Fishery Data Series No. 91-28

Age, Length, and Species Compositions of Groundfish Harvested in the Marine Sport Fisheries of Resurrection Bay, Alaska, 1988-1990

by

Doug Vincent-Lang

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ABSTRACT

Halibut *Hippoglossus stenolepis*, lingcod *Ophiodon elongatus*, and rockfish *Sebastes* were sampled from the sport creel of boat anglers returning to Seward, Alaska. Fish were sampled for age and length composition and rockfish were additionally sampled for species composition. Halibut ranged in age from 2 to 22 years, with the predominant ages being 6 through 10 years. Lingcod ranged in age from 3 to 21 years, with the predominant ages being 5 through 11 years. Fifteen species of rockfish were identified in the sport harvest. The majority of the rockfish, however, were black *S. melanops* and yelloweye *S. ruberrimus*. Species composition of rockfish varied through the summer. Black rockfish ranged in age from 3 to 52 years with the predominant ages being 5 through 13. Yelloweye rockfish ranged in age from 8 to 87, with the predominant ages being 20 through 25. Black rockfish essentially cease growth by age 13, whereas yelloweye rockfish continue to gain throughout their life. Halibut and lingcod continue to gain growth throughout their lives. Annual survival rates for black rockfish ranged from 0.57 to 0.78 whereas rates for yelloweye rockfish ranged from 0.89 to 0.93. Annual survival rates for halibut and lingcod ranged from 0.62 to 0.67 and 0.53 to 0.77, respectively.

KEY WORDS: Halibut, *Hippoglossus stenolepis*, lingcod, *Ophiodon elongatus*, rockfish, *Sebastes*, Resurrection Bay, Seward, Alaska, age, length, species composition, annual survival rates.

INTRODUCTION

The recreational fishery in Resurrection Bay (Figure 1) is one of the largest marine sport fisheries in Alaska (Mills 1990). Most of the effort in this fishery has been by private boat anglers; however, a growing private and militarily-administered charter boat industry and shoreline fishery have also developed in recent years (Carlon and Vincent-Lang 1990). Historically, the fishery has targeted coho salmon *Oncorhynchus kisutch* during the months of July through September. In recent years, however, halibut *Hippoglossus stenolepis*, lingcod *Ophiodon elongatus*, and rockfish *Sebastes* have been increasingly targeted during June and early July, before the coho salmon arrive in catchable numbers.

Between 1977 and 1989, an average of 4,741 halibut have been harvested annually by sport anglers returning to Seward, Alaska (Table 1, Figure 2). A record 11,423 halibut were harvested during 1988. The average rockfish harvest over this same period was 22,259, with harvests of over 30,000 during 1986 and 1988 (Table 1, Figure 2). Data regarding historical lingcod harvests are sparse largely because the statewide postal harvest survey does not include this species. Data collected since 1986 as part of a creel survey indicate an expanding fishery for this species (Table 1, Figure 2).

Many bottomfish stocks along the Pacific west coast have been depressed for many years due to overfishing. Although bottomfish stocks are generally considered healthy in Alaska, concern has been raised regarding the status of several local stocks that receive heavy sport and commercial effort. Unfortunately, little historical information is available to assess the structures or health of these local stocks. For the larger of the two fisheries which target these stocks, the commercial fishery, reporting areas tend to be large, adding further uncertainty. For these reasons, a monitoring program was initiated during 1988[1] in Seward to assess the age, length, and species compositions of the bottomfish sport harvests out of Seward. This effort will be expanded to other ports in 1991. These data will be used to assess stock structure and sustainable yields of various local stocks of bottomfish species.

The objective of this report is to summarize the age, length, and species composition data collected during, and before, 1990 in Seward.

METHODS

Sample Collection

Halibut, lingcod, and rockfish were sampled from the sport creel of boat anglers returning to Seward, Alaska. Fish were collected from charter, military, and private anglers returning to the Seward small boat harbor between June and September. No attempt was made to sample fish either randomly or systematically; rather to optimize the collection of samples. All fish were measured for total length. The sagittal otoliths were removed from

[1] Sampling of lingcod from the sport fishery was initiated in 1987.

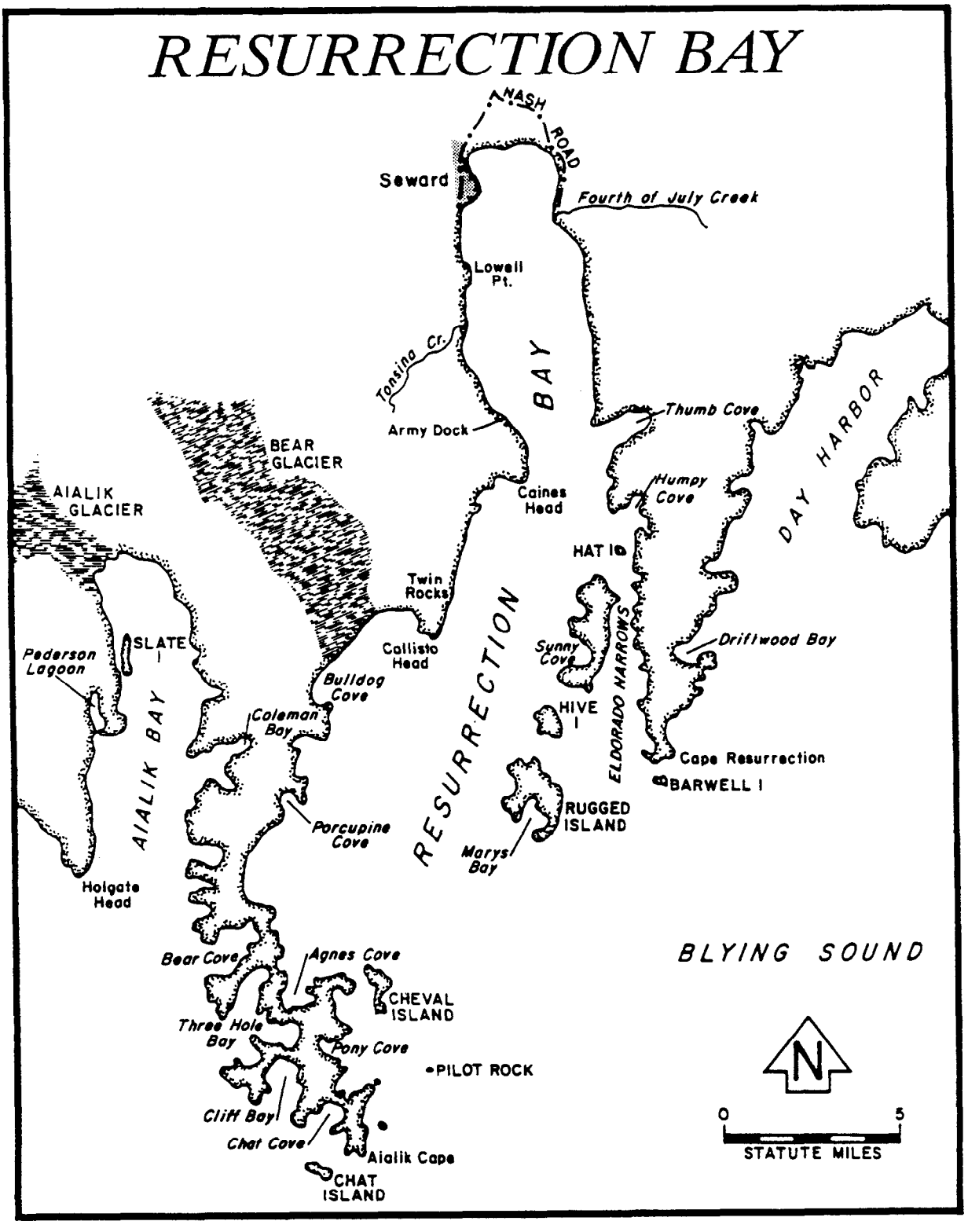


Figure 1. Map of Resurrection Bay, Alaska.

Table 1. Harvests of halibut, rockfish, and lingcod by sport anglers returning to Resurrection Bay, Alaska, 1977-1989.

Year	Halibut[a]	Rockfish[a]	Lingcod
1977	1,674	12,783	
1978	2,642	17,438	
1979	2,838	21,752	
1980	2,936	27,948	
1981	3,337	19,516	
1982	2,809	22,878	
1983	2,225	17,990	
1984	3,242	22,845	
1985	5,486	17,068	
1986	9,648	37,574	
1987	6,620	12,333	2,142[b]
1988	11,423	34,906	2,927[c]
1989	6,852	24,334	5,505[d]
Mean	4,741	22,259	3,028

[a] Source Mills 1977-1990.

[b] Source Vincent-Lang et al. 1988.

[c] Source Carlon and Vincent-Lang 1989.

[d] Source Carlon and Vincent-Lang 1990.

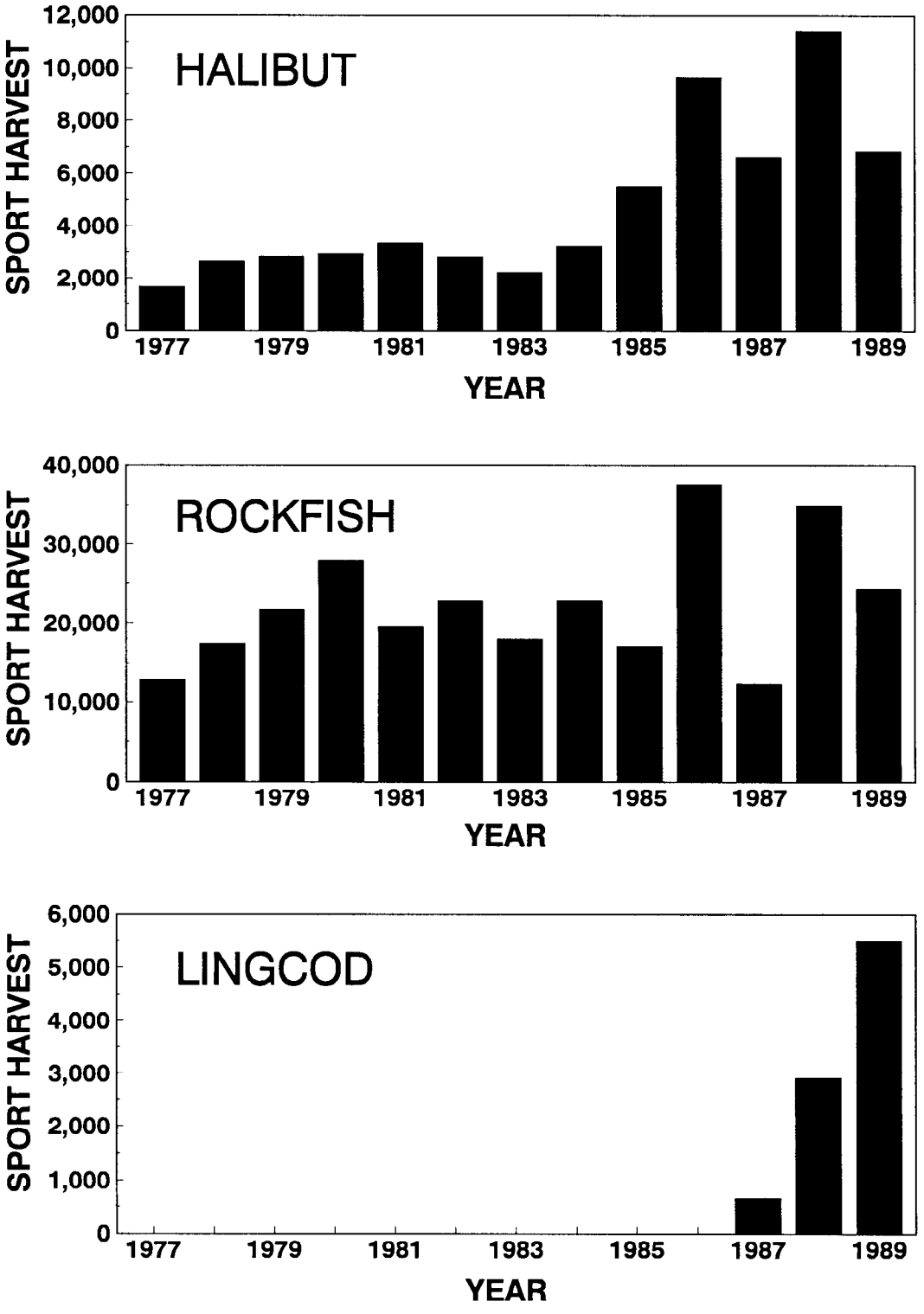


Figure 2. Harvests of halibut, rockfish, and lingcod by sport anglers returning to Seward, Alaska, 1977-1989.

all sampled halibut and rockfish and stored in dry coin envelopes. The fourth through eighth finrays of the posterior dorsal fin were removed from sampled lingcod and stored in dry coin envelopes. All coin envelopes were labeled with location, species, date, and length. Rockfish were speciated using several commercially available keys (Hart 1973, Eschemeyer et al. 1983, Kramer and O'Connell 1988).

Age Determination

Otoliths from adult halibut and rockfish were aged using the break and burn procedure described by Chilton and Beamish (1982) and the Pacific coast groundfish aging technicians (1984). Otoliths from juvenile halibut and rockfish were prepared for examination following the methods outlined by Boehlert and Yoklavich (1987). Finrays from lingcod were aged following the procedures described by Chilton and Beamish (1982). Otoliths and finrays were viewed under transmitted light with a compound microscope at 400X magnification.

Age, Length, and Species Statistics

Age composition and mean length-at-age were calculated for each species and year. Letting p_{hi} equal the estimated proportion of age group h in stratum i, the variance of p_{hi} was estimated using the normal approximation to the binomial (Scheaffer et al. 1979):

$$\hat{V}(p_{hi}) = \hat{p}_{hi}(1-\hat{p}_{hi})/(n_{Ti}-1) \quad , \qquad (1)$$

where n_{Ti} is the total number of fish sampled during stratum i.

Species compositions of rockfish were compared for significant differences between months within years using chi-square tests conducted at an alpha level of 0.05.

Survival Rates

Annual survival rates of lingcod, halibut, and rockfish were estimated using catch curve analyses (Robson and Chapman 1961, Archibald et al. 1981). The instantaneous mortality rate (Z) was estimated as the negative slope of a regression of the natural log of the estimated age proportions for the fully recruited ages. Annual survival rates (S) were calculated as $S = e^{-Z}$. Ages used in the regression ranged from the first fully recruited age to the age at which the age distribution flattened out and the estimated proportion was small. This was a subjective decision based on each data set. Assumptions of a catch curve analyses are that mortality does not vary by age and recruitment is constant (Robson and Chapman 1961). In most cases, however, age distributions indicated that either year class strength was highly variable or mortality varied by year or age class. Thus, the estimated annual survival rates in this study only serve as rough long-term approximations of their true values. The large number of age classes in most of the analyses, however, negate the effects of strong year classes on the long term estimate.

RESULTS

Rockfish

During 1989 and 1990, 2,076 rockfish were sampled from the sport harvest returning to Seward. Within this sample, 15 species of rockfish were identified (Table 2). Black rockfish comprised a majority of the harvest during both years with yelloweye rockfish comprising the second largest component of the harvest (Tables 3 and 4). During both 1989 and 1990, there were significant differences ($P < 0.05$) in the composition of the sampled harvests between months. In both years, more yelloweye rockfish were harvested early in the season than predicted.

Sufficient data were only collected to calculate age composition and mean length-at-age statistics for black and yelloweye rockfish. Sampled black rockfish ranged in age from 3 through 52, with the predominant age classes being 5 through 13 (Figure 3, Appendix A1 and A2). Age composition of black rockfish shifted from predominantly younger fish with a modal age of 10 in 1989 to predominantly older fish with a modal age of 12 in 1990. Sampled yelloweye rockfish ranged in age from 8 through 87, with the predominant age classes being 20 through 25 (Figure 4, Appendix A3 and A4). Mean length-at-age generally increased with age for both species; however, the relationship broke down at the older age classes due to small sample sizes (Figures 5 and 6, Appendix A5 and A6).

Annual survival rates for black rockfish ranged from 0.57 to 0.78, averaging 0.68 (Table 5). Annual survival rates for yelloweye rockfish were higher than those estimated for black rockfish, ranging from 0.89 to 0.93, averaging 0.91 (Table 5).

Halibut

During 1989 and 1990, 603 halibut were sampled from the sport harvest returning to Seward. Sampled halibut ranged in age from 2 through 22, with the predominant age classes being 6 through 10 (Figure 7, Appendix A7 and A8). Mean length-at-age generally increased with age; however, the relationship broke down at the older age classes due to small sample sizes (Figure 8, Appendix A9). Annual survival rates for halibut ranged from 0.62 to 0.67, averaging 0.65 (Table 3).

Lingcod

From 1987 through 1990, 991 lingcod were sampled from the sport harvest returning to Seward. Sampled lingcod ranged in age from 3 through 21, with the predominant age classes being 5 through 11 (Figure 9, Appendix A10 through A13). The 1981 cohort was the predominant age class each year. Mean length-at-age generally increased with age; however, the relationship broke down at the older age classes due to small sample sizes (Figure 10, Appendix A14). Annual survival rates for lingcod ranged from 0.53 to 0.77, averaging 0.65 (Table 5).

Table 2. Species of rockfish[a] harvested by sport anglers returning to Resurrection Bay, Alaska, 1989-1990.

Common Name	Scientific Name
Black rockfish	*Sebastes melanops*
Bocaccio	*Sebastes paucispinis*
Canary rockfish	*Sebastes pinniger*
China rockfish	*Sebastes nebulosus*
Copper rockfish	*Sebastes caurinus*
Dusky rockfish	*Sebastes ciliatus*
Pacific ocean perch	*Sebastes alutus*
Quillback rockfish	*Sebastes maliger*
Redstripe rockfish	*Sebastes proriger*
Rougheye rockfish	*Sebastes aleutianus*
Silvergray rockfish	*Sebastes brevispinis*
Tiger rockfish	*Sebastes nigrocinctus*
Vermilion rockfish	*Sebastes miniatus*
Yelloweye rockfish	*Sebastes ruberrimus*
Yellowtail rockfish	*Sebastes flavidus*

[a] Source Kramer and O'Connell 1988.

Table 3. Species composition of rockfish harvested by sport anglers returning to Seward, Alaska, during 1989.

Species	Total	Month			
		June	July	August	September
Number:					
Black	612	73	262	114	163
Yelloweye	179	52	85	31	11
Quillback	16	3	3	6	4
Bocaccio	13	0	3	9	1
China	7	1	3	1	2
Silvergrey	5	2	2	1	0
Copper	2	0	2	0	0
Perch	1	0	0	0	1
Tiger	1	0	1	0	0
Vermillion	1	1	0	0	0
Unspecified	36	0	25	7	4
All Species	873	132	386	169	186
Percent:					
Black	70.1	55.3	67.9	67.5	87.6
Yelloweye	20.5	39.4	22.0	18.3	5.9
Quillback	1.8	2.3	0.8	3.6	2.2
Bocaccio	1.5	0.0	0.8	5.3	0.5
China	0.8	0.8	0.8	0.6	1.1
Silvergrey	0.6	1.5	0.5	0.6	0.0
Copper	0.2	0.0	0.5	0.0	0.0
Perch	0.1	0.0	0.0	0.0	0.5
Tiger	0.1	0.0	0.3	0.0	0.0
Vermillion	0.1	0.8	0.0	0.0	0.0
Unspecified	4.1	0.0	6.5	4.1	2.2
All Species	100.0	100.0	100.0	100.0	100.0

Table 4. Species composition of rockfish harvested by sport anglers returning to Seward, Alaska, during 1990.

Species	Total	Month			
		June	July	August	September
Number:					
Bocaccio	9	7	2	0	0
Copper	7	0	1	5	1
Black	691	269	222	167	33
Yelloweye	398	197	108	77	16
Canary	9	1	2	6	0
Quillback	30	11	10	9	0
Tiger	9	1	5	3	0
China	33	8	11	13	1
Rougheye	2	0	2	0	0
Dusky	37	13	17	4	3
Yellowtail	2	0	0	1	1
Silvergrey	26	0	22	4	0
Redstripe	4	3	0	1	0
Unspecified	2	1	1	0	0
All Species	1,259	511	403	290	55
Percent:					
Bocaccio	0.7	1.4	0.5	0.0	0.0
Copper	0.6	0.0	0.2	1.7	1.8
Black	54.9	52.6	55.1	57.6	60.0
Yelloweye	31.6	38.6	26.8	26.6	29.1
Canary	0.7	0.2	0.5	2.1	0.0
Quillback	2.4	2.2	2.5	3.1	0.0
Tiger	0.7	0.2	1.2	1.0	0.0
China	2.6	1.6	2.7	4.5	1.8
Rougheye	0.2	0.0	0.5	0.0	0.0
Dusky	2.9	2.5	4.2	1.4	5.5
Yellowtail	0.2	0.0	0.0	0.3	1.8
Silvergray	2.1	0.0	5.5	1.4	0.0
Redstripe	0.3	0.6	0.0	0.3	0.0
Unspecified	0.2	0.2	0.2	0.0	0.0
All Species	100.0	100.0	100.0	100.0	100.0

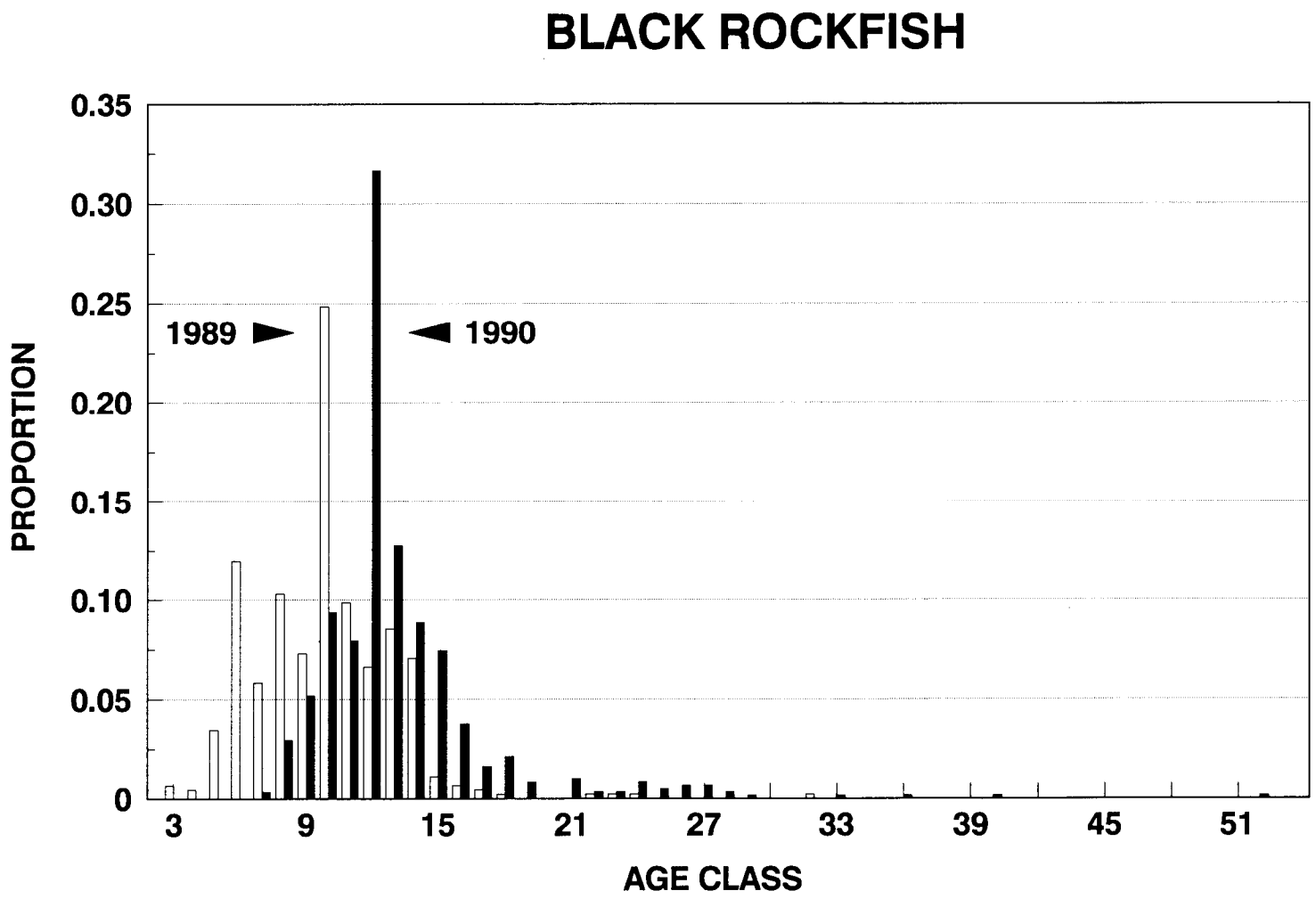


Figure 3. Age composition of black rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

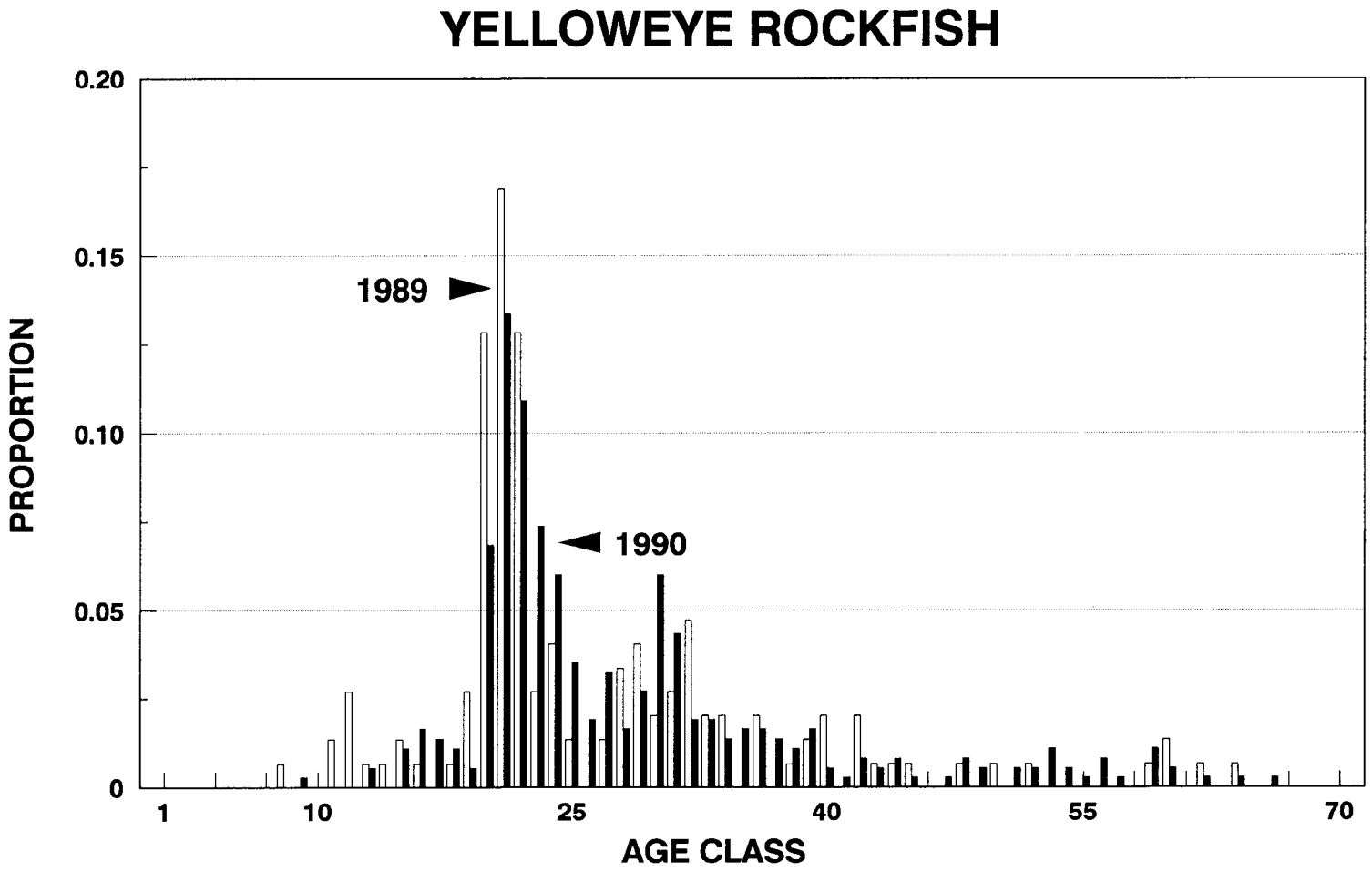


Figure 4. Age composition of yelloweye rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

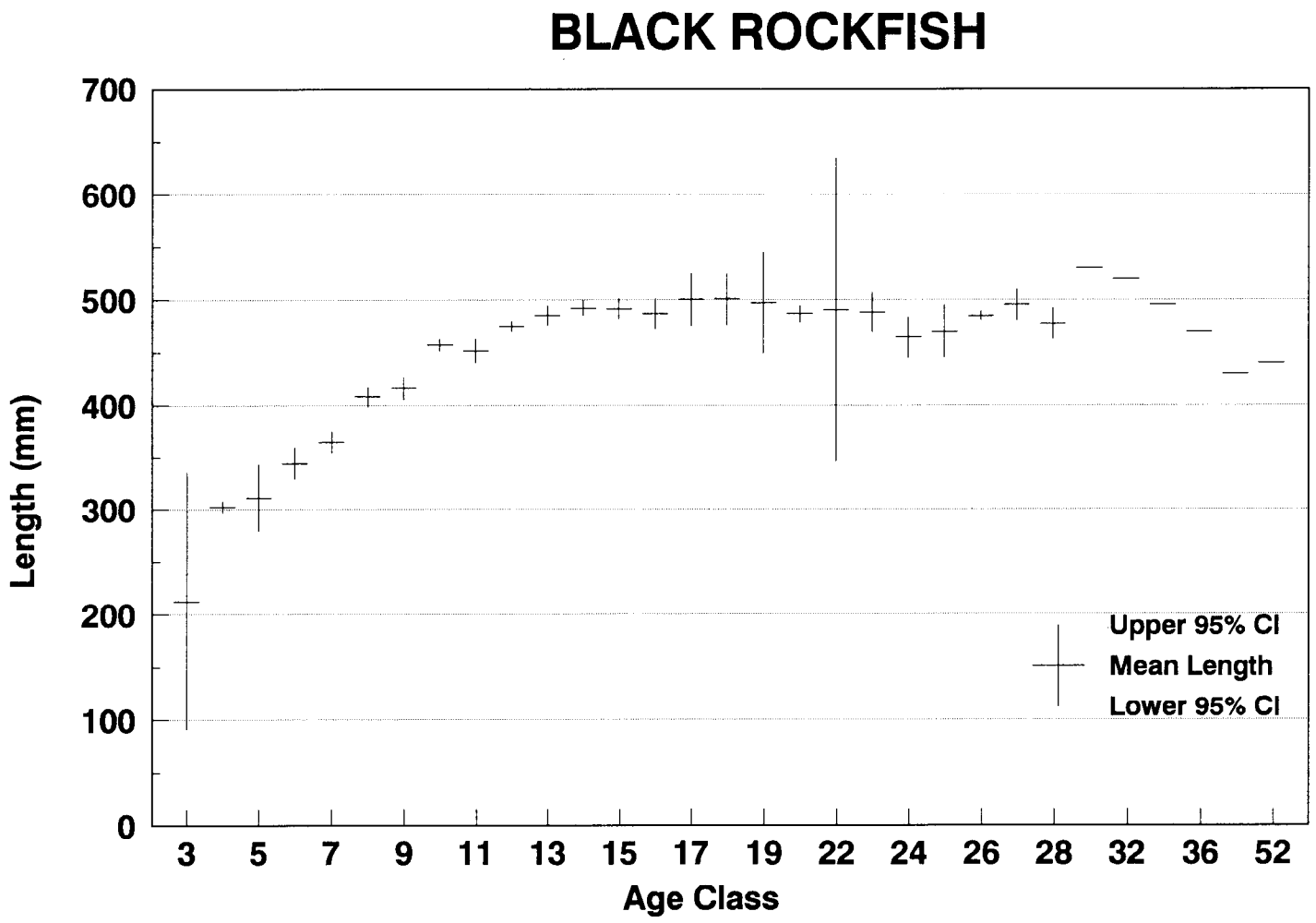


Figure 5. Mean length-at-age of black rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

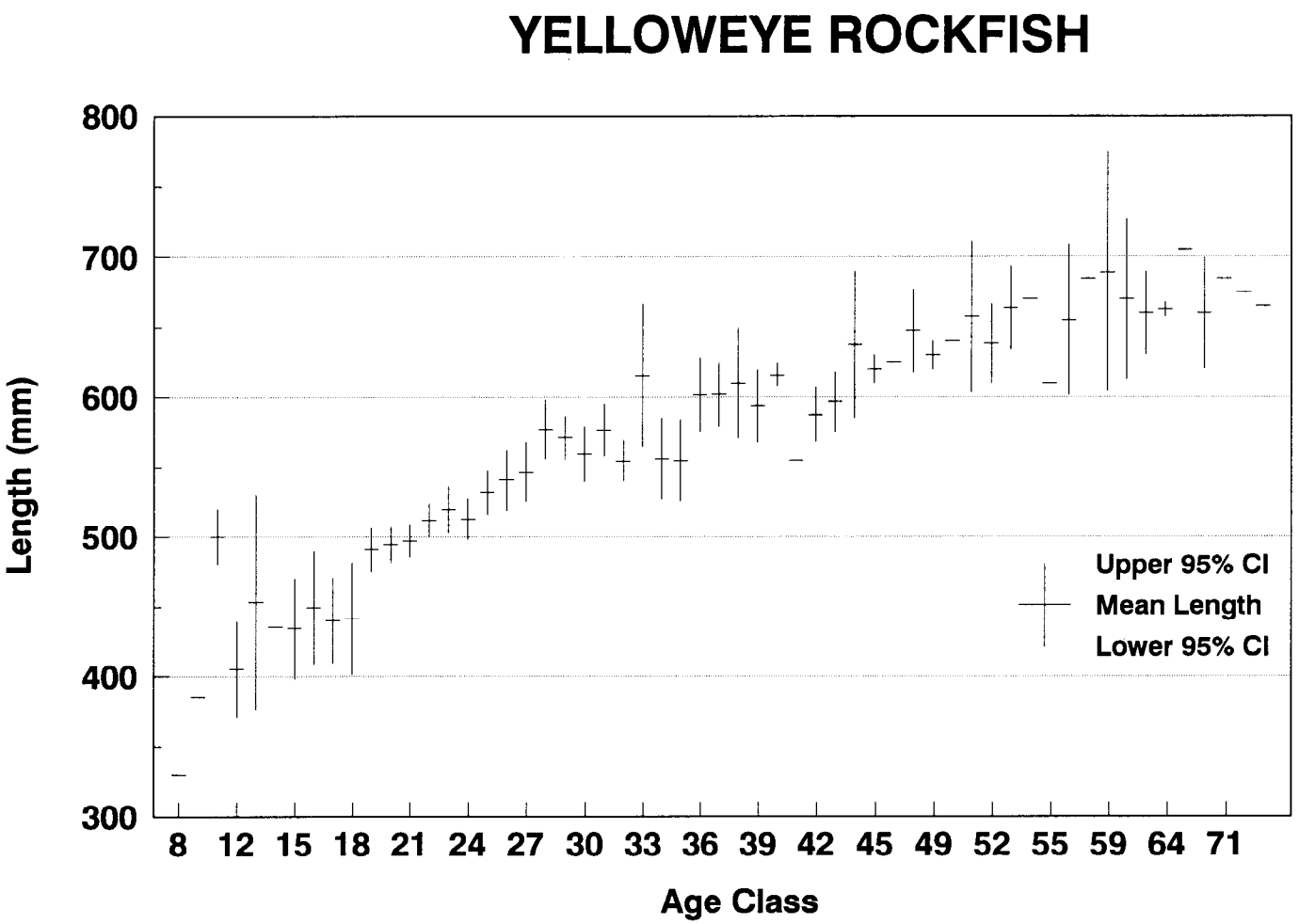


Figure 6. Mean length-at-age of yelloweye rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

Table 5. Estimated annual survival rates for black rockfish, yelloweye rockfish, lingcod, and halibut.

Species	Dataset	Year	Z	S	Ages Used
Black Rockfish	Seward Area Sport	1990	0.25	0.78	12-28
	Seward Area Sport	1989	0.57	0.57	10-17
	Gulf of Alaska Commercial[a]	1984	0.68	0.51	8-12
	Gulf of Alaska Commercial[a]	1981	0.13	0.87	18-33
	Gulf of Alaska Commercial[a]	1980	0.18	0.83	17-34
Yelloweye Rockfish	Seward Area Sport	1990	0.12	0.89	21-40
	Seward Area Sport	1989	0.07	0.93	21-42
Lingcod	Seward Area Sport	1990	0.64	0.53	9-14
	Seward Area Sport	1989	0.43	0.65	8-17
	Seward Area Sport	1987	0.26	0.77	6-15
Halibut	Seward Area Sport	1990	0.47	0.62	8-17
	Seward Area Sport	1989	0.41	0.67	10-17

[a] Source Bechtol (*Unpublished*)

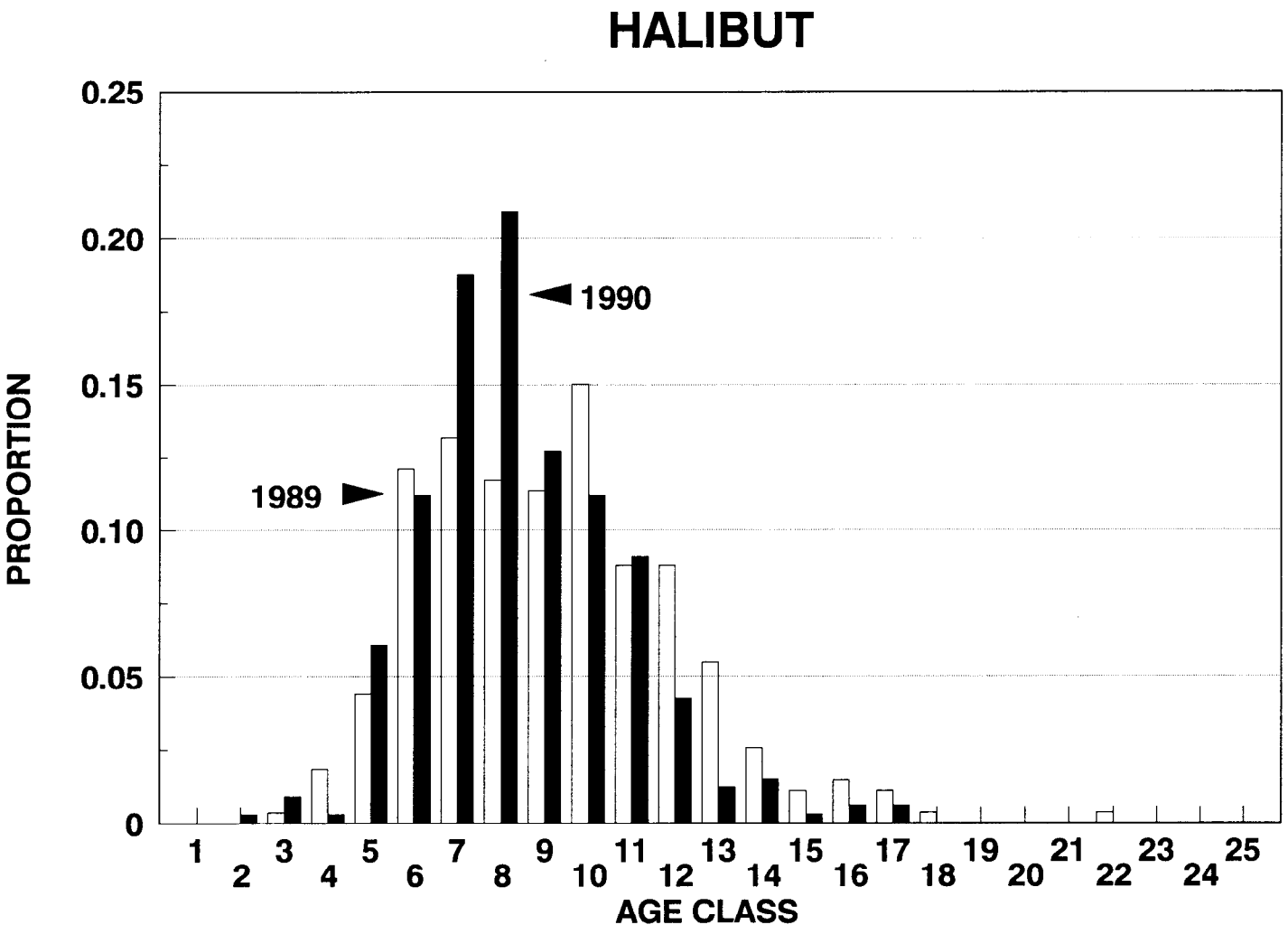


Figure 7. Age composition of halibut sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

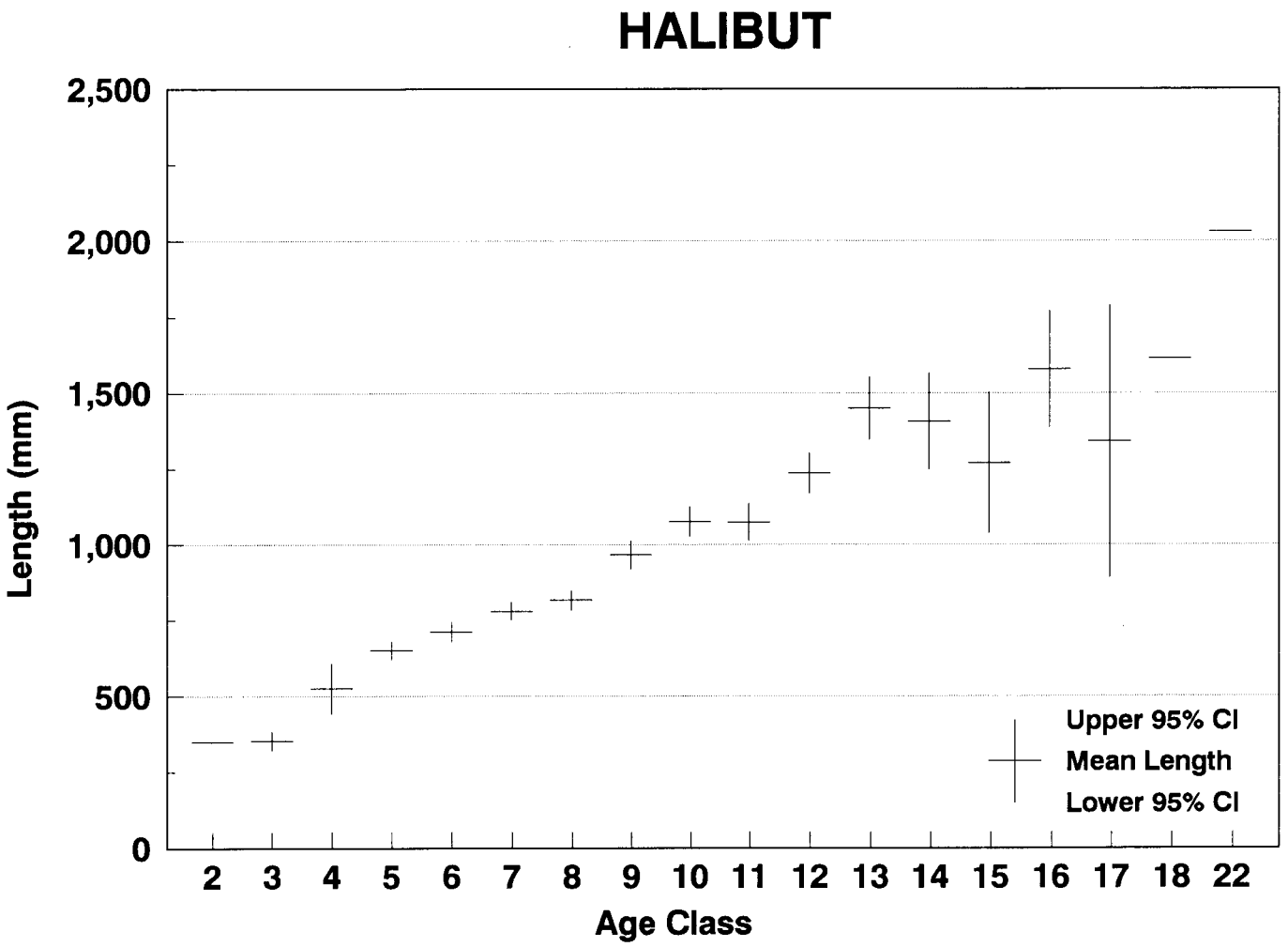


Figure 8. Mean length-at-age of halibut sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

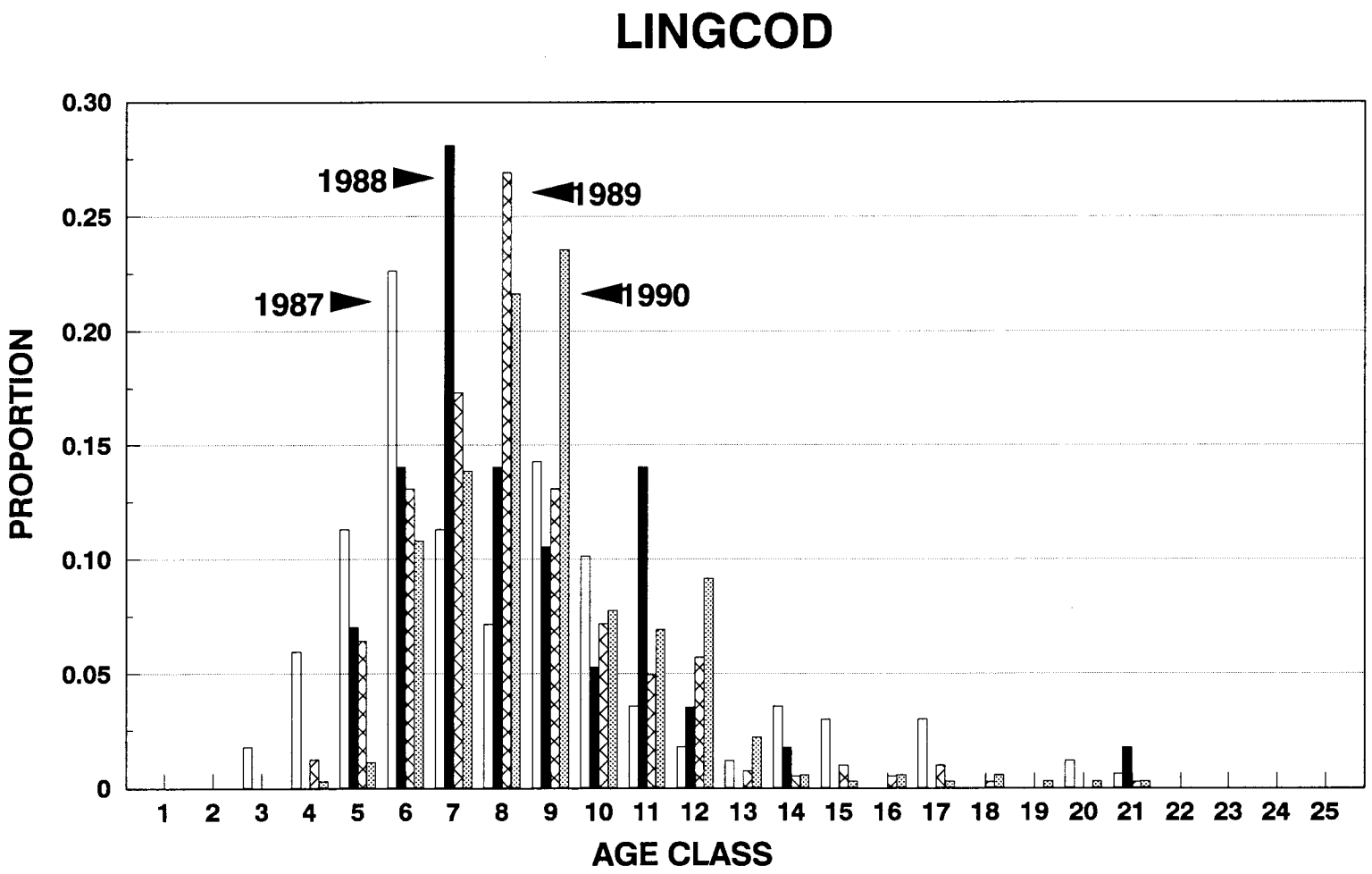


Figure 9. Age composition of lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1987-1990.

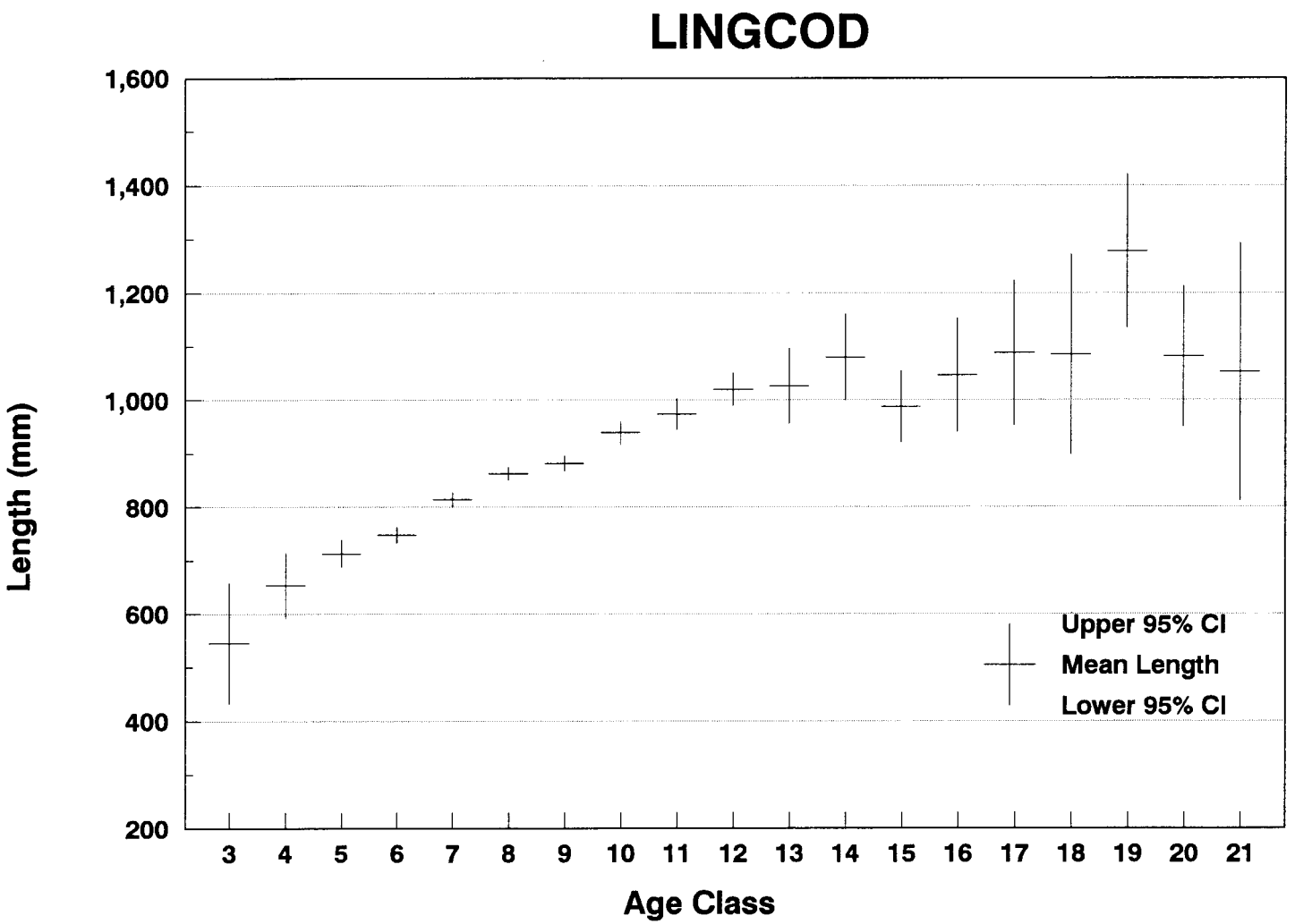


Figure 10. Mean length-at-age of lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1987-1990.

DISCUSSION

Rockfish

The age composition statistics for the Seward area black rockfish sport harvest during both 1989 and 1990 approximate those for the commercial Gulf of Alaska harvest (Bechtol *Unpublished*) during 1984 (Figure 11). The 1989 and 1990 sport data and the 1984 commercial data, however, differ from the commercial harvest for 1980 and 1981 in that during both 1980 and 1981 older rockfish were harvested in the commercial fishery than were harvested in either the commercial fishery during 1984 or in the sport fishery during 1989 and 1990. There are several possible explanations for this observed decrease. First is that the sport fishery harvests younger rockfish. The 1984 commercial harvest data, however, do not support this explanation. Second is that the older fish have been harvested in the various fisheries and are no longer available. This explanation is partially supported in that the older age classes were present in the 1984, 1989, and 1990 harvests, but in proportionally low numbers. If this decrease in older rockfish presence is not an artifact of sampling and is due to over-harvest of old rockfish, it is a trend which needs to be monitored in that it is a first sign of stress on the black rockfish population.

In contrast, the age compositions for the Seward area yelloweye rockfish sport harvest during both 1989 and 1990 approximate those for the commercial Gulf of Alaska harvest during 1980, 1981, and 1984 (Figure 11). A minor difference is that older age classes make up a higher proportion of the age composition in the commercial harvest than they do in the sport harvest. These data point to a generally healthy population.

The mean length-at-age statistics for both black and yelloweye rockfish Seward area sport harvest closely approximate those for the Gulf of Alaska commercial harvest (Bechtol *Unpublished*) (Figure 12). For black rockfish, these data indicate that very little growth occurs after age 13. In contrast, yelloweye rockfish appear to continue to grow with age over their life span.

The estimated annual survival rates for the black rockfish calculated from the Seward area sport harvest closely approximate those estimated based on the commercial harvest data (Table 3). The mean annual survival rate estimated from the sport harvest data was 0.68 and was similar to the value (0.74) from the commercial harvest data. These data approximate those reported in the literature (Archibald et al. 1981) for rockfish with a life span less than 50 years (0.75-0.90). In combination, these data indicate that recruitment is only about 30% annually under steady state conditions. Thus, under ideal conditions, only 30% of the population can be removed annually if the population can sustain itself. As was explained above, however, there are signs that the population may be under stress and thus must be watched closely. Unfortunately, insufficient numbers of yelloweye rockfish were aged from the Gulf of Alaska commercial harvest to perform a catch curve analyses. Reported survival rates (Archibald et al. 1981) for rockfish with long life spans (greater than 50 years), such as yelloweye rockfish, indicate similar high survival rates (0.94-0.97) as estimated in this study.

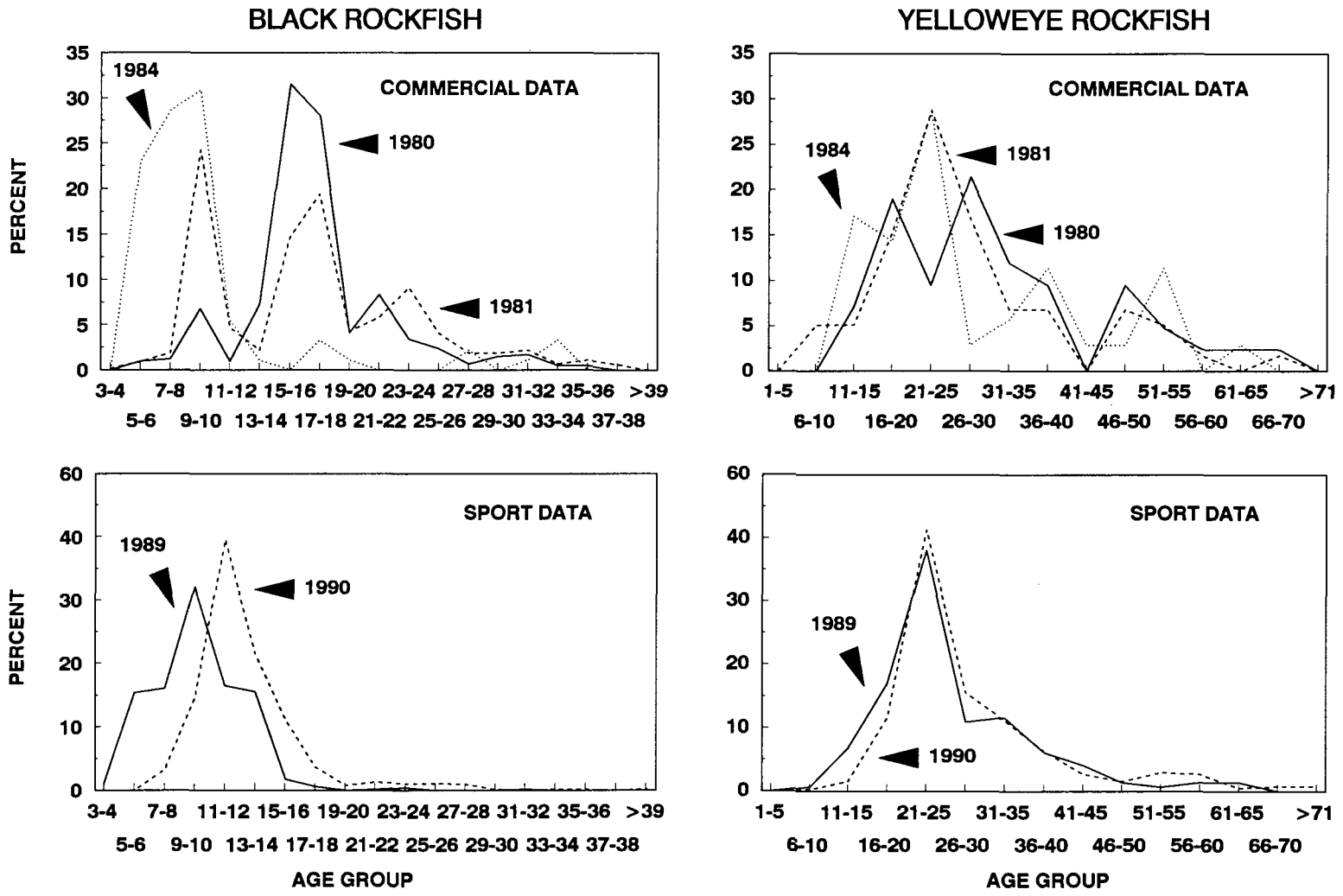
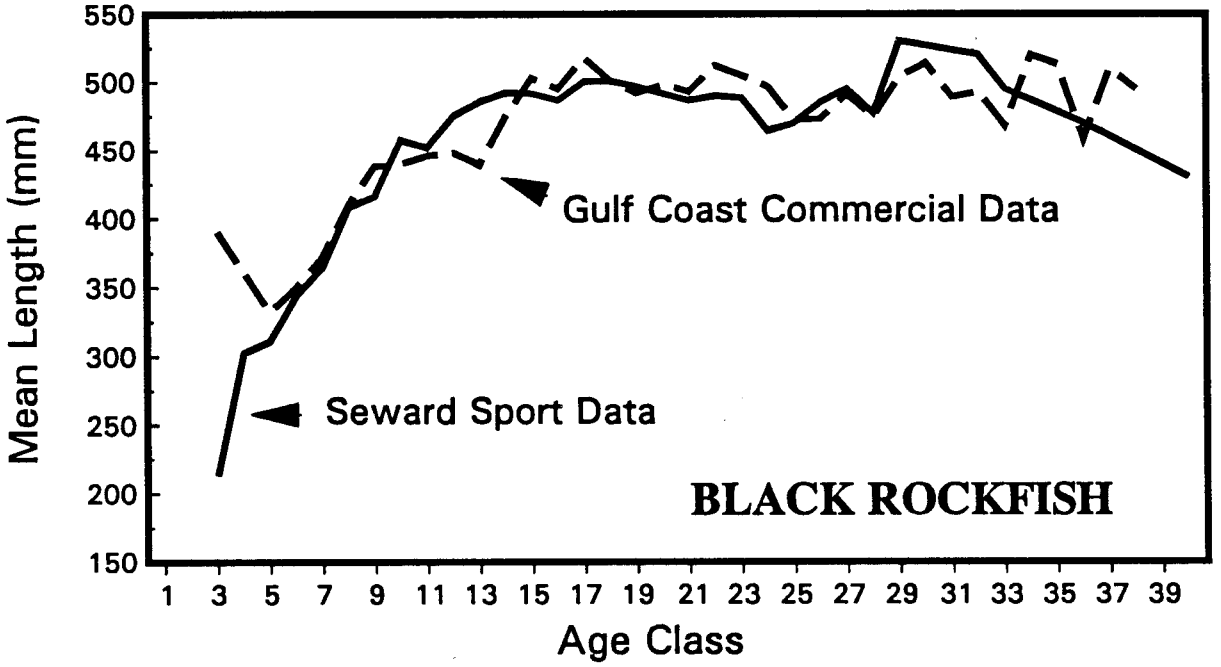


Figure 11. Comparison of age compositions of black and yelloweye rockfish harvested in the Seward area sport fishery and the Gulf of Alaska commercial test-fishery.



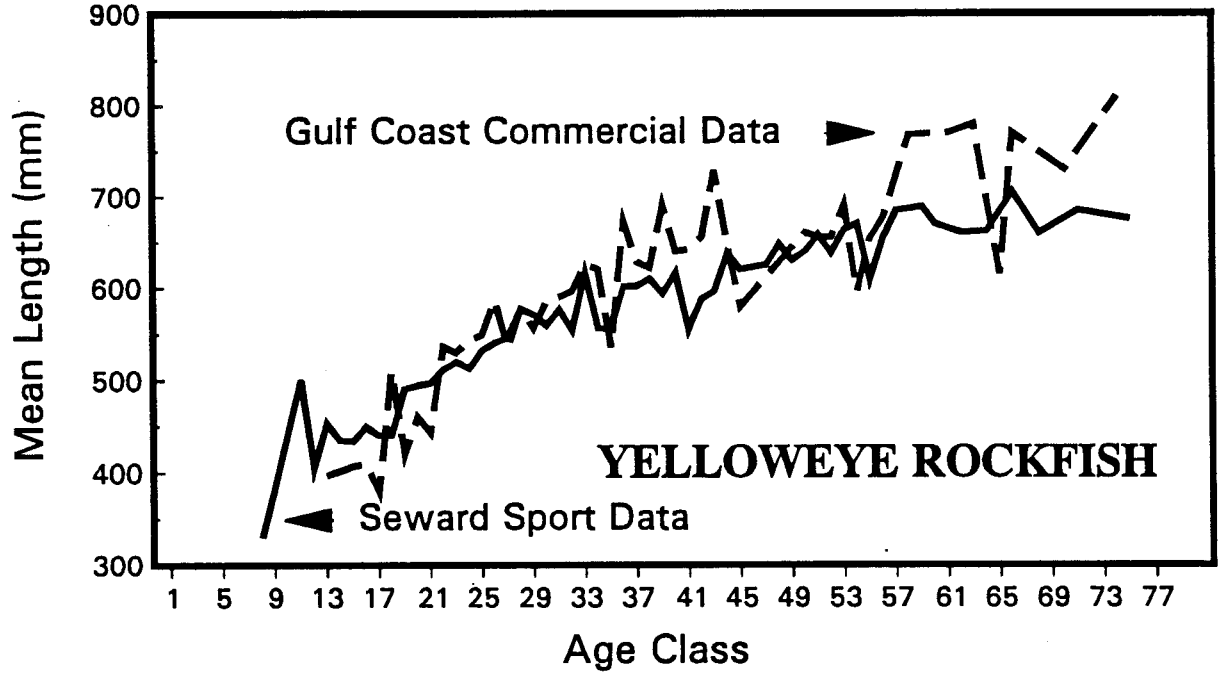


Figure 12. Comparison of mean length-at-age statistics of black and yelloweye rockfish harvested in the Seward area sport fishery and the Gulf of Alaska commercial test-fishery.

Halibut

The age composition of halibut harvested in the Seward area sport fishery was younger than that harvested in the Gulf of Alaska commercial fishery (Figure 13). The difference is likely the result of the 813 mm (32 in) minimum size restriction on the commercial fishery. Based on mean length-at-age statistics for the Seward area sport harvest (Figure 8, Appendix A9), an 813 mm halibut is about 8 years old. This is the age below which few halibut are harvested in the commercial fishery. In contrast, most of the sport harvest is supported by halibut age 8 or less.

Mean length-at-age for halibut ages 5 to 11 showed close agreement between commercial and sport samples (Figure 14). There was a tendency for greater mean length-at-age for older sport-caught halibut; however, this may be due to small sample sizes of larger halibut from the sport fishery.

Lingcod

The age composition statistics for the Seward area lingcod sport harvest show that a single brood year has supported the sport harvest from 1986 through 1990 (Figure 9). This situation closely resembles a case history of lingcod in Puget Sound, Washington (Bargmann 1985). During the late 1970s and early 1980s, the Washington Department of Fisheries (WDF) noticed that the mean length of lingcod harvested in the various target fisheries increased annually. By the mid-1980s, however, the average size in the harvest decreased significantly. Corresponding with this decrease in mean length was a significant drop in the numbers of harvested lingcod in the target fisheries. These conditions led to a total closure of the lingcod fisheries in Puget Sound.

Based on data collected since the closure, WDF biologists now believe that a single age class supported the target fisheries and that little recruitment occurred in the population during the peak of the fishery. Based on research conducted on the life history of lingcod (Bargmann 1985), it appears that successful lingcod spawning only occurs once every 6 or 7 years. This, coupled with estimated annual survival rates of about 0.60-0.70 (Table 5), indicate that lingcod are extremely vulnerable to overharvest. The lingcod fishery in Puget Sound was reopened recently with conservative bag limits (1 or 2, depending upon the area). To guarantee that sufficient numbers of sexually mature lingcod are always present in the population to reproduce when the conditions are right, a minimum size limit was enacted for the fishery. This minimum size limit (560 mm, 22 in) was set to assure that male and female lingcod could spawn at least once prior to being subject to harvest[2].

These same conditions appear to be occurring around Seward. The age composition statistics for the Seward area lingcod sport harvest show that a single brood year has supported the sport harvest from 1986 through 1990 (Figure 9). Also, little recruitment is evident into the population (Figure 9). If unchecked, these conditions could result in a total crash of the lingcod population. To guarantee against such a crash, it may be wise to

[2] Hook and release mortality of lingcod has been assumed to be small.

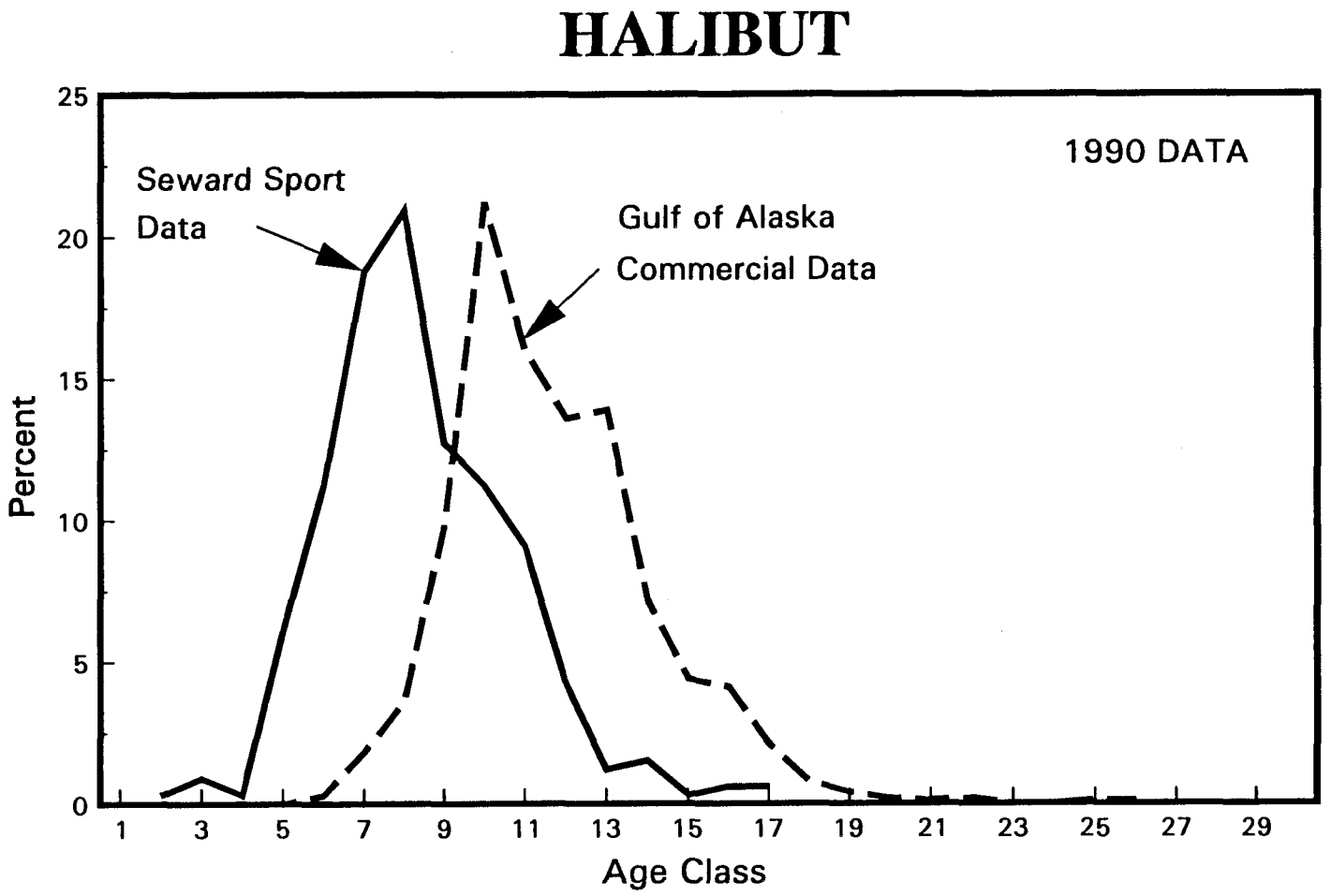


Figure 13. Comparison of age compositions of halibut harvested in the Seward area sport fishery and the Gulf of Alaska commercial test-fishery.

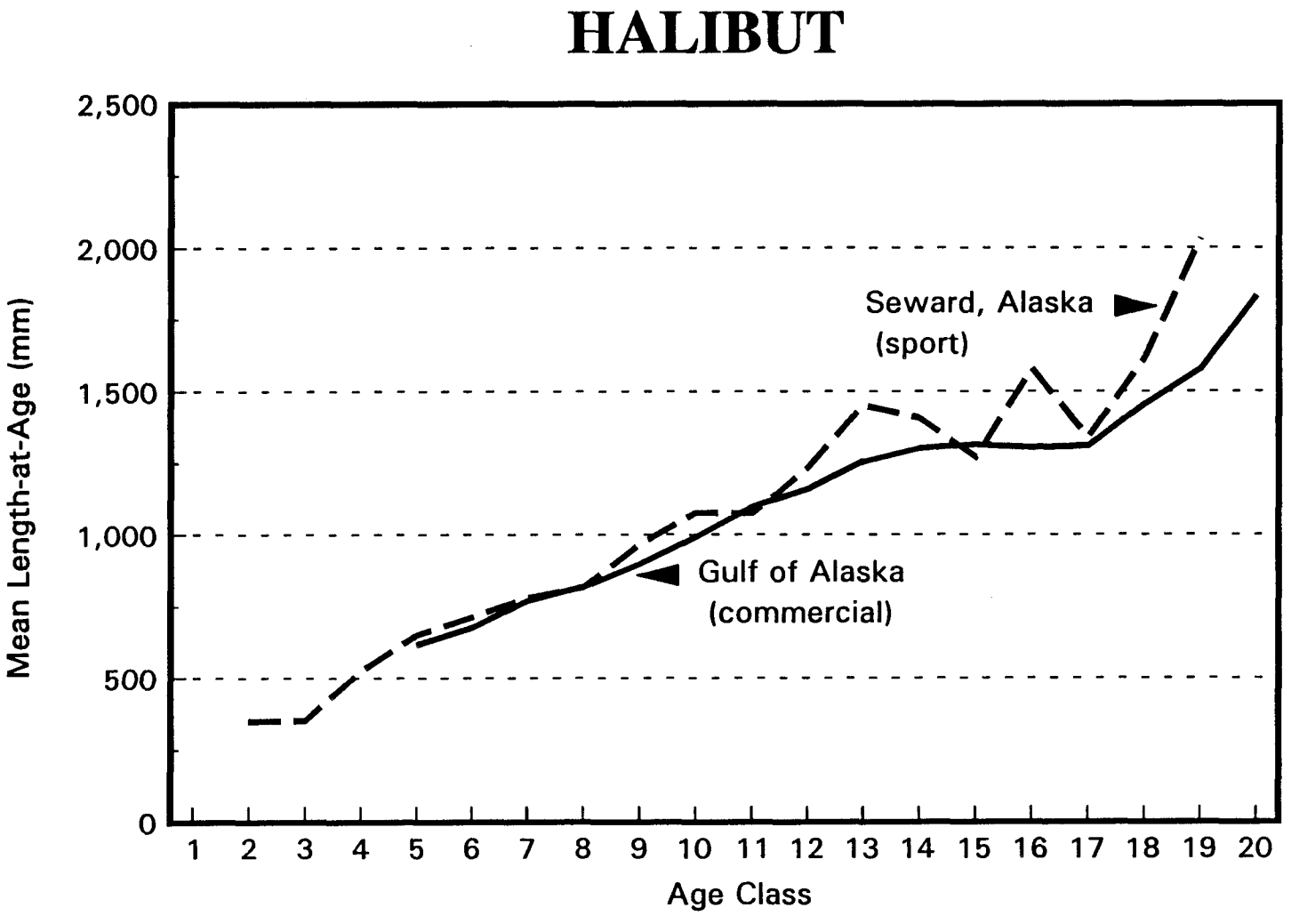


Figure 14. Comparison of mean length-at-age statistics of halibut harvested in the Seward area sport fishery and the Gulf of Alaska commercial test-fishery.

implement a minimum size limit on the fishery. A similar length as that used in Puget Sound could be applied to the Seward area fishery as there appears to be little difference in mean length-at-age statistics between the two locations (Figure 15). This would assure that sexually mature adults would be available in the population to reproduce when environmental conditions are right.

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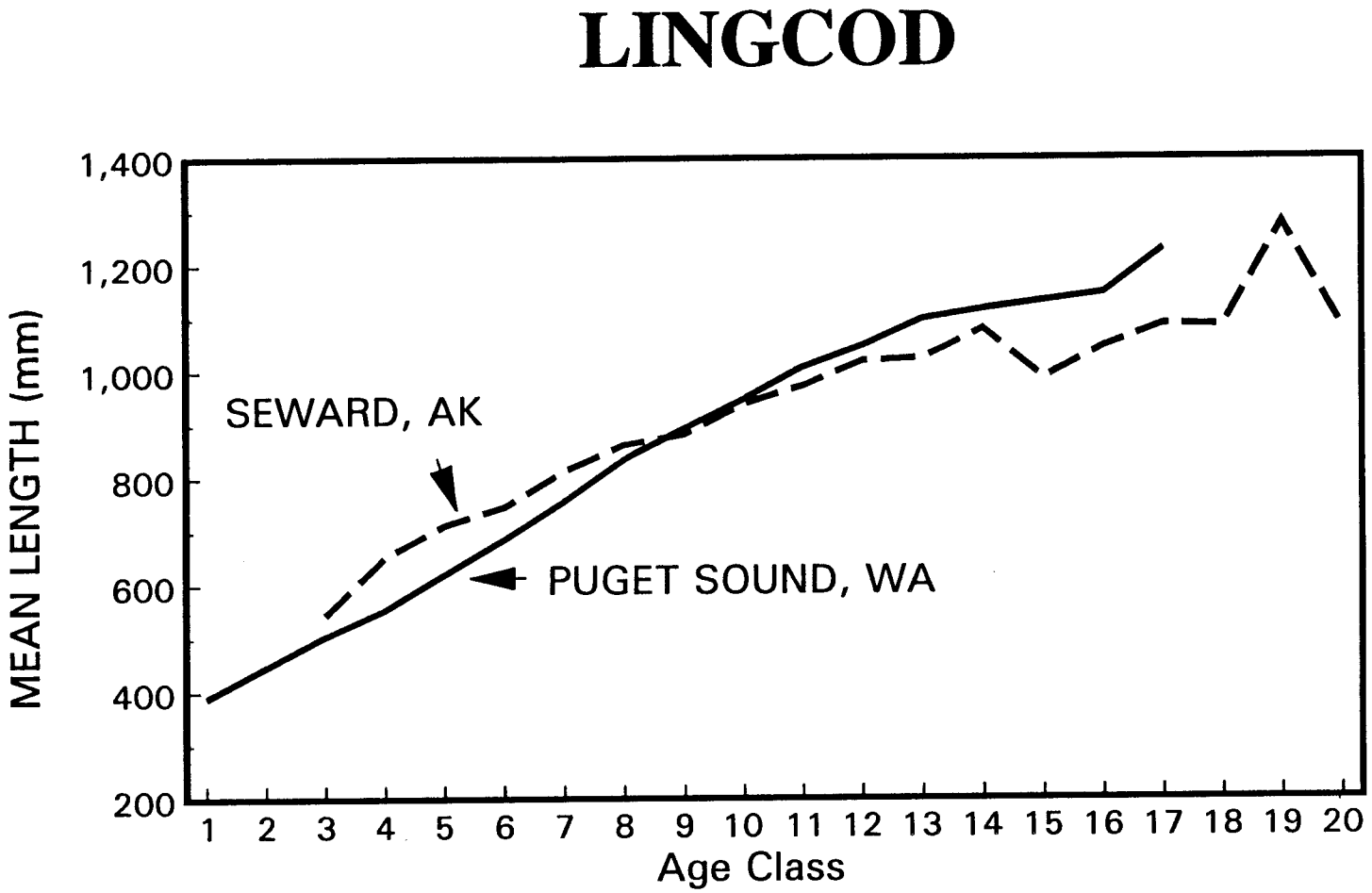

Figure 15. Comparison of mean length-at-age statistics of lingcod harvested in the Seward area sport fishery and Puget Sound commercial and sport fisheries.

LITERATURE CITED

Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfishes (*Scorpaenidae*) from B. C. coastal waters, 1977-1979. Canadian Tech. Report of Fisheries and Aquatic Sciences, No. 1048.

Bargmann, G. 1985. Management studies on lingcod in Puget Sound, Washington 1982 to 1984. State of Washington, Department of Fisheries Progress Report No. 234.

Bechtol, B. *Unpublished*. Commercial test fish data. Located at: Alaska Department of Fish and Game, Division of Commercial Fisheries, 3298 Douglas St., Homer, Alaska 99603. (907) 235-8191.

Boehlert, G. W. and M. M. Yoklavich. 1987. Daily growth increments in otoliths of juvenile black rockfish, *Sebastes melanops*: An evaluation of autoradiography as a new method of validation. Fishery Bulletin: 85(4):826-832.

Carlon, J. A. and D. Vincent-Lang. 1989. Sport effort for and harvest of coho salmon, halibut, rockfish, and lingcod in Resurrection Bay sport fisheries, Alaska, during 1988. Alaska Department of Fish and Game, Fishery Data Series No. 83. Juneau.

_____. 1990. Sport effort for and harvest of coho salmon, halibut, rockfish, and lingcod in Resurrection Bay sport fisheries, Alaska, during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-6. Anchorage.

Chilton, D. E. and R. J. Beamish. 1982. Age determination methods for fishes studied by the groundfish program at the Pacific Biological Station. Canadian Special Publication of Fisheries and Aquatic Sciences 60. Ottawa, Canada.

Eschemeyer, W. N., E. S. Herald, and H. Hammann. 1983. A field guide to Pacific Coast fishes of North America. The Peterson Field Guide Series. Houghton Mifflin Company. Boston.

Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada. Bulletin 180.

Kramer, D. E. and V. M. O'Connell. 1988. Guide to northeast Pacific rockfishes. Marine Advisory Bulletin 25. University of Alaska.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-I-A). Juneau.

_____. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-I-A). Juneau.

_____. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A). Juneau.

_____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A). Juneau.

_____. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-I-A). Juneau.

_____. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-I-A). Juneau.

_____. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-I-A). Juneau.

_____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-I-A). Juneau.

_____. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2). Juneau.

_____. 1987. Alaska statewide sport fisheries harvest report 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2. Juneau.

_____. 1988. Alaska statewide sport fisheries harvest report 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52. Juneau.

_____. 1989. Alaska statewide sport fisheries harvest report 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122. Juneau.

_____. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44. Anchorage.

Pacific Coast Groundfish Aging Technicians. 1984. Manual on generalized age determination procedures for rockfish. Prepared for the Canada-U.S. Groundfish Committee. Sponsored by the Pacific Marine Fisheries Commission.

Robson, D. S. and D. G. Chapman. 1961. Catch curve and mortality rates. Trans. Amer. Fish. Soc. 90:181-189.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1979. Elementary survey sampling. Duxbury Press, North Scituate, Massachusetts.

Vincent-Lang, D. S., R. H. Conrad, and E. T. McHenry. 1988. Sport harvests of coho *Oncorhynchus kisutch* and chinook *O. tshawytscha* salmon in Resurrection Bay, Alaska, during 1987. Alaska Department of Fish and Game, Fishery Data Series No. 39. Juneau.

APPENDIX A

Age composition and mean length-at-age summaries.

Appendix A1. Age composition statistics for black rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989 (N = 467).

AGE	COUNT	PROPORTION	STANDARD ERROR
3	3	0.006	0.004
4	2	0.004	0.003
5	16	0.034	0.008
6	56	0.120	0.015
7	27	0.058	0.011
8	48	0.103	0.014
9	34	0.073	0.012
10	116	0.249	0.020
11	46	0.099	0.014
12	31	0.066	0.012
13	40	0.086	0.013
14	33	0.071	0.012
15	5	0.011	0.005
16	3	0.006	0.004
17	2	0.004	0.003
18	1	0.002	0.002
22	1	0.002	0.002
23	1	0.002	0.002
24	1	0.002	0.002
32	1	0.002	0.002

Appendix A2. Age composition statistics for black rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1990 (N = 661).

AGE	COUNT	PROPORTION	STANDARD ERROR
7	2	0.003	0.002
8	18	0.029	0.007
9	32	0.052	0.009
10	58	0.094	0.012
11	49	0.079	0.011
12	196	0.317	0.019
13	79	0.128	0.013
14	55	0.088	0.011
15	46	0.074	0.011
16	23	0.037	0.008
17	10	0.016	0.005
18	13	0.021	0.006
19	5	0.008	0.004
21	6	0.010	0.004
22	2	0.003	0.002
23	2	0.003	0.002
24	5	0.008	0.004
25	3	0.005	0.003
26	4	0.006	0.003
27	4	0.006	0.003
28	2	0.003	0.002
29	1	0.002	0.002
33	1	0.002	0.002
36	1	0.002	0.002
40	1	0.002	0.002
52	1	0.002	0.002

Appendix A3. Age composition statistics for yelloweye rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989 (N = 148).

AGE	COUNT	PROPORTION	STANDARD ERROR
8	1	0.007	0.007
11	2	0.014	0.010
12	4	0.027	0.013
13	1	0.007	0.007
14	1	0.007	0.007
15	2	0.014	0.010
16	1	0.007	0.007
18	1	0.007	0.007
19	4	0.027	0.013
20	19	0.128	0.028
21	25	0.169	0.031
22	19	0.128	0.028
23	4	0.027	0.013
24	6	0.041	0.016
25	2	0.014	0.010
27	2	0.014	0.010
28	5	0.034	0.015
29	6	0.041	0.016
30	3	0.020	0.012
31	4	0.027	0.013
32	7	0.047	0.018
33	3	0.020	0.012
34	3	0.020	0.012
36	3	0.020	0.012
38	1	0.007	0.007
39	2	0.014	0.010
40	3	0.020	0.012
42	3	0.020	0.012
43	1	0.007	0.007
44	1	0.007	0.007
45	1	0.007	0.007
48	1	0.007	0.007
50	1	0.007	0.007
52	1	0.007	0.007
59	1	0.007	0.007
60	2	0.014	0.010
62	1	0.007	0.007
64	1	0.007	0.007

Appendix A4. Age composition statistics for yelloweye rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1990 (N = 366).

AGE	COUNT	PROPORTION	STANDARD ERROR
9	1	0.003	0.003
13	2	0.005	0.004
15	4	0.011	0.005
16	6	0.016	0.007
17	5	0.014	0.006
18	4	0.011	0.005
19	2	0.005	0.004
20	25	0.068	0.013
21	49	0.134	0.018
22	40	0.109	0.016
23	27	0.074	0.014
24	22	0.060	0.012
25	13	0.036	0.010
26	7	0.019	0.007
27	12	0.033	0.009
28	6	0.016	0.007
29	10	0.027	0.009
30	22	0.060	0.012
31	16	0.044	0.011
32	7	0.019	0.007
33	7	0.019	0.007
34	5	0.014	0.006
35	6	0.016	0.007
36	6	0.016	0.007
37	5	0.014	0.006
38	4	0.011	0.005
39	6	0.016	0.007
40	2	0.005	0.004
41	1	0.003	0.003
42	3	0.008	0.003
43	2	0.005	0.004
44	3	0.008	0.005
45	1	0.003	0.003
47	1	0.003	0.003
48	3	0.008	0.005
49	2	0.005	0.004
51	2	0.005	0.004
52	2	0.005	0.004
53	4	0.011	0.005

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Appendix A4. (Page 2 of 2).

AGE	COUNT	PROPORTION	STANDARD ERROR
54	2	0.005	0.004
55	1	0.003	0.003
56	3	0.008	0.005
57	1	0.003	0.003
59	4	0.011	0.005
60	2	0.005	0.004
62	1	0.003	0.003
64	1	0.003	0.003
66	1	0.003	0.003
68	2	0.005	0.004
71	1	0.003	0.003
75	1	0.003	0.004
87	1	0.003	0.003

Appendix A5. Mean length-at-age statistics for black rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

AGE	MEAN LENGTH	SAMPLE SIZE	STANDARD ERROR
3	213	3	62
4	303	2	3
5	311	16	16
6	344	55	8
7	365	29	5
8	408	66	5
9	416	66	5
10	457	174	3
11	452	95	6
12	475	227	2
13	485	119	5
14	492	88	4
15	492	51	5
16	487	26	7
17	500	12	13
18	501	14	12
19	497	5	24
21	487	6	4
22	490	3	73
23	488	3	9
24	464	6	10
25	470	3	13
26	485	4	2
27	495	4	7
28	478	2	8
29	530	1	
32	520	1	
33	495	1	
36	470	1	
40	430	1	
52	440	1	

Appendix A6. Mean length-at-age statistics for yelloweye rockfish sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

AGE	MEAN LENGTH	SAMPLE SIZE	STANDARD ERROR
8	330	1	
9	385	1	
11	500	2	10
12	405	4	17
13	453	3	39
14	435	1	
15	434	6	18
16	449	7	21
17	440	5	16
18	441	5	20
19	491	6	8
20	494	44	6
21	497	74	6
22	512	59	6
23	520	31	8
24	513	28	7
25	532	15	8
26	541	7	11
27	546	14	11
28	577	11	11
29	571	16	8
30	559	25	10
31	577	20	9
32	554	14	7
33	616	10	26
34	556	8	15
35	555	6	15
36	602	9	13
37	602	5	12
38	610	5	20
39	594	8	13
40	616	5	4
41	555	1	
42	588	6	10
43	597	3	11
44	638	4	27
45	620	2	5
47	625	1	
48	648	4	15

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Appendix A6. (Page 2 of 2).

AGE	MEAN LENGTH	SAMPLE SIZE	STANDARD ERROR
49	630	2	5
50	640	1	
51	658	2	28
52	638	3	14
53	664	4	15
54	670	2	0
55	610	1	
56	655	3	28
57	685	1	
59	689	5	43
60	670	4	29
62	660	2	15
64	663	2	3
66	705	1	
68	660	2	20
71	685	1	
75	675	1	
87	665	1	

Appendix A7. Age composition statistics for halibut sampled from the harvest of sport anglers returning to Seward, Alaska, 1989 (N = 273).

AGE	COUNT	PROPORTION	STANDARD ERROR
3	1	0.004	0.004
4	5	0.018	0.008
5	12	0.044	0.012
6	33	0.121	0.020
7	36	0.132	0.021
8	32	0.117	0.020
9	31	0.114	0.019
10	41	0.150	0.022
11	24	0.088	0.017
12	24	0.088	0.017
13	15	0.055	0.014
14	7	0.026	0.010
15	3	0.011	0.006
16	4	0.015	0.007
17	3	0.011	0.006
18	1	0.004	0.004
22	1	0.004	0.004

Appendix A8. Age composition statistics for halibut sampled from the harvest of sport anglers returning to Seward, Alaska, 1990 (N = 330).

AGE	COUNT	PROPORTION	STANDARD ERROR
2	1	0.003	0.003
3	3	0.009	0.005
4	1	0.003	0.003
5	20	0.061	0.013
6	37	0.112	0.017
7	62	0.188	0.022
8	69	0.209	0.022
9	42	0.127	0.018
10	37	0.112	0.017
11	30	0.091	0.016
12	14	0.042	0.011
13	4	0.012	0.006
14	5	0.015	0.007
15	1	0.003	0.003
16	2	0.006	0.004
17	2	0.006	0.004

Appendix A9. Mean length-at-age statistics for halibut sampled from the harvest of sport anglers returning to Seward, Alaska, 1989-1990.

AGE	MEAN LENGTH	SAMPLE SIZE	STANDARD ERROR
2	350	1	
3	353	4	16
4	525	6	42
5	650	32	15
6	712	70	17
7	780	98	14
8	816	101	16
9	966	73	24
10	1076	78	25
11	1074	54	31
12	1235	38	34
13	1450	19	53
14	1407	12	81
15	1270	4	119
16	1579	6	98
17	1340	5	229
18	1615	1	
22	2030	1	

Appendix A10. Age composition statistics for lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1987 (N = 168).

AGE	COUNT	PROPORTION	STANDARD ERROR
3	3	0.018	0.010
4	10	0.060	0.018
5	19	0.113	0.025
6	38	0.226	0.032
7	19	0.113	0.025
8	12	0.071	0.020
9	24	0.143	0.027
10	17	0.101	0.023
11	6	0.036	0.014
12	3	0.018	0.010
13	2	0.012	0.008
14	6	0.036	0.014
15	5	0.030	0.013
17	1	0.006	0.006
20	2	0.012	0.008
21	1	0.006	0.006

Appendix A11. Age composition statistics for lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1988 (N = 57).

AGE	COUNT	PROPORTION	STANDARD ERROR
5	4	0.070	0.034
6	8	0.140	0.046
7	16	0.281	0.060
8	8	0.140	0.046
9	6	0.105	0.041
10	3	0.053	0.030
11	8	0.140	0.046
12	2	0.035	0.025
14	1	0.018	0.018
21	1	0.018	0.018

Appendix A12. Age composition statistics for lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1989 (N = 405).

AGE	COUNT	PROPORTION	STANDARD ERROR
4	5	0.012	0.005
5	26	0.064	0.012
6	53	0.131	0.017
7	70	0.173	0.019
8	109	0.269	0.022
9	53	0.131	0.017
10	29	0.072	0.013
11	20	0.049	0.011
12	23	0.057	0.012
13	3	0.007	0.004
14	2	0.005	0.003
15	4	0.010	0.005
16	2	0.005	0.003
17	4	0.010	0.005
18	1	0.002	0.002
21	1	0.002	0.002

Appendix A13. Age composition statistics for lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1990 (N = 361).

AGE	COUNT	PROPORTION	STANDARD ERROR
4	1	0.003	0.003
5	4	0.011	0.006
6	39	0.108	0.016
7	50	0.139	0.018
8	78	0.216	0.022
9	85	0.235	0.022
10	28	0.078	0.014
11	25	0.069	0.013
12	33	0.091	0.015
13	8	0.022	0.008
14	2	0.006	0.004
15	1	0.003	0.003
16	2	0.006	0.004
18	1	0.003	0.003
19	2	0.006	0.004
20	1	0.003	0.003
21	1	0.003	0.003

Appendix A14. Mean length-at-age statistics for lingcod sampled from the harvest of sport anglers returning to Seward, Alaska, 1987-1990.

AGE	MEAN LENGTH	SAMPLE SIZE	STANDARD ERROR
3	545	3	58
4	653	16	31
5	713	53	13
6	747	138	8
7	814	155	7
8	863	207	6
9	882	168	7
10	939	77	11
11	973	59	15
12	1020	61	16
13	1026	13	36
14	1080	11	41
15	988	10	34
16	1046	4	54
17	1088	5	69
18	1085	2	95
19	1278	2	73
20	1082	3	67
21	1053	4	123