3.7	12	22	0.1	0.5	1.2	3.1
	slender codling	1	2	2.0	2	2	0.6	0.6	0.6	0.6
	snailfishes	180	1	4.1	43	742	0.0	0.8	10.5	149.5
	wolf-eel	1	1	1.0	1	1	1.7	1.7	1.7	1.7
rockfishes	aurora rockfish	90	1	6.3	79	563	0.3	2.6	29.9	237.6
	bank rockfish	119	1	3.5	116	419	0.4	4.4	199.2	528.3
	blackgill rockfish	42	1	3.7	18	156	1.0	5.8	26.5	243.4
	greenstriped rockfish	14	1	2.2	4	31	0.2	0.8	3.1	11.8
	harlequin rockfish	10	2	2.0	2	20	0.4	0.7	1.4	6.8
	quillback rockfish	5	2	2.8	6	14	0.7	2.2	5.8	11.2
	red banded rockfish	22	1	2.5	5	54	0.6	2.9	9.1	64.6
	rosethorn rockfish	6	2	6.5	19	39	0.4	1.6	4.1	9.6
	sharpchin rockfish	65	1	62.3	3,588	4,049	0.2	13.8	764.7	897.3
	stripetail rockfish	16	1	3.4	14	55	0.2	1.9	16.6	30.2
	tiger rockfish	1	2	2.0	2	2	1.0	1.0	1.0	1.0
	yelloweye rockfish	8	2	2.1	3	17	0.4	4.9	13.0	39.2
thornyheads	longspine thornyhead	177	1	38.9	803	6,885	0.1	4.7	97.2	830.5
	shortspine thornyhead	3,039	0	87.8	4,401	266,781	0.0	23.0	1,056.5	69,848.9
	unident. thornyhead	44	0	384.7	1,666	16,925	0.1	104.4	535.7	4,595.0
skates	sandpaper skate	17	1	2.4	5	40	0.7	1.9	5.2	31.6
		5,246	**0**	**59.0**	**8,838**	**525,376**	**0.0**	**16.2**	**1,620.4**	**144,472.4**

Appendix B, Table 2. Summary statistics for all potentially benthic taxa for all hauls outside EFHCAs (weight in kg).

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
invertebrates	anemones	16	1	2.6	10	41	0.0	0.2	0.6	3.3
	barnacles	1	2	2.0	2	2	0.6	0.6	0.6	0.6
	basket star	4	1	2.0	3	8	0.0	0.1	0.1	0.2
	brittle stars	3	0	2.0	4	6	0.0	0.0	0.0	0.1
	corals-bryozoans	4	2	2.0	2	8	0.0	0.1	0.2	0.4
	crabs	3	0	0.7	2	2	0.0	0.0	0.1	0.1
	Dungeness crab	28	1	4.9	54	136	0.3	2.4	36.1	66.8
	hermit crabs	1	2	2.0	2	2	0.0	0.0	0.0	0.0
	lamp shells	1	3	3.0	3	3	0.1	0.1	0.1	0.1
	sea cucumbers	5	2	2.4	4	12	0.0	0.1	0.1	0.4
	sea pen-sea whip	35	1	9.7	98	339	0.0	0.2	3.5	8.7
	sea stars	36	0	2.7	10	98	0.0	0.2	4.5	7.7
	snail eggs	3	3	8.7	13	26	0.5	1.4	1.8	4.2
	snail shells	2	2	2.0	2	4	0.0	0.0	0.0	0.0
	snails	1	3	3.0	3	3	0.1	0.1	0.1	0.1
	sponges	1	2	2.0	2	2	0.0	0.0	0.0	0.0
flatfishes	Aleutian skate	2	2	2.0	2	4	0.9	0.9	0.9	1.9
	butter sole	1	3	3.0	3	3	0.7	0.7	0.7	0.7
	Dover sole	751	1	20.4	735	15,324	0.2	7.6	272.6	5,727.5
	English sole	77	1	7.8	75	599	0.2	2.7	26.4	209.6
	flathead sole	13	1	8.3	56	108	0.0	2.3	18.9	29.4
	petrale sole	3	2	5.0	11	15	0.5	2.0	4.5	5.9
	rex sole	2,117	0	87.3	8,838	184,759	0.0	17.6	1,620.4	37,192.8
	slender sole	75	1	6.3	149	472	0.0	0.8	12.3	57.5
	turbot (greenland)	1	1	1.0	1	1	2.8	2.8	2.8	2.8
lingcod	Lingcod	859	1	4.2	82	3,604	0.5	18.4	447.2	15,810.2
other demersal fishes	black eelpout	1	2	2.0	2	2	0.2	0.2	0.2	0.2
	blacktail snailfish group	2	2	2.0	2	4	0.3	0.3	0.3	0.6
	eelpouts	417	1	8.4	188	3,495	0.0	0.8	54.7	334.1

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
	pacific flatnose	5	2	2.4	4	12	0.2	0.5	0.9	2.3
	poachers	4	2	10.3	31	41	0.0	3.8	15.2	15.3
	pricklebacks	7	2	3.3	7	23	0.0	0.0	0.1	0.3
	quillfish	4	2	3.8	6	15	0.0	0.1	0.2	0.4
	ronquils	5	2	4.0	12	20	0.1	0.4	0.5	1.9
	slender codling	1	2	2.0	2	2	0.6	0.6	0.6	0.6
	snailfishes	149	1	3.9	43	582	0.0	0.8	8.4	118.7
	wolf-eel	1	1	1.0	1	1	1.7	1.7	1.7	1.7
rockfishes	aurora rockfish	81	1	6.4	79	522	0.3	2.7	29.9	222.0
	bank rockfish	94	1	3.9	116	366	0.4	5.1	199.2	476.2
	blackgill rockfish	35	1	3.8	18	133	1.0	5.8	26.5	202.0
	greenstriped rockfish	14	1	2.2	4	31	0.2	0.8	3.1	11.8
	harlequin rockfish	9	2	2.0	2	18	0.4	0.7	1.4	5.9
	quillback rockfish	5	2	2.8	6	14	0.7	2.2	5.8	11.2
	red banded rockfish	19	1	2.5	5	48	0.6	3.2	9.1	59.9
	rosethorn rockfish	5	2	7.4	19	37	0.4	1.8	4.1	9.2
	sharpchin rockfish	64	1	63.2	3,588	4,047	0.2	14.0	764.7	896.9
	stripetail rockfish	16	1	3.4	14	55	0.2	1.9	16.6	30.2
	tiger rockfish	1	2	2.0	2	2	1.0	1.0	1.0	1.0
	yelloweye rockfish	8	2	2.1	3	17	0.4	4.9	13.0	39.2
thornyheads	longspine thornyhead	166	1	40.1	803	6,657	0.1	4.8	97.2	800.0
	shortspine thornyhead	2,746	0	92.3	4,401	253,593	0.0	24.2	1,056.5	66,336.0
	unident. thornyhead	40	0	407.8	1,666	16,313	0.1	110.8	535.7	4,433.6
skates	sandpaper skate	14	2	2.5	5	35	0.7	1.9	5.2	26.5
		4,724	**0**	**61.8**	**8,838**	**491,666**	**0.0**	**16.7**	**1,620.4**	**133,168.1**

Appendix B, Table 3. Summary statistics for all potentially benthic taxa for hauls with at least 50% of their length inside EFHCAS (weight in kg).

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
invertebrates	anemones	1	3	3.0	3	3	0.1	0.1	0.1	0.1
	crabs	1	0	0.0	0	0	0.0	0.0	0.0	0.0
	sea pen-sea whip	1	2	2.0	2	2	0.9	0.9	0.9	0.9
flatfishes	Dover sole	15	2	15.9	94	238	0.4	7.5	57.0	112.9
	English sole	8	1	3.1	8	25	0.2	1.0	3.0	8.2
	flathead sole	4	3	4.8	7	19	0.4	1.7	3.5	6.7
	rex sole	38	1	31.8	350	1,208	0.1	8.8	79.3	336.1
	slender sole	1	9	9.0	9	9	0.8	0.8	0.8	0.8
lingcod	lingcod	59	1	6.2	40	363	4.3	35.4	267.7	2,087.7
other demersal fishes	eelpouts	2	2	7.0	12	14	0.0	0.1	0.1	0.1
	Pacific flatnose	1	2	2.0	2	2	0.7	0.7	0.7	0.7
	ronquils	1	2	2.0	2	2	1.2	1.2	1.2	1.2
	snailfishes	2	4	8.0	12	16	0.9	5.7	10.5	11.5
rockfishes	bank rockfish	1	1	1.0	1	1	0.5	0.5	0.5	0.5
	blackgill rockfish	1	2	2.0	2	2	1.6	1.6	1.6	1.6
	harlequin rockfish	1	2	2.0	2	2	0.9	0.9	0.9	0.9
thornyheads	longspine thornyhead	4	6	51.5	94	206	1.1	7.0	13.7	28.2
	shortspine thornyhead	34	0	23.3	177	793	0.1	8.4	44.8	284.6
	unident. thornyhead	2	55	211.5	368	423	20.4	55.2	89.9	110.3
		121	**0**	**18.8**	**368**	**3,328**	**0.0**	**16.9**	**267.7**	**2,993.0**

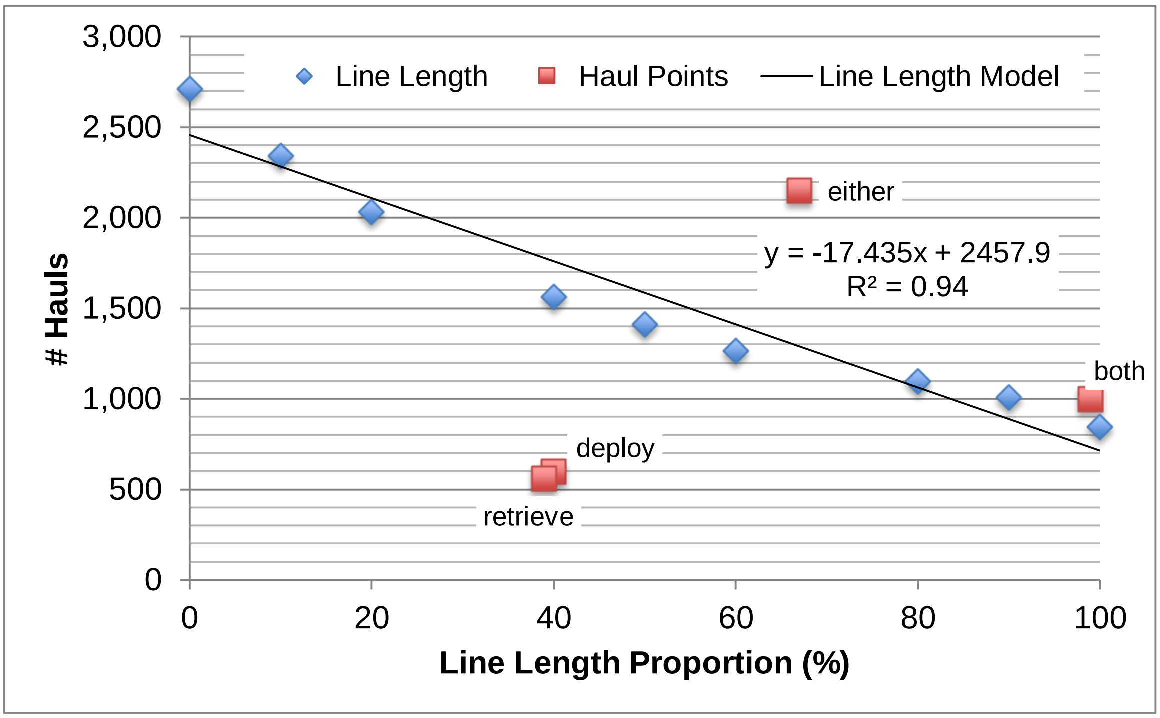
Appendix B, Table 4. Summary statistics for all potentially benthic taxa for hauls with either deploy, retrieve or both points inside EFHCAs (weight in kg).

Taxon Group	Taxon	# Hauls	Min Count	Mean Count	Max Count	Total Count	Min Weight	Mean Weight	Max Weight	Total Weight
invertebrates	anemones	2	2	2.5	3	5	0.1	0.7	1.2	1.3
	crabs	1	0	0.0	0	0	0.0	0.0	0.0	0.0
	sea pen-sea whip	2	2	2.0	2	4	0.9	1.6	2.2	3.1
	sea stars	1	4	4.0	4	4	0.0	0.0	0.0	0.0
flatfishes	Dover sole	50	1	14.7	205	735	0.3	5.9	66.8	293.5
	English sole	14	1	3.6	8	50	0.2	1.3	3.1	18.2
	flathead sole	7	2	4.4	7	31	0.4	1.6	3.5	10.9
	rex sole	125	1	29.4	350	3,677	0.1	6.7	79.3	831.3
	slender sole	7	2	3.6	9	25	0.1	0.3	0.8	1.8
	turbot (greenland)	1	2	2.0	2	2	1.1	1.1	1.1	1.1
lingcod	lingcod	77	1	6.9	79	530	4.3	38.7	420.2	2,977.5
other demersal fishes	eelpouts	8	2	6.8	21	54	0.0	3.8	15.5	30.4
	pacific flatnose	1	2	2.0	2	2	0.7	0.7	0.7	0.7
	Ronquils	1	2	2.0	2	2	1.2	1.2	1.2	1.2
	Snailfishes	13	2	6.8	29	88	0.2	1.6	10.5	21.3
rockfishes	aurora rockfish	5	2	3.4	9	17	0.3	1.2	2.9	5.9
	bank rockfish	10	1	2.2	5	22	0.5	2.6	8.8	26.4
	blackgill rockfish	5	2	3.2	7	16	1.6	6.6	13.8	33.0
	harlequin rockfish	1	2	2.0	2	2	0.9	0.9	0.9	0.9
thornyheads	longspine thornyhead	7	1	30.7	94	215	0.1	4.2	13.7	29.3
	shortspine thornyhead	113	0	33.1	599	3,743	0.0	9.1	147.6	1,026.3
	unident. thornyhead	2	55	211.5	368	423	20.4	55.2	89.9	110.3
skates	sandpaper skate	2	2	2.0	2	4	0.9	1.9	2.8	3.7
		272	**0**	**21.2**	**599**	**9,651**	**0.0**	**11.9**	**420.2**	**5,428.2**

Appendix C.

How do our methods of determining the location of tow lines influence the proportion of possible seafloor contact inside of and outside of EFHCAs?

To ascertain how our methods of determining the location of towlines influence the proportion of possible seafloor contact inside of and outside of EFHCAs, we developed a series of comparisons using different haul start and end point intersections and a range of towline length proportions. The tabular information in the body of the report has been further summarized in Appendix C, Figure 1. Starting with the line length proportion (blue diamonds), as the threshold for meeting the definition for being inside an EFHCA is more constrained (i.e., line length proportion increases), the number of hauls meeting those criteria decreases, as one would expect. The second series (red squares) shows the number of hauls inside EFHCAs based on four different haul point scenarios: deploy, retrieve, either, both. The X value for each of those four scenarios corresponds to the mean towline length proportion for each set of hauls.



Appendix C, Figure 1. Relationship between towline length proportion and number of hauls intersecting EFHCAs (blue diamonds), and number of hauls inside EFHCAS based on four different haul point scenarios (red squares).

Appendix D

Power Point presentation from ad-hoc midwater gear seafloor contact information session held at the Northwest Fisheries Science Center, Seattle, 12-17-2014.

Science, Service, Stewardship

AD-HOC MID-WATER GEAR BOTTOM CONTACT INFORMATION SESSION

Waldo Wakefield, Michelle McClure NWFSC

Collaborators - Curt Whitmire, Vanessa Tuttle, Kayleigh Somer (NWFSC); Mary Yoklavich (SWFSC); Steve Copps, John Stadler (WCR)

NOAA FISHERIES SERVICE

Presented at NOAA NMFS NWFSC , Seattle, 12/17/2014

ANALYSIS OF WHITING DATA WITHIN AND OUTSIDE EFH CONSERVATION AREAS FOR BOTTOM CONTACT

At Sea Whiting Fishery

- Estimated frequency of bottom contact by vessels using midwater trawl gear in the at-sea hake fishery
- Bottom contact is defined as the presence of either **one or more** benthic or demersal fish or invertebrate taxa in the catch.
- Bottom contact is reported as frequency of hauls both coastwide and within existing EFH conservation areas – within means >50% of tow length inside EFH cons. area
- Data sources:

    -- At-Sea Hake Observer Program (at-sea sector; 12 Jun 2006 – 31 Dec 2013)

Invertebrate & Fish Taxa Applied to At Sea Whiting Fishery (listed in order of decreasing abundance by weight)

DUNGENESS CRAB	SHORTSPINE THORNYHEAD	YELLOWEYE ROCKFISH
SNAIL EGGS	REX SOLE	HARLEQUIN ROCKFISH
SEA PEN-SEA WHIP	LINGCOD	SANDPAPER SKATE
CRABS	DOVER SOLE	POACHERS
SEA STARS	STRIPETAIL ROCKFISH	ROSETHORN ROCKFISH
ANEMONES	SHARPCHIN ROCKFISH	QUILLBACK ROCKFISH
SEA CUCUMBERS	UNIDENT. THORNYHEAD	PETRALE SOLE
BARNACLES	GREENSTRIPED ROCKFISH	TURBOT (GREENLAND)
CORALS-BRYOZOANS	LONGSPINE THORNYHEAD	PACIFIC FLATNOSE
BASKETSTAR	BANK ROCKFISH	RONQUILS
LAMP SHELLS	EELPOUTS	WOLF-EEL
SNAILS	ENGLISH SOLE	TIGER ROCKFISH
BRITTLESTARS	SLENDER SOLE	BLACKTAIL SNAILFISH GROUP
SNAIL SHELLS	BLACKGILL ROCKFISH	BLACK EELPOUT
HERMIT CRABS	AURORA ROCKFISH	BUTTER SOLE
SPONGES	SNAILFISHES	SLENDER CODLING
	RED BANDED ROCKFISH	PRICKLEBACKS
	FLATHEAD SOLE	QUILLFISH

Note: There were a total of 199 unique fish and invertebrate taxa enumerated from 20,039 midwater trawl hauls. Of these 199 taxa, 53 taxa were considered benthic (defined as occurring on the seafloor or within 2 meters (6.5') of the seafloor).

Rockfishes and Flatfishes *Excluded* From Benthic Taxa Applied to At Sea Whiting Fishery

Rockfishes excluded from benthic taxa:

- YELLOWTAIL ROCKFISH
- WIDOW ROCKFISH
- ROUGHEYE ROCKFISH
- SPLITNOSE ROCKFISH
- DARK BLOTCHED ROCKFISH
- PACIFIC OCEAN PERCH
- REDSTRIPE ROCKFISH
- SHORTBELLY ROCKFISH
- CHILIPEPPER ROCKFISH
- BOCACCIO ROCKFISH
- SHORTRAKER ROCKFISH
- SHORTRAKER/ROUGHEYE ROCKFISH
- SILVERGRAY ROCKFISH
- YELLOWMOUTH ROCKFISH
- DUSKY ROCKFISH
- VERMILION ROCKFISH
- BLACK ROCKFISH
- BLUE ROCKFISH

Flatfishes excluded from benthic taxa:

- ARROWTOOTH FLOUNDER
- PACIFIC HALIBUT
- CALIFORNIA HALIBUT
- PACIFIC SANDDAB

AT SEA WHITING FISHERY -- INVERTS

Taxon Group	Taxon	# of Hauls
	SEA PEN-SEA WHIP	37
	DUNGENESS CRAB	30
	STARFISHES	21
	SEA ANEMONE	15
	BASKETSTARS	4
	CORALS-BRYOZOANS	4
	SEA CUCUMBERS	4
	SNAIL EGGS	4
	BRITTLESTARS	2
	CRABS	2
	SNAIL SHELLS	2
	BARNACLES	1
	HERMIT CRABS	1
	LAMP SHELLS	1
	SNAILS	1
	SPONGES	1

AT SEA WHITING FISHERY -- FISH

Taxon Group	Taxon	# of Hauls	Max # Per Haul
	REX SOLE	1,973	8838
	DOVER SOLE	732	735
	ENGLISH SOLE	93	75
	SLENDER SOLE	69	149
	FLATHEAD SOLE	19	56
	PETRALE SOLE	3	11
	TURBOT (GREENLAND)	2	22
	BUTTER SOLE	1	3
	LINGCOD	879	82
	EELPOUT UNIDENTIFIED	393	188
	SNAILFISH UNIDENTIFIED	165	43
	PACIFIC FLATNOSE	6	4
	RONQUIL UNIDENTIFIED	6	12
	PRICKLEBACK UNIDENTIFIED	5	7
	POACHER UNIDENTIFIED	4	31
	QUILLFISH	4	6
	BLACK EELPOUT	1	2
	BLACKTAIL SNAILFISH GROUP	1	2
	SLENDER CODLING	1	2
	WOLF-EEL	1	1
	BANK ROCKFISH	67	116
	AURORA ROCKFISH	65	56
	SHARPCHIN ROCKFISH	62	3588
	BLACKGILL ROCKFISH	31	10
	RED BANDED ROCKFISH	18	5
	STRIPETAIL ROCKFISH	15	14
	GREENSTRIPED ROCKFISH	14	4
	HARLEQUIN ROCKFISH	9	2
	YELLOWEYE ROCKFISH	8	3
	ROSETHORN ROCKFISH	6	19
	QUILLBACK ROCKFISH	5	6
	TIGER ROCKFISH	1	2
	SHORTSPINE THORNYHEAD	2,521	4410
	LONGSPINE THORNYHEAD	172	803
	THORNYHEAD UNIDENT	22	1666
	SANDPAPER SKATE	12	5

AT SEA WHITING FISHERY

	Inside		Outside		Inside + Outside	
Hauls (total)	949	4.7%	19,090	95.3%	20,039	100.0%
Hauls with >=1 benthic taxa	115	12.1%	4,353	22.8%	4,468	22.3%
Hauls with >=2 benthic taxa	31	3.3%	1,808	9.5%	1,839	9.2%
Hauls with 1 benthic taxa	84	8.8%	2,545	13.3%	2,629	13.1%

AT SEA WHITING FISHERY

(Effect of decision rule for determining inside and outside of EFH Cons. Areas)

Proportion of tow inside Cons. Areas = 0.1	Inside		Outside		Inside+Outside	
Hauls	1,653	8.2%	18,386	91.8%	20,039	100.0%
Hauls with >=1 benthic taxa	284	17.2%	4,184	22.8%	4,468	22.3%
Hauls with >1 benthic taxa	112	6.8%	1,727	9.4%	1,839	9.2%
Hauls with 1 benthic taxa	172	10.4%	2,457	13.4%	2,629	13.1%

Proportion of tow inside Cons. Areas = 0.5	Inside		Outside		Inside+Outside	
Hauls	949	4.7%	19,090	95.3%	20,039	100.0%
Hauls with >=1 benthic taxa	115	12.1%	4,353	22.8%	4,468	22.3%
Hauls with >1 benthic taxa	31	3.3%	1,808	9.5%	1,839	9.2%
Hauls with 1 benthic taxa	84	8.9%	2,545	13.3%	2,629	13.1%

Proportion of tow inside Cons. Areas = 0.9	Inside		Outside		Inside+Outside	
Hauls	624	3.1%	19,415	96.9%	20,039	100.0%
Hauls with >=1 benthic taxa	66	10.6%	4,402	22.7%	4,468	22.3%
Hauls with >1 benthic taxa	12	1.9%	1,827	9.4%	1,839	9.2%
Hauls with 1 benthic taxa	54	8.7%	2,575	13.3%	2,629	13.1%

AT SEA WHITING FISHERY

	# Hauls	
Hauls with 1 benthic invert taxa	123	0.6%
Hauls with > = 1 benthic invert taxa	130	0.6%
Hauls with 1 fish taxa	4427	22.1%
Hauls with > = 1 fish taxa	7386	36.9%
Total # of hauls inside and outside of the Cons. Areas	20,039	

At Sea Whiting

	Inside EFHCA		Outside EFHCA	
# Benthic Taxa	# Hauls		# Hauls	
1	84	8.9%	2,545	13.3%
2	17	1.8%	1,049	5.5%
3	10	1.1%	480	2.5%
4	1	0.1%	188	1.0%
5	3	0.3%	61	0.3%
6	0	0.0%	22	0.1%
7	0	0.0%	6	0.0%
8	0	0.0%	2	0.0%
Total # of Hauls	**949**		**19,090**	
>=1 Benthic taxa	115	12.1%	4,353	22.8%
>1 Benthic Taxa	31	3.3%	1,808	9.5%
1 Benthic taxa	84	8.8%	2,545	13.3%

ANALYSIS OF WHITING DATA FOR BOTTOM CONTACT

Shore-Side Whiting Fishery

- Summary of estimated frequency of bottom contact by vessels using midwater trawl gear
- Bottom contact is defined as the presence of either **one or more** benthic or demersal fish or invertebrate taxa in the catch
- Bottom contact is reported as frequency of **trips** coastwide
- Data sources:

  --Data sources: IFQ shore-side hake fish ticket matched 2011 - 2013 observer data.

SHORE-SIDE WHITING FISHERY
4,989 hauls from 2,574 trips

	Inside + Outside	
Trips (total)	2,574	
Trips with >=1 benthic taxa	1,808	70.2%
Trips with >=2 benthic taxa	955	37.1%
Trips with 1 benthic taxa	853	33.1%

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Shore-Side Whiting

	Coastwide	
# Benthic Taxa	# Trips	% Total
1	853	33.1%
2	351	13.6%
3	197	7.7%
4	193	7.5%
5	143	5.6%
6	43	1.7%
7	19	0.7%
8	7	0.3%
9	2	0.1%
Total # of trips	**2,574**	
>= 1 Benthic taxa	1,808	70.2%
>1 Benthic taxa	955	37.1%
1 Benthic taxa	853	33.1%