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The 2020 Longline Survey of the Gulf of Alaska and Eastern Aleutian Islands on the FV *Alaskan Leader*: Cruise Report AL-20-01

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The 2020 Longline Survey of the Gulf of Alaska and Eastern Aleutian Islands on the FV *Alaskan Leader*: Cruise Report AL-20-01

K. Siwicke, P. Malecha, and C. Rodgveller

Auke Bay Laboratories

Alaska Fisheries Science Center

NOAA, National Marine Fisheries Service

17109 Point Lena Loop Road

Juneau, AK 99801

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ABSTRACT

The Alaska Fisheries Science Center has annually conducted a bottom longline survey in Alaska since 1988. The survey samples demersal waters of the upper continental slope and is primarily designed to assess the sablefish (*Anoplopoma fimbria*) stock, although several other groundfish species are caught and enumerated. In 2020, the 43rd annual longline survey sampled stations in the eastern Aleutian Islands region and the Gulf of Alaska. The primary objectives of the survey were to determine 1) the relative abundance of groundfish species through a standardized longline survey, 2) the age composition of sablefish through otolith collection, and 3) the movement patterns of selected groundfish species through a tag and release program.

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INTRODUCTION

On 31 August 2020, the Alaska Fisheries Science Center (AFSC) completed the 43rd annual longline survey of Alaska sablefish (*Anoplopoma fimbria*) and other groundfish resources of the upper continental slope (Fig. 1). This survey was designed to continue the time series (1978–1994) of the Gulf of Alaska portion of the Japan-U.S. cooperative longline survey that was discontinued after 1994 (Kimura and Zenger 1997). The National Marine Fisheries Service (NMFS) has surveyed the Gulf of Alaska annually since 1987; since 1996, the eastern and central Aleutian Islands have been surveyed in even years and the eastern Bering Sea has been surveyed in odd years (Rutecki et al. 2016). The Gulf of Alaska and the eastern Aleutian Islands region were sampled in 2020. The purpose of this report is to summarize raw survey data and detail survey operations. Data generated from the longline survey will be used for calculating relative population numbers and weights. This information is available by management area and station at: https://apps-afsc.fisheries.noaa.gov/maps/longline/Map.php. Ultimately, the data will be used for assessing stock status of Alaska groundfish. Stock Assessment and Fishery Evaluation (SAFE) Reports can be found at: https://www.npfmc.org/safe-stock-assessment-and-fishery-evaluation-reports.

METHODS

Survey Objectives

1. Collect relative abundance and size composition data of the most commercially important groundfish species: sablefish, shortspine thornyhead (*Sebastolobus alascanus*), Greenland turbot (*Reinhardtius hippoglossoides*), Pacific cod (*Gadus macrocephalus*), rougheye rockfish (*Sebastes aleutianus*), blackspotted rockfish (*S. melanostictus*), and shortraker rockfish (*S. borealis*).

2. Collect relative abundance and size composition data of other groundfish species caught during the survey including arrowtooth flounder (*Atheresthes stomias*), Kamchatka flounder (*A. evermanni*), grenadiers (Macrouridae), skates (Rajidae), and spiny dogfish (*Squalus acanthias*).
3. Collect sablefish otoliths to study the age composition of the population.
4. Tag and release sablefish, shortspine thornyhead, and Greenland turbot throughout the cruise to determine migration patterns.
5. Conduct special projects related to groundfish biology, stock assessment, and marine mammal interactions.

Vessel and Gear

Survey operations in 2020 were conducted using the FV *Alaskan Leader*, a chartered U.S. freezer longline vessel. The 46-m (150 ft) long vessel carried standard longline hauling gear and was equipped with radios, radars, GPS receivers, a processing line, plate freezers, and refrigerated holds. Vessel personnel consisted of a captain, mate, two engineers, cook, one contract chief scientist, two contract biologists, six fishermen, and five processors.

Gear configuration was standardized and has been consistent for all survey years since 1988 (Sigler and Zenger 1989). Each longline set consisted of a flag and buoy array at each end followed sequentially by varying lengths by depth of 9.5-mm diameter nylon buoy line, a 92-m (50 fm) section of 9.5-mm polypropylene floating line, a 16-kg (35 lb) piece of chain (to dampen the effect of wave surge on the buoy line), 92 m (50 fm) of 9.5-mm nylon line, a 27-kg (60 lb) halibut anchor, and 366 m (200 fm) of 9.5-mm nylon running line. Units of gear (skates) were 100 m (55 fm) long and contained 45 size 13/0 Mustad circle hooks. Hooks were attached to 38-cm (15 in) gangions that were secured to beckets tied into the groundline at 2-m (6.5 ft) intervals. Five meters (16 ft) of groundline were left bare at each skate end. Gangions were constructed of medium lay #60 thread nylon, becket material was medium lay #72 thread nylon, and groundline was medium lay 9.5-mm (3/8 in) diameter nylon. The groundline was weighted with 3.2-kg (7 lb) lead balls between each skate. Hooks were hand baited with chopped squid (*Illex* sp.) at a rate of about 5.7 kg (12.5 lb) per 100 hooks. Squid eyes and tentacles were not used for bait.

Operations

The 2020 charter began on 26 May in Kodiak, Alaska, and ended on 31 August in Dutch Harbor, Alaska. The charter period was divided into six legs, all staffed by contracted chief scientist Jason Wright (Saltwater, Inc.) and contracted biologists Daisy Perez and Sara Bunker (Alaskan Observers, Inc.). Normally, the chief scientist role is staffed by a full-time NMFS employee and rotated by legs. However, due to the outbreak of COVID-19 in the spring of 2020, this position was contracted out for the duration of the survey to minimize potential exposure of the vessel to the virus. NMFS staff were in regular communications with the vessel and scientific party throughout the survey. The initiation of survey sampling was delayed by several days due to repairs on the vessel communications system, one day was lost to mechanical issues, and one day of sampling was canceled due to weather.

The stations sampled during each leg were as follows: Leg 1 (26 May – 16 June), along the upper continental slope of the eastern Aleutian Islands region; Leg 2 (17 June – 4 July), from the western end of Umnak Island and extending eastward to Sand Point; Leg 3 (5 – 20 July), off Dixon Entrance near the U.S.-Canada boundary toward Yakutat; Leg 4 (21 July – 4 August), between Yakutat and Cordova including a 3-day experiment (see Appendix); Leg 5 (5 – 17 August), from Cordova to Kodiak; and Leg 6 (18 – 31 August), from Kodiak to Sand Point (Fig. 1). In 2020, stations 73 and 74 were moved from Leg 2 to Leg 6 because of delays in the start of the survey and coordination of offloads, and stations 122 and 123, each a single set of 90 skates, were not sampled because of a weather delay at the end of the survey.

The longline survey has gone through changes throughout its history, and a brief history from Rutecki et al. (2016) follows. From 1988 to 1990 the survey period was from 26 June to 12 September. The survey periods in 1991 through 1994 were about 18 days later than in 1988 through 1990. The 1991–1994 surveys were delayed to avoid the commercial trawl fishery that started 45 days later than in 1988 through 1990. Starting in 1995, the survey period was moved back to near the 1988–1990 time periods because of the extensive increase in length of the fishing season resulting from the implementation of

the Individual Fishing Quota (IFQ) system in the sablefish and Pacific halibut (*Hippoglossus stenolepis*) longline fisheries. Beginning in 1998 the order in which the stations were sampled was changed to avoid conflicting with an early July rockfish fishery in the central Gulf of Alaska. Instead of continuing to sample in an easterly direction from Sand Point to Dixon Entrance, the survey vessel transited to Dixon Entrance at the end of Leg 2 during early July and resumed sampling in a westerly direction going from Dixon Entrance to Sand Point. Sampling order has been the same since 1998. From 2009 to present, the survey starting and ending dates were several days earlier than previous years. This was done to accommodate the vessel's schedule and desire to finish the survey prior to the fall Pacific cod fishing start date.

The gear was set from shallow to deep and was retrieved in the same order, except on occasions when the groundline parted or sea conditions dictated that it be pulled from the opposite direction. Setting began at about 0630 hours Alaska Daylight Time. Retrieval began at about 0930 hours and was completed by about 1730 hours. At each station along the upper continental slope, two baited groundlines were laid end-to-end; the total groundline set each day was 18 km (9.7 nautical miles [nmi]) long and contained 180 skates and 8,100 hooks (note that in past years, 160 skates [7,200 hooks] were fished in a typical day). A single groundline of 90 skates was set at each station in the gullies, except Amatuli Gully (station 87) where 180 skates were set. Specific information regarding longline survey protocols and additional details about the survey gear can be found at: https://archive.afsc.noaa.gov/ABL/MESA/pdf/LSprotocols.pdf.

Data Collection

Catch data were recorded on hand-held ruggedized computers. During gear retrieval a biologist stationed above the vessel's rail recorded the species of each hooked fish and the condition of each unoccupied hook (baited or ineffective [i.e., absent, straightened, broken, or tangled]). Time of day was recorded as each hook was tabulated, and depth was entered at the beginning of the first, last, and every fifth skate, in addition to when crossing into a new depth stratum (0–100 m, 101–200 m, 201–300 m, 301–400 m, 401–600 m, 601–800 m, 801–1,000 m, and 1,001–1,200 m).

Length data were collected with a custom-built barcode-configured measuring board and barcode readers connected to ruggedized computers running customized software. Length was recorded by depth stratum for sablefish, Pacific cod, grenadiers, arrowtooth flounder, Kamchatka flounder, Greenland turbot, shortspine thornyhead, spiny dogfish, rougheye/blackspotted/shortraker rockfish, and multiple other rockfish species. Lengths of sablefish, giant grenadier (*Albatrossia pectoralis*), spiny dogfish, and Pacific cod were recorded by sex. Sablefish, shortspine thornyhead, and Greenland turbot were tagged at a rate of 1.1% of the gear by selecting these species caught on the first 10 hooks of skate 10, 30, 50, 70, and 90 of each set. This was a decrease in tagged fish from previous years, where all 45 hooks on those skates were tagged due to the decrease in staffing for 2020. Catch and length frequency data were transferred to a computer and electronic backup media twice a day. As in previous surveys, the charter vessel was allowed to retain species of value (except prohibited species such as salmon, halibut, and crab) once the scientific data were recorded.

RESULTS AND DISCUSSION

In 2020, a total of 14 stations along the upper continental slope of the eastern Aleutian Islands region and 47 stations along the upper continental slope of the Gulf of Alaska were sampled at a rate of one station per day (Fig. 1). Surveyed depths ranged from approximately 200 to 1,000 m, although at some stations depths less than 200 m or more than 1,000 m were sampled. In addition, 23 stations were sampled in gullies at the rate of 1 or 2 stations per day. The sampled gullies were Shelikof Trough, Amatuli Gully, W-grounds, Yakutat Valley, Spencer Gully, Ommaney Trench, and Dixon Entrance. One station (103) was sampled on the continental shelf off Baranof Island. Stations spanned a variety of management areas and habitat types, and not all were used in abundance index calculations reported for sablefish, notably gully stations on the continental shelf (Table 1). However, abundance calculations are performed for all species at all stations and are available at the station level for slope and gully stations.

One hundred forty-six longline hauls were completed during normal survey operations in 2020 (Table 2); six additional hauls (201–206) were completed during three days of experimental fishing during Leg 4 in July (see Appendix). During normal survey operations, sablefish was the most frequently caught species, followed by giant grenadier, shortspine thornyhead, Pacific cod, Pacific halibut, and rougheye/blackspotted rockfish (Table 3). Catch of the most abundant species by station is presented in Table 4. Sablefish was also the highest catch by weight, followed by giant grenadier, Pacific halibut, and Pacific cod (Table 5). Length and sex were recorded for 104,712 sablefish by region and depth stratum, with a greater number of females being caught, especially at shallower depths and in the western Aleutian Islands and western Gulf of Alaska (Fig. 2).

A total of 1,230 sablefish, 103 shortspine thornyhead, and 1 Greenland turbot were tagged with external numbered tags and released during the survey. Otoliths and length-weight data were collected from 2,751 sablefish. The survey caught 29 previously tagged sablefish (including 3 from the Alaska Department of Fish and Game and 3 from Fisheries and Oceans Canada) and re-tagged and released 3 of them. Additionally, one previously tagged shortspine thornyhead was recovered. Information on tagged fish can found at https://www.fisheries.noaa.gov/resource/map/alaska-groundfish-tagging-map.

Killer whale (*Orcinus orca*) depredation on the catch occurred at seven stations in the eastern Aleutian Islands, five stations in the western Gulf of Alaska, and one station in the central Gulf of Alaska (Table 6). Since 1990, portions of the gear affected by killer whale depredation during domestic longline surveys have been excluded from the analysis of the survey data.

Sperm whale (*Physeter macrocephalus*) observations have been recorded during the longline survey since 1998 (Hill et al. 1999). Sperm whales were observed during survey operations at 21 stations in 2020, which includes slope and gully stations (Table 7). Apparent sperm whale depredation is defined as sperm whales being present with the occurrence of damaged sablefish (Hanselman et al. 2018). Sperm whales were observed at one station in the Aleutian Islands with no depredation evident, one station in the western Gulf of Alaska with depredation evident, seven stations in the central Gulf of Alaska with

depredation evident at five, four stations in the West Yakutat region with depredation evident at all four, and eight stations in the East Yakutat/Southeast region with depredation evident at seven. Longline survey catch rates and abundance indices are not adjusted for sperm whale depredation in the survey.

It was requested that fishermen stay at least 5 nmi away from each survey station for 7 days before and 3 days after the planned sampling date (3 days allow for survey delays). Survey calendars were available to each IFQ holder before the beginning of each fishing season. In 2019, a letter was included with the calendar that included details of the request for the fleet to avoid survey stations and the rationale. Additionally, throughout the survey, the skipper of the survey vessel made announcements on the radio detailing the planned set locations for the upcoming days. Vessels encountered near survey stations were contacted by the survey vessel captain and interviewed to determine potential effects on survey catches.

Typically, vessels have been aware of the survey and have not fished close to survey locations. There are some instances where survey gear was fished nearby commercial fishing gear or where commercial fishing had recently occurred. In 2020 there were a few instance of vessel interactions. In the Gulf of Alaska, there was one interaction with a longliner in West Yakutat and three interactions with pot boats (two in the Central Gulf of Alaska and one in the Western Gulf of Alaska). There was also one interaction in the Aleutian Islands with a trawler.

Gear damage and loss occurs during survey operations may have impacts on catch. In 2020, the gear parted at five stations (53, 54, 77, 98, 107). When gear parted, it was retrieved by hauling from the opposite end of the set. At station 53, one skate of gear was lost, and at station 54, 34 skates were lost and an entire set (90 skates) was not sampled due to a very late retrieval because of submerged buoys (Table 2). On a few occasions, the inccorrect number of skates was set (see Table 2).

Several special projects were conducted during the 2020 longline survey. Stereo cameras that were installed outboard of the hauling station collected imagery that will be used as a training dataset to develop machine learning for length measurements and

species identification. Two temperature-depth recorders were attached to the longline to assess temperatures occurring at the gear depth. A genetics study to investigate the stock structure of shortspine thornyhead in Alaska waters was completed with sampling of the Aleutian Islands, and a collection of fin clips were frozen and brought back for laboratory analysis.

In 2020, collections of hydrocorals was initiated to investigate the use of their matrix chemistry as an indicator of environmental history. Hydrocorals produce a calcium carbonate hard structure that incorporates carotenoids into its matrix producing a pink, yellow, orange, or brown color. Carotenoids are a purely plant-based protein and cannot be produced by coral but must be obtained through diet, stemming primarily from phytoplankton and secondarily zooplankton. The color patterns in a cross section of coral bases show a ring pattern indicating an interrupted pattern of carotenoid incorporation into the matrix. An investigation into the use of these patterns to indicate environmental history is ongoing.

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Table 1. -- Stations fished in 2020 AFSC longline survey. "Management area" refers to the North Pacific Fishery Management Council sablefish management areas, "Habitat" refers to the station habitat type, and "Abundance" indicates whether or not station catches were used in abundance index calculations.

Station no.	Management area	Habitat	Abundance
35	Aleutian Islands	Slope	Yes
37	Aleutian Islands	Slope	Yes
38	Aleutian Islands	Slope	Yes
39	Aleutian Islands	Slope	Yes
40	Aleutian Islands	Slope	Yes
42	Aleutian Islands	Slope	Yes
53	Aleutian Islands	Slope	Yes
54	Aleutian Islands	Slope	Yes
55	Aleutian Islands	Slope	Yes
57	Aleutian Islands	Slope	Yes
58	Aleutian Islands	Slope	Yes
59	Aleutian Islands	Slope	Yes
60	Aleutian Islands	Slope	Yes
61	Aleutian Islands	Slope	Yes
62	Western Gulf of Alaska	Slope	Yes
63	Western Gulf of Alaska	Slope	Yes
64	Western Gulf of Alaska	Slope	Yes
65	Western Gulf of Alaska	Slope	Yes
66	Western Gulf of Alaska	Slope	Yes
67	Western Gulf of Alaska	Slope	Yes
68	Western Gulf of Alaska	Slope	Yes
69	Western Gulf of Alaska	Slope	Yes
70	Western Gulf of Alaska	Slope	Yes
71	Western Gulf of Alaska	Slope	Yes
72	Central Gulf of Alaska	Slope	Yes
73	Central Gulf of Alaska	Slope	Yes
74	Central Gulf of Alaska	Slope	Yes
75	Central Gulf of Alaska	Slope	Yes
76	Central Gulf of Alaska	Slope	Yes
77	Central Gulf of Alaska	Slope	Yes
78	Central Gulf of Alaska	Slope	Yes

Table 1. -- Cont.

79	Central Gulf of Alaska	Slope	Yes
80	Central Gulf of Alaska	Slope	Yes
81	Central Gulf of Alaska	Slope	Yes
82	Central Gulf of Alaska	Slope	Yes
83	Central Gulf of Alaska	Slope	Yes
84	Central Gulf of Alaska	Slope	Yes
85	Central Gulf of Alaska	Slope	Yes
86	Central Gulf of Alaska	Slope	Yes
87	Central Gulf of Alaska	Gully	No
88	Central Gulf of Alaska	Slope	Yes
89	Eastern Gulf of Alaska	Slope	Yes
90	Eastern Gulf of Alaska	Slope	Yes
91	Eastern Gulf of Alaska	Slope	Yes
92	Eastern Gulf of Alaska	Slope	Yes
93	Eastern Gulf of Alaska	Slope	Yes
94	Eastern Gulf of Alaska	Slope	Yes
95	Eastern Gulf of Alaska	Slope	Yes
96	Eastern Gulf of Alaska	Slope	Yes
97	Eastern Gulf of Alaska	Slope	Yes
98	Eastern Gulf of Alaska	Slope	Yes
99	Eastern Gulf of Alaska	Slope	Yes
100	Eastern Gulf of Alaska	Slope	Yes
101	Eastern Gulf of Alaska	Slope	Yes
102	Eastern Gulf of Alaska	Slope	Yes
103	Eastern Gulf of Alaska	Gully	No
104	Eastern Gulf of Alaska	Slope	Yes
105	Eastern Gulf of Alaska	Slope	Yes
106	Eastern Gulf of Alaska	Slope	Yes
107	Eastern Gulf of Alaska	Slope	Yes
108	Eastern Gulf of Alaska	Slope	Yes
120	Central Gulf of Alaska	Gully	No
121	Central Gulf of Alaska	Gully	No
128	Central Gulf of Alaska	Gully	No
129	Central Gulf of Alaska	Gully	No
130	Central Gulf of Alaska	Gully	No
131	Central Gulf of Alaska	Gully	No

Table 1. -- Cont.

132	Central Gulf of Alaska	Gully	No
133	Central Gulf of Alaska	Gully	No
134	Central Gulf of Alaska	Gully	No
135	Central Gulf of Alaska	Gully	No
136	Eastern Gulf of Alaska	Gully	No
137	Eastern Gulf of Alaska	Gully	No
138	Eastern Gulf of Alaska	Gully	No
139	Eastern Gulf of Alaska	Gully	No
142	Eastern Gulf of Alaska	Deep Gully	Yes
143	Eastern Gulf of Alaska	Deep Gully	Yes
144	Eastern Gulf of Alaska	Deep Gully	Yes
145	Eastern Gulf of Alaska	Deep Gully	Yes
148	Eastern Gulf of Alaska	Deep Gully	Yes
149	Eastern Gulf of Alaska	Deep Gully	Yes
523	Central Gulf of Alaska	Slope	No
535	Central Gulf of Alaska	Slope	No

Table 2. -- Set information by station and haul for the 2020 AFSC longline survey. Positions are in decimal degrees (DD) format and depths are in meters (m).

Station	Haul	Date	Skates retrieved	Start latitude	Start longitude	End latitude	End longitude	Start depth	End depth
35*	1	06/03	90	53.03	-170.10	53.06	-170.20	174	179
35*	2	06/03	80	53.06	-170.21	53.10	-170.29	192	574
37	3	06/04	90	52.28	-173.50	52.34	-173.50	159	610
37	4	06/04	98	52.36	-173.51	52.42	-173.50	634	779
38	5	06/05	90	52.25	-174.84	52.31	-174.78	174	652
38	6	06/05	90	52.31	-174.77	52.34	-174.68	370	819
39	7	06/06	90	52.13	-175.57	52.14	-175.66	107	430
39	8	06/06	90	52.15	-175.67	52.17	-175.77	560	622
40	9	06/07	90	51.97	-176.45	52.02	-176.43	111	404
40	10	06/07	90	52.03	-176.41	52.06	-176.33	486	820
54*	11	06/08	56	51.77	-178.16	51.75	-178.26	98	511
54	12	06/08	0	51.75	-178.28	51.74	-178.38	665	942
42	13	06/09	80	51.78	-178.96	51.72	-178.88	270	470
42	14	06/09	79	51.64	-178.80	51.71	-178.88	823	511
53	15	06/10	79	51.40	-178.62	51.35	-178.55	234	570
53	16	06/10	80	51.35	-178.54	51.37	-178.45	553	627
55	17	06/11	90	51.60	-177.61	51.55	-177.70	235	424
55	18	06/11	90	51.55	-177.71	51.53	-177.79	326	887
57*	19	06/12	90	51.73	-176.00	51.66	-176.00	186	399
57*	20	06/12	90	51.65	-176.02	51.59	-176.06	420	763
58	21	06/13	90	51.85	-175.14	51.77	-175.15	176	367
58*	22	06/13	90	51.78	-175.12	51.70	-175.12	356	815
59*	23	06/14	90	51.88	-174.33	51.82	-174.42	124	326
59*	24	06/14	90	51.82	-174.43	51.77	-174.52	326	632
60*	25	06/15	90	51.92	-173.50	51.87	-173.61	118	324
60*	26	06/15	90	51.88	-173.63	51.87	-173.75	242	540
61*	27	06/16	80	52.38	-170.30	52.38	-170.41	232	544
61*	28	06/16	80	52.38	-170.42	52.37	-170.52	556	482
62*	29	06/17	90	52.66	-169.01	52.60	-169.10	133	609
62*	30	06/17	90	52.62	-169.11	52.55	-169.19	340	853
64*	31	06/18	90	53.20	-166.86	53.12	-166.89	205	314
64*	32	06/18	90	53.12	-166.91	53.04	-166.95	314	1204

Table 2. -- Cont.

63	33	06/19	90	52.97	-168.13	52.92	-168.21	107	317
63	34	06/19	90	52.91	-168.21	52.85	-168.22	335	786
65	35	06/20	80	53.58	-165.72	53.52	-165.72	121	280
65	36	06/20	80	53.44	-165.79	53.50	-165.74	467	306
68*	37	06/23	90	54.15	-161.59	54.09	-161.68	150	308
68*	38	06/23	90	54.09	-161.70	54.06	-161.81	252	648
66	39	06/24	90	53.74	-164.47	53.68	-164.56	136	300
66	40	06/24	90	53.68	-164.57	53.63	-164.67	297	597
67	41	06/25	90	53.97	-163.26	53.90	-163.33	114	420
67	42	06/25	90	53.91	-163.34	53.86	-163.44	360	595
69*	43	06/26	90	54.31	-161.06	54.26	-161.16	171	418
69*	44	06/26	90	54.26	-161.18	54.21	-161.25	402	833
70	45	06/27	90	54.37	-160.23	54.30	-160.29	144	293
70	46	06/27	90	54.30	-160.28	54.23	-160.29	312	645
71*	47	06/28	90	54.51	-159.24	54.44	-159.31	142	274
71*	48	06/28	90	54.44	-159.31	54.38	-159.41	290	655
72*	49	06/29	90	54.63	-158.58	54.56	-158.65	124	374
72*	50	06/29	90	54.57	-158.66	54.49	-158.71	308	844
75	51	06/30	90	55.64	-155.85	55.57	-155.86	142	214
75	52	06/30	90	55.57	-155.87	55.51	-155.83	210	213
148	53	07/05	90	54.65	-132.84	54.60	-132.92	347	380
149	54	07/05	90	54.60	-133.02	54.60	-133.15	409	389
108	55	07/06	90	54.47	-133.92	54.49	-134.02	305	587
108	56	07/06	90	54.50	-134.01	54.55	-134.08	348	893
107	57	07/07	90	54.90	-134.29	54.96	-134.36	224	354
107	58	07/07	90	54.96	-134.36	55.02	-134.46	433	850
106	59	07/08	90	55.35	-134.74	55.39	-134.83	366	619
106	60	07/08	90	55.40	-134.83	55.39	-134.94	392	813
105	61	07/09	90	55.59	-134.97	55.58	-135.06	245	514
105	62	07/09	90	55.59	-135.05	55.63	-135.14	450	798
144	63	07/10	90	55.93	-134.91	56.01	-134.92	199	370
145	64	07/10	90	56.10	-135.03	56.04	-134.93	322	361
104	65	07/11	90	55.98	-135.44	56.03	-135.54	348	628
104	66	07/11	90	56.03	-135.53	56.08	-135.61	552	835
103	67	07/12	90	56.38	-135.35	56.38	-135.49	156	193
103	68	07/12	90	56.39	-135.49	56.37	-135.62	192	229

Table 2. -- Cont.

102	69	07/13	90	56.85	-136.00	56.90	-136.10	215	730
102	70	07/13	90	56.76	-136.10	56.98	-136.13	625	899
101	71	07/14	90	57.19	-136.24	57.22	-136.34	215	787
101	72	07/14	90	57.23	-136.34	57.30	-136.38	796	823
100	73	07/15	90	57.62	-136.53	57.61	-136.64	218	722
100	74	07/15	90	57.62	-136.65	57.66	-136.75	662	665
142	75	07/16	90	57.92	-137.00	57.92	-137.13	445	409
143	76	07/16	90	57.97	-137.07	57.97	-137.19	426	290
99	77	07/17	90	57.88	-137.37	57.89	-137.48	177	540
99	78	07/17	90	57.89	-137.50	57.89	-137.62	558	680
98	79	07/18	90	58.14	-138.73	58.15	-138.85	222	823
98	80	07/18	90	58.16	-138.85	58.18	-138.98	635	668
97	81	07/19	90	58.47	-139.47	58.46	-139.60	194	467
97	82	07/19	90	58.46	-139.61	58.42	-139.70	417	620
138	83	07/23	90	59.42	-140.94	59.43	-141.09	219	297
139	84	07/23	90	59.41	-141.17	59.35	-141.25	321	326
96	85	07/24	90	58.68	-140.64	58.68	-140.78	254	724
96	86	07/24	90	58.69	-140.79	58.73	-140.90	510	686
95	91	07/27	90	59.05	-141.34	59.04	-141.48	294	552
95	92	07/27	90	59.05	-141.50	59.05	-141.64	581	885
94	93	07/28	90	59.39	-142.17	59.42	-142.29	234	447
94	94	07/28	90	59.43	-142.28	59.50	-142.39	386	936
93	95	07/29	90	59.55	-142.57	59.59	-142.68	130	588
93	96	07/29	90	59.59	-142.68	59.57	-142.80	572	651
136	99	07/31	90	59.76	-143.71	59.75	-143.58	158	302
137	100	07/31	90	59.67	-143.38	59.72	-143.50	295	312
92	101	08/01	90	59.56	-143.82	59.56	-143.66	664	171
92	102	08/01	90	59.59	-143.97	59.57	-143.85	494	580
91	103	08/02	90	59.52	-144.72	59.48	-144.85	187	460
91	104	08/02	90	59.49	-144.86	59.46	-144.97	440	746
90	105	08/03	90	59.50	-145.53	59.52	-145.69	157	1250
90	106	08/03	90	59.53	-145.70	59.52	-145.85	572	247
134	107	08/06	90	59.61	-146.97	59.55	-147.06	210	209
135	108	08/06	90	59.52	-147.15	59.44	-147.15	221	208
89	109	08/07	90	59.26	-146.86	59.22	-146.97	190	602
89	110	08/07	90	59.22	-146.99	59.16	-147.08	563	947

Table 2. -- Cont.

88	111	08/08	90	59.15	-147.61	59.08	-147.61	248	536
88	112	08/08	90	59.08	-147.64	59.01	-147.63	422	988
132	113	08/09	90	59.08	-149.40	59.04	-149.52	184	225
133	114	08/09	90	58.92	-149.65	58.95	-149.52	238	244
130	115	08/10	90	58.72	-149.19	58.77	-149.08	178	215
131	116	08/10	90	58.80	-149.05	58.84	-148.93	238	252
87	117	08/11	90	59.13	-148.65	59.06	-148.65	154	197
87	118	08/11	90	59.05	-148.65	58.98	-148.65	215	242
86	119	08/12	90	58.69	-148.34	58.61	-148.34	283	452
86	120	08/12	90	58.61	-148.33	58.54	-148.35	498	823
85	121	08/13	90	58.29	-148.62	58.23	-148.66	225	500
85	122	08/13	90	58.22	-148.64	58.17	-148.69	503	730
84	123	08/14	90	57.97	-149.17	57.92	-149.23	166	505
84	124	08/14	90	57.92	-149.25	57.85	-149.32	468	738
128	125	08/15	90	58.00	-149.85	57.98	-149.99	225	262
129	126	08/15	90	58.08	-149.91	58.06	-150.06	295	315
83	127	08/16	90	57.63	-149.93	57.56	-149.95	395	564
83	128	08/16	90	57.57	-149.97	57.49	-150.00	535	880
82	129	08/17	74	57.40	-150.58	57.32	-150.59	214	514
82	130	08/17	90	57.32	-150.61	57.24	-150.60	520	744
535	131	08/19	90	57.35	-150.67	57.28	-150.68	222	498
535	132	08/19	90	57.28	-150.69	57.21	-150.68	450	771
523	133	08/20	90	57.22	-151.04	57.14	-151.04	192	582
523	134	08/20	90	57.14	-151.06	57.06	-151.05	484	572
81	135	08/21	90	57.12	-151.22	57.05	-151.28	260	532
81	136	08/21	90	57.05	-151.30	56.97	-151.30	556	852
80	137	08/22	90	56.48	-152.22	56.42	-152.29	146	514
80	138	08/22	90	56.43	-152.31	56.36	-152.35	387	687
79	139	08/23	90	56.30	-153.08	56.27	-153.18	273	462
79	140	08/23	90	56.27	-153.21	56.22	-153.28	470	786
78	141	08/24	90	55.99	-154.03	55.91	-154.01	248	538
78	142	08/24	90	55.92	-154.04	55.84	-154.04	504	966
77	143	08/25	90	56.04	-154.58	55.97	-154.57	232	546
77	144	08/25	90	55.98	-154.60	55.94	-154.58	515	882
76	145	08/26	90	55.77	-155.14	55.70	-155.18	155	330
76	146	08/26	90	55.69	-155.19	55.63	-155.27	356	610

Table 2. -- Cont.

121	147	08/27	90	55.73	-156.35	55.75	-156.21	248	243
120	148	08/27	90	55.76	-156.20	55.79	-156.08	238	209
74	149	08/28	90	55.24	-156.68	55.17	-156.75	152	306
74	150	08/28	90	55.17	-156.73	55.10	-156.76	385	758
73	151	08/29	90	54.85	-157.74	54.80	-157.80	180	364
73	152	08/29	90	54.79	-157.82	54.72	-157.85	348	682

*Station catch was entirely or partially impacted by killer whale depredation.

Table 3. -- Total estimated catch in numbers of major species (>100 individuals) caught in the 2020 AFSC longline survey by management area: AI = Aleutian Islands, WGOA = Western Gulf of Alaska, EGOA = Eastern Gulf of Alaska, WY = West Yakutat, and EYSE = East Yakutat and Southeastern Alaska.

Species common name	AI	WGOA	CGOA	WY	EYSE	Total
Sablefish	18,066	25,195	65,054	17,248	29,276	154,839
Giant grenadier	11,842	11,238	12,204	3,590	3,321	42,195
Shortspine thornyhead	1,217	980	3,896	1,781	2,517	10,391
Pacific cod	7,192	1,178	910	112	346	9,738
Pacific halibut	2,148	586	2,362	1,097	1,143	7,336
Rougheye/blackspotted rockfish	2,049	1,322	689	428	2,279	6,767
Shortraker rockfish	886	507	683	1,209	1,127	4,412
Spiny dogfish	0	4	2,034	40	1,168	3,246
Arrowtooth flounder	692	223	1,377	185	169	2,646
Yellow Irish lord	2,304	28	0	0	0	2,332
Aleutian/Bering/Alaska skate	880	199	489	91	120	1,779
Longnose skate	4	165	650	365	517	1,701
Pacific grenadier	42	63	1,108	296	135	1,644
Whiteblotched skate	1,180	9	0	0	0	1,189
Sea anemone	13	69	530	112	349	1,073
Redbanded rockfish	15	16	302	120	463	916
Sea pen/whip	64	28	445	24	21	582
Brittle star	162	75	154	10	80	481
Yelloweye rockfish	0	83	29	70	238	420
Commander skate	371	5	2	2	20	400
Kamchatka flounder	380	0	1	1	0	382
Lips/jaws - depredation	110	86	47	41	33	317
Sponge	205	58	15	3	12	293
Dover sole	1	4	166	44	77	292
Bryozoan	180	27	36	1	9	253
Greenland turbot	249	0	0	0	0	249
Walleye pollock	59	101	67	14	6	247
Mud skate	242	1	0	0	0	243
Starfish	55	10	33	24	75	197
Gorgonian coral	149	9	0	3	10	171
Crinoid	14	9	134	4	4	165

Table 3. -- Cont.

Hydrocoral	135	8	11	2	6	162
Basket star	56	7	23	14	26	126
Spotted ratfish	0	0	0	0	119	119
Sea cucumber	107	3	0	0	1	111

Table 4. -- Catch in numbers by station for major species in the 2020 AFSC longline survey. SF = sablefish; PC = Pacific cod; GR = giant grenadier; PH = Pacific halibut; ATF = arrowtooth flounder; GT = Greenland turbot; RF = rougheye, blackspotted, and shortraker rockfish; ST = shortspine thornyhead; SK = skate; OS = Other Species.

Station	SF	PC	GR	PH	ATF	GT	RF	ST	SK	OS
35*	231	1,039	248	477	50	1	167	8	739	378
37	3,043	328	1,659	16	32	75	12	22	190	216
38	2,654	372	1,439	76	34	76	72	243	40	100
39	1,995	490	1,082	470	170	11	30	27	17	517
40	1,784	171	1,326	106	63	74	19	109	87	175
42	949	664	163	63	1	5	266	31	332	199
53	1,949	56	453	50	0	5	219	282	8	212
54*	0	765	0	88	30	0	15	0	58	922
55	1,578	435	828	106	60	0	80	107	67	390
57*	1,211	376	995	102	98	1	75	82	25	492
58*	1,167	253	1,067	84	84	1	152	65	17	193
59*	306	541	1,367	206	47	0	345	89	35	719
60*	358	1,596	104	217	13	0	1,449	28	172	711
61*	841	106	1,111	87	9	0	34	124	125	95
62*	1,663	203	1,690	59	8	0	373	88	25	90
63	2,965	344	764	51	20	0	223	143	19	149
64*	2,780	2	296	5	5	0	540	109	9	114
65	2,122	97	1,357	46	43	0	46	65	27	156
66	3,412	68	1,033	15	28	0	69	78	21	90
67	2,810	149	632	80	28	0	347	101	6	126
68*	1,715	38	576	33	3	0	149	77	7	58
69*	1,869	31	2,297	23	10	0	28	82	12	48
70	2,910	137	1,330	206	36	0	21	113	49	109
71*	2,949	109	1,263	68	42	0	33	124	13	65
72*	1,784	162	1,059	46	77	0	219	133	25	55
73	3,490	14	1,039	17	32	0	22	57	14	49
74	3,963	7	674	23	34	0	16	294	8	60
75	3,742	24	0	39	17	0	7	1	7	43
76	3,077	246	304	74	57	0	93	96	9	406
77	2,467	0	1,471	22	25	0	46	154	0	180
78	2,390	0	636	43	31	0	44	127	0	621

Table 4. -- Cont.

79	3,559	0	998	30	26	0	154	156	3	107
80	2,319	30	469	99	22	0	124	293	8	119
81	2,487	0	611	18	21	0	58	164	1	284
82	2,130	3	757	50	43	0	52	185	2	75
83	2,842	0	638	0	7	0	13	180	0	180
84	2,860	37	1,022	221	59	0	34	141	17	276
85	2,392	2	411	52	145	0	41	309	15	143
86	1,830	1	746	123	39	0	95	312	41	89
87	1,303	100	0	527	76	0	13	83	86	138
88	2,510	0	449	24	17	0	96	250	5	234
89	2,202	20	1,091	173	12	0	123	136	25	267
90	909	10	706	156	3	0	536	48	14	87
91	2,232	73	424	119	28	0	104	207	41	140
92	2,014	7	514	83	13	0	58	83	17	63
93	1,969	0	125	65	6	0	6	289	4	69
94	1,703	0	141	38	21	0	196	231	31	98
95	2,385	0	186	86	12	0	255	271	36	99
96	1,753	0	403	16	16	0	231	184	14	90
97	1,549	2	464	45	3	0	340	151	12	139
98	1,681	0	454	38	3	0	194	61	5	755
99	2,038	0	304	60	13	0	39	116	9	153
100	2,348	16	229	41	2	0	25	126	8	58
101	2,558	8	325	23	4	0	121	180	20	80
102	1,503	0	359	1	9	0	34	150	5	108
103	1,510	159	0	512	26	0	0	4	76	604
104	1,956	0	354	3	7	0	830	268	10	67
105	1,801	8	185	46	2	0	133	154	18	111
106	2,382	0	226	0	1	0	422	199	7	142
107	1,510	8	205	13	1	0	650	172	32	143
108	1,497	0	137	5	2	0	344	105	8	126
120	1,833	28	0	92	113	0	2	5	12	114
121	1,516	1	0	71	84	0	0	19	5	118
128	1,828	47	0	143	44	0	11	32	8	19
129	1,921	1	0	42	32	0	13	66	34	31
130	1,074	50	0	96	35	0	5	58	54	47
131	1,378	15	0	108	46	0	16	215	49	109

Table 4. -- Cont.

132	665	72	0	98	67	0	4	51	50	167
133	1,060	1	0	84	73	0	9	117	73	55
134	1,385	14	0	25	36	0	5	30	56	816
135	840	7	0	81	27	0	34	53	72	1,149
136	277	2	0	44	9	0	11	103	26	42
137	569	0	0	112	15	0	74	83	67	19
138	650	0	0	141	23	0	25	111	24	43
139	585	0	0	64	27	0	18	35	69	15
142	1,312	0	40	8	1	0	7	71	2	5
143	1,815	0	39	100	29	0	40	71	33	40
144	348	21	0	116	27	0	127	263	47	159
145	1,189	0	0	18	12	0	71	239	29	201
148	1,005	124	0	80	23	0	7	75	96	278
149	1,274	0	0	34	4	0	22	112	128	121
523	3,050	26	308	41	28	0	31	117	1	59
535	3,359	22	612	73	64	0	115	198	2	51

*Station catch was entirely or partially impacted by killer whale depredation.

Table 5. -- Total estimated catch in weight (kg) of major species (>100 kg) caught in the 2020 AFSC longline survey by management area: AI = Aleutian Islands, WGOA = western Gulf of Alaska, EGOA = eastern Gulf of Alaska, WY = west Yakutat, and EYSE = east Yakutat and Southeastern Alaska. Weight (kg) derived from length-weight relationship when lengths available. For all others an average weight proxy from longline fisheries was applied to numbers caught.

Species common name	AI	WGOA	CGOA	WY	EYSE	Total
Sablefish	32,287	46,423	139,431	47,780	76,680	342,601
Giant grenadier	38,184	30,952	34,099	9,295	10,940	123,470
Pacific halibut	12,675	3,458	13,938	6,473	6,745	43,289
Pacific cod	23,121	5,907	2,963	295	1,035	33,321
Longnose skate	30	1,230	4,846	2,721	3,854	12,681
Rougheye/blackspotted rockfish	2,185	1,910	1,009	625	4,365	10,094
Shortspine thornyhead	1,386	796	2,601	1,142	2,067	7,992
Spiny dogfish	0	9	4,399	96	3,222	7,726
Shortraker rockfish	880	736	1,083	2,255	1,879	6,833
Whiteblotched skate	6,356	48	0	0	0	6,404
Arrowtooth flounder	1,374	373	2,900	429	312	5,388
Yellow Irish lord	1,931	23	0	0	0	1,954
Redbanded rockfish	27	28	536	213	822	1,626
Pacific grenadier	44	58	886	240	97	1,325
Commander skate	1,182	16	6	6	64	1,274
Yelloweye rockfish	0	239	84	202	686	1,211
Kamchatka flounder	1,014	0	4	5	0	1,023
Mud skate	819	3	0	0	0	822
Lingcod	0	0	255	205	329	789
Greenland turbot	736	0	0	0	0	736
Dover sole	1	6	247	65	115	434
Spotted ratfish	0	0	0	0	433	433
Skates unidentified	360	10	0	0	0	370
Walleye pollock	84	144	95	20	9	352
Sea anemone	4	19	147	31	97	298
Octopus	189	63	32	6	6	296
Blue shark	0	0	185	53	26	264
Canary rockfish	0	0	0	0	160	160
Pacific sleeper shark	58	0	0	0	58	116

Table 5. -- Cont.

Roughtail skate	85	6	3	0	19	113
Sea pen/whip	12	5	84	5	4	110

Table 6. -- Stations and skates depredated by killer whales during the 2020 AFSC longline survey. Number of skates affected refers to skates determined to be depredated and removed from abundance calculations.

Station	Region	Number of skates affected	Number of skates fished
35	Aleutian Islands	152	170
54	Aleutian Islands	56	56
57	Aleutian Islands	132	180
58	Aleutian Islands	73	180
59	Aleutian Islands	100	180
60	Aleutian Islands	118	180
61	Aleutian Islands	134	160
62	Western Gulf of Alaska	154	180
64	Western Gulf of Alaska	137	180
68	Western Gulf of Alaska	165	180
69	Western Gulf of Alaska	170	180
71	Western Gulf of Alaska	103	180
72	Central Gulf of Alaska	158	180

Table 7. -- Stations that had sperm whales present during hauling operations in the 2020 AFSC longline survey. Depredation is defined as sperm whales being present with the occurrence of damaged fish on the line.

Station	Region	Depredation
42	Aleutian Islands	No
71	Western Gulf of Alaska	Yes
81	Central Gulf of Alaska	Yes
82	Central Gulf of Alaska	No
83	Central Gulf of Alaska	Yes
84	Central Gulf of Alaska	No
85	Central Gulf of Alaska	Yes
90	West Yakutat	Yes
91	West Yakutat	Yes
92	West Yakutat	Yes
96	West Yakutat	Yes
97	East Yakutat/Southeast	Yes
98	East Yakutat/Southeast	Yes
100	East Yakutat/Southeast	Yes
101	East Yakutat/Southeast	Yes
102	East Yakutat/Southeast	Yes
103	East Yakutat/Southeast	Yes
104	East Yakutat/Southeast	Yes
105	East Yakutat/Southeast	No
523	Central Gulf of Alaska	Yes
535	Central Gulf of Alaska	Yes

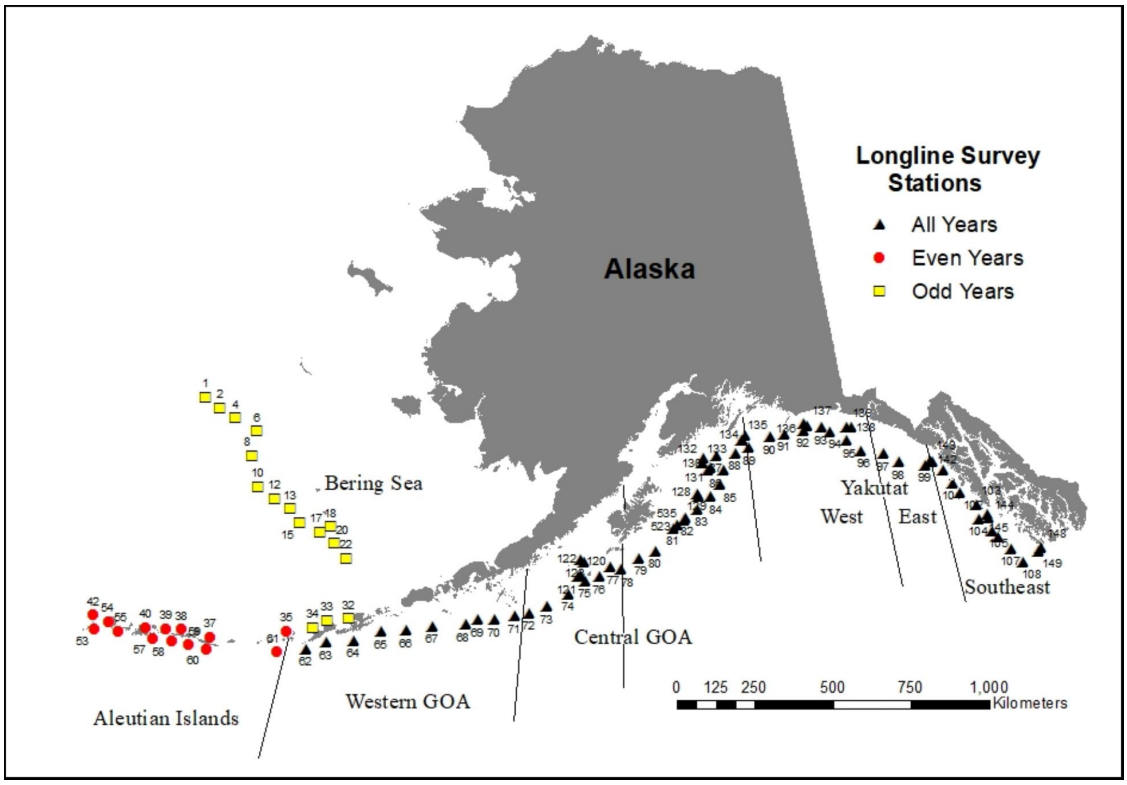


Figure 1. -- Map of NMFS longline survey station locations. Bering Sea stations are sampled in odd years; stations in the eastern and central Aleutian Islands are sampled in even years; Gulf of Alaska (GOA) stations are sampled every year.

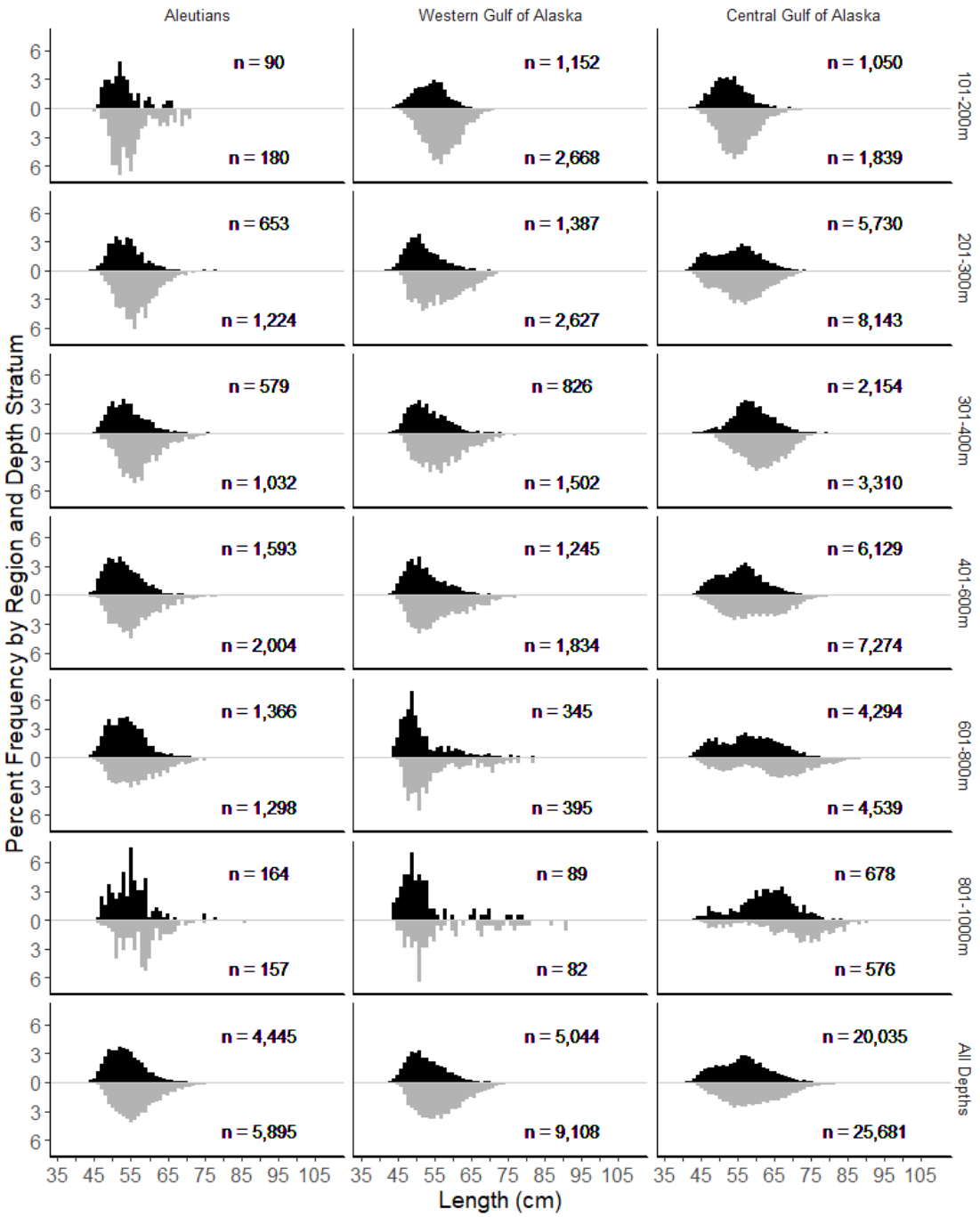


Figure 2. -- Size composition of sablefish measured during the 2020 AFSC longline survey by region and depth stratum. Males are shown in black and females are shown in grey below the x-axis.

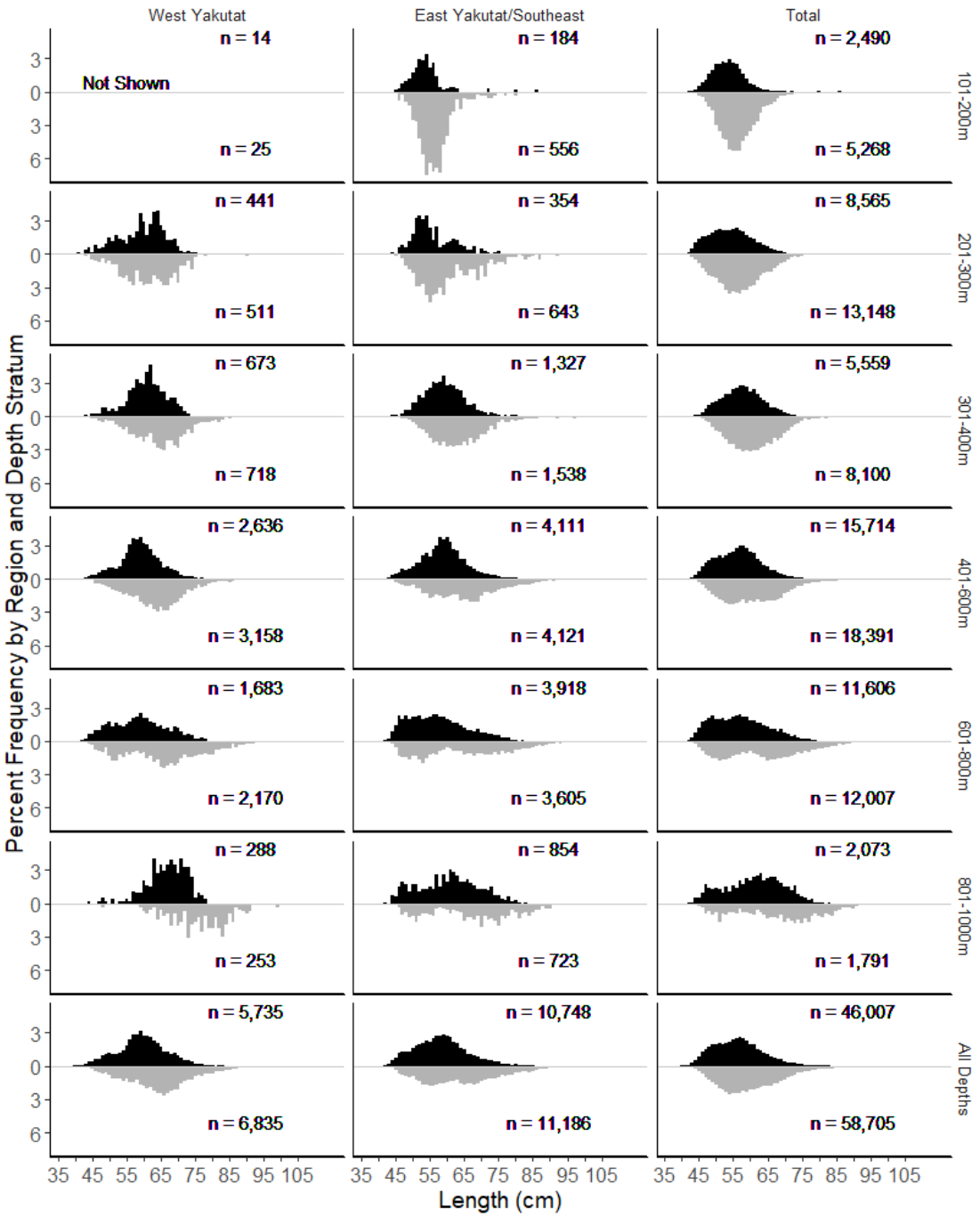


Figure 2. -- Cont.

APPENDIX: Experimental Fishing

In 2020, the longline survey sampled three "random" experimental stations in the Gulf of Alaska. The objective of this experiment was to compare catch rates of standard stations with "random" stations in similar habitats to determine if standard stations are superior fishing locations that may bias survey results. Standard data collections occurred at experimental stations, but otoliths were not collected and fish were not tagged. The suitable habitat for the experimental stations was identified by the vessel master and approved by the survey coordinator. The locations of the experimental stations were spatially separated from standard survey stations by at least 5 miles and the depth ranges sampled were comparable to standard stations (approximately 200–800 m).

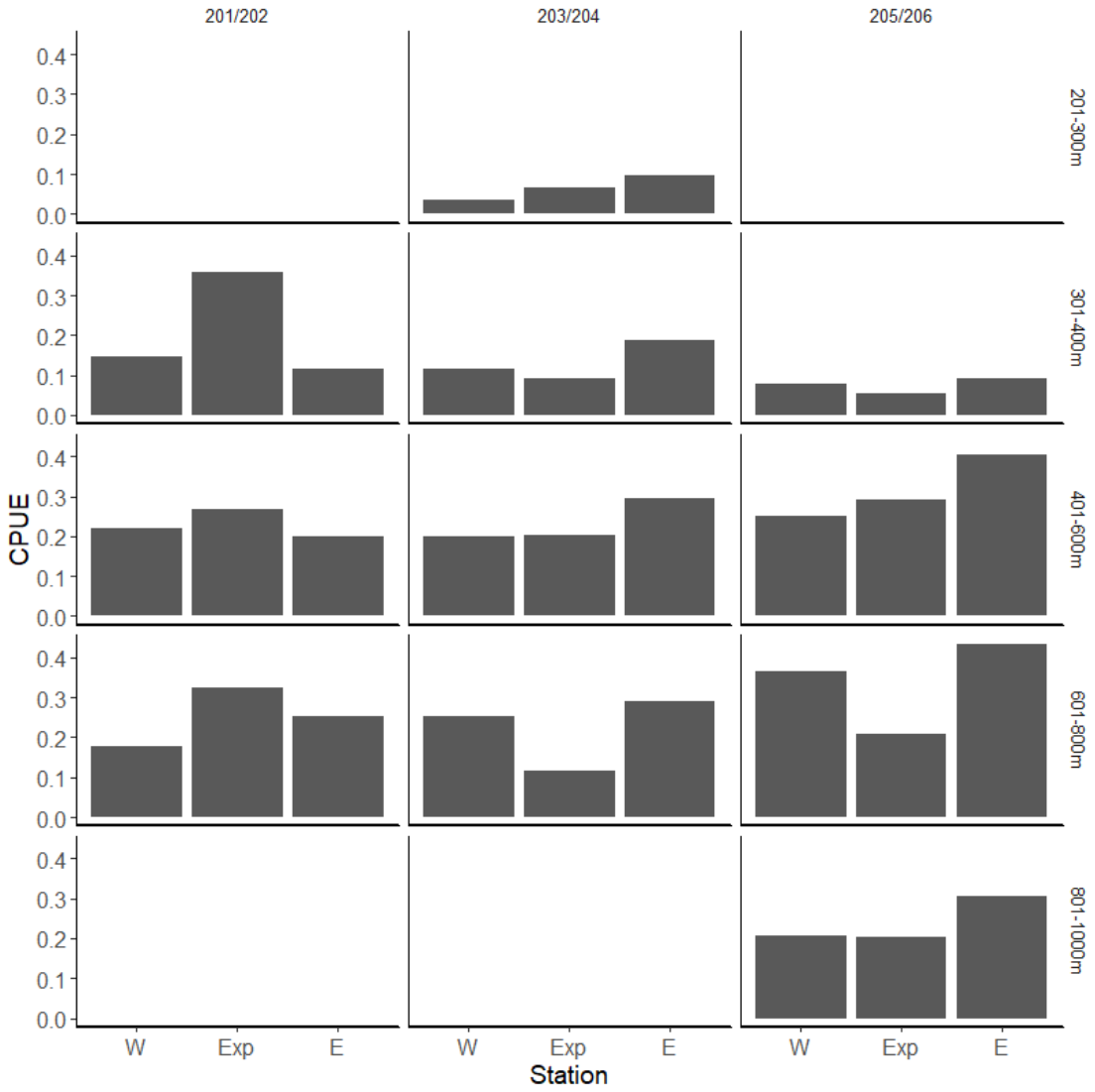
During the three days of experimental fishing, two sets were made each day for a total of six sets of 90 skates each (Appendix Table A-1). The stations were located in the West and East Yakutat management regions. The experimental sets were fished in depths between 283 and 933 m. During the three experimental fishing days, the main issue that may have affected catch rates and complicates comparison with standard sets was that sperm whales were observed depredating on the longline on five of the six hauls (87–90 and 98). On all six sets of the 2020 experiment combined, 4,967 sablefish, 1,384 giant grenadier, 447 shortspine thornyhead, 249 Pacific grenadier, and 148 rougheye/blackspotted/shortraker rockfish made up the bulk of the catch.

Using the nearest station east and west of each experimental fishing station, we compared the catch per unit effort (CPUE) of sablefish in respective depth strata that were sampled by both experimental and standardized stations. CPUE was calculated as the number of sablefish per actively per actively fishing hook (i.e., all hooks that were not deemed ineffective upon retrieval). For experimental station 201/202 the standard station 97 was west and 98 was east. For experimental station 203/204, the standard station 98 was west and 99 was east. For experimental station 205/206, the standard station 94 was west and 95 was east. Catch rates were reasonably similar between experimental and their closest standard stations, though 201/202 seemed to have a higher CPUE at all depths,

while both 203/204 and 205/206 had much lower CPUE in depths between 600 and 800 m (Appendix Fig. A-1). We did not find evidence that the survey stations had higher catch rates of sablefish compared to nearby standard stations, though sperm whale depredation was prevalent for experimental and nearby standard stations, thus making comparisons difficult.

Appendix Table A-1. -- Set information for experimental hauls from the 2020 AFSC longline survey. Positions are in decimal degrees (DD) format and depths are in meters (m).

Station	Haul	Date	Skates retrieved	Start latitude	Start longitude	End latitude	End longitude	Start depth	End depth
201	87	07/25	90	59.32	139.41	58.29	139.29	367	464
202	88	07/25	90	58.29	139.28	58.27	139.18	600	563
203	89	07/26	90	58.00	138.15	57.33	138.26	274	735
204	90	07/26	90	58.01	138.29	58.01	138.40	556	600
205	97	07/30	90	59.20	141.75	59.20	141.20	279	748
206	98	07/30	90	59.21	141.23	59.23	142.02	796	796



Appendix Figure A-1. -- Catch per unit effort (CPUE) of sablefish shown for experimental fishing stations ('Exp', labeled at top) and their closest west ('W') and east ('E') standardized station by depth stratum (at right, in meters).

U.S. Secretary of Commerce
Gina M. Raimondo

Performing the duties of
Under Secretary of Commerce for
Oceans and Atmosphere
Benjamin Friedman

Acting Assistant Administrator for
Fisheries
Paul Doremus

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National Marine
Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, WA 98115 6349