Hook and Line Survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes spp.*) in Southern Strait of Georgia (Statistical Areas 18 and 19) June 19-29, 2005

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HOOK AND LINE SURVEY OF LINGCOD (*Ophiodon elongatus)* AND ROCKFISH *(Sebastes spp.)* IN SOUTHERN STRAIT OF GEORGIA (STATISTICAL AREAS 18 and 19) JUNE 19-29, 2005

by

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ABSTRACT

Haggarty, D.R., and King J.R. 2006. Hook and line survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes spp.*) in northern Strait of Georgia (statistical areas 18 and 19) June 19-29, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2623: vii + 44 p.

Research fishing methods using hook and line gear were conducted in the 1980's and early 1990's to assess near shore reef fish abundance in the Strait of Georgia. These surveys were reinstated in 2003 to assess lingcod and rockfish abundance. This survey was conducted in Statistical Area (SA) 18 and 19 between June 19-29, 2005. We compare the lingcod catch rates in SA 18 and 19 to catch data collected in the summer of 2004 in SA 13 through 17 to investigate spatial patterns in the relative abundance of lingcod in the Strait of Georgia. Despite high lingcod catch rates in SA 19 in the Strait of Georgia Creel Survey, lingcod research catch rates were higher in the northern Strait of Georgia, particularly SA 13, than in SA 18 or 19. Smaller lingcod were caught in the south than in the northern Strait of Georgia. Higher lingcod catch rates were, however, apparent at the southernmost sites in SA 19. We also compare our lingcod and rockfish catch per unit of effort (CPUE) data to historical CPUE from 1993. Lingcod catch rates in SA 18 and 19 are significantly greater in 2005 than in 1993 in the shallow depth stratum, but not in the deep. Copper and quillback rockfish catch rates are significantly lower in 2005 than in 1993 in both depth strata. This survey highlights the importance of fishery independent surveys.

RÉSUMÉ

Haggarty, D.R., and King, J.R. 2006. Hook and line survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes spp.*) in northern Strait of Georgia (statistical areas 18 and 19) June 19-29, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2623: vii + 44 p.

Dans les années 1980 et au début des années 1990, des méthodes de pêche scientifique à la ligne ont été utilisées pour évaluer l'abondance des poissons de récifs côtiers dans le détroit de Georgia. Ces relevés sont effectués de nouveau depuis 2003 pour évaluer l'abondance des sébastes et de la morue-lingue. Ce relevé a été réalisé du 19 au 29 juin 2005 dans les zones statistiques (ZS) 18 et 19. Nous comparons les taux de capture de morues-lingues dans les ZS 18 et 19 aux données de capture obtenues à l'été de 2004 dans les ZS 13 à 17 pour étudier la répartition spatiale de l'abondance relative de la morue-lingue dans le détroit de Georgia. Malgré les forts taux de capture de morue-lingues obtenus pour la ZS 19 dans le cadre de l'enquête auprès des pêcheurs dans le détroit de Georgia, les taux de capture de morue-lingues obtenus dans le relevé scientifique ont été plus élevés dans le nord du détroit de Georgia, particulièrement dans la ZS 13, que dans les ZS 18 et 19. De plus petites morues-lingues ont été capturées dans le sud que dans le nord du détroit de Georgia. Toutefois, les taux de capture de morues-lingues ont été plus élevés aux sites les plus au sud de la ZS 19. Nous comparons aussi nos données de capture de morues-lingues et de sébastes par unité d'effort (CPUE) aux CPUE de 1993. Les taux de capture de morues-lingues dans les ZS 18 et 19 ont été significativement plus élevés en 2005 qu'en 1993 dans la strate peu profonde mais pas dans la strate profonde. Les taux de capture des sébastes cuivrés et des sébastes à dos épineux ont été significativement plus faibles en 2005 qu'en 1993 dans les deux strates de profondeur. Ce relevé met en évidence l'importance des relevés indépendants de la pêche.

INTRODUCTION

Lingcod (*Ophiodon elongatus*) populations in the Strait of Georgia appear to have been at a very low level of abundance for several decades (Richards and Hand 1989; King 2001). In response to conservation concerns, the commercial fishery was closed in 1990. The recreational fishery, prior to 2002, was subject to regulations including a winter non-retention period to protect nest guarding males, non-retention of fish less than 65 cm, a one per day bag limit, and an annual catch limit of 10 lingcod per year. In 2002, the recreational fishery was closed for the retention of lingcod as an additional measure to protect this stock (King 2001).

A stock assessment framework for lingcod recommended development of fishery independent sources of relative abundance to monitor changes in the Strait of Georgia lingcod population (King *et al.* 2003). One recommendation was to resume the hook and line surveys of nearshore reef fishes conducted in the Strait of Georgia in 1985, 1987-88 and 1993. In 1984 hook and line surveys were developed to estimate lingcod and rockfish catch per unit of effort (CPUE) (Richards and Cass 1985). In 1993, a handline survey for lingcod was conducted in Statistical Areas 18 and 19 during three sampling periods, June, August and October (Yamanaka and Murie 1995). We have since conducted a subsequent survey of the Southern Strait of Georgia (SA 17, 18 and 19) in October 2003 (Haggarty and King 2004), and a survey of the Northern Strait of Georgia (SA 13, 14, 15, and 16) in June and July of 2004 (Haggarty and King 2005).

Between June 19–29, 2005, we conducted a hook and line survey in SA 18 and 19, re-visiting nine of the twenty sites sampled in 1993 and 2003 (Yamanaka and Murrie 1995, Haggarty and King 2004). Some of the sites chosen in 1993, were areas identified by fishermen as sites with frequent lingcod catches; others were randomly selecting sites from 1 minute latitude by 1 minute longitude blocks that encompassed rocky habitat. We also sampled seven new sites in SA 19 in areas with frequent recreational lingcod catches.

The purpose of this survey was to evaluate the relative abundance of lingcod and rockfish in SA 18 and 19. We compare temporal trends in reef fish catch rates with the June sampling period of the 1993 survey (Yamanaka and Murie 1995). We also analyse spatial trends of lingcod relative abundance in Strait of Georgia by comparing data from this survey to the 2004 survey of the Northern Strait of Georgia (Haggarty and King 2005). Previous attempts to look at spatial patterns in the Strait have been confounded by seasonal behavioural changes which may affect catch rates.

Another objective of this survey was to investigate high lingcod catch rates in the recreational creel survey data in SA 19. According to creel survey data, the highest recent (2000-2004) lingcod catch rates in the Strait of Georgia have been in the creel sub-area 19-C (see Appendix Figure 1 for maps of Creel Survey sub-areas). All sites sampled in SA 19 in 1993 and 2003 were to the north in the creel sub-areas of 19-A and 19-B; therefore, we had no fishery-independent data with which to corroborate the high recreation catch rates. In addition, the 2003 survey (Haggarty and King 2004) did not show an increase in lingcod relative abundance in SA 18 and 19 between 2003 and 1993 (Haggarty and King 2003). Three of the seven new sites in SA 19 surveyed in June 2005 were in creel survey sub-area 19-C, two were in 19-D, and one was at the southern extent of 19-B.

While the primary focus of this survey was to investigate the relative abundance of lingcod, other nearshore reef fishes such as rockfishes (*Sebastes* spp.), kelp greenling (*Hexagrammos decagrammus*), cabezon (*Scorpaenichthys marmoratus*) and spiny dogfish (*Squalus acanthias*) were caught in all survey years. The 2005 lingcod survey provides an index of relative abundance for copper rockfish (*S. caurinus*) and quillback rockfish (*S. maliger*) in addition to lingcod. Nearshore rockfish species in the Strait of Georgia have suffered serious declines in abundance (Yamanaka and Lacko, 2001). A rockfish conservation strategy that includes a reduction in fishing mortality, the implementation of rockfish conservation areas, improved catch monitoring and stock assessment has been implemented.

METHODS

The vessel used as a platform for fishing was a 6.7 m aluminium "Lifetimer" boat equipped with twin 115-horse power engines, a depth sounder, GPS, and laptop computer with the geographic positioning software "Nobeltech®" and the program "Tides and Currents®". Fishing was conducted using the handline survey methodology developed by Richards *et al.* (1985) and Richards and Cass (1985).The fishing crew consisted of four research personnel, with three or four people fishing at a time (depending on environmental conditions). We used Zebco® Rhino® rods with Rhino® RBCXL reels, rigged with 13.6 kg (30 lb) test mono-filament line and a 170 g (6 oz) mooching weight. Two single Mustad #92553 size 3/0 hooks with a 6 cm spacing were tied with 7 kg (15 lb) test mono-filament leader. We used 12 cm frozen herring as bait, hooked through the snout and forward of the dorsal fin.

We revisited sampling sites surveyed in SA 18 and 19 in the summer of 1993. The seven new sites in SA 19 were fishing areas with high recreational lingcod encounters. Recreational lingcod CPUE (released and retained) from the Strait of Georgia Creel Survey database were plotted by area for all records that included information about locations fished between 2000-2004 (pers. com. K. Hein, Fisheries & Oceans Canada). Sites with the highest lingcod catch rates were chosen as sampling sites. All sites represented areas of presumed lingcod (age 2+) and rockfish habitat with appropriate depths.

As in Haggarty and King (2004, 2005) as well as Yamanaka and Murrie (1995), we sampled two depth strata per site (0-25 m, 26-50 m). As in previous studies, fishing effort was defined as the total fishing time of all fishers. Each fisher kept track of her own fishing time, which represented the time the line was on or near the bottom, using a digital stop watch strapped to the butt of the rod. Fishing time started when the gear touched the bottom and stopped whenever a fish was hooked, there was a bite, the gear become fouled on the bottom, or the line was reeled in.

Each site and depth stratum was fished for a total of 30 minutes of bottom time. We adjusted our position within the site if no fish were caught within 5 minutes, if we felt we were no longer in appropriate lingcod habitat, or if we were no longer within the depth stratum. Variables recorded for each set included weather, tide, currents, sea state and the minimum, maximum and modal depths encountered. We stopped fishing if the current or wind was too strong for fishing to be effective.

A catch was recorded if a fish was brought to the surface and could be identified to species. Lingcod and kelp greenling were sampled for fork length (mm), sexed externally and then released. Rockfish were measured for total length (mm) and then retained and sampled for weight, sex and stage of maturity. Otoliths of rockfishes were collected for age estimation. Fork or total length for other species was measured before releasing them.

Analyses

Catch per unit of effort (CPUE) was calculated as the number of fish per hour (fish/hr) for total fishes (sum of all species), lingcod, copper rockfish and quillback rockfish. Fisher bias was examined by calculating each individual fisher's CPUE for lingcod and total catches and comparing the individual catch rates using a Freidman two-way non-parametric analysis with fisher and set as factors. Differences in median CPUE and lingcod length between depth stratum, year, statistical areas and creel survey sub-areas were tested with the Mann-Whitney test (non-parametric t-test, test statistic U) or Kruskal-Wallis test (non-parametric ANOVA, test statistic H). We used non-parametric statistics since data were not normally distributed. When significant differences were obtained with the Kruskal-Wallis test, we used a comparison of mean ranks procedure to compare the individual mean ranks of the different groups and to identify subsets of similar mean ranks (Analytical Software, 2000). In comparing catch rates between 2005 and 1993, only data from the June sampling period in 1993 (Yamanaka and Murie 1995) were used. All analyses were performed using Statistix software (Analytical Software, 2000).

RESULTS

We sampled 16 sites between June 19 to 29, 2005 (Figure 1). We fished for a total of 25.6 hours (bottom time) over the entire survey. A total of 17.6 hrs were fished in SA 19 and 8.0 in SA 18. Location, depth, time and environmental data for each set are reported in Appendix Table 1. Appendix Table 2 presents the catch and effort data for each set including the effort by each fisher. Length and sex data for lingcod, copper rockfish, quillback rockfish and kelp greenling are presented in Appendix Tables 3-6. Biological data from all other species are in Appendix Table 7.

Catch Rates

Individual Fishers

We compared the total and lingcod CPUEs among the four primary fishers and found a statistically significant difference in catch rates (Table 1) for the total fish CPUE (TCPUE) as well as the lingcod CPUE (LCPUE). A comparison of mean ranks showed no pair-wise differences among fishers for the LCPUE, however, F3 had greater total fish catches than either F1 or F2. Despite this source of variability, further analyses were done using the cumulative CPUEs rather than individual fisher CPUEs.

Catch Rate by Depth and Area

We compared lingcod catch rates between depth stratum with both statistical areas pooled and found that significantly higher lingcod catch rates occurred in the shallow depth stratum (Table 2). There were also higher lingcod catch rates in the shallow stratum of SA 18 (Table 2). Due to the significant differences in overall catch rates between depth stratum, we looked for differences in lingcod catch rates among statistical areas within each depth stratum. Lingcod catch rates were significantly higher in the deep stratum in SA 19 than SA 18. There was no significant difference between SA 18 and 19 for shallow lingcod catch rates (Table 2).

Copper rockfish catch rates were also higher in the shallow stratum than in the deep with all statistical areas pooled, and in SA 19 when each statistical area was considered separately (Table 2). There were no significant differences among statistical areas when catch rates were compared within each depth stratum.

Quillback catch rates showed the opposite trend, with significantly higher catches in the deep stratum with all statistical areas pooled, and in SA 19 when each statistical area was considered separately (Table 2). When statistical areas were compared within each depth stratum, there were no significant differences in catch rates (Table 2).

Spatial Catch Rate Comparison

Summertime lingcod catch rates in SA 18 and 19 were compared to catch rates from SA 13-17 from 2004 (for Haggarty and King 2005) (Table 3). Lingcod catch rates in the northern Strait of Georgia are generally higher than in the south. In the shallow depth stratum, catch rates in SA 13 were significantly greater than in SA 14, 17, 18 and 19, but no different from SA 15 or 16. In the deep stratum, lingcod catch rates in SA 13 were greater than they were in SA 18 (Figure 2).

Copper and quillback rockfish catch rates were also compared among statistical area (Table 4). Although shallow and deep quillback catch rates were significantly different, no pair-wise differences exist. There is no difference in copper rockfish catch rates by statistical area in the Strait of Georgia.

Creel Survey Sub-area Comparison

Due to the high recreational lingcod catch rates in the creel survey sub-area 19-C, we compared lingcod catch rates by depth stratum among creel sub-areas. No difference was found in the shallow stratum; however, deep lingcod catch rates in area 19-C were significantly greater than in 18-B (Table 5).

Annual Catch Rate Comparisons

Only sites sampled in both 1993 and 2003 were included in the inter-annual comparison. As such, SA 18 and 19 were pooled since too few samples exist to look at Statistical Areas separately. In addition, the SA 19 sites sampled in both years inadequately represents the geographic extent of the statistical area. Lingcod catch rates in 2005 in the shallow depth stratum were significantly greater than they were in 1993 (Table 6). There is no difference in deep lingcod CPUE between years (Table 6, Figure 3).

Copper and quillback rockfish catch rates in both depth stratum were significantly lower in 2005 than they were in 1993 (Table 7, Figure 4, Figure 5).

Lingcod Biological Data

The median length of lingcod in the shallow depth stratum was 46 cm and 62 cm in the deep stratum. Lingcod were sexed externally since they were released alive. Many lingcod were too small to be sexed accurately, therefore, the two sexes were not separated for analysis.

We found a significant difference in lingcod length among sites (using pooled depth strata) (Table 8). Larger lingcod were caught at Forest Island than at Ten Mile Point or Great Chain Island.

The length of lingcod caught was also compared among statistical areas in the Strait of Georgia (Table 9, Figure 6). The median lingcod length in northern Strait of Georgia tends to be greater than it is in the southern Strait of Georgia. In the shallow stratum, lingcod in SA 16 are significantly longer than in SA 18 and lingcod in SA 19 were also significantly smaller than in SA 13, 15 and 16. In the deep stratum, significantly longer lingcod were caught in SA 13 and 15 than in SA 19.

Lingcod length was also compared among years. Lingcod caught in the shallow stratum in 2005 were significantly smaller than those caught in 1993. There is no difference in length between years in the deep stratum (Table 10).

DISCUSSION

A recent population model of Strait of Georgia lingcod (Logan *et al.* 2005) showed that the lingcod stocks in the south western portion of the Strait of Georgia (SA 17, 18 and 19) were depleted to 1.4% of the historical biomass (in 1927) and that current biomass has grown to 20.5% of the 1927 biomass. This sector of the Strait of Georgia showed the greatest recovery of all four regions in the Strait (northeast (SA 15 and 16), northwest (SA 13 and 14), southeast (SA 28 and 29) and southwest (SA 17, 18 and 19). Despite these model results, the hook and line surveys of the northern and southern Strait of Georgia do not seem to support this finding since no improvement with time was apparent in SA 18 and 19 (Haggarty and King 2004), but significant improvements in catch rates and size of lingcod were found in the northern Strait of Georgia (Haggarty and King 2005). Direct spatial comparisons within the Strait of Georgia using these two surveys are, however, confounded by the time of year sampled and lingcod behaviour that may affect seasonal catch rates. Male lingcod disperse offshore in the summertime and make a directed spawning migration to nearshore reef areas in the fall (Jagielo 1995, Cass *et al.* 1990).

This survey, completed at the same time of year as the survey of the northern Strait of Georgia (Haggarty and King 2005), shows that the relative abundance of lingcod in the Strait of Georgia is greatest in the northern strait, particularly SA 13, and lower the south, notably, SA 18. Lingcod caught in the southern Strait of Georgia also tended to be smaller than in the North. Lingcod in SA 19 had the lowest median length of all statistical areas and were significantly smaller than those in SA 13 and 15.

The Strait of Georgia lingcod population model (Logan *et al.* 2005) uses the Strait of Georgia Creel Survey lingcod catch per unit of effort as one of the input datasets. Creel survey data shows that the highest lingcod catch rates in the Strait of Georgia occurred in SA 19 (Logan *et al.* 2005) (see Appendix Figure 3). This result is not corroborated by the data presented in this report. The Strait of Georgia Creel survey is a fishery-dependent index; therefore, fisher behaviour as well as other uncontrolled factors may lead to over or underestimates of lingcod abundance. Conversely, the hook and line surveys use standardized methods and a systematic survey design to reduce bias, thereby allowing for more reliable spatial and temporal comparisons.

Within SA 19, creel survey catch rates were greatest in sub-area 19-C (see Appendix Figure 4). This survey also found a trend for greater catch rates to the southern extent of SA 19, as 19-C had significantly higher catch rates than sub-area 18-B and deep catch rates in 19-D also tended to be higher than other sub-areas. Creel survey sub-areas 19-C and 19-D are at the southern extent of the Strait of Georgia, near the Strait of Juan de Fuca (see Appendix Figure 2). The proximity of the west coast of Vancouver Island and the Strait of Juan de Fuca may influence lingcod catch rates in the southern portion of SA 19. Most of the lingcod caught at the sites in the 19-C and 19-D were, however, very small. The median length at the sites in 19-C and 19-D, as well as the southern-most site in 19-B (Ten Mile Point), was less than 38 cm. This may be indicative of a recent strong year class in the Strait of Georgia or it might be due to the migration of juvenile lingcod from the west coast of Vancouver Island and Strait of Juan de Fuca to the southern parts of SA 19.

Data from the 2005 hook and line survey were compared to hook and line data collected from the same areas in 1993. Lingcod catch rates were significantly higher in the shallow depth stratum in 2005; however, the length of the lingcod caught in 2005 was significantly lower than it was in 1993. This too may be indicative of a recent strong lingcod year class. There was no significant difference in catch rate nor lingcod size in the deep stratum.

This survey highlights the necessity of fishery independent data. Different conclusions about spatial abundance patterns of Strait of Georgia lingcod can be drawn from the fishery dependent creel survey than from the fishery independent hook and line survey. Stock assessments should not rely solely on fishery dependent data due to associated bias.

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Table 1. Descriptive statistics for lingcod Catch Per Unit of Effort (LCPUE) (fish/hour) and Total fish CPUE (TCPUE) for each fisher, June 19-29, 2005. We found a significant difference among fisher for each both catch rates for using the Friedman two way nonparametric ANOVA (X^2_r). No pair-wise differences were found for lingcod CPUE using a comparison of mean ranks; however, F3 had higher total catches than F1 or F2.

	LCPUE				**TCPUE**			
Fisher	F1	F2	F3	F4	F1	F2	F3	F4
N	54	54	54	54	54	54	54	54
Mean	3.5	3.3	6.2	4.9	6.2	5.6	12.9	8.5
SD	7.2	6.2	7.9	8.5	9.9	7.8	13.0	12.0
C.V.	204	189	128	174	159	138	101	141
Median	0	0	7.4	0	0	0	8.3	7.1
Range	0–32	0–24	0–38	0–43	0–48	0–32	0–68	0–60
	(Difference among fishers: X^2_r =12.7, p=0.0054, df=3)				(Difference among fishers: X^2_r =20.0, p=>0.0001, df=3)			

Table 2. Descriptive statistics for Lingcod, Copper rockfish and Quillback CPUE (fish/hour) for each depth stratum by statistical area, June 19-29, 2005. Shallow=0-25m, Deep=26-50m. Significant differences in catch rates between depth strata and statistical area were tested for using the Mann-Whitney test (U) and are shown in bold print.

	Shallow					Deep					
	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range	(Difference between depth strata)
Lingcod CPUE											
All sites	25	5.5	4.7	6.0	0–16.0	29	3.8	6.6	0.0	0–28.0	U=5.8, **p=0.0158**
18	10	4.6	4.8	5.0	0–16.0	12	0.7	1.8	0.0	0–6.0	U=4.4, **p=0.0356**
19	15	6.1	4.8	6.0	0–16.0	16	5.9	8.1	2.0	0–28.0	U=1.0, p=0.3125
(Difference between statistical areas)											
	U=0.8, p=0.3850, df=1					U=6.9, **p=0.0086**, df=1					
Copper CPUE											
All sites	25	1.1	1.5	0.0	0–4.0	29	0.6	1.9	0.0	0–10.0	U=4.6, **p=0.0328**
18	10	1.2	1.7	0.0	0–4.0	12	1.2	2.9	0.0	0–10.0	U=0.6, p=0.4432
19	15	1.2	1.7	0.0	0–4.0	16	0.1	0.5	0.0	0–2.0	U=5.4, **p=0.0200**
(Difference between statistical areas)											
	U=0.01, p=0.9246, df=1					U=2.0, p=0.1577, df=1					
Quillback CPUE											
All sites	25	0.1	0.4	0.0	0–2.0	29	1.7	3.0	0.0	0–14.0	U=9.2, **p=0.0024**
18	10	0	0	0.0	0	12	1.0	2.0	0.0	0–6.0	U=2.5, p=0.1121
19	15	0.1	0.5	0.0	0–2.0	16	2.4	3.6	1.0	0–14.0	U=6.8, **p=0.0092**
(Difference between statistical areas)											
	U=0.7, p=0.4142, df=1					U=1.6, p=0.2126, df=1					

Table 3. Descriptive statistics for Lingcod CPUE (fish/hour) for each depth stratum by statistical area. Data in SA 13-17 were collected June 14-July 9, 2004 (Haggarty and King 2005), data from SA 18-19 were collected June 19-29, 2005. Shallow=0-25m, Deep=26-50m. Significant differences in catch rates between depth strata are shown in bold print. A comparison of mean ranks showed that shallow lingcod catch rates in SA 13 were significantly higher than in SA 19, 18, 17, and 14. Lingcod catch rates in the deep stratum were significantly lower in SA 18 than SA 13.

			Shallow					**Deep**		
SA	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
13	10	16.2	7.5	15.7	6.7–33.2	9	9.1	8.1	9.7	0–23.4
14	6	2.6	1.6	2.3	0–5.1	7	0.6	1.1	0.0	0–2.9
15	18	6.8	6.1	6.4	0–25.0	9	8.1	3.4	7.8	3.4–12.7
16	11	8.7	9.8	5.5	0–34.3	9	2.6	2.5	3.8	0–6.1
17	5	3.0	2.0	2.9	1.2–5.9					
18	10	4.6	4.8	5.0	0–16.0	12	0.7	1.8	0.0	0–6.0
19	15	6.1	4.8	6.0	0–16.0	16	5.9	8.1	2.0	0–28.0
					(Difference among statistical areas)					
		H=24.7, **p=0.0004**, df=6					H=15.5, **p=0.0083**, df=5			

Table 4. Descriptive statistics for Copper and Quillback Rockfish CPUE (fish/hour) for each depth stratum by statistical area. Data in SA 13-17 were collected June 14-July 9, 2004 (Haggarty and King 2005), data from SA 18-19 were collected June 19-29, 2005. Shallow=0-25m, Deep=26-50m. Significant differences in catch rates were tested for using the Kruskal-Wallis test and shown in bold print. A comparison of mean ranks showed no significant pair-wise differences in quillback catch rates in the shallow stratum; however, deep catch rates in SA 13 were higher than they were in SA 18.

	Shallow					Deep				
Copper Rockfish										
SA	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
13	10	2.5	1.9	2.2	0–5.4	9	0.8	1.2	0.0	0–3.2
14	6	1.3	0.8	1.5	0–2.1	7	0.3	0.5	0.0	0–1.1
15	9	4.1	5.3	3.6	0–17.6	9	0.2	0.6	0.0	0–1.9
16	11	2.6	3.7	1.8	0–9.8	9	0.0	0.0	0.0	0–0.0
17	5	2.4	1.7	2.5	0–7.2					0–9.8
18	10	1.0	1.4	0.0	0–4.0	12	1.2	2.9	0.0	0–10.0
19	15	1.2	1.7	0.0	0–4.0	16	0.1	0.5	0.0	0–2.0
	(H=6.6, p=0.3641, df=6)					(H=6.6, p=0.2551, df=5)				
Quillback Rockfish										
SA	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
13	10	2.4	3.7	0.8	0–10.8	9	7.4	6.9	4.1	1.7–23.4
14	6	0.6	0.7	0.5	0–1.8	7	2.2	2.8	0.0	0–6.2
15	9	0.4	0.8	0.0	0–2.0	9	1.1	1.7	0.0	0–3.9
16	11	0.9	2.4	0.0	0–.9	9	1.3	2.2	0.0	0–5.4
17	5	2.6	3.2	1.2	0–7.2					
18	10	0	0	0	0	12	1.0	2.0	0.0	0–6.0
19	15	0.1	0.5	0	0–2.0	16	2.4	3.6	0.0	0–14.0
	(H=14.5, p=**0.0248**, df=6)					(H=14.1, p=**0.0149**, df=5)				

Table 5. Lingcod CPUE (fish/hour) by creel survey sub-area by depth stratum. Shallow=0-24 m, Deep=25-50 m. Significant differences in catch rates were tested for using the Kruskal Wallis test (H) and are shown are shown in bold print. A comparison of mean ranks showed that lingcod catch rates in the deep stratum in sub-area 19-C were significantly higher than in sub-area 18-B.

	Shallow					Deep				
Creel Sub-area	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
18-B	7	4.0	2.8	6.0	0–6	9	0.7	2.0	0.0	0–6
18-D	3	6.0	8.7	2.0	0–16	3	0.7	1.2	0.0	0–2
19-B	8	4.8	2.0	1.0	0–4	7	1.7	2.4	0.0	0–6
19-C	5	6.0	3.7	7.9	2–10	6	14.0	8.4	13.0	4–28
19-D	2	12.0	2.8	12.0	10–14	4	1.5	1.0	2.0	0–2.0
(Difference between creel sub-area)										
	H=4.62, p=0.333, df=4					H=16.8, **p=0.0021**, df=1				

Table 6. Inter-annual comparison of lingcod CPUE (fish/hour) by depth stratum. Shallow=0-25m, Deep=26-50m. Only the sites sampled in both years were compared. Significant differences were tested for using the Mann-Whitney test (U) and are shown in bold print. Lingcod catch rates were higher in the shallow stratum in 2005.

	Shallow					Deep				
	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
SA 18-19										
1993	52	1.0	2.1	0.0	0–9.0	52	1.2	3.0	0.0	0–15.7
2005	16	4.5	5.0	3.0	0–16.0	18	1.1	2.0	0.0	0–6.0
Difference among years:										
	U=13.3, **p=0.0003**, df=1						U=0.2, p=0.6544, df=1			

Table 7. Inter-annual comparison of copper and quillback rockfish catch rates (CPUE fish/hour) by depth stratum. Shallow=0-25m, Deep=26-50m. Only the sites sampled in both years were compared. Significant differences were tested for using the Mann-Whitney test (U) and are shown in bold print. Copper and quillback rockfish catch rates were significantly lower in 2005 in both depth strata.

	Shallow					Deep				
	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
Copper Rockfish										
1993	52	10.2	11.2	6.0	0–46.2	52	3.1	4.1	2.7	0–17.1
2005	16	1.1	1.6	0.0	0–4.0	18	0.9	2.4	0.0	0–10.0
Difference among years:										
	U=17.4, **p=<0.0001**, df=1					U=6.3, **p=0.0120**, df=1				
Quillback Rockfish										
1993	52	4.3	6.7	2.8	0–37.5	52	9.6	9.6	6.2	0–46.2
2005	16	0.0	0	0	0	18	1.1	1.8	0.0	0–6.0
Difference among years:										
	U=6.3, **p=0.0120**, df=1					U=21.6, **p=<0.0000**, df=1				

Table 8. Length lingcod caught at each sampling site, June 19-29, 2005. Lingcod sex and depth stratum were pooled. Significant differences among sites were tested for using a Kruskal Wallis test (H) and are shown in bold print. A comparison of mean ranks showed that significantly longer lingcod were caught at Forest Island than at Ten Mile Point or Great Chain Island.

Site	Site #	Creel Sub-area	N	Mean	SD	Med	Range
Coal	104	18-B	5	401.4	119.1	340.0	315–596
Imrie	204	18-B	3	500.3	185.3	480.0	326–695
Moresby	209	18-B	5	497.8	110.0	508.0	335–636
Gooch	110	19-B	12	477.8	158.9	465.0	327–900
D'arcy	203	19-B	6	476.2	57.4	467.5	406–566
Forest	207	19-B	7	599.7	110.5	589.0	457–796
Ten Mile Pt.	323	19-B	6	344.0	46.0	339.0	295–430
Discovery	320	19-C	19	398.4	75.7	358.0	310–547
Great Chain	321	19-C	18	371.3	77.1	338.5	288–541
Beaumont	322	19-C	14	406.8	74.6	382.0	310-525
Chatham	326	19-C	6	379.0	68.9	367.5	306-504
Trial	324	19-D	14	391.5	87.4	362.0	286–565

(Difference among sites)
H=31.5, **p=0.0009**, **df=11**

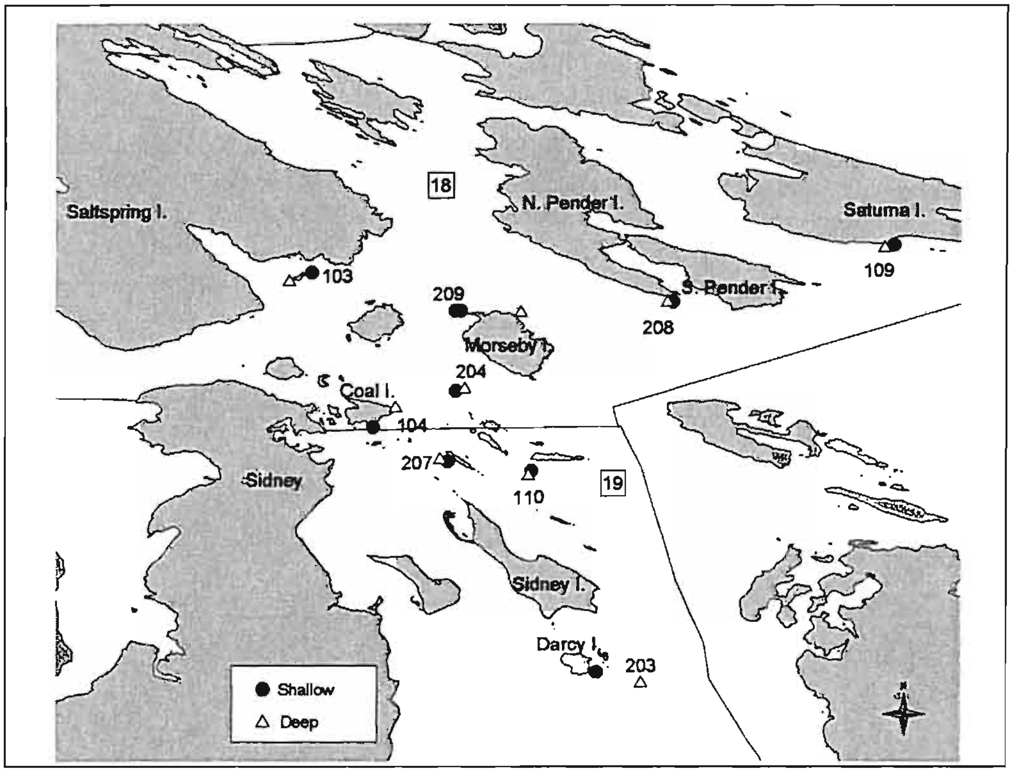
Table 9. Length lingcod (pooled sexes) caught by Statistical Area in each depth stratum. Shallow=0-25m, Deep=26-50m. Data in SA 13-17 were collected June 14-July 9, 2004 (Haggarty and King 2005), data from SA 18-19 were collected June 19-29, 2005. Significant differences among Statistical Areas were tested for using a Kruskal Wallis test (H) and are shown in bold print. A comparison of mean ranks showed that significantly longer lingcod were caught in the shallow stratum of SA 16 than in SA 18. Lingcod in the shallow stratum of SA 19 were also smaller than those caught in SA 13, 15. In the deep stratum, significantly longer lingcod were caught in SA 13 and 15 than in SA 19.

			Shallow					**Deep**		
SA	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
13	102	519.7	108.9	494.0	325–931	45	608.4	133.3	594.0	296–960
14	16	495.9	103.2	479.0	296–721	4	516.8	54.3	500.0	475–592
15	58	508.1	74.7	491.5	313–791	35	587.7	90.9	593.0	419–900
16	65	523.5	65.8	512.0	405–685	16	512.5	83.7	489.0	358–718
17	11	523.4	92.4	486.0	426–710	–	–	–	–	–
18	22	443.2	114.4	440.0	315–695	1	485.0	–	485.0	–
19	45	415.3	87.1	395.0	295–610	49	419.9	128.7	370.0	286–900
(Difference among SA)										
	H=45.6, **p=<0.0001**, df=6						H=56.9, **p=<0.0001**, df=5			

Table 10. Length of lingcod (sexes pooled) caught by depth stratum in 1993 and 2005. Significant differences between years was tested for using a Mann-Whitney test (U) and are shown in bold print. Significantly longer lingcod were caught in 1993 than in 2005 in the shallow stratum.

	Shallow					Deep					
	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range	(Difference among depth strata)
1993	31	511.7	72.4	492.0	363–709	10	562.5	104.6	566	362–723	U=9.1, df=1, p=0.0026,
2005	33	459.0	102.9	460.0	315–695	6	669.7	152.6	624.5	485–900	U=3.2, df=1, p=0.0732,
(Difference among years)	U=4.9, **p=0.0276**, df=1					U=1.2, p=0.2781, df=1					

A)



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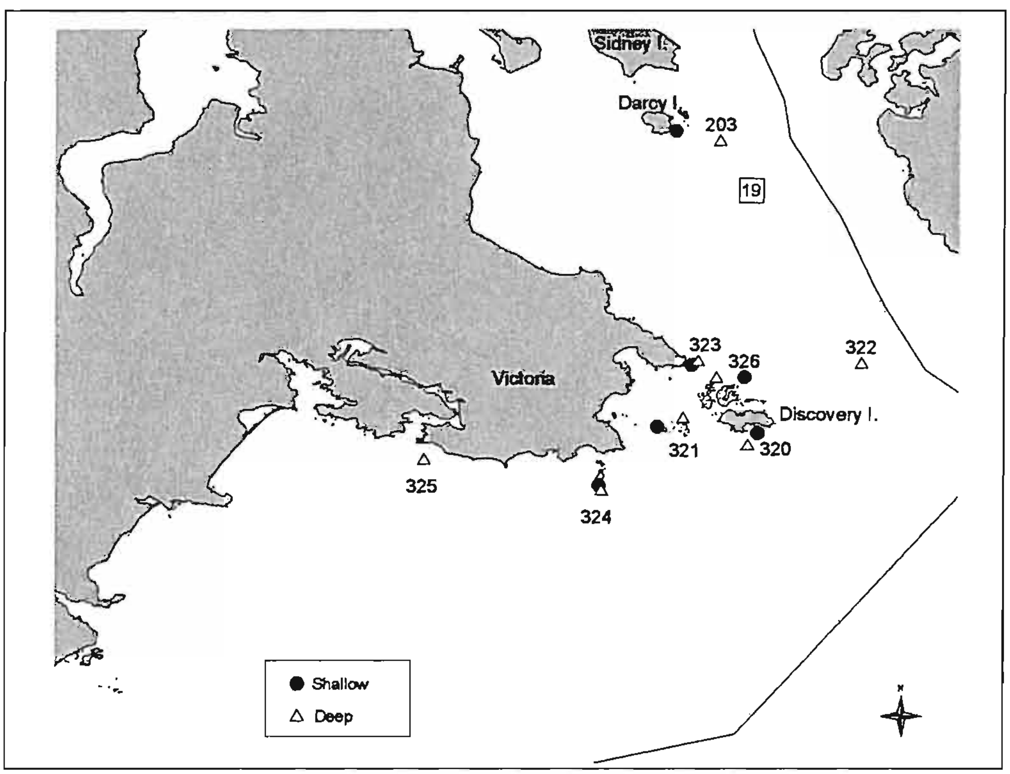
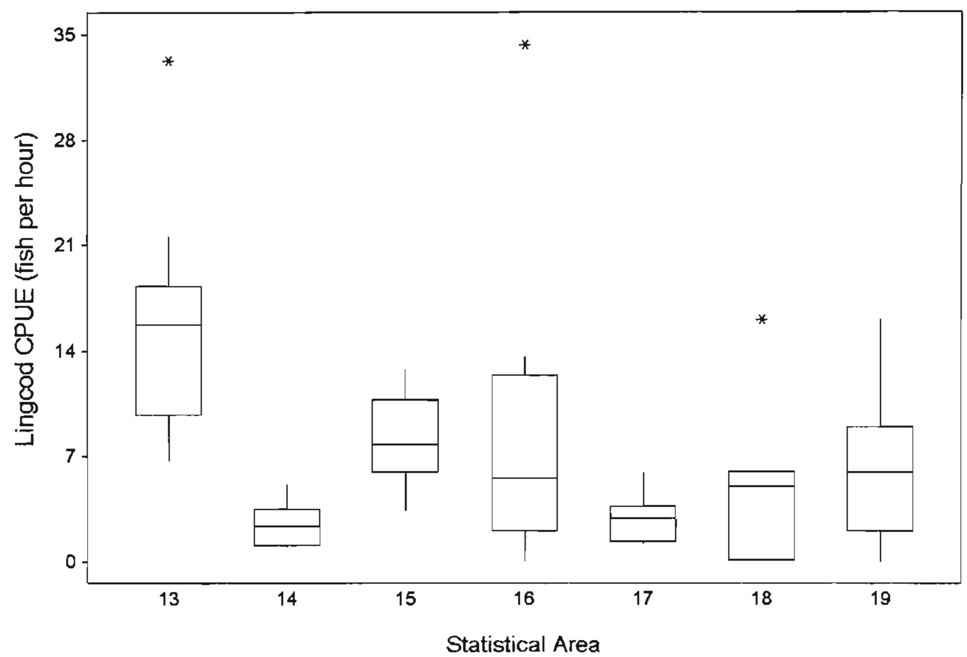


Figure 1. Sites sampled by hook and line June 19-29. A) Previously sampled sites; B) New sites (except D'arcy Island, site 203).

A



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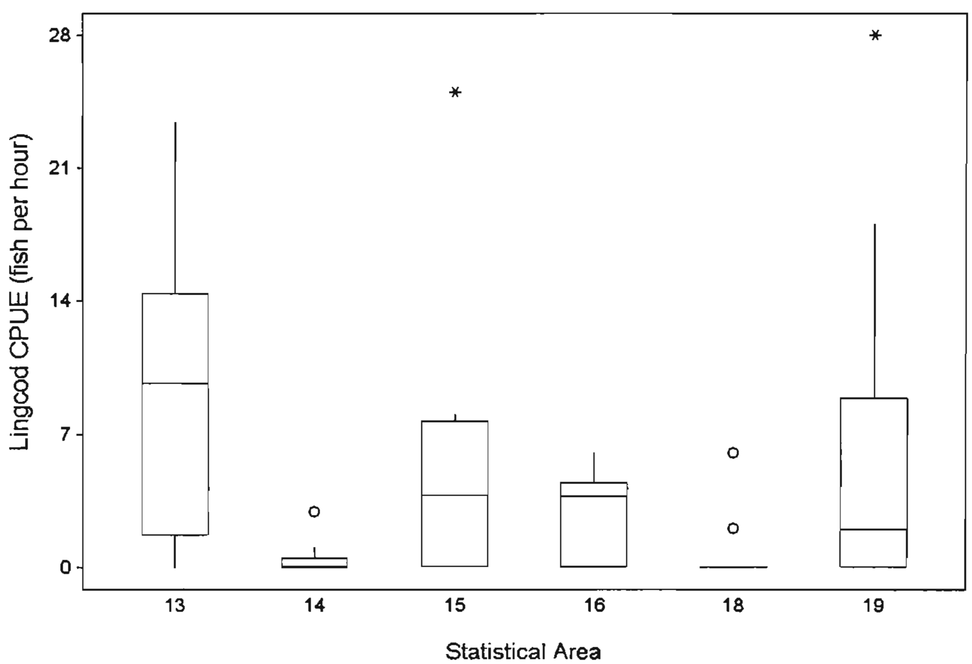
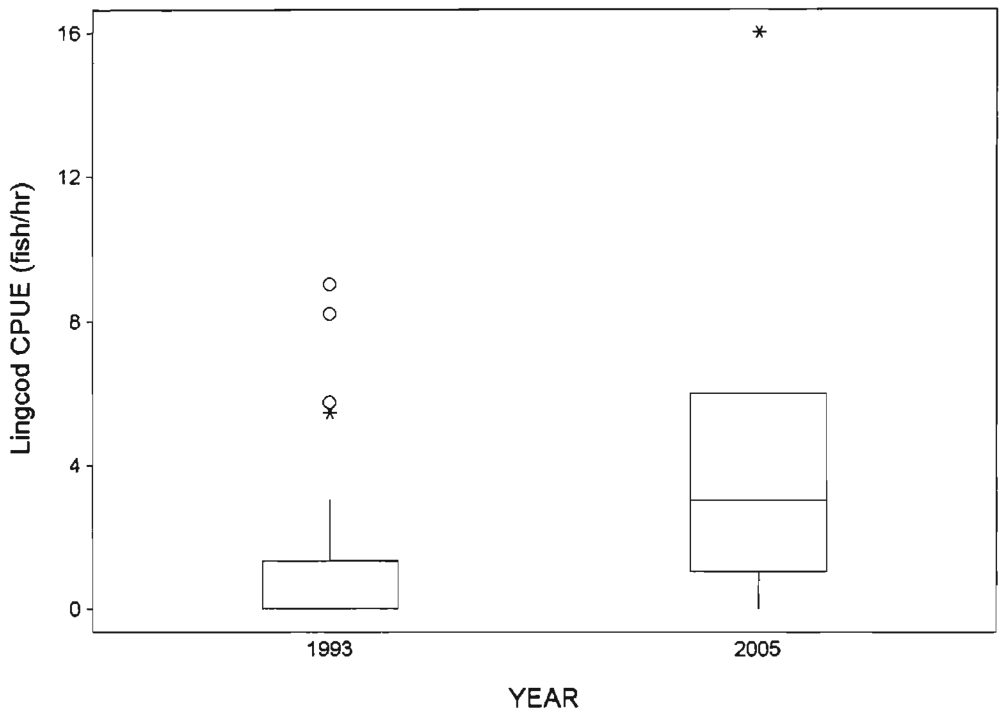


Figure 2. Boxplot representing the lingcod catch per unit of effort (fish per hour) by Statistical Areas. Data in SA 13-17 were collected June 14-July 9, 2004; data in SA 18 and 19, June 19-29, 2005. A=Shallow (0-25m), B=Deep (26-50 m). The median is indicated by the horizontal line in the box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by * and °. Lingcod catch rates in SA 13 were significantly higher than in SA 14, 17, 18 and 19 in the shallow stratum and greater than SA 18 in the deep stratum.

A



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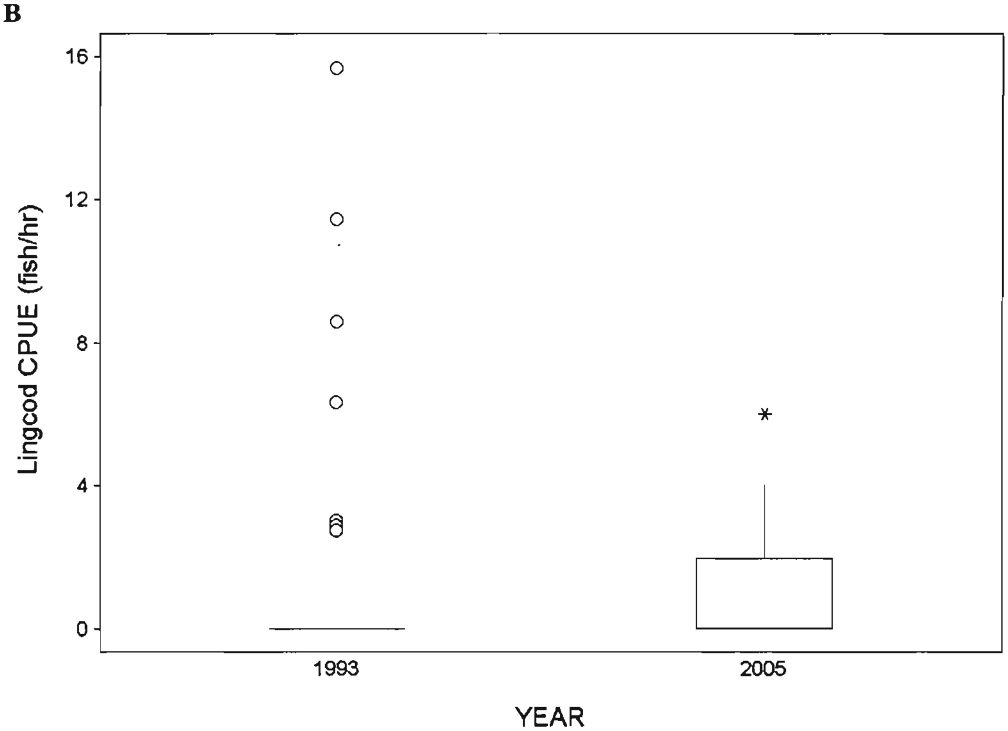
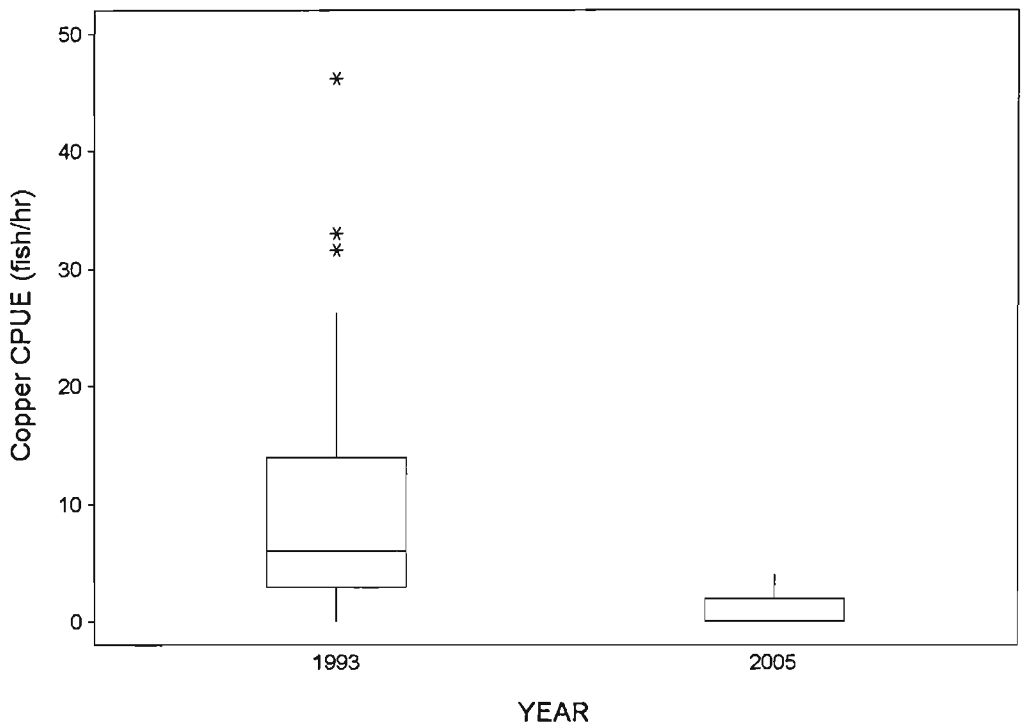


Figure 3. Boxplot representing lingcod CPUE (fish/hour) by depth stratum per year in Statistical Areas 18 and 19. A=Shallow (0-25m), B=Deep (26-50 m). The median is indicated by the horizontal line in the box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are shown as * and °. Lingcod catch rates were significantly higher in 2005 than in 1993 in the shallow depth stratum, but there was no difference in the deep stratum.

A



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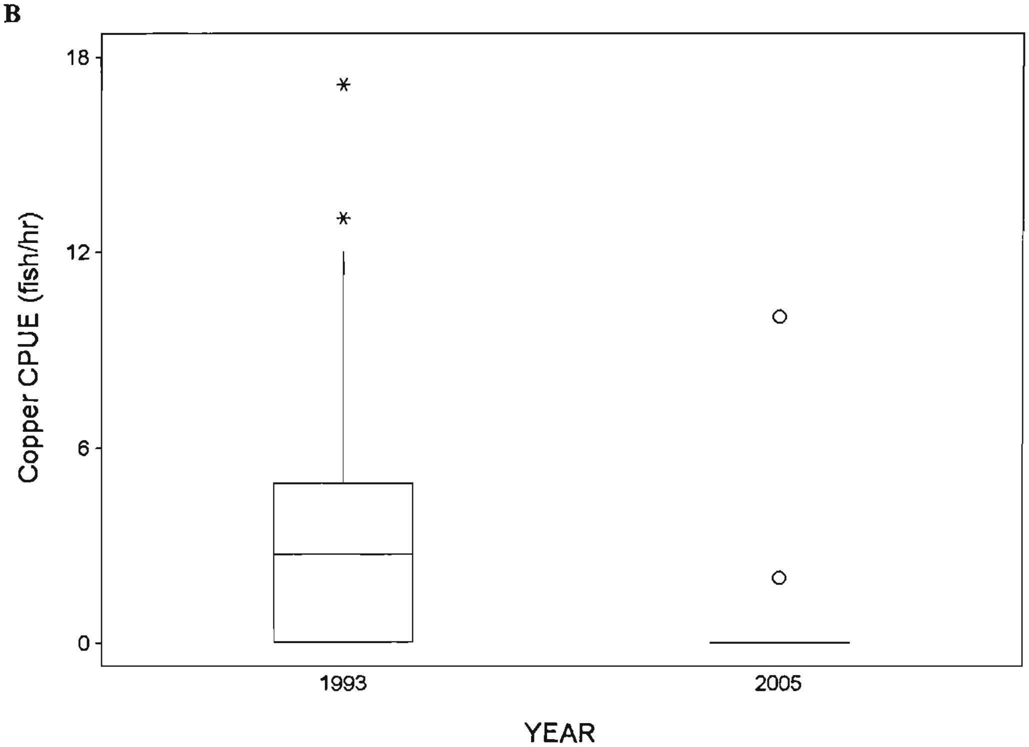
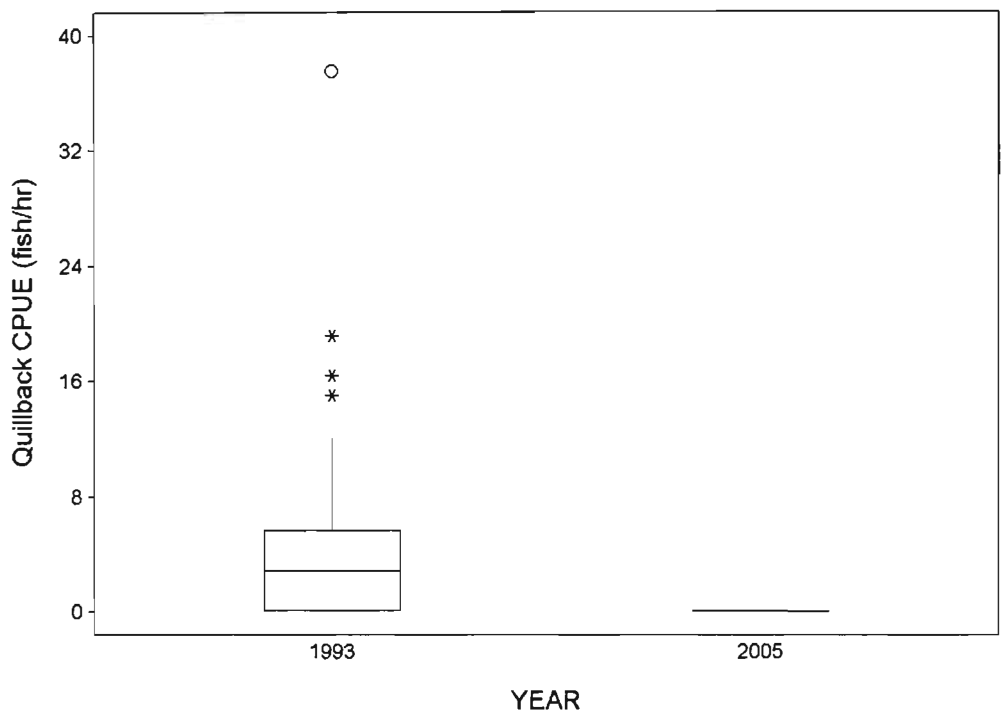


Figure 4. Boxplot representing copper rockfish CPUE (fish/hour) by depth stratum per year in Statistical Areas 18 and 19. A=Shallow (0-25m), B=Deep (26-50 m). The median is indicated by the horizontal line in the box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by * and °. Copper rockfish were significantly lower in both depth strata in 2005 than in 1993.

A



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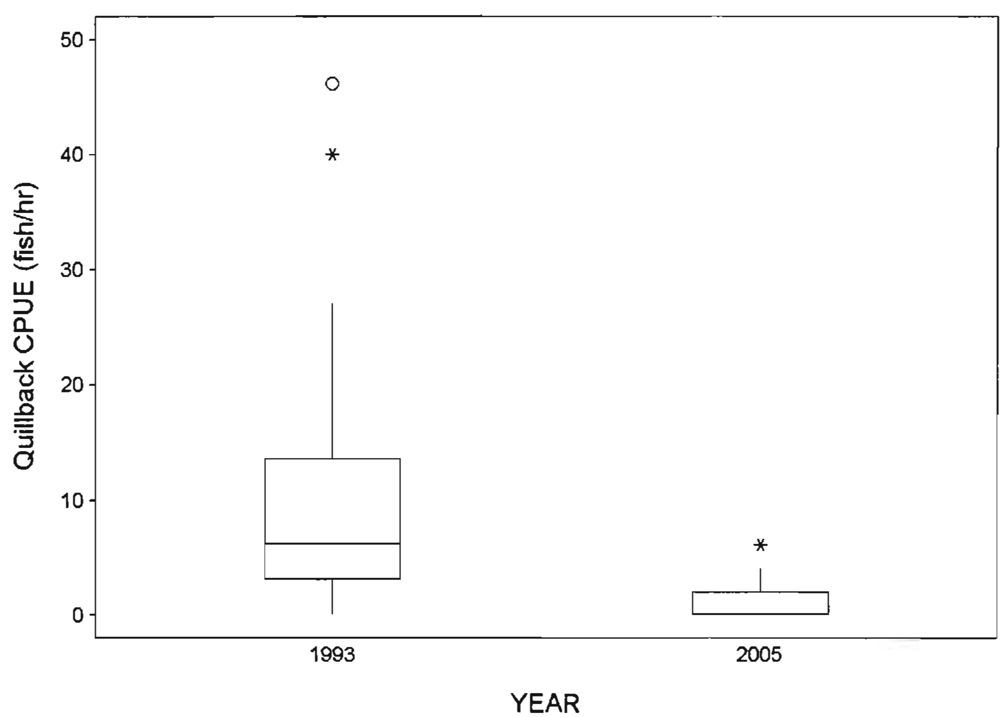
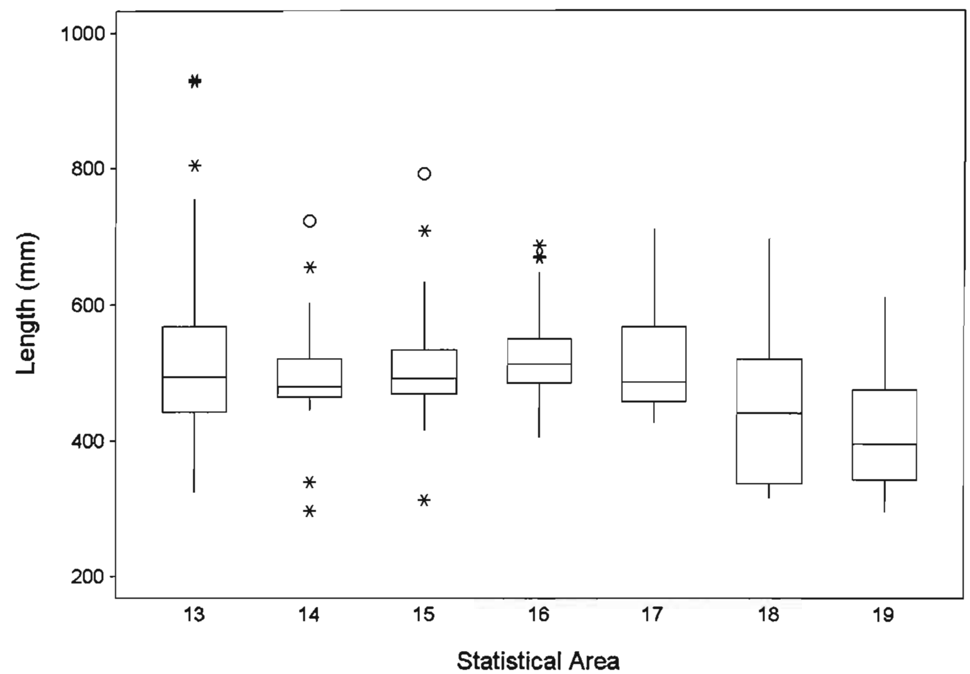


Figure 5. Boxplot representing the quillback rockfish catch per unit of effort (fish per hour) by depth stratum per year in Statistical Areas 18 and 19. A=Shallow (0-25m), B=Deep (26-50 m). The median is indicated by the horizontal line in the box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by * and °. Quillback catch rates were significantly lower in both depth strata in 2005 than they were in 1993.

A



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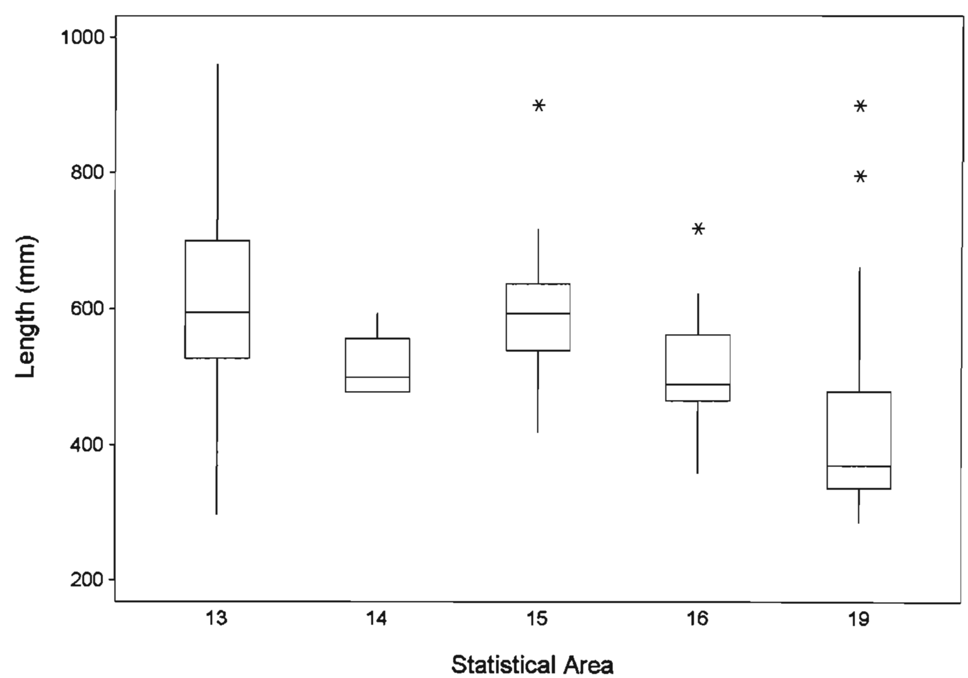

Figure 6. Boxplot representing the length (mm) of lingcod caught by Statistical Area. Data in SA 13-17 were collected June 14-July 9, 2004; data in SA 18 and 19, June 19-29, 2005. A=Shallow (0-25m), B=Deep (26-50 m). The median is indicated by the horizontal line in the box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by * and °. Significantly longer lingcod were caught in the shallow stratum of SA 16 than in SA 18. Lingcod in the shallow stratum of SA 19 were also smaller than those caught in SA 13, 15. In the deep stratum, significantly longer lingcod were caught in SA 13 and 15 than in SA 19.

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APPENDIX

Appendix Table 1. Location, depth, time, and environmental characteristics for each fishing set for the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 – 29, 2005. SA = Statistical Area. Depth stratum (DS) 1 = 0-25 m (shallow); depth stratum 2 = 26-50 m (deep). See Appendix Table 8 for sea state, tide, current, and weather codes.

Set	Month	Day	Site No.	Site name	SA	DS	Latitude (DD)	Longitude (DD)	Modal Depth (m)	Start Time	Finish Time	Sea State	Tide	Current	Weather
1	6	20	104	Coal	18	1	48.6837	-123.3647	18	9:35	10:20	1	4	1	1
2	6	20	104	Coal	18	2	48.6784	-123.3648	34	10:26	12:00	1	4	0	1
3	6	20	209	Moresby	18	1	48.7319	-123.3333	8	12:43	13:20	2	2	0	1
4	6	20	209	Moresby	18	2	48.7318	-123.3053	45	13:30	15:30	2	2	0	1
5	6	20	204	Imrie	18	1	48.6939	-123.3313	8	15:50	16:30	3	2	0	1
6	6	21	320	Discovery	19	1	48.4195	-123.2318	8	9:00	9:45	0	4	0	3
7	6	21	320	Discovery	19	2	48.4138	-123.2361	38	9:50	10:40	0	4	0	3
8	6	21	323	Ten Mile Pt	19	1	48.4514	-123.2623	14	11:00	11:50	0	2	0	3
9	6	21	203	D'arcy	19	1	48.5658	-123.2215	12	13:40	14:10	1	2	1	4
10	6	21	203	D'arcy	19	2	48.5597	-123.2823	29	14:20	15:10	1	2	1	4
11	6	22	103	Russel	18	1	48.7500	-123.4028	12	8:35	9:25	1	4	0	4
12	6	22	103	Russel	18	2	48.7463	-123.4134	38	9:35	10:22	1	4	3	4
13	6	22	208	Wallace Pt	18	1	48.7363	-123.2344	16	10:58	11:50	2	4	3	4
14	6	22	208	Wallace Pt	18	2	48.7360	-123.2343	38	12:20	13:15	3	2	3	4
15	6	22	110	Gooch	19	2	48.6623	-123.3025	43	13:40	15:13	2	2	0	4
16	6	22	110	Gooch	19	1	48.6580	-123.3008	12	15:24	16:14	3	2	5	1
17	6	23	109	Taylor Pt	18	1	48.7629	-123.1313	8	9:30	10:25	0	1	1	3
18	6	23	109	Taylor Pt	18	2	48.7621	-123.1356	35	10:30	11:30	0	1	1	4
19	6	23	208	Wallace Pt	18	1	48.7366	-123.2305	8	11:40	12:15	0	4	1	1
20	6	23	208	Wallace Pt	18	2	48.7366	-123.2369	40	12:55	13:25	0	4	3	1
21	6	23	204	Imrie	18	2	48.6954	-123.3363	40	13:45	14:35	1	4	1	1
22	6	23	207	Forest	19	1	48.6620	-123.3404	14	14:45	15:20	0	2	1	1
23	6	23	207	Forest	19	2	48.6627	-123.3429	39	15:30	16:30	0	2	1	1
24	6	24	104	Coal	18	1	48.6774	-123.3743	15	8:30	9:17	0	1	3	4
25	6	24	104	Coal	18	2	48.6771	-123.3651	-	9:30	10:24	1	1	3	3
26	6	25	110	Gooch	19	2	48.6552	-123.3016	42	9:30	11:30	1	1	5	3
27	6	25	110	Gooch	19	1	48.6569	-123.3003	8	11:35	12:10	1	1	1	3
28	6	25	207	Forest	19	1	48.6613	-123.3395	14	12:35	13:26	2	4	3	3
29	6	25	207	Forest	19	2	48.6610	-123.3416	38	13:30	14:45	1	4	3	1
30	6	25	104	Coal	18	2	48.6876	-123.3631	30	15:15	16:00	1	2	0	1
31	6	26	203	D'arcy	19	1	48.5620	-123.2699	11	9:45	10:30	3	1	3	4

Appendix Table 1. (Cont.)

Set	Month	Day	Site No.	Site name	SA	DS	Latitude (DD)	Longitude (DD)	Mode Depth (m)	Start Time	Finish Time	Sea State	Tide	Current	Weather
32	6	26	203	D'arcy	19	2	48.5574	-123.2491	42	11:00	12:39	4	1	3	4
33	6	26	204	Imrie	18	1	48.6944	-123.3358	12	13:40	14:30	2	2	3	4
34	6	26	204	Imrie	18	2	48.6957	-123.3316	45	14:40	15:10	2	2	1	4
35	6	27	325	Brotchie L.	19	2	48.4069	-123.3876	11	10:10	10:50	2	1	1	4
36	6	27	325	Brotchie L.	19	2	48.4038	-123.3877	35	11:05	11:35	2	1	3	4
37	6	27	324	Trial	19	2	48.3925	-123.3036	30	12:15	12:44	1	1	3	2/6
38	6	27	324	Trial	19	1	48.3945	-123.3058	14	12:55	13:25	1	4	3	2/6
39	6	27	321	Great Chain	19	1	48.4206	-123.2778	14	13:44	14:15	1	1	3	4
40	6	27	321	Great Chain	19	2	48.4265	-123.2662	28	14:25	15:00	1	4	3	4
41	6	27	323	Ten Mile Pt	19	2	48.4536	-123.2592	36	15:15	15:53	1	4	1	3
42	6	27	323	Ten Mile Pt	19	1	48.4513	-123.2623	14	16:05	16:32	2	2	1	4
43	6	28	322	Beaumont	19	2	48.4524	-123.1834	42	10:00	11:30	1	1	1	3
44	6	28	320	Discovery	19	1	48.4192	-123.2316	12	11:41	12:10	1	1	1	4
45	6	28	320	Discovery	19	2	48.4146	-123.2430	42	12:40	13:26	1	1	3	4
46	6	28	324	Trial	19	1	48.3944	-123.3064	14	13:40	14:15	2	4	3	3
47	6	28	324	Trial	19	2	48.3925	-123.3045	38	14:20	14:45	2	4	3	3
48	6	28	321	Great Chain	19	1	48.4223	-123.2785	14	14:55	15:25	2	4	3	3
49	6	28	321	Great Chain	19	2	48.4278	-123.2676	38	15:35	16:03	2	4	3	3
50	6	29	326	Chatham	19	2	48.4457	-123.2507	39	9:54	10:50	2	4	3	4
51	6	29	326	Chatham	19	1	48.4456	-123.2379	15	11:00	11:40	3	3	3	3
52	6	29	104	Coal	18	2	48.6871	-123.3641	42	13:00	13:30	4	3	3	3
53	6	29	209	Moresby	18	1	48.7321	-123.3361	15	13:45	14:20	4	3	3	1
54	6	29	209	Moresby	18	2	48.7209	-123.2945	42	14:25	15:10	3	1	1	1
55	6	26	203	D'arcy	19	2	48.5574	-123.2491	42	11:00	12:39	4	1	3	4

Appendix Table 2. Effort data by set and depth stratum for each fisher and number of fish caught by species for the 2005 hook and line survey of lingcod and rockfish (RF) in the Strait of Georgia, June 19 – 29, 2005. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). Species codes: 467=lingcod, 044=spiny dogfish, 407=copper rockfish, 424=quillback rockfish, 461=kelp greenling, 621=rock sole, 124=chinook salmon, 596=Pacific sanddab.

				Effort (minutes)													
Set	Month	Day	DS	Fisher 1	Fisher 2	Fisher 3	Fisher 4	Total time	Total fish	467	044	407	424	461	621	124	596
1	6	20	1	7.5	7.5	7.5	7.5	30	3	3	0	0	0	0	0	0	0
2	6	20	2	7.75	7.75	7.5	7	30	2	0	0	0	1	0	1	0	0
3	6	20	1	7.5	7.5	7.5	7.5	30	4	3	0	1	0	0	0	0	0
4	6	20	2	7.5	7.5	7.5	7.5	30	6	0	1	1	3	0	0	0	1
5	6	20	1	7.5	7.5	7.5	7.5	30	1	0	0	1	0	0	0	0	0
6	6	21	1	7.5	7.5	7.75	7.5	30.25	5	4	0	0	0	0	0	0	0
7	6	21	2	7.5	7.5	7.5	7.5	30	8	6	0	0	2	0	0	0	0
8	6	21	1	7.75	7.5	7.5	7.5	30.25	7	3	0	1	0	3	0	0	0
9	6	21	1	7	7.5	7.5	8	30	0	0	0	0	0	0	0	0	0
10	6	21	2	8	7.5	7.5	7	30	1	0	0	0	1	0	0	0	0
11	6	22	1	7.5	7.5	7.5	7.5	30	1	0	0	0	0	0	0	0	1
12	6	22	2	7	7.75	7.75	7.5	30	2	0	0	0	0	0	0	0	2
13	6	22	1	7.5	7.5	7.5	7.5	30	3	1	0	1	0	1	0	0	0
14	6	22	2	6.5	7.5	7.5	8.5	30	0	0	0	0	0	0	0	0	0
15	6	22	2	9	7.5	6	7.5	30	1	1	0	0	0	0	0	0	0
16	6	22	1	5.5	9.5	7.5	7.5	30	1	1	0	0	0	0	0	0	0
17	6	23	1	7.5	7.5	7.5	7.5	30	11	8	0	2	0	1	0	0	0
18	6	23	2	7.5	7.5	7.5	7.5	30	8	1	0	5	2	0	0	0	0
19	6	23	1	7.5	7.5	7.5	7.5	30	0	0	0	0	0	0	0	0	0
20	6	23	2	3	2	3.5	2	10.5	0	0	0	0	0	0	0	0	0
21	6	23	2	7.5	7.5	7.5	7.5	30	1	0	0	0	0	0	0	1	0
22	6	23	1	7.5	7.5	7.5	7.5	30	2	1	1	0	0	0	0	0	0
23	6	23	2	8	7	6.5	8.5	30	7	3	2	0	2	0	0	0	0
24	6	24	1	7.75	7.5	7	7.75	30	4	3	1	0	0	0	0	0	0
25	6	24	2	0.75	1	1.5	1.5	4.75	0	0	0	0	0	0	0	0	0
26	6	25	2	7.5	7.5	6.5	8.5	30	3	0	1	1	0	0	0	0	1

Appendix Table 2. (Cont.)

Set	Month	Day	DS	Effort (minutes) Fisher 1	Fisher 2	Fisher 3	Fisher 4	Fisher 5	Total	Total fish	467	044	407	424	461	621	124	596
27	6	25	1	7.5	6.5	7.5	8	29.5	1	1	0	0	0	0	0	0	0	7.5
28	6	25	1	6.5	7.5	8.5	7.5	30	4	2	0	2	0	0	0	0	0	6.5
29	6	25	2	8.5	7.5	6.5	7.5	30	5	2	2	0	1	0	0	0	0	8.5
30	6	25	2	6.5	8.5	7.5	7.5	30	3	3	0	0	0	0	0	0	0	6.5
32	6	26	1	7.5	7.5	7.5	7.5	30	10	8	0	2	0	0	0	0	0	7.5
33	6	26	2	4.5	3	8.5	7.5	23.5	2	0	2	0	0	0	0	0	0	4.5
34	6	26	1	7.5	6.5	7.5	8.5	30	3	3	0	0	0	0	0	0	0	7.5
35	6	26	2	7.25	7.5	7.5	7.75	30	3	0	3	0	0	0	0	0	0	7.25
36	6	27	2	7.5	8	7	7.5	30	1	1	0	0	0	0	0	0	0	7.5
37	6	27	2	3.5	3.5	3.5	3.5	14	0	0	0	0	0	0	0	0	0	3.5
38	6	27	2	7.5	7.5	7.5	7.5	30	1	1	0	0	0	0	0	0	0	7.5
39	6	27	1	7.5	7.5	7.5	7.5	30	8	7	0	0	0	1	0	0	0	7.5
40	6	27	1	7.5	7.5	7.5	7.5	30	2	1	0	1	0	0	0	0	0	7.5
41	6	27	2	7.5	7.5	7.5	7.5	30	9	9	0	0	0	0	0	0	0	7.5
42	6	27	2	7.5	7.5	7.5	7.5	30	5	0	0	0	2	0	0	0	3	7.5
43	6	27	1	7.5	7.5	7.5	7.5	30	5	3	0	2	0	0	0	0	0	7.5
44	6	28	2	7.5	7.5	8	7	30	24	14	0	0	7	3	0	0	0	7.5
45	6	28	1	7.5	7.5	7.5	7.5	30	8	4	0	0	1	3	0	0	0	7.5
46	6	28	2	6.5	7.5	7.5	8.5	30	4	4	0	0	0	0	0	0	0	6.5
47	6	28	1	7.5	7.5	7.5	7.5	30	7	5	0	0	0	2	0	0	0	7.5
48	6	28	2	7.75	7.75	6.5	8.25	30.25	2	1	1	0	0	0	0	0	0	7.75
49	6	28	1	7.5	7.5	7.5	7.5	30	3	1	0	0	0	2	0	0	0	7.5
50	6	28	2	6.5	7.5	8.5	7.5	30	9	7	0	0	2	0	0	0	0	6.5
51	6	29	2	7.5	8	7	7.5	30	8	2	4	0	2	0	0	0	0	7.5
52	6	29	1	6.5	7.5	8.5	7.5	30	6	5	0	1	0	0	0	0	0	6.5
53	6	29	2	5.5	3	4.5	0	13	3	0	3	0	0	0	0	0	0	5.5
54	6	29	1	6.5	7.5	8.5	7.5	30	2	2	0	0	0	0	0	0	0	6.5
55	6	29	2	7.5	6.5	8.5	7.5	30	2	0	0	1	0	0	0	0	1	7.5

Appendix Table 3. Capture depth (m), biological data and fisher ID for lingcod (*Ophiodon elongatus*) captured during the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 – 29, 2005. Sex: 1=male, 2=female, 3=undetermined. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). Lingcod without lengths were not landed (NL). All fish were released unless noted as kept[1].

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Sex	Fisher
1	104	Coal	6	20	1	12	315	3	3
1	104	Coal	6	20	1	14	435	3	4
1	104	Coal	6	20	1	17	321	3	3
3	209	Moresby	6	20	1	8	541	3	3
3	209	Moresby	6	20	1	8	636	1	2
3	209	Moresby	6	20	1	11	469	3	4
6	320	Discovery	6	21	1	7	489	3	4
6	320	Discovery	6	21	1	9	330	3	3
6	320	Discovery	6	21	1	9	449	3	2
6	320	Discovery	6	21	1	12	462	3	4
7	320	Discovery	6	21	2	34	547	3	3
7	320	Discovery	6	21	2	37	310	3	1
7	320	Discovery	6	21	2	37	390	3	2
7	320	Discovery	6	21	2	38	335	3	1
7	320	Discovery	6	21	2	41	474	1	1
7	320	Discovery	6	21	2	41	516	3	1
8	323	Ten Mile	6	21	1	8	317	3	3
8	323	Ten Mile	6	21	1	8	339	1	3
8	323	Ten Mile	6	21	1	9	430	1	2
13	208	Wallace	6	22	1	18	381	3	3
15	110	Gooch	6	22	2	–	NL	3	4
16	110	Gooch	6	22	1	12	571	1	2
17	109	Taylor Pt	6	23	1	7	445	2	4
17	109	Taylor Pt	6	23	1	8	348	3	3
17	109	Taylor Pt	6	23	1	10	327	3	2
17	109	Taylor Pt	6	23	1	10	352	3	4
17	109	Taylor Pt	6	23	1	10	485	1	2
17	109	Taylor Pt	6	23	1	11	560	1	1
17	109	Taylor Pt	6	23	1	12	520	2	4
17	109	Taylor Pt	6	23	1	15	335	3	2
18	109	Taylor Pt	6	23	2	37	485	2	4
22	207	Forest	6	23	1	15	457	3	3
23	207	Forest	6	23	2	35	589	2	3
23	207	Forest	6	23	2	38	NL	3	4
23	207	Forest	6	23	2	38	588	2	2
24	104	Coal	6	24	1	16	340	3	4
24	104	Coal	6	24	1	16	596	1	1
24	104	Coal	6	24	1	18	NL	3	3
27	110	Gooch	6	25	1	8	405	3	3
28	207	Forest	6	25	1	19	610	2	4
28	207	Forest	6	25	1	21	498	2	4
29	207	Forest	6	25	2	38	796	2	3
29	207	Forest	6	25	2	40	660	2	4

Appendix Table 3. (Cont.)

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Sex	Fisher
31	203	D'arcy	6	26	1	6	406	2	2
31	203	D'arcy	6	26	1	6	515	2	4
31	203	D'arcy	6	26	1	10	460	2	1
31	203	D'arcy	6	26	1	10	566	1	3
31	203	D'arcy	6	26	1	11	NL	3	4
31	203	D'arcy	6	26	1	11	435	1	2
31	203	D'arcy	6	26	1	11	475	1	1
33	204	Imrie	6	26	1	11	480	1	2
33	204	Imrie	6	26	1	17	326	3	4
33	204	Imrie	6	26	1	17	695	2	2
35	325	Brotchie	6	27	2	12	569	1	3
38	324	Trial	6	27	2	41	286	3	3
39	324	Trial	6	27	1	9	535	2	3
39	324	Trial	6	27	1	9	565	1	1
39	324	Trial	6	27	1	12	450	1	4
39	324	Trial	6	27	1	13	324	3	3
39	324	Trial	6	27	1	14	395	2	1
39	324	Trial	6	27	1	14	495	1	4
39	324	Trial	6	27	1	15	346	3	4
40	321	Great Chain	6	27	1	15	300	2	3
41	321	Great Chain	6	27	2	26	311	3	3
41	321	Great Chain	6	27	2	26	335	3	2
41	321	Great Chain	6	27	2	26	480	2	1
41	321	Great Chain	6	27	2	28	302	3	3
41	321	Great Chain	6	27	2	28	308	3	2
41	321	Great Chain	6	27	2	29	329	3	1
41	321	Great Chain	6	27	2	34	477	1	3
41	321	Great Chain	6	27	2	35	350	3	2
41	321	Great Chain	6	27	2	35	541	2	3
43	323	Ten Mile	6	27	1	12	339	3	2
43	323	Ten Mile	6	27	1	17	295	3	3
43	323	Ten Mile	6	27	1	22	344	3	3
44	322	Beaumont	6	28	2	36	505	2	1
44	322	Beaumont	6	28	2	38	350	3	1
44	322	Beaumont	6	28	2	39	494	1	4
44	322	Beaumont	6	28	2	40	322	3	2
44	322	Beaumont	6	28	2	40	335	2	4
44	322	Beaumont	6	28	2	41	310	3	3
44	322	Beaumont	6	28	2	42	363	3	3
44	322	Beaumont	6	28	2	42	374	3	4
44	322	Beaumont	6	28	2	42	460	1	3
44	322	Beaumont	6	28	2	42	525	2	4
44	322	Beaumont	6	28	2	45	370	3	4
44	322	Beaumont	6	28	2	45	390	3	2
44	322	Beaumont	6	28	2	45	397	3	3

Appendix Table 3. (Cont.)

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Sex	Fisher
44	322	Beaumont	6	28	2	48	500	3	3
45	320	Discovery	6	28	1	7	325	3	2
45	320	Discovery	6	28	1	13	344	3	3
45	320	Discovery	6	28	1	14	358	3	1
45	320	Discovery	6	28	1	16	454	1	4
46	320	Discovery	6	28	2	28	435	2	1
46	320	Discovery	6	28	2	39	350	3	2
46	320	Discovery	6	28	2	42	310[1]	3	4
46	320	Discovery	6	28	2	42	347	3	3
47	324	Trial	6	28	1	12	370[1]	3	1
47	324	Trial	6	28	1	13	315[1]	3	1
47	324	Trial	6	28	1	14	354	3	3
47	324	Trial	6	28	1	14	392	3	3
47	324	Trial	6	28	1	16	344[1]	3	1
48	324	Trial	6	28	2	36	310[1]	3	3
49	321	Great Chain	6	28	1	15	341	3	3
50	321	Great Chain	6	28	2	32	336	3	3
50	321	Great Chain	6	28	2	33	288	3	2
50	321	Great Chain	6	28	2	33	365	3	4
50	321	Great Chain	6	28	2	33	462	2	1
50	321	Great Chain	6	28	2	35	306	3	4
50	321	Great Chain	6	28	2	35	410	1	3
50	321	Great Chain	6	28	2	38	442	3	1
51	326	Chatham	6	29	2	38	352	3	4
51	326	Chatham	6	29	2	39	345	3	4
52	326	Chatham	6	29	1	6	336	3	4
52	326	Chatham	6	29	1	9	383	3	3
52	326	Chatham	6	29	1	12	393	3	1
52	326	Chatham	6	29	1	20	306	3	4
52	326	Chatham	6	29	1	22	504	1	3
54	209	Moresby	6	29	1	15	508	2	3
54	209	Moresby	6	29	1	16	335[1]	3	1

[1] kept.

Appendix Table 4. Capture depth (m), biological data, and fisher ID for Copper rockfish (*Sebastes caurinus*) captured during the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 –29, 2005. Sex: 1=male, 2=female, 3=undetermined. For maturity codes, see Appendix Table 9. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). Fish were frozen at the end of each field day and sampled at a later date. Fish lengths are fresh lengths.

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Weight (g)	Sex	Maturity	Fisher
3	Moresby	209	6	20	1	7	300	423	2	7	3
4	Moresby	209	6	20	2	38	280	370	2	7	4
5	Imrie	204	6	20	1	6	289				1
8	Ten Mile	323	6	21	1	8	305	471	1	7	2
13	Wallace	208	6	22	1	18	335	590	2	7	4
17	Taylor	109	6	23	1	9	275	355	2	6	4
17	Taylor	109	6	23	1	10	247	264	1	2	1
18	Taylor	109	6	23	2	37	371	853	2	7	3
18	Taylor	109	6	23	2	27	366	726	2	7	4
18	Taylor	109	6	23	2	27	372	845	2	7	3
18	Taylor	109	6	23	2	25	369	929	2	6	1
18	Taylor	109	6	23	2	35	361	767	1	7	3
26	Gooch	110	6	25	2	31	340	474	1	7	3
28	Forest	207	6	25	1	15	300	483	2	3	3
28	Forest	207	6	25	1	13	315	541	2	6	4
31	D'arcy	203	6	26	1	6	344	801	2	6	3
31	D'arcy	203	6	26	1	9	348	730	1	7	3
40	Great Chain	321	6	27	1	12	320	560	1	7	4
43	Ten Mile	323	6	27	1	9	312	523	2	6	1
43	Ten Mile	323	6	27	1	12	261	338	1	2	3
52	Chatham	326	6	29	1	16	373	916	1	7	3
55	Moresby	209	6	29	2	35	282	360	1	7	2

Appendix Table 5. Capture depth (m), biological data, and fisher ID for Quillback rockfish (*Sebastes maliger*) captured during the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 –29, 2005. Sex: 1=male, 2=female, 3=undetermined. For maturity codes, see Appendix Tables 9. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). Fish were frozen at the end of each field day and sampled at a later date. Fish lengths are fresh lengths.

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Weight (g)	Sex	Maturity	Fisher
2	Coal	104	6	20	2	30	355	838	1	7	4
4	Moresby	209	6	20	2	49	265	1121	1	7	4
4	Moresby	209	6	20	2	44	324	591	1	7	3
4	Moresby	209	6	20	2	33	400	1171	2	7	3
7	Discovery	320	6	21	2	36	334	680	1	7	3
7	Discovery	320	6	21	2	35	388[1]				2
10	D'arcy	203	6	21	2	25	290	448	1	7	4
18	Taylor	109	6	23	2	42	300	462	2	3	3
18	Taylor	109	6	23	2	32	239	221	1	2	2
23	Forest	207	6	23	2	38	328	669	2	3	3
23	Forest	207	6	23	2	38	390	1227	2	7	1
29	Forest	207	6	25	2	38	390	1206	2	7	4
42	Ten Mile	323	6	27	2	34	240	224	2	2	4
42	Ten Mile	323	6	27	2	36	306	507	1	7	3
44	Beaumont	322	6	28	2	34	349	813	2	7	4
44	Beaumont	322	6	28	2	40	432	1837	2	7	1
44	Beaumont	322	6	28	2	42	360	903	1	7	4
44	Beaumont	322	6	28	2	40	345	672	1	7	1
44	Beaumont	322	6	28	2	48	409	1340	2	7	1
44	Beaumont	322	6	28	2	55	450	2047	2	7	3
44	Beaumont	322	6	28	2	41	474	2157	1	7	3
45	Discovery	320	6	28	1	20	323[2]				3
50	Great Chain	321	6	28	2	28	250	288	1	7	1
50	Great Chain	321	6	28	2	28	282	403	2	2	3
51	Chatham	326	6	29	2	39	362	910	1	7	4

[1]Not Sampled, [2]Not landed

Appendix Table 6. Capture depth (m), biological data and fisher ID for kelp greenling (*Hexagrammos decagrammus*) captured during the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 – 29, 2005. Sex: 1=male, 2=female, 3=undetermined. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). All fish were released.

Set	Site #	Site Name	Month	Day	DS	Capture Depth (m)	Length (mm)	Sex	Fisher
6	Discovery	320	6	21	1	6	320	1	4
8	Ten Mile	323	6	21	1	8	371	1	1
8	Ten Mile	323	6	21	1	8	380	1	2
8	Ten Mile	323	6	21	1	8	380	1	3
13	Wallace	208	6	22	1	12	301	1	2
17	Taylor	109	6	23	1	12	376	2	2
31	D'arcy	203	6	26	1	6	428	2	2
39	Trial	324	6	27	1	12	335	1	1
44	Beaumont	322	6	28	2	38	320	2	3
44	Beaumont	322	6	28	2	38	323	2	1
44	Beaumont	322	6	28	2	42	345	2	3
45	Discovery	320	6	28	1	7	356	2	4
45	Discovery	320	6	28	1	8	363	2	1
45	Discovery	320	6	28	1	12	345	1	3
47	Trial	324	6	28	1	11	354	1	4
47	Trial	324	6	28	1	13	336	2	3
49	Great Chain	321	6	28	1	9	371	1	3
49	Great Chain	321	6	28	1	13	388	1	3

Appendix Table 7. Capture depth (m), biological data, fisher ID, and leader weight for dogfish (*Squalus acanthias*) (044), Chinook salmon (*Oncorhynchus tshawytscha*) (124), captured during the 2005 hook and line survey of lingcod and rockfish in the Strait of Georgia, June 19 – 29, 2005. Sex: 1=male, 2=female, 3=undetermined. Depth stratum (DS) 1 = 0-25 m (shallow); 2 = 26-50 m (deep). Dogfish without lengths were not landed (NL). All fish were released.

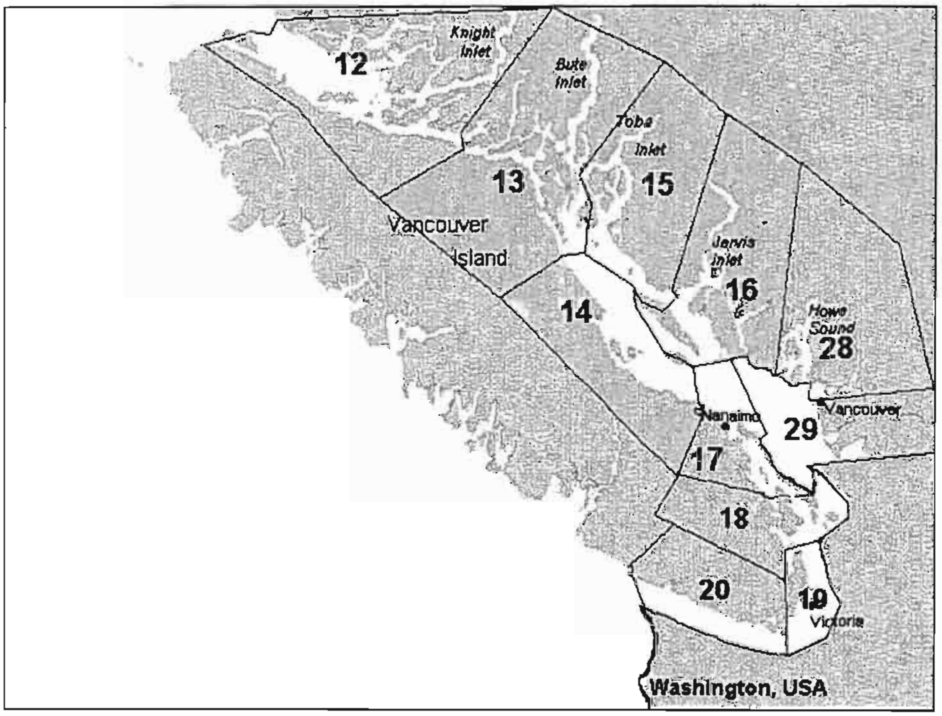
Set	Site #	Site Name	Month	Day	DS	Species	Capture Depth (m)	Length (mm)	Sex	Fisher
4	Moresby	209	6	20	2	044	45	740	1	3
22	Forest	207	6	23	1	044		NL		3
23	Forest	207	6	23	2	044		NL		3
24	Coal	104	6	24	1	044	17	NL		3
26	Gooch	110	6	25	2	044	37	NL	1	2
29	Forest	207	6	25	2	044	35	NL		1
29	Forest	207	6	25	2	044	35	648	2	4
30	Coal	104	6	25	2	044	30	NL		3
30	Coal	104	6	25	2	044	40	690	2	1
30	Coal	104	6	25	2	044	40	755	2	2
32	D'arcy	203	6	26	2	044	40	592	1	3
32	D'arcy	203	6	26	2	044	42	NL		3
34	Imrie	204	6	26	2	044	45	NL		3
34	Imrie	204	6	26	2	044	45	742	1	2
34	Imrie	204	6	26	2	044	48	665	2	4
48	Trial	324	6	28	2	044	37	NL		3
51	Chatham	326	6	29	2	044	34	NL		4
51	Chatham	326	6	29	2	044	40	NL	1	2
51	Chatham	326	6	29	2	044	42	NL		2
51	Chatham	326	6	29	2	044	42	NL		4
53	Coal	104	6	29	2	044	31	NL		3
53	Coal	104	6	29	2	044	42	NL		3
53	Coal	104	6	29	2	044	45	NL		3
21	Imrie	204	6	23	2	124	42	730		1
4	Moresby	209	6	20	2	596	40	276		4
11	Russel	103	6	22	1	596	16	282	2	3
12	Russel	103	6	22	2	596	28	345	2	2
12	Russel	103	6	22	2	596	38	285	2	1
26	Gooch	110	6	25	2	596	35	248	2	1
42	Ten Mile	323	6	27	2	596	36	295	2	4
42	Ten Mile	323	6	27	2	596	36	303		2
42	Ten Mile	323	6	27	2	596	37	225		3
55	Moresby	209	6	29	2	596	43	285	2	4
2	Coal	104	6	20	2	621	26	200	1	2

Appendix Table 8. Codes used to describe sea state, tide, current, and weather.

Code	Description
Sea State	
1	calm
2	ripple
3	chop
4	swell
Tide	
1	ebb
2	flood
3	high
4	low
Current	
0	none
1	weak (minimal)
2	moderate-weak
3	moderate
4	moderate-strong
5	strong
Weather	
1	sun
2	rain
3	partly cloudy
4	overcast
5	high cloud
6	fog/overcast

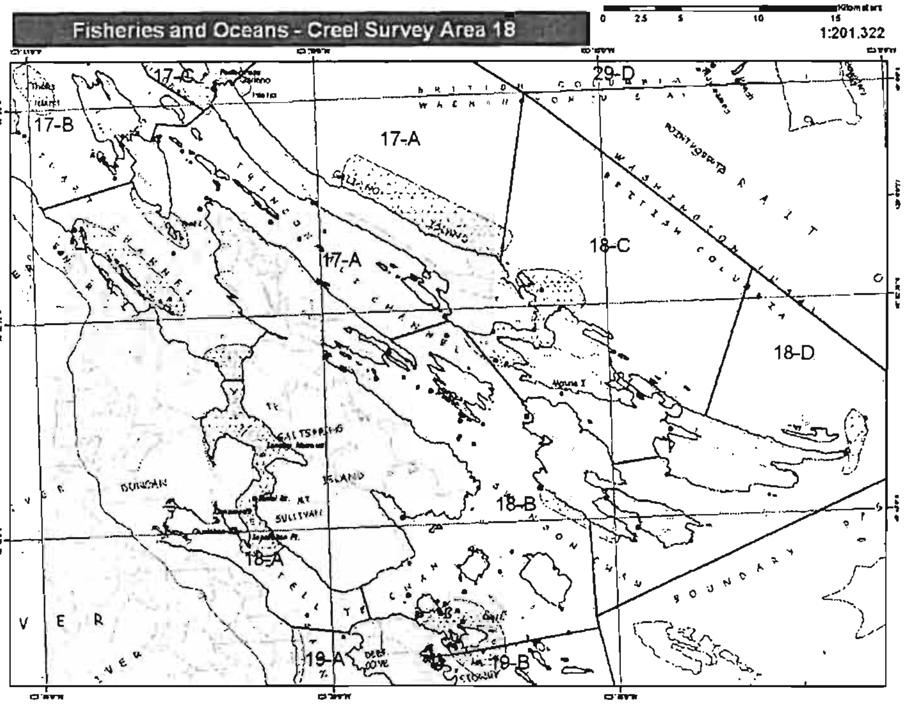
Appendix Table 9. Reproductive maturity codes.

Maturity Stage	Male	Female
	Rockfish (*Sebastes spp.*)	
STAGE 1: Immature	• Testes are translucent and string-like. • Located in the back of the body cavity	• Ovaries are translucent and very small • Colouring can be clear, amber, or yel4
STAGE 2: Maturing - small	• Testes are ribbon-like and swelling in size • Colour is translucent-white or brown-white	• Ovaries developing for this year's cycle but still relatively small • Ovaries semi-translucent or opaque • Colouring usually yel4, but can be 7 pink
STAGE 3: Maturing - large	• Testes are large • Colour is translucent-white	• Ovaries large and contain eggs that can be distinguished by direct observation • Eggs opaque and orange-yel4 or cream
STAGE 4: Mature	• Testes are very large and easily broken • Colour is white	• Ovaries are large • Eggs are translucent and orange-yel4 or cream
STAGE 5: Ripe	• Testes are very large with free f4ing sperm • Colour is white • Sperm is running when gonad is cut or fish's body cavity is pressed	• Ovaries large and full of eyed eggs or larvae • Eyed eggs translucent yel4 with visible black dots • Larvae grey to grey-green with black dots • Eyed eggs and larvae f4 freely from vent when pressure applied to body cavity
STAGE 6: Spent	• Testes are smaller. • Colour is creamy-brown. • When testes are broken, some remaining sperm is evident but is of a thicker consistency, not f4ing	• Ovaries large and flaccid • Colour red to red-purple • A few larvae may be present
STAGE 7: Resting	• Testes are smaller and ribbon-like • Colour is brown	• Ovaries firm and 3 in size • Colour red-grey; some with black blotches

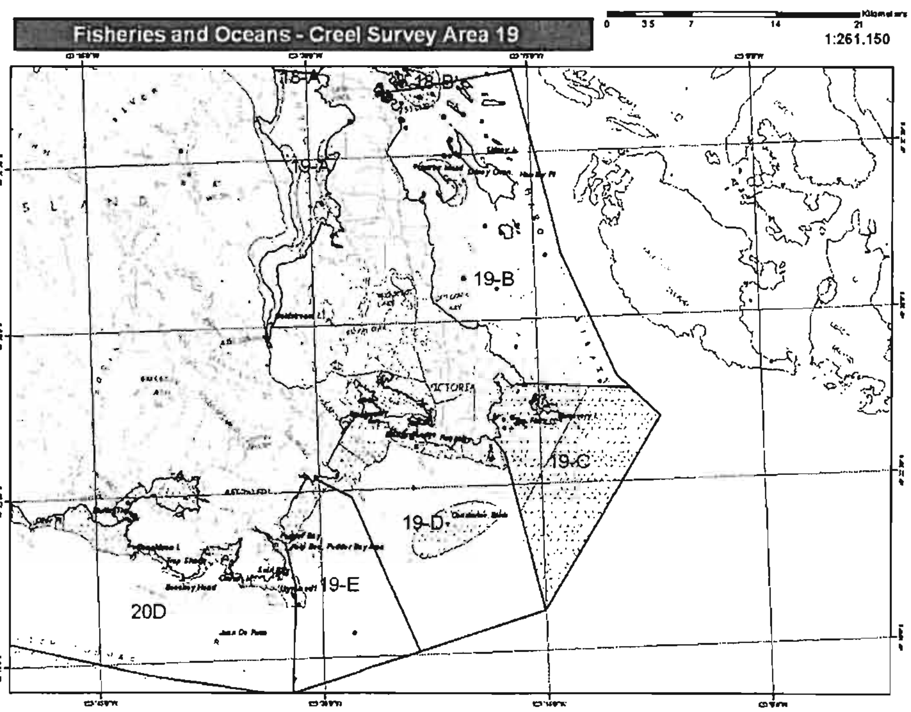


Appendix Figure 1. Minor Statistical Areas (SA) in the Strait of Georgia.

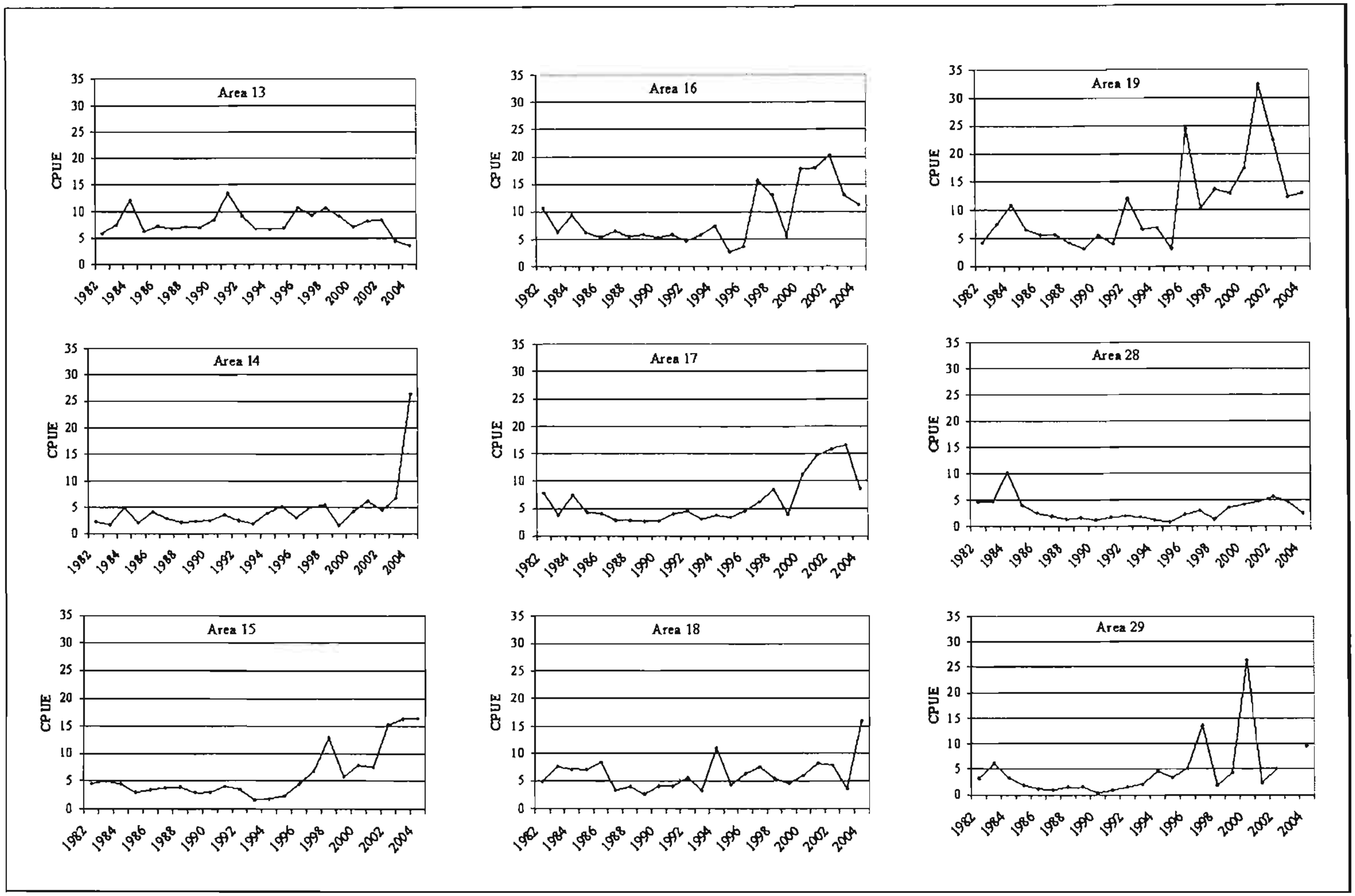
A



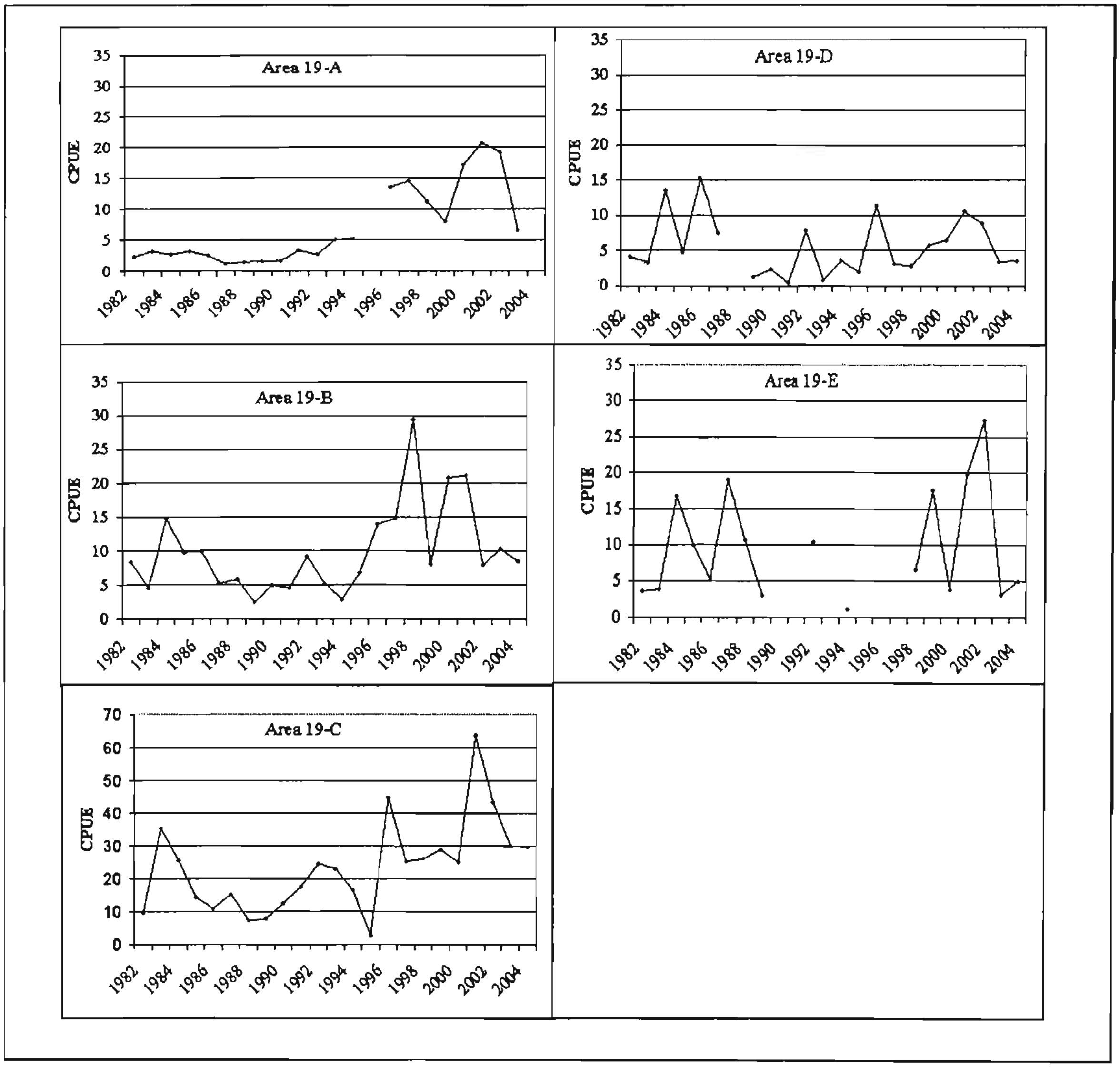
B



Appendix Figure 2. Strait of Georgia Creel Survey sub-areas. A=SA 18, B=SA 19.



Appendix Figure 3. Strait of Georgia Creel Survey Data by Statistical Area, 1982-2004, lingcod encounters (kept and released) per 100 hours of fishing in May to September, directed plus non-directed effort.



Appendix Figure 4. Strait of Georgia Creel Survey Data for sub-areas of SA 19, 1982-2004, lingcod encounters (kept and released) per 100 hours of fishing in May to September, directed plus non-directed effort. See Appendix Figure 2 for a map of creel survey sub-areas.