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# Data Report: 2007 Gulf of Alaska Bottom Trawl Survey

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P. G. von Szalay, M. E. Wilkins, and M. H. Martin

**U.S. DEPARTMENT OF COMMERCE**
National Oceanic and Atmospheric Administration
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## PREFACE

This data report is one of three types of standard reports presenting data from the 2007 Gulf of Alaska groundfish survey conducted by the National Marine Fisheries Service (NMFS). The three standard reports are:

1) **Cruise Report** outlines the survey objectives; documents itinerary, personnel, and vessels employed; and summarizes major accomplishments.

2) **Report to Industry** is a fishing log consisting of raw haul and catch data for each haul made during the survey, catch summaries for the major species, catch per unit effort by haul, and gear specifications and diagrams.

3) **Data Report** (this document), contains detailed descriptions of the survey planning and operation, species distribution and abundance charts, length frequency plots, tables of estimated biomass, catch per unit effort, average weight and length estimates, length frequency plots, length-weight regression parameters, list of identified species, survey strata specifications and charts, and trawl descriptions and diagrams.

**ABSTRACT**

Scientists of the Groundfish Assessment Program of Alaska Fisheries Science Center's Resource Assessment and Conservation Engineering (RACE) Division conducted the fifth biennial groundfish assessment survey of the Gulf of Alaska during the summer of 2007. These surveys extend the series of surveys, previously conducted every three years between 1984 and 1999, which comprise the time series used in stock assessments of Gulf of Alaska groundfish resources. The survey area covered the continental shelf and upper continental slope to 1,000 m in the Gulf of Alaska from Islands of Four Mountains (170°W long.) to Dixon Entrance (132°40'W long.). The survey was conducted aboard three chartered commercial trawlers, the F/V *Gladiator*, F/V *Sea Storm*, and F/V *Vesteraalen*. Trawl haul samples were collected successfully at 820 survey stations using standard RACE Division Poly Nor'Eastern high-opening bottom trawl nets with rubber bobbin roller gear.

The primary survey objectives were to define the distribution and estimate the relative abundance of the principal groundfish within the survey area and to collect data to estimate biological parameters useful to groundfish researchers and managers including age, growth, length-weight relationships, feeding habits, and size, sex, and age composition. The survey also collected ancillary data requested by other research groups. A total of 185 fish and 415 invertebrate species were captured in survey tows. Arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), giant grenadier (*Albatrossia pectoralis*), Pacific halibut (*Hippoglossus stenolepis*), and walleye pollock (*Theragra chalcogramma*) were, in order, the

most abundant species within the survey area. Northern rockfish (*Sebastes polyspinus*), Pacific cod (*Gadus macrocephalus*), sablefish (*Anoplopoma fimbria*), and flathead sole (*Hippoglossoides elassodon*) were locally abundant in some areas. Survey results are presented including estimates of catch per unit of effort, biomass, population size composition, and length-weight relationships, as well as charts depicting the distribution of catch for commercially important species encountered during the survey.

# CONTENTS

# INTRODUCTION

The fifth biennial groundfish survey of groundfish and invertebrate resources of the Gulf of Alaska (GOA) was conducted during the summer of 2007 by the National Marine Fisheries Service's (NMFS) Alaska Fisheries Science Center (AFSC). Scientists from the Groundfish Assessment Program of AFSC's Resource Assessment and Conservation Engineering (RACE) Division in Seattle, Washington, were responsible for the survey's design and operations. The biennial regimen extends the series begun in 1984, previously conducted every three years between 1984 and 1999, that have provided an information time series of distribution, abundance, and biological characteristics of GOA groundfish resources.

In this report, we document the operations and results of the 2007 GOA bottom trawl survey. Results of routine analyses of distribution, relative abundance, size composition, and biological characteristics are shown for the principal groundfish species in each of the five International North Pacific Fisheries Commission (INPFC) statistical areas in the GOA: Shumagin, Chirikof, Kodiak, Yakutat, and Southeastern. These results provide stock assessment scientists and resource managers the most current information to be used for subsequent stock assessments. Only the 2007 survey results are presented and no comparisons are made to previous GOA surveys.

The survey objectives were to:

**1**) Delineate the distributions of major groundfish and commercially important invertebrate species inhabiting the continental shelf and upper continental slope of the GOA in depths ≤ 1,000 m.

**2**) Collect data used to estimate the abundance of the major groundfish species.

**3**) Collect data on specific biological characters of interest to researchers and resource managers including:

- size, sex, and age composition
- growth and length-weight relationships
- food habits

**4)** Collect specimens and related information for special research projects on behalf of researchers at the Resource Assessment & Conservation Engineering (RACE), Resource Ecology & Fisheries Management (REFM), and Auke Bay Laboratories divisions of the Alaska Fisheries Science Center, the Alaska SeaLife Center, Sheldon Jackson College, the International Pacific Halibut Commission, Oregon State University, and the Northwest Fisheries Science Center. The projects included:

- A study of how the condition of Pacific ocean perch larvae is affected by the age and size of adult female spawners;
- Taxonomic studies of snailfish, eelpouts, cephalopods, crab, and sand lance;
- Genetic studies of Pacific ocean perch, ronquils, flatfishes, gadoids, forage fishes, and deepwater corals;
- A study on the relative trophic levels of Pacific sleeper shark;

- A study of light levels at trawl stations;
- A study of marine mammal food habits;
- A seabird/fishery interaction study;
- A study of arrowtooth flounder seasonal energetics.

## METHODS

### Survey Area

The Gulf of Alaska forms the northeastern border of the Pacific Ocean and consists of complex bathymetric features ranging from jagged, mountainous pinnacles to flat, muddy areas. These features provide a variety of habitats resulting in a complex ecosystem mosaic (Fig. 1). Prevailing rough bottom conditions in many areas require the standard use of rubber bobbin roller gear for all bottom trawling operations. The 2007 GOA survey included the entire continental shelf and upper portion of the continental slope down as deep as the 1,000 m depth contour.

The total area the survey represents is approximately 320,000 km$^2$ (Table 1). The continental shelf, waters shallower than about 200 m and consisting of about 79% of the total Gulf of Alaska survey area, extends approximately 220 km (120 nautical miles (nmi)) off Cook Inlet and narrows to 40 km (22 nmi) off Dixon Entrance and 20 km (11 nmi) off the Islands of Four Mountains. Gullies intrude onto the shelf in many areas, extending from the upper slope to the inner shore. These gully areas make up about 16% of the total survey area. The outer shelf is bordered by the continental slope, a region approximately 20 km in width, which descends steeply to the abyssal Aleutian Trench in the western and central GOA and to the Alaska Plain in the eastern GOA. The survey assessed only that portion of the slope between 200 and 1,000 m, an area of approximately 68,635 $km^2$. About 32% (101,489 $km^2$) of the total survey area is within the Kodiak INPFC area (Table 1). The portion of the survey area contained within the Chirikof INPFC area and the Shumagin INPFC area are approximately equal at about 21% (68,053 $km^2$) and 20% (65,228 $km^2$), respectively, while the Yakutat INPFC survey area makes up about 18% (57,197 $km^2$). The Southeastern INPFC survey area comprises the smallest portion, about 9% of the total survey area (28,038 $km^2$).

## Vessels

Since the inception of the Gulf of Alaska bottom trawl survey series in 1984, commercial trawlers and crew have been chartered to conduct the survey operations under the supervision and guidance of RACE Groundfish Assessment Program staff. Three vessels (occasionally two) have been chartered each year the survey has been done. Since these surveys generate quantitative data for a time series to describe trends in abundance, distribution, and population biology characteristics of managed resources, it is essential that standardized methods be maintained. Stringent standards for selecting charter vessels are specified whenever new charters are arranged to ensure that the sampling platforms can adequately collect samples and do so in as similar a manner as possible within and between years. As such, vessels and crews must meet minimum criteria in terms of size, main engine horsepower, fishing machinery, skipper and crew experience, and navigational and safety equipment. Continuity of suitable

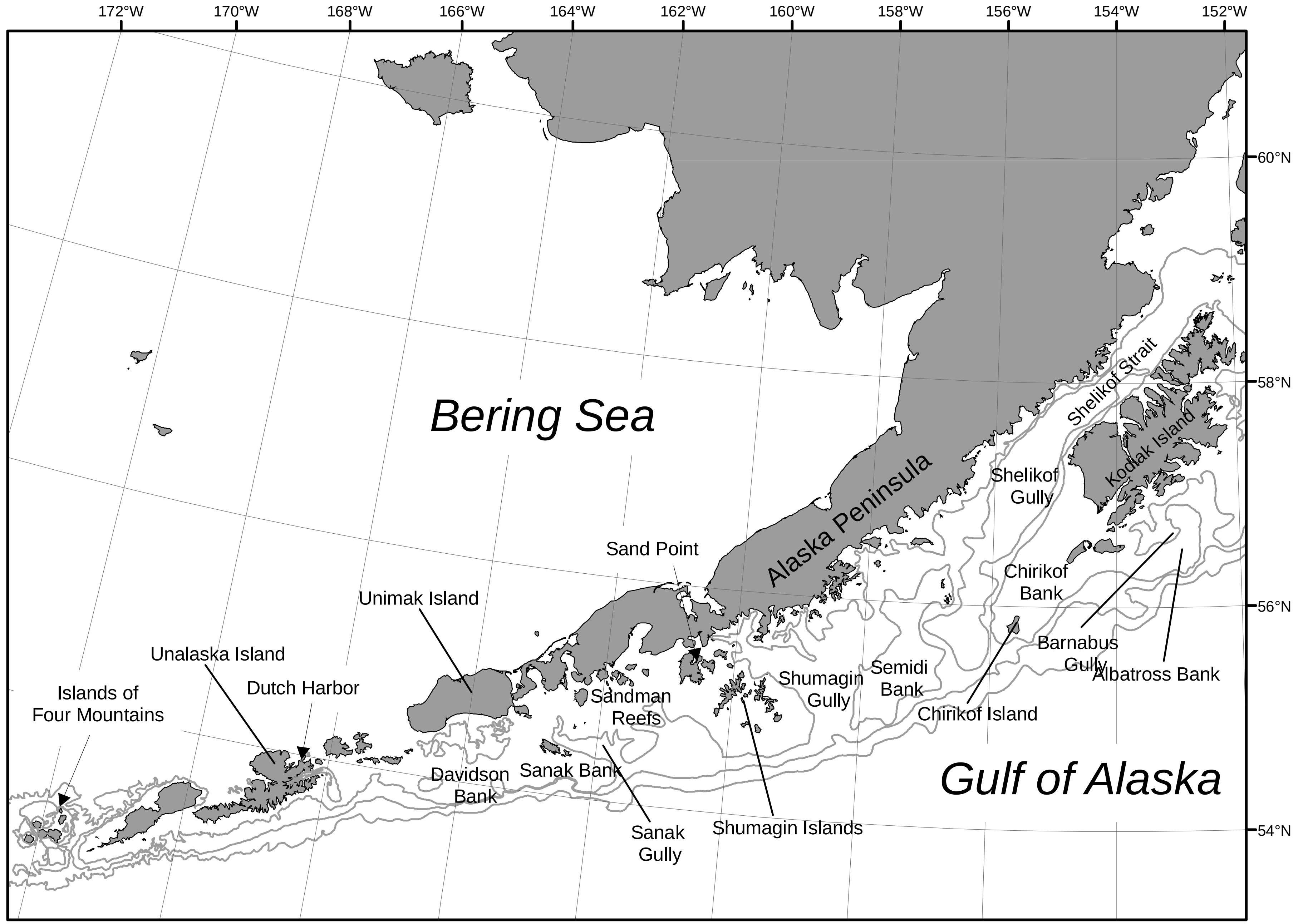


Figure 1.-- Bathymetric and geographic features of the survey area for the 2007 Gulf of Alaska biennial groundfish survey.

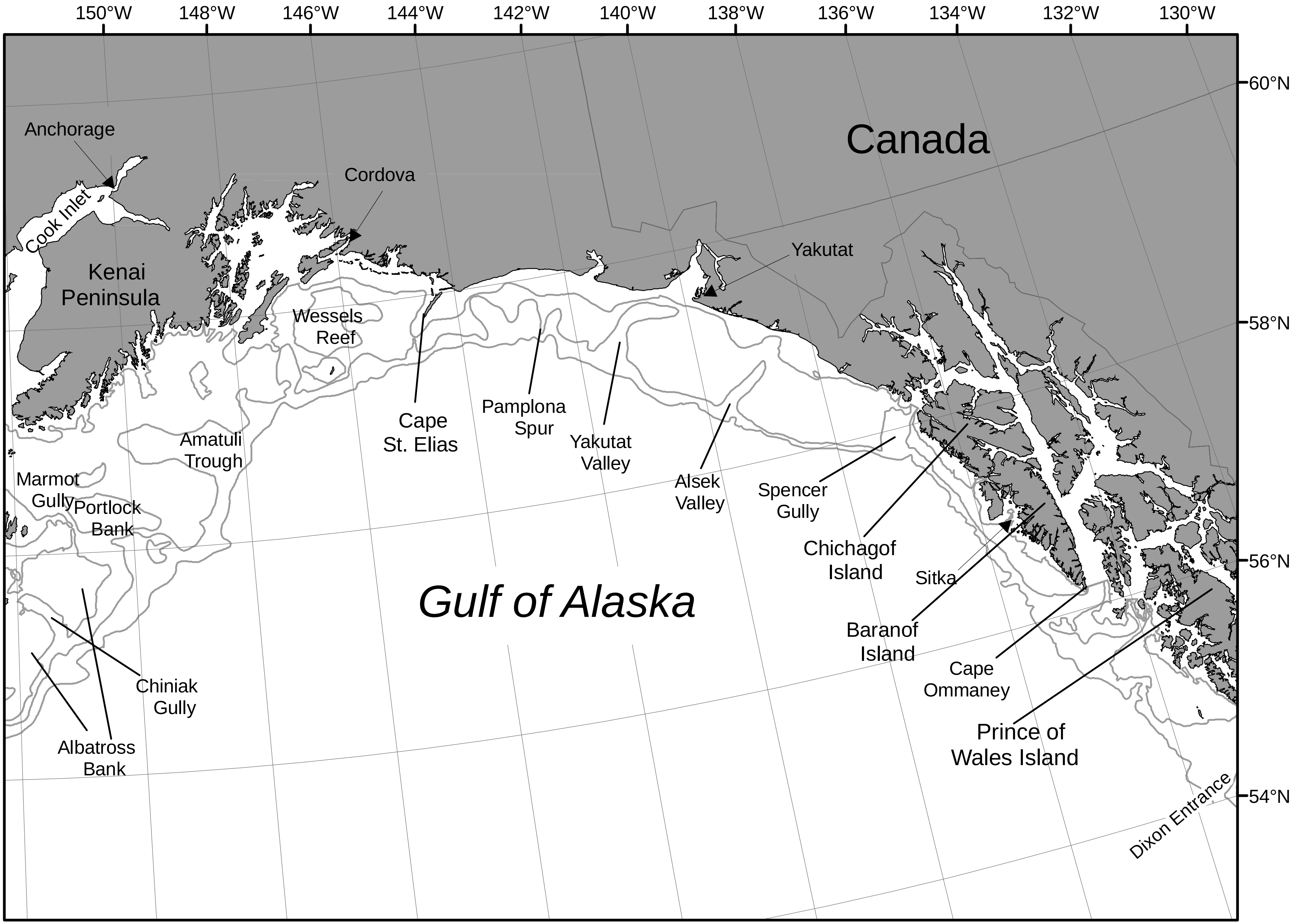


Figure 1. -- Continued.

platforms has been further enhanced in the past decade through the use of multi-year charters, assuring both the government and the contractors a stable planning situation for as much as four years at a time.

In 2007, three U.S. commercial fishing vessels, F/V *Gladiator*, F/V *Sea Storm,* and F/V *Vesteraalen* were chartered to conduct the Gulf of Alaska bottom trawl survey. All three vessels were house-forward stern trawlers with stern ramps; forward and aft net storage reels (mounted aft over the stern ramp and forward of the working deck); telescoping deck cranes; propeller nozzles; and paired, controlled-tension hydraulic trawl winches with 1,280 m, 1,460 m, and 2,200 m of 2.54 cm (*Gladiator, Sea Storm, and Vesteraalen*, respectively) diameter steel cable. The *Gladiator*, *Sea Storm,* and *Vesteraalen* are all 37.8 m in overall length (LOA) and powered by single 1,710 continuous HP main engines (1,725 HP on the *Vesteraalen*). The *Gladiator* was operated by Captain Ed French for the first and fourth legs and by Captain Buck Graham for the second and third legs. Captain Ken Sjong skippered the *Vesteraalen* for the first three legs, followed by Captain Tim Cosgrove on the final leg. The *Sea Storm* was operated by Captain Steve Branstiter for the first, second, and fourth legs, and by Captain Jerry Ellefson for the third leg. All vessels were equipped with GPS receivers with video position plotters, at least two radars, single sideband and VHF transmitter-receivers, color video fish-finders, paper recorder depth sounders, and autopilots.

## Fishing Gear

The fishing gear and protocols for deployment are described in detail in Stauffer (2004).

All vessels used standard RACE Division Poly Nor'Eastern four-seam bottom trawls with 24.2 m roller gear constructed with 36 cm rubber bobbins separated by 10 cm rubber disks. The fishing dimensions of the trawls during deployment were monitored and recorded using Scanmar acoustic net mensuration equipment mounted on the wing-tips and headrope of the trawl. Each trawl and associated rigging was measured and certified as conforming to standard measurements prior to its use in the survey.

## Survey Design

The 2007 biennial survey used stratified random sampling consistent with previous GOA surveys (Britt and Martin 2000, Martin and Clausen 1995, Stark and Clausen 1995, Munro and Hoff 1995). The Gulf of Alaska was divided into 59 strata defined by water depth, bottom terrain (e.g., shelf, gully, and slope), and INPFC statistical area (Appendix A). As in previous surveys, a modified Neyman optimal allocation strategy (Cochran 1977) catch rates from the 1990-2005 surveys was used to allocate effort among strata. Neyman optimum allocation calculations were made for each of the principal groundfish species for each previous survey year using the estimated time to perform a tow in a given stratum as the cost variable, since observations in deeper strata have a greater probability of unacceptable gear performance. A mean sample size was estimated for each species across years and then a weighted mean of the estimated sample sizes was calculated using each species's mean biomass multiplied by its ex-vessel value as the weighting variable. These numbers were rounded to whole numbers and represented the number of stations allocated to each stratum with the additional constraint that each stratum was required to have at least two samples.

The calculated number of stations was randomly selected without replacement from polygons formed from the intersection of a grid composed of cells 25 $km^2$ in area and the stratum boundaries. Since many of the polygons formed by this process are less than 25 $km^2$, the probability of selection was directly related to each polygon's area. Small polygons (less than 5 $km^2$ in area) were excluded from the pool available for assignment since a vessel would be unable to perform a valid tow within such a small area. To maximize efficient use of survey time and optimize fuel consumption, assignment of tows to vessels was non-random in the Central GOA where the shelf is nearly 200 km wide in places. In general, the *Vesteraalen* was assigned to sample the outer shelf and slope stations, the *Gladiator* the middle shelf stations, and the *Sea Storm* the near-shore stations. However, tows in all strata, with the exception of those between Kodiak Island and Cook Inlet, were assigned randomly between at least two boats.

We allocated 825 stations among the 59 strata. Geographic center points of the assigned station polygon were considered to define the location of the station. Vessels were assigned stations and were directed to thoroughly search each area using echosounder returns to locate sufficient trawlable bottom to perform a successful 15-minute tow, preferably through the center point. If trawlable bottom could not be found in the immediate area of the assigned point, a suitable location within the station polygon was sought. If, in the judgment of the field party chief and skipper, no trawlable grounds could be found within the polygon within 2 hours, a nearby alternate station was selected from successful tows completed during previous GOA surveys. If sufficient trawlable bottom was encountered while transiting to the alternate site, this location was instead selected for the sample.

## Data Collection Techniques

The protocols used by the AFSC's RACE Division for conducting bottom trawl surveys have been standardized (Stauffer 2004). Criteria for a successful tow include maintaining a continuous vessel speed of 3 knots (5.56 m/sec) while keeping the net in contact with the bottom and in fishing configuration for 15 minutes. Occasionally, tows of shorter duration were necessary to avoid obstacles (and, hence, net damage) or when net configuration (e.g., reduced wing spread) indicated that an exceptionally large catch was affecting the performance of the trawl. The track of the vessel was recorded every 2 seconds during each tow using the vessel's global positioning system (GPS). Pressure at depth, water temperature, and time were recorded every 3 seconds during most tows using a Seabird SBE-39 bathythermograph placed on the headrope of the net. The vertical and horizontal net openings were monitored with Scanmar net mensuration equipment. Scanmar net spread data were generally not collected for tows over extremely rough bottom so as not to risk losing the instruments. Backup surface water temperatures were measured at most stations with a bucket thermometer. To minimize fishing power differences between the survey vessels, standardized trawling and gear handling methods were practiced including the use of scope ratio tables (trawl warp relative to bottom depth) and maintaining a 3-knot trawling speed.

A trawl sample was considered successful if horizontal and vertical net openings remained within established tolerances, the roller gear maintained consistent contact with the bottom, the net suffered little or no damage during the tow, and there were no conflicts with derelict fishing gear. Trawl samples were considered unsuccessful when the field party chief judged that the catch was affected by trawl damage, an unstable trawl configuration, insufficient bottom contact, in the event the duration of the tow was less than 10 minutes.

## Collection and Processing of Samples

Catches were sorted to species or other appropriate taxonomic levels and then weighed in aggregate using an electronic monion-compensating scale. Catches weighing less than approximately 1,000 kg were emptied directly onto a sorting table, sorted by species, and weighed to the nearest 0.1 kg using a Marel model M1100 digital scale. Species groups weighing less than about 2 kg were generally weighed to the nearest 2 g on a Marel model M60 digital scale. Larger catches were processed in like manner by iteratively filling the sorting table from the codend, sorting, and weighing until the entire catch had been processed. Alternatively, the total weight of the catch was weighed with Measurement Systems International Portaweigh Model 4300 crane scale and the sorting table was filled with a portion of the catch. The excess catch was dumped into a deck bin and the one-three dominant species making up the bulk of the catch were identified. The contents of the deck bin were sorted, discarding the predominant species and retaining the non-dominant species, which were sorted and weighed with those from the table. Total weight estimates for the predominant species were calculated by expanding their proportion by weight from the sorted sample to the difference between the total catch weight and the total weight of all non-dominant species. Pacific halibut were measured and discarded as promptly as possible and their weights were estimated from the length data. Numbers and weights of all taxa were estimated for each haul.

Additional biological information was recorded from individuals of species of commercial value, ecological importance, or abundance in the survey area. A random subsample of 100-300 individuals (target subsample size was species-dependent) of each of these species identified in the catch was sorted by sex and individual fork lengths (FL) were measured using Polycorder (Omnidata) data loggers with barcode readers and barcoded length strips. Fish that could not be readily sexed were classified as unsexed and measured. Age structures were collected from randomly selected samples of walleye pollock (See Appendix Table B-1 for scientific names of fish species) and stratified samples (by area, sex, and size) of other target species. Every attempt was made to distribute the age specimen collections over the entire survey area. Individuals sampled for age were measured to the nearest 1 cm (FL) and weighed to the nearest 2-5 g (scale accuracy depends on the weight of the specimen) with a Marel model M60 scale.

Stomach samples for selected species were collected throughout the survey area by biologists from the AFSC's Resource Ecology and Ecosystem Modeling (REEM) Program aboard the *Vesteraalen*. In addition, stomach samples for selected species were scanned for their content aboard the *Sea Storm* by REEM staff. Ancillary data and specimens including whole specimens, ovaries, a variety of tissues, and acoustic data, were collected for several other research projects including a study of how size and age of adult female Pacific ocean perch effect the condition of their larvae, taxonomic studies of snailfish, eelpouts, cephalopods, crabs, and sand lance, genetic studies of Pacific ocean perch, ronquils, several species of flatfishes, gadoids, forage fishes, and deepwater corals. Additional studies included a Pacific sleeper shark study on relative trophic levels, studies of light level variability, marine mammal food habits, seabird abundance, and the seasonal energetics of arrowtooth flounder.

## Abundance, Size composition, and Length-Weight Relations

Biomass estimates were calculated using the area-swept method (Alverson and Pereyra 1969). The area swept was calculated as the product of estimated distance towed by the estimated mean net spread for each tow. The distance towed was assumed to be represented by the distance traveled over ground by the vessel between the time when the footrope came into contact with the bottom (on-bottom) and the time when the center of the footrope left the bottom (off-bottom). The distance traveled by the vessel was estimated by smoothing the GPS location data and measuring the distance along this line. The mean net spread was estimated by averaging the smoothed net spread readings from the Scanmar units between on-bottom and off-bottom positions. Net spreads for tows for which there were insufficient or no Scanmar readings were estimated by a stepwise generalized additive model using net number, net height (when available), mean speed over ground (when available), depth, total catch and the actual scope/expected scope ratio as variables. For each species, catch-per unit effort (CPUE) was calculated as catch weight (kg) per area swept by the trawl in hectares (ha). Mean CPUE was calculated, including zero catches, within each stratum. Mean CPUE values of combined strata were calculated as the weighted average of the component strata CPUE means weighted by stratum area. Biomass estimates were calculated by multiplying each stratum mean CPUE by the stratum area and summing the results to obtain estimates by INPFC statistical areas and depth intervals. The 95% confidence interval was calculated for each species biomass estimate. A detailed description of the analytical procedures is presented in Wakabayashi et al. (1985).

Population length compositions were estimated by expanding the length-frequency to the total catch for each species by length and sex category at each station (Wakabayashi et al. 1985). The stratum population within a sex-length category was calculated by multiplying the stratum population by the proportion of fish in that category from the summed station data. Population size composition estimates were summed over strata to derive estimates by area.

Individual length and weight measurements were used to establish length-weight relationships. The length-weight allometric relationship was expressed as:

$$W = a * L^b,$$

where $W$ is weight (in grams), L is length (in mm), and $a$ and $b$ are the fitted parameters from a non-linear least squares regression.

## Survey Limitations

Due to the nature of this survey, there are some limitations in its ability to estimate fish abundance across all species. Obviously, populations whose entire depth range is not covered by the survey are not fully sampled (e.g., sablefish, shortspine thornyhead). Populations that extend into areas untrawlable with the survey gear are not fully represented (e.g., many rockfish species). Populations of species that exhibit a highly contagious distribution pattern (e.g., Atka mackerel and Pacific ocean perch) or are highly restricted in the amount of available habitat in the Gulf of Alaska (e.g., yellowfin sole and starry flounder) would be better sampled with a different survey design. For these reasons, estimates of abundance are considered more reliable for species that are widely and more uniformly distributed from this survey.

Estimates of fish abundance within the survey area are routinely represented as absolute biomass estimates. These estimates make the assumption that 100% of the fish within the path of the trawl are captured. In fact, the situation is much more complex. As with any fishing gear, the survey trawl exhibits size selectivity (e.g., fish small enough to pass through the net mesh are not sampled well, or larger fish may be able to outswim the trawl, at least for a short time). Fish are herded into the path of the trawl by the doors and the bridles in front of the trawl. Some fish escape under the footrope of the net. The rate of herding and escapement depend upon several factors including the species, water temperature, and the speed of the vessel. This is an active area of research at the AFSC (Munro and Somerton, 2002; Somerton and Weinberg 2000; Somerton and Munro, 2001). Given these limitations, survey abundance estimates are probably best considered as relative measures of abundance and are used to monitor trends across the time series.

**RESULTS**

Out of a total of 892 attempted tows, 820 (92%) were completed successfully at allocated survey stations and were included in the biomass and size composition analysis (Table 1). Three of the originally allocated stations were never occupied due to lack of time. Net spread measurements were successfully collected for 821 tows (96%). Headrope depth and temperature measurements were successfully collected for 809 tows (95%). Bottom temperatures ranged from 2.3° to 11.2°C. Sea surface temperatures were successfully collected at 847 stations (99+ %) and ranged from 3.2° to 15.1°C.

Net height and spread were measured for all but 27 survey hauls (for these hauls net dimensions were estimated from other bottom trawl hauls). Net spread on average ranged from 13.4 to 19.5 m. Average net heights of successfully completed tows ranged from 3.9 to 8.9 m. Temperatures were successfully recorded for all but 38 tows. Average bottom temperatures ranged from 0. °C to 11.2°C. Sea surface temperatures ranged from 3.2° to 15.1°C.

Table 1. -- Number of stations allocated, attempted, and successfully completed and sampling density for the 2007 Gulf of Alaska biennial bottom trawl survey by International North Pacific Fisheries Commission statistical areas and depth intervals.

| INPFC area | Depth range (m) | Stations allocated | Stations attempted | Stations successful | Area ($km^2$) | Sampling density (stations/1000 $km^2$) |
|---|---|---|---|---|---|---|
| **Shumagin** | 1 - 100 | 133 | 139 | 133 | 41,289 | 3.22 |
| | 101 - 200 | 39 | 39 | 39 | 14,677 | 2.66 |
| | 201 - 300 | 17 | 18 | 17 | 2,788 | 6.10 |
| | 301 - 500 | 9 | 10 | 9 | 2,531 | 3.56 |
| | 501 - 700 | 5 | 5 | 5 | 2,006 | 2.49 |
| | 701 - 1000 | 3 | 2 | 2 | 1,937 | 1.03 |
| | **All depths** | **206** | **213** | **205** | **65,228** | **3.14** |
| **Chirikof** | 1 - 100 | 82 | 82 | 82 | 26,035 | 3.15 |
| | 101 - 200 | 69 | 71 | 69 | 23,849 | 2.89 |
| | 201 - 300 | 26 | 29 | 26 | 11,546 | 2.25 |
| | 301 - 500 | 10 | 10 | 10 | 1,604 | 6.23 |
| | 501 - 700 | 7 | 7 | 7 | 1,953 | 3.58 |
| | 701 - 1000 | 5 | 5 | 5 | 3,066 | 1.63 |
| | **All depths** | **199** | **204** | **199** | **68,053** | **2.92** |
| **Kodiak** | 1 - 100 | 97 | 101 | 97 | 38,516 | 2.52 |
| | 101 - 200 | 126 | 130 | 127 | 43,332 | 2.93 |
| | 201 - 300 | 30 | 30 | 30 | 11,490 | 2.61 |
| | 301 - 500 | 10 | 10 | 10 | 2,912 | 3.43 |
| | 501 - 700 | 6 | 7 | 6 | 1,745 | 3.44 |
| | 701 - 1000 | 4 | 5 | 4 | 3,494 | 1.14 |
| | **All depths** | **273** | **283** | **274** | **101,489** | **2.70** |
| **Yakutat** | 1 - 100 | 11 | 11 | 11 | 16,661 | 0.66 |
| | 101 - 200 | 33 | 34 | 33 | 29,382 | 1.12 |
| | 201 - 300 | 17 | 17 | 17 | 5,170 | 3.29 |
| | 301 - 500 | 9 | 10 | 9 | 2,628 | 3.42 |
| | 501 - 700 | 3 | 4 | 3 | 1,469 | 4.08 |
| | 701 - 1000 | 3 | 3 | 3 | 1,887 | --- |
| | **All depths** | **76** | **79** | **76** | **57,197** | **1.33** |
| **Southeastern** | 1 - 100 | 11 | 11 | 11 | 6,546 | 1.68 |
| | 101 - 200 | 23 | 26 | 22 | 11,084 | 1.98 |
| | 201 - 300 | 18 | 19 | 17 | 5,052 | 3.37 |
| | 301 - 500 | 13 | 12 | 11 | 3,117 | 3.53 |
| | 501 - 700 | 4 | 2 | 3 | 1,033 | 2.90 |
| | 701 - 1000 | 2 | 2 | 2 | 1,206 | 1.66 |
| | **All depths** | **71** | **72** | **66** | **28,038** | **2.35** |
| **All areas** | 1 - 100 | 334 | 344 | 334 | 129,047 | 2.59 |
| | 101 - 200 | 290 | 300 | 290 | 122,324 | 2.37 |
| | 201 - 300 | 108 | 113 | 107 | 36,046 | 2.97 |
| | 301 - 500 | 51 | 52 | 49 | 12,792 | 3.83 |
| | 501 - 700 | 25 | 25 | 27 | 8,206 | 3.29 |
| | 701 - 1000 | 17 | 17 | 13 | 11,590 | 1.12 |
| | **All depths** | **825** | **851** | **820** | **320,005** | **2.56** |

## Catch Results by Area

At least 185 fish species from 40 families were captured during the 2007 survey. Appendix B presents lists of fish (Appendix B-1) and invertebrate (Appendix B-2) species encountered during the survey. Relative abundance estimates, reported as CPUE, are presented in Table 2 for the 20 most abundant groundfish species in each of the five INPFC areas.

Over the entire survey area, arrowtooth flounder was the most abundant groundfish encountered during the survey (Table 2). Arrowtooth flounder had the highest CPUE of any species in four of the five INPFC areas and had the second highest CPUE in the Yakutat area. Pacific ocean perch, giant grenadier, Pacific halibut, and walleye pollock were also very important components of the Gulf-wide species composition.

In the Shumagin INPFC area, arrowtooth flounder had by far the greatest CPUE of any species. Giant grenadier, Pacific ocean perch, northern rockfish, Pacific cod, Pacific halibut and walleye pollock were also relatively abundant in this area. In the Chirikof INPFC area, arrowtooth flounder completely dominated all other species in terms of CPUE. Giant grenadier, northern rockfish, walleye pollock, Pacific halibut, flathead sole, and Pacific ocean perch were also important components of the species composition. In the Kodiak INPFC area, arrowtooth flounder was by far the dominant component of the groundfish CPUE. Pacific ocean perch, Pacific halibut, and giant grenadier were also realtively abundant in this area. In the Yakutat INPFC area, spiny dogfish and arrowtooth flounder were the two dominant species. The mean CPUEs of both species were more than twice that of the next two most abundant species: Pacific halibut and Pacific ocean perch. In the Southeastern INPFC area, arrowtooth flounder again predominated with a mean CPUE almost three times that of the next most abundant groundfish, Pacific ocean perch. Pacific halibut, spotted ratfish, and walleye pollock were also important catch components.

Table 2. -- Mean CPUE (kg/ha) for the 20 most abundant groundfish in each International North Pacific Fisheries Commission area during the 2007 biennial Gulf of Alaska bottom trawl survey.

| Shumagin area | | Chirikof area | | Kodiak area | |
|---|---|---|---|---|---|
| Species | CPUE | Species | CPUE | Species | CPUE |
| arrowtooth flounder | 40.5 | arrowtooth flounder | 86.5 | arrowtooth flounder | 83.7 |
| giant grenadier | 27.4 | giant grenadier | 21.3 | Pacific ocean perch | 29.7 |
| Pacific ocean perch | 24.2 | northern rockfish | 13.6 | Pacific halibut | 16.8 |
| northern rockfish | 17.5 | walleye pollock | 13.3 | giant grenadier | 12.9 |
| Pacific cod | 17.5 | Pacific halibut | 11.9 | flathead sole | 9.8 |
| Pacific halibut | 16.9 | flathead sole | 11.3 | sablefish | 9.4 |
| walleye pollock | 15.0 | Pacific ocean perch | 11.3 | walleye pollock | 8.0 |
| atka mackerel | 12.3 | sablefish | 6.1 | Pacific cod | 7.9 |
| flathead sole | 12.0 | dusky rockfish | 5.6 | southern rock sole | 5.3 |
| southern rock sole | 12.0 | rex sole | 5.4 | rex sole | 3.9 |
| northern rock sole | 10.1 | Pacific cod | 4.5 | Pacific sleeper shark | 2.9 |
| yellowfin sole | 3.3 | eualchon | 4.0 | dover sole | 2.8 |
| sablefish | 3.2 | starry flounder | 3.4 | spiny dogfish | 2.7 |
| yellow irish lord | 1.9 | southern rock sole | 3.0 | shortspine thornyhead | 2.4 |
| shortspine thornyhead | 1.9 | Alaska skate | 2.4 | starry flounder | 2.1 |
| starry flounder | 1.8 | northern rock sole | 2.4 | blackspotted rockfish | 2.1 |
| rex sole | 1.8 | dover sole | 2.3 | northern rockfish | 2.0 |
| butter sole | 1.1 | shortspine thornyhead | 2.0 | northern rock sole | 2.0 |
| big skate | 0.9 | big skate | 1.8 | dusky rockfish | 1.9 |
| dusky rockfish | 0.8 | Pacific sleeper shark | 1.3 | yellowfin sole | 1.8 |
| Number of hauls | 205 | Number of hauls | 199 | Number of hauls | 274 |

| Yakutat area | | Southeastern area | | All areas | |
|---|---|---|---|---|---|
| Species | CPUE | Species | CPUE | Species | CPUE |
| spiny dogfish | 23.0 | arrowtooth flounder | 38.1 | arrowtooth flounder | 60.6 |
| arrowtooth flounder | 22.8 | Pacific ocean perch | 35.2 | Pacific ocean perch | 21.5 |
| Pacific halibut | 10.4 | Pacific halibut | 17.5 | giant grenadier | 15.2 |
| Pacific ocean perch | 9.2 | spotted ratfish | 11.4 | Pacific halibut | 14.7 |
| giant grenadier | 5.5 | walleye pollock | 9.7 | walleye pollock | 9.9 |
| Pacific herring | 5.2 | silvergray rockfish | 7.4 | flathead sole | 8.8 |
| sablefish | 5.0 | Pacific hake | 7.0 | Pacific cod | 7.3 |
| shortspine thornyhead | 3.9 | sablefish | 6.1 | northern rockfish | 7.1 |
| flathead sole | 3.7 | shortraker rockfish | 5.1 | sablefish | 6.3 |
| walleye pollock | 3.5 | shortspine thornyhead | 4.5 | spiny dogfish | 5.1 |
| lingcod | 3.3 | dover sole | 4.3 | southern rock sole | 5.1 |
| starry flounder | 2.9 | sharpchin rockfish | 4.0 | rex sole | 3.2 |
| dover sole | 2.4 | redstripe rockfish | 3.9 | northern rock sole | 3.2 |
| salmon shark | 2.2 | rex sole | 3.5 | shortspine thornyhead | 2.6 |
| eulachon | 1.6 | southern rock sole | 2.9 | atka mackerel | 2.6 |
| silvergray rockfish | 1.5 | Pacific cod | 2.5 | starry flounder | 2.3 |
| shortraker rockfish | 1.4 | lingcod | 2.2 | dusky rockfish | 2.3 |
| big skate | 1.4 | rougheye rockfish | 2.2 | dover sole | 2.2 |
| Pacific hake | 1.1 | blackspotted rockfish | 1.9 | eualchon | 1.6 |
| rex sole | 1.0 | flathead sole | 1.4 | yellowfin sole | 1.3 |
| Number of hauls | 76 | Number of hauls | 66 | Number of hauls | 820 |

## Catch Results by Species

For each commercially or ecologically important species, the following information is presented:

1. A brief synopsis of the data collected.
2. A table presenting the number of hauls, the number of hauls with catch, mean CPUE, estimated biomass with 95% confidence intervals, and mean weight of that species by INPFC area and depth.
3. A figure showing the distribution and relative abundance of that species.
4. A figure showing the estimated size composition of the population for that species.
5. CPUE and biomass estimates (with 95% confidence intervals) by stratum for that species.

For other species that were locally abundant (other flatfish and other rockfish, skates, capelin, eulachon, and Pacific hake), only items 1, 2, and 6 above are presented.

The scientific names follow the fifth edition of the Common and Scientific Names of Fishes from the United States and Canada (Robins et al. 1991). The exceptions to this are in the orders Pleuronectiformes (flatfish) and Scorpaeniformes (rockfish) scientific names. The names used throughout this report reflect recent reexamination of the phylogeny of these orders (Berendzen 1997, Cooper and Chapleau 1998, Ivankov 1996, Orr and Matarese 2000, Rass 1996, Orr and Blackburn 2004, Orr and Hawkins 2008).

**Pages 22 through 247 are available as separate Adobe .pdf files.**