Fishery Data Series No. 93-33

Assessment of the Recreational Harvest and Fishery for Lingcod in Southcentral Alaska

by

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ABSTRACT

Age, length, and sex data were collected from 1,155 lingcod *Ophiodon elongatus* harvested by recreational anglers at Kodiak, Homer, Seward, and Valdez in 1992. Eight hundred eighty-seven of the samples were from Seward, the primary port of harvest. Age ranged from 3 to 23 years and length ranged from 58.0 to 130.0 centimeters. Sex ratio varied by port but was not significantly different from 50:50. Age composition was significantly different among ports. The proportion of the harvest under age 7 was highest at Homer (37%) and lowest at Seward (2%). Less than 10% of the Seward harvest was under 80 centimeters, indicating a continued decline in recruitment. Seventy-six percent of the Seward harvest came from the most heavily fished waters near Cape Aialik, the Chiswell Islands, and Seal Rocks. Sex ratio was skewed toward males and fish were smaller in areas closer to the Port of Seward. Anglers at Kodiak and Seward were interviewed to examine the effects of proposed bag limits. Eighty-one percent of Kodiak harvest consisted of creels with fewer than three lingcod per angler. Seventy-one percent of the Seward harvest consisted of creels of one fish per angler. Recently implemented regulations will reduce harvest, but minimum size limits will necessitate fishery-independent sampling to assess relative changes in year class strength.

KEY WORDS: Lingcod, *Ophiodon elongatus*, Kodiak, Homer, Seward, Valdez, Alaska, Gulf of Alaska, Prince William Sound, Cook Inlet, Kachemak Bay, Resurrection Bay, Chiniak Bay, marine, sport fishery, harvest, age, length, sex, bag limits.

INTRODUCTION

Marine recreational fisheries are increasing in popularity in Southcentral Alaska. Participation in saltwater sport finfish fisheries has grown from 229,000 angler-days in 1981 to nearly 452,000 angler-days in 1991 (Appendix A; Mills 1982-1992). Although salmon *Oncorhynchus*, halibut *Hippoglossus stenolepis*, and rockfishes *Sebastes* are the major targets of marine anglers, lingcod *Ophiodon elongatus* are becoming increasingly popular, especially in waters near Seward, Alaska. For example, lingcod made up about 5% of the total bottomfish harvest (rockfishes, lingcod, halibut) at Seward in 1973 (Alaska Department of Fish and Game, unpublished data on file in Anchorage), compared with nearly 16% in 1991 (Mills 1992). Anglers target lingcod because they are large and aggressive, have an excellent flavor, and are relatively easy to find and catch.

Lingcod are harvested by recreational anglers from Cape Suckling to Kodiak Island (Figure 1). The principal area of harvest is the Gulf of Alaska between Cape Puget and Nuka Bay. In Prince William Sound, lower Cook Inlet, and the Gulf of Alaska west of Gore Point, lingcod are generally taken incidentally to the directed harvest of halibut, rockfishes, and salmon. Estimates of lingcod harvest prior to 1991 are not available, but the number of fish taken is believed to be inconsequential. Charter operators report increasing directed fishing for lingcod in these waters in recent years. By contrast, the port of Seward has supported a directed lingcod sport fishery since the mid-1980s. Annual sport harvest from Resurrection Bay and adjacent areas increased from at least 2,142 fish in 1987 to 6,955 in 1990, then decreased slightly in 1991 to 6,213 (Table 1). Estimates for 1987 through 1989 were minimum estimates because creel surveys did not span the entire bottomfishing season. The Seward-based fishery accounted for about 47% of the Southcentral Alaska sport harvest of lingcod in 1991. Most lingcod are harvested between late May and early September.

Lingcod are also taken in commercial jig (hand and mechanical) and longline fisheries (Table 2). Harvest occurs throughout the year, but is highly variable from month to month and from year to year (Vincent-Lang and Bechtol 1992). Variation in commercial harvest reflects the opportunistic nature of the fishing fleet and its ability to respond to changes in processing demands and socioeconomic conditions. Few vessels targeted lingcod prior to 1990 and most of the harvest was bycatch in longline fisheries for other species. Beginning in the 1990s, portions of the commercial fleet diverted their effort toward groundfish following economic declines in crab and salmon fisheries. Additional effort was directed toward lingcod in 1991 as other groundfish fisheries were closed due to achievement of directed harvest quotas and halibut bycatch quotas. Most commercial harvest has come from the Nuka Bay area, with catches as high as 56,929 pounds in 1991. Record high numbers of lingcod were taken near Seward in early 1992, primarily as bycatch in the spring Pacific cod *Gadus macrocephalus* longline fishery. Although commercial harvests have generally increased in recent years, the recreational fishery has accounted for most of the harvest, particularly near Seward (Table 2).

The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish began collecting lingcod sport harvest data in 1987 at Seward. The number of lingcod harvested by private boats and commercial charter boats was estimated by creel surveys in 1987, 1988, and 1989 (Vincent-Lang et al. 1988; Carlon and

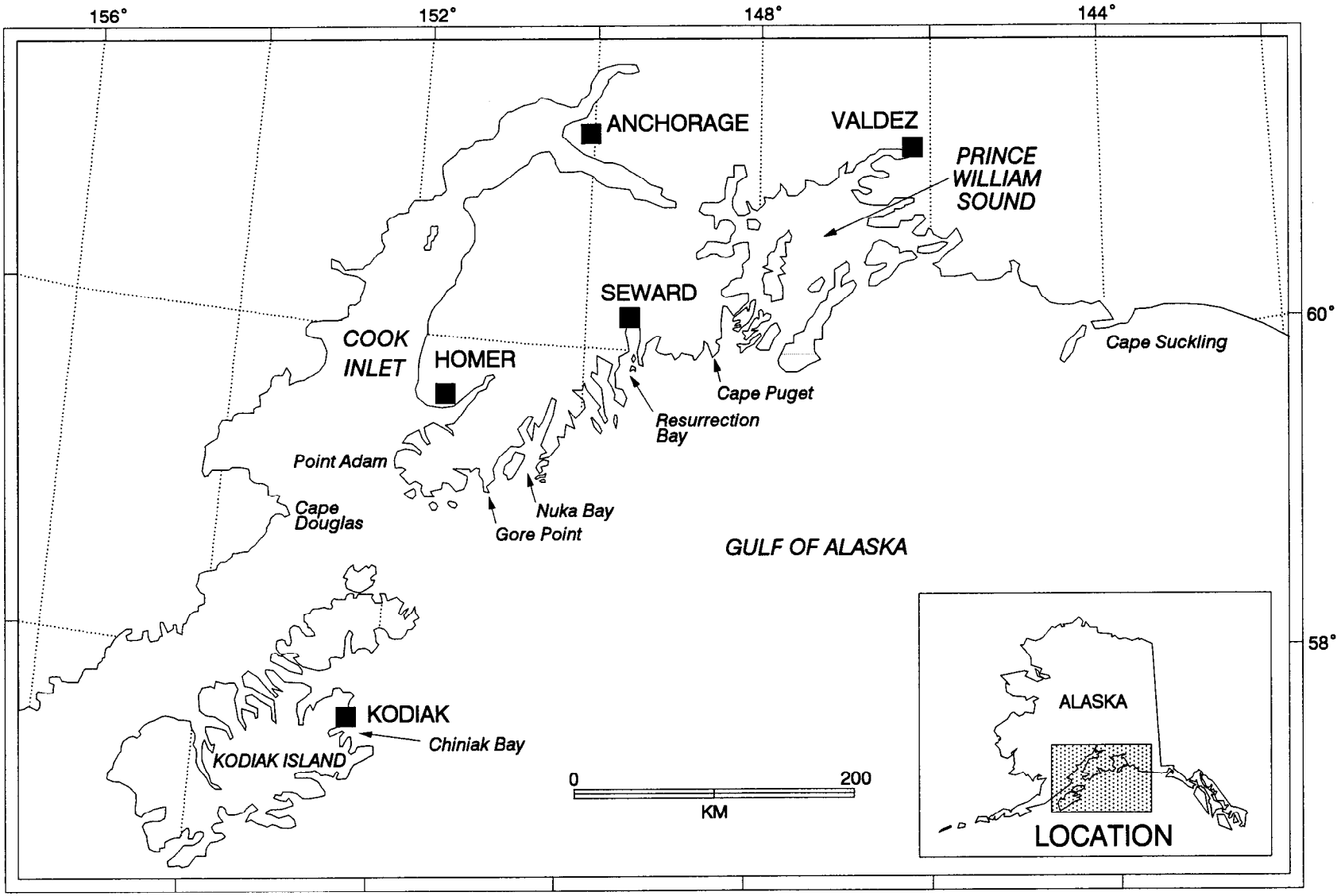

Figure 1. Waters and ports sampled for lingcod in Southcentral Alaska, 1992.

Table 1. Recreational lingcod harvest in Southcentral Alaska, 1987-1991. Estimates for Seward, 1987-1989, were from onsite creel surveys (see footnotes), while all other estimates were from the statewide postal survey (Mills 1991, 1992). Dashes indicate estimates are not available.

Year	AK Penin.	Kodiak	Cook Inlet[a]	Seward[b]	PWS[c]	Total
1987	-	-	-	2,142[d]	-	-
1988	-	-	-	4,189[e]	-	-
1989	-	-	-	5,505[f]	-	-
1990	-	-	-	6,955	-	-
1991	993	1,352	2,754	6,213	1,979	13,291

[a] Cook Inlet-Cook Inlet and Gulf of Alaska waters east to Gore Point.

[b] Seward-Gulf of Alaska waters from Cape Puget to Gore Point.

[c] Prince William Sound-Cape Suckling to Cape Puget.

[d] Creel survey conducted Jul 6 - Sep 13 (Vincent-Lang et al. 1988).

[e] Creel survey conducted Jul 1 - Sep 14 (Carlon and Vincent-Lang 1989).

[f] Creel survey conducted Jun 1 - Sep 10 (Carlon and Vincent-Lang 1990).

Table 2. Commercial harvest of lingcod (pounds round weight) in selected northern Gulf of Alaska waters, 1987-1992 (Vincent-Lang and Bechtol 1992). The estimated sport harvest (pounds round weight) for the Seward area is shown for comparison with the commercial harvest in the Resurrection area.

Year	Commercial Harvest				Sport Harvest at Seward[f]
	PWS[b]	Cook Inlet[c]	Nuka[d]	Resurrection[e]	
1987	594	2,005	23,077	1,631	28,353
1988	1,338	165	18,796	3,587	75,434
1989	1,280	0	1,042	8,127	74,688
1990	8,117	979	1,867	1,391	107,623
1991	19,539	3,360	56,929	7,931	111,044
1992[a]	2,160	30	8,529	20,470	-

[a] Preliminary ADF&G fish ticket data through July 15, 1992.

[b] Prince William Sound - All waters enclosed by lines from Point Whitshed to Point Bentinck, from Cape Hinchinbrook to Zaikof Point, and Cape Cleare to Cape Puget.

[c] All waters west of 151° W. long. and north of Cape Douglas, including Cook Inlet, Kachemak Bay, and the Chugach Islands.

[d] All waters between 150° W. and 151° W. longitude.

[e] All waters outside Prince William Sound from 147° W. long. to 150° W. long.

[f] The weight of the sport harvest was estimated as the number harvested multiplied by the mean weight. Mean weight was estimated separately for each year using $Mean = (\Sigma\ w_i)/n$, where the w_i are the predicted weights for each of n fish sampled. Weights were predicted using the relationship $Wt(kg) = 1.8605 \times 10^{-5}\ Length(cm)^{2.85}$ developed from fish weighed in 1991 and 1992.

Vincent-Lang 1989 and 1990). In addition, the Seward Military Recreation Camp has reported the total number of lingcod harvested (i.e. a census) by Army and Air Force charter boats every year since 1987. Because the ADF&G creel surveys were designed primarily to estimate coho salmon *O. kisutch* harvest and generally did not include the entire bottomfishing season, the 1987 through 1989 lingcod harvest estimates are considered minimal. The ADF&G sport fish postal survey has provided the only estimates of lingcod harvest for Kenai Peninsula waters since 1989, and for all other areas since 1991.

Age and size data have also been collected from the Seward lingcod harvest since 1987. These data show that the 1981 year class supported about 25% of the harvest each year, and that recruitment appeared to be declining (Vincent-Lang 1991). Additional age and size data collected in 1991 supported the observed decline in recruitment (Meyer 1992). The proportion of lingcod under age 6 in the harvest decreased from 19.0% in 1987 to only 1.4% in 1991 (Figure 2). Corresponding proportions of lingcod under 70 cm in length decreased from 18.7% in 1987 to 1.3% in 1991.

The ADF&G launched a hook and line survey in the spring of 1992 to determine the duration of nest-guarding by male lingcod. The survey was designed to monitor seasonal changes in the sex composition of the catch from offshore pinnacles. Sex was determined based on external appearance of anal papilla. A total of 534 lingcod were tagged and released during six sampling trips between April 21 and June 24. Changes in sex ratio suggested that nest-guarding was complete by June 23 (D. Vincent-Lang, ADF&G, Anchorage, 9/9/92 memorandum). Survey data also supported anecdotal reports from the sport fleet that catch rates and sizes of male and female lingcod generally increased with increasing distance from the port of Seward.

In early 1992, the ADF&G closed the sport and commercial fisheries by emergency order to the retention of lingcod until July 1 in Prince William Sound and Gulf of Alaska waters east of Cape Douglas. The closure was enacted in response to the observed declines in recruitment, reports of depressed catch rates in heavily fished waters near Seward, and the high bycatch of lingcod in commercial longline fisheries. Managers resolved to propose sport and commercial fishery regulations that would provide for sustained yield and prevent the fishery from compounding the effects of declining recruitment.

The ADF&G established a long-term harvest monitoring program for recreational lingcod, rockfish, and halibut fisheries in Southcentral Alaska in 1991 (Meyer 1992). This report focuses on lingcod fishery data collected in 1992. Objectives of the annual assessment were tailored to address the major lingcod management issues and provide information for proposed regulations. Objectives were to:

1. Estimate the age, length, and sex composition of lingcod harvested in the sport fisheries at Kodiak, Homer, Seward, and Valdez;
2. Estimate the frequency distributions of the number of lingcod harvested per day by sport anglers at Seward and Kodiak, in order to evaluate the effects of proposed bag limits; and
3. Estimate the spatial distribution of recreational bottomfishing effort at each port.

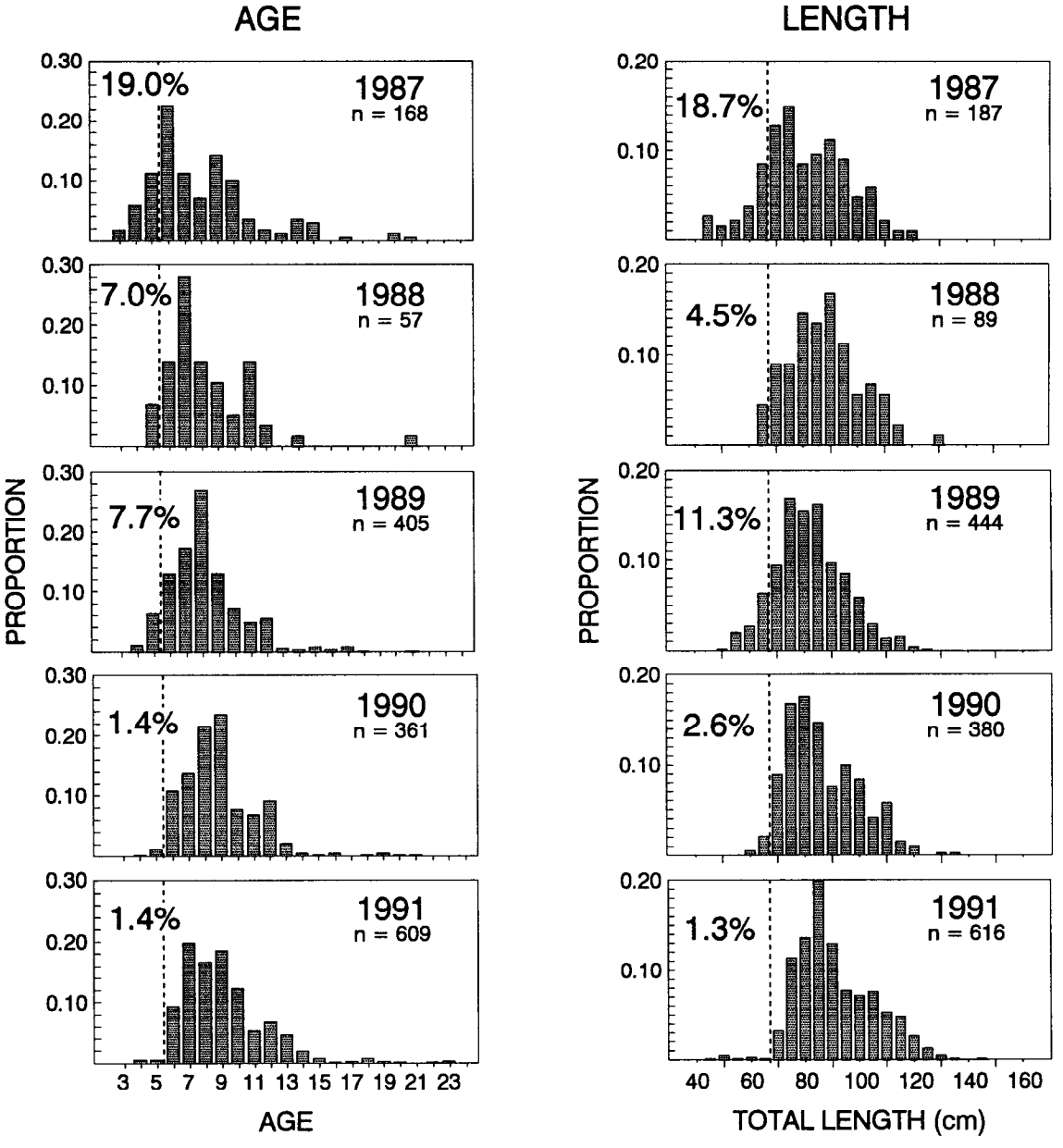

Figure 2. Trends in age and length composition of lingcod harvested in the Seward sport fishery, 1987-1991. Percentages indicate the relative proportions of the harvest under age 6 and 70 cm (recruits).

The ADF&G is considering implementation of a lingcod stock assessment program for the rapidly developing sport fishery at Seward. Data on spatial patterns or trends in relative abundance and size were needed to help formulate objectives of the assessment program and understand development in the fishery. In addition to examining overall age, length, and sex composition (Objective 1), the following tasks were undertaken for the Seward fishery:

1. Estimate the relative proportions of the sport harvest taken by area and user group, and
2. Estimate the length and sex composition of the sport harvest by area and user group.

METHODS

Study Design

Technicians were stationed at Kodiak, Homer, Seward, and Valdez, the major ports of recreational lingcod landings in Southcentral Alaska. Lingcod were sampled from anglers returning to St. Paul Harbor and St. Herman's Harbor in Kodiak, the public boat harbor and Military Recreation Camp at Seward, and the main harbors in Homer and Valdez. Fish carcasses were obtained at public, charter, and military camp fish cleaning facilities. Labeled barrels were left near the cleaning stations or boat ramps to collect fish when technicians were busy or off-duty. Signs were posted near the barrels in each harbor explaining the sampling program and requesting angler cooperation. Sampling was conducted for an average of 7.0 hours per day, 5 days per week (including all weekends). The hours sampled varied by port and by day in response to weather and other variables, but generally included the period 1500-2200 hours when most anglers return to port. Because technicians were present when most anglers return to port, they were effective at advertising the sampling project and could easily monitor angler compliance.

Sampling for age, sex, and length composition was designed to be proportional to harvest at each port. All lingcod seen during the work shift were sampled at Kodiak, Homer, and Valdez. At Seward, harvest was usually too great to sample every fish each day. In addition, harvest varied widely by day and by month. To accommodate the variable harvest and avoid sampling bias, lingcod were sampled systematically (e.g. every third fish). The sampling fraction was adjusted each month based on observed harvests so that all fish available during the work shift could be sampled. The sampling rate was applied consistently to private, charter, and military components of the harvest.

The total length of all lingcod was measured to the nearest 5 mm. Sex was determined by examination of gonads. The ADF&G statistical area, or "stat area" (Figure 3), that the fish was taken from was determined whenever possible from angler interviews for fish sampled at Seward. The fourth through eighth rays of the posterior lobe of the dorsal fin were removed and prepared for aging as described by Chilton and Beamish (1982).

Private and charter anglers were interviewed at all ports to gather information on harvest and the distribution of effort. Samplers attempted to interview anglers or charter boat crew from a constant proportion of the boats returning to port. The proportion varied by port as a function of the number

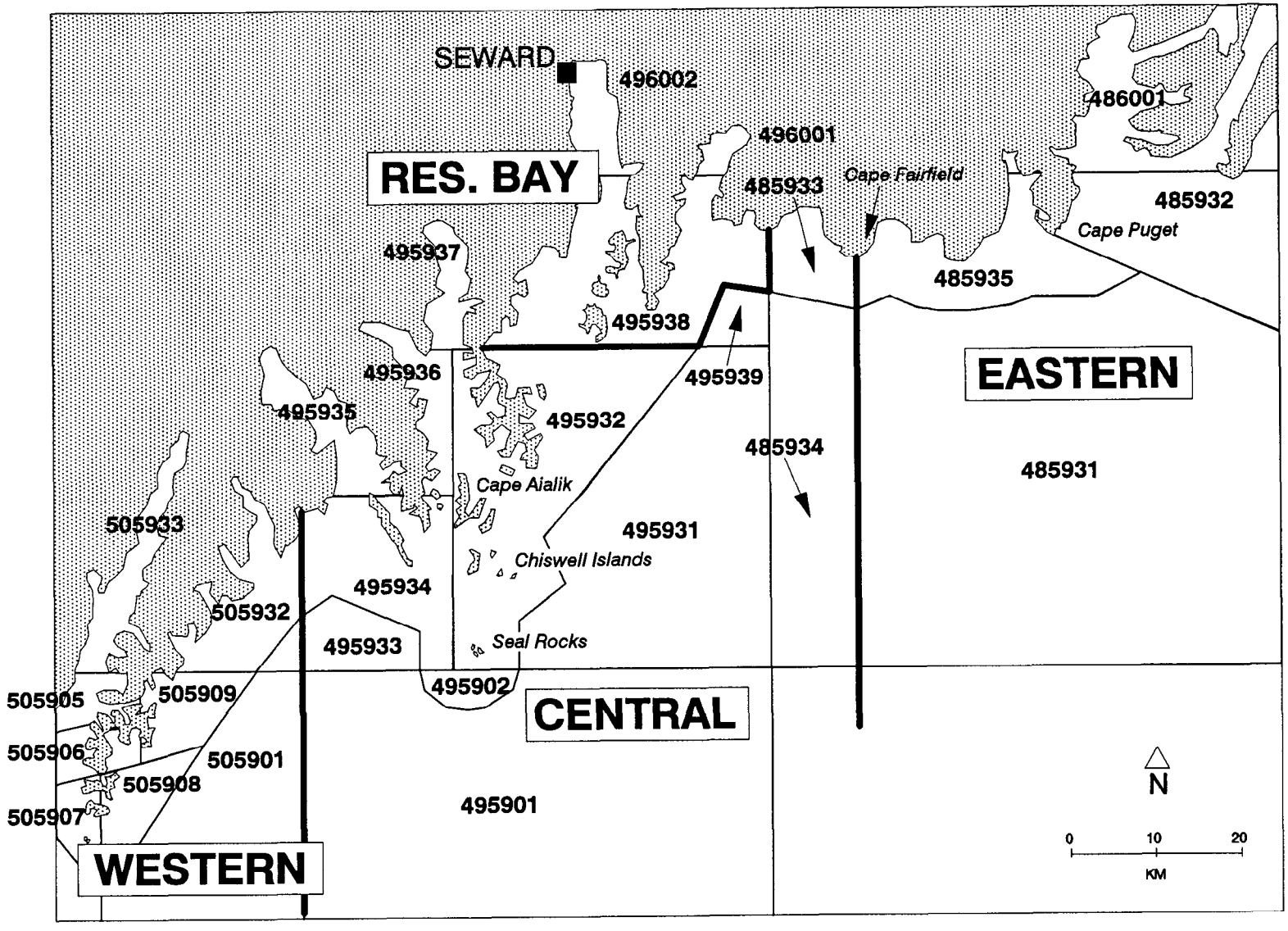

Figure 3. Alaska Department of Fish and Game statistical areas (6-digit numbers) near Seward, Alaska. Larger areas indicate statistical areas pooled for data analysis.

of fish landed. Most boats returned within a 2-hour period, allowing samplers to conduct interviews during the busiest time of day, and sample fish carcasses later as space became available at the cleaning tables. Effort and harvest information was also collected from Seward Military Recreation Camp charter boats through a voluntary logbook system. Each day the camp recorded the number of anglers, the area(s) fished, and the number of lingcod (and other species) harvested by each boat. These data constituted a complete census of all military effort after June 25, and all lingcod harvest in 1992.

Data Analysis

Age, Length, and Sex Composition:

A minimum sample size of 128 was needed to estimate age, length, and sex composition such that all of the estimated proportions were within 0.10 of the true proportions with a probability of at least 95% (Thompson 1987). The proportion of each age class in the sport harvest (Objective 1) was estimated for each month or area as (Cochran 1977):

$$\hat{p}_i = \frac{n_i}{n}, \qquad (1)$$

where:

$\hat{p}_i$ = the estimated proportion of age class i in the harvest,

n_i = the number of fish of age i in the sample, and

n = the number of fish of all ages in the sample.

The unbiased estimator of the variance of each proportion was

$$Var(\hat{p}_i) = \frac{\hat{p}_i (1 - \hat{p}_i)}{n - 1}. \qquad (2)$$

The finite population correction (FPC) to the estimated variance (Cochran 1977) was ignored because the sample was small relative to the harvest and because the total harvest was unknown. Estimates of variance were therefore conservative (slightly larger than if harvest were known). Variation in estimates is reported as standard error (square root of the variance). Length and sex composition were computed using the above equations by substituting length and sex for age (Objective 1). All data were pooled to obtain age, length, and sex composition for the entire season at each site using equations 1 and 2.

Differences in age and sex composition among months and among ports were tested using chi-square contingency tables (Conover 1980). Age classes near the tails of the age distributions were pooled so that chi-square statistics were made up mostly of differences in the primary age classes. Differences in length composition among months and ports were tested using k-sample Anderson-Darling tests (Scholz and Stephens 1987) employing the test statistic T_{akn} to

determine probabilities. Raw data files for all analyses are listed in Appendix D.

Spatial Patterns of Harvest in the Seward Fishery:

The proportion of the Seward harvest taken in each area and by each user group (Task 1) was estimated using equations 1 and 2, substituting area or user group for age. Analysis of length and sex composition by area and user group (Task 2) proceeded similarly. Data were initially examined by stat area, but because the number of fish taken in some stat areas was small, data were pooled into four larger areas (Figure 3):

1. The Eastern Area-east of Cape Fairfield,
2. The Central Area-between Cape Fairfield and 150° W. longitude,
3. The Resurrection Bay Area-Resurrection Bay and Day Harbor, and
4. The Western Area-west of 150° W. longitude.

Four user groups were identified: (1) commercial charter boats, (2) private boats, (3) U.S. Air Force (USAF) charter boats, and (4) U.S. Army charter boats. The USAF and Army charter boats were separated for analysis because of differences in size and gear type. The four USAF boats were 13-15 meters long (43-50 feet), could carry 18-24 anglers, and typically fished with bait or jigs. All 12 Army boats, on the other hand, were 27 feet long, carried up to seven anglers, and mostly fished for lingcod by trolling in 1992.

Evaluation of Bag Limits:

The effects of proposed bag limits at Seward and Kodiak were evaluated using data from the Seward Military Recreation Camp and interviews with private and chartered anglers (Objective 2). Data consisted of the number of anglers and the total number of lingcod harvested on each boat each day. Data were evaluated on a per-boat basis because anglers were unwilling or unable to provide personal data. Although illegal, anglers often share their bag limit overage with less fortunate anglers on their boat ("party-fish"). The frequency histogram of the harvest was computed for each boat trip as follows:

1. The frequency of fish representing the first fish in the bag limit was either the number of anglers or the number of fish harvested, whichever was less. For example, if 15 lingcod were landed by a boat with 7 anglers, 7 of those fish represented the first fish in the bag limit.

2. The frequency of fish representing the second, third, etc. fish in the bag limit was obtained by repeating the above procedure using the fish remaining from each previous calculation. For the example above, seven of the remaining eight fish would be apportioned to the second fish in the bag limit, and the remainder would represent the third fish. The frequency histogram for this boat would then be:

First	*7*
Second	*7*
Third	*1*

The frequency histogram for the entire harvest was obtained by summing over all boat trips. A proposed bag limit of *n* fish was then assumed to reduce the harvest by the proportion of the total frequency histogram representing greater than *n* fish. For example, if the total frequency histogram were *First-400, Second-80, Third-10,* a bag limit of one fish would be expected to reduce the harvest by the proportion 90/490, or about 18%. This analysis assumed that harvest and catch rates would be similar in the upcoming year and that anglers will continue to party-fish.

Distribution of Bottomfishing Effort:

At all areas but Homer, the spatial distribution of recreational effort was estimated by the proportions of boat-trips taken in each stat area (Objective 3). Only boat trips targeting bottomfish (lingcod, halibut, rockfish) were included. Most boats target more than one species during each trip. When a boat reported fishing in more than one area on a given day, one boat-trip was tallied in each area fished. At Homer, effort was tallied by four larger areas: (1) north of the latitude of Anchor Point, (2) east of a line between Anchor Point and Dangerous Cape (Kachemak Bay), (3) south of a line between Point Adam and Cape Douglas, and (4) all other Cook Inlet waters. Seward data were also pooled to look at patterns over the broader areas described above. The proportion of effort spent in each area was calculated separately for military boats and civilian boats at Seward because the relative amounts of effort by each group were unknown. Effort data provided by the Seward Military Recreation Camp constituted a complete census, while the exact proportion of the civilian fleet interviewed was unknown.

RESULTS

Sampling was conducted from mid-May through mid-September. Starting and ending dates varied with differences in fishing effort and expected harvest. Dates sampled at each port were as follows:

Kodiak	June 4 - September 7
Homer	May 16 - September 11
Seward	May 16 - September 13
Valdez	June 1 - September 7

Data were collected from 1,155 lingcod in 1992 (Table 3). The largest sample was obtained at Seward (887), the primary port of recreational lingcod landings coastwide. The sample was drawn from a total of about 3,863 fish available to the sampler. Expanding again to account for days not sampled results in a minimum harvest estimate of 5,300 lingcod for the period July 1-September 13. Similar minimum estimates for other ports were all less than 150 fish for the entire season. No lingcod were sampled at Homer, Seward, or Valdez until July because the fishery was closed to protect nest-guarding males.

Age, Length, and Sex Composition

Final estimates of age composition were obtained after repeated aging. The reader worked with a past reader to establish consistent aging criteria. Final ages were not assigned to 1992 data until the two readers aged a

Table 3. Number of lingcod sampled by month at Kodiak, Homer, Seward, and Valdez in 1992.

Port	Period	Sampling Rate	Number of Fish Sampled	Number of Fish Observed[a]
Kodiak	Jun	1/1	15	
	Jul	1/1	26	same
	Aug	1/1	54	
	Sep	1/1	0	
	Total		95	
Homer	Jul	1/1	54	
	Aug	1/1	14	same
	Sep	1/1	0	
	Total		68	
Seward	Jul 1-10	1/3	163	489
	Jul 11-31	1/5	312	1,560
	Aug	1/5	292	1,460
	Sep 1-7	1/5	50	250
	Sep 8-13	1/1	70	104[b]
	Total		887	3,863
Valdez	Jul	1/1	38	
	Aug	1/1	55	same
	Sep	1/1	12	
	Total		105	

[a] Calculated by dividing the sample size by the sampling rate. This was the total number of lingcod encountered by the sampler during work shifts.

[b] Includes 34 missed fish.

subsample of past data and differences in their resultant distributions were not significant ($\chi^2 = 4.96$, $P = 0.55$, $df = 6$).

Final estimates of age composition for Kodiak, Homer, and Valdez incorporated all available data. For Seward, however, only ages from fish sampled in July and September were used because of time and funding constraints. There was no difference in age composition between these months ($\chi^2 = 11.87$, $P = 0.16$, $df = 8$). Sample sizes were too small at other ports for comparisons among months.

Ages estimated for 690 lingcod ranged from 3 to 23 years (Figure 4; Appendix B1). Sixty-eight percent of the Seward harvest was composed of ages 8-11. Although sample sizes at Kodiak, Homer, and Valdez were small, fish under age 7 made up a higher proportion of the harvest than at Seward. Differences in age composition among ports were highly significant ($\chi^2 = 145.07$, $P < 0.01$, $df = 18$).

Lengths of 1,136 lingcod ranged from 58.0 to 130.0 cm (Figure 5, Appendix B2). As with ages, differences among ports were highly significant ($T_{akn} = 26.54$, $P < 0.01$, $m = 3$). Fish harvested at Seward and Valdez tended to be larger than the other ports. About 40% of the lingcod harvested at Homer and Kodiak were under 80 cm in length, compared with less than 10% at Valdez and Seward. There were no differences in length composition among months at any of the ports (P-values ranged from 0.07 at Seward to 0.42 at Homer).

There was a significant difference ($\chi^2 = 8.35$, $P = 0.04$, $df = 3$) among ports in the overall sex composition of the sport harvest. Males made up the highest proportion of the harvest at Kodiak and the lowest proportion at Homer and Valdez (Figure 6, Appendix B3). Even though there were differences between ports, the sport fishery did not appear to be selective for either sex. The sex ratio of the season harvest was not significantly different from 50:50 at any port (Kodiak $\chi^2 = 3.05$, $P = 0.08$, $df = 1$; Homer $\chi^2 = 1.92$, $P = 0.17$, $df = 1$; Seward $\chi^2 = 0.88$, $P = 0.35$, $df = 1$; Valdez $\chi^2 = 2.78$, $P = 0.10$, $df = 1$). Differences in sex composition were not significant among months at Kodiak ($\chi^2 = 0.265$, $P = 0.88$, $df = 2$), Homer ($\chi^2 = 0.75$, $P = 0.39$, $df = 1$), or Valdez ($\chi^2 = 1.85$, $P = 0.40$, $df = 2$). Sex composition varied significantly among months at Seward ($\chi^2 = 8.89$, $P = 0.01$, $df = 2$), primarily because of differences between July and August.

Spatial Patterns of Harvest in the Seward Fishery:

The stat area of harvest was recorded for 622 (70%) of the fish sampled at Seward. Most lingcod (63.3%) were taken in stat area 495932, which includes waters on the east and west sides of Cape Aialik, the Chiswell Islands, and Seal Rocks (Figure 7). Other major stat areas of harvest included 495938 (Day Harbor and southern Resurrection Bay) with 12.7%, and 495934 (Granite Island and the mouth of Harris Bay) with 7.2%. Army boats accounted for 80% of the harvest in stat area 495932 and 42% in stat area 495938 (Appendix C1).

On a larger scale, the majority of the lingcod harvest came from waters just outside of Resurrection Bay. About 76% of the harvest was taken from the Central Area, compared with 13% from the Resurrection Bay Area, 6% from the Eastern Area, and 5% from the Western Area (Figure 7, Table 4). About 71% of the Central Area harvest and 42% of the Resurrection Bay Area harvest were

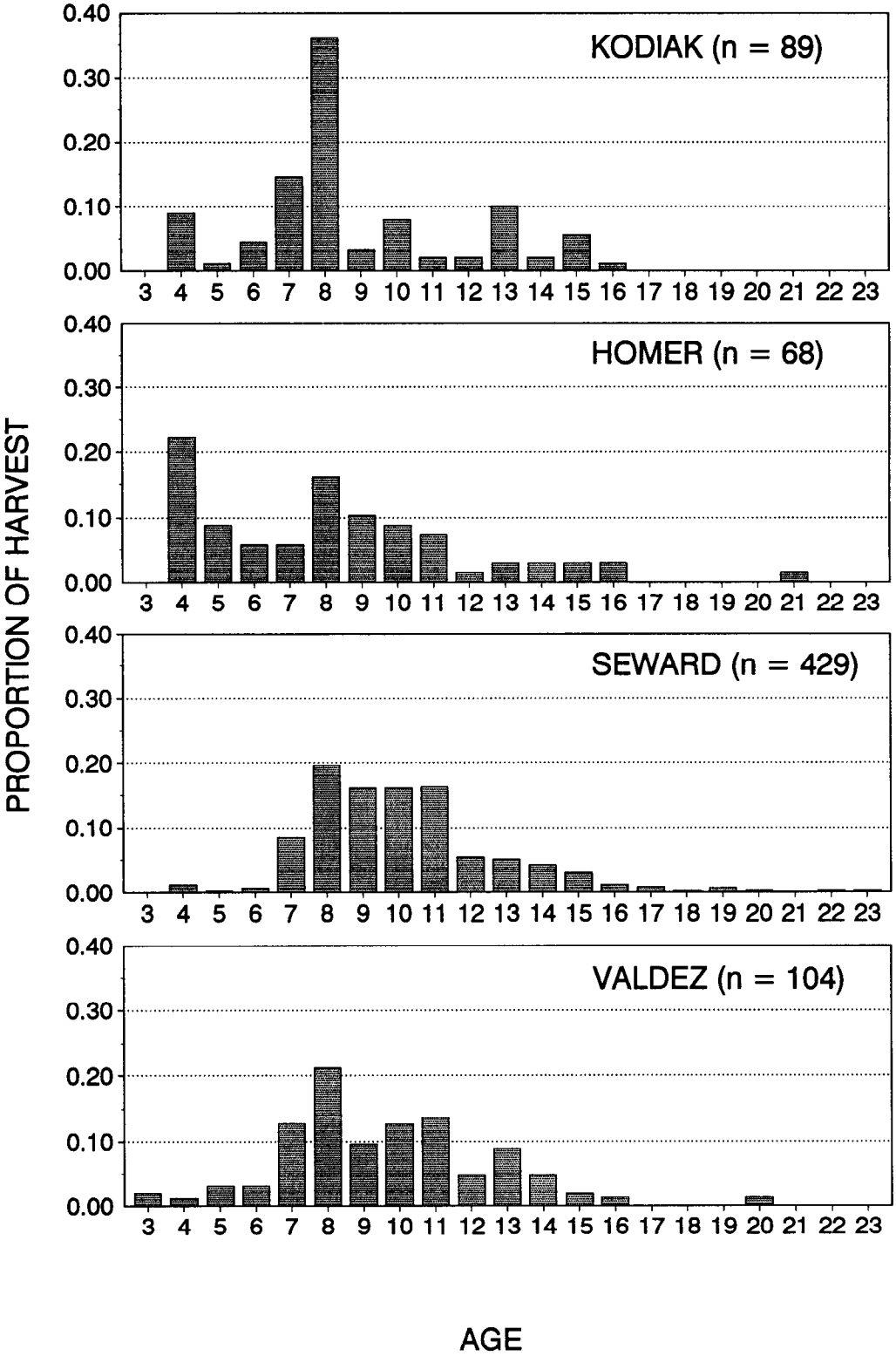

Figure 4. Age composition of lingcod harvested in the Kodiak, Homer, Seward, and Valdez sport fisheries, 1992.

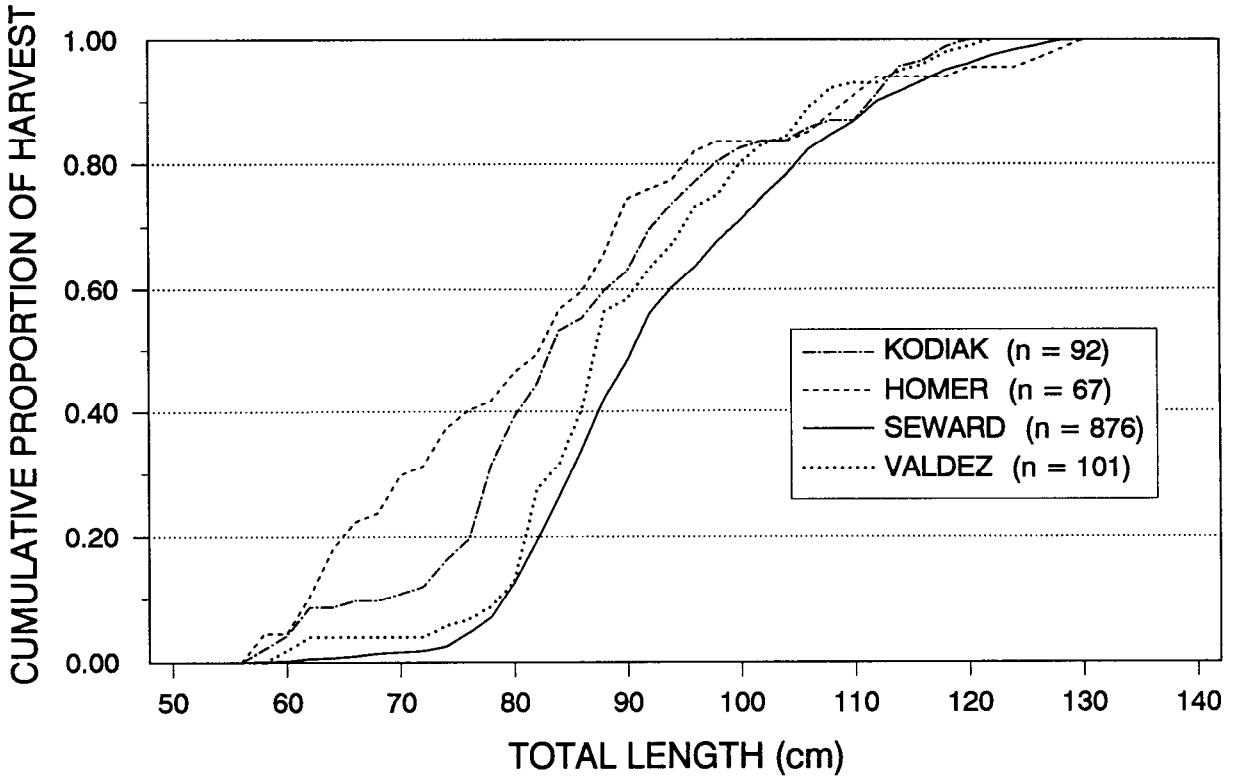

Figure 5. Cumulative length-frequency distributions of lingcod harvested in the Kodiak, Homer, Seward, and Valdez sport fisheries, 1992.

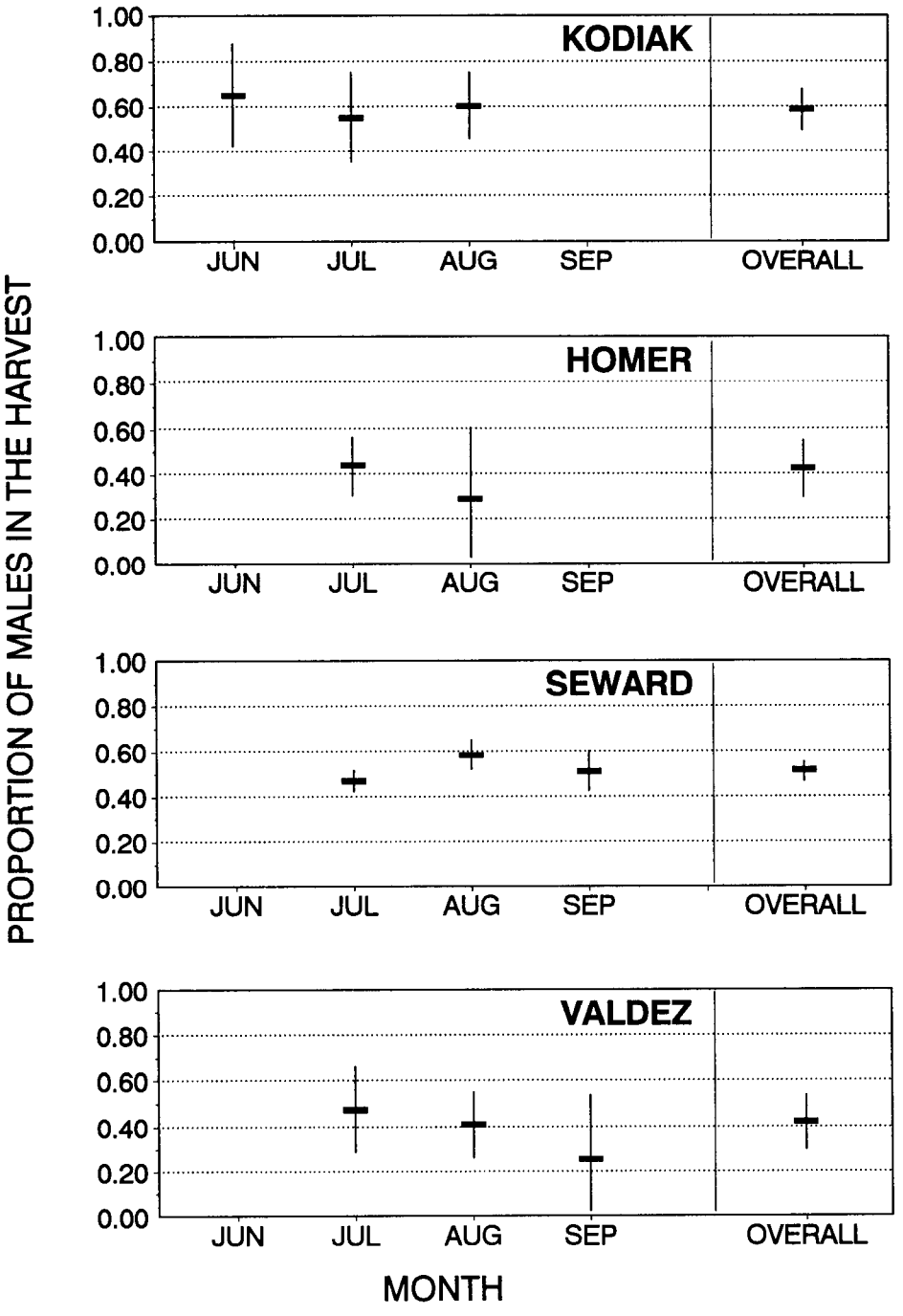

Figure 6. Sex composition (proportion of males) of lingcod harvested in the Kodiak, Homer, Seward, and Valdez sport fisheries, 1992. Vertical bars indicate 95% confidence intervals for the proportion of males.

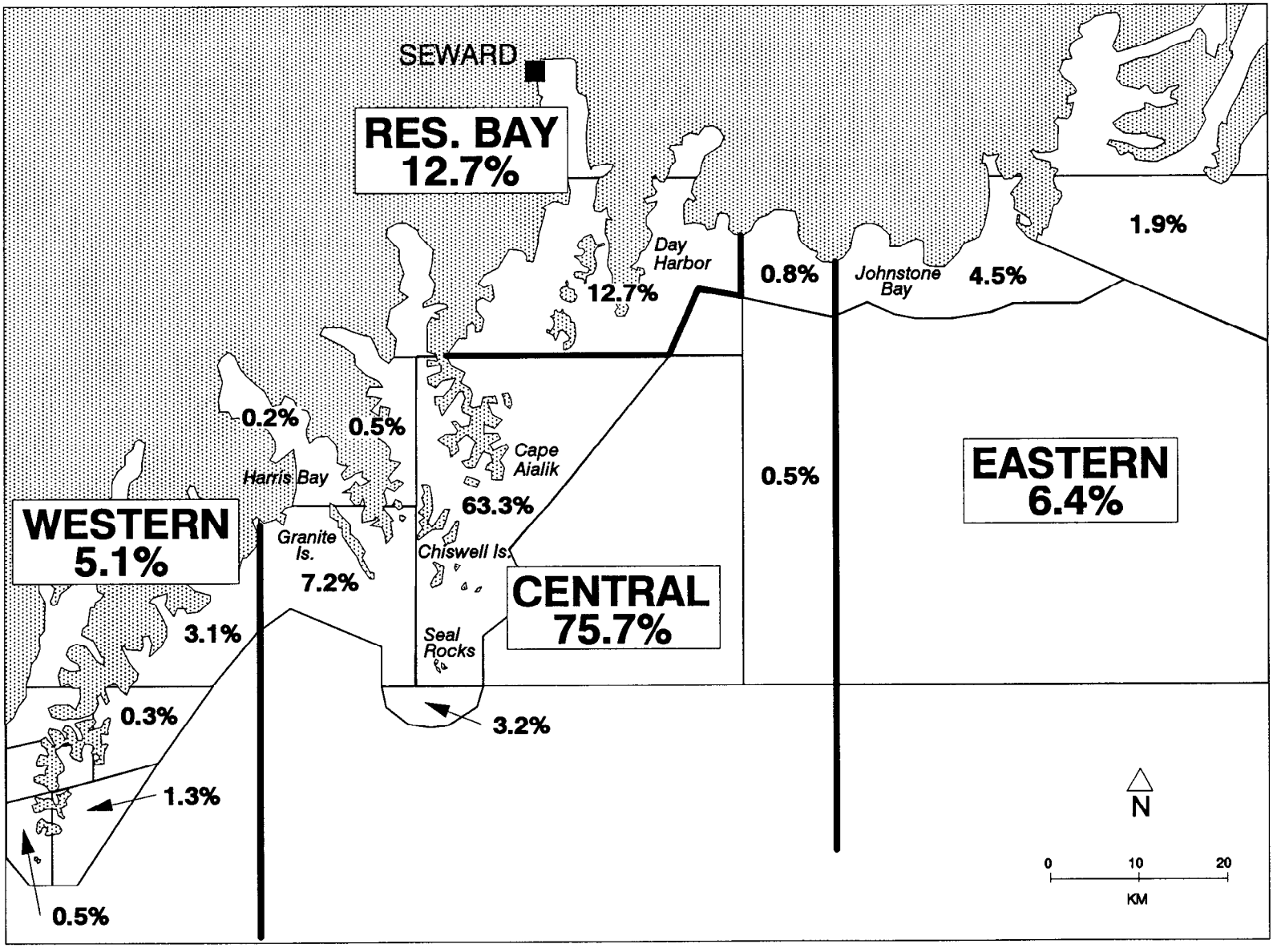

Figure 7. Percentage of lingcod harvest by statistical area and pooled statistical area in the Seward sport fishery, 1992.

Table 4. Number of lingcod harvested by area and user group in the Seward sport fishery, 1992. The first number in parentheses indicates the percentage of the row, and the second number indicates percentage of the column (row percentages calculated only for known user groups).

	Number and Percentage by User Group					
Area[a]	USAF	Army	Charter	Private	Unknown	Total
Eastern	2 (5.4) (3.6)	0	32 (86.5) (21.3)	3 (8.1) (7.0)	3	40 (6.4)
Central	47 (10.0) (83.9)	332 (70.9) (91.2)	72 (15.4) (48.0)	17 (3.6) (39.5)	3	471 (75.7)
Resurrection Bay	2 (2.6) (3.6)	32 (42.1) (8.8)	20 (26.3) (13.3)	22 (29.0) (51.2)	3	79 (12.7)
Western	5 (15.6) (8.9)	0	26 (81.3) (17.3)	1 (3.1) (2.3)	0	32 (5.1)
Total	56 (9.1)	364 (59.4)	150 (24.5)	43 (7.0)	9	622

[a] See the methods section for definitions of areas.

taken by Army boats. In contrast, civilian charter boats took 87% of the Eastern Area harvest and 81% of the Western Area harvest.

Examining harvest patterns within each user group, civilian charter boats spread their harvest across a wider area than other users. Civilian charters took 21% of their harvest in the Eastern, 48% in the Central, 13% in the Resurrection Bay, and 17% in the Western areas. Other user groups took from 87.5% (USAF) to 100% (Army) of their harvest from the Central and Resurrection Bay areas (Table 4).

Length of harvested fish varied by area and by user group (Table 5). While most of the harvest was from the Central and Resurrection Bay areas, these fish were significantly smaller ($T_{akn} = 6.23$, $P < 0.01$, $m = 3$) than fish taken in the Eastern and Western areas (Figure 8). Fish harvested by Army boats averaged 92.5 cm and fish harvested by private boats averaged 94.2 cm, but these groups fished mostly in the Central and Resurrection Bay areas. Fish taken by USAF and civilian charters averaged nearly 100 cm in length (Table 5).

Sex ratio also varied by area and user group (Table 6). Males made up 56% of the Central and 51% of the Resurrection Bay area harvests, compared with 32% of the Western and 38% of the Eastern area harvests. Since females grow faster and attain a greater size than males (Cass et al. 1990), the higher proportions of females may account for the larger size of fish in the Eastern and Western areas. Differences in sex composition among areas were significant ($\chi^2 = 10.62$, $P = 0.01$, $df = 3$). Deviation from a 50:50 sex ratio was significant only in the Central ($\chi^2 = 6.89$, $P = 0.01$, $df = 1$) and Western areas ($\chi^2 = 3.90$, $P = 0.04$, $df = 1$). Males constituted 62% of the Army harvest and 58% of the private harvest, compared with only 37% for civilian charters and 42% for USAF boats (Table 6).

Evaluation of Bag Limits

No bag or possession limits were in effect for Kodiak in 1992. Harvest data were obtained from 182 boat trips between June 6 and September 7. Anglers kept an average of two lingcod or less on 81% of the boat trips (Figure 9). A bag limit of two fish would therefore be expected to reduce harvest by about 19%. A bag limit of five fish would probably have no effect on the harvest.

The ADF&G introduced a proposal to reduce the bag limit from two lingcod to one in waters between Cape Puget and Gore Point (Vincent-Lang and Bechtol 1992). Virtually all of the Seward harvest was from this area. The Seward Military Recreation Camp reported a lingcod harvest of 3,804 lingcod from 723 boat trips after June 30. Data for 708 boat trips and 3,735 lingcod were used to evaluate the proposal. About 68% of the military harvest was composed of fish representing the first fish in the bag limit, suggesting a one fish bag limit would reduce the military harvest by about 32%. Seventeen fish (0.5%) were recorded as *third fish* in the bag limit because Army boats did not always report skippers or deck hands that fished as anglers. Interviews from 84 civilian boat trips between July 24 and September 13 were used to evaluate the proposal for civilian charter and private harvest. About 77% of the civilian harvest was composed of first fish in the bag limit, suggesting that a bag limit of one fish would reduce civilian harvest by about 23%. Assuming that 68.5% of the Seward harvest was from military boats and 31.5% from

Table 5. Mean length (cm) of lingcod harvested by area and user group in the Seward sport fishery, 1992. Numbers in each cell are the mean, standard error, and sample size.

Area[a]	User Group					Total
	USAF	Army	Charter	Private	Unknown	
Eastern	96.5 5.5 2	- - 0	96.3 2.7 31	106.0 10.8 3	90.00 2.00 3	96.6 2.4 39
Central	101.0 2.1 47	92.7 0.6 327	99.0 1.5 72	96.0 2.7 17	107.3 10.7 3	94.7 0.6 466
Resurrection Bay	83.5 7.0 2	90.5 2.0 32	100.1 3.6 20	92.9 2.8 22	99.3 13.3 2	93.7 1.5 78
Western	96.4 3.6 5	- - 0	106.3 2.3 26	58.5 - 1	- - 0	103.2 2.5 32
ALL	99.8 1.8 56	92.5 0.6 359	99.9 1.1 149	94.2 2.1 43	98.8 5.2 8	95.2 0.5 615

[a] See the methods section for definitions of areas.

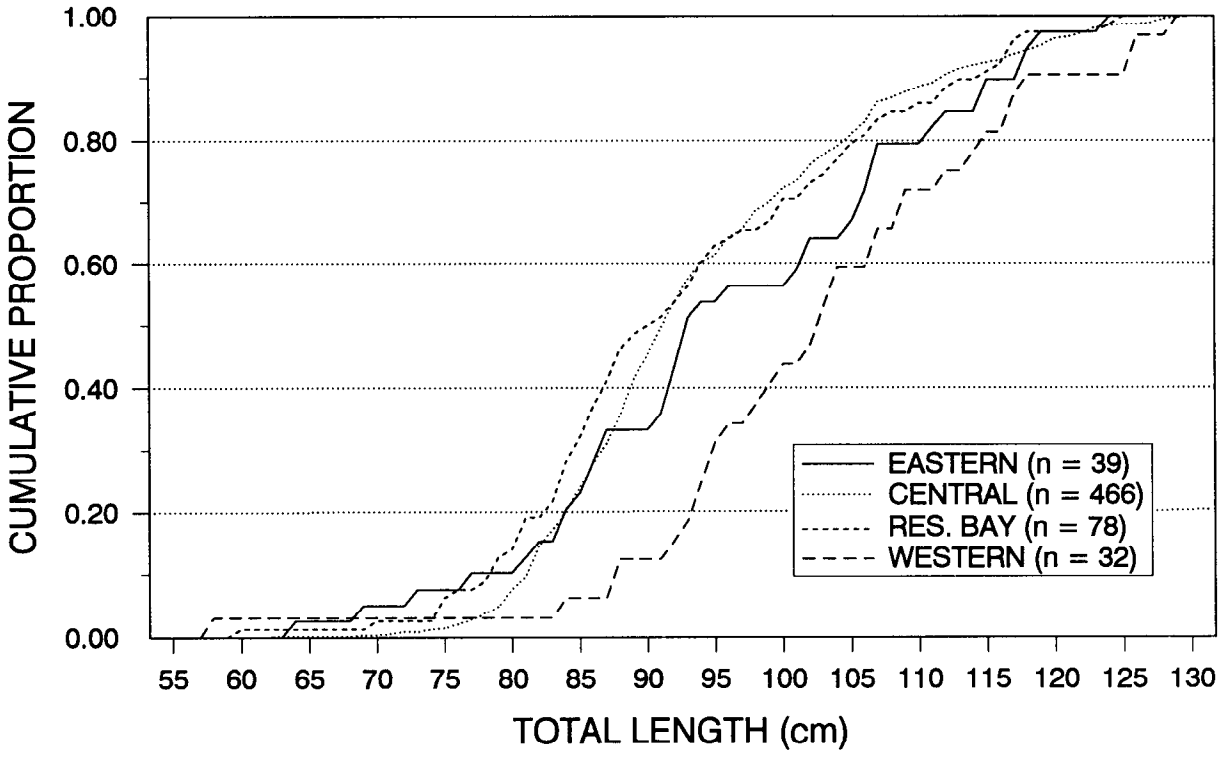

Figure 8. Cumulative length-frequency distributions of lingcod harvested in the Eastern, Central, Resurrection Bay, and Western areas by the Seward sport fishery, 1992.

Table 6. Sex composition (percent males) and sample size (in parentheses) by user group and area of 583 lingcod harvested in the Seward sport fishery, 1992. Totals for each area may include fish taken by unknown user groups.

Area[a]	Percent Males by User Group				Total
	USAF	Army	Charter	Private	
Eastern	100.0 (2)	- (0)	35.5 (31)	33.3 (3)	38.5 (39)
Central	36.4 (44)	62.3 (308)	44.8 (67)	47.1 (17)	56.3 (439)
Resurrection Bay	50.0 (2)	56.3 (32)	26.3 (19)	68.4 (19)	51.4 (74)
Western	60.0 (5)	- (0)	24.0 (25)	100.0 (1)	32.3 (31)
ALL	41.5 (53)	61.8 (340)	36.6 (142)	57.5 (40)	53.2 (583)

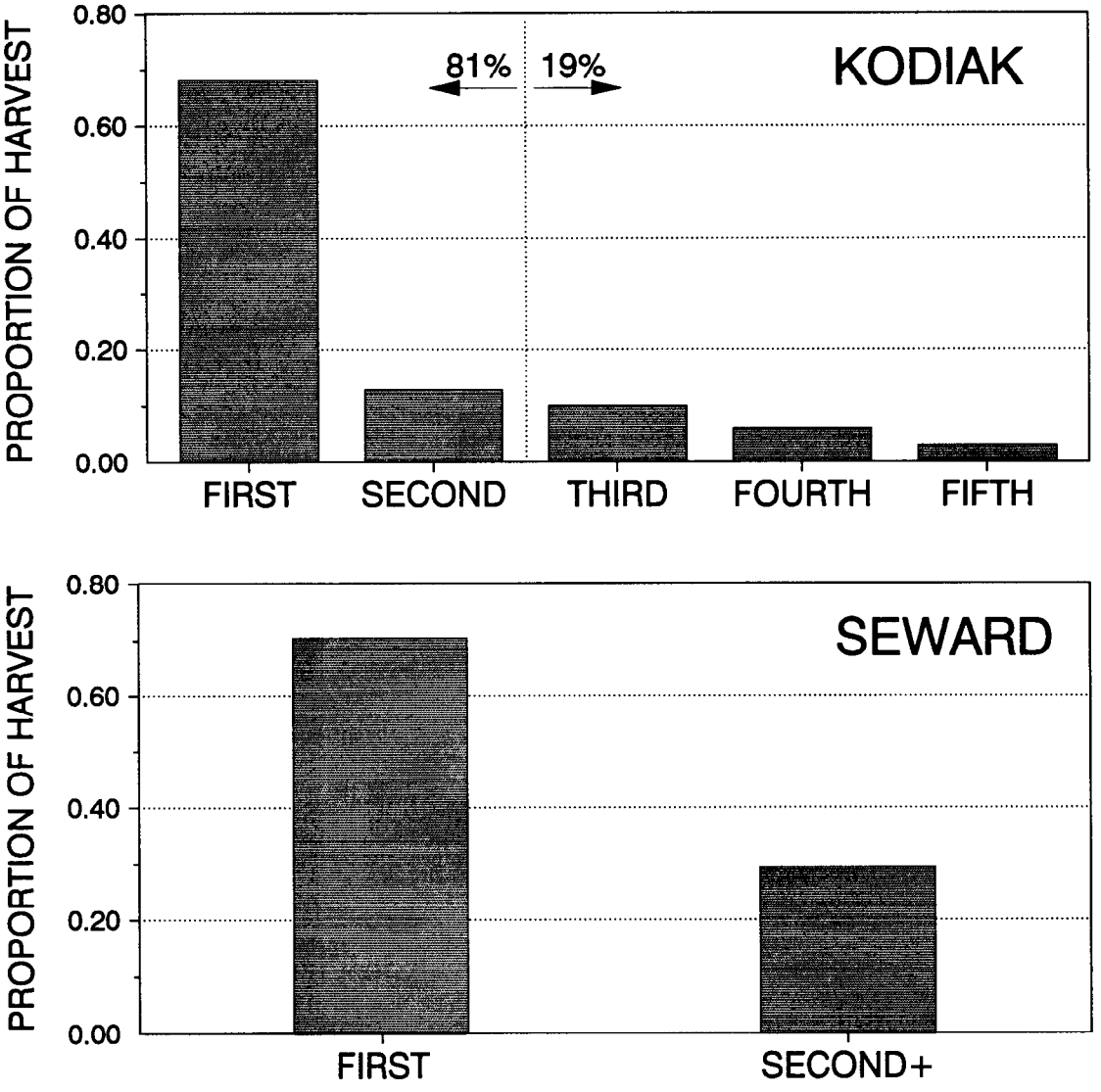

Figure 9. Proportions of the 1992 Kodiak and Seward sport harvests that consisted of the first, second, etc. fish harvested per angler. Kodiak harvest data are for the period June 4-September 7. Interpretation of graphs is as follows: 81% of the Kodiak harvest consisted of creels with fewer than three fish per angler.

civilian boats (Table 4), reducing the bag limit to one fish would likely cause an overall reduction in harvest of about 29% (Figure 9).

Distribution of Bottomfishing Effort

The distribution of bottomfishing effort by the Kodiak fleet was obtained from angler interviews representing 187 boat trips. Charter boats accounted for 16% of the boat trips, and private boats accounted for the remaining 84%. The majority of boats (78%) fished within Chiniak Bay, with fewer trips (15%) to protected areas in the southern half of Marmot Bay (Figure 10). These estimates only reflect effort by boats originating from the two main boat harbors in the City of Kodiak. A significant amount of recreational effort is attributable to anglers launching from the U.S. Coast Guard station at Women's Bay. The U.S. Coast Guard rental fleet is not permitted outside of Chiniak Bay. Additional bottomfishing effort occurs at Anton Larsen Bay, primarily on weekends (L. Schwarz, ADF&G, Kodiak, personal communication).

Homer bottomfishing effort data were obtained through interviews representing 825 boat trips. Most charter boat trips (84%) were in waters outside of Kachemak Bay and south of Anchor Point (Figure 11). Private boats spent 34% of their trips inside Kachemak Bay compared with only 12% for charter boats. In general, private boats stayed closer to port. The charter boats, which are typically larger, spent 36% of their boat trips south of Point Adam, compared with only 13% of private boat trips. Overall, 5% of boat trips were north of Anchor Point, 22% were in Kachemak Bay, 47% were outside Kachemak Bay in Cook Inlet, and 26% were south of Point Adam.

The Seward Military Recreation Camp provided data on 553 Army boat trips and 264 USAF boat trips from June 26 until the camp closed on September 7. This time frame included all bottomfishing trips for lingcod because the season did not open until July 1. Army boats concentrated their bottomfishing effort near Cape Aialik and the Chiswell Islands, with 87% of their effort in stat area 495932 alone (Appendix C2). USAF boats spread their effort across a larger area, but still spent 66% of their boat trips in the Chiswell Islands (stat area 495932). On a broader scale, all military effort was distributed as follows: Eastern Area-1%, Central Area-80%, Resurrection Bay Area-11%, and Western Area-8% (Figure 12).

Civilian bottomfishing effort data at Seward were collected from 130 charter boat trips and 156 private boat trips. Private boats spent 51% of their effort in stat area 495938, the southern portion of Resurrection Bay and in Day Harbor (Appendix C2). Also popular for private boats were the Chiswell Islands (stat area 495932) and Johnstone Bay (stat area 485935). Like the USAF boats, civilian charters spread their effort across a larger area. Johnstone Bay (485935) and southern Resurrection Bay (495938) were the most popular destinations with 36% and 21% of their effort (Appendix C2). In contrast to private boats, only 11% of charter boat trips were in the Cape Aialik-Chiswell Islands area (495932). On a larger scale, charter boats fished mostly in the Eastern Area (43% of charter effort) while private boats fished mostly in the Resurrection Bay Area (56% of private effort). Overall civilian effort was greatest in the Resurrection Bay Area and lowest in the Western Area (Figure 12). The percentage of the total effort in each area that was attributable to each user group could not be determined because the total effort by the civilian fleet was unknown.

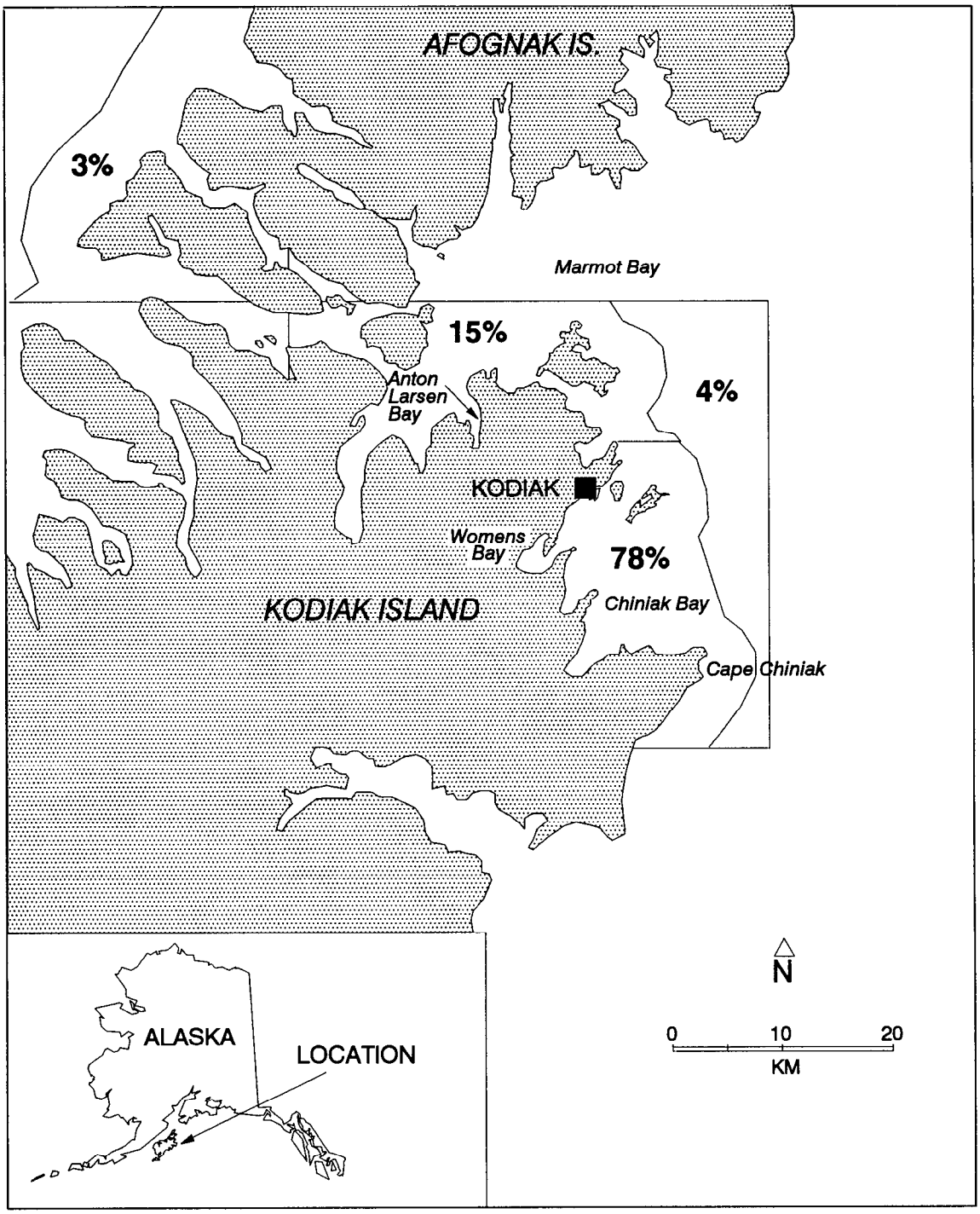

Figure 10. Spatial distribution of fishing effort (percent of boat trips) for all bottomfish in the Kodiak sport fishery, 1992.

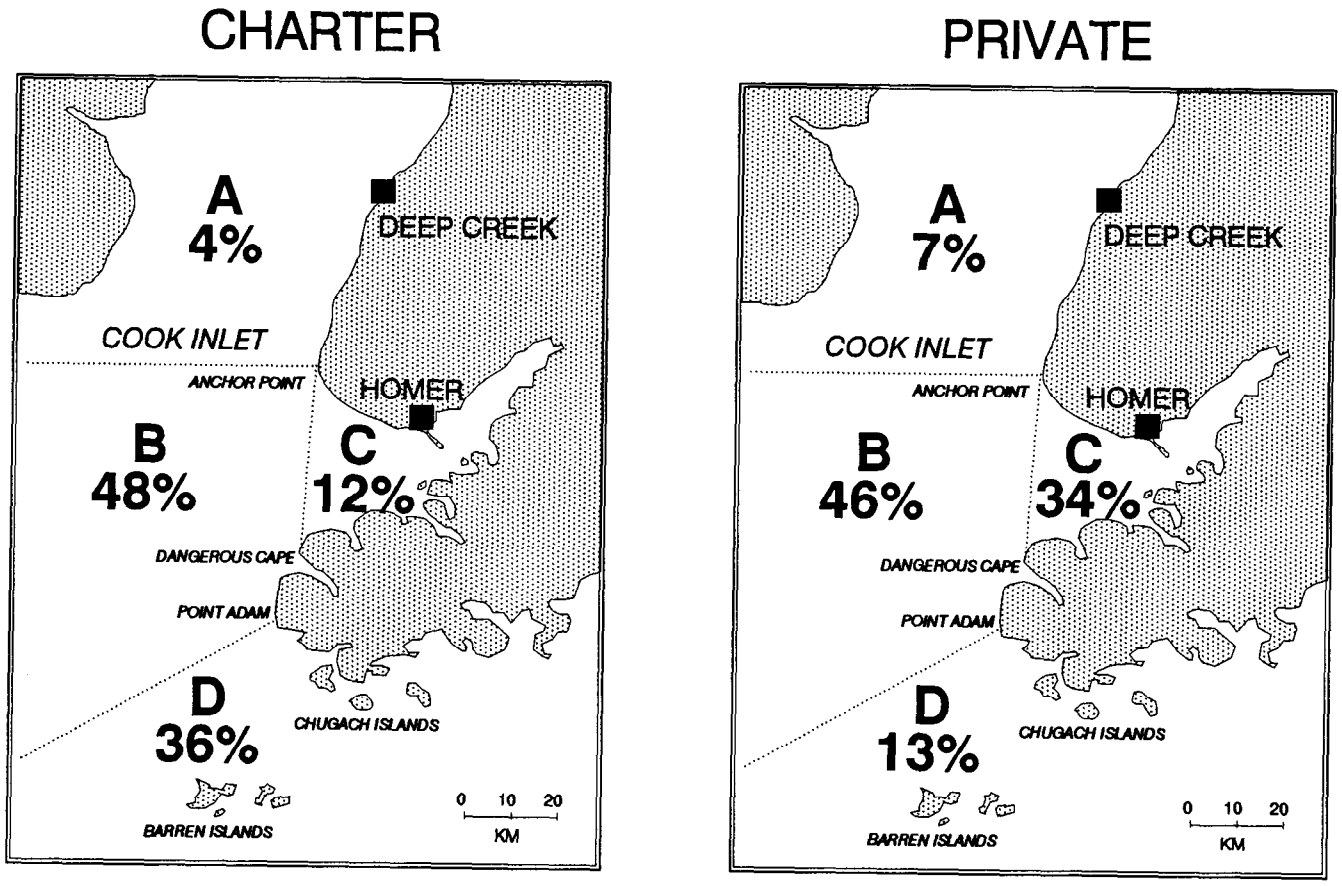

Figure 11. Spatial distribution of fishing effort (percent of boat trips) for all bottomfish by charter and private boats in the Homer sport fishery, 1992.

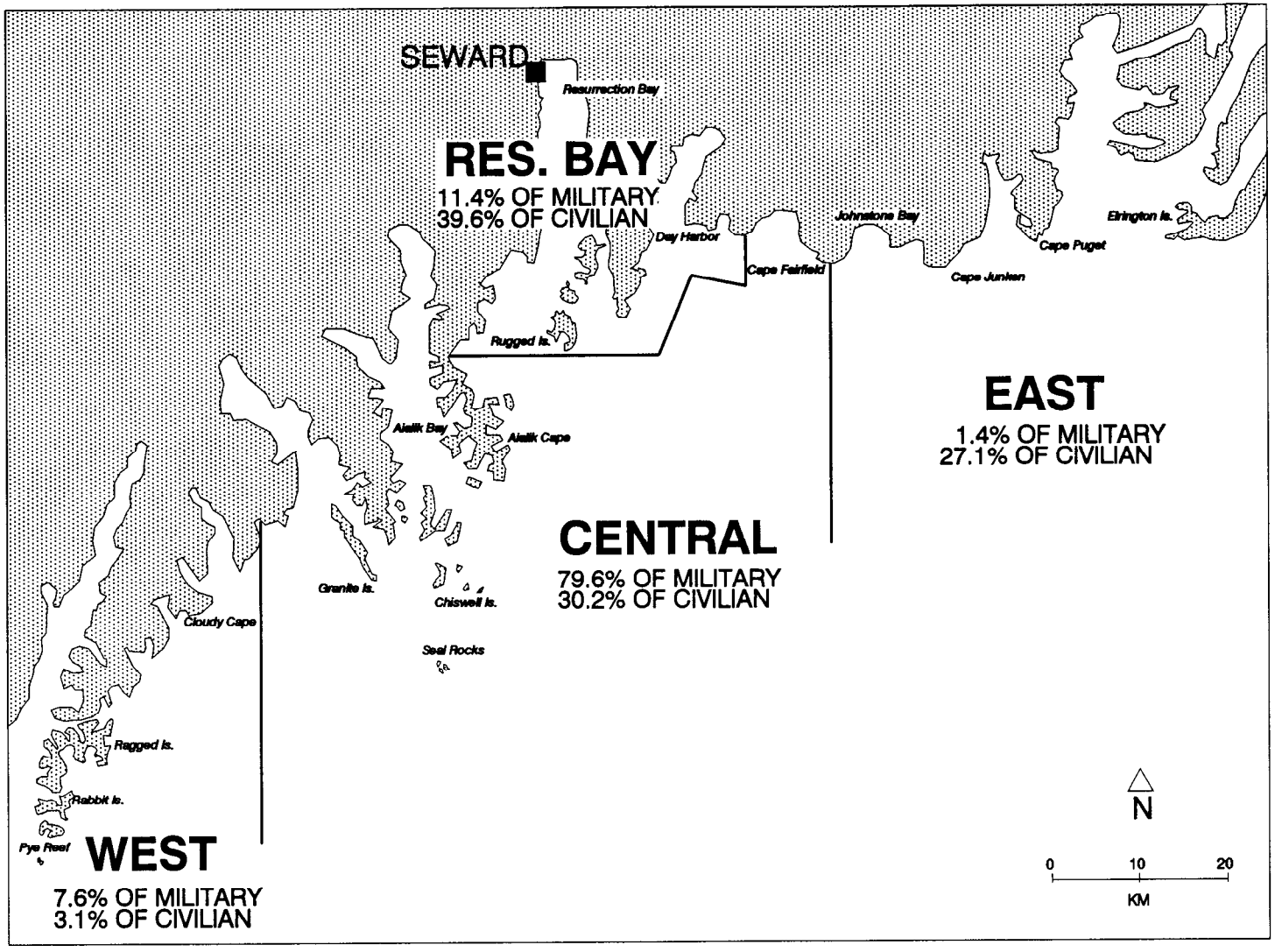

Figure 12. Spatial distribution of fishing effort (percent of boat trips) for all bottomfish by military and civilian boats in the Seward sport fishery, 1992.

Valdez effort data were obtained through interviews representing 116 boat trips. Similar to other ports, the smaller private boats were more likely to fish waters close to port. Effort was spread throughout Prince William Sound, but the most heavily fished waters included areas around Hinchinbrook Entrance and Bligh Island (Figure 13). Surprisingly, 39% of the boat trips were spent outside Hinchinbrook Entrance, with the Seal Rocks area accounting for nearly 22%. Only about 5% of boat trips were spent within Valdez Arm.

DISCUSSION

Fisheries and Stock Status

The most heavily utilized lingcod stocks coastwide are near Seward. Although there is little historical harvest information for areas other than Seward, recent postal survey estimates support this conclusion (Table 1). The postal surveys may actually overestimate harvest in areas other than Seward. Many anglers in Cook Inlet are unfamiliar with marine fish identification, and may be reporting Pacific cod as lingcod. For example, anglers reported an estimated harvest of 567 lingcod at Deep Creek in 1991 (Mills 1992), yet lingcod are observed only extremely rarely by knowledgeable anglers and creel survey crews (D. Nelson, ADF&G, Soldotna, personal communication). Rocky, high-energy habitats preferred by lingcod are lacking throughout most of Cook Inlet.

Although this project was designed primarily to document age, length, and sex characteristics of the recreational harvest, observed trends in these data provide information regarding stock status. Differences in age and size composition among ports suggest that there is some degree of stock separation. More importantly, data also suggest that recruitment in the Seward area continues to be depressed compared with other areas sampled. The Seward harvest had generally lower proportions of fish under 7 years of age (Figure 4) and 70 cm (Figure 5).

It is not clear to what extent the Seward fishery has been responsible for observed declines in recruitment. The declines in recruitment of 5-year-olds that was first evident in 1988 would have resulted from failure of the 1983 year class. It is generally believed that recreational harvest prior to 1987 was minor and sustainable. The 1987 and 1988 creel survey harvest estimates, however, may be low by as much as one-third because they did not begin sampling until July. In 1989, for example, 36% of the lingcod harvest was taken during June (Carlon and Vincent-Lang 1990). Although recruitment in lingcod is known to be variable (Cass et al. 1990), one way the fishery could have reduced year class strength was by harvesting nest-guarding males early in the year.

Lingcod harvest data collected in 1992 at Seward presented a paradox. Most of the harvest (63%) was taken from the Cape Aialik-Chiswell Islands area, generally reported by charter boat operators to have lower lingcod densities than areas farther from Seward (Figure 7). Low catch rates in this area during an ADF&G hook and line survey in early 1992 supported the claims of lower fish density (Vincent-Lang and Bechtol 1992). In addition, fish from this area tended to be smaller than fish taken to the east and west, and were more often males.

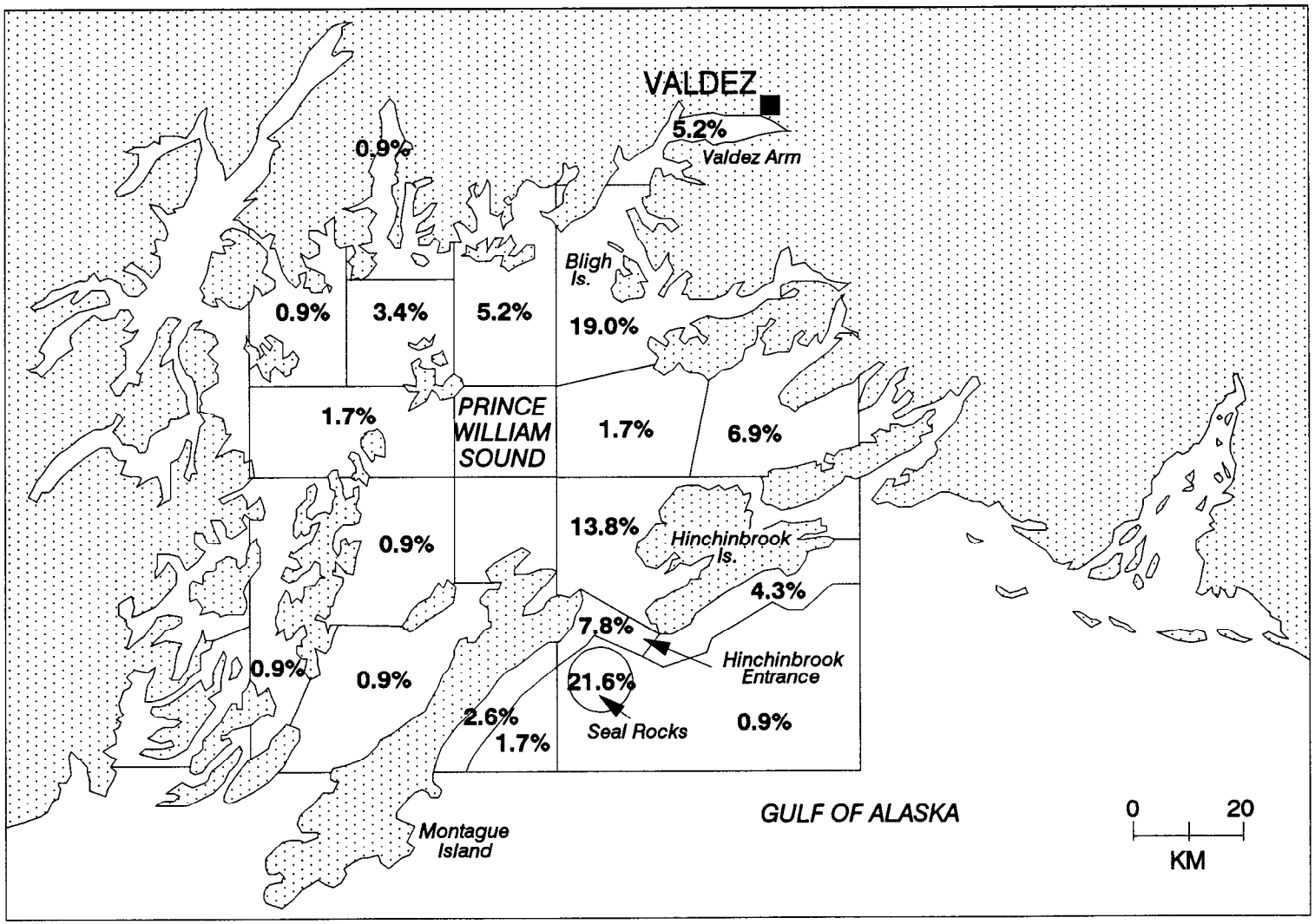

Figure 13. Spatial distribution of fishing effort (percent of boat trips) for all bottomfish in the Valdez sport fishery, 1992.

This paradox may be explained by the fact that more effort was spent in the Cape Aialik-Chiswell Islands area, and by differences in vulnerability to various gear types or techniques. Army boats accounted for 80% of the harvest in this area, and spent 87% of their boat trips in this area. Army boats generally trolled for lingcod, while the larger USAF and civilian charter boats generally jigged or fished with bait. The Army boats may have been able to sustain catch rates by covering more water, picking up fish in areas where fish density was too low to support jig fishing. The differences in size and sex composition by area could have been due to true segregation of fish, but were more likely due to differences in gear types.

Although the overall sex ratio of the harvest was about 50:50, this may not be indicative of a 50:50 ratio in the population. The balanced sex ratio may have resulted from a fortuitous combination of selectivity for males by smaller boats, and selectivity for females by larger boats. Gear type or depths fished by different size boats may have been the vehicle for selectivity.

Based on the observed declines in recruitment, the history of harvest during the nest-guarding season, and rising sport and commercial harvests, the Alaska Board of Fisheries enacted sweeping regulation changes for lingcod fisheries effective in 1993:

1. A closed season of January 1-June 30 was established for all fisheries to protect nest-guarding male lingcod in the Prince William Sound, Cook Inlet-Resurrection Bay Saltwater, and Kodiak regulatory areas. This includes all Gulf of Alaska waters from Cape Suckling to Kodiak.

2. The sport bag and possession limit was reduced from two fish (two in possession) to one fish (one in possession) between Cape Puget and Gore Point. A daily bag and possession limit of two lingcod was established for the sport fishery in the Kodiak regulatory area to provide for long-term sustained yield.

3. Resurrection Bay was closed to the retention of lingcod north of a line between Cape Resurrection and Cape Aialik to rebuild depressed stocks.

4. A minimum size limit of 89 cm (35 inches) total length was established for sport and commercial fisheries in the Prince William Sound and Cook Inlet-Resurrection Bay Saltwater areas. The minimum size limit was established to enhance recruitment by allowing all lingcod the opportunity to spawn at least once before being harvested.

Although it was not clear if declines in recruitment were fishery-induced, these regulations were intended to minimize future impacts yet provide for continued harvest. The closed season and bag limit reduction together should cause significant reductions in harvest. The minimum size limit will likely have three effects: (1) it will further reduce harvest, (2) it will increase the age and size of entry into the harvest, and (3) it will increase the proportion of females in the harvest.

Research Recommendations

Given that some Southcentral Alaska lingcod stocks are depressed and regulations were put in place to rebuild them, harvest sampling and stock assessment will continue on an annual basis. The goal of research programs should be to provide information necessary to manage harvest for sustained yield. This will require accurate data on removals, age, length, sex and reproduction, mortality rates, and abundance.

Estimates of harvest are now obtained through the statewide postal survey (Mills 1992). The accuracy of harvest estimates may be improved by providing information on the identification of lingcod (and other marine fishes) in the questionnaire. Another valuable, although minimum, estimate of harvest is obtained inseason by expanding sample sizes by sampling rates. The current sampling design incorporating systematic sampling should be continued to provide these estimates.

Information on user groups, gear types, and the location of harvest should be collected at all ports. The spatial distribution of harvest may provide clues about relative fish density that could be useful in designing abundance surveys. User group data at Seward appeared to be associated with boat size and gear type. Additional data of this nature should be gathered to enhance our understanding of selectivity by the fishery. Information on the distribution of fishing effort, particularly effort targeted on lingcod, should also be gathered. Use of boat-trips as a unit of effort may be misleading because boat size limits the number of anglers. For example, smaller boats fished closer to Seward in 1992 but generally carried fewer anglers. Future analyses of effort should be standardized by angler-days to account for variation in the number of anglers per boat.

A fishery-independent sampling program for age and size will be needed to monitor stocks. The establishment of an 89 cm minimum size limit will delay age at entry into the harvest by 2-3 years and cause knife-edge recruitment on the basis of length. As a result, harvest data will cease to provide information on recruitment or relative year class strength for at least several years. In the meantime, continued harvest in the absence of recruitment could cause collapse of stocks near Seward. An annual sampling program conducted in a standardized manner could provide the necessary age and size data, and perhaps additional life history information.

Estimation of sustainable levels of harvest may ultimately require estimates of abundance or biomass. Information on maturity and fecundity, migration, mortality, growth rate, and exploitation rate would be useful in simulations for estimating sustainable harvest. It may be possible to design a fishery-independent survey program to obtain some of these data in addition to the age and size data. For example, sampling could be conducted late in fall to obtain maturity information and released fish could be tagged to examine migration to or from spawning areas. Alternatively, sampling could be conducted in spring prior to the fishery, and tagging could be conducted to estimate exploitation rate for selected areas (Jagielo 1991). Survey catch rates could also be used as indicators of relative abundance, though this method is often hindered by relationships between catchability and abundance (Paloheimo and Dickie 1964, Cooke and Beddington 1984, Richards and Schnute 1986). Hilborn and Walters (1992) stress that catch rate data should be

spatially stratified when effort and harvest are not random, as is the case in most bottomfish fisheries.

Catch-at-age analysis is a popular and powerful tool for producing estimates of stock size. Although the current time series of catch and age data from the Seward fishery is insufficient to produce reliable estimates, the stock assessment sampling program should be designed to gather the necessary data. Catch-at-age data alone are usually insufficient to reliably estimate stock size because of correlation between estimates of fishing mortality and abundance (Deriso et al. 1985). Auxiliary information such as effort or catch per unit of effort (CPUE) can be used to "tune" estimates of stock size, but these must be based on accurate estimates of effective effort, and not include time spent running or searching for lingcod. Given the difficulty of estimating effective effort in the fishery, fishery-independent sampling to estimate CPUE may be a better tool for tuning catch-at-age analyses.

The accuracy of catch-at-age methods also depends on precision in age determination. Identification of annuli near the nucleus and edge of fin rays is difficult. Interpretation of early annuli may be improved by sampling juvenile (age 0-3) lingcod and using length-frequency distributions to identify cohorts. Development of a lingcod aging manual and standardized interpretation of fin ray characteristics should be undertaken to minimize between-reader and within-reader variation.

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Numerous Department of Fish and Game personnel made significant contributions to the information presented in this report. Port sampling was conducted by Robert Anderson, Sandra Christen, Alan Heckart, Michael Parish, Kim Phillips, William Romberg, and Matthew Miller. Matt Miller prepared and read lingcod fin rays and wrote the first draft of a lingcod aging manual. Larry Erie assisted with fin ray interpretation. Biometrician James Hasbrouck gave advice in planning and data analysis. Robert Lafferty supervised the spring hook and line survey and arranged vessel contracts. Thomas Cappiello purchased equipment and supplies, assembled opercular tags, and edited tagging data files. Bob Candopolous and the crew of the *MV Legacy* did an outstanding job of locating lingcod. Margaret Leonard spruced up the report for publication. Through it all, Doug Vincent-Lang provided technical guidance and administrative and moral support.

Cooperation of the general public was outstanding. Jack Dyer and numerous other employees at the Seward Military Recreation Camp provided extremely valuable lingcod harvest and effort data, as well as facilities for fish sampling. The vast majority of charter boat operators and anglers throughout the region were cooperative, hospitable, and genuinely concerned for the resource.

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APPENDIX A

Appendix A. Estimated angler effort for saltwater finfish in Southcentral Alaska, 1981-1991 (Mills 1982-1992).

Year	Estimated Effort in Angler-Days					Total Southcentral Alaska	Statewide	Percent of Statewide Effort In Southcentral
	AK Penin.	Kodiak[a]	Cook Inlet[b]	Seward[c]	PWS[d]			
1981	11,828	29,857	96,755	56,410	33,669	228,519	435,933	50.1
1982	9,075	41,113	95,622	49,167	30,826	225,803	467,380	46.9
1983	8,035	40,217	159,912	40,144	36,063	284,371	543,383	51.5
1984	10,127	34,213	142,255	44,669	40,670	271,934	554,712	47.7
1985	3,035	33,032	132,765	47,472	66,291	282,595	565,119	49.7
1986	6,411	31,762	149,417	51,375	51,681	290,646	578,027	49.4
1987	7,307	38,671	192,203	42,143	69,425	349,749	650,120	53.4
1988	8,222	30,522	190,409	50,251	78,367	357,771	675,479	52.1
1989	10,713	35,485	170,536	47,386	80,119	344,239	708,028	47.3
1990	15,690	34,969	226,648	69,485	98,000	444,792	824,190	52.3
1991	20,851	42,315	214,157	71,332	102,927	451,582	829,161	52.6

[a] Kodiak: encompasses the Kodiak and Afognak Island groups, including the Barren and Trinity Islands.

[b] Cook Inlet: includes all waters north of a line roughly from Gore Point to Cape Douglas.

[c] Seward: includes Gulf of Alaska waters from Cape Puget to Gore Point.

[d] Prince William Sound: includes all waters between Cape Suckling and Cape Puget.

APPENDIX B

Appendix B1. Observed frequencies and proportions, by age class, of lingcod harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

	Number of Fish						Proportions						
Age	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
4	-	2	4	2	-	8	-	0.133	0.167	0.040	-	0.090	0.030
5	-	1			-	1	-	0.067			-	0.011	0.011
6	-		2	2	-	4	-		0.083	0.040	-	0.045	0.022
7	-	1	3	9	-	13	-	0.067	0.125	0.180	-	0.146	0.038
8	-	5	6	21	-	32	-	0.333	0.250	0.420	-	0.360	0.051
9	-		1	2	-	3	-		0.042	0.040	-	0.034	0.019
10	-	2	3	2	-	7	-	0.133	0.125	0.040	-	0.079	0.029
11	-			2	-	2	-			0.040	-	0.022	0.016
12	-	1		1	-	2	-	0.067		0.020	-	0.022	0.016
13	-	1	2	6	-	9	-	0.067	0.083	0.120	-	0.101	0.032
14	-		2		-	2	-		0.083		-	0.022	0.016
15	-	2	1	2	-	5	-	0.133	0.042	0.040	-	0.056	0.025
16	-			1	-	1	-			0.020	-	0.011	0.011
	-	15	24	50	-	89	-	1.000	1.000	1.000	-	1.000	
HOMER:													
4	-	-	10	5	-	15	-	-	0.185	0.357	-	0.221	0.051
5	-	-	4	2	-	6	-	-	0.074	0.143	-	0.088	0.035
6	-	-	2	2	-	4	-	-	0.037	0.143	-	0.059	0.029
7	-	-	3	1	-	4	-	-	0.056	0.071	-	0.059	0.029
8	-	-	10	1	-	11	-	-	0.185	0.071	-	0.162	0.045
9	-	-	7		-	7	-	-	0.130		-	0.103	0.037
10	-	-	5	1	-	6	-	-	0.093	0.071	-	0.088	0.035
11	-	-	4	1	-	5	-	-	0.074	0.071	-	0.074	0.032
12	-	-		1	-	1	-	-		0.071	-	0.015	0.015
13	-	-	2		-	2	-	-	0.037		-	0.029	0.021
14	-	-	2		-	2	-	-	0.037		-	0.029	0.021
15	-	-	2		-	2	-	-	0.037		-	0.029	0.021
16	-	-	2		-	2	-	-	0.037		-	0.029	0.021
17	-	-			-		-	-			-		
18	-	-			-		-	-			-		
19	-	-			-		-	-			-		
20	-	-			-		-	-			-		
21	-	-	1		-	1	-	-	0.019		-	0.015	0.015
	-	-	54	14	-	68	-	-	1.000	1.000	-	1.000	

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Appendix B1. (Page 2 of 2).

	Number of Fish						Proportions						
Age	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
4	-	-	2	-	3	5	-	-	0.006	-	0.025	0.012	0.005
5	-	-		-	1	1	-	-		-	0.008	0.002	0.002
6	-	-	3	-		3	-	-	0.010	-		0.007	0.004
7	-	-	31	-	5	36	-	-	0.100	-	0.042	0.084	0.013
8	-	-	64	-	20	84	-	-	0.206	-	0.168	0.196	0.019
9	-	-	47	-	22	69	-	-	0.152	-	0.185	0.161	0.018
10	-	-	55	-	14	69	-	-	0.177	-	0.118	0.161	0.018
11	-	-	47	-	23	70	-	-	0.152	-	0.193	0.163	0.018
12	-	-	16	-	7	23	-	-	0.052	-	0.059	0.054	0.011
13	-	-	17	-	5	22	-	-	0.055	-	0.042	0.051	0.011
14	-	-	13	-	5	18	-	-	0.042	-	0.042	0.042	0.010
15	-	-	5	-	8	13	-	-	0.016	-	0.067	0.030	0.008
16	-	-	2	-	3	5	-	-	0.006	-	0.025	0.012	0.005
17	-	-	3	-	1	4	-	-	0.010	-	0.008	0.009	0.005
18	-	-	1	-		1	-	-	0.003	-		0.002	0.002
19	-	-	2	-	1	3	-	-	0.006	-	0.008	0.007	0.004
20	-	-		-	1	1	-	-		-	0.008	0.002	0.002
21	-	-		-			-	-		-			
22	-	-	1	-		1	-	-	0.003	-		0.002	0.002
23	-	-	1	-		1	-	-	0.003	-		0.002	0.002
	-	-	310	-	119	429	-	-	1.000	-	1.000	1.000	
VALDEZ:													
3	-	-	2			2	-	-	0.053			0.019	0.014
4	-	-	0		1	1	-	-			0.083	0.010	0.010
5	-	-	1	2		3	-	-	0.026	0.037		0.029	0.016
6	-	-	1	2		3	-	-	0.026	0.037		0.029	0.016
7	-	-	4	8	1	13	-	-	0.105	0.148	0.083	0.125	0.033
8	-	-	12	6	4	22	-	-	0.316	0.111	0.333	0.212	0.040
9	-	-	5	4	1	10	-	-	0.132	0.074	0.083	0.096	0.029
10	-	-	2	9	2	13	-	-	0.053	0.167	0.167	0.125	0.033
11	-	-	4	9	1	14	-	-	0.105	0.167	0.083	0.135	0.034
12	-	-		4	1	5	-	-		0.074	0.083	0.048	0.021
13	-	-	5	4		9	-	-	0.132	0.074		0.087	0.028
14	-	-	1	3	1	5	-	-	0.026	0.056	0.083	0.048	0.021
15	-	-		2		2	-	-		0.037		0.019	0.014
16	-	-		1		1	-	-		0.019		0.010	0.010
17	-	-					-	-					
18	-	-					-	-					
19	-	-					-	-					
20	-	-	1			1	-	-	0.026			0.010	0.010
	-	-	38	54	12	104	-	-	1.000	1.000	1.000	1.000	

Appendix B2. Observed frequencies and proportions, by length class, of lingcod harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

Length Class[a]	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
55	-	1	1		-	2	-	0.067	0.038		-	0.022	0.015
60	-	1	3	2	-	6	-	0.067	0.115	0.039	-	0.065	0.026
65	-	1			-	1	-	0.067			-	0.011	0.011
70	-	1	1	3	-	5	-	0.067	0.038	0.059	-	0.054	0.024
75	-	2	6	7	-	15	-	0.133	0.231	0.137	-	0.163	0.039
80	-	1	3	12	-	16	-	0.067	0.115	0.235	-	0.174	0.040
85	-	3	2	5	-	10	-	0.200	0.077	0.098	-	0.109	0.033
90	-	2	2	8	-	12	-	0.133	0.077	0.157	-	0.130	0.035
95	-	1	2	4	-	7	-	0.067	0.077	0.078	-	0.076	0.028
100	-			3	-	3	-			0.059	-	0.033	0.019
105	-	1	1	1	-	3	-	0.067	0.038	0.020	-	0.033	0.019
110	-		2	2	-	4	-		0.077	0.039	-	0.043	0.021
115	-	1	3	3	-	7	-	0.067	0.115	0.059	-	0.076	0.028
120	-			1	-	1	-			0.020	-	0.011	0.011
	-	15	26	51	-	92	-	1.000	1.000	1.000	-		
HOMER:													
55	-	-	2	1	-	3	-	-	0.038	0.071	-	0.045	0.025
60	-	-	6		-	6	-	-	0.113		-	0.090	0.035
65	-	-	4	3	-	7	-	-	0.075	0.214	-	0.104	0.038
70	-	-	5	2	-	7	-	-	0.094	0.143	-	0.104	0.038
75	-	-	3	2	-	5	-	-	0.057	0.143	-	0.075	0.032
80	-	-	9	1	-	10	-	-	0.170	0.071	-	0.149	0.044
85	-	-	4	2	-	6	-	-	0.075	0.143	-	0.090	0.035
90	-	-	6	1	-	7	-	-	0.113	0.071	-	0.104	0.038
95	-	-	4	1	-	5	-	-	0.075	0.071	-	0.075	0.032
100	-	-			-		-	-			-		
105	-	-	3		-	3	-	-	0.057		-	0.045	0.025
110	-	-	3	1	-	4	-	-	0.057	0.071	-	0.060	0.029
115	-	-			-		-	-			-		
120	-	-	1		-	1	-	-	0.019		-	0.015	0.015
125	-	-	2		-	2	-	-	0.038		-	0.030	0.021
130	-	-	1		-	1	-	-	0.019		-	0.015	0.015
	-	-	53	14	-	67	-	-	1.000	1.000	-	1.000	

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Appendix B2. (Page 2 of 2).

Length Class[a]	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
55	-	-		1		1	-	-	0.000	0.003	0.000	0.001	0.001
60	-	-	2	2	2	6	-	-	0.004	0.007	0.017	0.007	0.003
65	-	-	1	4	1	6	-	-	0.002	0.014	0.008	0.007	0.003
70	-	-	3	2	1	6	-	-	0.006	0.007	0.008	0.007	0.003
75	-	-	19	22	3	44	-	-	0.041	0.076	0.025	0.050	0.007
80	-	-	83	41	16	140	-	-	0.178	0.141	0.133	0.160	0.012
85	-	-	82	64	21	167	-	-	0.176	0.221	0.175	0.191	0.013
90	-	-	83	44	21	148	-	-	0.178	0.152	0.175	0.169	0.013
95	-	-	37	27	12	76	-	-	0.079	0.093	0.100	0.087	0.010
100	-	-	50	20	7	77	-	-	0.107	0.069	0.058	0.088	0.010
105	-	-	37	21	13	71	-	-	0.079	0.072	0.108	0.081	0.009
110	-	-	29	14	9	52	-	-	0.062	0.048	0.075	0.059	0.008
115	-	-	23	14	2	39	-	-	0.049	0.048	0.017	0.045	0.007
120	-	-	10	10	6	26	-	-	0.021	0.034	0.050	0.030	0.006
125	-	-	6	4	6	16	-	-	0.013	0.014	0.050	0.018	0.005
130	-	-	1			1	-	-	0.002	0.000	0.000	0.001	0.001
	-	-	466	290	120	876	-	-	1.000	1.000	1.000	1.000	
VALDEZ:													
60	-	-	2	1	1	4	-	-	0.065	0.017	0.083	0.040	0.020
65	-	-					-	-	0.000	0.000	0.000	0.000	0.000
70	-	-	1	1		2	-	-	0.032	0.017	0.000	0.020	0.014
75	-	-	1	1	1	3	-	-	0.032	0.017	0.083	0.030	0.017
80	-	-	4	15	2	21	-	-	0.129	0.259	0.167	0.208	0.041
85	-	-	10	15	2	27	-	-	0.323	0.259	0.167	0.267	0.044
90	-	-	3	2	2	7	-	-	0.097	0.034	0.167	0.069	0.025
95	-	-	4	6	2	12	-	-	0.129	0.103	0.167	0.119	0.032
100	-	-	4	4	1	9	-	-	0.129	0.069	0.083	0.089	0.028
105	-	-	1	7		8	-	-	0.032	0.121	0.000	0.079	0.027
110	-	-		1	1	2	-	-	0.000	0.017	0.083	0.020	0.014
115	-	-	1	3		4	-	-	0.032	0.052	0.000	0.040	0.020
120	-	-		2		2	-	-	0.000	0.034	0.000	0.020	0.014
	-	-	31	58	12	101	-	-	1.000	1.000	1.000	1.000	

[a] Lower limits of 10 cm length classes (e.g. 60 = 60.0-69.9 cm).

Appendix B3. Observed frequencies by sex and proportions of male lingcod in the sport harvest each month at Kodiak, Homer, Seward, and Valdez, 1992.

Port	Month	Number of Fish			Proportion Males[a]	
		Female	Male	Unknown	p	SE(p)
Kodiak	Jun	5	9	1	0.643	0.133
	Jul	11	14	1	0.560	0.101
	Aug	18	27	9	0.600	0.074
	Total	34	50	11	0.595	0.054
Homer	Jul	28	22	4	0.440	0.071
	Aug	9	4	1	0.308	0.133
	Total	37	26	5	0.413	0.063
Seward	Jul	233	210	32	0.474	0.024
	Aug	111	159	22	0.589	0.030
	Sep	57	59	4	0.509	0.047
	Total	401	428	58	0.516	0.017
Valdez	Jul	14	13	11	0.481	0.098
	Aug	25	17	13	0.405	0.077
	Sep	9	3		0.250	0.131
	Total	48	33	24	0.407	0.055

[a] The proportion of males was computed using only fish of known sex.

APPENDIX C

Appendix C1. Observed number of lingcod harvested by statistical area and user group in the Seward sport fishery, July 1-September 13, 1992.

ADF&G Statistical Area[a]	User Group					Total
	USAF	Army	Charter	Private	Unknown	
485932	0	0	12	0	0	12
485935	2	0	20	3	3	28
485933	0	1	3	1	0	5
495938	2	32	20	22	3	79
495932	13	312	54	13	2	394
495936	0	2	0	1	0	3
495935	0	0	1	0	0	1
495934	21	17	5	2	0	45
505932	5	0	13	1	0	19
505909	0	0	2	0	0	2
505907	0	0	3	0	0	3
505908	0	0	8	0	0	8
485934	0	0	3	0	0	3
495902	13	0	6	0	1	20
Total	56	364	150	43	9	622

[a] See Figure 3 for location of statistical areas.

Appendix C2. Number of boat trips reported by statistical area and user group in the Seward sport fishery, 1992. The total number of boat trips in each statistical area could not be determined because user groups were not sampled proportionately.

ADF&G Statistical Area[a]	User Group			
	USAF	Army	Charter	Private
485931	2	0	1	0
485932	0	0	8	2
485933	10	1	10	7
485934	0	0	1	0
485935	31	0	47	18
486001	0	0	0	1
495901	0	0	2	0
495902	10	0	1	1
495931	0	0	3	1
495932	59	482	14	37
495933	0	0	0	0
495934	59	0	2	0
495935	2	0	3	0
495936	10	0	0	1
495937	0	0	0	0
495938	19	62	27	80
495939	0	0	2	1
496001	0	2	0	4
496002	2	6	0	3
505901	0	0	1	0
505905	0	0	0	0
505906	0	0	0	0
505907	0	0	0	0
505908	0	0	1	0
505909	0	0	1	0
505932	60	0	6	0
505933	0	0	0	0
Total:	264	553	130	156

[a] See Figure 3 for location of statistical areas.

APPENDIX D

Appendix D. Names and contents of ASCII computer files containing 1992 lingcod raw data. All DTA files are in Mark Sense Biological (AWL, Version 1.1) format.

Location	Filename	Inclusive Dates	Contents
Kodiak	Q7540BA2.DTA	Jun 4 - Aug 29	Age, length, sex data
	KODINT92.WK1	Jun 4 - Sep 7	Angler interview data
Homer	10030BA2.DTA	Jul 3 - Aug 29	Age, length, sex data
	HOMINT92.WK1	May 22 - Sep 11	Angler interview data
Seward	10020BA2.DTA	May 17 - Aug 16	Age, length, sex data
	10020BA2.DTA	Aug 20 - Sep 13	Age, length, sex data
	SEWINT92.WK1	May 17 - Sep 13	Private angler interview data
	RECDAT92.WK1	Jun 26 - Sep 7	Seward Military Recreation Camp Data
Valdez	J0010BB2.DTA	Jul 2 - Sep 4	Age, length, sex data
	VALINT92.WK1	Jun 2 - Sep 8	Angler interview data