APPENDIX J
LINGCOD IN OREGON
AND CALIFORNIA

An Examination of the 1992 and 1993 Commercial and Recreational Lingcod Sampling in Oregon and California

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Introduction

This is a report on the commercial and recreational fishery for lingcod (*Ophiodon elongatus*) in Oregon and California, which includes the Oregon portion of the Columbia International North Pacific Fisheries Commission (INPFC) area, the Eureka INPFC area, the Monterey INPFC area, and the Conception INPFC area. A separate document will deal with the Vancouver INPFC area and Washington portion of the Columbia INPFC area (Jagielo 1994). Lingcod are an important component of both the commercial and recreational west coast groundfish fishery. Depletion of lingcod stocks in historical fisheries such as Puget Sound and Straits of Georgia have led to the closure of commercial fisheries and severe reductions of recreational fisheries. This sort of severe localized overfishing of lingcod has led to concern about lingcod harvesting in other areas. In the commercial fishery, trawl landings of lingcod are often associated with mixed rockfish landings and become an increasingly larger portion of the landings from south to north along the coast moving toward the center of lingcod abundance off British Columbia (Adams and Hardwick 1992). Non-trawl commercial and recreational landings are an expanding portion of the total removals. In this document, the available landings, length-frequencies, and age composition data for both commercial and recreational lingcod fisheries, along with Alaska Fisheries Science Center (AFSC) trawl survey time series and life history information, are presented and reviewed to provide a qualitative assessment of lingcod in these areas.

Description of the Fishery

Data Sources

Commercial lingcod landings are included from 1981 to 1993, but are available from PacFIN and the Historical Annotated Database (Lynde 1986) back until 1956 (in Adams 1986). Estimates of trawl landings are complete, but non-trawl landings should be considered minimum estimates, due to non-reporting. More concentrated sampling efforts have improved non-trawl commercial estimates in recent years. Lingcod landings for the Oregon portion of the Columbia INPFC area are only available from trawl and non-trawl gears and are taken from summing landings in the Vancouver and Columbia INPFC area and subtracting landings from the PMFC 3A, 3B, and 3C areas (from Jagielo 1994). Commercial length and age composition sampling was initiated in California and Oregon in January 1992. In California, some length-only sampling is done due to processor's concerns about clipping fin rays defacing the fish and reducing value. Some earlier trawl length composition data is available for California.

Recreational lingcod landing estimates are made by the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) for the period from mid 1979 to 1989. The 1981 to 1989 data are used here. This data along with length composition data from the MRFSS are summarized in Silberberg and Adams (1993). Recreational data is only available for the entire Columbia INPFC area. In addition, more concentrated catch and length data is available for the Commercial Passenger Fishing Vessel (CPFV) fishery in the Monterey INPFC area (Reilly et al. 1993). Age composition sampling was initiated for the Monterey area CPFV fishery in January 1992, and for Oregon in January 1994.

The AFSC triennial trawl survey provides fishery-independent abundance estimates of west coast groundfish stocks. The surveys have been conducted in 1977, 1980, 1983, 1986, 1989, and 1992. The shallow depth of the survey is 55 m (91 m in 1977); thereby missing some component of the lingcod resource, and limiting its usefulness. Again in the Columbia, data is only available for the entire area. The Conception area was not sampled in 1980, 1983, and 1986. There are few lingcod length frequency samples from the survey, since lingcod was never a target species.

Columbia Area

Landings

Commercial lingcod landings in the Oregon portion of the Columbia area follow a coast-wide pattern of dropping from a high level during 1981 to 1985, to a low in 1986, and remaining at a decreased level afterwards (Fig. 1 and Table 1). Commercial landing came largely from trawl gear, but an increased portion came from non-trawl gear (largely hook gear) during 1986 to 1990. There were no gill net landings after 1985. Columbia area recreational landings were small compared to the entire Columbia area commercial landings. Although the recreational time series for the entire Columbia area is too short to be conclusive, the recreational landings also appear to have a cyclical pattern, but with different timing.

Length and Age Frequency Distributions

Both male and female trawl landed lingcod from the Oregon portion of the Columbia area peaked at between 450 and 550 mm (Fig. 2) or at about two, three, and four year-old fish (Fig. 3). The decline in numbers at size was much sharper for males than for females. There were a substantial number of 350 to 450 mm females, although they were not as large a proportion of the total as for males at that size. Recreationally landed lingcod during the period 1981 to 1989 also had a unimodal distribution with an average size of 630 mm (see Silberberg and Adams 1993, Appendix A).

Lingcod landed in the Coos Bay fishery were smaller than those landed in the rest of the Columbia area (Fig. 4). This may be due to the small lingcod being taken in association with trawls targeted on Petrale sole[1]. Over 35% of the Coos Bay lingcod were under 450 mm, and were essentially 1+ age fish. These landings of young lingcod in the Coos Bay fishery occurred almost exclusive in the first two quarters of the year.

AFSC Survey Information

Survey biomass estimates for the entire Columbia area showed a sharp decline from the higher 1977 and 1980 estimate, and, then, from 1983 on, remained relatively constant at a level of around 3,000 mt (Fig. 5). There were single large catches which increased both the 1977 (1,050 kg/km off Washington) and the 1980 (963 kg/km off Oregon) Columbia biomass estimate. Survey length frequencies (Fig. 6) showed a much larger portion of larger fish for both males and females than in the commercial landings, but the sample also come from a time period ranging from 1983 to 1992 and are from a deeper depth range than the commercial and recreational landings.

Eureka Area

Landings

Lingcod commercial landings in Eureka INPFC area also followed a pattern of high landings in 1981-1985 (ave. 371 mt), fell to a low in 1986 (207 mt), increased again through 1990 (ave. 360 mt), and decreased afterwards (ave. 188 mt) (Table 2 and Fig. 7). Non-trawl commercial landings have been an increasing portion of the total commercial landings, mostly from hook gear, and in some years, have almost equaled trawl landings (Table 2).

Recreational landings are a significant portion of the total removals in the Eureka area (Table 2), averaging 36% of the total removals and ranging from 26 to 47% during the period from 1981 until 1989. There is no discernable increasing or decreasing annual trend in recreational landings. There may be a cyclical pattern in recreational landings with an earlier period than the commercial landings, but again the short time period is too short to be conclusive.

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[1]M. Hosie, Oregon Dept. of Fish and Wildlife, Charleston, OR. Personal Communication, 1994.

Length and Age Frequency Distributions

Length frequency distribution of trawl landed lingcod taken in the 1992 and 1993 peaked between 450 and 650 mm (Fig. 8), slightly larger than lingcod from the Columbia area. Although there was a small sample size, the average length of the males was larger than the females. The female lengths correspond to three, four, five and six year-old lingcod (Fig. 9). These female lengths were smaller than a peak of between 550 and 750 mm found in length frequencies taken between 1978 and 1983 (Fig. 10). Recreational landed fish from 1981 to 1989 had an average size of 650 mm (see Silberberg and Adams 1993, Appendix A).

AFSC Survey Information

The survey biomass estimates range around 400 mt during the period 1977 to 1992 (Fig. 11). The concern is that the last estimate (1992) is dramatically lower than previous years. There were not sufficient length samples measured to be analyzed.

Monterey Area

Landings

Monterey commercial landings also showed a similar pattern of highs between 1981 and 1985 (ave. 698 mt), dropping to a 1986 low (355 mt), increasing again from 1987 until 1990 (ave. 742 mt), and decreasing after that (ave. 500 mt) (Fig. 12 and Table 3). The difference in the Monterey landings was that the increase in 1987 to 1990 period was as high or higher than the 1981 to 1985 period. Non-trawl landings showed a consistent increase over the period, split equally between gill net and hook gear categories (Table 3). There was also a corresponding decrease in the trawl landings.

Recreational landings are a substantial portion of the total lingcod removals in the Monterey area, averaging 42% of the total removals and ranging from 28 to 58% (Fig. 12 and Table 3). As in other areas, there was no increasing or decreasing trend, but does appear to be some cyclical trend with a low in 1984. Lingcod CPFV catch-per-angler-hour from 1988 until 1993 showed no consistent pattern (Reilly et al. 1993, Wilson-Vandenberg[2]). Comparisons between current and earlier data (Miller and Geibel 1973) are confounded by the introduction of a 22 inch size limit in 1981, a reduction in catch limit from 10 to 5 fish in 1982, and changes in fishing practices. Comparison of MRFSS data with

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[2]D. Wilson-Vandenberg, California Dept. of Fish and Game, Monterey, CA. Personal Communication, 1994.

similar estimates from WDF and CDF&G show much a sharper decline in catch of the MRFSS data (Silberberg and Adams 1993).

Length and Age Frequency Distributions

Both male and female trawl landed lingcod from the Monterey area peaked at the 450 to 550 mm range (Fig. 13). These tended to be three, four and five year-old fish (Fig. 14), slightly older than lingcod in the northern two areas. Trawl landed lingcod from 1978 to 1983 were larger for both males and females (Fig. 15). Both sexes have decreased about 100 mm from 1987-1983 to 1992-1993. Reilly et al. (1993) found no trend in CPFV mean length from Monterey area ports between 1988 and 1991, and found an overall mean length of 662 mm.

AFSC Survey Information

Monterey area survey biomass estimates ranged around 1,200 mt (Fig. 16). The estimates showed no discernable trend, but as in the Eureka area, estimates ended in 1992 with the lowest estimate in the series. Length frequency distributions from a limited number of fish were dominated by young lingcod (Fig. 17). These young lingcod came from the 1989 and 1992 surveys, and were from a variety of areas and depths.

Conception Area

Landings

Recreational lingcod landings were the largest part of total removals in the Conception area, averaging 71% and ranging from 31% to 91% (Fig. 18 and Table 4). Commercial landings were very small, and did not show the pattern found in the other areas. Trawl landings decreased sharply after 1982, and after 1983, non-trawl landings were greater than trawl landings. The non-trawl landing came from both gill nets and hook gear, with hook gear landings increasing in recent years.

Length and Age Frequency Distributions

Length frequency distributions for trawl landed lingcod from the Conception area during 1980 to 1985 peaked in the 550 to 650 mm range (Fig. 19). Length frequencies during 1986 to 1991 peaked at a smaller size (Fig. 20) for an average reduction in size of around 100 mm. The few 1992 and 1993 samples for females also peaked in the 450 to 550 mm range, being mostly two, three and four year-old fish. There were no samples from the non-trawl fishery. Recreationally landed lingcod from the Conception area were the smallest of all the areas, averaging 610 mm from 1981 to 1989 (see Silberberg and Adams 1993).

Life History Information

Size and Age at Maturity

Size at maturity for lingcod at 20%, 50%, and 80% maturity is estimated from central California (Richards et al. 1990 from data in Miller and Geibel 1973) (Table 5). Size at 50% maturity for males is 424 mm and for females is 588 mm. Lingcod in California tend to mature at smaller sizes than those from higher latitudes.

Age at maturity for central California (Table 6) was estimated using Miller and Geibel's (1973) size at maturity and current growth curves from the Monterey area. Age at 50% maturity for males is 2.2 years and for females is 4.7 years. The range in age at maturity with latitude is not as great as in the size at maturity.

Growth

Von Bertalanffy growth curves for lingcod from the Columbia and Monterey INPFC areas are similar (Table 7), although the parameters have to be considered preliminary, since they use only two years of data with few older fish. There is surprisingly little difference in the parameter estimates, considering the wide variety of areas and aging structures used in the different studies.

Discussion

Although there are only two years of sampling along with limited historical data, there are some conclusions that can be drawn. The lingcod landed in the 1992-1993 sampling are small and young. Around one half of the females that are landed are smaller the Miller and Geibel (1973) central California 50% size at maturity (Table 8). Also, whenever there are historical data, there are substantial increases in the percent of females under the 50% size between the historical data and recent sampling.

The unimodal length and age lingcod distributions from the 1992-1993 sampling could be the result of two circumstances. Either the population has a small, young structure, or a recent strong year-class is entering into the fishery. It is difficult to distinguish between the two with this little data. However, separation of the Columbia area length data, which has the largest sample size, gives some indication that there is a strong year-class entering the fishery. The unimodal distribution at small size means that no earlier strong year-classes are in evidence.

It is difficult to make recommendations in this situation, except for the ubiquitous call for more data. The Oregon sampling seems adequately cover the fishery, partly because there

is a limited non-trawl and recreational fishery. The California sampling is restricted by smaller landings, length-only sampling, and only very limited sampling of a substantial non-trawl and recreational fisheries.

Silberberg and Adams (in prep.) examined the potential effect of lingcod trawl trip limits ranging from 0.45 to 13.61 mt (1,000 to 30,000 lb) using the 1981-1988 Pacfin Research data base (Jacobson and Huppert 1986). Trip limits could accomplish sizable reductions in coast-wide landings, ranging from 1335 mt for 0.45 mt (1,000 lb) trip limit to 89 mt for a 13.61 mt (30,000 lb) limit (Fig. 21). In the 1981 to 1988 time period, this would result in an average reduction ranging from 48% to 3% of total commercial landings. The impact of a coast-wide trip limits would fall largely on the Columbia and Vancouver areas, with the degree varying with limit size (Fig. 22). For the 13.61 mt (1,00 lb) limit, 75% of the reduction would come from these two areas. In California, reduction of the sport bag limit from five to three fish would reduce recreational landings 29% or an average of 223 mt (Silberberg and Adams 1993).

Acknowledgements

Lingcod port samples were obtained from the Oregon Department of Fish and Wildlife, and the California Department of Fish and Game. Kelly Silberberg and Thomas Laidig provided lingcod ages. Mark Wilkins provided the AFSC survey data. Don Pearson provided additional California port sampling data.

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Table 1. Commercial lingcod landings in the Oregon portion of the Columbia INPFC area and recreational landings from the entire Columbia INPFC area in metric tons by year and gear.

Year	Trawl	Non-Trawl Gear	Total Commercial	Recreat. Landings
1981	497	51	548	283
1982	742	69	811	494
1983	963	56	1019	149
1984	391	43	434	165
1985	465	81	546	228
1986	242	91	333	220
1987	261	111	372	202
1988	378	100	478	262
1989	427	125	552	218
1990	308	176	484	
1991	426	41	467	
1992	272	68	340	
1993	368	74	442	

Table 2. Eureka INPFC area commercial and recreational lingcod landings (mt) by year and gear.

Year	Trawl	Shrimp Trawl	Hook	Total Commercial	Recreat. Landings
1981	349	8	22	380	236
1982	511	12	27	553	220
1983	363	0	28	395	137
1984	263	1	8	288	113
1985	183	2	43	238	214
1986	95	3	90	207	187
1987	204	1	104	321	177
1988	182	3	107	314	204
1989	186	4	176	387	199
1990	232	3	176	419	
1991	140	6	66	213	
1992	90	4	59	155	
1993	139	2	38	184	

Table 3. Monterey INPFC area commercial lingcod landings (mt) by year and gear.

Year	Trawl	Gill Net	Hook	Total Commercial	Recreat. Landings
1981	760	8	60	835	620
1982	734	59	37	846	507
1983	431	72	10	581	361
1984	406	26	4	736	292
1985	223	90	19	492	562
1986	124	89	52	355	486
1987	320	152	70	625	457
1988	309	170	104	664	532
1989	413	209	201	938	514
1990	341	174	166	742	
1991	300	103	132	560	
1992	191	86	129	441	
1993	268	82	99	498	

Table 4. Conception INPFC area commercial and recreational lingcod landings (mt) by year and gear.

Year	Trawl	Gill Net	Hook	Total Commercial	Recreat. Landings
1981	149	10	5	167	123
1982	134	18	3	163	73
1983	40	3	1	46	47
1984	9	3	1	21	77
1985	7	9	1	21	128
1986	3	7	2	16	166
1987	2	9	4	16	175
1988	3	18	2	20	155
1989	-	17	2	20	127
1990	1	18	6	21	
1991	15	43	11	72	
1992	16	25	20	64	
1993	8	38	20	71	

Table 5. Size at maturity estimates for lingcod by area.

Sex	Length at percent maturity (mm) 20%	50%	80%
West Coast of Vancouver Island - Richards et al. (1990).			
Male	497	571	620
Female	599	636	674
Washington - Jagielo (1994).			
Male	342	513	633
Female	450	634	780
Central California - estimated from Miller and Geibel (1973).			
Male	369	424	495
Female	532	588	662

Table 6. Age at maturity estimates for lingcod by area.

Sex	Length at percent maturity (mm) 20%	50%	80%
West Coast of Vancouver Island - Richards et al. (1990).			
Male	2.4	3.5	4.5
Female	3.3	3.9	4.8
Washington - Jagielo (1994).			
Male	1.5	3.4	5.4
Female	2.5	4.6	6.6
Central California - estimated from Miller and Geibel (1973).			
Male	1.4	2.2	3.5
Female	3.8	4.7	6.0

Table 7. Parameters for von Bertalanffy growth curve for lingcod from different geographical areas with citations and aging structure used.

Geographical Location	Sex	von Bertalanffy Parameters k	L_∞	t_0
Vancouver Island (Chatwin 1956, vertebrae)	F	0.143	1182	-1.55
	M	0.246	936	-0.62
Vancouver Island (Beamish and Chilton 1977, fin rays)	F	0.149	1171	-2.15
	M	0.079	1062	-8.06
Northern California (Miller and Geibel 1973, otoliths)	F	0.087	1546	-1.70
	M	0.214	850	-1.33
Columbia INPFC Area (Oregon) (This study, fin rays)	F	0.097	1319	-2.10
	M	0.205	816	-1.63
Monterey INPFC Area (This study, fin rays)	F	0.089	1256	-2.43
	M	0.156	817	-2.49

Table 8. Percent of landed lingcod that are under the California 50% size at maturity (males 424 mm, females 588 mm) by area.

INPFC Area	Males	Females
Columbia		
1992-1993	18%	58%
Eureka		
1992-1993	8%	54%
1978-1983	2%	24%
Monterey		
1992-1993	8%	64%
1978-1983	10%	35%
Conception		
1986-1991	7%	61%
1980-1985	1%	31%

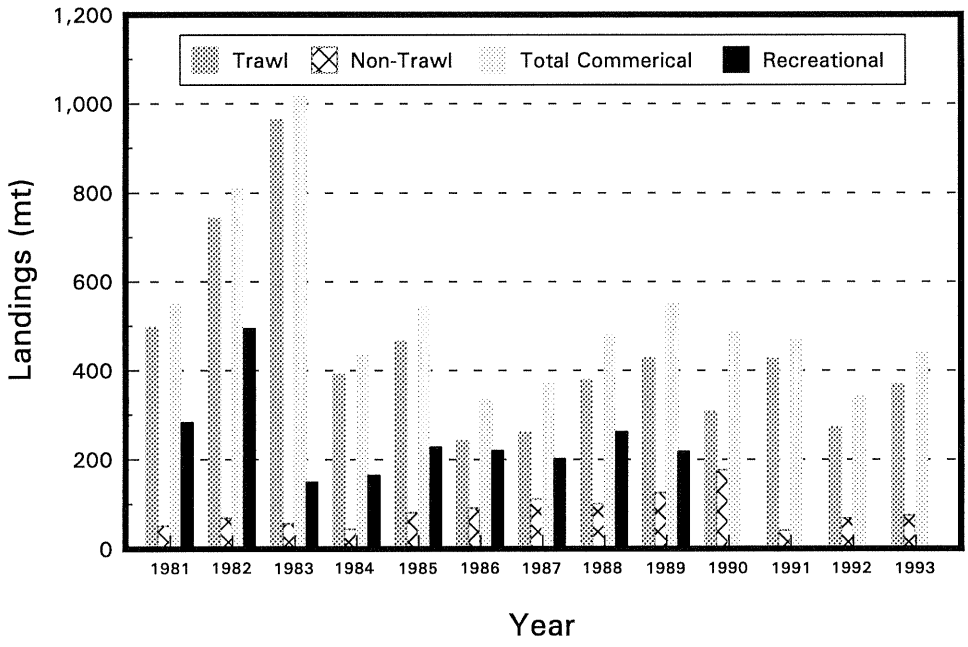
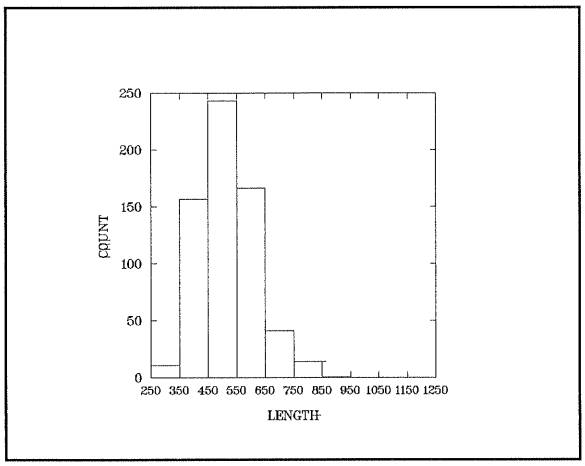


Figure 1. Trawl, non-trawl, and total commercial lingcod landings from the Oregon portion of the Columbia area and recreational landings from the entire Columbia INPFC area.



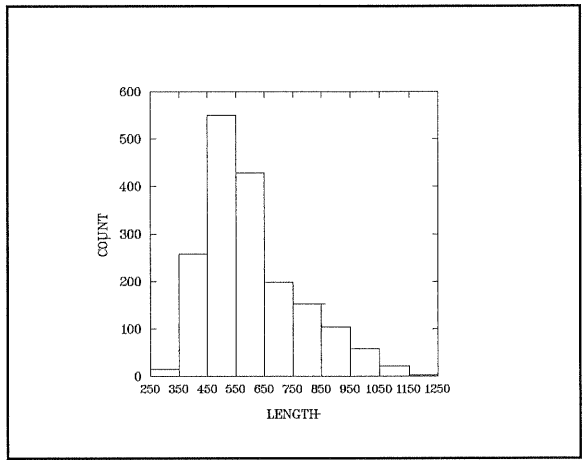
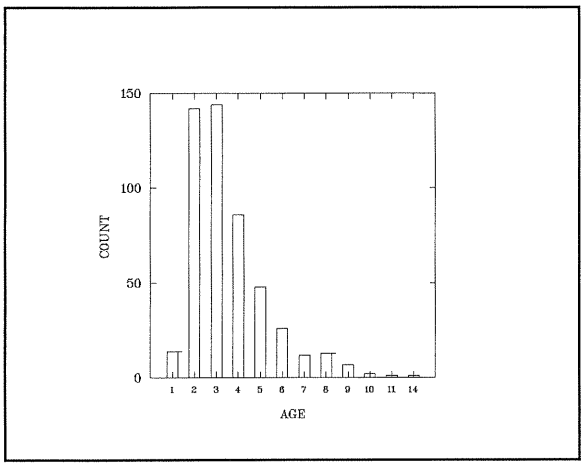


Figure 2. Length frequencies for trawl landed male (n=633) and female (n=1,789) lingcod from the Oregon portion of the Columbia area in 1992 and 1993.



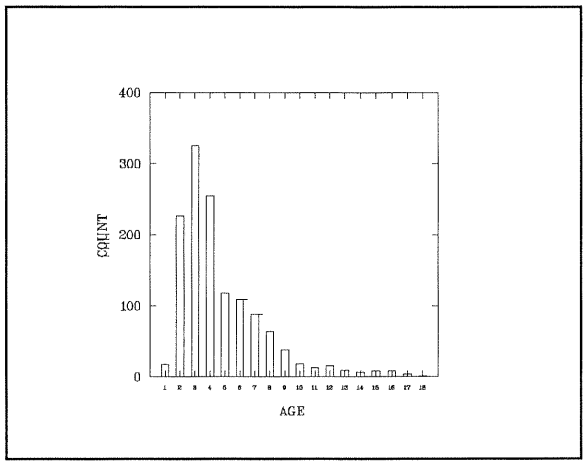


Figure 3. Lingcod age frequency distributions from the Oregon portion of the Columbia area for males (n=496) and females (n=1,326) in 1992 and 1993.

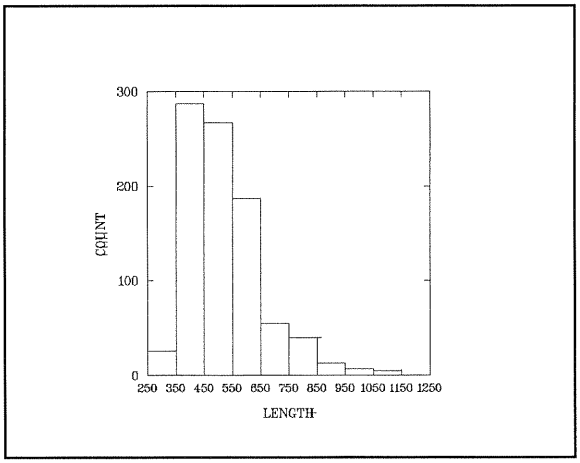


Figure 4. Length frequency for trawl landed lingcod (n=887) from Coos Bay Oregon during 1992 and 1993.

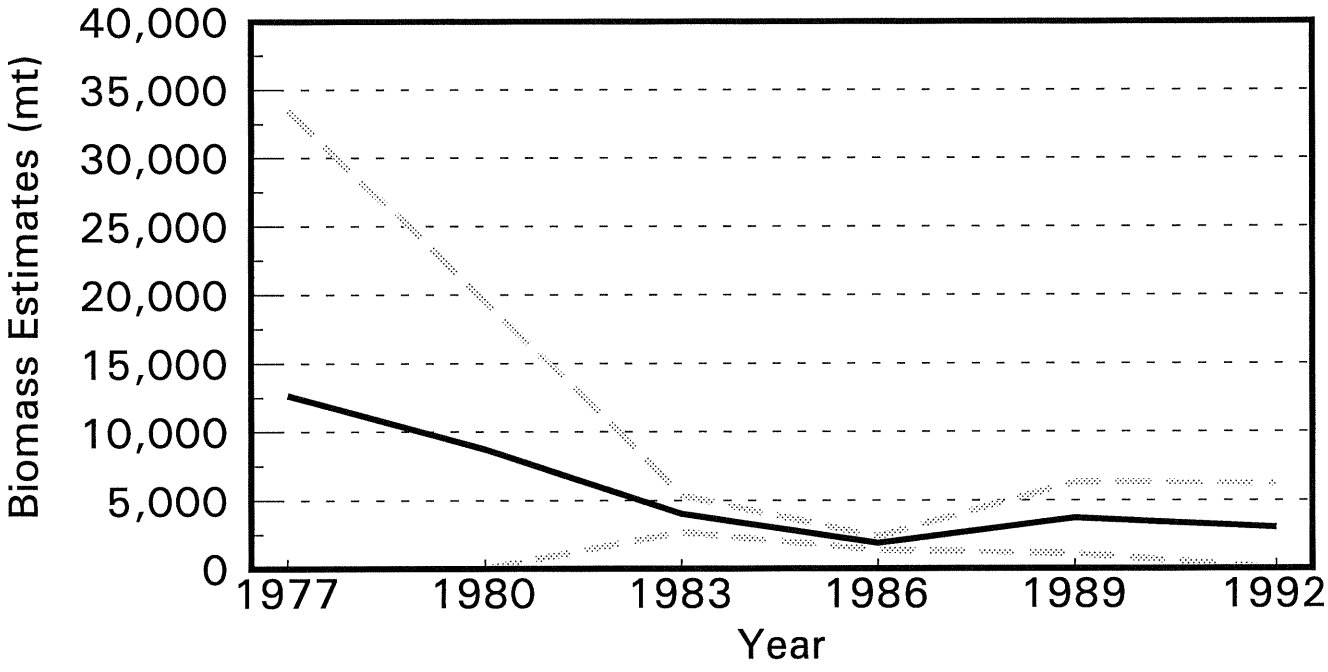
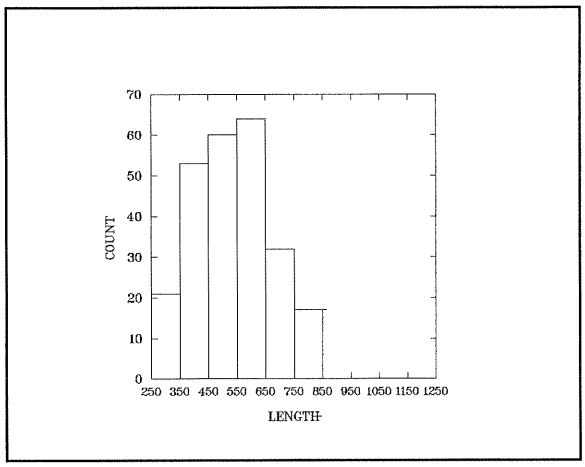


Figure 5. Lingcod biomass estimates and 90% confidence limits for the AFSC triennial survey for the Columbia INPFC area.



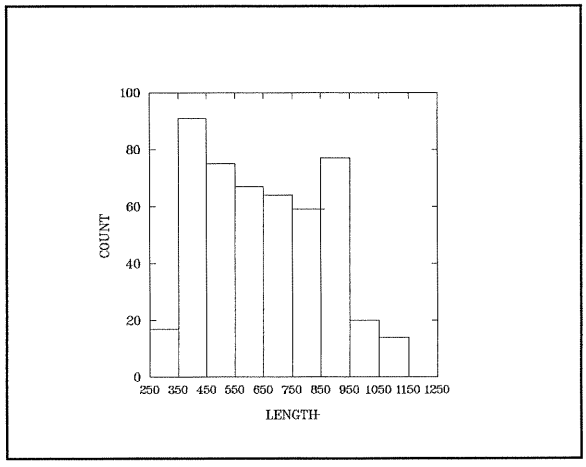


Figure 6. Lingcod length frequencies from AFSC triennial surveys for males (n=251) and females (n=489) over the period from 1983 until 1992.

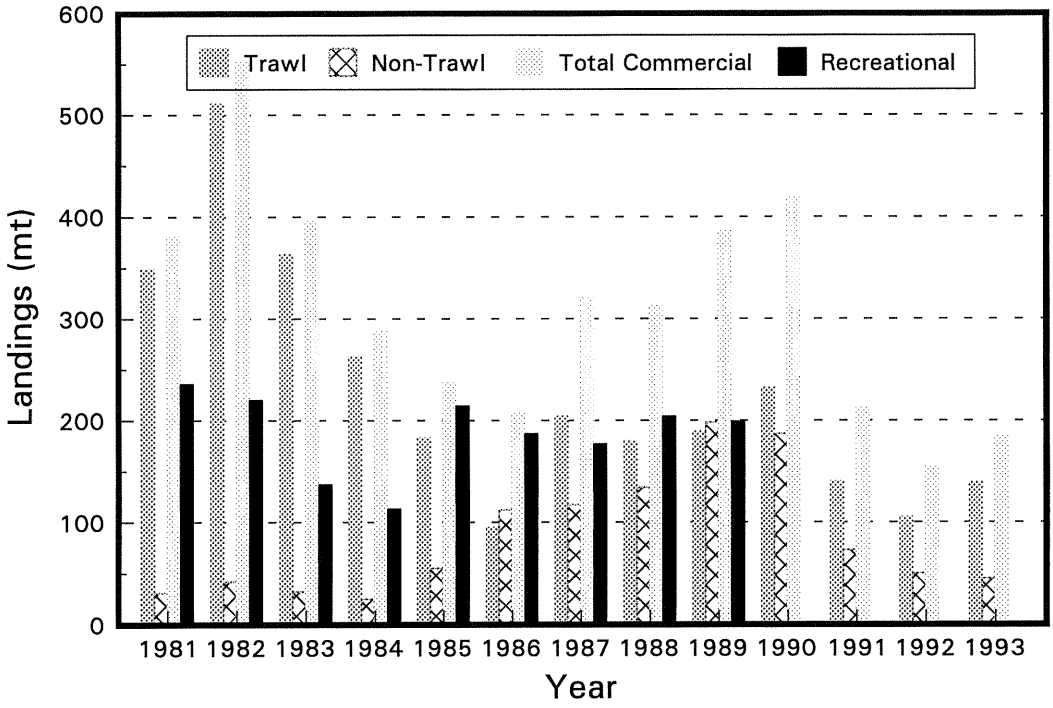
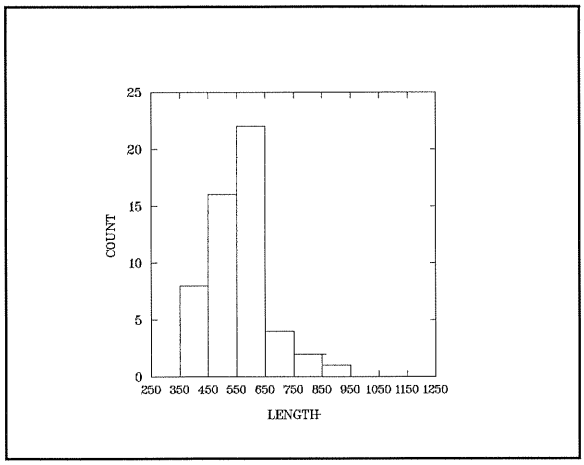


Figure 7. Trawl, non-trawl, and total commercial and recreational lingcod landings from the Eureka INPFC area.



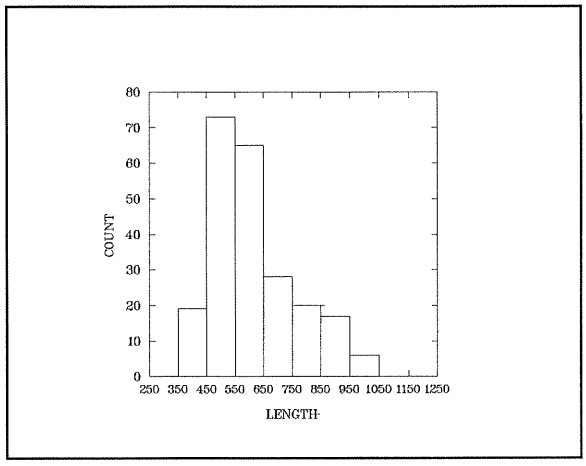


Figure 8. Length frequencies for trawl landed male (n=53) and female (n=228) lingcod from the Eureka INPFC area in 1992 and 1993.

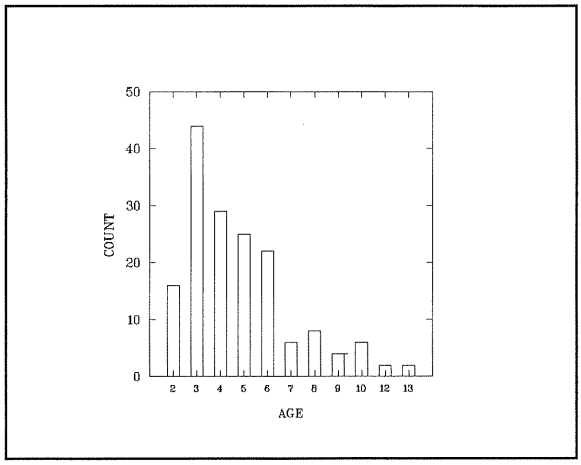
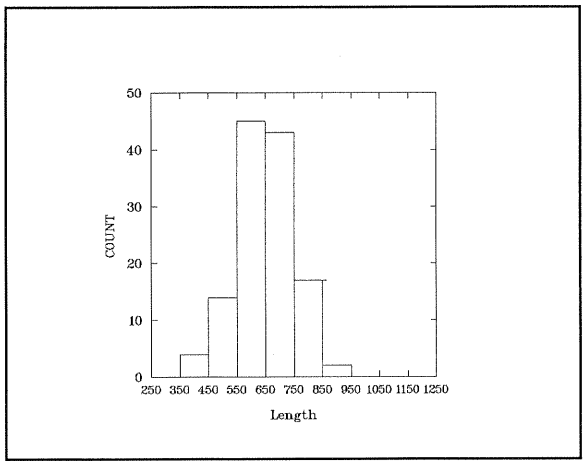


Figure 9. Age frequencies for trawl landed female (n=164) lingcod from the Eureka INPFC area from 1992 and 1993.



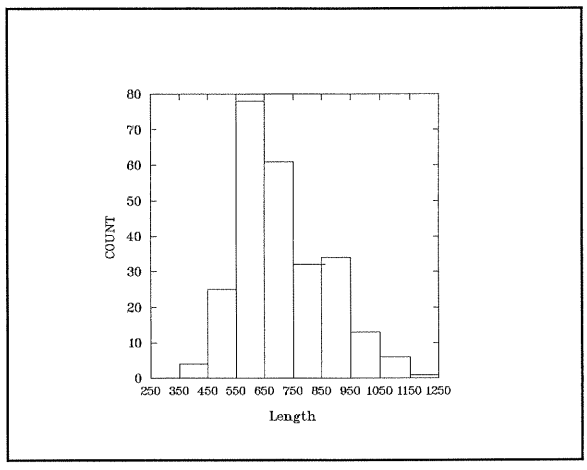


Figure 10. Length frequencies for trawl landed male (n=125) and female (n=254) lingcod from the Eureka INPFC area from 1978 to 1983.

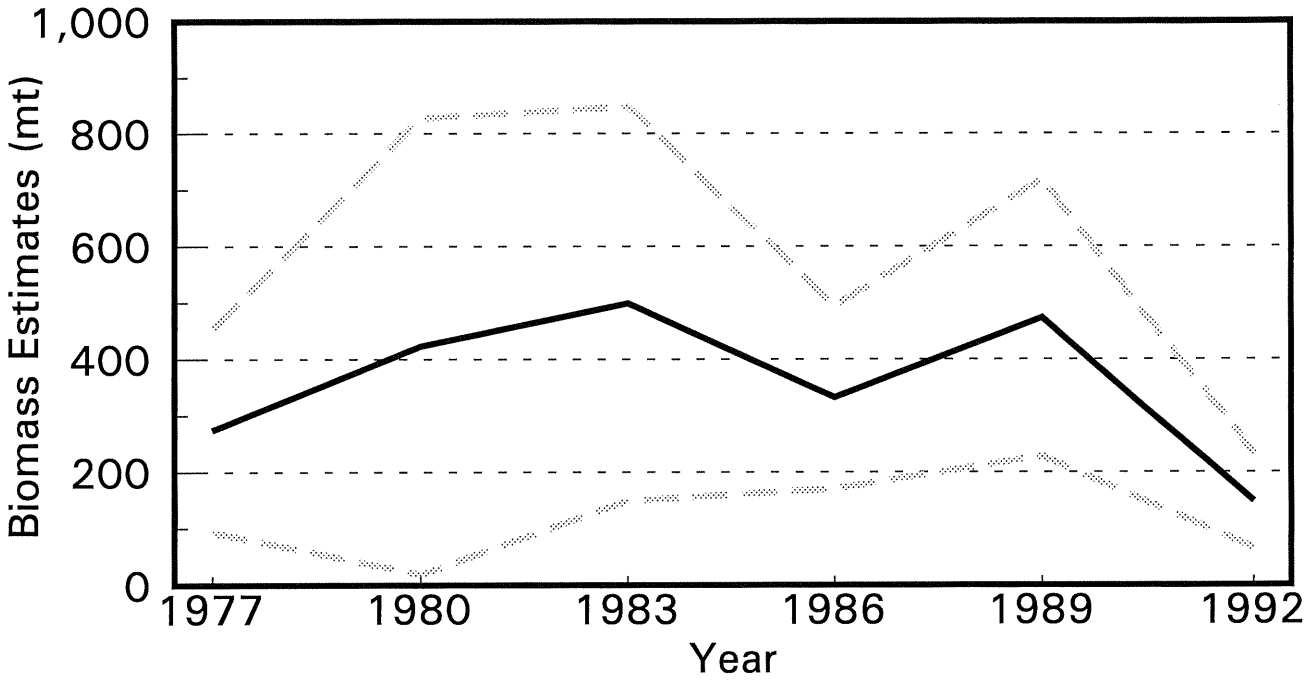


Figure 11. Lingcod biomass estimates and 90% confidence limits for the AFSC triennial survey for the Eureka INPFC area.

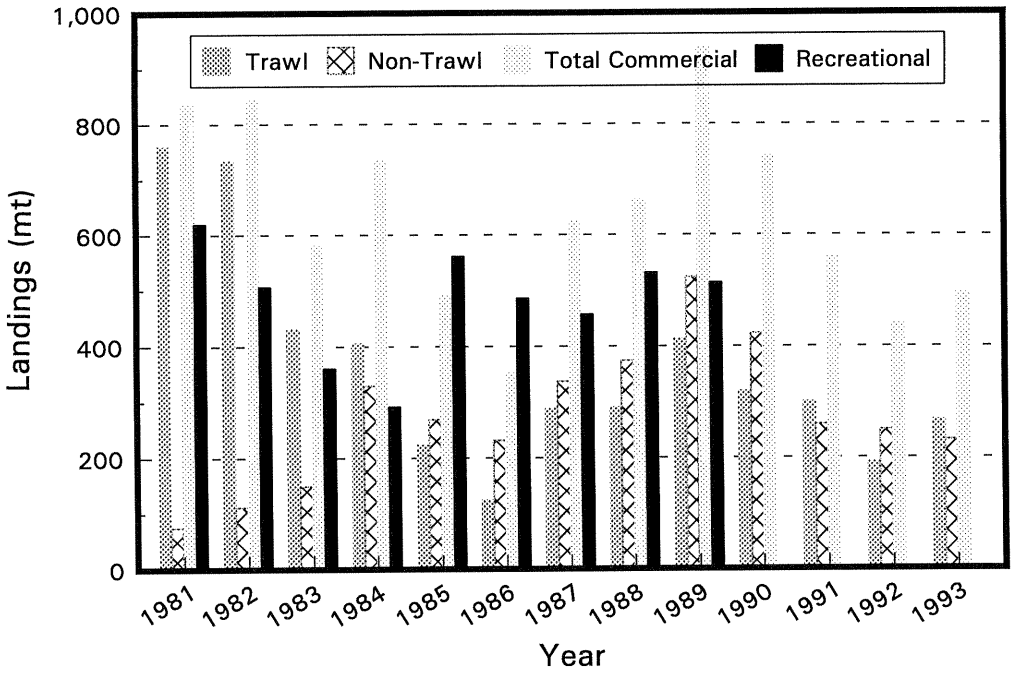
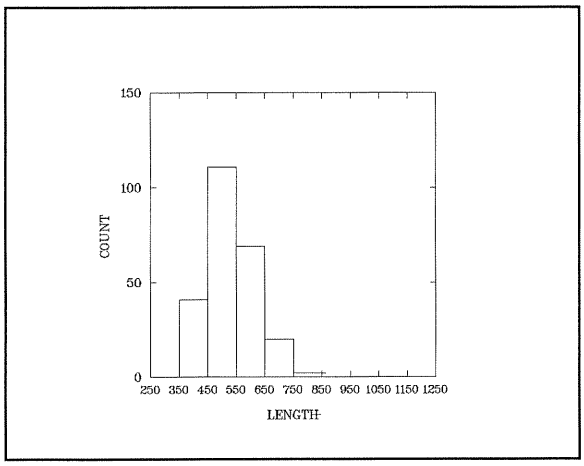


Figure 12. Trawl, non-trawl, and total commercial and recreational lingcod landings from the Monterey INPFC area.



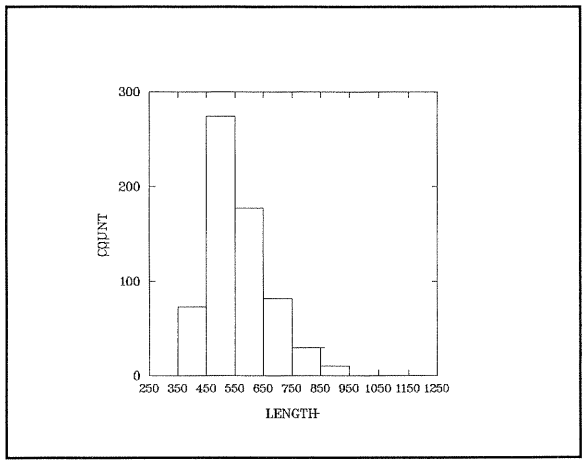
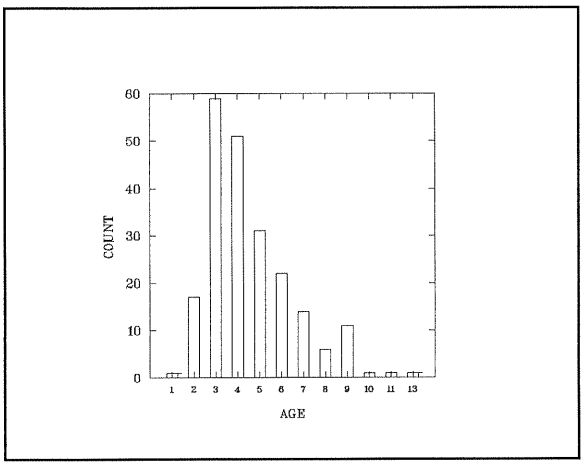


Figure 13. Length frequencies for trawl landed male (n=243) and female (n=646) lingcod from the Monterey INPFC area from 1992 and 1993.



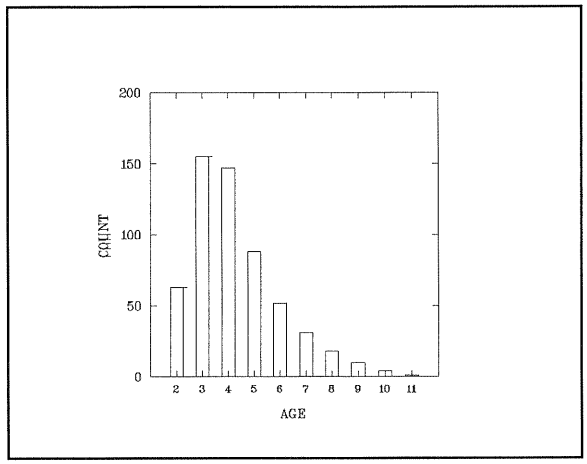


Figure 14. Lingcod age frequencies for trawl landed males (n=215) and females (n=569) from the Monterey INPFC area from 1992 and 1993.

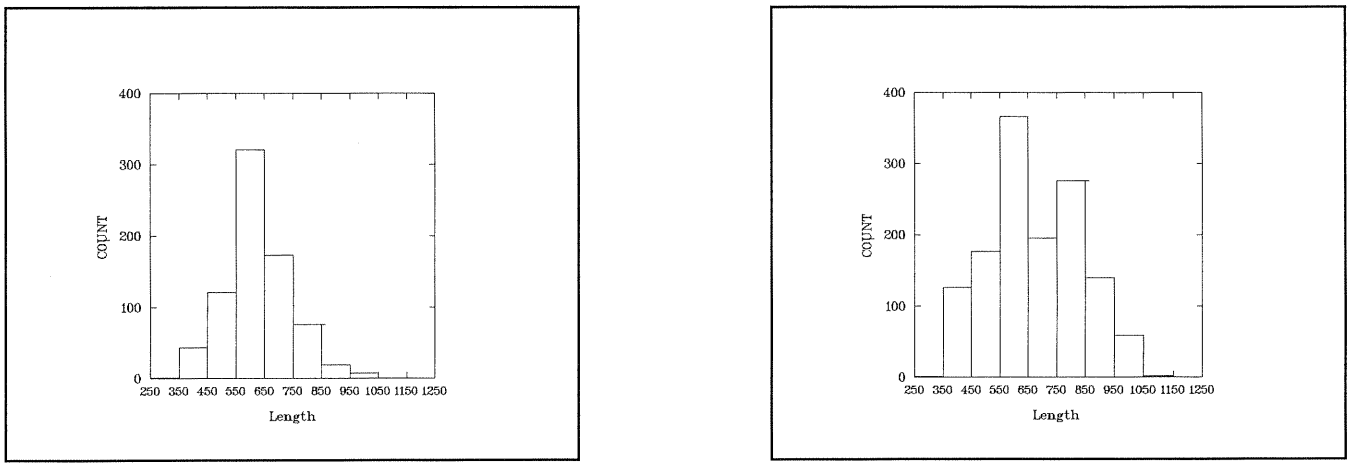


Figure 15. Length frequencies for trawl landed male (n=761) and female (n=1,346) lingcod from the Monterey INPFC area from 1978 to 1983.

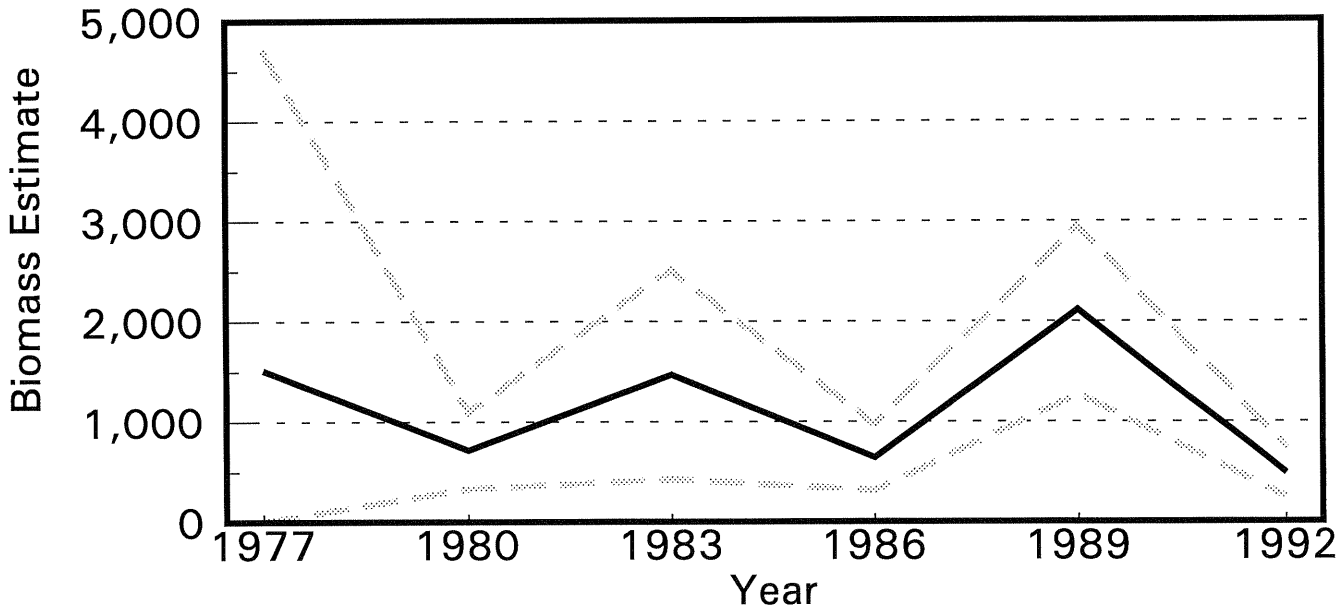


Figure 16. Lingcod biomass estimates and 90% confidence limits for AFSC triennial survey for the Monterey INPFC area.

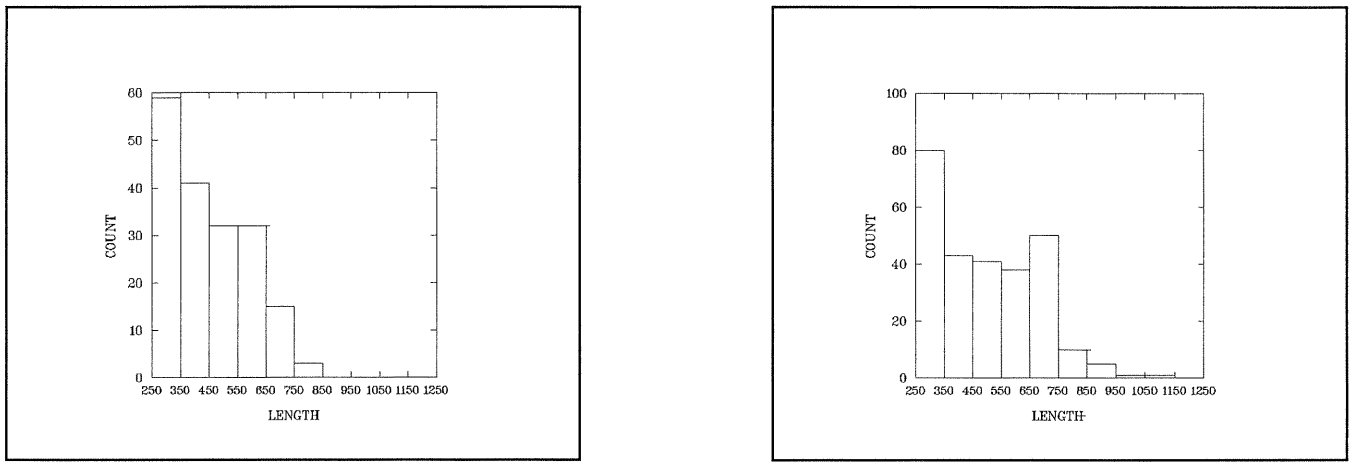


Figure 17. Lingcod length frequencies from AFSC triennial surveys for males (n=182) and females (n=275) from the Monterey INPFC area from the 1989 and 1992 surveys.

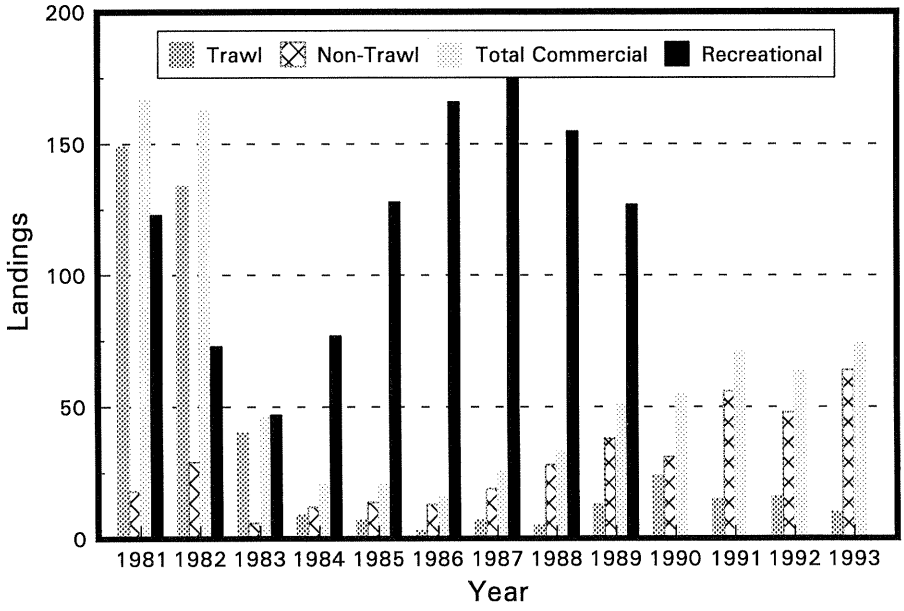


Figure 18. Trawl, non-trawl and total commercial and recreational lingcod landings from the Conception INPFC area.

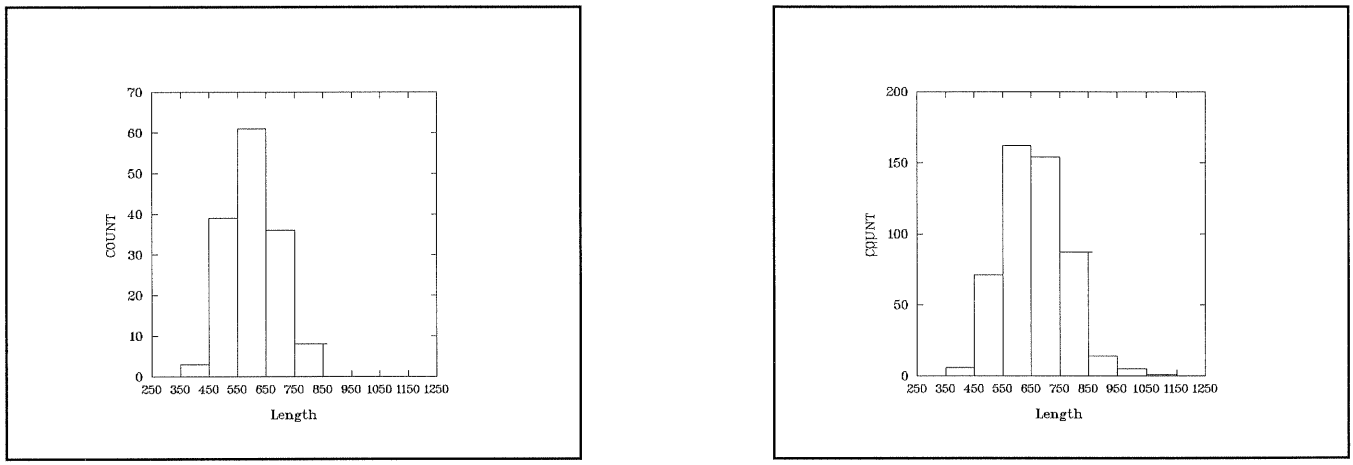


Figure 19. Length frequencies for trawl landed male (n=147) and female (n=501) lingcod from the Conception INPFC area from 1980 to 1985.

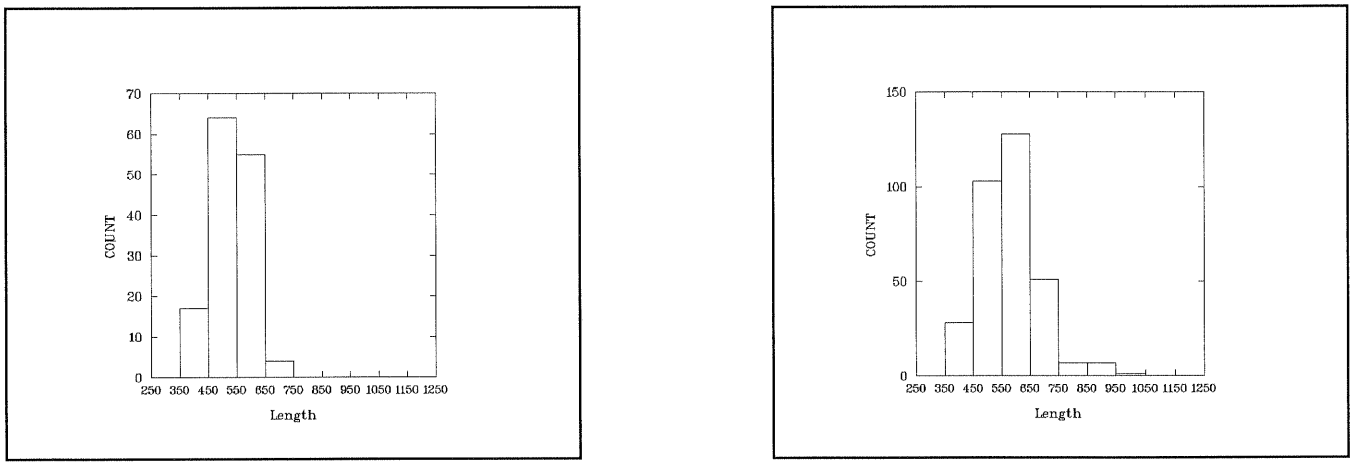


Figure 20. Length frequencies for trawl landed male (n=140) and female (n=325) lingcod from the Conception INPFC area from 1986 to 1991.

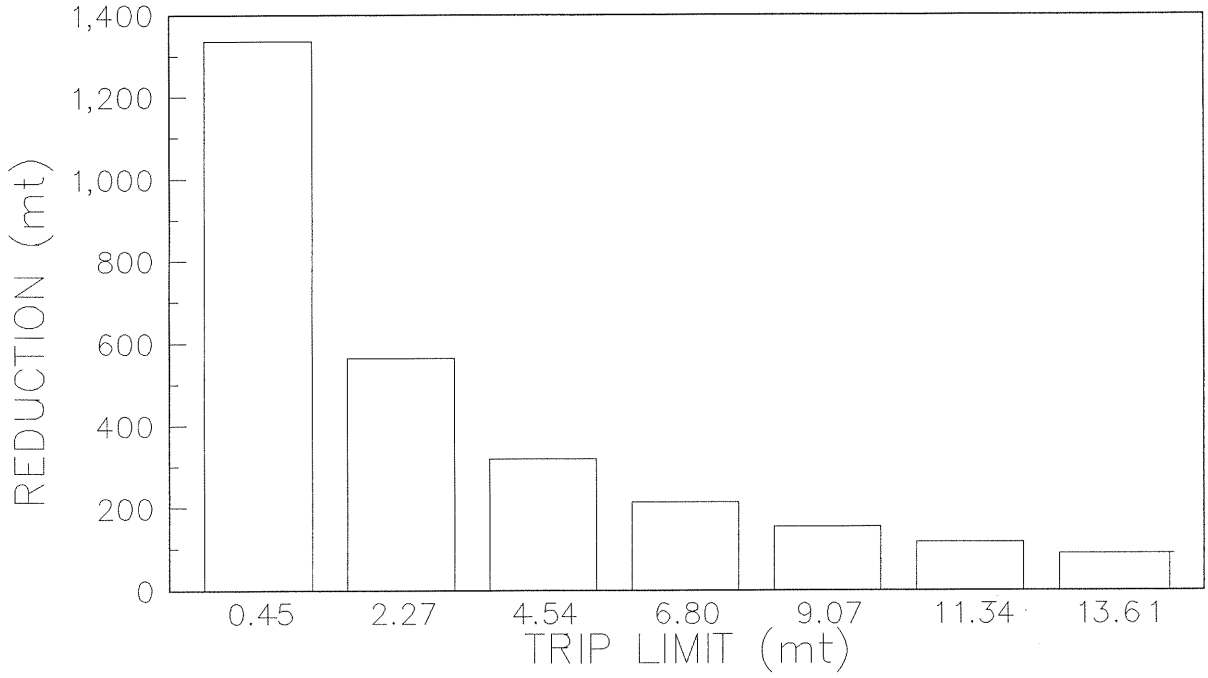


Figure 21. Coast-wide reductions in lingcod landings resulting from hypothetical trip limits ranging from 0.45 to 13.61 mt (1,000 to 30,000 lb) calculated from 1981-1988 PacFIN research data base.

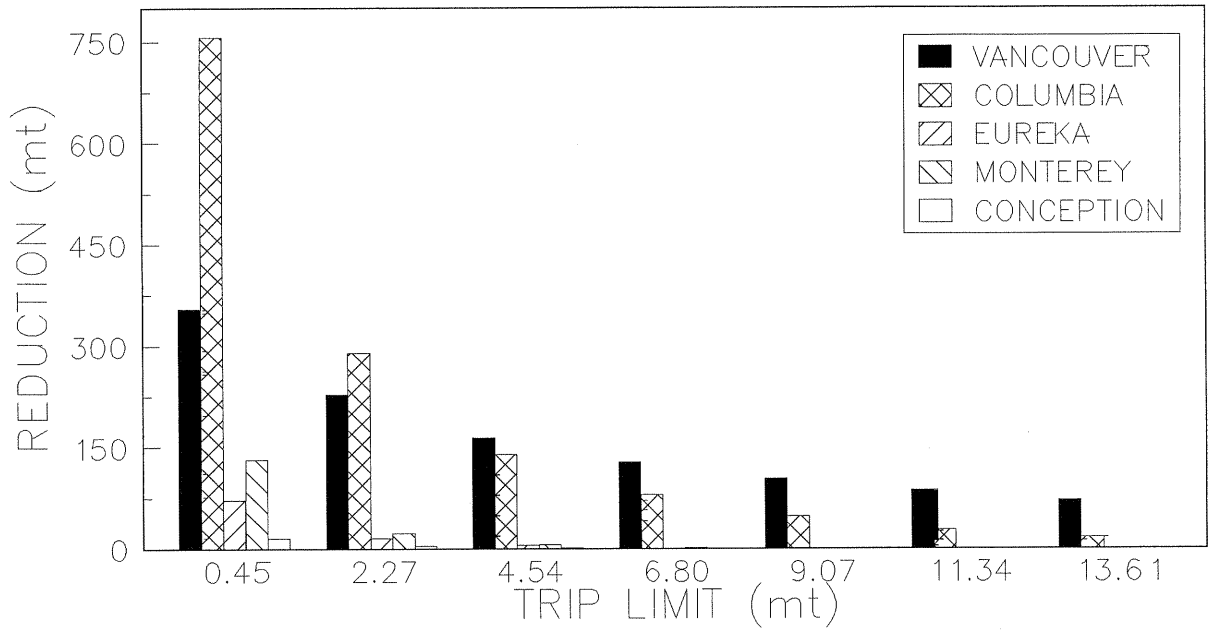


Figure 22. Reductions in lingcod landings for each INPFC area resulting from hypothetical trip limits ranging from 0.45 to 13.61 mt (1,000 to 30,000 lb) calculated from 1981-1988 PacFIN research data.