

December 16, 2003

CRUISE RESULTS

CRUISE 2003-01
CHARTERED FISHING VESSELS
GLADIATOR, NORTHWEST EXPLORER, AND SEA STORM
GULF OF ALASKA BIENNIAL BOTTOM TRAWL SURVEY
OF GROUND FISH RESOURCES
MAY 20 - AUGUST 9, 2003

The third biennial bottom trawl survey of Gulf of Alaska (GOA) groundfish resources was conducted from May 20 through August 9, 2003, by the Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC), Seattle, Washington. The standard biennial GOA survey area, established in 1999, stretches from the U.S.-Canada border at Dixon Entrance ($54^{\circ} 30' N$ latitude) to the Islands of the Four Mountains at the base of the Aleutian Islands ($170^{\circ} W$ longitude) including depths from approximately 10 to 1,000 m. The entire standard area was surveyed in 1999. Due to conflicting commitments in 2001, only the area west of $147^{\circ} W$ longitude and depths to 500 m were surveyed that year. Although sufficient time and resources were available to survey the entire standard area in 2003, none of the vessels were equipped to fish as deep as 1,000 m. Consequently, hauls in the deepest strata (700-1,000 m) were eliminated from this year's survey design.

Prior to the first biennial survey conducted in 1999, GOA groundfish resources had been surveyed by the RACE Division triennially with surveys conducted in 1984, 1987, 1990, 1993 and 1996. Each of the triennial surveys covered the entire continental shelf to 500 m depths, but only the 1984 and 1987 triennial surveys included deeper stations to 1,000 m.

ITINERARY

Survey sampling was conducted aboard the chartered commercial trawlers *Gladiator*, *Northwest Explorer*, and *Sea Storm*, each of which was chartered for a 75-day period. Vessel charters were divided into four legs of 18-19 days each and staffed by scientific personnel from the AFSC and other cooperating agencies and institutions (Table 1). Sampling operations began near the Islands of Four Mountains and extended eastward on the continental shelf and slope to the U.S.-Canada border at Dixon Entrance. Positions of stations to be sampled were pre-selected. If unable to sample at the designated station due to rough bottom, excessive currents, or fishing

gear conflicts, Field Party Chiefs (FPCs) selected a nearby alternate station.

Itineraries of the *Gladiator* and *Northwest Explorer*

May 20 First day of charter. Equipment, supplies, and sampling gear loaded aboard vessels in Dutch Harbor, AK.
May 22 Began measuring/marketing warps as per standardization protocols.
May 24 Beginning of Leg 1 - Sampled stations in Western GOA.
June 6 Arrived Sand Point, AK. Exchanged scientific personnel.
June 7 Began Leg 2 - Vessels departed Sand Point, resumed survey eastward.
June 25 Arrived Kodiak, AK. Exchanged scientific personnel.
June 26 Began Leg 3 - Vessels departed Kodiak, resumed survey eastward.
July 14 Arrived Cordova, AK. Exchanged scientific personnel.
July 15 Began Leg 4 - Vessels departed Cordova, resumed survey eastward.
July 31 Arrived Ketchikan, AK. Unloaded vessels.
August 2 Last day of charter.

Itinerary of the *Sea Storm*

May 27 First day of charter. Equipment, supplies, and sampling gear loaded aboard vessel in Dutch Harbor, AK.
May 29 Began measuring/marketing warps as per standardization protocols.
May 31 Beginning of Leg 1 - Sampled stations in Western GOA.
June 13 Arrived Sand Point, AK. Exchanged scientific personnel.
June 14 Began Leg 2 - Vessels departed Sand Point, resume survey eastward.
July 2 Arrived Kodiak, AK. Exchanged scientific personnel.
July 3 Began Leg 3 - Vessels departed Kodiak, resumed survey eastward.
July 21 Arrived Cordova, AK. Exchanged scientific personnel.
July 22 Began Leg 4 - Vessels departed Cordova, resumed survey eastward.
August 7 Arrived Ketchikan, AK. Unloaded vessels.
August 9 Last day of charter.

OBJECTIVES

The primary focus of the biennial groundfish assessment surveys is to build a standardized time series of data to describe and monitor the distribution, abundance, and biological condition of GOA groundfish stocks. Specific objectives of the 2003 survey were to:

- Describe the distribution and relative abundance of the principal groundfish and invertebrate species inhabiting the GOA;
- Collect data to define various species-specific biological parameters *i.e.*, age, sex, size, growth rates, length-weight relationships, and feeding habits;
- Collect integrated net configuration and position data for all trawl hauls to obtain precise area-swept estimates;

- Record surface-to-bottom water column temperatures; and,
- Collect specimens and data requested by individual scientists from the AFSC or cooperating agencies and institutions.

VESSELS AND GEAR

The *Gladiator*, *Northwest Explorer*, and *Sea Storm* are all house-forward trawlers with stern ramps, multiple net storage reels (mounted forward of the working deck and/or aft over the stern ramp), telescoping deck cranes, propeller nozzles, and paired, controlled-tension hydraulic trawl winches with 1,830 m of 2.54 cm (*Gladiator* and *Sea Storm*) or 2.98 cm (*Northwest Explorer*) diameter steel cable. The *Gladiator* and *Sea Storm* are both 37.8 m in overall length (LOA) and powered by single 1,710 continuous HP main engines. The *Northwest Explorer* is 49.4 m LOA and propelled by twin 1,800 HP main engines. Each vessel is equipped with a full suite of state-of-the-art navigational and fishing electronics including Global Positioning Systems (GPS) with video position plotters, radars, color video fish-finders, and recording depth sounders. Each vessel's crew consisted of the captain, lead fisherman, engineer-fisherman, fisherman, and cook or cook-fisherman. Captain Dan Clark operated the *Gladiator* for the first three legs, followed by Captain Mike Reardon for the last leg. The *Northwest Explorer* was operated by Captain Shawn O'Brien for the entire survey, and the *Sea Storm* was operated by Captain Steve Branstiter for the first two legs and the final leg and by Captain Miles Cavanaugh for the third leg.

Stations were sampled with the RACE Division's standardized Poly-Nor'Eastern high opening bottom trawls rigged with roller gear. This trawl has a 27.2 m headrope with twenty-one 30 cm diameter floats and a 24.3 m long, ½-inch longlink alloy chain fishing line attached to a 24.9 m, 0.95 cm diameter 6×19 galvanized steel wire footrope. The roller gear is 24.2 m long and constructed of 1.9 cm diameter 6×19 galvanized steel wire rope and 36 cm rubber bobbins separated by a solid string of 10 cm rubber disks. In addition, 5.9 m wire rope extensions with 10- and 20 cm rubber disks were used to span each lower flying wing section. The trawls are constructed with 12.7 cm stretched-mesh polyethylene web with a 3.2 cm stretched-mesh nylon liner in the codend. Bridles consist of triple 54.9 m long, 1.6 cm diameter galvanized wire rope. Chain setback extensions to the headrope and side panel attachments are 46 and 23 cm, respectively. Steel 1.83 × 2.74 m V-doors weighing approximately 800 kg each are used to spread the net. Fishing dimensions of the trawls were measured using Scanmar¹ acoustic net mensuration equipment and fishing performance was monitored with electronic bottom contact sensors (BCS) and Seabird SBE-19 micro-bathythermographs.

¹ Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

SURVEY AREA

The standard biennial GOA survey area includes waters shallower than 1,000 m between the U.S.-Canada border at Dixon Entrance and the Islands of the Four Mountains, excluding the inside waters of Southeast Alaska. The total area covered by the standard survey is 320,006 km². The deepest standard strata (700-1,000 m) were omitted during the 2003 survey, reducing the total area this year by 4% to 308,416 km². Strata were defined in depth ranges of 1-100, 101-200, 201-300, 301-500, and 501-700 m, which comprised 40%, 42%, 12%, 4%, and 3% of the 2003 survey area, respectively.

SURVEY DESIGN AND METHODS

Similar to previous surveys of the same area, the 2003 GOA survey employed a stratified-random design utilizing 54 strata based on the 100, 200, 300, 500, and 700 m isobaths, major geographic features such as banks and gullies, and International North Pacific Fishery Commission (INPFC) regulatory areas. A modified Neyman optimum allocation strategy using data from previous GOA surveys was used to allocate effort between strata. Optimum allocation calculations were made for each of the principal groundfish species in each survey year based on that year's survey data and the estimated time to perform a tow in a given stratum as the cost variable (deeper tows take longer to execute and are more likely to require repeated tows to obtain a satisfactory sample; therefore they cost more). The mean of the resulting proportions was then calculated, resulting in an estimate of optimal allocation for each of the principal groundfish species. A weighted mean of these values was then calculated using the product of each species' current ex-vessel value times its biomass as the weighting variable. This determined the proportion of total survey effort allocated to each stratum which, when multiplied by the estimated available effort (total number of tows), determined the number of tows assigned to each stratum.

The target on-bottom duration for a standard trawl haul is 15 minutes. Trawling time on bottom was estimated during the tow using real-time net configuration data (wingspread and headrope height) acoustically transmitted to the vessel. GPS data were collected every two seconds throughout the tow. Temperature and depth were recorded every six seconds by a micro-bathythermograph attached to the trawl headrope. The BCS, a recording tilt sensor attached to the fishing line to detect contact with the bottom, collected data every six seconds. Final tow durations, start and end times and geographic positions were estimated from all available information collected from each tow.

The operational guidelines for successfully completing a standard survey tow are:

- 15 minutes towing time (distance fished approximately 1.4 km (0.74 nmi) at a speed of 3 knots).
- Appropriate length of trawl warp deployed, as specified in the standard survey scope table. The goal of each tow was to not exceed 10 m of depth change over

the 15 minute towing period.

- Net mensuration indicates fishing gear operating within normal limits, taking into account that the net width tends to increase and net height decreases as more trawl warp is deployed.
- Survey gear remains in continuous contact with the bottom.
- No significant hang-ups, gear damage or gear conflicts (e.g. crab pots).

Catches were sorted to species, weighed and counted according to standard RACE Division protocol. Extensive size composition data were collected with barcode based recording devices and downloaded to computer database files after each tow. A variety of biological data including age structures (otoliths and skate vertebrae), lengths, and weights of individual specimens were collected and entered in the computer database.

Special collection requests from researchers within the AFSC Groundfish Program, other research units, agencies and educational institutions included otoliths and corresponding biological data from Pacific halibut for the International Pacific Halibut Commission, stomachs and corresponding data for studies of trophic dynamics by the REFM Division, mollusc and sea star collections for the Los Angeles County Museum of Natural History, juvenile Pacific ocean perch for energetics studies related to habitat, specimens of various Steller sea lion prey species for fatty acid analyses by the University of Washington School of Aquatic and Fishery Sciences, specimens of pelagic prey species of seabirds for fatty acid analyses by the University of Alaska Fairbanks School of Fisheries and Ocean Sciences, and specimens of snailfish, bathymasterids, and selected *Bathyraja* species. Scientists aboard the vessels also collected information on sightings of short-tailed albatross, filed weather observations with the National Weather Service twice daily, and collected continuous echosounder data streams aboard the *Gladiator* and the *Sea Storm*.

RESULTS

Sampling proceeded from west to east. Some pre-assigned stations were not sampled due to unsuitable bottom conditions. In cases where trawlable bottom could not be found at a given station, an alternate location was sampled. Of the 877 standard survey tows attempted, 807 tows, ranging in depth from 13 m to 667 m, were successfully completed.

Arrowtooth flounder was by far the most abundant species survey-wide followed by Pacific halibut, Pacific ocean perch (POP), walleye pollock, giant grenadier, and Pacific cod (Table 2). POP was the only species among these to show an apparent decrease in biomass since 2001 in Western (WGOA) and Central GOA (CGOA) waters shallower than 500 m. The estimated biomass of arrowtooth flounder increased in this region by 87% since 2001. Nearly 78% of the estimated arrowtooth flounder biomass was found in the CGOA subarea. The estimated biomass of Pacific halibut increased by 50% since 2001. Two thirds of the estimated halibut biomass was

found in the CGOA, 18% was in the Eastern GOA (EGOA), and 16% in the WGOA. Pacific ocean perch biomass was distributed similarly (16/62/22% in WGOA, CGOA, and EGOA, respectively) and showed a 47% decline since 2001. Walleye pollock began to recover somewhat from a decade-long downward trend in abundance which saw its estimated biomass decline from 783,000 t in 1990 to 209,000 t in 2001. The estimated biomass of pollock increased by 84% since 2001 in the WGOA and CGOA. Pollock distribution exhibited a 50/41/9% split among the WGOA, CGOA, and EGOA areas, respectively.

Throughout the survey, biological data were collected from many species with length measurements being the most common. Nearly 280,000 fish representing 90 species were measured for length, including approximately 74,000 arrowtooth flounder, 26,000 flathead sole, 25,000 pollock, 24,000 rock sole (northern and southern combined), 18,500 Pacific ocean perch, 18,000 rex sole, 16,500 shortspine thornyheads, 13,000 Pacific halibut, and 9,000 Pacific cod (Table 3). Approximately 11,200 otoliths were collected from 21 species along with 13,000 length-weight observations representing 51 species. In addition, a total of 159 fish and 190 invertebrate specimens were collected and vouchered for systematics analysis and identification.

Size composition estimates for the entire GOA are presented in Figure 2 for five of the most abundant groundfish species. Arrowtooth flounder were well represented at all sizes between 20 and 60 cm. Similarly, Pacific halibut were abundant at all sizes between 35 and 80 cm, but particularly between 35 and 50 cm. A strong mode of small pollock at around 20 cm was evident in addition to a broader mode between 35 and 60 cm. The Pacific cod size distribution was similar to that of pollock, with a weaker mode around 20 cm and a broad mode between 40 and 65 cm. The size distribution of POP was dominated by a strong mode at 35-40 cm with small modes between 10 and 30 cm.

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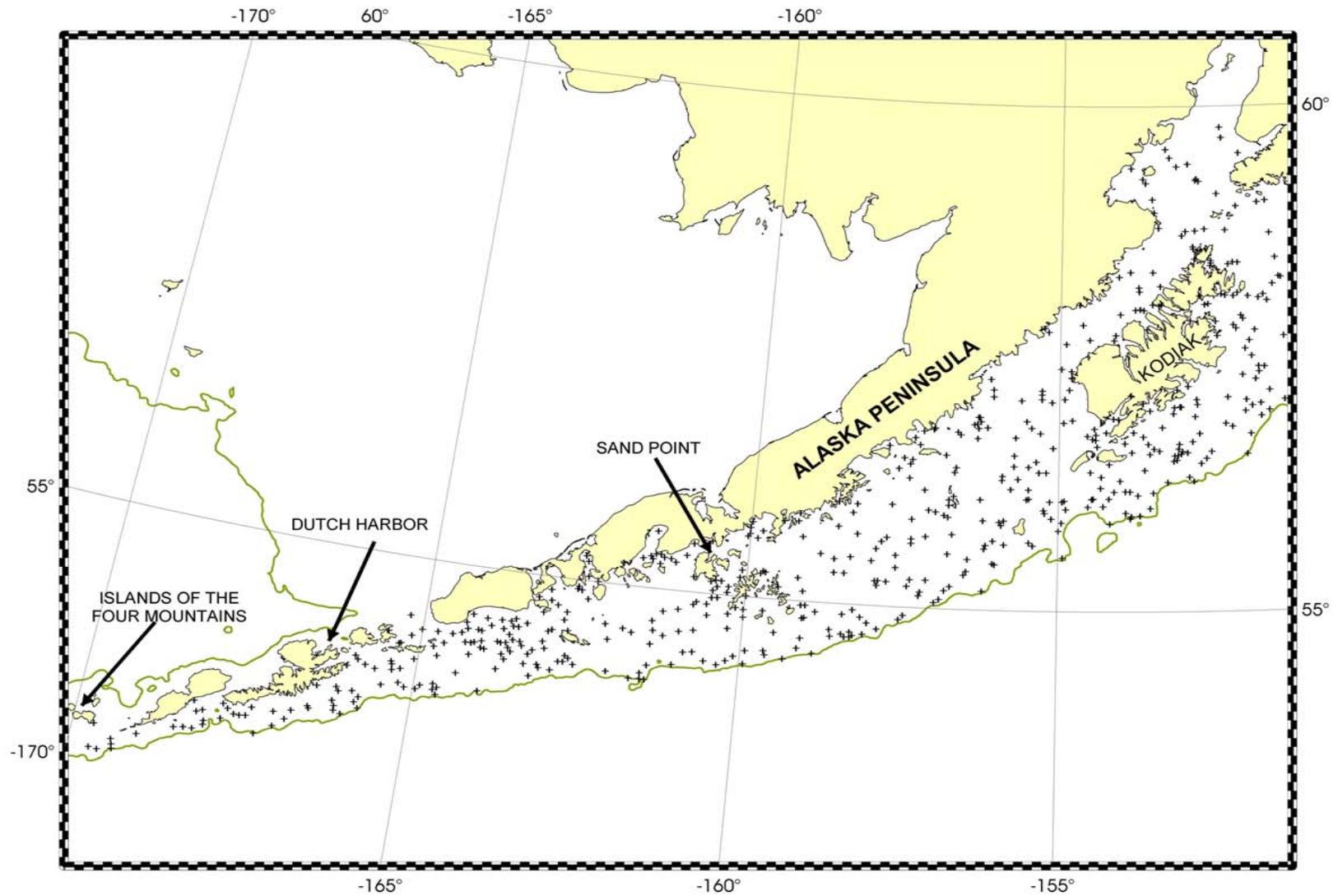


Figure 1.—Locations of stations successfully sampled during the 2003 biennial bottom trawl survey of groundfish resources in the Gulf of Alaska (western half of survey area).

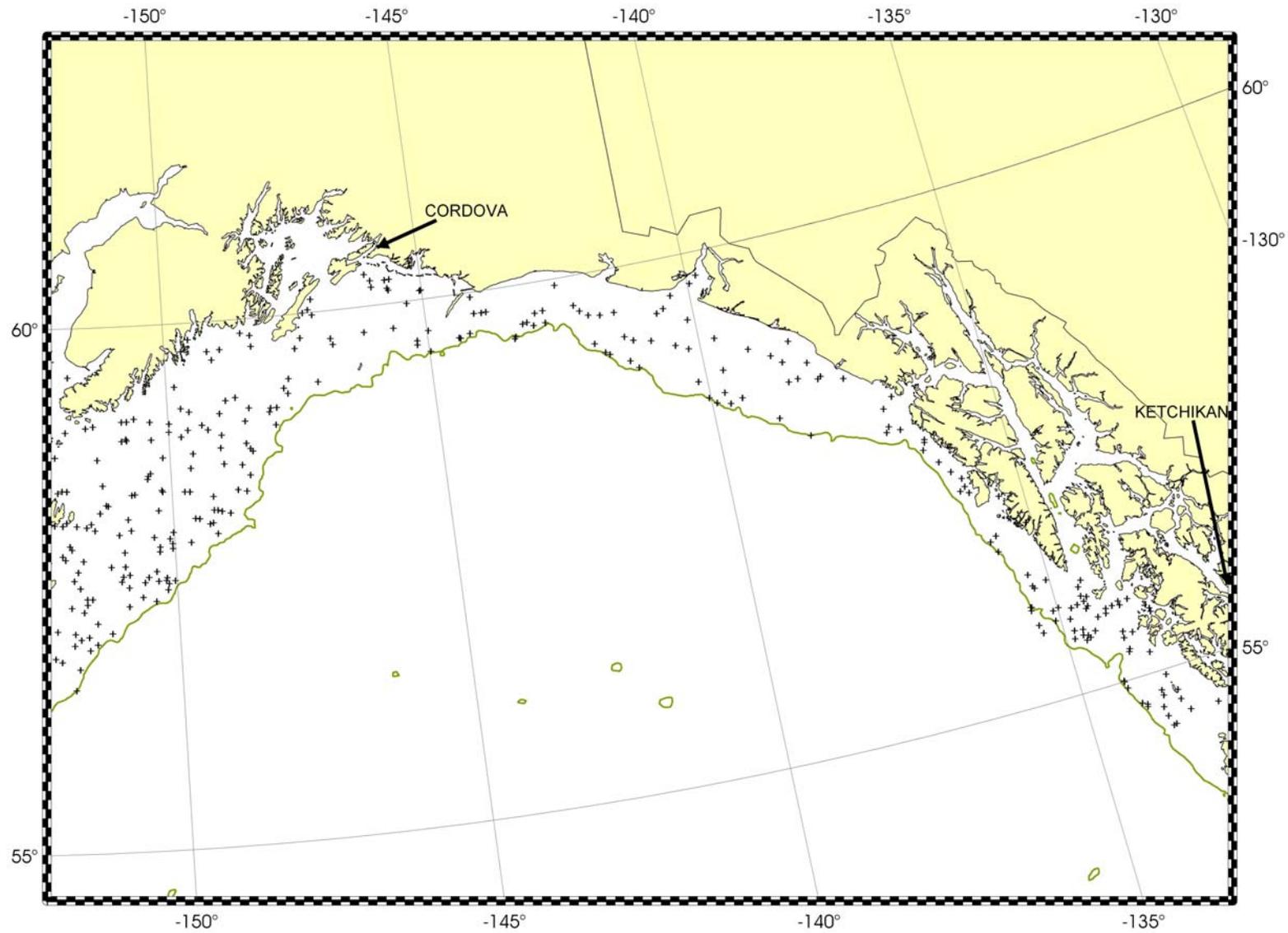


Figure 1 (continued).—Locations of stations successfully sampled during the 2003 biennial bottom trawl survey of groundfish resources in the Gulf of Alaska (eastern half of survey area).

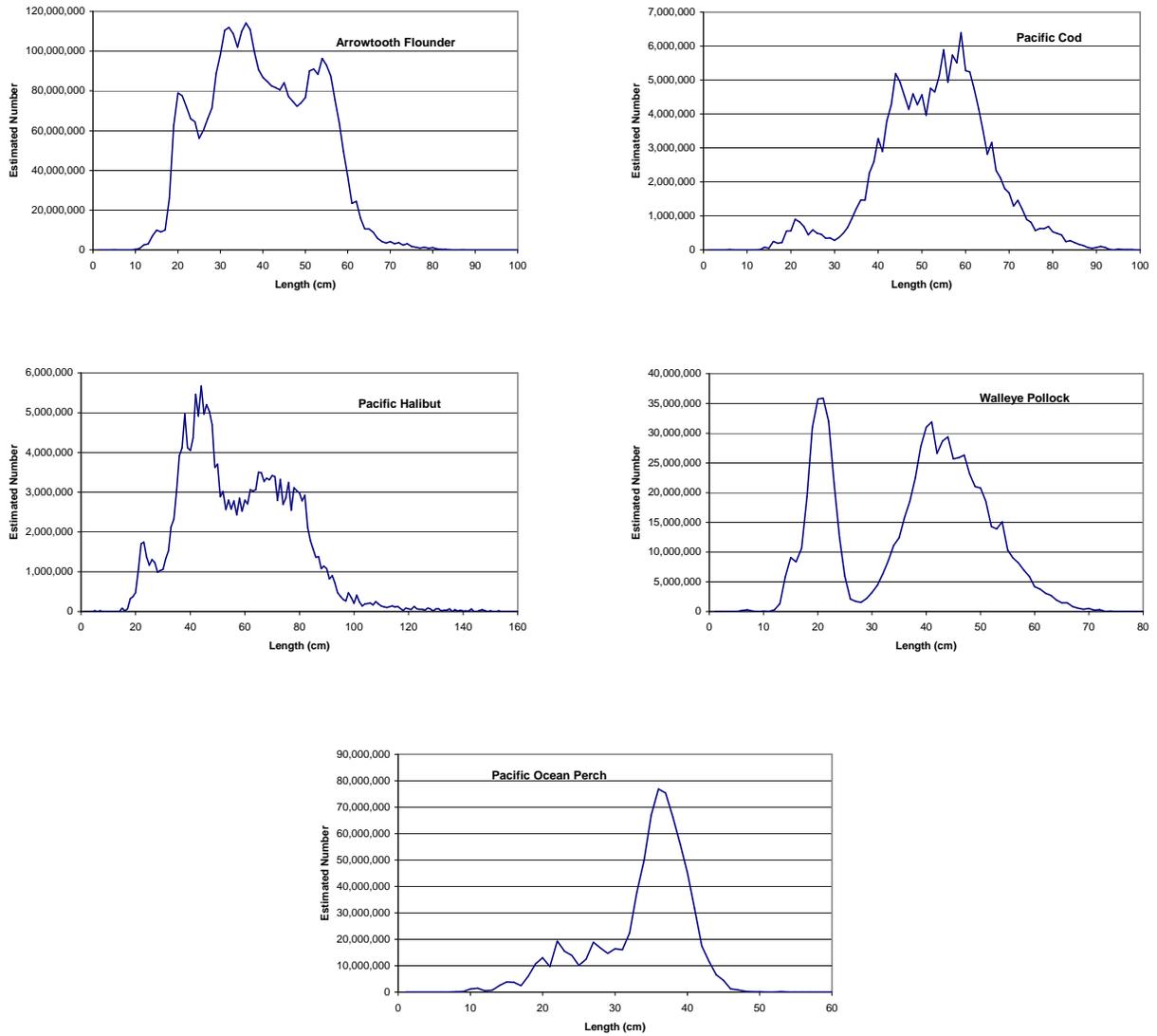


Figure 2.– Estimated size compositions for five of the most abundant groundfish from the results of the 2003 biennial bottom trawl survey of groundfish resources in the Gulf of Alaska.

Table 1.– Scientific staff and affiliations for the 2003 Biennial Bottom Trawl Survey of Groundfish Resources of the Gulf of Alaska.
 Bolded names indicate Field Party Chief.

	<u>Leg 1</u>	<u>Leg 2</u>	<u>Leg 3</u>	<u>Leg 4</u>
<i>Gladiator</i>	Bill Flerx	Bill Flerx	Jay Orr	Liz Chilton
	Chris Rooper	Alisa Abookire	Paul von Szalay	Dennis Benjamin
	Mark Zimmermann	Scott McKillip	Vanessa Lowe	Scott McKillip
	Mei-sun Yang ¹	Dana Hanselman ²	Stephanie Korn ¹	Chris Johnston
	Paul Logan ³	Paul Logan ³	Paul Logan ³	Paul Logan ³
	Kai Palenscar ⁴	Ivonne Ortiz ¹	Brooke Martin	Dan Garrett
<i>Northwest Explorer</i>	Bob Lauth	Liz Chilton	Skip Zenger	Frank Shaw
	Robin Harrison	Eric Brown	Jim Stark	Lyle Britt
	Jay Orr	Duane Stevenson	Bob McConnaughey	Jake Gregg ¹
	Paul Von Szalay	Cynthia Yeung	Delsa Anderl ¹	Jerry Berger ¹
	Frank Shaw	Katherine Pearson	Jennifer Ferdinand ¹	Emily Thompson
	Ned Laman	Sarah Gaichas ¹	Ron Erickson	Kathryn Sobocinski
<i>Sea Storm</i>	Nate Raring	Michael Martin	Nate Raring	Bill Flerx
	Michael Martin	Ron Payne	Jason Conner	Jason Conner
	Jim Stark	Jason Conner	George Cronin	Tyler Yasenak
	Roger Clark	Keith Smith	Larry Haaga	Dan Decker ¹
	Lee Hulbert ²	Matt Kookesh	Jon Short ¹	Roger Clark
	Hillary Emberton ³	Hillary Emberton ³	Hillary Emberton ³	Hillary Emberton ³

All personnel are from the AFSC RACE Division unless otherwise indicated.

1. AFSC Resource Ecology and Fisheries Management Division (REFM), Seattle, WA
2. AFSC Auke Bay Laboratory, Auke Bay, AK
3. International Pacific Halibut Commission, Seattle, WA
4. California Academy of Sciences, San Francisco, CA
5. Visiting Scientist, Oregon State University, Newport, OR
6. Visiting scientist, University of Washington, Seattle, WA

Table 2.– Estimated biomass (t) of selected species from the 2003 Biennial Bottom Trawl Survey of Groundfish Resources of the Gulf of Alaska.

Species	Regulatory Area Estimated Biomass (t)			Total
	Western GOA	Central GOA	Eastern GOA	
Arrowtooth flounder	341,620	2,198,828	282,379	2,822,828
Pacific halibut	99,390	418,494	116,332	634,217
Pacific ocean perch	72,851	283,045	101,498	457,394
Walleye pollock	213,291	173,753	37,475	424,519
Giant grenadier	147,494	191,590	57,816	396,900
Pacific cod	75,052	207,619	14,689	297,361
Flathead sole	67,055	172,167	19,388	258,609
Sablefish	18,415	175,676	46,073	240,164
Sharks unident.	15,325	100,944	38,810	155,079
Southern rock sole	55,116	65,251	6,900	127,267
Eulachon	1,610	95,014	16,882	113,506
Shortspine thornyhead	20,922	53,250	27,404	101,576
Rex sole	13,265	58,027	28,659	99,950
Dover sole	3,149	49,314	46,865	99,327
Northern rock sole	43,127	36,871	0	79,998
Light dusky rockfish	4,039	53,927	12,896	70,862
Northern rockfish	9,146	57,218	5	66,368
Atka mackerel	59,374	5,646	514	65,533
Starry flounder	5,355	49,793	3,382	58,530
Big skate	9,602	33,864	11,980	55,447
Yellowfin sole	42,178	12,560	0	54,738
Silvergray rockfish	0	65	51,851	51,916
Rougheye rockfish	8,921	24,617	9,670	43,208
Shortraker rockfish	11,166	17,288	13,568	42,023
Longnose skate	782	25,856	13,080	39,718
Butter sole	3,370	25,123	2,655	31,148
Lingcod	0	4,499	26,496	30,995
Sculpin unident.	13,150	13,137	345	26,632
Spotted ratfish	0	0	18,600	18,600
English sole	334	5,363	12,135	17,832
Aleutian skate	4,401	10,772	640	15,813
Chum salmon	526	14,103	193	14,821
Pacific herring	30	637	10,303	10,970

Table 3.– Biological data (individual lengths and weights and age structures) collected during the 2003 Biennial Bottom Trawl Survey of Groundfish Resources of the Gulf of Alaska.

Species	Number Measured	Number Weighed	Number of Otoliths	Species	Number Measured	Number Weighed	Number of Otoliths
<i>Lamna ditropis</i>	2	1		<i>Microgadus proximus</i>	490		
<i>Squalus acanthias</i>	1,157	407		<i>Gadus macrocephalus</i>	9,125	737	737
<i>Somniosus pacificus</i>	27	22		<i>Antimora microlepis</i>	20		
<i>Bathyraja sp.</i>	1	1		<i>Theragra chalcogramma</i>	25,324	1,120	1,123
<i>Raja binoculata</i>	179	166		<i>Ophiodon elongatus</i>	264	14	
<i>Bathyraja interrupta</i>	105	101		<i>Pleurogrammus monopterygius</i>	2,349	488	490
<i>Raja rhina</i>	276	250		<i>Hexagrammos stelleri</i>	5		
<i>Bathyraja parmifera</i>	22	19		<i>Hexagrammos decagrammus</i>	53		
<i>Bathyraja aleutica</i>	128	107		<i>Merluccius productus</i>	393		
<i>Bathyraja maculata</i>	3	1		<i>Thaleichthys pacificus</i>	4,045	171	
<i>Citharichthys sordidus</i>	237			<i>Mallotus villosus</i>	1,165	15	
<i>Atheresthes stomias</i>	73,705	1,034	1,038	<i>Oncorhynchus tshawytscha</i>	108	13	
<i>Atheresthes evermanni</i>	5			<i>Oncorhynchus kisutch</i>	12	2	
<i>Reinhardtius hippoglossoides</i>	1			<i>Oncorhynchus gorboscha</i>	7		
<i>Hippoglossus stenolepis</i>	13,256	16	284	<i>Oncorhynchus keta</i>	323	24	
<i>Hippoglossoides elassodon</i>	25,905	1,015	1,016	<i>Oncorhynchus nerka</i>	23		
<i>Lyopsetta exilis</i>	608	57		<i>Zaprora silenus</i>	70	2	2
<i>Eopsetta jordani</i>	165	6		<i>Sebastolobus alascanus</i>	16,547	710	710
<i>Parophrys vetulus</i>	1,214			<i>Sebastolobus altivelis</i>	812		
<i>Microstomus pacificus</i>	6,791	510	510	<i>Sebastes aleutianus</i>	3,030	534	534
<i>Embassichthys bathybius</i>	14			<i>Sebastes alutus</i>	18,479	1,346	1,364
<i>Glyptocephalus zachirus</i>	17,916	602	602	<i>Sebastes brevispinis</i>	848	94	91
<i>Limanda aspera</i>	3,477			<i>Sebastes ciliatus</i>	26	4	4
<i>Platichthys stellatus</i>	1,109			<i>Sebastes variabilis</i>	1,889	407	277
<i>Psettichthys melanostictus</i>	97			<i>Sebastes cramerii</i>	8		
<i>Lepidopsetta polyxystra</i>	11,097	520	521	<i>Sebastes diploproa</i>	4		
<i>Lepidopsetta bilineata</i>	12,523	582	582	<i>Sebastes elongatus</i>	175	44	
<i>Isopsetta isolepis</i>	2,962	2		<i>Sebastes entomelas</i>	2		
<i>Pleuronichthys decurrens</i>	5			<i>Sebastes flavidus</i>	24		
<i>Pleuronectes quadrituberculatus</i>	367			<i>Sebastes helvomaculatus</i>	238	79	
<i>Anoplopoma fimbria</i>	5,743	486	492	<i>Sebastes maliger</i>	25		
<i>Bathymaster signatus</i>	70			<i>Sebastes melanops</i>	28		
<i>Clupea pallasii</i>	574	3		<i>Sebastes nigrocinctus</i>	1		
<i>Coryphaenoides acrolepis</i>	34			<i>Sebastes paucispinis</i>	2		
<i>Albatrossia pectoralis</i>	3,343			<i>Sebastes pinniger</i>	42	23	
<i>Coryphaenoides cinereus</i>	433			<i>Sebastes polyspinis</i>	3,182	276	276
<i>Gymnocanthus galeatus</i>	4			<i>Sebastes proriger</i>	944		
<i>Malacocottus zonurus</i>	2			<i>Sebastes ruberrimus</i>	39	1	
<i>Hemilepidotus jordani</i>	1,423	276		<i>Sebastes babcocki</i>	324	49	
<i>Triglops forficata</i>	18			<i>Sebastes saxicola</i>	9		
<i>Myoxocephalus polyacanthocephalus</i>	223	16		<i>Sebastes variegatus</i>	818		
<i>Myoxocephalus jaok</i>	95	2		<i>Sebastes wilsoni</i>	58		
<i>Dasycottus setiger</i>	15			<i>Sebastes zacentrus</i>	1,453	50	50
<i>Hemitripterus bolini</i>	84	20		<i>Sebastes borealis</i>	1,112	460	494
<i>Trichodon trichodon</i>	28			<i>Sebastes reedi</i>	50	42	

