

## Calculations of Indices of Abundance from the Alaska Fishery Science Center's Longline Survey

This document describes how indices of abundance are computed for groundfish caught on the Alaska Fishery Science Center's (AFSC) longline survey. For complete information on the survey and available data contact Cara Rodgveller ([cara.rodgveller@noaa.gov](mailto:cara.rodgveller@noaa.gov), 907-789-6052) for a document titled Database\_Background\_Instructions.doc.

**Survey History and Vessels** – Catch, length, and abundance indices are available from annual longline surveys conducted cooperatively by Japan (1979-1994) and the U.S. National Marine Fisheries Service, AFSC (1988-present). The U.S. started conducting the survey in 1988, creating overlap between the two countries between 1988-1994. Since 1994, the U.S. has conducted the survey independently. For standardization purposes, it is best to use Japanese survey data from 1979-1994 and U.S. survey data from 1990-present, although all data is available.

**Stations and Sampling** – Stations are spaced systematically (~20-30 km apart) along the slope from the eastern Gulf of Alaska west to the Aleutian Islands and north into the eastern Bering Sea. At each station, depths from ~150-1000 meters are sampled. The same stations are sampled each year except in the eastern Aleutian Islands and the eastern Bering Sea, which are sampled every other year at the beginning of the survey (last week of May-early June). Beginning in 1996 the eastern Aleutian Islands were sampled in even years and the Bering Sea in odd years. After the Aleutian Islands or the Bering Sea is sampled, the western Gulf of Alaska is sampled eastward towards Kodiak. The vessel then transits to Ketchikan and samples the eastern and central Gulf heading back west, finishing the survey in late August in Dutch Harbor.

At each station 160 skates are set (1 skate = 45 hooks spaced 2 meters for a total of 7,200 hooks). The exceptions are gullies and Bering Sea stations. At the gully stations (120-149), there is little variation in depth and so stations consist of 80 skates instead of 160. Within each gully two stations are fished in relatively close proximity. In the Bering Sea, from 1979-1994 stations had from 160-180 skates set, and from 1997-present stations have 180 skates instead of the typical 160.

**CPUE, RPN, and RPW's** – Because we do not know the area of attraction for longline gear, an absolute biomass calculation is not possible. However, from catch rates and fish lengths, unitless, relative indices of abundance can be calculated (relative population number, RPN; relative population weight, RPW). These indices are essentially area weighted measures of numbers and weights of fish and can be tracked through time to follow trends in abundance.

**CPUE** – A catch rate per skate (CPUE) is calculated by dividing the number of fish caught on a skate by the number of effective hooks. Ineffective hooks are not fishing effectively because they are bent, broken, tangled, or missing. Unbaited hooks (hooks that are missing bait when the gear is retrieved) are counted as effective. Skates are not included in the CPUE calculations if they had greater than 5 ineffective hooks. Skates are also currently excluded from index calculations if there was obvious killer whale depredation on the skate. Killer whale depredation has only

been recorded since 1996. For Japanese data some skates may be missing, but the reason is not documented. An average catch rate is calculated for each species for each depth stratum (Table 1) for each station. The overall CPUE for each stratum within each geographic area (Table 2) is calculated by taking an average of the CPUE from all stations at that stratum.

*RPN* – The CPUE is multiplied by the area size of the stratum within each geographic area to calculate an RPN. Currently area sizes are only available for strata 3-7 (200-1000 m) and only for some gullies. Only non-gully stations are used to calculate geographic area RPN and RPW's (with the exception of gully stations 142-145, 148, and 149). See Table 2 for a list of which geographic area and management area stations are in and whether the station is used for RPN and RPW calculations.

*RPW* – Lengths from some species (shortraker and roughey rockfish, giant grenadier, Pacific grenadier, shortspine thornyhead, spiny dogfish (2010-present), Pacific cod, sablefish, arrowtooth flounder, Greenland turbot, yelloweye rockfish, and dusky rockfish) are taken at each depth strata at each station they are caught. For giant grenadier, Pacific grenadier, arrowtooth flounder, and spiny dogfish, 50 fish from each depth stratum are randomly sampled. Sablefish, giant grenadier (2006-present), Pacific grenadier (2010-present) Pacific cod, and spiny dogfish (2010-present) are currently sexed. For these species, for the years when lengths were taken, weights are estimated from length-weight relationships obtained from previous studies. Average weight is multiplied by RPN to obtain an RPW for each depth stratum and geographic area. See Table 2 for a list of which geographic area and management area each station is in and whether the station is used for RPN and RPW calculations currently.

*Exceptions* – Because the domestic survey only samples the eastern Aleutian Islands, extrapolations for the western Aleutian Islands (WAI) for this survey are done from ratios of sablefish catch rates between eastern and western AI from previous Japanese surveys. Extrapolations to WAI are not needed for Japanese data since the area was sampled in the Japanese survey. The extrapolation for the northwest AI is 18% of the RPN in the northeast AI and the southwest is 66% of the southeast AI. These extrapolations are included in the values for the Aleutian Islands management area RPN's and RPW's for sablefish only. For other species, the same ratios can be calculated from Japanese catch rates from 1985-1994 in the AI. In the spreadsheet of survey results sent out annually to stock assessment authors (Area20##.xls, where 20## is the current year), the sablefish ratio is used to extrapolate total AI RPN and RPW for all species.

For gully stations 142 and 143, stratum 6 is extrapolated from CPUE from stations in the same management area in stratum 6. For stations 144 and 145, stratum 5 is extrapolated using the same method. Gullies are not included in area-wide RPN, CPUE, and RPW calculations except for stations 142-144 (Spencer Gully and Ommaney Trench) and 148-149 (Dixon Entrance) (Table 2).

Shortraker and roughey rockfish are currently identified to species when lengths are taken but not when catch is initially tallied at the vessel's rail. For U.S. cruises, catch is extrapolated by strata from species proportions from taking lengths. Catch broken out by species is not available for Japanese cruises for shortraker and roughey rockfish. Other rockfish, skates, and sculpin

species were grouped in some years and differentiated to the species level in other years. See “Database\_background\_instructions.doc” file for details on species code changes and other survey details. It is important to read this document before using longline survey data.

Since the Bering Sea and Aleutian Islands have only been sampled every other year since 1996, Aleutians in even years and Bering Sea in odd, an extrapolation is done to fill in data for the missing years. This is done by multiplying the ratio of the current year and the previous year’s RPNs (or RPW or CPUE) in the Gulf of Alaska (GOA) by the previous year RPN for the area with missing data. For example, in 2008 the Aleutian Islands were sampled. To extrapolate RPNs for 2008 in the Bering Sea we use the following calculation:

$$2008 \text{ Bering Sea RPN} = 2010 \text{ GOA RPN} / 2009 \text{ GOA} * 2007 \text{ Bering Sea RPN}$$

GOA = all areas in the Gulf added together

*Summarizing RPN’s, RPW’s, and CPUE* – RPNs and RPWs are additive and can be simply added together to obtain a total value for all strata within a geographic area or for all geographic areas within a North Pacific Fishery Management Council sablefish management area, etc. See table 2 for a list of which stations are in each area. CPUE is a rate and cannot be added to get a total. Instead CPUEs by stratum and geographic area must be averaged to get an area-wide CPUE. When obtaining an average it is important to consider weighting the catch rate by the area size.

Table 1. Depth strata used on the survey for summarizing catch rates and for RPN and RPW calculations.

Depth Stratum	Description
0	No definition
1	0-100 meters
2	101-200 meters
3	201-300 meters
4	301-400 meters
5	401-600 meters
6	601-800 meters
7	801-1000 meters
8	1001-1200 meters
9	1201 + meters

Table 2. The geographic area and North Pacific Fishery Management Council area (NPFMC) for each station, standard station locations in decimal degrees, whether the station is used in RPN calculations (RPN Flag), and whether the station is currently sampled annually (Active Flag).

Station	Geographic area	NPFMC area	Latitude	Longitude	RPN Flag	Active Flag
1	Bering 4 slope	Bering Sea	58.778	-177.575	YES	YES
2	Bering 4 slope	Bering Sea	58.620	-176.642	YES	YES
3	Bering 4 slope	Bering Sea	58.600	-176.010	YES	NO
4	Bering 4 slope	Bering Sea	58.497	-175.670	YES	YES
5	Bering 4 slope	Bering Sea	58.550	-174.500	YES	NO
6	Bering 4 slope	Bering Sea	58.600	-174.312	YES	YES
7	Bering 3 slope	Bering Sea	58.100	-173.800	YES	NO
8	Bering 3 slope	Bering Sea	57.628	-174.165	YES	YES
9	Bering 3 slope	Bering Sea	57.080	-173.400	YES	NO
10	Bering 3 slope	Bering Sea	56.828	-173.378	YES	YES
11	Bering 3 slope	Bering Sea	56.650	-172.100	YES	NO
12	Bering 3 slope	Bering Sea	56.627	-172.353	YES	YES
13	Bering 3 slope	Bering Sea	56.467	-171.452	YES	YES
14	Bering 3 slope	Bering Sea	56.300	-171.300	YES	NO
15	Bering 3 slope	Bering Sea	56.147	-170.732	YES	YES
16	Bering 2 slope	Bering Sea	56.100	-169.800	YES	NO
17	Bering 2 slope	Bering Sea	56.038	-169.618	YES	YES
18	Bering 2 slope	Bering Sea	56.243	-169.172	YES	YES
19	Bering 2 slope	Bering Sea	56.030	-168.500	YES	NO
20	Bering 2 slope	Bering Sea	55.808	-168.802	YES	YES
21	Bering 2 slope	Bering Sea	55.500	-168.200	YES	NO
22	Bering 2 slope	Bering Sea	55.458	-168.998	YES	YES
23	Bering 2 slope	Bering Sea	55.020	-167.010	YES	NO
24	Bering 2 slope	Bering Sea	55.080	-167.150	YES	NO
25	Bering 2 slope	Bering Sea	54.500	-167.300	YES	NO
26	Bering 2 slope	Bering Sea	54.500	-167.100	YES	NO
27	Bering 2 slope	Bering Sea	54.600	-166.400	YES	NO
28	Bering 2 slope	Bering Sea	54.700	-166.400	YES	NO
29	Bering 2 slope	Bering Sea	54.900	-166.040	YES	NO
30	Bering 1 slope	Bering Sea	54.400	-165.600	YES	NO
31	Bering 1 slope	Bering Sea	54.100	-166.400	YES	NO
32	Bering 1 slope	Bering Sea	53.772	-167.335	YES	YES
33	Bering 1 slope	Bering Sea	53.615	-168.312	YES	YES
34	Bering 1 slope	Bering Sea	53.362	-168.962	YES	YES
35	NE Aleutians slope	Aleutians	53.030	-170.103	YES	YES
36	NE Aleutians slope	Aleutians	52.800	-171.200	YES	NO
37	NE Aleutians slope	Aleutians	52.280	-173.497	YES	YES
38	NE Aleutians slope	Aleutians	52.252	-174.843	YES	YES
39	NE Aleutians slope	Aleutians	52.147	-175.602	YES	YES

Station	Geographic area	NPFMC area	Latitude	Longitude	RPN Flag	Active Flag
40	NE Aleutians slope	Aleutians	51.970	-176.450	YES	YES
41	NE Aleutians slope	Aleutians	51.900	-177.500	YES	NO
42	NE Aleutians slope	Aleutians	51.773	-178.963	YES	YES
43	NW Aleutians slope	Aleutians	52.050	178.300	YES	NO
44	NW Aleutians slope	Aleutians	52.250	176.100	YES	NO
45	NW Aleutians slope	Aleutians	52.700	174.400	YES	NO
46	NW Aleutians slope	Aleutians	53.080	172.900	YES	NO
47	SW Aleutians slope	Aleutians	52.500	173.050	YES	NO
48	SW Aleutians slope	Aleutians	52.300	174.300	YES	NO
49	SW Aleutians slope	Aleutians	52.000	175.800	YES	NO
50	SW Aleutians slope	Aleutians	51.700	177.100	YES	NO
51	SW Aleutians slope	Aleutians	51.700	178.100	YES	NO
52	SW Aleutians slope	Aleutians	51.311	179.000	YES	NO
53	SE Aleutians slope	Aleutians	51.403	-178.618	YES	YES
54	SE Aleutians slope	Aleutians	51.763	-178.165	YES	YES
55	SE Aleutians slope	Aleutians	51.592	-177.617	YES	YES
56	SE Aleutians slope	Aleutians	51.600	-176.700	YES	NO
57	SE Aleutians slope	Aleutians	51.733	-175.993	YES	YES
58	SE Aleutians slope	Aleutians	51.767	-175.142	YES	YES
59	SE Aleutians slope	Aleutians	51.882	-174.338	YES	YES
60	SE Aleutians slope	Aleutians	51.920	-173.502	YES	YES
61	SE Aleutians slope	Aleutians	52.442	-170.310	YES	YES
62	Shumagin Slope	Western Gulf of Alaska	52.663	-168.988	YES	YES
63	Shumagin Slope	Western Gulf of Alaska	52.965	-168.135	YES	YES
64	Shumagin Slope	Western Gulf of Alaska	53.192	-166.855	YES	YES
65	Shumagin Slope	Western Gulf of Alaska	53.583	-165.685	YES	YES
66	Shumagin Slope	Western Gulf of Alaska	53.737	-164.468	YES	YES
67	Shumagin Slope	Western Gulf of Alaska	53.970	-163.263	YES	YES
68	Shumagin Slope	Western Gulf of Alaska	54.133	-161.637	YES	YES
69	Shumagin Slope	Western Gulf of Alaska	54.315	-161.060	YES	YES
70	Shumagin Slope	Western Gulf of Alaska	54.365	-160.235	YES	YES
71	Shumagin Slope	Western Gulf of Alaska	54.510	-159.255	YES	YES
72	Chirikof slope	Central Gulf of Alaska	54.633	-158.580	YES	YES
73	Chirikof slope	Central Gulf of Alaska	54.852	-157.737	YES	YES
74	Chirikof slope	Central Gulf of Alaska	55.240	-156.673	YES	YES
75	Chirikof slope	Central Gulf of Alaska	55.642	-155.848	YES	YES
76	Chirikof slope	Central Gulf of Alaska	55.767	-155.138	YES	YES
77	Chirikof slope	Central Gulf of Alaska	56.042	-154.567	YES	YES
78	Chirikof slope	Central Gulf of Alaska	55.973	-154.022	YES	YES
79	Kodiak slope	Central Gulf of Alaska	56.303	-153.077	YES	YES
80	Kodiak slope	Central Gulf of Alaska	56.485	-152.213	YES	YES
81	Kodiak slope	Central Gulf of Alaska	57.118	-151.222	YES	YES

Station	Geographic area	NPFMC area	Latitude	Longitude	RPN Flag	Active Flag
82	Kodiak slope	Central Gulf of Alaska	57.402	-150.573	YES	YES
83	Kodiak slope	Central Gulf of Alaska	57.632	-149.917	YES	YES
84	Kodiak slope	Central Gulf of Alaska	57.972	-149.167	YES	YES
85	Kodiak slope	Central Gulf of Alaska	58.293	-148.617	YES	YES
86	Kodiak slope	Central Gulf of Alaska	58.688	-148.340	YES	YES
87	Amatuli Gully	Central Gulf of Alaska	59.127	-148.650	NO	YES
88	Kodiak slope	Central Gulf of Alaska	59.155	-147.603	YES	YES
89	W Yakutat slope	Eastern Gulf of Alaska	59.263	-146.852	YES	YES
90	W Yakutat slope	Eastern Gulf of Alaska	59.500	-145.525	YES	YES
91	W Yakutat slope	Eastern Gulf of Alaska	59.522	-144.712	YES	YES
92	W Yakutat slope	Eastern Gulf of Alaska	59.555	-143.652	YES	YES
93	W Yakutat slope	Eastern Gulf of Alaska	59.550	-142.563	YES	YES
94	W Yakutat slope	Eastern Gulf of Alaska	59.388	-142.163	YES	YES
95	W Yakutat slope	Eastern Gulf of Alaska	59.050	-141.343	YES	YES
96	W Yakutat slope	Eastern Gulf of Alaska	58.685	-140.640	YES	YES
97	East Yakutat slope	Eastern Gulf of Alaska	58.468	-139.467	YES	YES
98	East Yakutat slope	Eastern Gulf of Alaska	58.140	-138.730	YES	YES
99	East Yakutat slope	Eastern Gulf of Alaska	57.878	-137.378	YES	YES
100	Southeast slope	Eastern Gulf of Alaska	57.618	-136.537	YES	YES
101	Southeast slope	Eastern Gulf of Alaska	57.188	-136.235	YES	YES
102	Southeast slope	Eastern Gulf of Alaska	56.852	-135.997	YES	YES
103	Southeast Shelf	Eastern Gulf of Alaska	56.383	-135.348	NO	YES
104	Southeast slope	Eastern Gulf of Alaska	55.983	-135.437	YES	YES
105	Southeast slope	Eastern Gulf of Alaska	55.558	-134.967	YES	YES
106	Southeast slope	Eastern Gulf of Alaska	55.347	-134.735	YES	YES
107	Southeast slope	Eastern Gulf of Alaska	54.900	-134.287	YES	YES
108	Southeast slope	Eastern Gulf of Alaska	54.450	-133.930	YES	YES
109	Bering 5 slope	Bering Sea	60.900	-178.500	NO	NO
110	Bering 5 slope	Bering Sea	60.100	-178.800	NO	NO
111	Bering 5 slope	Bering Sea	60.400	-178.300	NO	NO
112	Bering 5 slope	Bering Sea	60.460	-178.300	NO	NO
113	Bering 5 slope	Bering Sea	59.800	-178.500	NO	NO
114	Bering 5 slope	Bering Sea	59.600	-177.200	NO	NO
115	Bering 5 slope	Bering Sea	59.600	-178.200	NO	NO
116	Bering 5 slope	Bering Sea	59.400	-177.300	NO	NO
117	Bering 5 slope	Bering Sea	59.200	-178.100	NO	NO
118	Shumagin Gully	Western Gulf of Alaska	55.050	-158.200	NO	NO
119	Shumagin Gully	Western Gulf of Alaska	55.100	-158.500	NO	NO
120	Shelikof Trough	Central Gulf of Alaska	55.788	-156.077	NO	YES
121	Shelikof Trough	Central Gulf of Alaska	55.750	-156.202	NO	YES
122	Shelikof Trough	Central Gulf of Alaska	56.187	-155.963	NO	YES
123	Shelikof Trough	Central Gulf of Alaska	56.232	-156.130	NO	YES

Station	Geographic area	NPFMC area	Latitude	Longitude	RPN Flag	Active Flag
124	Shelikof Trough	Central Gulf of Alaska	56.988	-155.063	NO	YES
125	Shelikof Trough	Central Gulf of Alaska	57.002	-155.303	NO	YES
126	Shelikof Trough	Central Gulf of Alaska	57.347	-155.040	NO	YES
127	Shelikof Trough	Central Gulf of Alaska	57.348	-155.245	NO	YES
128	Amatuli Gully	Central Gulf of Alaska	58.000	-149.842	NO	YES
129	Amatuli Gully	Central Gulf of Alaska	58.083	-149.908	NO	YES
130	Amatuli Gully	Central Gulf of Alaska	58.727	-149.197	NO	YES
131	Amatuli Gully	Central Gulf of Alaska	58.802	-149.048	NO	YES
132	Amatuli Gully	Central Gulf of Alaska	59.083	-149.400	NO	YES
133	Amatuli Gully	Central Gulf of Alaska	58.950	-149.508	NO	YES
134	Amatuli Gully	Central Gulf of Alaska	59.617	-146.967	NO	YES
135	Amatuli Gully	Central Gulf of Alaska	59.515	-147.153	NO	YES
136	W-Grounds	Eastern Gulf of Alaska	59.747	-143.587	NO	YES
137	W-Grounds	Eastern Gulf of Alaska	59.673	-143.382	NO	YES
138	Yakutat Valley	Eastern Gulf of Alaska	59.417	-140.937	NO	YES
139	Yakutat Valley	Eastern Gulf of Alaska	59.413	-141.168	NO	YES
140	Alsek Strath	Eastern Gulf of Alaska	58.600	-139.080	NO	NO
141	Alsek Strath	Eastern Gulf of Alaska	58.600	-139.300	NO	NO
142	Spencer Gully	Eastern Gulf of Alaska	57.915	-137.010	YES	YES
143	Spencer Gully	Eastern Gulf of Alaska	57.967	-137.077	YES	YES
144	Ommaney Trench	Eastern Gulf of Alaska	55.930	-134.902	YES	YES
145	Ommaney Trench	Eastern Gulf of Alaska	56.033	-134.927	YES	YES
146	Iphigenia Gully	Eastern Gulf of Alaska	55.540	-134.400	NO	NO
147	Iphigenia Gully	Eastern Gulf of Alaska	55.520	-134.660	NO	NO
148	Dixon Entrance	Eastern Gulf of Alaska	132.838	-133.838	YES	YES
149	Dixon Entrance	Eastern Gulf of Alaska	132.838	-133.838	YES	YES