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Rockfish Adaptive Sampling Experiment in the Central Gulf of Alaska, 1998

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ROCKFISH ADAPTIVE SAMPLING EXPERIMENT

IN THE CENTRAL GULF OF ALASKA, 1998

Chartered Fishing Vessel *Unimak Enterprise* Cruise 98-01

by

David Clausen[1], Dana Hanselman[2], Chris Lunsford[1],
Terrance Quinn II[2], and Jonathan Heifetz[1]

[1]Auke Bay Laboratory
Alaska Fisheries Science Center
11305 Glacier Highway
Juneau, AK 99801-8626

[2]University of Alaska Fairbanks
Juneau Center, School of Fisheries and Ocean Sciences
11120 Glacier Highway
Juneau, AK 99801

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ABSTRACT

A chartered factory trawler was used in August 1998 to conduct an experimental bottom-trawl survey of slope rockfish in two study areas northeast of Kodiak Island, Alaska. The experiment targeted three rockfish species: Pacific ocean perch (*Sebastes alutus*), shortraker rockfish (*Sebastes borealis*), and rougheye rockfish (*Sebastes aleutianus*), and used a new survey technique, adaptive sampling. Our objective was to determine whether this technique would provide improved estimates of abundance for these species when compared with simple random sampling, which has been the standard design for all previous trawl surveys of rockfish in this region. Adaptive sampling is not yet widely used in fisheries, but previous research has indicated that for clustered populations, such as those observed for many rockfish species, it may have benefits over simple random sampling. In the experiment, one study area focused on Pacific ocean perch and the other focused on shortraker and rougheye rockfish. The study areas were divided into strata, and each stratum was sampled initially by conducting bottom tows at random locations. This was followed by an adaptive phase in which a systematic pattern of closely spaced tows was made around the random tows that showed high catches of rockfish. Estimates of rockfish abundance were computed for each stratum based on just the random tows, and also on two adaptive estimators that incorporated data from both the random and the adaptive tows. Contrary to initial expectations, preliminary adaptive sampling results for Pacific ocean perch showed only modest gains in the precision of abundance estimates when compared with random sampling. These results, however, appeared to be highly dependent on the stratification pattern used. For shortraker and rougheye rockfish, adaptive sampling found a substantially larger abundance in one stratum than did random sampling, whereas in the other stratum, the two methods showed almost identical results. Further studies on the efficacy of adaptive sampling for surveying rockfish abundance will be conducted in 1999.

A record is also provided of the location and major species caught for each of the 190 tows completed during the cruise.

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INTRODUCTION

During the period 5–21 August 1998, the chartered fishing vessel *Unimak Enterprise* was used to conduct experimental trawling for rockfish in the central Gulf of Alaska near Portlock Bank, northeast of Kodiak Island. This research was a cooperative effort between the Alaska Fisheries Science Center's (AFSC) Auke Bay Laboratory (ABL) and the University of Alaska, Fairbanks (UAF), Juneau Center, School of Fisheries and Ocean Sciences. The AFSC's Resource Ecology and Fishery Management Division (REFM) and the Resource Assessment and Conservation Engineering Division (RACE) also participated in the cruise. The purpose was to investigate a new technique, adaptive sampling, for assessing abundance of three species of slope rockfish: Pacific ocean perch (*Sebastes alutus*), shortraker rockfish (*Sebastes borealis*), and rougheye rockfish (*Sebastes aleutianus*). To prevent waste and defray government charter costs, the F/V *Unimak Enterprise* was allowed to retain, process, and sell the catch as part of the charter agreement for this cruise. The 1998 research represents the first part of a 2-year study, the second part of which is planned for summer 1999.

This report documents the objectives and methods of this cruise and presents preliminary results of the adaptive sampling experiment. It also contains detailed records of location and catch for each haul fished during the cruise, which may be useful to both scientists and the commercial fishing industry.

OBJECTIVES

1. Test a new trawl-survey design, adaptive sampling, to determine the potential of this technique for improving abundance estimates of slope rockfish.

2. For each haul, obtain volumetric estimates of the net's codend catch size, and compare these with total catch weight determined from the vessel's flow scale. This information will be used to develop sampling protocols in the National Marine Fisheries Service (NMFS) fishery observer program.

3. For selected hauls, subsample portions of the catch from the vessel's conveyer belt to determine the within-haul variability of the species catch composition. This information will be used to develop sampling protocols in the NMFS fishery observer program.

4. Obtain a hard copy of the echosounder trace for each haul to examine the relationship between echo sign and the size and species composition of the catch.

VESSEL AND GEAR

The F/V *Unimak Enterprise* is a 56.1-m (184-ft) factory stern trawler equipped with two main engines providing a total of 3,000 hp. Deck equipment included paired hydraulic trawl winches with 1,646 m (900 fm) of 2.86-cm (1⅛-in) cable per drum, two hydraulic net reels mounted forward on the trawl deck, and four lifting winches for moving nets and dumping the catch. Electronic equipment consisted of two differential Global Positioning System (GPS) units linked to a computer with SeaPlot[1] navigational software, two video depth sounders (one with color printout), two radars, and a Furuno CN-10B wireless net sounder. An enclosed factory was located immediately below the trawl deck where the catch was processed and frozen. The factory was equipped with an electronic, motion-compensated, conveyer-belt flow scale for determining the total weight of each haul before processing. For this cruise, the F/V *Unimak Enterprise* carried a crew of 35, including processors.

A high-opening, poly-Nor'eastern bottom trawl was used for all fishing operations. This net was constructed of 12.7-cm (5-in) stretched mesh polyethylene with four seams, and measured 27.2 m (89-ft, 1-in) along the headrope and 24.7 m (81 ft, 7-in) along the footrope. For a detailed description and diagram of this net, see Stark (1997). This trawl has been the standard used by the AFSC for triennial groundfish surveys in the Gulf of Alaska since 1987. One difference from the standard triennial survey set-up was that specialized "tire gear" (Fig. 1) was mounted along the footrope of the nets to facilitate trawling over rough bottom areas where rockfish are commonly found. The gear was developed by the REFM and RACE Divisions after consultations with the fishing industry in 1993, and had been used previously during NOAA ship *Miller Freeman* Cruise 96-06. The tire gear consisted of a 4.57-m (15-ft) section of 60.96 cm (24 in) diameter split automobile tires along the center of the footrope. Connected to either side of the tire section was a 5.41-m (17-ft, 9-in) section of nine rubber "rockhopper" disks. The rockhopper disks decreased in size from 60.96 cm (24 in) in diameter closest to the tires to 45.72 cm (18 in) in diameter at the outer end of each section. The rockhopper gear then connected with a 4.44-m (14-ft, 7-in) section of five 45.72-cm (18-in) steel bobbins extending along each wing. The nets and tire gear were supplied by the RACE Division for the charter. Two modifications to the nets and tire gear were made by the F/V *Unimak Enterprise* crew to improve ease of operation: 1) a customized codend designed for the vessel was used in the net rather than RACE's standard codend. This codend was constructed of 8-mm twine with 10.16-cm (4-in) stretched mesh webbing and was shaped so the catch could be dumped easily into the vessel's "live tanks". No liner was used in the codend. 2) Holes were drilled in the tire gear bobbins so they would fill with water and cause the net to sink faster during setting.

The vessel supplied the accessory trawl gear of bridles, sweeps, backstraps (cables connecting the sweeps to the doors), and doors for the charter. The bridles, constructed of 6 × 19 wire-core cable, were connected to the net at three places on each side: the

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

headrope, side panel, and footrope. The footrope bridle section was 54.86 m (180 ft) long and 2.86 cm (1⅛ in) in diameter. The headrope and side panel bridle sections were 1.59 cm (⅝ in) in diameter and 24.38 m (80 ft) long. The headrope and side panel bridle sections then came together and formed a single section of cable 30.48 m (100 ft) long. The sweeps were forward of the bridles, and consisted of a single 27.43 m (90 ft) length of cable on each side. Each sweep was then connected to each door by a pair of backstrap cables 13.72 m (45 ft) long. Doors were "Tiburon" Type 7, weighing 2,200 kg (4,850 lb) each, and measured 3.10 m (122 in) by 2.82 m (111 in).

RATIONALE FOR EXPERIMENT

NMFS scientists rely on results of triennial bottom-trawl surveys to assess the stock condition of slope rockfish in Alaska. These surveys, however, are believed to do a relatively poor job of estimating rockfish abundance. In particular, biomass estimates for rockfish often fluctuate greatly from survey to survey, which does not seem reasonable considering the slow growth and low natural mortality rates of all *Sebastes* species. The estimates for some species also have wide confidence limits, making interpretation of trends in stock abundance difficult. One important factor that may contribute to the surveys' problematic assessment of rockfish involves the fundamental design of the surveys: they all have used a stratified random method to select their pattern of trawl stations. This may be inappropriate for many slope rockfish species, such as Pacific ocean perch, that are known to have a highly clustered distribution.

In this cruise, we compared an alternative survey design, adaptive sampling (Thompson and Seber 1996), to the standard stratified random methodology. Adaptive sampling is a relatively new technique which, to date, has been little used in fisheries applications. However, it appears to be particularly appropriate for sampling populations with a clustered distribution, such as Pacific ocean perch. In adaptive sampling, random or systematic sampling is used initially to locate concentrations of the targeted species, and is then followed by additional intensive sampling in the vicinity of the concentrations. A brief exploratory adaptive sampling experiment for Pacific ocean perch was conducted by the AFSC in April 1996 using the NOAA ship *Miller Freeman*,[2] and its limited results indicated that adaptive sampling may have benefits over random sampling in assessment surveys for rockfish (Quinn and Haldorson 1998). The 1998 experiment on the F/V *Unimak Enterprise* was a follow-up to the 1996 work, but it was much expanded in duration and area. The goal of the 1998 study, along with that planned for 1999, is to provide a comprehensive evaluation of adaptive sampling methods for rockfish assessment in Alaska.

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[2]Clausen, D. M., and J. Heifetz. 1996. *Miller Freeman* cruise 96-06 — spatial distribution of Pacific ocean perch aggregations. Available from Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801-8626. unpublished, 5 p.

STUDY AREAS

Two study areas were selected for the experiment, one for Pacific ocean perch and the other for shortraker and rougheye rockfish (Fig. 2). The Pacific ocean perch study area, approximately 2,196 km^2, was located on the southern edge of Portlock Bank, northeast of Kodiak Island and encompassed depths of approximately 150–300 m, corresponding to the preferred summer depth range of adult Pacific ocean perch. It was chosen for two reasons: 1) in recent years, it has generally been a location of high catches of Pacific ocean perch in the commercial fishery, and 2) it covers an area of variable topography that includes both the upper continental slope and a gully extending into the continental shelf, thereby providing a range of possible habitats for Pacific ocean perch. For the experiment, the study area was divided into four strata based on topography and habitat: west gully, east gully, slope, and slope-gully intersection (where the gully merged with the continental slope).

The shortraker-rougheye study area (approximately 900 km^2), on the northeastern edge of Portlock Bank extending across the entrance to Amatuli Gully, encompassed depths of approximately 300–500 m, corresponding to the preferred depths for adult shortraker and rougheye rockfish. The area was selected because large catches of shortraker and rougheye rockfish have been taken there by the commercial fishery, and also because of its proximity to the Pacific ocean perch study area. It was bisected by a submerged telephone cable that we wanted to avoid while trawling, so we excluded the cable area from our experiment, and divided the study area into two strata, "north" and "south". The cable area formed the boundary between the strata.

METHODS

Experimental Design

The experiment focused on Pacific ocean perch because of its large commercial value and the considerable uncertainty concerning its assessment. Accordingly, the shortraker and rougheye rockfish portion of the experiment was deemed of lesser importance. Therefore, we arbitrarily allocated approximately 75% of the fishing effort in the cruise to the Pacific ocean perch study area, and 25% to the shortraker-rougheye study area.

Our main hypothesis was that adaptive sampling would be more effective in providing accurate and precise estimates of rockfish abundance than would the standard stratified random survey design. This hypothesis was supported by the initial study done on the NOAA ship *Miller Freeman* in 1996. A secondary hypothesis was that assessment of Pacific ocean perch abundance would benefit more from an adaptive sampling design than would shortraker and rougheye rockfish, because we believed Pacific ocean perch to be more clustered in their distribution than shortraker and rougheye rockfish, making the former particularly amenable to adaptive sampling.

Each of the six strata formed separate sampling units for which abundance estimates were calculated. Each stratum was sampled initially with 12–15 randomly located stations (trawl hauls). In each stratum, after random sampling was completed, the experiment switched to an adaptive sampling phase. In this mode, a series of additional hauls in each stratum was made systematically around a selected number (r) of the random stations with the highest catch-per-unit-effort (CPUE) of the target species. For the shortraker-rougheye study area, we combined the target species CPUE for shortraker and rougheye rockfish. The value of r was initially set to 3. In the west gully, east gully, and slope-gully intersection strata, a cross pattern of four tows around each selected high-CPUE station was used for the adaptive sampling (Fig. 3a). For these strata, the bottom topography required that all tows be made in a general east-west direction. Consequently, the cross pattern consisted of adaptive tows on the eastern and western sides of each selected random tow, and parallel tows to the north and south. In the slope and shortraker-rougheye strata, the parallel adaptive tows were omitted, resulting in a linear pattern in which only two adaptive tows were made, one to each end of the selected random station (Fig. 3a). This linear pattern was necessary because of the steeply sloping bottom in these strata. A distance of 0.1 nautical miles (nmi) (0.19 km) was planned between all adaptive tows and the track of the initial random station to avoid depletion effects on the catches.

Adaptive sampling was continued beyond this first level around any adaptive tows whose CPUE exceeded a specified threshold value in each stratum. If the CPUE in an adaptive tow did not exceed the threshold, then no further adaptive sampling was done around the tow. The threshold value, c, was set equal to the $r + 1^{th}$ highest CPUE of the initial random stations. For example, in a stratum where the three stations with the highest CPUE were selected for adaptive sampling (i.e., $r = 3$), then additional adaptive tows beyond the first level would be made around those adaptive tows in which the CPUE was greater than the fourth highest CPUE of the random stations in that stratum. A cross or linear pattern of tows, similar to that used for the first level of adaptive sampling, was also followed in this additional adaptive sampling, and a distance of 0.1 nmi was maintained between the track of each tow. To limit the amount of adaptive sampling, an arbitrary stopping rule of S levels was imposed, in which $S = 1$ was defined to be the first level of adaptive sampling shown in Figure 3a. For those strata where the cross pattern of adaptive sampling was used, the stopping rule was $S = 3$ levels, allowing for a maximum of 24 adaptive tows around each high-CPUE random station. For the strata with the linear pattern of adaptive sampling, the stopping rule was $S = 6$ levels, for a maximum of 12 adaptive tows around each high-CPUE random station. See Figure 3b for diagrams of the maximum number of adaptive tows that could be made. A further stopping rule was that no adaptive sampling would extend beyond a stratum boundary. The result of adaptive sampling around each high-CPUE station was a network of tows that extended over and, in some cases, delineated the geographic boundaries of a rockfish aggregation.

Statistical Methods

Statistical analysis of the results was based on adaptive cluster sampling with order statistics (Thompson and Seber 1996). First, abundance for the targeted rockfish species in each stratum was estimated from the initial random stations. Then, two adaptive estimators of abundance, Hansen-Hurwitz and Horvitz-Thompson, were calculated. Estimates of variance, standard error (SE), and coefficient of variation (CV) were computed for each estimator. The Hansen-Hurwitz estimator essentially replaces stations around which adaptive sampling occurred with the mean of the network of adaptive tows that exceeded the threshold CPUE. The Horvitz-Thompson estimator is based on the probability of sampling a network given the initial stations sampled and involves the number of distinct networks sampled (in contrast to the Hansen-Hurwitz estimator based on the initial stations). This estimator often outperforms other estimators as seen in simulation studies.[3]

Fishing Operations

Fishing operations were conducted 24 hours a day; no attempt was made to account for possible day-night differences in catch rates. Duration of all trawl hauls was 15 minutes on bottom, measured from the time the net reached equilibrium on the bottom until the time that retrieval of the net began. Equilibrium time was based on the skipper's judgment as to when the net was on bottom and fishing properly. We chose 15 minutes to correspond with the standard duration of hauls during the triennial trawl surveys. Also, tows of this relatively short duration were necessary in the experiment to determine more precisely the extent of rockfish concentrations in the adaptive phase. Vessel speed during the tows was approximately 3.5 knots (kt) (6.5 km/h), so that distance towed over the bottom was about 0.9 nmi (1.7 km). During retrieval, vessel speed was approximately 1 kt (1.9 km/h) or less. On a few occasions, the gear snagged on the bottom and was retrieved early, resulting in a shorter distance towed.

Positioning for each tow was determined on a computer using SeaPlot navigational software linked to differential GPS. As much as possible, tows were in a straight line and generally followed a constant depth contour. For positioning the random stations, a list of random starting positions was compiled for each stratum. Originally, the direction of each random tow was chosen at random, but this created difficulties in placement of the adaptive tows when two random stations were close to each other. Subsequently, all tows in a stratum were made in the same direction. Because of the orientation of the contours, this tended to be approximately east or west in the Pacific ocean perch study area, or approximately north or south in the shortraker-rougheye study area. For the adaptive stations, every effort was made to position the tows along the same heading as the random

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[3]Su, Z., and T. J. Quinn, II. 1999. Use of a stopping rule in adaptive cluster sampling with order statistics. Unpubl. manuscr. Available from Z. Su., University of Alaska Fairbanks, Juneau Center, School of Fisheries and Ocean Sciences, 11120 Glacier Hwy., Juneau AK 99801.

station they were associated with so that a symmetrical sampling network would result. In most cases, the skipper was able to do a good job of this, while also maintaining the planned distance of 0.1 nmi between all tows. The only exceptions occurred when strong currents or winds unexpectedly forced the vessel off course during a tow or caused the net to sink too fast or slowly; a few times, this resulted in two trawl paths crossing.

On a small number of tows, a SCANMAR net mensuration system, provided by the RACE Division, was used to measure the width and height of the net opening. This equipment included acoustic sensors that attached to the net, a hydrophone deployed over the side of the vessel to receive data from the sensors, and a microcomputer system in the wheelhouse to interpret and store the data. A micro-bathythermograph (micro-BT) was also mounted on the net for a selected number of tows. This device recorded the time when the net reached and left bottom and provided a water temperature profile during the tow.

The vessel's Simrad ES 380 depth sounder was used to obtain a color printout of the bottom trace and fish sign associated with each tow, until the printer broke down about halfway through the cruise. To ensure comparability of all the printouts, all settings for the sounder were standardized at the beginning of the cruise, and they remained undisturbed for the duration of the cruise.

Catch Sampling

When the net was hauled aboard at the end of a tow, a scientist measured the dimensions of the codend with a tape measure to determine a volumetric estimate of the catch. The catch was then dumped through a hydraulic opening in the deck into the factory's "live tank". From the live tank, a conveyer belt transported the catch to either the scientific sampling area or the commercial processing line, where the fish were processed or discarded. Total weight of the catch for each haul was obtained from a Scanvaegt electronic flow scale (Scanflow 4674/4600) that was mounted along the conveyer belt before the catch reached the sampling or processing areas. Accuracy of the scale was verified every 1–2 days using samples of known weight.

Catches less than approximately 1 metric ton (t) were scientifically sampled in their entirety ("whole-haul" sampling). The catch was sorted by species, and each species was then weighed and counted according to standard RACE Division protocol. A Marel motion-compensated platform scale (model M15) provided by the vessel was used for all the scientific weighing. The sum of all the platform scale weights was used to determine the total weight of the catch for each of these hauls. The only exception to this procedure was for Pacific halibut (*Hippoglossus stenolepis*), which were measured individually for length, and a length-weight regression was used to determine their weight. This special procedure for Pacific halibut was followed to increase the survival of these fish, as all were released overboard soon after measurement. If available, a random subsample of 150 fish/species was taken for length measurements of Pacific ocean perch, shortraker rockfish, rougheye rockfish, and other abundant rockfish species in each haul. If less than 150 fish/species were caught, then all fish caught were measured. Sex was not determined for any of the fish measured because dissection necessary for the sexing would have disfigured the fish and lessened their commercial value. The length data were collected electronically with data loggers and barcode-based recording devices and downloaded later to computer database files. After all the scientific sampling was completed, the fish became property of the vessel for commercial processing or discard.

For catches greater than approximately 1 t, five 100-kg subsamples were taken and sampled for species composition using procedures similar to those described above. The remainder of the catch went directly without sampling to commercial processing or discard. This subsampling scheme was determined by the NMFS fishery observer program for their study of within-haul variability of species composition. The 100-kg subsamples were selected systematically with a random starting point as the catch passed over the flow scale. In this manner, the subsamples were dispersed throughout the entire haul to reduce bias caused by possible species segregation in the net and live tank. In some instances, we unintentionally ended up with only three or four subsamples from a haul when the catch weight turned out to be less than expected. The subsample data were later expanded over the weight of the haul's entire catch (determined from the flow scale) to yield estimates of the total catch composition. For the rockfish length measurements, 30 fish/species/subsample were measured. If 30 fish were not available in a subsample, then all the rockfish in the subsample were measured. In addition, up to 5 randomly selected subsamples were made for some hauls so that the observer program could later compare systematic subsampling to random subsampling.

Commercial Processing of Catch

All the catch of the following species was retained by the vessel for commercial processing: Pacific ocean perch, shortraker rockfish, rougheye rockfish, shortspine thornyhead (*Sebastolobus alascanus*), Dover sole (*Microstomus pacificus*), rex sole (*Errex zachirus*), and sablefish (*Anoplopoma fimbria*). For certain hauls, other species were also retained, including Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), arrowtooth flounder (*Atheresthes stomias*), flathead sole (*Hippoglossoides elassodon*), northern rockfish (*Sebastes polyspinis*), light dusky rockfish (*Sebastes* n. sp.), and prowfish (*Zapora silenus*).

RESULTS

General Results

Fishing operations were conducted from 7 August to 19 August (Appendix Table 1). A total of 190 hauls was completed during the cruise (Appendix Table 2; Figs. 4, 5). Of these, 4 were test tows, 81 were random stations, 103 were adaptive stations, and 2 were invalid. Because of their close proximity to each other, the adaptive stations are not depicted in these figures. All the random and adaptive stations were trawled successfully; no station was skipped because of untrawlable bottom. Hang-ups or net damage, however, sometimes occurred, especially in the steep topography of the shortraker-rougheye study area (see performance data in Appendix Table 2).

The predominant species caught during the cruise was Pacific ocean perch. An estimated total of nearly 305 t of Pacific ocean perch was caught, over one-half the catch weight for all species combined (Table 1). Other major species caught, in descending order of total catch, included arrowtooth flounder, rougheye rockfish, sablefish, shortraker rockfish, Pacific cod, and Pacific halibut. Total catches in individual hauls ranged up to 38 t (Appendix Table 3). Although we used the same net as the AFSC triennial surveys, our catches appeared to be consistently greater than in comparable survey tows. The larger catches may have been caused by the heavier doors used by the F/V *Unimak Enterprise* (the doors weighed 2.2 times those used in the surveys) or by the vessel's sweeps and backstraps herding more fish into the net (the bridle arrangement used in the surveys does not include sweeps or backstraps). Also, the use of tire gear along the net's footrope in our cruise may have had some unknown effect that increased the catchability of the net.

Our catch data for hauls that were subsampled had to be corrected from the original raw data because of errors in weight measurement by the flow scale. At sea, between hauls 61 and 107, we noticed that the flow scale sometimes registered catch weight even though no catch was passing over at that time. Testing the flow scale with known weights confirmed that the scale was overweighing the catch by an average of 5.87% during this period. Consequently, we adjusted the subsampled catches for hauls 61–107 downward by 5.87%. In addition, the remaining flow-scale tests when the scale was functioning normally indicated a slight tendency to overweigh (mean of all the tests showed the scale was over by 0.19%); hence, we also adjusted the subsampled catches for hauls 1–60 and 108–190 downward by 0.19%.

The total number of fish measured for length during the cruise is listed by species in Table 1.

Because of technical problems with the SCANMAR system and time constraints, valid net mensuration data were collected from only five hauls for net width and three hauls for net height. Among these hauls, average width of the net ranged from 16.6 to 20.5 m (mean = 18.5 m), and average height from 7.6 to 9.0 m (mean = 8.5 m). The heights were based on only a few acoustic signals from the height-sensing unit, so these data should be viewed with caution.

Hard copies of the depth sounder trace for each tow were collected only for hauls 1–89. After haul 89, the printer for the depth sounder ceased functioning, and we were not able to save any sounder data for the rest of the cruise. The depth sounder data have not been analyzed yet.

Micro-BT data were collected from nine hauls. These data for hauls in the Pacific ocean perch study area indicated that the net was on bottom for approximately 1.5 minutes before the declared equilibrium time and remained on bottom for approximately 3.8 minutes after haulback. There was some variation between hauls in these times. For example, on-bottom times before equilibrium varied from 0.5 minutes to 4 minutes. For the deeper tows in the shortraker-rougheye study area, the on-bottom times were somewhat longer: about 1.8 minutes before equilibrium and 5.0 minutes after haulback. Some catch was undoubtedly taken during these periods before and after the standard on-bottom duration of 15 minutes. Presumably, the quantity was negligible compared to that caught during the standard 15-minute portion of the tow, especially because vessel speed was slow (≤1 kt [1.9 km/h]) during haulback.

Results of the data collected for the NMFS fishery observer program on codend volumetric estimates and on within-haul variability of the species catch composition will be analyzed and reported by that program.

Adaptive Sampling Results

These adaptive sampling results are considered preliminary. A more comprehensive and rigorous evaluation will be done after the second year of studies is complete in summer 1999.

Summary information about the random and adaptive stations in each stratum is given in Table 2. The strata are listed in the order in which they were fished. After sampling in the slope and slope-gully intersection strata was completed, time constraints caused us to reduce the sampling in the remaining strata. Specifically, the number of random stations around which adaptive sampling occurred (r) had to be lowered from three in the slope and slope-gully intersection strata to only one or two in the remaining strata. The greatest sampling effort was in the slope-gully intersection stratum, where 51 total adaptive stations were fished because large concentrations of Pacific ocean perch were encountered in that area. Threshold values of CPUE (c), for determining whether additional adaptive sampling would take place around adaptive hauls, ranged from 397 kg/nmi in the west gully stratum to 2,122 kg/nmi in the shortraker-rougheye north stratum.

Statistical results of the experiment are listed in Table 3 for three methods of estimating abundance: simple random sampling (SRS) based on only the random stations, and the Hansen-Hurwitz and Horvitz-Thompson methods, which incorporated both the random and adaptive stations. A detailed presentation of the results for each stratum follows:

Slope

Fifteen random stations were fished, and the top three in terms of Pacific ocean perch CPUE were chosen for random sampling. The threshold value, equal to the fourth highest CPUE of Pacific ocean perch in the random tows, was 435 kg/nmi. The amount of adaptive sampling, which was in a linear pattern, was moderate, with eight stations exceeding the threshold value. None of the adaptive sampling networks overlapped. The three abundance estimates were similar here, with a slight decrease (4%) in CV for the adaptive estimators.

Slope-Gully Intersection

Fifteen random stations were fished, and the top three were chosen for adaptive sampling. The threshold value, equal to the fourth highest CPUE of Pacific ocean perch in the random tows, was 464 kg/nmi. The adaptive sampling design was conducted in the cross pattern. The amount of adaptive sampling was extensive, with 44 stations exceeding the threshold value. Because of the extensive sampling, all three adaptive sampling networks overlapped to form one large network. Sampling was discontinued when each of the three networks reached stratum boundaries, and when a network overlapped another. This overlap of networks caused significantly different abundance estimates between the two adaptive estimators; that is, 1,111 kg/nmi for Hansen-Hurwitz vs. 466 kg/nmi for Horvitz-Thompson. All three abundance estimates were at least 31% different from each other. The Hansen-Hurwitz estimator had a substantially lower CV than SRS, whereas CV of the Horvitz-Thompson estimator was much higher. However, the Horvitz-Thompson estimator had the lowest variance and SE. Also, if the additional effort of sampling in the adaptive phase had been used in simple random sampling, the latter's SE and CV would have been halved.

West Gully

Fifteen random stations were fished, and only the top two stations were chosen for adaptive sampling. The threshold value, equal to the third highest CPUE of Pacific ocean perch in the random tows, was 397 kg/nmi. The adaptive sampling design was conducted in the cross pattern, and adaptive effort was low, with only one station exceeding the threshold value. The differences between the three estimators were slight, and CVs were also similar.

East Gully

Twelve random stations were fished, and only the top station was chosen for adaptive sampling. The threshold value, equal to the second highest CPUE of Pacific ocean perch in the random tows, was 919 kg/nmi. Adaptive sampling was conducted in the cross pattern, and adaptive effort was moderate, with five stations exceeding the threshold value. The three different abundance estimates were similar, as were their CVs.

Shortraker-Rougheye North

Twelve random stations were fished, and the top two were chosen for adaptive sampling. The threshold value, equivalent to the third highest shortraker-rougheye CPUE, was 2,122 kg/nmi. Adaptive sampling was conducted in the linear pattern, and adaptive effort was moderate, with five stations exceeding the threshold value. There was no network overlap, but each network was truncated by the southern stratum boundary. The abundance estimates were ~37% higher for both adaptive estimates, with an increase in CV of ~10% for each as compared with SRS. Most of the adaptive stations had higher CPUEs than those in the initial random stations. These higher densities probably would not have been discovered in simple random sampling, even with much greater effort.

Shortraker-Rougheye South

Twelve random stations were fished, and the top two were chosen for adaptive sampling. The threshold value, equal to the third highest shortraker-rougheye CPUE, was 887 kg/nmi. Adaptive sampling was conducted in the linear pattern, and adaptive effort was low, with only one station exceeding the threshold value. The three different abundance estimates and their associated CVs were nearly identical.

PRELIMINARY CONCLUSIONS

The preliminary results presented in this report indicate that modest gains in survey precision were obtained for Pacific ocean perch with adaptive sampling. When compared with simple random sampling, CV for at least one adaptive estimator of Pacific ocean perch abundance decreased in all four strata sampled.

We divided the Pacific ocean perch study area into four strata representing different habitat types in order to see how adaptive sampling worked with different densities and clusterings of fish. However, such stratification increases the sampling efficiency of simple random sampling prior to adaptive sampling because stratification usually improves estimation of mean density. Had we not stratified the area, the sampling efficiency of adaptive sampling compared with simple random sampling would have been higher. Therefore, future experimentation needs to account for the interaction of stratification and adaptive sampling.

The slope-gully intersection stratum is where clusters of fish were encountered and adaptive sampling should have worked best. Indeed, the drops in abundance, SE, and CV for the Hansen-Hurwitz estimator compared with those for simple random sampling were greatest here. The Horvitz-Thompson estimate and its SE were even lower, but its CV was higher because the three adaptive networks merged and dominated the estimator. It is not possible to tell which estimator is better in this case, because the results from adaptive sampling were so variable. The merging of networks occurred because the size of the intersection stratum was small. Further experimentation and research should investigate the effects of small areas versus large areas on adaptive sampling estimates.

Our *a priori* hypothesis was that adaptive sampling may not provide significant benefits in surveying abundance of shortraker and rougheye rockfish because they tend not to be clustered. However, we found aggregations in the north stratum by adaptive sampling that were not found by simple random sampling, suggesting that the distribution of shortraker and rougheye rockfish may be more clustered than we thought. Consequently, adaptive sampling resulted in higher CV values and a considerable increase in abundance estimates compared with simple random sampling. The higher CVs for adaptive estimators in this instance are not an indication of an inferior approach, but that the sampling happened to obtain higher CPUEs. For the south stratum, results of random and adaptive sampling were almost identical and in accord with the null hypothesis. Therefore, the question of whether adaptive sampling provides a benefit for shortraker and rougheye rockfish remains unresolved without further experimentation.

One ancillary factor that may also be important when evaluating adaptive sampling is whether it is more efficient than simple random sampling in terms of practical efficiencies such as cost. Additional costs are incurred in adaptive sampling because stations are added. Of practical interest is how precise are adaptive sampling estimates compared with a conventional simple random sampling design for the same costs. The number of stations sampled and travel time between survey stations are important factors when considering costs (Thompson and Seber 1996). With adaptive sampling, there may be less travel time and, therefore, lower costs per sampling station because sampling is within a network of nearby units. Adaptive sampling allowed us to devote much more time to trawling than had we done only simple random sampling. With less travel time between stations, more stations can be sampled. Factors that influence the merits of adaptive sampling as a practical survey design for slope rockfish will be the focus of analyses and field experiments in 1999.

ACKNOWLEDGMENTS

We thank the crew of the F/V *Unimak Enterprise*, in particular Captain Paul Ison and Production Manager Rob Elzig, for their excellent cooperation in this study. We also thank Dave King and his crew at the RACE Division Net Loft in Seattle for preparing all the fishing gear used during the cruise. Finally, we wish to acknowledge the hard work of the following scientists that participated on the cruise: Jim Stark, Nate Raring, Rebecca Reuter, and Pat Malecha of the AFSC and Zheming Su of the UAF, Juneau Center, School of Fisheries and Ocean Sciences.

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TABLES

Table 1.--Summary by species of the total catch round weight and number of fish sampled for length during F/V *Unimak Enterprise* Cruise 98-01.

Species	Catch (kg)	Percent of Total	No. of Length Samples
Pacific ocean perch	304,998.9	53.15	14,663
arrowtooth flounder	90,073.3	15.70	—
rougheye rockfish	44,828.6	7.81	2,995
sablefish	25,513.1	4.45	—
shortraker rockfish	20,790.3	3.62	1,015
Pacific cod	19,399.2	3.38	—
Pacific halibut	14,857.2	2.59	474
giant grenadier	11,628.7	2.03	—
shortspine thornyhead	9,363.4	1.63	—
walleye pollock	8,833.3	1.54	—
Dover sole	4,982.7	0.87	—
rex sole	4,084.5	0.71	—
light dusky rockfish	2,529.7	0.44	21
northern rockfish	2,454.0	0.43	102
sharpchin rockfish	1,620.7	0.28	215
flathead sole	1,525.9	0.27	—
prowfish	1,492.3	0.26	—
offal (fish processing waste)	993.0	0.17	—
bigmouth sculpin	964.4	0.17	—
longnose skate	527.1	0.09	—
skate unident.	387.6	0.07	—
harlequin rockfish	282.5	0.05	—
silvergray rockfish	229.5	0.04	—
Alaska skate	195.9	0.03	—
redbanded rockfish	169.3	0.03	—
other species	1,083.7	0.19	—
Total	573,808.7		19,485

Table 2.--Summary information on stations fished in each stratum during the adaptive sampling experiment for rockfish, F/V *Unimak Enterprise* Cruise 98-01. Notation and terminology used are based upon that of Thompson and Seber (1996). Terms are defined on the next page.

Stratum Network	n_1	r	$y>c$	ν	ν'	Network Units	Edge Units
			Pacific ocean perch study area				
Slope	15	3	435	29	23	8	6
Adaptive network 1						3	2
Adaptive network 2						2	2
Adaptive network 3						3	2
Intersection[1]	15	3	464	66	59	44	8
Adaptive network 1						17	1
Adaptive network 2						14	3
Adaptive network 3						13	4
West gully	15	2	397	26	16	1	10
Adaptive network 1						1	6
Adaptive network 2						0	4
East gully	12	1	919	24[2]	17	6	6
Adaptive network 1						6	6
			Shortraker-rougheye study area				
North	12	2	2,122	19	17	5	2
Adaptive network 1						3	1
Adaptive network 2						2	1
South	12	2	887	17	13	1	4
Adaptive network 1						0	2
Adaptive network 2						1	2

[1]One of the initial random stations was also an edge unit.

[2]Three additional adaptive stations were completed in the east gully stratum (for a total of 27), but results for these stations had to be excluded from the experiment when we later decided to change the value of r here from 2 to 1.

Table 2.--Continued.

Explanation of Notation and Terminology

n_1 = number of initial random stations.

r = number of high-CPUE stations around which adaptive sampling occurred.

$y > c$ = the threshold CPUE value (kg/nmi) used to determine whether adaptive sampling continued beyond the first level.

ν = total number of stations fished (random + adaptive).

ν' = number of stations used in the computation of the adaptive estimators (random + adaptive – edge units).

network units = number of stations in network with CPUE > threshold (i.e., stations meeting the criterion $y > c$, excluding initial random stations meeting the criterion).

edge units = number of adaptive stations in network with CPUE < threshold (i.e., stations not meeting the criterion $y > c$ that are also not initial random stations).

Table 3.--Rockfish abundance estimates (kg/nmi) and associated statistics for each stratum in the adaptive sampling experiment conducted during F/V *Unimak Enterprise* Cruise 98-01. Results from three methods of estimation are shown: SRS (simple random sampling), the Hansen-Hurwitz adaptive estimator, and the Horvitz-Thompson adaptive estimator. Data are for Pacific ocean perch only in the Pacific ocean perch study area, and for combined shortraker and rougheye rockfish in the shortraker-rougheye study area.

Stratum	Statistic*	SRS	Hansen-Hurwitz	Horvitz-Thompson
		Pacific ocean perch study area		
Slope	abundance	422	420	421
	variance	27,658	22,156	22,149
	SE	166	149	149
	CV	39.4%	35.4%	35.4%
Intersection	abundance	1,461	1,111	466
	variance	676,191	261,150	102,750
	SE	822	511	321
	CV	56.3%	46.0%	68.8%
West gully	abundance	297	291	291
	variance	17,732	16,178	16,176
	SE	133	127	127
	CV	44.8%	43.7%	43.7%
East gully	abundance	346	335	339
	variance	45,109	40,799	40,680
	SE	212	202	202
	CV	61.3%	60.3%	59.6%
		Shortraker-rougheye study area		
North	abundance	1,376	1,884	1,885
	variance	86,217	351,127	351,021
	SE	294	593	592
	CV	21.3%	31.5%	31.4%
South	abundance	516	516	517
	variance	16,512	16,553	16,553
	SE	129	129	129
	CV	24.9%	24.9%	24.9%

*SE = standard error; CV = coefficient of variation.

FIGURES

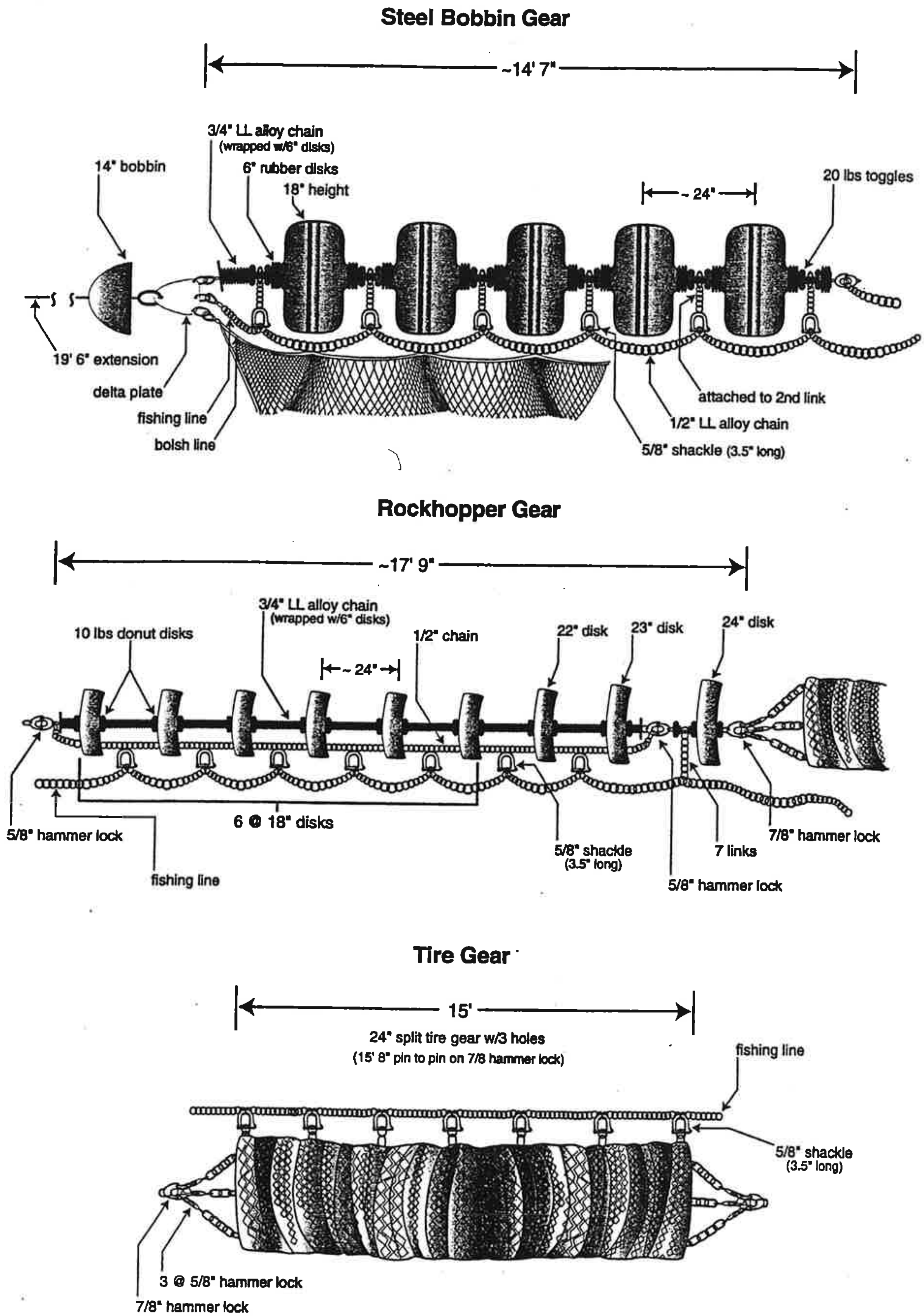


Figure 1.--Diagram of the steel bobbin, rockhopper, and tire gear used during F/V *Unimak Enterprise* Cruise 98-01.

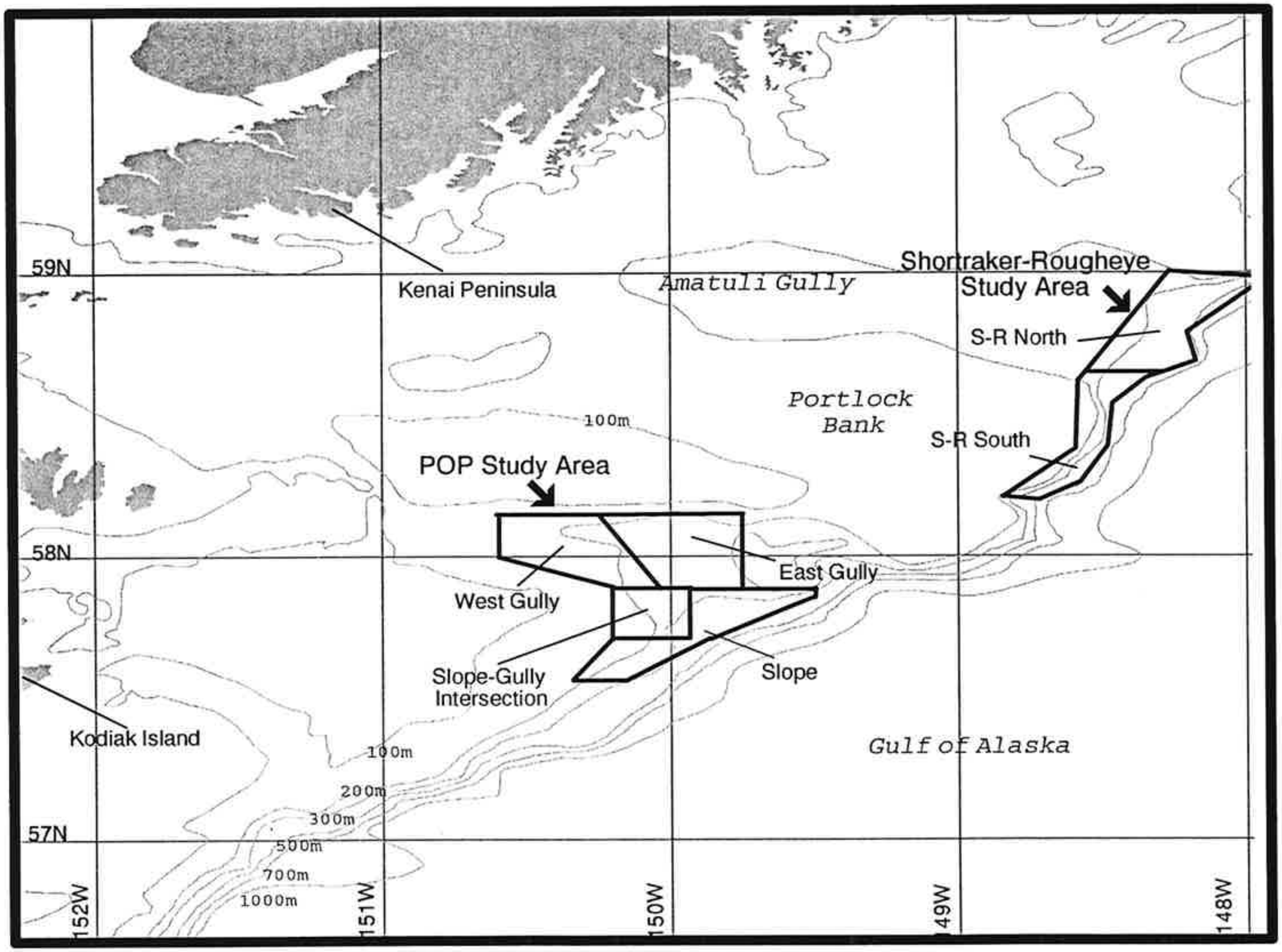
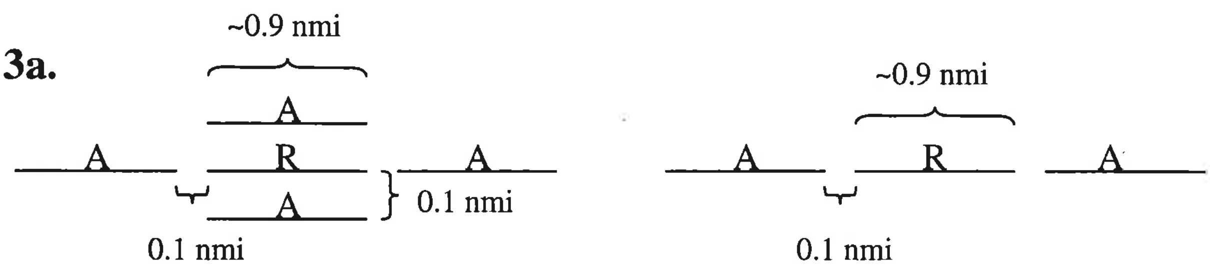


Figure 2.--Study areas and strata fished during the rockfish adaptive sampling experiment in the central Gulf of Alaska, F/V *Unimak Enterprise* Cruise 98-01 (POP = Pacific ocean perch).

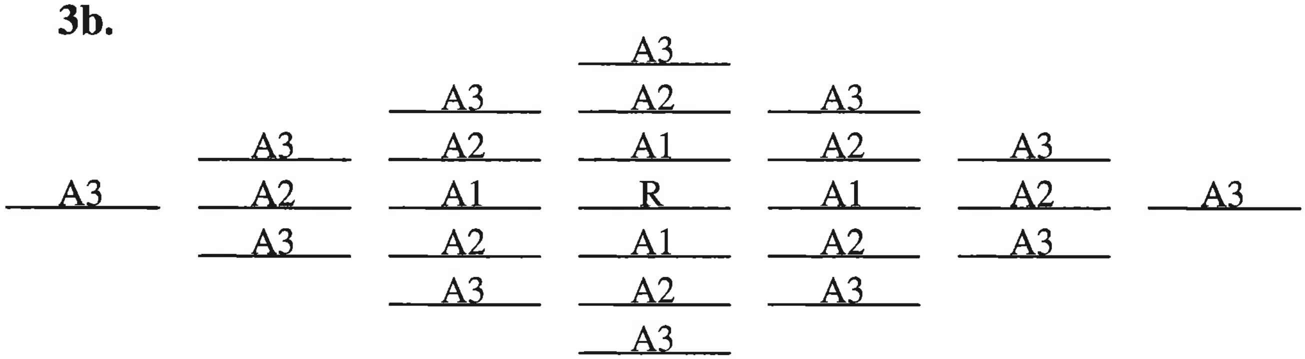
3a.



Cross pattern

Linear pattern

3b.



Cross pattern: Maximum number of possible adaptive tows around each random station (24 total, 3 levels).

Linear pattern: Maximum number of possible adaptive tows around each random station (12 total, 6 levels).

Figure 3.--Diagrams of the idealized sampling patterns for adaptive tows during the rockfish adaptive sampling experiment, F/V *Unimak Enterprise* Cruise 98-01. Figure 3a shows the basic cross and linear patterns and their distances (not to scale). Figure 3b shows the maximum possible number of adaptive tows for each pattern. The initial random station is denoted as "R," and the adaptive stations as "A" and their respective level number.

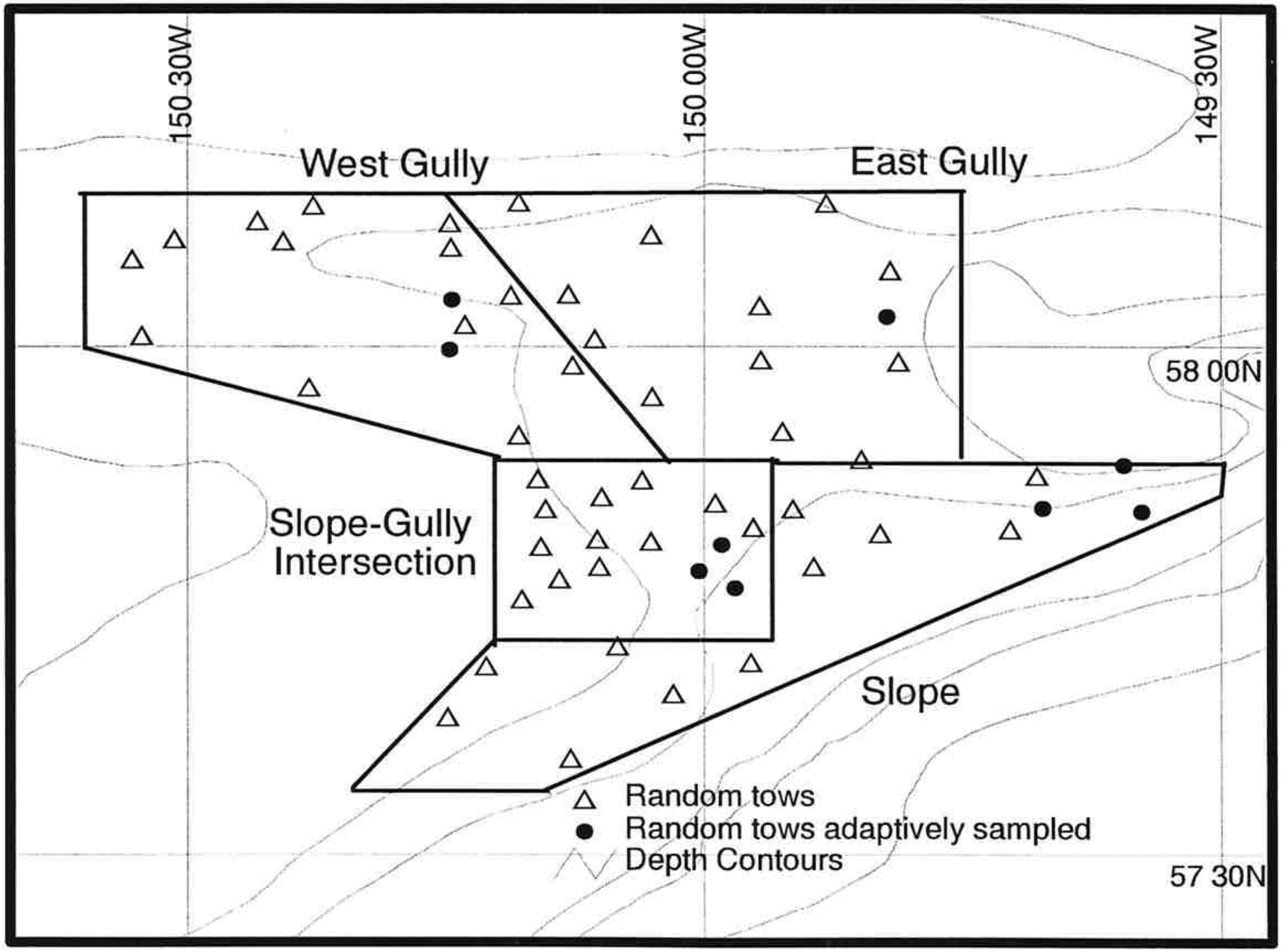


Figure 4.--Random hauls fished in the Pacific ocean perch study area, F/V *Unimak Enterprise* Cruise 98-01. Black dots denote the random hauls around which adaptive sampling occurred.

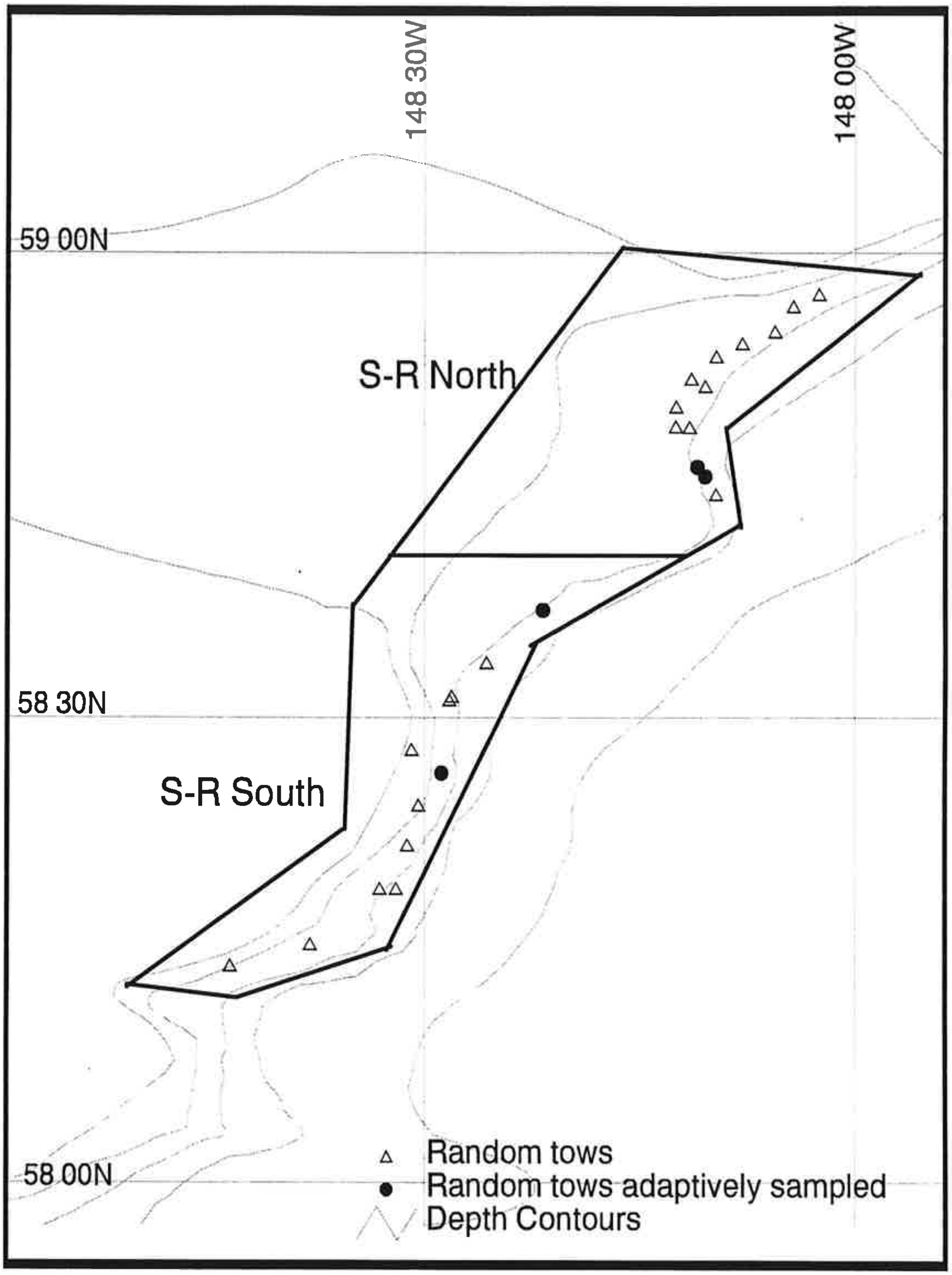


Figure 5.--Random hauls fished in the shortraker-rougheye study area, F/V *Unimak Enterprise* Cruise 98-01. Black dots denote the random hauls around which adaptive sampling occurred.

APPENDIX

Appendix Table 1.--Itinerary and scientific personnel, F/V *Unimak Enterprise* Cruise 98-01.

Itinerary	
August 5	Begin charter in Kodiak, AK; load vessel.
August 6	In port, Kodiak, waiting for repair of vessel's flow scale; depart for fishing grounds in late evening.
August 7	Conduct two trial tows in afternoon; begin adaptive sampling experiment for Pacific ocean perch in evening.
August 8–15	Continue adaptive sampling experiment for Pacific ocean perch.
August 16	Finish adaptive sampling experiment for Pacific ocean perch at midday; begin adaptive sampling experiment for shortraker and rougheye rockfish in evening.
August 17–18	Continue adaptive sampling experiment for shortraker and rougheye rockfish.
August 19	Finish adaptive sampling experiment for shortraker and rougheye rockfish in evening; depart for Kodiak.
August 20	Arrive Kodiak at midday; unload vessel.
August 21	Finish unloading vessel; end charter.

Scientific Personnel

Name	Position	Organization*
Jonathan Heifetz	Co-Chief Scientist	NMFS-ABL
David Clausen	Co-Chief Scientist	NMFS-ABL
Chris Lunsford	Fishery Biologist	NMFS-ABL
Rebecca Reuter	Fishery Biologist	NMFS-ABL
Pat Malecha	Fishery Biologist	NMFS-ABL
James Stark	Fishery Biologist	NMFS-RACE
Nate Raring	Fishery Biologist	NMFS-REFM
Terrance Quinn II	Fisheries Professor	UAF-JCSFOS
Dana Hanselman	Graduate Student	UAF-JCSFOS
Zhenming Su	Graduate Student	UAF-JCSFOS

*NMFS-ABL = NMFS Auke Bay Laboratory, Auke Bay, Alaska.
NMFS-RACE = NMFS Resource Assessment and Conservation Engineering Division, Seattle, Washington.
NMFS-REFM = NMFS Resource Ecology and Fishery Management Division, Seattle, Washington
UAF-JCSFOS = University of Alaska Fairbanks, Juneau Center, School of Fisheries and Ocean Sciences, Juneau, Alaska.

Appendix Table 2.--Hauls fished during F/V *Unimak Enterprise* cruise 98-01. Start and end positions refer to the position of the vessel at equilibrium time and at haul back, respectively. For a description of the codes for performance, haul type, and stratum, see notes at end of the table.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
1	7-Aug-98	12:00	58 00.64	149 18.18	58 00.50	149 18.02	254	0.05	0.30	−1.00	T	—
2	7-Aug-98	17:40	57 56.61	149 18.18	57 57.58	149 18.12	348	0.32	1.80	0	T	—
3	7-Aug-98	19:44	57 50.18	149 34.62	57 49.62	149 36.04	262	0.25	1.74	0	R	1
4	7-Aug-98	21:09	57 52.91	149 35.64	57 53.07	149 37.20	157	0.25	1.57	0	R	1
5	7-Aug-98	22:20	57 50.34	149 40.32	57 50.34	149 38.95	274	0.25	1.52	0	R	1
6	7-Aug-98	23:33	57 49.11	149 42.23	57 49.06	149 41.07	287	0.25	1.39	0	R	1
7	8-Aug-98	0:50	57 52.34	149 40.69	57 52.15	149 39.20	241	0.25	1.70	0	R	1
8	8-Aug-98	2:16	57 48.90	149 49.81	57 48.87	149 51.34	260	0.25	1.56	0	R	1
9	8-Aug-98	3:45	57 53.26	149 50.90	57 53.20	149 49.12	256	0.25	1.72	0	R	1
10	8-Aug-98	4:54	57 50.36	149 54.82	57 50.24	149 56.64	258	0.25	1.76	0	R	1
11	8-Aug-98	6:06	57 46.91	149 53.63	57 46.75	149 51.91	254	0.25	1.59	2	R	1
12	8-Aug-98	6:45	57 41.30	149 57.32	57 41.30	149 55.78	225	0.25	1.52	0	R	1
13	8-Aug-98	8:40	57 39.40	150 01.78	57 39.20	150 03.42	282	0.25	1.93	0	R	1
14	8-Aug-98	9:54	57 42.21	150 05.05	57 42.52	150 03.93	181	0.25	1.35	0	R	1
15	8-Aug-98	11:13	57 35.66	150 07.72	57 35.07	150 09.08	298	0.25	1.80	0	R	1
16	8-Aug-98	12:23	57 38.02	150 14.88	57 38.82	150 14.43	188	0.25	1.61	0	R	1
17	8-Aug-98	13:24	57 41.06	150 12.68	57 41.67	150 11.61	157	0.25	1.65	0	R	1
18	8-Aug-98	16:42	57 50.61	149 33.19	57 50.12	149 34.52	247	0.25	1.61	0	A	1
19	8-Aug-98	18:00	57 49.40	149 37.48	57 49.69	149 35.95	284	0.25	1.67	0	A	1
20	8-Aug-98	19:00	57 51.00	149 31.95	57 50.34	149 33.20	249	0.25	1.93	0	A	1
21	8-Aug-98	21:00	57 48.81	149 39.16	57 49.29	149 37.95	285	0.25	1.48	0	A	1
22	8-Aug-98	22:14	57 48.47	149 40.62	57 48.81	149 39.37	284	0.25	1.45	0	A	1
23	9-Aug-98	0:00	57 49.25	149 40.06	57 49.14	149 41.96	285	0.25	1.70	0	I	—
24	9-Aug-98	1:00	57 53.30	149 39.26	57 53.09	149 37.71	192	0.25	1.56	0	A	1
25	9-Aug-98	3:00	57 53.19	149 33.20	57 52.99	149 34.84	159	0.25	1.70	0	A	1

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
26	9-Aug-98	4:22	57 53.39	149 31.12	57 53.19	149 32.83	198	0.25	1.78	0	A	1
27	9-Aug-98	5:50	57 53.43	149 41.11	57 53.32	149 39.53	212	0.25	1.63	0	A	1
28	9-Aug-98	7:12	57 50.28	149 42.27	57 50.27	149 40.66	280	0.25	1.69	0	A	1
29	9-Aug-98	8:00	57 50.29	149 37.42	57 50.26	149 39.09	267	0.25	1.65	0	A	1
30	9-Aug-98	9:00	57 50.22	149 44.08	57 50.25	149 42.52	280	0.25	1.65	0	A	1
31	9-Aug-98	10:50	57 50.40	149 36.18	57 50.36	149 37.96	256	0.25	1.72	0	A	1
32	9-Aug-98	12:40	57 50.55	149 34.98	57 50.23	149 36.77	243	0.25	1.87	0	A	1
33	9-Aug-98	14:52	57 52.14	150 09.65	57 51.42	150 08.97	194	0.25	1.57	0	R	2
34	9-Aug-98	15:50	57 51.03	150 05.91	57 50.11	150 05.93	210	0.25	1.76	0	R	2
35	9-Aug-98	16:49	57 52.07	150 03.62	57 52.88	150 04.37	230	0.25	1.70	0	R	2
36	9-Aug-98	18:00	57 50.68	149 59.36	57 50.82	150 01.01	251	0.25	1.63	0	R	2
37	9-Aug-98	19:00	57 48.16	149 59.00	57 48.59	149 57.59	220	0.25	1.70	0	R	2
38	9-Aug-98	20:00	57 49.24	149 57.12	57 48.87	149 58.72	251	0.25	1.70	0	R	2
39	9-Aug-98	21:00	57 48.42	150 03.07	57 47.55	150 02.86	209	0.25	1.70	0	R	2
40	9-Aug-98	22:00	57 48.51	150 06.17	57 49.30	150 05.56	207	0.25	1.74	0	R	2
41	9-Aug-98	23:00	57 48.13	150 09.50	57 47.36	150 08.79	188	0.25	1.65	0	R	2
42	10-Aug-98	0:30	57 50.32	150 09.18	57 49.47	150 09.41	196	0.25	1.63	0	R	2
43	10-Aug-98	1:47	57 44.99	150 10.54	57 45.92	150 10.75	161	0.25	1.78	0	R	2
44	10-Aug-98	2:52	57 46.19	150 08.39	57 45.32	150 08.46	192	0.25	1.69	2.1	R	2
45	10-Aug-98	4:13	57 46.90	150 06.07	57 47.59	150 07.15	205	0.25	1.76	0	R	2
46	10-Aug-98	6:32	57 46.59	150 00.31	57 46.13	149 58.74	179	0.25	1.89	2.1	R	2
47	10-Aug-98	7:55	57 45.62	149 58.17	57 45.35	149 56.61	183	0.25	1.72	0	R	2
48	10-Aug-98	9:07	57 45.83	149 58.84	57 45.59	149 57.15	183	0.25	1.67	0	A	2
49	10-Aug-98	12:28	57 45.38	149 55.87	57 45.54	149 57.63	201	0.25	1.82	0	A	2
50	10-Aug-98	15:58	57 45.52	149 58.44	57 45.26	149 56.76	183	0.25	1.80	0	A	2
51	10-Aug-98	17:06	57 46.02	150 00.28	57 45.65	149 58.58	183	0.25	1.80	0	A	2
52	10-Aug-98	18:15	57 45.88	149 58.05	57 45.57	149 56.38	198	0.25	1.85	0	A	2

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
53	10-Aug-98	19:59	57 45.53	149 55.56	57 45.64	149 57.21	210	0.25	1.72	0	A	2
54	10-Aug-98	21:42	57 44.98	149 54.98	57 45.22	149 56.54	207	0.25	1.65	0	A	2
55	10-Aug-98	22:53	57 45.32	149 58.18	57 45.13	149 56.70	179	0.25	1.59	0	A	2
56	11-Aug-98	0:43	57 45.94	150 00.59	57 45.69	149 59.21	177	0.25	1.52	0	A	2
57	11-Aug-98	2:01	57 46.41	150 01.95	57 46.08	150 00.47	187	0.25	1.63	0	A	2
58	11-Aug-98	3:52	57 46.03	149 59.69	57 45.67	149 58.25	181	0.25	1.67	2	A	2
59	11-Aug-98	5:26	57 45.62	149 55.47	57 45.78	149 56.98	221	0.25	1.65	0	A	2
60	11-Aug-98	6:30	57 44.88	149 55.35	57 45.14	149 56.82	210	0.25	1.59	0	A	2
61	11-Aug-98	7:30	57 45.02	149 57.08	57 45.26	149 58.87	174	0.25	1.83	1.11	A	2
62	11-Aug-98	11:11	57 45.64	150 00.02	57 45.42	149 58.47	179	0.25	1.59	0	A	2
63	11-Aug-98	12:48	57 46.36	150 02.52	57 46.08	150 01.08	192	0.25	1.54	0	A	2
64	11-Aug-98	14:08	57 46.46	150 01.25	57 46.07	149 59.86	183	0.25	1.54	0	A	2
65	11-Aug-98	15:00	57 46.26	150 00.00	57 45.91	149 58.49	183	0.25	1.63	0	A	2
66	11-Aug-98	16:15	57 46.76	150 00.23	57 46.26	149 58.58	183	0.25	1.74	2.1	A	2
67	11-Aug-98	22:55	57 45.91	149 56.92	57 46.08	149 58.52	192	0.25	1.72	0	A	2
68	11-Aug-98	23:53	57 46.44	150 00.38	57 46.12	149 58.97	179	0.25	1.57	0	A	2
69	12-Aug-98	2:45	57 47.11	150 02.11	57 46.70	150 00.70	190	0.25	1.61	0	A	2
70	12-Aug-98	4:15	57 46.94	150 00.08	57 46.49	149 58.65	185	0.25	1.63	2	A	2
71	12-Aug-98	5:45	57 46.11	149 57.33	57 46.31	149 58.93	194	0.25	1.69	0	A	2
72	12-Aug-98	11:50	57 45.87	149 55.57	57 45.94	149 57.40	205	0.25	1.82	0	A	2
73	12-Aug-98	14:24	57 46.86	150 02.07	57 46.54	150 00.63	194	0.25	1.54	0	A	2
74	12-Aug-98	15:40	57 47.40	150 01.91	57 46.97	150 00.55	188	0.25	1.59	0	A	2
75	12-Aug-98	16:44	57 47.53	150 03.95	57 47.16	150 02.30	201	0.25	1.76	0	A	2
76	12-Aug-98	17:38	57 47.14	150 00.12	57 46.59	149 58.66	183	0.25	1.72	0	A	2
77	12-Aug-98	18:39	57 42.28	149 57.35	57 42.53	149 59.09	205	0.25	1.74	0	A	2
78	12-Aug-98	20:00	57 46.03	149 55.53	57 46.04	149 57.24	216	0.25	1.57	0	A	2
79	12-Aug-98	21:15	57 46.62	150 01.72	57 46.29	150 00.04	194	0.25	1.76	0	A	2

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
80	12-Aug-98	22:35	57 47.33	150 03.84	57 46.89	150 02.26	199	0.25	1.78	0	A	2
81	13-Aug-98	0:34	57 47.69	150 03.48	57 47.31	150 02.20	198	0.25	1.61	0	A	2
82	13-Aug-98	1:35	57 47.48	150 01.44	57 47.05	150 00.15	179	0.25	1.65	0	A	2
83	13-Aug-98	2:47	57 47.67	150 00.83	57 48.07	149 59.45	190	0.25	1.59	2	A	2
84	13-Aug-98	4:07	57 48.28	149 59.28	57 48.67	149 57.93	216	0.25	1.57	0	A	2
85	13-Aug-98	5:24	57 48.05	149 56.26	57 48.59	149 57.66	256	0.25	1.67	0	A	2
86	13-Aug-98	6:23	57 47.92	149 59.33	57 48.31	149 57.80	223	0.25	1.76	0	A	2
87	13-Aug-98	7:39	57 47.46	150 00.90	57 47.84	149 59.35	192	0.25	1.76	0	A	2
88	13-Aug-98	8:42	57 47.99	150 00.49	57 48.38	149 59.06	207	0.25	1.67	0	A	2
89	13-Aug-98	9:53	57 48.47	149 59.54	57 48.81	149 58.07	220	0.25	1.61	0	A	2
90	13-Aug-98	14:58	57 49.05	149 57.12	57 48.54	149 58.48	249	0.25	1.69	0	A	2
91	13-Aug-98	16:06	57 48.66	149 56.92	57 48.17	149 58.33	252	0.25	1.63	0	A	2
92	13-Aug-98	17:00	57 47.62	149 59.50	57 48.05	149 58.08	201	0.25	1.67	0	A	2
93	13-Aug-98	18:00	57 47.18	150 00.90	57 47.68	149 59.50	183	0.25	1.72	0	A	2
94	13-Aug-98	19:00	57 47.65	150 01.79	57 48.13	150 00.34	183	0.25	1.76	0	A	2
95	13-Aug-98	20:00	57 48.18	150 01.18	57 48.53	149 59.57	201	0.25	1.72	0	A	2
96	13-Aug-98	21:00	57 48.67	149 59.65	57 48.89	149 58.10	220	0.25	1.63	0	A	2
97	13-Aug-98	22:20	57 48.56	149 56.50	57 48.07	149 58.05	247	0.25	1.82	0	A	2
98	13-Aug-98	23:00	57 47.82	149 58.07	57 47.39	149 59.54	212	0.25	1.78	1.11	A	2
99	14-Aug-98	1:40	57 54.69	150 10.73	57 55.49	150 10.82	196	0.25	1.48	0	R	3
100	14-Aug-98	2:50	57 58.83	150 07.59	57 59.58	150 08.42	225	0.25	1.65	0	R	3
101	14-Aug-98	3:55	57 59.78	150 14.75	58 00.60	150 15.60	187	0.25	1.80	0	R	3
102	14-Aug-98	5:01	58 01.27	150 13.88	58 00.67	150 12.90	192	0.25	1.50	0	R	3
103	14-Aug-98	6:25	58 02.97	150 11.23	58 03.57	150 12.59	241	0.25	1.76	0	R	3
104	14-Aug-98	7:34	58 02.69	150 14.66	58 03.33	150 15.82	201	0.25	1.69	0	R	3
105	14-Aug-98	8:45	58 05.81	150 14.71	58 06.39	150 16.19	249	0.25	1.80	0	R	3
106	14-Aug-98	9:50	58 07.23	150 14.74	58 07.79	150 16.06	227	0.25	1.69	0	R	3

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
107	14-Aug-98	10:52	58 08.27	150 22.69	58 07.92	150 24.32	170	0.25	1.78	0	R	3
108	14-Aug-98	11:53	58 07.37	150 25.91	58 07.57	150 24.19	174	0.25	1.76	0	R	3
109	14-Aug-98	13:02	58 06.19	150 24.44	58 05.59	150 23.11	199	0.25	1.80	0	R	3
110	14-Aug-98	14:19	58 06.29	150 30.74	58 05.67	150 29.43	177	0.25	1.80	0	R	3
111	14-Aug-98	15:20	58 05.12	150 33.20	58 04.43	150 32.12	163	0.25	1.69	0	R	3
112	14-Aug-98	16:20	58 00.60	150 32.65	57 59.99	150 31.32	154	0.25	1.70	0	R	3
113	14-Aug-98	17:29	57 57.52	150 22.93	57 57.13	150 21.40	166	0.25	1.72	0	R	3
114	14-Aug-98	18:54	58 02.20	150 13.64	58 02.82	150 14.86	198	0.25	1.63	0	A	3
115	14-Aug-98	19:55	58 02.65	150 14.98	58 03.26	150 16.25	201	0.25	1.69	0	A	3
116	14-Aug-98	21:00	58 03.94	150 16.99	58 03.35	150 15.84	207	0.25	1.67	0	A	3
117	14-Aug-98	22:00	58 02.76	150 14.20	58 03.35	150 15.50	203	0.25	1.72	0	A	3
118	14-Aug-98	23:10	58 01.92	150 13.62	58 02.51	150 14.56	199	0.25	1.56	0	A	3
119	15-Aug-98	0:04	58 02.33	150 14.84	58 02.93	150 16.05	194	0.25	1.69	0	A	3
120	15-Aug-98	1:20	58 03.80	150 17.20	58 03.11	150 15.93	198	0.25	1.89	0	A	3
121	15-Aug-98	2:26	58 01.24	150 16.40	58 00.46	150 15.54	187	0.25	1.74	0	A	3
122	15-Aug-98	3:31	57 59.67	150 14.43	58 00.51	150 15.10	183	0.25	1.65	0	A	3
123	15-Aug-98	4:36	57 58.71	150 13.99	57 59.51	150 14.71	183	0.25	1.69	0	A	3
124	15-Aug-98	5:40	57 59.57	150 15.24	58 00.40	150 15.87	185	0.25	1.69	0	A	3
125	15-Aug-98	7:29	58 03.03	150 07.84	58 02.43	150 06.78	285	0.25	1.61	0	R	4
126	15-Aug-98	8:36	58 00.44	150 06.33	57 59.72	150 05.39	249	0.25	1.76	0	R	4
127	15-Aug-98	9:24	57 57.00	150 03.02	57 56.25	150 01.83	250	0.25	1.85	0	R	4
128	15-Aug-98	10:23	57 54.94	149 55.45	57 54.19	149 54.32	250	0.25	1.74	0	R	4
129	15-Aug-98	11:36	57 59.16	149 56.69	57 59.78	149 57.91	265	0.25	1.76	0	R	4
130	15-Aug-98	12:45	58 02.34	149 56.75	58 01.77	149 55.40	265	0.25	1.69	0	R	4
131	15-Aug-98	13:50	57 59.05	149 48.72	57 58.58	149 47.39	207	0.25	1.67	0	R	4
132	15-Aug-98	14:50	58 01.65	149 49.40	58 02.25	149 50.66	220	0.25	1.74	0	R	4
133	15-Aug-98	15:55	58 04.42	149 49.17	58 03.88	149 47.87	258	0.25	1.69	0	R	4

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
134	15-Aug-98	17:17	58 08.39	149 52.89	58 08.68	149 54.66	198	0.25	1.78	0	R	4
135	15-Aug-98	18:33	58 06.53	150 03.06	58 07.31	150 04.16	274	0.25	1.80	0	R	4
136	15-Aug-98	19:34	58 08.46	150 10.75	58 09.09	150 12.02	192	0.25	1.69	0	R	4
137	15-Aug-98	21:57	58 01.50	149 49.63	58 02.08	149 50.70	225	0.25	1.61	0	A	4
138	15-Aug-98	23:01	58 02.78	149 51.71	58 02.15	149 50.51	247	0.25	1.70	0	A	4
139	16-Aug-98	0:00	58 01.65	149 48.91	58 02.21	149 50.10	225	0.25	1.59	0	A	4
140	16-Aug-98	1:05	58 00.90	149 47.81	58 01.47	149 49.09	198	0.25	1.63	0	A	4
141	16-Aug-98	2:10	58 01.38	149 49.80	58 01.99	149 50.98	225	0.25	1.67	0	A	4
142	16-Aug-98	3:00	58 02.71	149 52.25	58 02.15	149 50.95	256	0.25	1.70	0	A	4
143	16-Aug-98	3:34	58 02.77	149 51.27	58 02.22	149 50.00	256	0.25	1.61	0	A	4
144	16-Aug-98	5:27	58 01.82	149 48.82	58 02.38	149 50.11	220	0.25	1.78	0	A	4
145	16-Aug-98	6:42	58 00.99	149 47.35	58 01.59	149 48.87	198	0.25	1.83	0	A	4
146	16-Aug-98	7:54	58 00.21	149 46.22	58 00.83	149 47.64	172	0.25	1.80	0	A	4
147	16-Aug-98	9:07	58 00.72	149 47.85	58 01.33	149 49.18	198	0.25	1.69	0	A	4
148	16-Aug-98	9:55	58 01.18	149 49.94	58 01.79	149 51.02	216	0.25	1.61	0	A	4
149	16-Aug-98	10:50	58 02.59	149 52.51	58 02.00	149 51.06	250	0.25	1.80	0	A	4
150	16-Aug-98	12:06	58 00.10	149 46.53	58 00.64	149 47.72	186	0.25	1.57	0	A	4
151	16-Aug-98	13:03	58 00.66	149 48.40	58 01.28	149 49.57	205	0.25	1.69	0	A	4
152	16-Aug-98	22:06	58 54.91	148 05.50	58 54.33	148 06.71	397	0.25	1.57	0	R	5
153	16-Aug-98	23:20	58 51.37	148 10.39	58 51.09	148 10.89	373	0.25	1.70	0	R	5
154	17-Aug-98	0:30	58 48.71	148 11.43	58 47.84	148 11.52	373	0.25	1.67	1	R	5
155	17-Aug-98	2:30	58 45.55	148 10.40	58 44.70	148 10.03	390	0.25	1.67	2.1	R	5
156	17-Aug-98	4:21	58 44.38	148 09.65	58 43.54	148 09.41	408	0.25	1.63	0	R	5
157	17-Aug-98	5:43	58 46.11	148 10.90	58 46.83	148 11.33	371	0.25	1.43	0	R	5
158	17-Aug-98	6:54	58 48.80	148 12.39	58 49.56	148 11.57	329	0.25	1.65	0	R	5
159	17-Aug-98	8:04	58 51.82	148 11.31	58 52.52	148 10.58	335	0.25	1.57	0	R	5
160	17-Aug-98	9:36	58 50.04	148 12.38	58 50.73	148 11.75	304	0.25	1.48	-4.4	R	5

Appendix Table 2.--Continued.

Haul No.	Date	Time	Start Position Lat.(N)	Start Position Long.(W)	End Position Lat.(N)	End Position Long.(W)	Depth (m)	Duration (h)	Distance Fished (km)	Perform-ance	Haul Type	Stra-tum
161	18-Aug-98	0:02	58 53.28	148 09.58	58 53.82	148 08.32	357	0.25	1.59	0	R	5
162	18-Aug-98	1:20	58 54.12	148 07.81	58 54.03	148 07.18	—	0.12	0.63	-1.12	I	—
163	18-Aug-98	4:19	58 56.51	148 04.28	58 57.25	148 03.64	342	0.25	1.54	0	R	5
164	18-Aug-98	5:33	58 57.27	148 02.46	58 57.64	148 01.14	386	0.25	1.50	0	R	5
165	18-Aug-98	7:40	58 47.69	148 11.54	58 46.89	148 11.34	368	0.25	1.48	0	A	5
166	18-Aug-98	9:53	58 45.12	148 10.63	58 45.91	148 10.88	368	0.25	1.48	0	A	5
167	18-Aug-98	10:16	58 43.99	148 10.27	58 44.75	148 10.41	371	0.25	1.46	0	A	5
168	18-Aug-98	11:37	58 43.09	148 10.67	58 43.83	148 10.26	371	0.25	1.52	0	A	5
169	18-Aug-98	13:06	58 46.51	148 10.89	58 45.89	148 10.50	384	0.25	1.30	1.11	A	5
170	18-Aug-98	15:10	58 43.88	148 10.01	58 44.01	148 10.01	384	0.05	0.30	1.12	A	5
171	18-Aug-98	16:19	58 42.96	148 10.53	58 43.69	148 10.02	380	0.25	1.52	0	A	5
172	18-Aug-98	18:14	58 36.90	148 21.64	58 36.14	148 22.39	377	0.25	1.61	0	R	6
173	18-Aug-98	19:36	58 33.56	148 25.61	58 32.79	148 26.14	335	0.25	1.54	1.11	R	6
174	18-Aug-98	21:10	58 31.40	148 28.04	58 31.04	148 28.79	333	0.20	0.98	1.12	R	6
175	18-Aug-98	22:27	58 31.16	148 28.22	58 30.51	148 29.30	357	0.25	1.69	0	R	6
176	18-Aug-98	23:51	58 27.96	148 30.83	58 27.14	148 30.20	326	0.25	1.72	0	R	6
177	19-Aug-98	0:58	58 26.42	148 28.74	58 25.59	148 28.40	333	0.25	1.61	2.4	R	6
178	19-Aug-98	2:32	58 24.34	148 30.33	58 23.42	148 30.11	307	0.25	1.70	2.1	R	6
179	19-Aug-98	3:59	58 21.77	148 31.12	58 22.53	148 30.46	366	0.25	1.61	0	R	6
180	19-Aug-98	5:11	58 18.95	148 31.90	58 18.07	148 31.84	375	0.25	1.63	0	R	6
181	19-Aug-98	6:25	58 18.93	148 33.06	58 18.14	148 33.38	316	0.25	1.57	0	R	6
182	19-Aug-98	7:54	58 15.34	148 37.93	58 15.18	148 39.50	384	0.25	1.57	0	R	6
183	19-Aug-98	9:06	58 13.97	148 43.50	58 13.49	148 44.92	400	0.25	1.59	0	R	6
184	19-Aug-98	11:56	58 27.40	148 30.06	58 26.63	148 29.22	342	0.25	1.62	0	A	6
185	19-Aug-98	13:08	58 24.81	148 29.73	58 25.60	148 29.15	344	0.25	1.61	0	A	6
186	19-Aug-98	15:58	58 43.00	148 10.60	58 43.76	148 10.14	377	0.25	1.52	1.11	T	—
187	19-Aug-98	17:07	58 43.44	148 10.53	58 44.25	148 10.34	362	0.25	1.57	0	T	—
188	19-Aug-98	18:42	58 37.56	148 20.88	58 36.76	148 21.65	369	0.25	1.57	0	A	6
189	19-Aug-98	19:55	58 35.42	148 23.91	58 36.07	148 22.94	373	0.25	1.57	0	A	6
190	19-Aug-98	22:03	58 34.60	148 24.73	58 35.30	148 23.92	366	0.25	1.54	1.2	A	6

Appendix Table 2.--Continued.

Notes
Geodetic positions are in degrees and decimal minutes. Performance codes: 0 Good performance 1.00 Satisfactory performance, hung up 1.11 Satisfactory performance, hung up, but completed tow 1.12 Satisfactory performance, hauled back early due to hang 1.20 Satisfactory performance, major hang, stopped forward progress of vessel 2.00 Satisfactory performance, unspecified gear damage 2.10 Satisfactory performance, wing damaged 2.40 Satisfactory performance, belly damaged -1.00 Unsatisfactory performance -1.12 Unsatisfactory performance, major hang, stopped forward progress of vessel -4.40 Unsatisfactory performance, large fish catch affected net performance Haul types: T = test or experimental tow R = random station A = adaptive station I = invalid tow Stratum codes: 1 = Pacific ocean perch slope 2 = Pacific ocean perch slope-gully intersection 3 = Pacific ocean perch west gully 4 = Pacific ocean perch east gully 5 = Shortraker-rougheye north 6 = Shortraker-rougheye south

Appendix Table 3.--Catch by species for hauls completed during F/V *Unimak Enterprise* Cruise 98-01. — indicates no catch.

	Haul (kg round weight)																			
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Pacific ocean perch	583.8	18.8	1,495.1	448.8	1,815.7	326.8	234.7	116.9	33.7	9.3	21.5	284.7	155.6	123.6	71.6	212.9	9.9	472.0	693.9	267.9
arrowtooth flounder	25.8	46.5	448.5	139.0	114.0	43.2	152.5	92.2	69.9	81.7	100.1	50.5	138.9	129.3	413.8	1,259.8	69.0	88.9	3,265.8	177.9
rougheye rockfish	2.6	1,026.0	280.3	0.4	58.0	32.3	12.1	2.2	2.9	3.7	0.6	15.1	13.1	3.4	44.7	9.1	—	56.6	336.7	35.6
sablefish	137.0	100.1	51.8	35.8	—	8.2	30.4	8.1	10.5	7.3	7.7	—	14.9	9.4	3.1	3.0	—	36.3	2,121.3	135.4
shortraker rockfish	18.2	2,352.2	—	—	—	24.3	—	—	—	—	—	—	—	—	43.6	25.6	—	—	431.4	—
Pacific cod	—	—	107.3	66.9	11.0	—	45.0	30.7	49.6	11.7	10.5	128.1	105.1	44.8	6.9	151.5	3.9	46.6	—	47.6
Pacific halibut	—	—	—	39.8	—	16.0	0.8	60.0	45.1	31.4	12.8	14.1	88.8	149.6	129.3	—	72.9	49.0	517.5	52.9
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	1.8	281.1	136.1	2.8	72.3	47.5	45.7	11.3	14.6	48.2	30.3	42.9	98.3	13.6	69.7	2.4	—	65.8	144.7	109.7
walleye pollock	73.5	—	12.0	2.0	—	4.1	6.9	106.0	27.5	68.0	237.4	1.0	6.5	0.4	46.0	0.5	0.8	84.3	—	26.8
Dover sole	5.2	45.4	13.4	—	16.7	14.2	15.2	5.3	3.6	15.1	8.8	3.7	19.9	5.1	8.9	14.1	—	3.5	19.2	16.2
rex sole	—	1.9	—	14.7	31.9	4.0	5.7	20.5	12.1	43.2	42.6	2.0	3.4	3.8	20.0	35.2	—	5.8	—	3.2
light dusky rockfish	—	—	—	129.0	23.7	—	—	—	—	—	0.4	1.4	3.6	—	—	—	—	—	—	—
northern rockfish	—	—	—	54.2	20.8	0.8	—	—	—	—	0.3	1.0	—	1.5	0.6	0.8	—	1.2	—	0.7
sharpchin rockfish	—	—	1.4	234.9	36.2	—	11.8	5.7	0.7	—	—	35.8	3.8	44.2	11.0	0.8	0.5	58.7	—	24.3
flathead sole	—	—	—	—	—	—	—	0.6	—	6.1	1.9	—	—	0.4	0.7	4.5	—	—	—	—
prowfish	—	—	—	—	—	—	—	—	—	—	—	6.5	—	—	3.9	—	—	—	—	2.2
harlequin rockfish	—	—	—	3.6	2.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5
silvergray rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—	—	—	—	—	—	1.6	0.6	0.4	—	—	5.7	0.8	—	—	—	—	13.6	—	10.6
redstripe rockfish	—	—	—	25.5	—	—	—	—	—	0.3	—	—	—	1.2	—	—	—	—	—	—
Other species	—	37.5	7.7	52.6	27.0	2.9	16.9	3.2	1.5	12.7	2.1	16.3	22.2	1.2	24.7	13.2	48.1	1.3	5.0	9.3
Grand Total	847.9	3,909.5	2,553.6	1,250.0	2,230.2	524.3	579.3	463.3	272.1	338.7	477.0	608.8	674.9	531.5	898.5	1,733.4	205.1	983.7	7,535.4	920.8

Appendix Table 3.--Extended.

Species	Haul (kg round weight)																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Pacific ocean perch	3,590.0	315.2	2,829.4	1,013.3	1,297.2	219.6	370.3	1,679.3	469.8	228.5	1,241.7	427.7	282.6	442.0	178.5	274.0	2,753.2	92.0	76.1	50.6
arrowtooth flounder	4,852.9	117.3	438.9	170.0	174.0	98.3	74.5	39.0	192.0	118.4	102.0	74.3	—	174.1	126.6	94.3	91.4	140.0	—	44.4
rougheye rockfish	1,086.3	209.7	222.9	—	—	—	2.2	45.0	43.8	—	13.5	12.0	—	4.3	—	2.4	3.7	—	1.3	—
sablefish	611.6	—	—	42.3	105.0	49.4	11.3	16.6	3.6	10.0	52.7	7.0	5.5	—	4.9	12.4	129.3	8.0	13.8	—
shortraker rockfish	801.5	32.3	93.8	—	—	—	—	63.9	—	18.9	—	—	—	—	—	—	—	—	—	—
Pacific cod	—	—	—	54.5	22.1	27.5	26.9	11.8	102.6	13.9	198.9	102.0	23.2	49.0	34.5	53.8	252.6	5.5	148.6	54.3
Pacific halibut	—	119.4	—	—	36.6	42.6	14.2	216.1	80.6	—	227.7	253.6	37.1	58.6	35.9	—	61.1	23.7	23.1	60.3
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	139.1	133.3	129.9	8.6	—	11.9	26.7	61.5	106.2	22.6	54.8	25.9	4.1	—	48.4	85.1	20.1	36.3	0.9	—
walleye pollock	—	3.2	—	70.3	104.5	70.2	9.9	—	3.6	2.0	1.7	28.8	306.3	314.0	93.9	21.8	19.3	77.2	31.9	17.4
Dover sole	—	22.9	50.0	14.3	16.7	12.2	2.3	10.6	7.0	10.4	—	1.7	6.1	5.1	6.3	13.5	23.8	21.3	11.6	5.1
rex sole	—	1.7	3.1	5.7	9.7	7.3	17.4	9.1	3.0	57.4	8.4	2.9	16.8	22.7	44.5	31.0	20.8	22.2	39.6	35.7
light dusky rockfish	—	—	—	—	225.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
northern rockfish	—	—	—	—	282.3	9.6	1.9	—	—	—	—	—	—	0.6	—	0.8	—	—	—	—
sharpchin rockfish	—	1.3	—	1.4	367.9	17.2	69.6	13.4	—	2.3	1.3	37.4	1.2	—	—	—	—	—	—	—
flathead sole	—	—	—	—	—	—	1.1	—	—	1.0	—	—	8.3	11.6	28.7	30.8	11.9	17.0	15.0	24.4
prowfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26.0	—	—	—
harlequin rockfish	—	—	—	—	211.2	7.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—	—	—	—	—	—	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—	—	—	—	—	1.1	3.3	0.8	—	0.6	—	5.4	—	1.1	—	1.5	—	—	2.3	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	1.8	26.9	24.6	7.2	2.1	12.3	5.8	1.2	18.3	4.0	1.3	0.6	7.9	1.5	2.1	21.2	60.2	7.3	6.3	21.1
Grand Total	11,083.1	983.1	3,792.5	1,387.6	2,854.5	586.7	639.8	2,168.3	1,030.5	490.0	1,903.7	979.4	699.1	1,084.6	604.3	642.6	3,473.1	450.5	370.5	313.3

Appendix Table 3.--Extended.

Species	Haul (kg round weight)																			
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Pacific ocean perch	96.7	45.6	114.1	24.7	26.3	5,506.1	10,831.4	15,234.2	4,209.4	975.0	8,696.5	478.3	3,902.5	3,388.2	3,218.9	1,826.3	284.6	1,577.9	5,422.0	11,741.8
arrowtooth flounder	26.3	63.0	87.6	84.2	61.7	166.5	67.7	345.1	129.5	46.4	132.1	78.9	35.1	74.2	85.1	90.9	72.3	86.9	82.1	—
rougheye rockfish	—	—	—	—	—	2.7	—	—	4.4	2.6	—	4.0	6.5	5.1	—	—	—	5.8	7.8	24.4
sablefish	—	0.4	2.2	1.8	—	57.7	87.5	—	—	—	—	38.7	—	—	—	—	9.0	—	—	—
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific cod	52.0	32.3	83.7	24.7	23.9	57.7	307.7	178.9	224.4	138.6	82.0	334.9	34.3	64.8	384.8	136.3	73.3	167.5	81.0	100.1
Pacific halibut	24.2	—	91.2	40.7	24.6	189.6	—	—	—	71.7	880.4	179.2	174.0	138.3	93.5	123.8	38.3	75.8	—	—
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	—	—	—	—	—	—	—	—	0.5	—	—	—	19.6	7.3	1.6	—	—	—	22.2	—
walleye pollock	93.5	69.8	3.3	61.5	38.7	24.2	22.6	—	34.6	—	60.0	—	14.7	—	54.6	53.8	24.6	19.3	13.3	—
Dover sole	4.8	10.1	45.1	26.3	9.7	—	—	—	10.3	—	—	4.0	—	1.4	—	—	14.7	4.3	15.5	—
rex sole	40.8	19.7	32.0	22.1	25.4	—	—	—	15.4	1.9	—	1.4	6.5	5.1	—	—	20.6	1.9	24.4	—
light dusky rockfish	—	—	—	—	—	22.8	—	108.6	—	27.5	—	28.2	71.9	80.8	45.0	—	2.9	—	—	48.7
northern rockfish	—	—	0.8	2.5	—	16.1	132.7	51.1	17.9	66.4	16.0	25.7	120.1	61.9	67.5	4.2	18.4	33.8	16.6	18.9
sharpchin rockfish	—	—	—	—	—	13.4	22.6	25.6	69.2	89.5	22.0	31.5	2.4	12.4	55.4	11.2	0.5	8.2	—	65.0
flathead sole	13.4	5.7	1.8	2.7	10.6	—	5.6	—	—	—	—	—	—	—	—	—	—	—	—	—
prowfish	—	—	—	—	—	100.7	84.7	92.7	—	26.8	—	—	—	—	—	—	—	15.5	—	—
harlequin rockfish	—	—	—	—	—	—	—	—	—	9.8	—	—	—	—	6.4	—	—	—	4.4	—
silvergray rockfish	—	—	—	—	—	20.1	—	—	—	—	—	17.0	—	—	41.0	—	2.5	—	—	—
redbanded rockfish	—	—	—	—	—	—	—	—	—	—	28.0	—	—	—	—	—	—	—	—	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	6.0	—	7.3	16.7	—	—	—	—	—	29.8
Other species	2.5	7.6	38.9	26.9	12.3	1.3	—	6.4	5.2	27.7	—	0.4	75.1	77.2	10.4	5.6	24.7	45.9	3.7	—
Grand Total	354.2	254.2	500.7	318.1	233.2	6,179.2	11,562.4	16,042.5	4,720.8	1,484.1	9,923.1	1,222.3	4,470.2	3,933.4	4,064.2	2,252.1	586.4	2,042.9	5,692.9	12,028.7

Appendix Table 3.--Extended.

Species	Haul (kg round weight)																			
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Pacific ocean perch	2,135.0	1,313.0	1,353.9	6,544.3	13,310.1	1,968.0	8,555.4	606.0	1,316.9	16,323.1	6,358.5	2,711.1	1,243.9	2,561.5	269.9	3,552.2	7,836.5	4,964.6	457.1	53.1
arrowtooth flounder	58.0	114.5	134.5	137.4	55.3	53.9	36.4	56.5	143.2	145.7	87.9	27.1	100.5	184.1	247.2	97.5	40.9	68.7	105.2	101.4
rougheye rockfish	—	0.8	—	—	—	—	—	0.5	—	—	—	13.6	3.2	—	0.3	—	18.0	1.9	0.7	—
sablefish	27.1	—	—	—	—	—	—	72.1	15.3	187.8	15.3	—	4.0	27.3	1.3	—	50.7	—	9.5	—
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific cod	33.1	87.1	127.0	215.6	55.3	110.1	447.1	229.6	183.5	32.4	—	21.2	298.3	188.7	531.4	173.4	—	—	391.3	120.8
Pacific halibut	288.3	—	34.5	68.6	—	43.3	437.1	163.8	—	—	—	164.2	98.9	123.7	100.9	—	—	156.9	89.6	31.4
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	—	—	—	—	—	—	—	—	—	—	17.4	28.9	—	—	—	—	9.8	25.8	—	0.3
walleye pollock	24.4	17.6	88.0	67.5	20.7	—	57.8	91.2	89.2	—	—	4.1	49.2	15.6	16.6	18.4	4.9	—	13.8	53.6
Dover sole	—	—	8.5	—	—	—	—	3.3	—	32.4	—	4.7	4.9	—	5.2	—	—	—	2.2	13.4
rex sole	2.7	—	14.6	4.7	—	5.5	—	—	17.8	12.9	9.8	15.9	28.0	7.2	50.3	11.2	9.8	58.2	14.3	52.9
light dusky rockfish	—	—	—	—	41.4	71.7	77.0	36.8	27.0	—	—	—	1.7	—	—	—	—	35.3	—	—
northern rockfish	34.7	14.1	7.5	35.5	24.2	—	64.2	31.8	31.1	16.2	22.3	—	10.3	48.8	1.2	14.4	32.7	—	3.9	0.7
sharpchin rockfish	117.7	35.5	1.4	3.5	—	—	—	2.3	—	—	—	—	0.2	1.3	—	2.4	—	—	—	—
flathead sole	—	—	—	—	—	—	—	—	—	—	—	2.4	0.3	—	4.6	—	—	6.7	1.0	2.0
prowfish	13.0	—	—	—	—	240.3	151.9	27.0	31.6	—	—	—	31.9	55.3	—	142.3	—	—	4.6	—
harlequin rockfish	9.2	7.2	2.3	4.7	—	1.8	—	—	—	—	—	—	0.3	2.6	—	—	—	—	—	—
silvergray rockfish	—	—	—	15.4	—	16.4	—	6.0	—	—	—	—	—	—	—	26.4	—	—	—	—
redbanded rockfish	—	4.6	—	—	—	—	—	—	2.5	—	—	5.9	5.0	1.3	—	—	6.5	—	—	—
redstripe rockfish	—	1.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	26.6	27.9	1.4	—	3.4	2.1	10.7	3.7	74.4	6.5	13.4	5.9	11.1	37.7	8.9	1.6	107.9	8.6	47.6	19.1
Grand Total	2,769.8	1,623.4	1,773.7	7,097.4	13,510.4	2,513.2	9,837.5	1,330.6	1,932.4	16,756.9	6,524.7	3,005.0	1,891.7	3,255.1	1,237.8	4,039.7	8,117.8	5,326.6	1,140.8	448.7

Appendix Table 3.--Extended.

Species	Haul (kg round weight)																			
	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Pacific ocean perch	84.1	549.2	2,852.9	2,532.7	114.5	2,277.0	3,047.2	16,864.2	4,963.4	599.9	671.1	1,699.6	1,447.4	4,621.0	3,270.5	1,689.5	184.8	393.8	63.5	28.7
arrowtooth flounder	88.4	96.2	76.2	145.5	121.1	69.7	154.4	228.6	33.1	221.5	303.0	92.2	99.6	209.9	140.6	127.7	90.0	52.6	52.0	361.3
rougheye rockfish	0.7	0.9	—	—	—	7.4	2.0	—	1.2	0.8	0.8	6.3	7.4	—	10.7	—	—	5.3	—	—
sablefish	35.2	49.2	—	—	—	—	18.6	—	—	12.5	15.0	—	—	117.7	350.6	47.9	—	6.9	6.3	13.1
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	—	5.1	—	—	—	—	—	—	—
Pacific cod	145.6	132.6	126.9	186.2	6.9	133.5	368.7	211.3	186.7	20.8	13.5	222.6	715.7	341.8	168.9	145.5	2.0	45.5	69.0	64.4
Pacific halibut	101.0	66.9	95.3	—	30.4	—	65.3	—	—	30.9	17.4	42.9	234.1	255.2	66.4	236.1	48.4	235.0	16.9	6.0
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	0.4	0.1	—	75.6	33.4	42.0	—	27.7	46.1	45.9	35.8	31.5	—	—	1.0	62.0	33.3	38.5	2.8	22.2
walleye pollock	39.5	31.9	19.6	—	32.5	—	8.6	—	—	9.2	—	—	—	14.2	2.9	—	5.8	12.3	154.7	236.5
Dover sole	4.7	3.3	13.9	63.4	38.3	23.7	—	—	34.3	8.8	9.5	—	—	—	—	40.4	41.5	43.1	27.8	44.6
rex sole	40.5	4.6	—	53.7	33.3	47.5	7.3	—	47.3	22.3	21.4	9.7	4.0	—	—	45.1	35.3	25.4	29.7	19.3
light dusky rockfish	—	34.4	114.6	—	—	—	15.3	—	22.4	2.0	—	—	—	134.7	1,052.7	13.6	—	4.3	—	—
northern rockfish	1.6	70.8	176.1	—	1.4	9.9	20.0	34.6	—	0.7	1.8	3.4	19.9	56.7	561.5	17.8	2.8	—	—	—
sharpchin rockfish	—	0.3	—	—	—	—	2.0	—	—	—	—	—	—	—	4.9	4.0	—	—	—	—
flathead sole	0.6	0.3	—	6.5	9.8	3.5	—	—	14.2	15.5	17.4	2.9	—	—	—	6.1	7.2	3.3	22.3	39.2
prowfish	3.5	5.2	—	40.7	—	—	59.2	—	44.9	—	—	111.6	—	65.2	68.4	14.5	—	12.0	—	—
harlequin rockfish	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	7.4	—	—	—	—	—
silvergray rockfish	1.2	10.8	—	—	—	—	—	—	—	—	—	—	—	—	55.7	13.1	1.4	—	—	—
redbanded rockfish	5.3	—	—	—	—	—	—	—	—	0.5	—	6.3	—	—	1.9	0.3	—	2.4	—	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	21.5	21.1	6.5	113.9	23.9	16.8	3.1	3.5	1.2	9.7	6.1	4.8	0.6	3.5	6.1	46.8	3.0	55.5	22.0	9.4
Grand Total	573.8	1,078.4	3,482.1	3,218.1	445.5	2,630.9	3,771.8	17,369.9	5,394.6	1,001.0	1,112.8	2,233.8	2,533.8	5,820.1	5,770.3	2,510.4	455.5	935.9	467.0	844.7

Appendix Table 3.--Extended.

Species	Haul (kg round weight) 101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Pacific ocean perch	525.2	96.4	14.9	1,893.8	65.8	5.6	299.2	245.5	166.2	94.4	362.2	77.8	201.9	250.2	1,723.0	136.2	107.1	—	6.9	4.7
arrowtooth flounder	835.1	21,799.1	1,011.0	1,899.0	1,183.3	1,694.4	1,231.4	1,409.2	239.1	581.6	1,223.6	312.5	288.4	5,814.1	847.3	619.4	1,070.1	8,453.1	1,327.8	710.0
rougheye rockfish	—	—	—	—	—	—	1.1	6.0	—	1.8	—	—	—	—	—	—	—	—	—	—
sablefish	227.3	4,234.2	478.3	1,355.4	352.3	573.2	103.0	376.1	252.1	21.2	94.5	4.4	28.0	2,001.8	829.2	246.3	422.4	889.5	455.3	257.2
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific cod	99.6	—	17.1	724.5	35.0	135.3	88.9	197.5	410.8	110.9	65.1	94.0	33.8	142.3	1,268.5	172.8	188.3	103.5	90.5	122.9
Pacific halibut	68.4	1,269.7	210.4	60.3	31.1	150.1	136.3	172.4	34.5	177.6	35.7	19.4	79.5	94.8	365.6	57.6	170.8	160.8	271.7	187.3
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	2.9	—	—	—	—	10.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
walleye pollock	24.7	—	51.2	16.6	121.0	240.6	43.3	153.9	34.7	145.4	9.1	4.1	—	—	—	52.1	58.2	33.3	96.9	496.0
Dover sole	97.2	—	10.7	16.6	37.1	16.7	82.0	58.6	239.0	288.0	54.4	48.6	57.0	62.1	85.8	41.8	53.1	96.5	82.1	47.7
rex sole	75.4	—	—	42.6	45.6	62.1	139.4	123.9	64.2	93.8	113.0	46.9	43.9	16.3	94.9	12.3	35.7	—	47.6	37.2
light dusky rockfish	7.3	—	—	—	—	—	3.1	12.8	—	—	—	—	—	—	—	—	—	—	—	—
northern rockfish	—	—	—	—	—	—	1.3	—	0.9	0.2	—	—	1.7	—	—	—	—	—	—	—
sharpchin rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
flathead sole	38.2	—	8.5	24.9	70.0	55.1	33.3	30.8	78.7	230.3	56.5	21.0	36.5	36.0	35.3	64.9	45.9	7.0	19.1	25.8
prowfish	—	—	—	—	—	—	10.4	—	—	—	—	—	—	—	—	—	—	—	—	—
harlequin rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	57.1	453.4	15.5	8.3	—	17.3	21.1	—	15.1	26.4	13.6	20.0	3.8	—	3.0	0.5	8.9	52.6	28.6	28.6
Grand Total	2,058.3	27,852.8	1,817.6	6,042.2	1,941.4	2,960.7	2,193.8	2,786.6	1,535.3	1,771.6	2,027.7	648.7	774.5	8,417.7	5,252.7	1,403.9	2,160.5	9,796.3	2,426.3	1,917.3

Appendix Table 3.--Extended.

	Haul (kg round weight)																			
Species	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Pacific ocean perch	48.9	25.0	11.3	156.2	16.6	18.9	35.7	112.9	59.9	41.3	828.6	2,399.2	103.4	67.6	25.4	236.0	3,275.2	112.5	557.3	426.0
arrowtooth flounder	1,041.1	1,083.2	347.7	755.8	770.8	1,138.4	318.8	248.7	482.4	231.3	59.1	52.0	347.5	908.6	528.9	1,872.3	143.9	235.6	22.1	45.7
rougheye rockfish	—	—	—	—	—	—	7.0	8.0	2.0	6.2	3.5	—	12.8	0.8	1.2	—	2.8	1.6	2.3	—
sablefish	271.9	294.8	145.3	285.9	315.5	91.5	79.2	63.5	87.4	648.4	4.7	—	249.1	18.1	290.6	627.1	161.0	633.6	145.7	77.9
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific cod	193.9	202.2	249.8	391.3	—	13.7	23.8	11.9	14.8	2.7	27.0	308.5	135.7	132.1	6.0	163.7	435.6	68.7	227.9	152.0
Pacific halibut	148.1	125.4	128.8	92.7	66.9	50.7	—	84.9	77.0	109.4	5.7	42.1	23.5	111.5	63.5	94.4	—	104.9	43.7	39.2
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
shortspine thornyhead	—	—	—	—	28.0	101.5	81.6	112.6	34.9	93.4	4.9	9.4	15.3	1.2	75.3	4.0	9.5	57.5	5.2	0.5
walleye pollock	134.4	41.9	87.3	20.3	62.6	73.5	162.9	85.4	115.9	156.4	7.0	35.9	218.5	27.9	160.6	279.7	57.8	148.1	65.7	86.8
Dover sole	53.1	65.7	30.3	88.4	40.0	8.1	4.2	13.0	17.4	35.2	1.9	—	11.3	3.4	21.7	13.6	—	27.3	—	—
rex sole	28.6	47.3	49.8	64.9	31.7	14.7	16.7	44.8	44.3	28.1	1.6	—	39.9	27.6	32.0	15.4	—	70.6	3.5	—
light dusky rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	1.6	—	—	—	—	—	—
northern rockfish	—	3.1	1.0	—	—	—	—	2.2	0.9	—	—	3.9	—	—	—	10.2	—	—	—	—
sharpchin rockfish	—	—	—	—	—	—	—	—	—	—	12.7	1.7	—	—	—	—	—	—	0.6	0.5
flathead sole	14.3	27.7	18.2	19.6	13.1	29.9	26.3	4.6	6.2	1.7	—	—	16.9	33.0	6.8	15.9	2.8	0.9	—	—
prowfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
harlequin rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—	—	—	—	—	—	1.0	—	—	—	4.4	1.1	—	2.1	—	14.2	8.5	—	9.9	1.7
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	24.5	30.0	33.0	46.0	64.9	34.5	12.9	4.8	4.8	15.5	1.3	3.3	12.3	13.1	6.0	105.2	2.8	0.5	—	12.1
Grand Total	1,958.8	1,946.2	1,102.5	1,921.0	1,410.1	1,575.4	770.1	797.3	947.9	1,369.6	962.4	2,857.0	1,186.2	1,348.6	1,217.9	3,451.8	4,099.8	1,462.0	1,083.9	842.5

Appendix Table 3.--Extended.

	Haul (kg round weight)																			
Species	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Pacific ocean perch	1,843.1	96.0	14.8	150.4	569.5	132.2	1,694.6	2,907.7	130.7	787.0	2,239.8	83.9	5.8	16.5	38.4	33.2	35.9	6,734.4	1,232.5	36,347.5
arrowtooth flounder	53.2	161.5	100.6	66.4	52.8	48.4	86.0	80.1	312.0	70.8	110.9	58.5	53.8	108.7	84.3	28.4	29.5	123.3	122.7	—
rougheye rockfish	0.9	7.2	13.5	3.9	2.1	—	—	—	12.6	0.6	—	85.0	344.1	419.7	788.2	29.9	1,637.7	1,619.8	1,289.4	185.9
sablefish	72.9	304.3	230.4	83.1	9.1	9.2	—	—	582.6	7.2	—	—	110.6	96.6	45.4	69.7	32.4	—	—	—
shortraker rockfish	—	—	—	—	—	—	—	—	—	—	—	123.7	141.7	188.5	1,616.6	861.4	869.3	116.5	513.9	212.9
Pacific cod	275.5	46.6	39.8	207.5	186.4	61.4	251.1	113.8	46.1	67.4	55.2	—	—	—	—	—	—	—	—	—
Pacific halibut	69.7	21.3	109.7	35.0	81.9	5.3	—	—	34.4	33.8	—	—	20.4	—	—	—	—	—	—	985.9
giant grenadier	—	—	—	—	—	—	—	—	—	—	—	7,851.4	52.9	74.4	236.2	120.9	—	—	—	—
shortspine thornyhead	17.9	46.6	66.5	9.6	3.9	—	—	2.4	44.8	1.4	—	134.7	288.3	127.9	122.2	106.2	84.9	136.8	386.2	19.5
walleye pollock	43.2	166.2	248.8	52.9	18.6	—	—	281.7	197.3	1.5	23.5	—	—	—	—	—	6.0	—	—	—
Dover sole	—	32.0	37.4	0.5	—	0.9	—	—	12.6	1.0	—	51.9	32.1	61.6	51.8	235.1	35.4	18.6	12.0	27.0
rex sole	2.6	305.3	158.5	4.1	—	2.7	—	1.8	32.2	7.2	—	—	0.6	3.0	20.9	59.3	3.0	5.1	—	—
light dusky rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
northern rockfish	—	—	—	—	—	—	—	5.5	—	—	2.7	—	—	—	—	—	—	—	—	—
sharpchin rockfish	—	—	—	0.2	—	—	—	1.8	—	2.6	11.8	—	—	—	—	—	—	—	—	—
flathead sole	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
prowfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
harlequin rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	0.9	—	—	1.0	—	0.5	—	2.4	1.7	—	—	—	—	—	—	—	—	—	—	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	2.2	12.8	4.5	6.6	11.0	9.5	—	5.4	12.1	3.1	0.9	7.7	7.1	16.2	8.7	32.2	—	11.8	2.6	—
Grand Total	2,382.0	1,200.4	1,024.6	621.2	935.3	270.1	2,031.7	3,402.6	1,419.1	983.6	2,444.8	8,396.8	1,057.4	1,113.0	3,012.6	1,576.2	2,734.1	8,766.3	3,559.3	37,778.7

Appendix Table 3.--Extended. * indicates no catch from that haul was processed.

	Haul (kg round weight)																			
Species	161	162*	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Pacific ocean perch	14.2		31.3	—	246.8	87.5	16.1	39.9	6.9	—	45.5	2.5	8.6	1.1	—	17.2	—	27.0	6.9	—
arrowtooth flounder	28.3		103.8	16.8	143.8	70.0	12.4	24.3	18.8	28.1	28.8	55.3	132.4	71.9	72.1	699.7	383.2	208.6	156.0	188.0
rougheye rockfish	792.8		1,036.7	79.1	1,118.8	4,753.0	4,749.2	3,357.7	218.5	361.2	6,114.4	255.9	454.8	235.9	53.3	89.2	674.9	199.7	83.9	459.8
sablefish	48.0		39.2	37.6	130.3	37.5	—	—	55.8	—	—	34.7	29.5	24.8	16.3	—	20.3	53.9	33.7	—
shortraker rockfish	233.0		678.1	135.6	213.5	1,538.1	1,539.0	953.5	261.6	667.8	1,114.0	397.2	281.3	124.4	50.8	95.1	673.3	127.7	53.8	325.2
Pacific cod	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific halibut	—		23.3	—	37.6	—	—	—	22.5	—	—	—	—	—	—	—	—	—	—	—
giant grenadier	250.4		17.9	624.7	—	—	—	—	452.4	—	—	565.1	—	16.0	153.6	—	15.9	—	27.0	—
shortspine thornyhead	296.0		108.8	93.8	124.0	60.0	128.6	121.5	31.8	11.1	178.8	236.3	297.2	74.0	197.7	—	333.8	253.3	139.2	156.8
walleye pollock	—		—	3.4	—	—	—	—	1.3	—	—	—	5.7	7.9	8.2	91.0	2.8	153.2	12.9	5.3
Dover sole	20.5		95.4	54.1	72.1	18.8	9.9	21.7	15.1	6.4	56.1	39.7	89.2	24.3	37.2	65.2	46.6	39.7	31.9	42.5
rex sole	—		1.0	9.6	7.5	6.2	7.4	7.8	1.0	—	12.1	1.5	4.0	12.0	7.6	8.6	10.4	8.2	6.9	1.9
light dusky rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
northern rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
sharpchin rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
flathead sole	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
prowfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
harlequin rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
redstripe rockfish	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other species	46.4		51.6	52.7	8.7	2.5	2.5	9.8	11.7	158.9	180.3	8.9	27.8	6.9	16.1	23.1	61.3	50.7	35.9	67.5
Grand Total	1,729.6		2,187.1	1,107.3	2,103.2	6,573.6	6,465.0	4,536.1	1,097.3	1,233.5	7,730.1	1,597.1	1,330.5	599.2	612.9	1,089.1	2,222.5	1,122.0	588.1	1,246.9

Appendix Table 3.--Extended.

	Haul (kg round weight)									
Species	181	182	183	184	185	186	187	188	189	190
Pacific ocean perch	71.1	22.8	3.5	5.1	2.5	70.6	110.5	3.1	4.3	7.3
arrowtooth flounder	495.9	56.4	154.8	706.9	427.5	98.8	93.2	27.0	29.9	—
rougheye rockfish	124.6	126.1	2.9	53.2	192.7	5,143.7	3,118.0	422.0	231.6	99.5
sablefish	21.5	—	48.4	74.0	46.4	112.9	67.6	34.2	45.6	70.0
shortraker rockfish	125.6	158.1	—	90.5	85.3	649.3	650.4	267.3	540.4	205.2
Pacific cod	—	—	—	—	—	—	—	—	—	—
Pacific halibut	32.7	—	—	29.1	5.1	—	—	—	77.9	—
giant grenadier	—	544.4	359.2	7.6	6.3	—	—	3.2	182.6	66.7
shortspine thornyhead	197.2	124.3	120.8	323.0	176.3	67.0	112.4	188.6	—	177.6
walleye pollock	148.1	3.0	45.8	10.8	12.5	—	—	2.1	1.0	—
Dover sole	221.7	24.7	53.5	67.7	35.9	14.1	54.8	20.7	56.4	35.0
rex sole	27.0	19.2	46.0	2.9	8.0	—	8.2	3.1	3.8	1.7
light dusky rockfish	—	—	—	—	—	—	—	—	—	—
northern rockfish	—	—	—	—	—	—	—	—	—	—
sharpchin rockfish	—	—	—	—	—	—	1.8	—	—	—
flathead sole	—	—	—	—	—	—	—	—	—	—
prowfish	—	—	—	—	—	—	—	—	—	—
harlequin rockfish	—	—	—	—	—	—	—	—	—	—
silvergray rockfish	—	—	—	—	—	—	—	—	—	—
redbanded rockfish	—	—	—	—	—	—	—	—	—	—
redstripe rockfish	—	—	—	—	—	—	—	—	—	—
Other species	32.5	8.8	12.5	24.5	56.0	7.1	3.7	4.6	13.0	14.1
Grand Total	1,498.0	1,087.9	847.3	1,395.3	1,054.5	6,163.5	4,220.6	975.9	1,186.4	677.1