Summary Report for the Inshore Rockfish (*Sebastes spp.*) Longline Survey Conducted in Statistical Areas 14 to 20, 28 and 29, from August 11 to September 6, 2005

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SUMMARY REPORT FOR THE INSHORE ROCKFISH (*Sebastes spp.*) LONGLINE SURVEY CONDUCTED IN STATISTICAL AREAS 14 TO 20, 28 AND 29, FROM AUGUST 11 TO SEPTEMBER 6, 2005

by

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Since 2003, a longline survey has been conducted in portions of the inside waters between Vancouver Island and the mainland, referred to as the Strait of Georgia Management region (statistical areas 12 to 20, 28 and 29), to provide catch rate indices and associated biological data for the assessment of inshore rockfish (*Sebastes ruberrimus, S. maliger, S. caurinus, S. nebulosus* and *S. nigrocinctus*). Statistical areas (SA) 12 and 13 were surveyed in the first two years and in 2005 the survey was moved south to SA 14 through 20, 28 and 29. Similar fishing and sampling methods were used for all three surveys (Lochead and Yamanaka, 2004, 2006). This report summarizes catch and biological sample data from the 2005 survey, and presents spatial analyses of catch rate by statistical area based on data from the 2003, 2004 and 2005 surveys. Quillback rockfish catch rates are low (<1 kg/skate) in SA 15 through 20, 28 and 29 and higher in SA 12 to 14. Catch rates are highest in SA 12 for quillback rockfish. Yelloweye rockfish catch rates are low (<1 kg/skate) in SA 18 through 20, 28 and 29 and higher in SA 12 through 17. Catch rates are highest in SA 15 for yelloweye rockfish.

Habitat is known to be an important influence on the distribution of rockfishes with the variation in substrate type and slope contributing to catch rate variability among sets. A spatial analysis of species catch rate and substrate class, determined by bathymetric position index (BPI) values, was conducted to quantify the catch rate-substrate relationship. Results indicate that quillback rockfish and yelloweye rockfish catch rates varied significantly with BPI classes. BPI analyses may be useful in future survey design whereby specific slope classes or habitats are targeted to reduce catch rate variability.

RÉSUMÉ

Lochead, J.K., and Yamanaka, K.L. 2007. Summary report for the inshore rockfish (*Sebastes spp.*) longline survey conducted in Statistical Areas 14 to 20, 28 and 29, from August 11 to September 6, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2690: viii + 53 p.

Depuis 2003, un relevé à la palangre est effectué dans les eaux intérieures situées entre l'île de Vancouver et la terre ferme, désignées comme la région de gestion du détroit de Georgia (zones satistiques 12 à 20, et 28 et 29), en vue d'obtenir des indices de taux de capture et des données biologiques connexes pour l'évaluation des sébastes côtiers (*Sebastes ruberrimus, S. maliger, S. caurinus, S. nebulosus* et *S. nigrocinctus*). Les zones statistiques 12 et 13 ont été recensées en 2003 et 2004. En 2005, le relevé a été effectué plus au sud, dans les zones 14 à 20 et les zones 28 et 29. Les mêmes méthodes de pêche et d'échantillonnage ont été utilisées pour les trois relevés (Lochead et Yamanaka, 2004; 2006). Sont ici résumées les données sur les prises et les données biologiques recueillies dans le cadre du relevé de 2005 et présentées des analyses spatiales des taux de capture selon la zone statistique fondées sur les données recueillies en 2003, 2004 et 2005. Les taux de capture du sébaste à dos épineux dans les zones 15 à 20, ainsi que dans les zones 28 et 29, sont faibles (<1 kg/jeu de lignes); ils sont plus élevés dans les zones 12 à 14, en particulier dans la zone 12. Les taux de capture du sébaste aux yeux jaunes sont faibles dans les zones 18 à 20, ainsi que dans les zones 28 et 29 (< 1 kg/jeu de lignes); ils sont plus élevés dans les zones 12 à 17, en particulier dans la zone 15.

L'habitat est reconnu comme agissant fortement sur la distribution des sébastes. La variation dans le type de substrat et la pente contribue à la variabilité des taux de capture entre les mouillages. L'analyse spatiale des taux de capture de chaque espèce selon le type de substrat, établi d'après les indices de position bathymétrique (IPB), a servi à quantifier la relation entre le taux de capture et le type de substrat. Les résultats de cette analyse révèlent que les taux de capture du sébaste à dos épineux et du sébaste aux yeux jaunes varient significativement selon les classes d'IPB. L'analyse des IPB pourrait se révéler utile dans la conception des plans d'échantillonnage futurs du fait qu'elle permettrait de cibler des classes de pente ou des parcelles d'habitat précises afin de réduire la variabilité des taux de capture.

1.0 INTRODUCTION

To provide a relative index of abundance for the assessment of inshore rockfish stocks, a longline survey has been conducted in the Strait of Georgia Management region annually since 2003. In 2003, a pilot survey was conducted in Statistical Areas (SA) 12 and 13 (Lochead and Yamanaka, 2004). In 2004, SA 12 and 13 were re-surveyed and the inter-annual variability in catch rates quantified (Lochead and Yamanaka, 2006). In 2005, SA 14 – 20, 28 and 29 were surveyed to expand the spatial coverage of relative abundance indices and biological data to the entire Strait of Georgia Management region.

2.0 METHODS

The 2005 survey methodology was identical to that used in 2003 and 2004. A general description of the survey methods is presented below; for a more detailed description see Lochead and Yamanaka (2004).

2.1 Survey Design

The survey employed a depth-stratified, random design to select 2 km by 2 km survey blocks to fish (Lochead and Yamanaka 2004). All waters in SA 14 – 20, 28 and 29 between the depths of 41 to 100 metres were stratified into shallow (41 – 70m) and deep (71 – 100m) depth strata using Canadian Hydrographic Service (CHS) charts. To ensure rockfish habitat was targeted, CHS charts were used to eliminate blocks that were located on flat, mud or sandy bottom. A total of 1114 blocks remained and these blocks were spatially stratified by statistical area then eight percent of the blocks within each statistical area were randomly selected to fish (ESRI ® ArcMap™ 9.0), totalling 89 sampling blocks for the survey. During the survey, if blocks were unfishable due to the lack of suitable habitat within the depth strata, these were removed from the survey grid and a new survey block was randomly selected from adjacent blocks using GIS software (ESRI ® ArcMap™ 9.0) and fished.

2.2 Survey Vessel

Since its inception, the survey has been conducted on board the fisheries research vessel CCGS *Neocaligus*. In 2005, the vessel was skippered by Captain Alan Young and Captain Bob Barker. The ship's compliment consisted of a bosun, engineer, deck hand/cook and 3 scientific staff.

2.3 Fishing Gear and Operations

Snap-type longline gear using in previous years was also used in 2005. Each longline set or 'string' consisted of two skates of groundline with 225 circle hooks (13/0) spaced 3.7 m (12 ft) apart, and perlon gangions measuring 0.38 m (1.2 ft) were crimped at both ends and attached to the circle hook with a swivel (Lochead and Yamanaka, 2004). Hooks were baited with thawed Argentinean squid, approximately 15 cm long, and cut into fifths.

For each set, the start and end positions and depths were recorded when the first and last anchors were set over the stern, from the vessel's global positioning system (GPS) and depth sounder, respectively (Lochead and Yamanaka, 2004). Minimum, maximum and modal depths were also recorded. Modal set depth was used to assign each set to either the shallow or deep depth stratum.

In all years, survey blocks were fished during daylight hours and soak time, described as the time elapsed between the last anchor over the stern and the first anchor retrieved on board, was standardized to 2 hours (Lochead and Yamanaka, 2004).

2.4 Data Collection

In 2005, for the first time, all hook by hook and biological data were recorded directly into an Allegro CE™ hand-held field computer (Juniper Systems Incorporated). The yield on each hook was recorded on deck as the gear was retrieved (Lochead and Yamanaka, 2004). The catch was identified to species and recorded with individual hook numbers. Fish and invertebrates were considered 'catch' if they broke the surface of the water during gear retrieval. Partial fish returning on hooks, usually heads whose bodies were predated, and fish drop-offs at the side of the vessel were also recorded into the Allegro CE™. Average whole fish weights for these species were estimated from previous surveys and added to the total catch weight. During gear retrieval, the catch was sorted by species into baskets and set aside for sampling. After retrieving the gear, the total catch weight, by species, was recorded and biological sampling began.

2.4.1 Biological sampling

Biological sampling consisted of measuring weight (W) in grams (g), length (L) in millimetres (mm) or centimetres (cm), and visually determining the sex (S) and maturity state (M) of the gonads (Westrheim, 1975). Both sagittal otoliths (O) were extracted from rockfish and fin rays (F) were removed from lingcod (*Ophiodon elongatus*) for subsequent age determination. L/W/S/M/O samples were collected from all rockfish, L/W/S/M/F samples were collected from lingcod, and L/S or L samples were collected from all other fish species. A matchstick-size piece of caudal fin was removed from rockfish and stored in ethanol for subsequent DNA analysis and a 10 cm by 10 cm flesh sample was collected from quillback and yelloweye rockfishes for subsequent metal analysis.

Sagittal otoliths from quillback and yelloweye rockfishes were aged in the Pacific Biological Station (PBS) ageing lab, using the burnt section technique for rockfishes (MacLellan, 1997).

2.4.2 Catch Rate Calculations

The catch rate (U), as defined in previous years, is the total weight in kilograms of fish per set (Wt) divided by the number of intact skates returned (N) from the set.

$$U_{is} = Wt_{is} / N_i$$

where *s* denotes the species, and *i* denotes the set.

All statistical analyses were performed using SPlus 2000 or Statistix version 7.0.

2.4.3 Bathymetric Positional Index

The bathymetric positional index (BPI) is one component of a benthic habitat model being developed and used for the stock assessment of inshore rockfish. The benthic habitat model uses high resolution (5 m) multibeam bathymetry, its derivatives (rugosity, slope, and BPI), and acoustic backscatter data in a multivariate spatial analysis to classify benthic habitat zones. A complete description of the bathymetric positional index and the full benthic habitat model is presented in Lacko *et al.* (*in prep*).

The bathymetric positional index (BPI) measures a point's position relative to the overall terrain or seascape. It is a result of a nearest-neighbour algorithm that compares the elevation of a cell to the mean elevation of the surrounding cells in a circular neighborhood (Iampietro and Kvitek, 2002). Positive BPI values represent bathymetric positions higher than the mean elevation for the specified neighbourhood (elevations) and negative values represent bathymetric positions lower than the mean elevation for the specified neighbourhood (depressions). Those values that fall near zero characterize positions near the mean (flats).

The raster calculator provided by the spatial analyst extension in ArcMap™ 9.1 was used to calculate the BPI rasters using the following equation (Lacko *et al*., *in prep*):

BPI<scalefactor> = int((bathy - focalmean(bathy,annulus,irad,orad)) + .5)

where:

scalefactor = fine or broad (see below)
bathy = input bathymetric raster
irad = inner radius of annulus
orad = outer radius of annulus

Two scalefactors were used to bring out fine and broad scale surficial features of the sea floor:

- fine scale - inner radius (irad) = 3-cells, outer radius (orad) = 10-cells
- broad scale - inner radius (irad) = 25 cells, outer radius (orad) = 50-cells

For simplicity, and in the absence of acoustic backscatter data, only the area of the seafloor which had been surveyed with multibeam sonar was classified into three distinct categories using bpi values:

- Zero or Negative BPI = flats/depressions
- Positive BPI (course scale) = slopes/mounds
- Positive BPI (fine scale) = peaks/ridge tops

During gear deployment the vessel's position was tracked in ArcMap™ 9.1 using the vessel's GPS. The vessel's track was used as an estimate of the longline set location on the sea floor. For this analysis, the hooks for each set were assumed to be evenly spaced, 12 feet apart, along the longline. Individual hooks and their associated catch were assigned to one of the three bpi categories (flat/depression, slope/mound, or peak/ridge top) based on their location. The proportion of hooks that yielded quillback and yelloweye rockfish catch were compared among the three bpi categories using pairwise proportion tests. Other rockfish species were not investigated because too few individuals were caught to enable a meaningful habitat-catch comparison.

3.0 RESULTS AND DISCUSSION

All data collected on the 2005 survey are archived in DFO's GFBio database and can be retrieved by specifying Trip ID 60506.

3.1 Survey set locations, depths and times

Figure 1 presents a map of the survey area illustrating the boundaries of the statistical areas, the survey grid and the location of the 89 fished sites.

Gear deployment took place between 0637 h and 1808 h and soak time varied from 99 to 127 minutes (mean ± 95% confidence interval =119.6 ± 0.61, median=120, mode=119). Fishing took place during daylight hours and gear retrieval was complete by 2025 h. Fifty-one sets were conducted in the shallow stratum (41 – 70 m) and 37 sets in the deep stratum (71 – 100 m). Set 83's modal set depth of 34 m was slightly less than the target depth range but was included as a shallow stratum set. Across all sets, the minimum depths ranged from 28 – 93m, the maximum depths ranged from 37 – 111m, and the modal depths ranged from 34 – 100m (Appendix A).

3.2 Catch Summary

3.2.1. Hook by Hook

A total of 19, 923 hooks were fished during the survey. Fifty-six percent of all hooks retrieved yielded catch, 24% were empty, and 19% were returned with bait (Table 1). Partial fish returning on hooks, usually heads whose bodies were predated, and fish drop offs at the side of the vessel were uncommon, together making up 1.7% of total hooks retrieved (Table 1).

A total of 23 species and 6 taxonomic groups were caught during the survey, including 7 rockfish and 14 other fish species (Table 2). Spiny dogfish (*Squalus acanthias*) were ubiquitous; occurring in all 89 sets (Table 2). A total of 146 quillback rockfish were observed in 43 of 89 sets and were the most geographically widespread *Sebastes* species in the catch (Table 2). More yelloweye rockfish were caught (211 fish) than quillback rockfish but they were present in only 37 of 89 sets (Table 2). Sunflower starfish (*Pycnopodia helianthoides*) were the most prevalent invertebrate species, found in 22 of 89 sets.

A total of 19 metric tonnes (t) of catch were landed during the 2005 survey (Table 2). The total catch of elasmobranchs was 18 t, which made up 95% of the total landings (Table 2). Spiny dogfish dominated the catch and represented 92% (17.5 t) of the total fish weight. Yelloweye rockfish were ranked second by weight with landings totalling 424 kg. Big skate (*Raja Binoculata*), sixgill shark (*Hexanchus griseus*) and lingcod (*Ophiodon elongates*) were observed in relatively small numbers, but were ranked third, fourth and fifth by weight with each species making up about 1% of the total landed fish weight. Sunflower starfish were ranked sixth by weight, making up 0.8% (0.15 t), and quillback rockfish ranked seventh, making up 0.6% (0.11 t) of the total fish landings. Canary (*S. pinniger*) and copper (*S. caurinus*) rockfish were much less common with landings of 0.14% (26 kg) and 0.22% (42 kg) of the total fish weight, respectively. Tiger (*S. nigrocinctus*), greenstriped (*S. elongatus*) and redstripe (*S. proriger*) rockfish were present in the catch, but were rare with total landings of 5 kg or less each.

All rockfish species and most other fish species were more commonly caught in the shallow stratum (Table 3, 4). Canary, redstripe, and tiger rockfishes were absent from sets conducted in the deep stratum (Table 3).

3.2.2 Biological Sampling

A total of 6013 fish were sampled on the survey, including 5449 spiny dogfish sampled for L/S and 412 rockfish sampled for L/W/S/M/O (Table 2). Figure 2 illustrates fork length frequency histograms by sex for all rockfish species taken on the survey and Table 5 presents rockfish fork length descriptive statistics.

Quillback rockfish fork lengths ranged from 234 – 410 mm, with a mean of 339 mm (Figure 2, Table 5). There were no significant differences in mean fork lengths between depth strata or sexes (Table 6). One-way analysis of variance revealed significant differences in fork lengths among statistical areas (Table 6). Pairwise comparisons of means show that quillback rockfish fork lengths in SA 15 and 29 were significantly smaller than those from statistical areas 17, 18 and 28 (Table 6).

Yelloweye rockfish fork lengths ranged from 277 – 675 mm (Figure 2, Table 5). No significant differences were found between depth strata, sexes or statistical areas (Table 6).

The fork length (mm) to weight (g) relationship for rockfish can be expressed as:

$$\text{Weight} = a\ \text{Length}^{b}$$

Constants were calculated for quillback and yelloweye rockfishes. These 2005 estimates are similar to those obtained in 2003 and 2004 (Lochead and Yamanaka, 2004; Lochead and Yamanaka, 2006):

quillback rockfish	$a = 0.537(10^{-6})$	$b = 3.21$	(Figure 3)
yelloweye rockfish	$a = 0.467(10^{-6})$	$b = 3.22$	(Figure 3)

The plot of proportion female by species illustrates strongly skewed sex ratios for a few species (Figure 4). Canary rockfish were 70% female (n=10), lingcod were 85% female (n = 41), and spotted ratfish were 77% female (n=48). Males dominated the catch for big skate which were 67% male (n=21), copper rockfish which were 62% male (n=29), and quillback rockfish which were 64% male (n=136).

The longline gear employed on the survey, coupled with the survey's depth range, generally targeted adult fish. Over 77% of all rockfish captured on the 2005 survey were sexually mature (Table 7). Only 23% of male rockfish and 27% of female rockfish were 'immature' or 'maturing'. The majority of males (69%) and females (77%) were observed to be 'resting' or 'developing' (Table 7), which is consistent with the reproductive cycle of these species (Love *et al*., 2002).

Age frequency distributions were plotted by sex for quillback rockfish (Figure 5). Ages ranged from 6 to 46, with a mean age of 19 (Table 8). The most frequently observed age was 11 (Table 8). No significant differences in quillback mean age were found among statistical areas, depth strata, or sexes (Table 9).

Age frequency distributions were also plotted by sex for yelloweye rockfish (Figure 6). Ages ranged from 5 to 65, with a mean age of 25 and a modal age of 19 (Table 8). Yelloweye rockfish mean ages were not significantly different among statistical areas, depth strata, or sexes (Table 9).

An adequate sample size of yelloweye rockfishes allowed estimates of von Bertalanffy growth parameters L_∞, k and t_0, to be derived from the 2005 yelloweye rockfish biological sampling data (Table 10). The von Bertalanffy (1938) growth equation models the relationship between fish length (mm) and age (years):

$$L_t = L_\infty [1-e^{-K(t-t_0)}]$$

where: L_t = fork length at age t

L_∞ = maximum (asymptotic) fork length
K = growth constant
t = age
t_0 = theoretical age when length equals zero

The estimate of L_∞ was larger for female yelloweye rockfishes than it was for males (Table 10). This is what is expected given that female rockfish grow to a slightly larger size than males (Love *et al*., 2002).

3.2.3 Catch Rates

Catch rate variability was high for most species captured on the survey (Table 11). This is expected on a longline survey where a broad range of depths and habitat types are encountered within a single string of gear. Spiny dogfish were captured in large numbers throughout the survey (Table 2). The catch rate coefficient of variation was 0.45 for spiny dogfish, a value that was an order of magnitude lower than it was for all other species (Table 11). This survey is likely to provide a reliable index of abundance for spiny dogfish. Quillback and yelloweye rockfishes catch rate CVs were 1.69 and 1.93, respectively. These values are slightly higher than those obtained in previous years. In 2003 and 2004, quillback rockfish catch rate CVs were 1.51 and 1.06, respectively, and yelloweye rockfish catch rate CVs were 1.81 and 1.50, respectively (Lochead and Yamanaka, 2004, 2006). Given the catch rate variability for these species, this survey is conforming to the initial expectation that it will provide useful relative indices of abundance for quillback and yelloweye rockfishes (Lochead and Yamanaka, 2004).

Overall mean rockfish catch rates ranged from 0.002 kg/skate for redstripe rockfish up to 2.38 kg/skate for yelloweye rockfish (Table 12). Quillback rockfish had the second highest mean catch rate of 0.62 kg/skate (Table 12). With catch rate data for pooled statistical areas, all rockfish had median catch rates equal to zero indicating that all rockfish were absent from at least half of the skates fished.

Quillback rockfish and yelloweye rockfish catch rates were highly variable with respect to start deployment time, sea state (Appendix B), tide and lunar phase, and no consistent trends were observed (Figures 7).

The spatial distributions of 2005 catch rates (kg/skate) were plotted by statistical area for all rockfish species and lingcod (Figures 8 – 15). No rockfish species were caught in SA 20, but all other SAs had at least one rockfish species present in the catch. SAs 16 and 17 had the highest rockfish species diversity with 6 of the 7 observed rockfish species present. Lingcod were encountered in low numbers throughout the survey area and were not caught in SAs 19 and 29 (Figure 15). The highest individual lingcod catch per set was 9 fish and this was achieved in one set in SA 14 and one other in SA 17.

The spatial distribution of rockfish catch rates varied greatly by species (Figures 8 – 14, Table 13). Canary rockfish were infrequently encountered and were observed in only two sets, one in SA 16 and one in SA 17. Small catches of copper rockfish were present in 12 sets distributed among SA 14 – 19. The highest catch of copper rockfish was 8.5 kg/skate from a shallow set conducted on the northeast side of Hornby Island. A total of 2.4 kg (8 fish) of greenstriped rockfish was present in 7 sets located in SA 14, 15, 16, 17 and 28. Small catches of tiger rockfish were present in 3 sets, one fish in SA 14, one in SA 16, and one in SA 17. Only one redstripe rockfish was caught on the survey east of Bowen Island in SA 28. Quillback rockfish catches were never more than 6.2 kg/skate and were distributed throughout all the SAs surveyed, except SA 20. The highest catch of quillback rockfish was from a set located between Denman and Hornby Islands, in Lambert Channel. Yelloweye rockfish catches were highest in SAs 14, 15, and 16 and decreased to the south. The southern boundary for yelloweye rockfish catch was 48˚ 41’ N. Yelloweye rockfish were not caught in SAs 19, 20 or 28.

Catch rates by species were plotted against modal set depths for the six most frequently encountered rockfish species in 2005 (Figure 16). These plots illustrate peaks in abundance within species specific depth ranges. Modal set depths at peak catch rates for canary, copper, greenstriped, quillback, tiger, and yelloweye rockfishes were 51, 44, 76, 50, 51, and 55 metres, respectively.

Quillback and yelloweye rockfish catch rates (kg/skate) were compared between depth strata. No significant differences were found for either species (Table 14 and 15).

Spiny dogfish, lingcod, quillback rockfish and yelloweye rockfish catch rates from all three survey years (2003, 2004 and 2005) were plotted by statistical area (Figure 17) and Kruskal-Wallis tests were used to test for differences among statistical areas (Table 16). Spiny dogfish catch rates were lowest in SA 12. Spiny dogfish catch rates from SA 12 were significantly lower than those from SA 13, 14, 16, 17, and 18. Lingcod catches were absent from SA 19 and were highest in SA 14 and 17, but no significant differences were detected among areas (Table 16).

Quillback rockfish catch rates showed an increasing trend with latitude (Figure 11.). Quillback rockfish catch rates from statistical area 12 were significantly higher than those from SA 15, 16, 17, 18, 19, and 20, but were not different from SA 13, SA 14, SA 28 and 29, and catch rates from SA 13 were significantly higher than those from SA 16 (Table 16). Yelloweye rockfish catch rates were highest in SA 13, 15 and 16 (Figure 14). Yelloweye rockfish catch rates from SA 13 and 15 were significantly higher than those from SA 12, 17, 18, 19, 20, 28 and 29, and SA 16 catch rates were significantly higher than SA 18, 19, 20 and 29 (Table 16).

3.3 Bathymetric Position Index

A total of 31 longline sets from the 2005 survey were located in areas which have been acoustically surveyed with multibeam sonar (Figure 18). Bathymetry derived from the multibeam surveys was used to calculate Bathymetric Position Index classes and catch rates were then analyzed relative to the BPI classes (Figure 18).

The proportion of the total occupied hooks by species (or species group) varied greatly by BPI classes (Figure 19). Flatfish and skates were primarily observed over flats/depressions, sculpins, rockfish, and lingcod were most commonly caught on the peaks/ridge tops, whereas spiny dogfish were present on all three BPI categories (Figure 19). When the rockfish species group was broken down into individual species, various patterns were observed (Figure 19). Tiger rockfish and greenstriped rockfish were caught on peaks/ridge tops only, copper rockfish on peaks/ridge tops and slopes/mounds, and yelloweye rockfish and quillback rockfish were observed on all three BPI classes (Figure 19). The only redstripe rockfish taken on the survey was located on the flats/depression BPI category (Figure 19), but this distribution pattern is based on a very low sample size.

Proportion tests were used to test for differences in the proportion of the total hooks that yielded quillback rockfish and yelloweye rockfish among the three BPI categories (Table 17). The proportion of total hooks that yielded a quillback rockfish was significantly lower on the flats/depressions than on the slopes/mounds and peaks/ridge tops (Table 17). For yelloweye rockfish, the proportion of hooks yielding a catch was significantly lower on the flats/ depressions category than it was on the peaks/ridge tops (Table 17).

A correspondence analysis was performed to visually present and quantify the interaction between species (or species group) and BPI category (Figures 20 and 21). The distance between the slope class point and the species (or species group) was used as a measure of their association. Results of the correspondence analysis indicate that flatfish and skates were associated with the flats/depressions category, lingcod associated with the peaks/ridge tops, rockfish and sculpins were associated to both slopes and peaks, and spiny dogfish were not associated with any one BPI category (Figure 20). Individual rockfish species patterns emerged (Figure 21). Yelloweye rockfish were equally associated with peaks/ridge tops and slopes/mounds, quillback rockfish were highly associated with slopes/mounds, copper, tiger and greenstriped rockfish were weakly associated with peaks/ridge tops, and the one redstripe rockfish was weakly associated with flats/depressions (Figure 21).

When hooks from all BPI slope categories were combined, quillback rockfish and yelloweye rockfish catch rate (#fish/hook) coefficients of variation were 12.5 and 10.6, respectively (Table 18). When catch rates were calculated by BPI category, catch rate (#fish/hook) coefficients of variation were highest on flats/depressions, and lowest on slopes/mounds and peaks/ridge tops (Table 18). Catch rate CV's for all categories combined were reduced by 8 – 18% when flats/depressions were not considered (Table 18).

4.0 CONCLUSIONS

The 2005 survey completed the initial collection of fishery-independent catch rate and accompanying biological data for the inside waters between Vancouver Island and the mainland (SA 12 to 20, 28 and 29). With all statistical areas now surveyed, spatial trends in relative abundance were analysed. Quillback rockfish catch rates were low (mean catch rate = 0.62 kg/skate) in the Strait of Georgia SAs 14 – 29 and were approximately one fifth of those observed in SAs 12 and 13 (mean catch rates = 3.01 – 3.24 kg/skate) (Lochead and Yamanaka, 2006). Yelloweye rockfish catch rates were also low in the southern region of the Strait of Georgia SAs 18 – 29 (mean catch rates = 0 – 0.35 kg/skate). In the central region of the Strait of Georgia SAs 14-17 yelloweye rockfish catch rates were highly variable (mean catch rate = 1.56 – 5.20 kg/skate), and were similar to rates observed in the northern regions SAs 12 and 13 (mean catch rate = 2.78 – 2.84 kg/skate) (Lochead and Yamanaka, 2006).

Rockfish species diversity was considerably lower in SA 14-20, 28 and 29 than in SA 12 and 13 (Lochead and Yamanaka 2004, 2006). A total of seven rockfish species were encountered in 2005, versus a total of 14 for the previous years.

Habitat is an important influence on the distribution rockfishes. Variation in substrate type and slope are major contributors to the variation in catch rates among sets. The distribution of catch on longline gear varied with BPI slope classes. BPI's may be used to improve future survey design by allowing specific slope classes to be targeted to reduce catch rate variability.

Additional research on catchability and interspecific competition for hooks for inshore species is recommended for future surveys, to improve our understanding of the catch rate – abundance relationship.

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Table 1. Summary of hook observations by description, DFO GFBio database code, number of hooks retrieved and percent of total hooks.

Description	GFBio Code	# hooks	% of total
Unknown	0	0	0
Empty hook	1	4764	23.9
Bait on hook	2	3725	18.7
Animal on hook (fish or invertebrate)	3	11096	55.7
Species head on hook	4	58	0.3
Species dropped off hook	5	280	1.4
Total		**19923**	**100**

Table 2. Summary of total catch and biological samples.

Species Name	Taxonomic Name	Total Weight (kg)	% of Marine Fish Total Weight	Total Count (#)	# of Sets with Species Present	Number of fish Sampled	Sample Types
SPINY DOGFISH	*SQUALUS ACANTHIAS*	17496.20	91.85	10557	89	5449	TL/S
YELLOWEYE ROCKFISH	*SEBASTES RUBERRIMUS*	423.57	2.22	211	37	211	FL/W/S/M/O/T/D
BIG SKATE	*RAJA BINOCULATA*	262.24	1.38	23	8	21	TL/S
SIXGILL SHARK	*HEXANCHUS GRISEUS*	210.00*	1.10	2	2	-	-
LINGCOD	*OPHIODON ELONGATUS*	204.96	1.08	46	21	41	FL/W/S/M/F
SUNFLOWER STARFISH	*PYCNOPODIA HELIANTHOIDES*	154.59	-	198	22	-	-
QUILLBACK ROCKFISH	*SEBASTES MALIGER*	110.83	0.58	146	43	146	FL/W/S/M/O/T/D
SPOTTED RATFISH	*HYDROLAGUS COLLIEI*	68.42	0.36	69	13	48	DFL/S
LONGNOSE SKATE	*RAJA RHINA*	61.22	0.32	20	10	18	TL/S
CABEZON	*SCORPAENICHTHYS MARMORATUS*	43.70	0.23	12	6	-	-
COPPER ROCKFISH	*SEBASTES CAURINUS*	41.98	0.22	29	12	29	FL/W/S/M/O
ARROWTOOTH FLOUNDER	*ATHERESTHES STOMIAS*	38.39	0.20	14	9	-	-
CANARY ROCKFISH	*SEBASTES PINNIGER*	26.24	0.14	10	2	10	FL/W/S/M/O
STARFISH	ASTERIODEA	22.39	-	42	22	-	-
PACIFIC COD	*GADUS MACROCEPHALUS*	22.04	0.12	11	6	7	FL/W
PACIFIC HALIBUT	*HIPPOGLOSSUS STENOLEPIS*	16.26	0.09	2	2	1	TL
PACIFIC SANDDAB	*CITHARICHTHYS SORDIDUS*	5.96	0.03	18	8	8	TL/S
TIGER ROCKFISH	*SEBASTES NIGROCINCTUS*	5.16	0.03	7	3	7	FL/W/S/M/O
ANEMONE	ACTINIARIA	4.86	-	13	9	-	-
SANDPAPER SKATE	*BATHYRAJA INTERRUPTA*	3.62	0.02	3	3	3	TL/S
SOUTHERN ROCK SOLE	*LEPIDOPSETTA BILINEATA*	2.42	0.01	4	3	4	TL/S
GREENSTRIPED ROCKFISH	*SEBASTES ELONGATUS*	2.40	0.01	8	7	8	FL/W/S/M/O
RED IRISH LORD	*HEMILEPIDOTUS HEMILEPIDOTUS*	2.28	0.01	3	2	-	-
SPONGES	PORIFERA	1.26	-	14	7	-	-
BOX CRABS	LOPHOLITHODES	0.86	-	1	1	-	-
SCULPINS	COTTIDAE	0.66	0.003	1	1	1	FL/S
RED ROCK CRAB	*CANCER PRODUCTUS*	0.40	-	1	1	-	-
REDSTRIPE ROCKFISH	*SEBASTES PRORIGER*	0.36	0.002	1	1	1	FL/W/S/M/O
SPIDER CRABS	OXYRHYNCHA	0.10	-	1	1	-	-
SOLASTERIDAE	SOLASTERIDAE	0.02	-	1	1	-	-
Total		**19023.39**	**100.00**	**11468**		**6013**	**-**

DFL = snout to posterior edge of second dorsal fin length, FL = fork length, TL = total length

W = weight, S = sex, M = maturity, O = otoliths, F = fin rays, T = tissue for mercury analysis, D = DNA

* estimated weight

Table 3. Rockfish counts by set. Shallow stratum sets (41-70m) are unshaded, and deep stratum sets (71-100m) are shaded grey.

Set #	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
1	-	2	-	-	-	-	-
2	7	-	-	1	-	4	6
3	-	2	-	4	-	-	9
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	3	-	-	6
7	-	-	-	2	-	-	-
8	-	-	-	1	-	-	1
9	-	3	-	18	-	-	-
10	-	9	-	7	-	2	16
11	-	-	-	-	-	-	-
12	-	-	-	3	-	-	4
13	-	-	-	1	-	-	3
14	-	-	1	4	-	1	11
15	-	-	-	-	-	-	-
16	-	1	-	1	-	-	18
17	-	-	-	2	-	-	6
18	-	-	-	2	-	-	1
19	-	1	-	-	-	-	-
20	-	-	1	2	-	-	3
21	-	-	-	2	-	-	2
22	-	-	-	4	-	-	15
23	-	-	-	2	-	-	20
24	-	-	-	1	-	-	2
25	-	-	-	3	-	-	11
26	-	-	-	2	-	-	7
27	-	-	-	1	-	-	3
28	-	-	-	3	-	-	6
29	-	-	1	1	-	-	1
30	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-
32	-	-	-	1	-	-	5
33	-	3	-	2	-	-	1
34	-	-	-	1	-	-	5
35	-	-	-	7	-	-	14
36	-	-	-	4	-	-	3
37	-	-	-	2	-	-	-
38	-	-	-	2	-	-	-
39	-	-	-	-	-	-	2
40	3	-	1	9	-	-	7
41	-	-	1	2	-	-	14
42	-	-	-	-	-	-	1
43	-	-	-	-	-	-	-
44	-	-	-	-	-	-	1
45	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-
48	-	-	-	-	-	-	2
49	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-
51	-	-	-	12	-	-	-
52	-	-	-	-	1	-	-
53	-	-	-	3	-	-	-
54	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-
56	-	-	-	-	-	-	1
57	-	-	1	5	-	-	1
58	-	-	-	9	-	-	1
59	-	-	-	-	-	-	-
60	-	1	-	1	-	-	-
61	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-
63	-	-	-	-	-	-	-
64	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-
66	-	3	2	5	-	-	2
67	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-
69	-	-	-	1	-	-	-
70	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-
72	-	1	-	1	-	-	-
73	-	1	-	7	-	-	-
74	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-
76	-	-	-	-	-	-	1
77	-	-	-	-	-	-	-
78	-	-	-	-	-	-	-
79	-	-	-	1	-	-	-
80	-	-	-	-	-	-	-
81	-	-	-	-	-	-	-
82	-	2	-	1	-	-	-
83	-	-	-	-	-	-	-
84	-	-	-	-	-	-	-
85	-	-	-	-	-	-	-
86	-	-	-	-	-	-	-
87	-	-	-	-	-	-	-
88	-	-	-	-	-	-	-
89	-	-	-	-	-	-	-
Total	**10**	**29**	**8**	**146**	**1**	**7**	**212**
Shallow	**10**	**28**	**5**	**83**	**1**	**7**	**143**
Deep	**0**	**1**	**3**	**63**	**0**	**0**	**69**

Table 4. Other fish species counts by set. Shallow stratum sets (41-70m) are unshaded, deep stratum sets (71-100m) are shaded grey.

Set #	Arrowtooth Flounder	Big Skate	Cabezon	Lingcod	Longnose Skate	Pacific Cod	Pacific Halibut	Pacific Sanddab	Red Irish Lord	Sandpaper Skate	Sculpins	Sixgill Shark	Southern Rock Sole	Spiny Dogfish	Spotted Ratfish
1	-	-	-	-	-	-	-	1	-	-	-	1	-	124	-
2	-	-	-	9	-	-	-	-	-	-	-	-	-	76	-
3	-	-	-	-	-	-	-	1	-	-	-	-	-	119	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	183	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	119	-
6	-	-	-	1	-	-	-	-	-	-	-	-	-	139	-
7	-	-	-	-	-	-	-	1	-	-	-	-	2	160	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	181	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	126	1
10	-	1	-	9	-	-	-	-	-	-	-	-	-	42	3
11	-	-	-	-	-	-	-	-	-	-	-	-	-	172	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	139	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	197	-
14	-	-	-	1	-	-	-	-	-	-	-	-	-	158	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	159	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	156	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	115	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	135	-
19	1	-	-	-	1	1	-	-	-	-	-	-	-	97	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	173	-
21	-	-	-	-	-	-	-	-	-	-	-	-	-	154	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	148	-
23	-	-	-	2	-	-	-	-	-	-	-	-	-	90	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	161	-
25	-	-	-	1	-	-	-	-	-	-	-	-	-	74	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1
27	-	-	-	1	-	-	-	-	-	-	-	-	-	100	-
28	-	-	-	1	-	-	-	-	-	-	-	-	-	43	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	75	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	128	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	192	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	59	-
33	-	-	-	1	1	-	-	-	-	-	-	-	-	75	-
34	-	-	-	2	-	-	-	-	-	-	-	-	1	1	-
35	-	-	-	4	-	-	-	-	-	-	-	-	-	11	-
36	-	-	-	-	-	-	-	-	-	-	-	-	-	176	-
37	-	-	-	-	3	-	-	-	-	-	-	-	-	163	3
38	-	-	-	-	-	-	-	-	-	-	-	-	-	164	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	191	1
40	-	-	-	2	-	-	-	-	-	-	-	-	-	24	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	107	7
42	-	-	-	-	-	-	-	-	-	-	-	-	-	203	-
43	-	-	-	-	-	1	-	-	-	-	-	-	-	169	2
44	-	-	-	1	-	-	-	-	-	-	-	-	1	93	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	181	-

Table 4. (continued)

Set #	Arrowtooth Flounder	Big Skate	Cabezon	Lingcod	Longnose Skate	Pacific Cod	Pacific Halibut	Pacific Sanddab	Red Irish Lord	Sandpaper Skate	Sculpins	Sixgill Shark	Southern Rock Sole	Spiny Dogfish	Spotted Ratfish
46	-	-	2	1	-	-	-	-	-	-	-	1	-	40	1
47	-	-	-	-	-	-	-	-	-	-	-	-	-	157	-
48	-	-	-	-	2	-	-	-	-	-	-	-	-	148	-
49	-	-	-	-	1	-	-	-	-	-	-	-	-	129	-
50	1	-	-	-	-	-	-	-	-	-	-	-	-	151	-
51	-	-	-	2	1	-	-	-	-	-	-	-	-	111	-
52	-	-	-	-	-	-	-	-	-	-	-	-	-	166	-
53	-	-	-	1	-	-	-	-	-	-	-	-	-	38	-
54	2	-	-	-	-	-	-	-	-	-	-	-	-	147	-
55	1	-	-	-	-	-	-	-	-	-	-	-	-	146	-
56	-	-	-	-	-	-	-	-	-	-	-	-	-	154	-
57	-	-	-	1	-	-	-	-	-	-	-	-	-	20	-
58	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-
59	-	-	-	-	-	-	-	-	-	-	-	-	-	176	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	183	-
61	1	-	-	-	-	-	-	-	-	-	-	-	-	171	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	161	-
63	1	-	-	-	-	-	-	-	-	-	-	-	-	140	-
64	-	-	-	-	-	-	-	-	-	-	-	-	-	156	-
65	-	-	-	-	-	-	-	-	-	-	-	-	-	168	-
66	-	-	-	2	-	-	-	1	-	-	-	-	-	50	-
67	-	-	-	-	-	-	-	-	-	-	-	-	-	151	-
68	-	-	-	-	-	-	-	-	-	-	1	-	-	160	-
69	-	-	-	-	-	-	-	5	-	-	-	-	-	103	-
70	-	-	-	-	-	-	-	-	-	-	-	-	-	174	-
71	-	-	-	-	-	-	-	6	-	-	-	-	-	101	-
72	-	-	-	1	-	-	-	1	-	-	-	-	-	56	-
73	-	-	3	2	-	-	-	-	-	-	-	-	-	66	-
74	-	1	-	-	-	-	-	-	-	1	-	-	-	176	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	129	-
76	-	-	1	-	-	-	-	-	-	-	-	-	-	150	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-	122	-
78	-	-	-	-	1	-	-	-	-	-	-	-	-	96	-
79	-	-	1	-	-	-	-	-	2	-	-	-	-	110	-
80	-	1	-	-	-	-	-	-	-	-	-	-	-	127	-
81	-	-	-	-	-	-	-	-	-	-	-	-	-	134	-
82	-	-	4	-	-	-	-	-	-	-	-	-	-	32	12
83	-	-	1	-	-	-	-	-	1	-	-	-	-	1	28
84	-	4	-	-	3	4	-	-	-	-	-	-	-	58	-
85	-	-	-	1	1	3	-	-	-	-	-	-	-	50	4
86	-	1	-	-	-	1	1	-	-	1	-	-	-	68	-
87	3	7	-	-	6	1	-	-	-	1	-	-	-	109	1
88	-	1	-	-	-	-	-	-	-	-	-	-	-	101	-
89	-	7	-	-	-	-	1	2	-	-	-	-	-	90	5
Total	**10**	**23**	**12**	**46**	**20**	**11**	**2**	**18**	**3**	**3**	**1**	**2**	**4**	**10557**	**69**
Shallow	**10**	**16**	**8**	**38**	**13**	**5**	**1**	**18**	**1**	**1**	**1**	**2**	**4**	**5866**	**59**
Deep	**0**	**7**	**4**	**8**	**7**	**6**	**1**	**0**	**2**	**2**	**0**	**0**	**0**	**4691**	**10**

Table 5. Fork length descriptive statistics for rockfish by species.

FORK LENGTH (MM)	Copper	Canary	Tiger	Greenstriped	Redstripe	Quillback	Yelloweye
Mean	418.2	529.0	345.0	261.6	303.0	338.6	461.3
Standard Error	10.6	10.9	14.0	20.0	0.0	2.8	5.3
Median	434.0	539.5	359.0	281.0	303.0	343.0	460.0
Standard Deviation	57.3	34.5	37.1	52.9	-	33.2	75.8
Sample Variance	3279.9	1191.3	1376.3	2798.3	-	1103.0	5746.3
Range	249	131	97	139	0	176	398
Minimum	290	448	286	171	303	234	277
Maximum	539	579	383	310	303	410	675
Total Count	29	10	7	7	1	137	203
95% Confidence Level	21.8	24.7	34.3	48.9	-	5.6	10.5

Table 6. One-way ANOVA and T-test results for differences in fork length (mm) between statistical areas, depth strata, and sexes for quillback and yelloweye rockfishes caught during the 2005 survey. Significant differences are noted with an asterisk (*).

One-Way ANOVA:									
Quillback Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**F Statistic**	**DF**	**p**
Statisical Area 14	340.8	264	410	37.3	10.9	32	2.83	7, 127	0.0090*
Statisical Area 15	327.2	253	373	27.4	8.4	33			
Statisical Area 16	335.1	253	398	39.9	11.7	20			
Statisical Area 17	357.2	315	396	30.5	8.5	12			
Statisical Area 18	359.4	329	388	21.7	6.0	8			
Statisical Area 19	367.5	331	404	51.6	14.0	2			
Statisical Area 20	-	-	-	-	-	0			
Statisical Area 28	349.5	303	385	22.2	6.4	17			
Statisical Area 29	319.5	276	370	25.9	8.1	11			
Pairwise Comparison of Means: SA15 and SA 29 significantly smaller than SA17, SA18 and SA28 (p<0.05)									
T-tests:									
Quillback Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**t Statistic**	**DF**	**p**
shallow (41-70m)	337.6	234	410	34.3	10.2	79	0.40	135	0.6862
deep (71-100m)	340.0	264	404	31.9	9.4	58			
female	335.1	234	398	38.0	11.3	49	-0.95	82	0.3463
male	341.1	264	410	30.2	8.8	87			
One-Way ANOVA:									
Yelloweye Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**F Statistic**	**DF**	**p**
Statisical Area 14	453.0	320	605	81.3	18.0	30	0.69	5, 195	0.6341
Statisical Area 15	453.6	277	608	61.4	13.5	91			
Statisical Area 16	468.5	280	675	84.6	18.1	60			
Statisical Area 17	481.9	283	662	97.4	20.2	19			
Statisical Area 18	488.0	488	488	-	-	1			
Statisical Area 19	-	-	-	-	-	0			
Statisical Area 20	-	-	-	-	-	0			
Statisical Area 28	437.0	349	523	87.0	19.9	3			
Statisical Area 29	-	-	-	-	-	0			
T-tests:									
Yelloweye Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**t Statistic**	**DF**	**p**
shallow (41-70m)	458.0	277	675	78.7	17.2	136	0.90	201	0.3689
deep (71-100m)	468.2	324	638	69.6	14.9	67			
female	449.6	277	675	83.0	18.5	99	-1.95	188	0.0524
male	470.9	291	605	68.6	14.6	95			

Table 7. Male and female rockfish maturity stages.

ROCKFISH MALE	Number (Proportion) of Individuals in Each Maturity Stage							Total N
	Immature	Maturing	Developing	Developed	Running	Spent	Resting	
Canary	0	0	0	0	0	3 (1.0)	0	3
Copper	0	1 (0.06)	2 (0.11)	0	0	0	15 (0.83)	18
Greenstriped	1 (0.5)	1 (0.5)	0	0	0	0	0	2
Quillback	0	15 (0.17)	35 (0.39)	7 (0.08)	0	0	32 (0.36)	89
Tiger	0	1 (0.20)	0	0	0	0	4 (0.80)	5
Yelloweye	9 (0.09)	21 (0.22)	11 (0.12)	4 (0.04)	0	3 (0.03)	47 (0.49)	95
Total	**10 (0.05)**	**39 (0.18)**	**48 (0.23)**	**11 (0.05)**	**0**	**6 (0.03)**	**98 (0.46)**	**212**

ROCKFISH FEMALE	Number (Proportion) of Individuals in Each Maturity Stage							Total N
	Immature	Maturing	Mature	Fertilized	Larvae	Spent	Resting	
Canary	0	0	2 (0.29)	2 (0.29)	0	0	3 (0.43)	7
Copper	0	1 (0.09)	2 (0.18)	0	0	0	8 (0.72)	11
Greenstriped	0	1 (0.25)	1 (0.25)	0	0	0	2 (0.50)	4
Quillback	1 (0.02)	9 (0.18)	21 (0.42)	0	0	0	19 (0.38)	50
Redstripe	0	1 (1.0)	0	0	0	0	0	1
Tiger	0	0	1 (0.50)	0	0	0	1 (0.50)	2
Yelloweye	0	25 (0.25)	29 (0.29)	0	0	0	46 (0.46)	100
Total	**1 (0.006)**	**37 (0.21)**	**56 (0.32)**	**2 (0.01)**	**0**	**0**	**79 (0.45)**	**175**

Table 8. Quillback and yelloweye rockfish age summary statistics.

Age (years)	Quillback	Yelloweye
Mean	18.6	25.0
Standard Error	0.66	0.80
Median	17	22
Mode	11	19
Standard Deviation	8.00	11.37
Sample Variance	64.01	129.37
Minimum	6	5
Maximum	46	65
Count	146	203
95% Confidence Level	1.31	1.57

Table 9. Results of two sample t-tests for differences in age (years) between statistical areas, depth strata, and sexes for quillback and yelloweye rockfishes captured during the 2005 survey.

One-Way ANOVA:									
Quillback Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**F Statistic**	**DF**	**p**
Statisical Area 14	19.1	8	46	9.2	48.3	38	0.89	7, 136	0.5186
Statisical Area 15	18.6	6	32	6.8	36.6	34			
Statisical Area 16	21.3	6	40	9.7	45.5	21			
Statisical Area 17	19.6	10	37	9.7	49.4	12			
Statisical Area 18	16.3	12	20	3.2	19.9	8			
Statisical Area 19	20.0	14	26	8.5	42.4	2			
Statisical Area 20	-	-	-	-	-	0			
Statisical Area 28	17.5	8	30	7.3	41.6	17			
Statisical Area 29	15.0	8	23	4.0	27.0	12			
T-tests:									
Quillback Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**t Statistic**	**DF**	**p**
shallow (41-70m)	19.1	6	46	8.7	45.5	84	-0.88	144	0.3822
deep (71-100m)	18.0	6	35	6.9	38.5	62			
female	17.6	6	40	8.4	47.8	50	-1.28	137	0.2038
male	19.4	6	46	7.8	40.0	89			

One-Way ANOVA:									
Yelloweye Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**F Statistic**	**DF**	**p**
Statisical Area 14	25.1	11	62	13.5	53.8	30	0.55	5, 195	0.7365
Statisical Area 15	25.8	5	60	10.4	40.3	91			
Statisical Area 16	24.3	10	65	11.4	46.9	60			
Statisical Area 17	22.6	8	54	12.8	56.6	16			
Statisical Area 18	12.0	12	12	-	-	1			
Statisical Area 19	-	-	-	-	-	0			
Statisical Area 20	-	-	-	-	-	0			
Statisical Area 28	22.7	14	32	9.0	39.8	3			
Statisical Area 29	-	-	-	-	-	0			
T-tests:									
Yelloweye Rockfish	**Mean**	**Min**	**Max**	**SD**	**CV**	**N**	**t Statistic**	**DF**	**p**
shallow (41-70m)	25.1	5	65	12.1	48.4	136	-0.09	160	0.9290
deep (71-100m)	24.9	11	54	9.7	39.1	67			
female	24.9	8	65	11.8	47.4	99	0.03	192	0.9736
male	24.9	5	62	11.3	45.5	95			

Table 10. von Bertalanffy parameter estimates (L_{∞}, K, and t_0) calculated using yelloweye rockfish biological data collected on the 2005 survey.

Species	**sex**	**L_{∞}**	**K**	**t_0**	**n**
Yelloweye rockfish	male	569.59	0.06884	-3.7994	94
Yelloweye rockfish	female	687.44	0.02809	-14.9660	102

Table 11. Mean catch rates (kg/skate), 95% confidence intervals and coefficients of variation for all vertebrate species captured on the 2005 survey.

Species Name	Taxonomic Name	Mean Catch Rate (kg/skate)	95% Confidence Interval	Coefficient of Variation
SPINY DOGFISH	*SQUALUS ACANTHIAS*	98.29	9.33	0.45
YELLOWEYE ROCKFISH	*SEBASTES RUBERRIMUS*	2.38	0.97	1.93
BIG SKATE	*RAJA BINOCULATA*	1.47	1.51	4.87
SIXGILL SHARK	*HEXANCHUS GRISEUS*	1.18	1.65	6.64
LINGCOD	*OPHIODON ELONGATUS*	1.15	0.82	3.39
QUILLBACK ROCKFISH	*SEBASTES MALIGER*	0.62	0.22	1.69
SPOTTED RATFISH	*HYDROLAGUS COLLIEI*	0.38	0.35	4.35
LONGNOSE SKATE	*RAJA RHINA*	0.34	0.35	4.79
CABEZON	*SCORPAENICHTHYS MARMORATUS*	0.25	0.23	4.46
COPPER ROCKFISH	*SEBASTES CAURINUS*	0.24	0.21	4.20
ARROWTOOTH FLOUNDER	*ATHERESTHES STOMIAS*	0.22	0.16	3.44
CANARY ROCKFISH	*SEBASTES PINNIGER*	0.15	0.23	7.30
PACIFIC COD	*GADUS MACROCEPHALUS*	0.12	0.14	5.42
PACIFIC HALIBUT	*HIPPOGLOSSUS STENOLEPIS*	0.09	0.13	6.96
PACIFIC SANDDAB	*CITHARICHTHYS SORDIDUS*	0.03	0.03	4.05
TIGER ROCKFISH	*SEBASTES NIGROCINCTUS*	0.03	0.04	6.96
SANDPAPER SKATE	*BATHYRAJA INTERRUPTA*	0.02	0.02	5.55
SOUTHERN ROCK SOLE	*LEPIDOPSETTA BILINEATA*	0.01	0.02	5.88
GREENSTRIPED ROCKFISH	*SEBASTES ELONGATUS*	0.01	0.01	4.33
RED IRISH LORD	*HEMILEPIDOTUS HEMILEPIDOTUS*	0.01	0.02	7.21
SCULPIN UNIDENTIFIED	COTTIDAE	0.004	0.007	9.43
REDSTRIPE ROCKFISH	*SEBASTES PRORIGER*	0.002	0.004	9.43

Table 12. Rockfish catch rate (kg/skate) summary statistics calculated using pooled data from all statistical areas (SA 14 – 20, 28 and 29).

All Statistical Areas	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0.1474	0.2358	0.0135	0.6220	0.0020	0.0290	2.3792
Standard Error	0.1141	0.1049	0.0062	0.1117	0.0020	0.0214	0.4866
Median	0	0	0	0	0	0	0
Standard Deviation	1.0761	0.9897	0.0584	1.0538	0.0191	0.2017	4.5907
Sample Variance	1.1579	0.9795	0.0034	1.1105	0.0004	0.0407	21.0747
Minimum	0	0	0	0	0	0	0
Maximum	9.5400	8.5300	0.4200	6.1500	0.1800	1.8100	20.1900
Total Number of Skates	178	178	178	178	178	178	178
Coefficient of Variation	7.2994	4.1963	4.3305	1.6942	9.4340	6.9595	1.9295
95% Confidence Level	0.2267	0.2085	0.0123	0.2220	0.0040	0.0425	0.9670

Table 13. Rockfish catch rate (kg/skate) summary statistics by statistical area.

Statistical Area 14	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	1.0382	0.0218	1.3545	0	0.0536	2.9609
Standard Error	0	0.7693	0.0218	0.5521	0	0.0536	1.4489
Median	0	0	0	0.8000	0	0	0
Standard Deviation	0	2.5516	0.0724	1.8310	0	0.1779	4.8054
Sample Variance	0	6.5107	0.0052	3.3527	0	0.0316	23.0918
Minimum	0	0	0	0	0	0	0
Maximum	0	8.5300	0.2400	6.1500	0	0.5900	15.9000
Total Number of Skates	22	22	22	22	22	22	22
Coefficient of Variation	-	2.4578	3.3166	1.3518	-	3.3166	1.6229
95% Confidence Level	0	1.7142	0.0486	1.2301	0	0.1195	3.2283

Statistical Area 15	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0.1181	0.0031	0.7319	0	0	5.2019
Standard Error	0	0.1181	0.0031	0.1505	0	0	1.5681
Median	0	0	0	0.575	0	0	3.125
Standard Deviation	0	0.4725	0.0125	0.6021	0	0	6.2723
Sample Variance	0	0.2233	0.0002	0.3626	0	0	39.3412
Minimum	0	0	0	0	0	0	0
Maximum	0	1.8900	0.0500	2.1100	0	0	20.1900
Total Number of Skates	32	32	32	32	32	32	32
Coefficient of Variation	-	4.0000	4.0000	0.8227	-	-	1.2058
95% Confidence Level	0	0.2518	0.0067	0.3209	0	0	3.3423

Statistical Area 16	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0.2238	0.0506	0.0181	0.4931	0	0.0113	4.2906
Standard Error	0.2238	0.0506	0.0120	0.2042	0	0.0113	1.4755
Median	0	0	0	0	0	0	1.365
Standard Deviation	0.8950	0.2025	0.0479	0.8169	0	0.0450	5.9018
Sample Variance	0.8010	0.0410	0.0023	0.6673	0	0.0020	34.8314
Minimum	0	0	0	0	0	0	0
Maximum	3.5800	0.8100	0.1800	2.8100	0	0.1800	17.1100
Total Number of Skates	32	32	32	32	32	32	32
Coefficient of Variation	4.0000	4.0000	2.6438	1.6566	-	4.0000	1.3755
95% Confidence Level	0.4769	0.1079	0.0255	0.4353	0	0.0240	3.1449

Table 13. (continued)

Statistical Area 17	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0.7338	0.4092	0.0323	0.3977	0	0.1392	1.5554
Standard Error	0.7338	0.2113	0.0323	0.1855	0	0.1392	0.9568
Median	0	0	0	0	0	0	0
Standard Deviation	2.6459	0.7618	0.1165	0.6688	0	0.5020	3.4497
Sample Variance	7.0009	0.5804	0.0136	0.4473	0	0.2520	11.9003
Minimum	0	0	0	0	0	0	0
Maximum	9.5400	2.3800	0.4200	1.9400	0	1.8100	11.5800
Total Number of Skates	26	26	26	26	26	26	26
Coefficient of Variation	3.6056	1.8616	3.6056	1.6817	-	3.6056	2.2179
95% Confidence Level	1.5989	0.4604	0.0704	0.4042	0	0.3034	2.0846

Statistical Area 18	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0.1178	0	0.4000	0	0	0.1133
Standard Error	0	0.0785	0	0.3347	0	0	0.1133
Median	0	0	0	0	0	0	0
Standard Deviation	0	0.2356	0	1.0041	0	0	0.3400
Sample Variance	0	0.0555	0	1.0082	0	0	0.1156
Minimum	0	0	0	0	0	0	0
Maximum	0	0.5900	0	3.0300	0	0	1.0200
Total Number of Skates	18	18	18	18	18	18	18
Coefficient of Variation	-	2.0006	-	2.5103	-	-	3.0000
95% Confidence Level	0	0.1811	0	0.7718	0	0	0.2613

Statistical Area 19	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0.0817	0	0.1700	0	0	0
Standard Error	0	0.0817	0	0.1143	0	0	0
Median	0	0	0	0	0	0	0
Standard Deviation	0	0.2000	0	0.2799	0	0	0
Sample Variance	0	0.0400	0	0.0784	0	0	0
Minimum	0	0	0	0	0	0	0
Maximum	0	0.4900	0	0.6600	0	0	0
Total Number of Skates	12	12	12	12	12	12	12
Coefficient of Variation	-	2.4495	-	1.6466	-	-	-
95% Confidence Level	0	0.2099	0	0.2938	0	0	0

Table 13. (continued)

Statistical Area 20	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0	0	0	0	0	0
Standard Error	0	0	0	0	0	0	0
Median	0	0	0	0	0	0	0
Standard Deviation	0	0	0	0	0	0	0
Sample Variance	0	0	0	0	0	0	0
Minimum	0	0	0	0	0	0	0
Maximum	0	0	0	0	0	0	0
Total Number of Skates	12	12	12	12	12	12	12
Coefficient of Variation	-	-	-	-	-	-	-
95% Confidence Level	0	0	0	0	0	0	0

Statistical Area 28	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0	0.0286	0.9614	0.0257	0	0.3471
Standard Error	0	0	0.0286	0.5396	0.0257	0	0.1955
Median	0	0	0	0	0	0	0
Standard Deviation	0	0	0.0756	1.4276	0.0680	0	0.5173
Sample Variance	0	0	0.0057	2.0382	0.0046	0	0.2676
Minimum	0	0	0	0	0	0	0
Maximum	0	0	0.2000	3.7700	0.1800	0	1.3100
Total Number of Skates	14	14	14	14	14	14	14
Coefficient of Variation	-	-	2.6458	1.4849	2.6458	-	1.4901
95% Confidence Level	0	0	0.0699	1.3204	0.0629	0	0.4784

Statistical Area 29	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0	0	0.9350	0	0	0
Standard Error	0	0	0	0.9350	0	0	0
Median	0	0	0	0	0	0	0
Standard Deviation	0	0	0	1.8700	0	0	0
Sample Variance	0	0	0	3.4969	0	0	0
Minimum	0	0	0	0	0	0	0
Maximum	0	0	0	3.7400	0	0	0
Total Number of Skates	8	8	8	8	8	8	8
Coefficient of Variation	-	-	-	2	-	-	-
95% Confidence Level	0	0	0	2.9756	0	0	0

Table 14. Rockfish catch rate (kg/skate) descriptive statistics by depth stratum.

Shallow (41 - 70m)	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0.2573	0.4024	0.0133	0.6163	0.0035	0.0506	2.8604
Standard Error	0.1985	0.1800	0.0089	0.1553	0.0035	0.0372	0.7689
Median	0	0	0	0	0	0	0
Standard Deviation	1.4174	1.2858	0.0637	1.1090	0.0252	0.2656	5.4911
Sample Variance	2.0091	1.6533	0.0041	1.2299	0.0006	0.0705	30.1519
Minimum	0	0	0	0	0	0	0
Maximum	9.5400	8.5300	0.4200	6.1500	0.1800	1.8100	20.1900
Total Number of Skates	102	102	102	102	102	102	102
Coefficient of Variation	5.5098	3.1957	4.7804	1.7995	7.1414	5.2494	1.9197
95% Confidence Level	0.3987	0.3616	0.0179	0.3119	0.0071	0.0747	1.5444

Deep (71 - 100m)	Canary	Copper	Greenstriped	Quillback	Redstripe	Tiger	Yelloweye
Mean	0	0.0127	0.0141	0.6468	0	0	1.7803
Standard Error	0	0.0127	0.0085	0.1640	0	0	0.4873
Median	0	0	0	0.2800	0	0	0.3300
Standard Deviation	0	0.0773	0.0518	0.9975	0	0	2.9638
Sample Variance	0	0.0060	0.0027	0.9951	0	0	8.7843
Minimum	0	0	0	0	0	0	0
Maximum	0	0.4700	0.2400	3.7700	0	0	14.7100
Total Number of Skates	74	74	74	74	74	74	74
Coefficient of Variation	-	6.0828	3.6876	1.5424	-	-	1.6648
95% Confidence Level	0	0.0258	0.0173	0.3326	0	0	0.9882

Table 15. Results of Wilcoxon rank sum tests for differences in catch rates between depth strata for quillback and yelloweye rockfish captured on the 2005 survey. No significant differences were found.

QUILLBACK ROCKFISH:								
Depth strata	**Mean**	**Min**	**Max**	**SD**	**CV**	**# of Sets**	**U Statistic**	**two-tailed p-value**
41-70m	0.62	0	6.15	1.11	1.80	51	893.5	0.6530
71-100m	0.65	0	3.77	1.00	1.54	37	993.5	
YELLOWEYE ROCKFISH:								
Depth strata	**Mean**	**Min**	**Max**	**SD**	**CV**	**# of Sets**	**U Statistic**	**two-tailed p-value**
41-70m	2.86	0	20.19	5.49	1.92	51	857	0.4179
71-100m	1.78	0	14.71	2.96	1.66	37	1030	

Table 16. Results of Kruskal-Wallis tests for differences in catch rates (kg/skate) among statistical areas for spiny dogfish, lingcod, and quillback and yelloweye rockfishes. Data for statistical areas 12 and 13 were collected in 2003 and 2004, and all other areas were surveyed in 2005. Means, minimums (Min), maximums (Max), standard deviations (SD), coefficients of variation (CV), total number of sets, F statistics (parametric ANOVA applied to ranks), and p values are presented for each species.

SPINY DOGFISH:

Staistical Area	Mean	Min	Max	SD	CV	# of Sets	F Statistic	two-tailed p-value
12	44.05	0	148.41	36.44	0.83	103	11.49	p<0.0001*
13	77.45	6.51	177.43	41.63	0.54	41		
14	121.88	39.78	214.29	46.79	0.38	11		
15	86.44	0.49	178.14	56.27	0.65	16		
16	116.23	30.23	169.40	38.06	0.33	16		
17	109.01	52.71	160.18	29.36	0.27	13		
18	101.28	51.86	167.71	37.37	0.37	9		
19	73.72	28.15	92.51	24.92	0.34	6		
20	52.78	0.62	92.73	29.91	0.57	6		
28	73.04	19.45	117.81	44.29	0.61	7		
29	120.09	80.04	145.87	31.72	0.26	4		

Pairwise comparisons of mean ranks:
SA 12 significantly different than SA 13, 14, 16, 17, and 18.

LINGCOD (Shallow Stratum Only)

Staistical Area	Mean	Min	Max	SD	CV	# of Sets	F Statistic	two-tailed p-value
12	1.41	0	25.09	3.84	2.72	49	1.04	0.4121
13	0.61	0	4.98	1.30	2.13	25		
14	2.98	0	20.89	7.90	2.65	7		
15	1.81	0	9.71	3.10	1.71	9		
16	1.57	0	6.08	2.21	1.41	9		
17	3.16	0	27.96	8.79	2.78	10		
18	0.26	0	1.58	0.65	2.50	6		
19	0	0	0	-	-	5		
20	0.50	0	1.51	0.87	1.74	3		
28	0.34	0	1.34	0.67	1.97	4		
29	0	0	0.00	-	-	1		

QUILLBACK ROCKFISH:

Staistical Area	Mean	Min	Max	SD	CV	# of Sets	F Statistic	two-tailed p-value
12	3.38	0	33.60	4.69	1.39	103	5.67	p <0.0001*
13	2.54	0	9.66	2.62	1.03	41		
14	1.35	0	6.15	1.83	1.35	11		
15	0.73	0	2.11	0.60	0.82	16		
16	0.49	0	2.81	0.82	1.66	16		
17	0.40	0	1.94	0.67	1.68	13		
18	0.40	0	3.03	1.00	2.51	9		
19	0.17	0	0.66	0.28	1.65	6		
20	0	0	0	0	0	6		
28	0.96	0	3.77	1.43	1.48	7		
29	0.94	0	3.74	1.87	2.00	4		

Pairwise comparisons of mean ranks:
SA 12 significantly different than SA 15, 16, 17, 18, 19, 20 (p<0.05); SA 13 significantly different than SA 16

Table 16 (continued).

YELLOWEYE ROCKFISH:								
Staistical Area	**Mean**	**Min**	**Max**	**SD**	**CV**	**# of Sets**	**F Statistic**	**two-tailed p-value**
12	2.08	0	22.31	4.01	1.93	103	4.93	p <0.0001*
13	4.62	0	26.75	5.73	1.24	41		
14	2.96	0	15.90	4.81	1.62	11		
15	5.20	0	20.19	6.27	1.21	16		
16	4.29	0	17.11	5.90	1.38	16		
17	1.56	0	11.58	3.45	2.22	13		
18	0.11	0	1.02	0.34	3.00	9		
19	0	0	0	0	0	6		
20	0	0	0	0	0	6		
28	0.35	0	1.31	0.52	1.49	7		
29	0	0	0	0	0	4		

Pairwise comparisons of mean ranks:
SA 13 and 15 significantly different than SA 12, 17, 18, 19, 20, 28 and 29;
SA 16 significantly different than SA 18, 19, 20 and 29

Table 17. Proportion of hooks yielding quillback and yelloweye rockfish catch for the three BPI categories: flats/depressions, slopes/mounds, and peaks/ridge tops. Results of pairwise proportion tests indicate where significant differences were found.

Quillback Rockfish:

BPI Category	Total # of hooks	Total # of Quillback	Proportion Quillback
Flats / depressions	2494	4	0.0016
Slopes / mounds	851	8	0.0094
Peaks / ridge tops	3370	31	0.0092
Proportion Test:			
Flats / depressions significantly different than Slopes / mounds (Z = -2.95, p = 0.0031*)			
Flats / depressions significantly different than Peaks / ridge tops (Z = -3.56, p = 0.0004*)			

Yelloweye Rockfish:

BPI Category	Total # of hooks	Total # of Yelloweye	Proportion Yelloweye
Flats / depressions	2494	12	0.0048
Slopes / mounds	851	9	0.0106
Peaks / ridge tops	3370	38	0.0113
Proportion Test:			
Flats / depressions significantly different than Peaks / ridge tops (Z = -2.52, p = 0.0118*)			

Table 18. Quillback and yelloweye rockfish catch rate (#fish/hook) coefficients of variation by BPI category, and for all categories combined.

Species	All	Flats / Depressions	Slopes / Mounds	Peaks / Ridge Tops
Quillback Rockfish	12.5	25	10.3	10.4
Yelloweye Rockfish	10.6	14.4	9.7	9.4

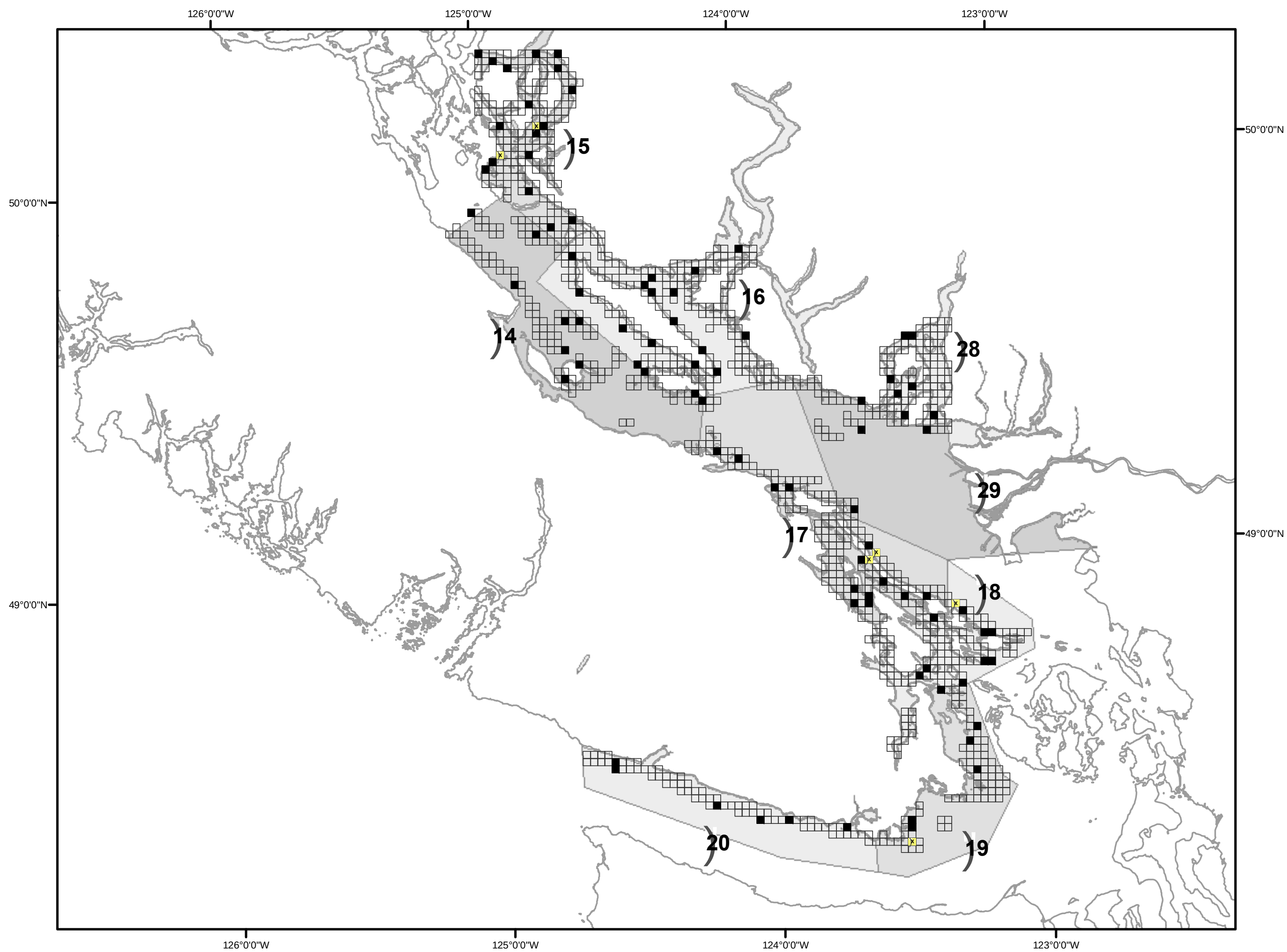


Figure 1. Survey block locations: black squares illustrate the 89 surveyed sites, and black X 's illustrate the 6 rejected blocks. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

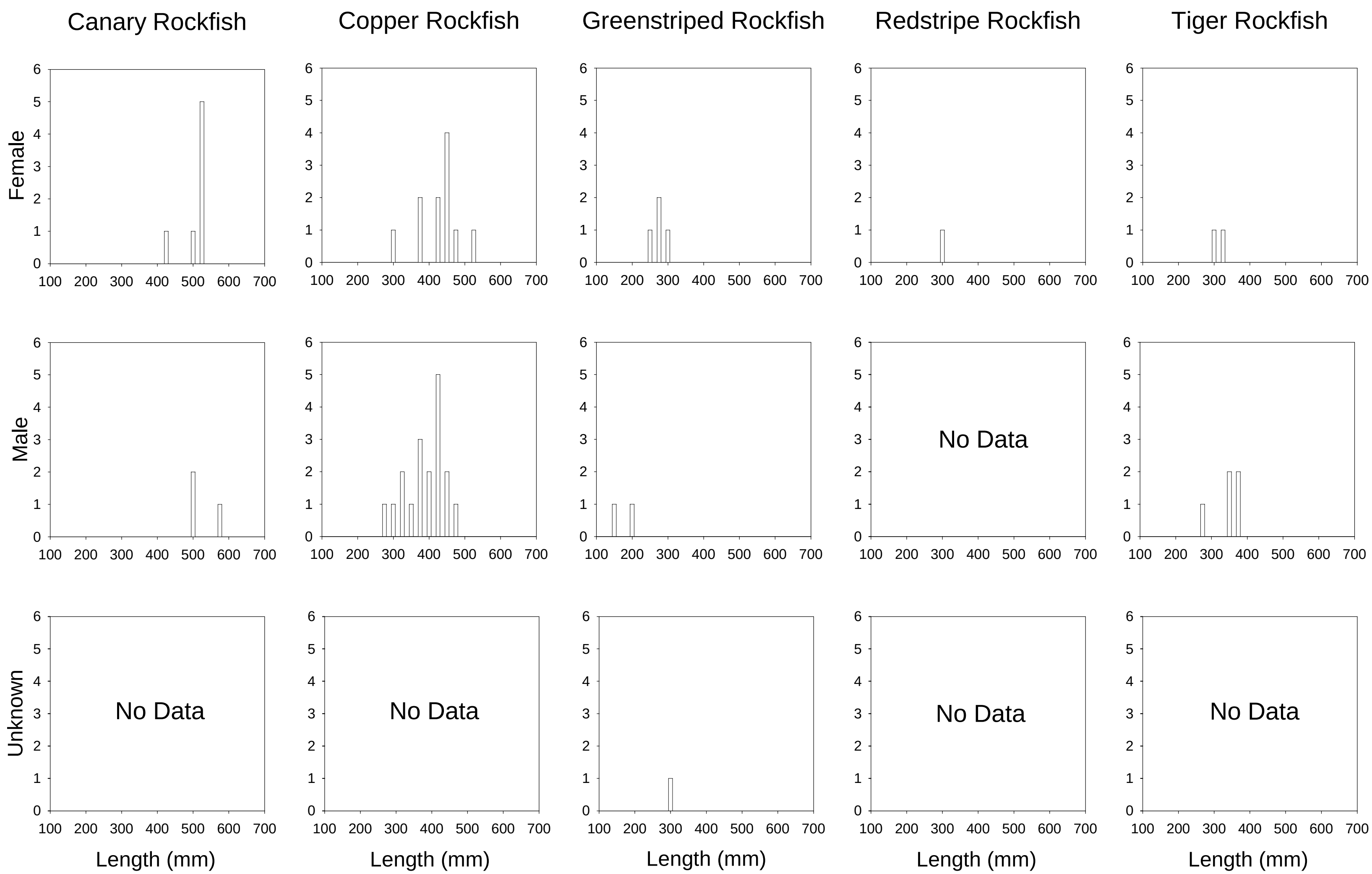


Figure 2. Canary, copper, greenstriped, redstripe, tiger rockfish length frequency histograms.

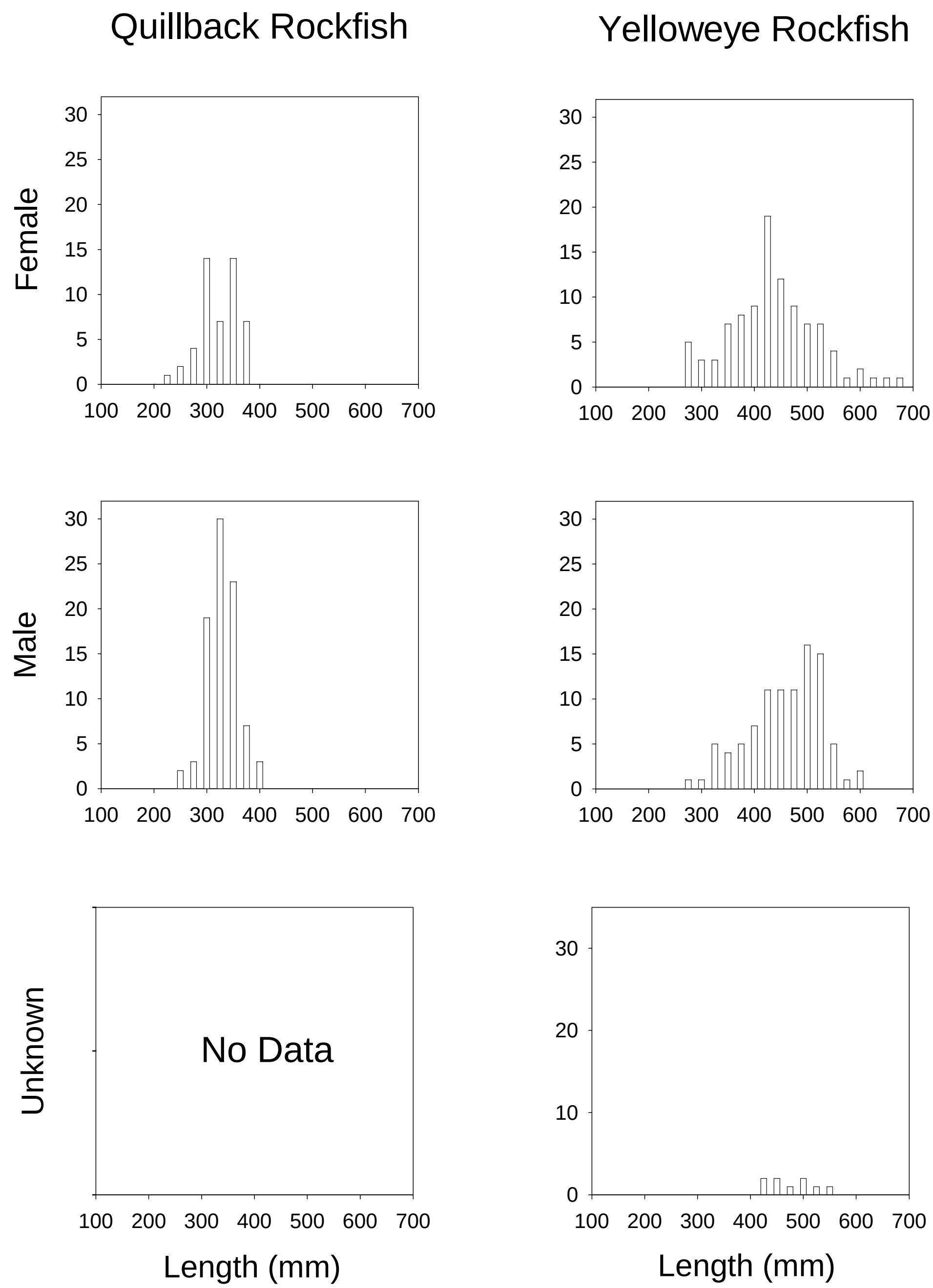
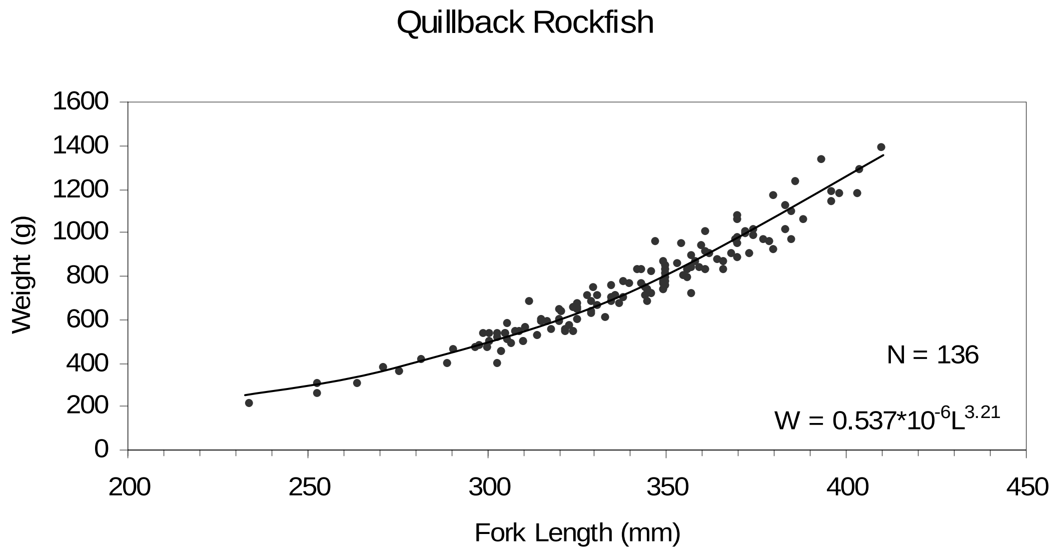


Figure 2 (continued).



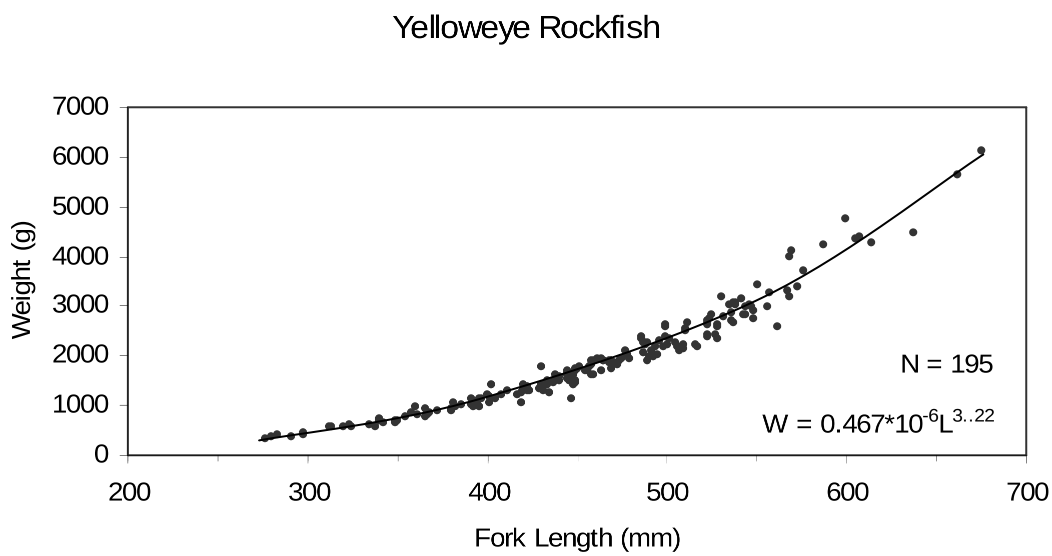


Figure 3. Length – weight relationship for quillback and yelloweye rockfish. Line equations are shown where ‘W’ equals weight in grams, ‘L’ equals fork length in millimetres and ‘n’ equals sample size.

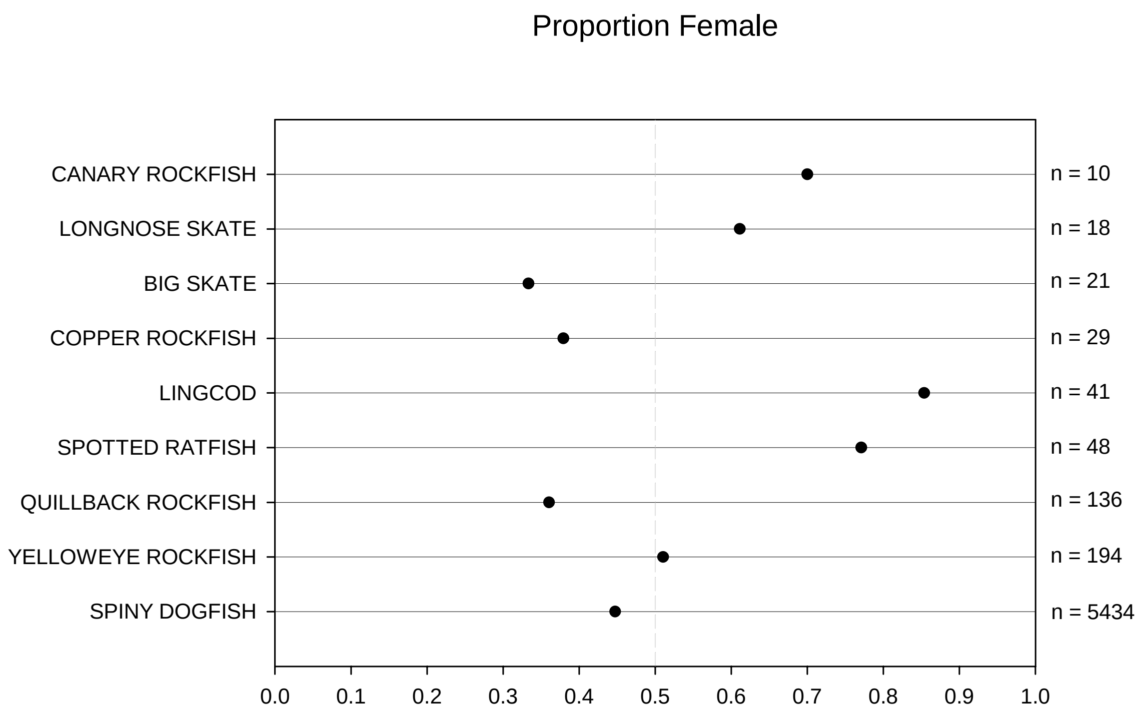


Figure 4. Proportion female for species where sample size (n) was 10 or more.

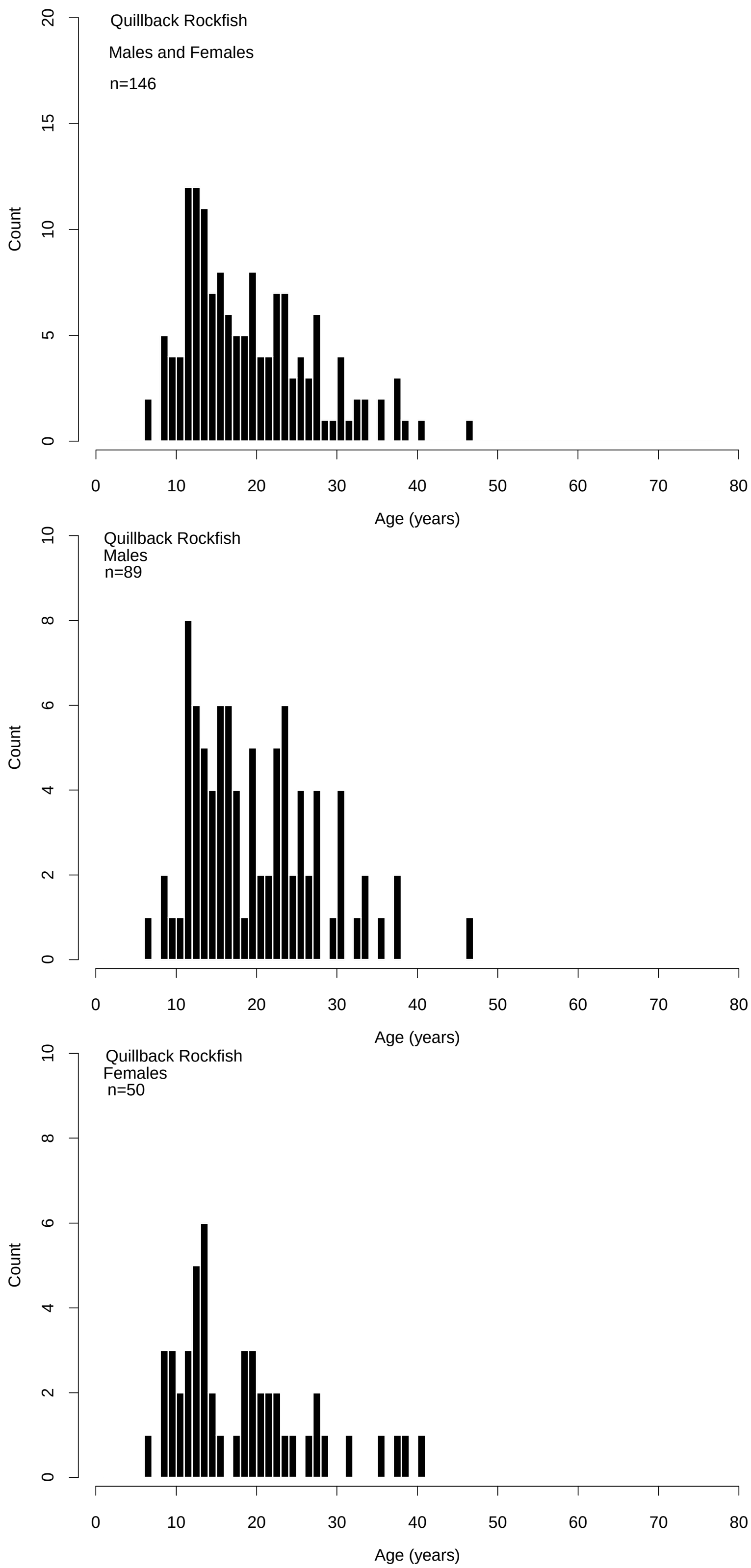


Figure 5. Age frequency distribution of quillback rockfish plotted with sexes combined (top), with males only (middle), and females only (bottom).

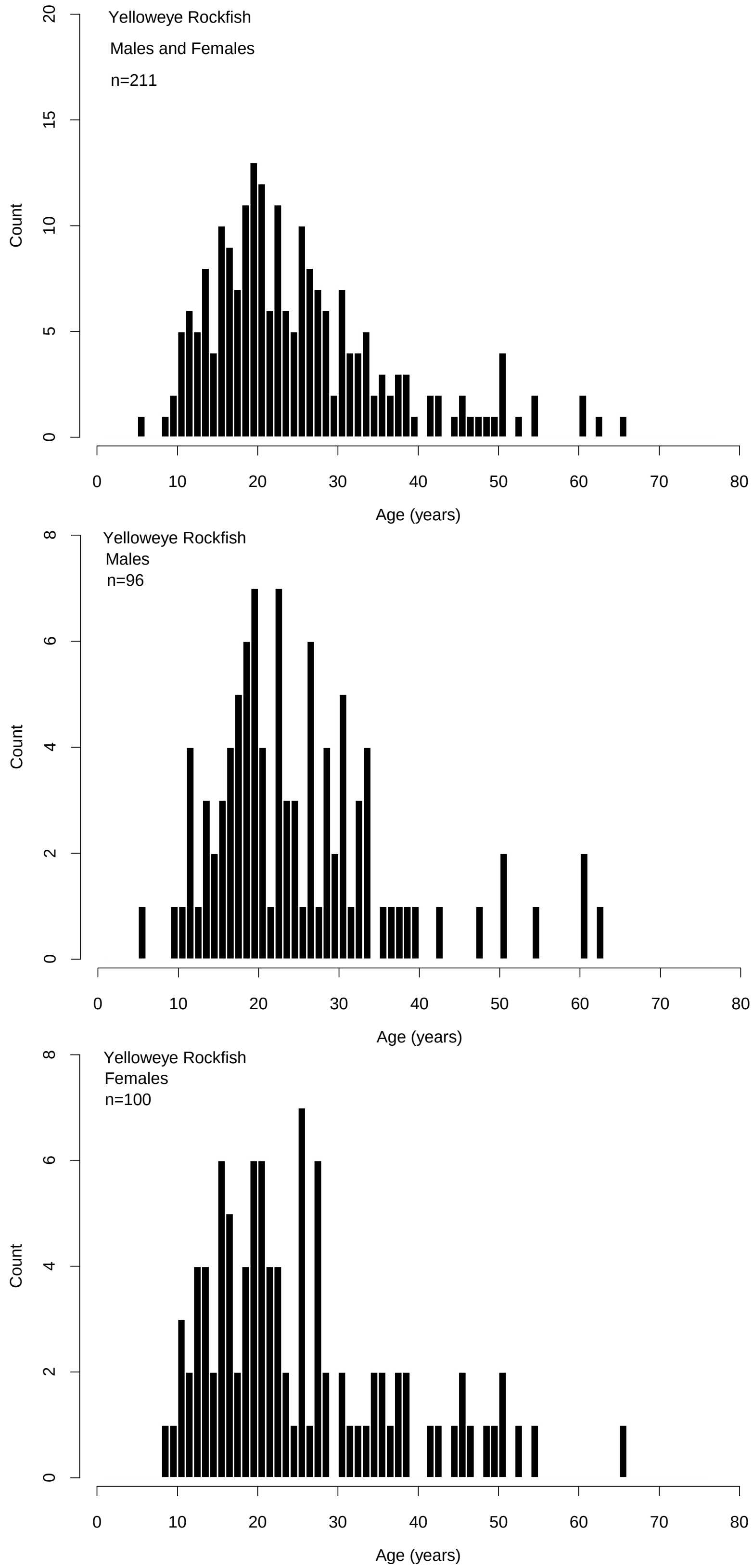


Figure 6. Age frequency distribution of yelloweye rockfish plotted with sexes combined (top), with males only (middle), and females only (bottom).

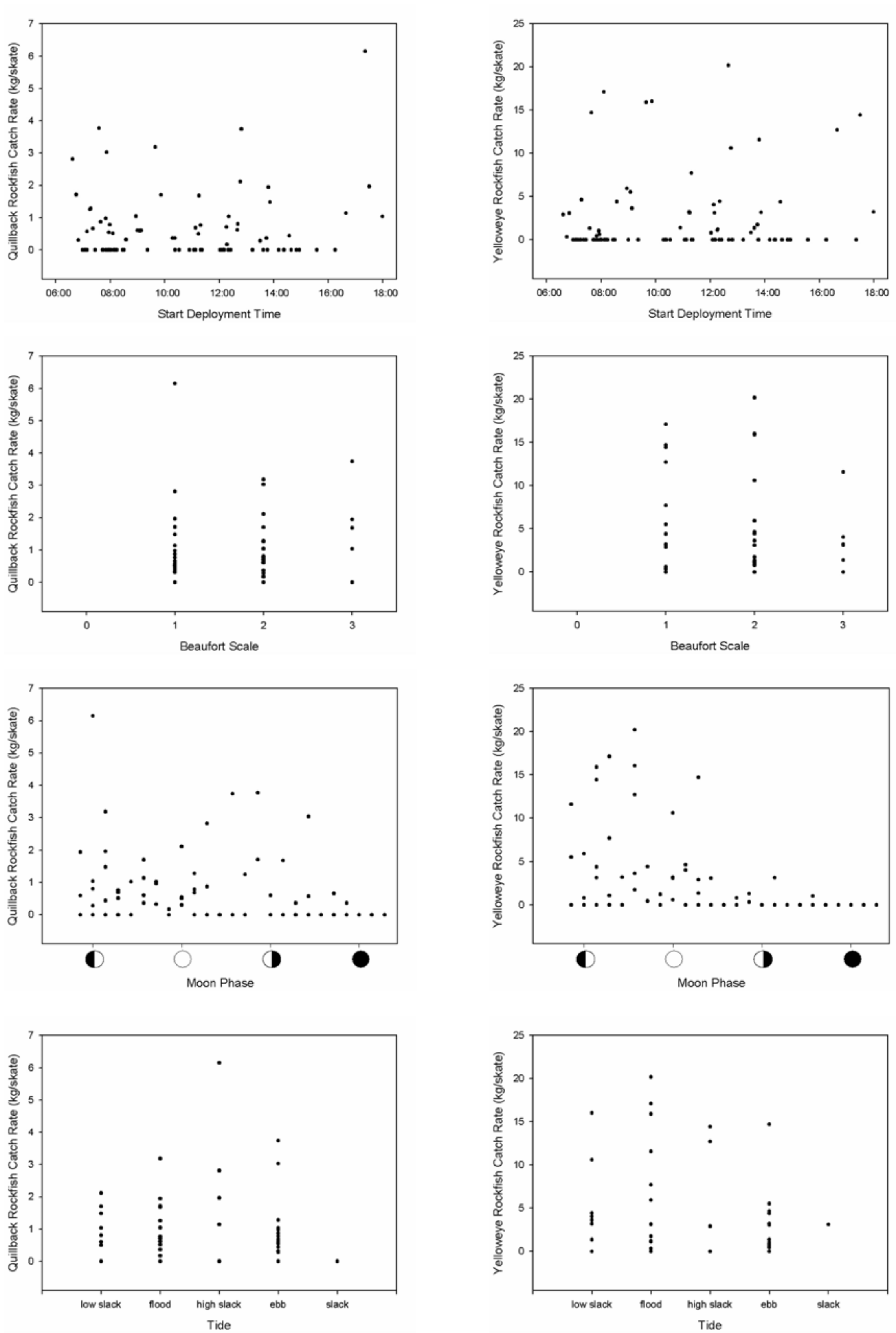


Figure 7. Quillback and yelloweye catch rates (kg/skate) plotted against deployment time, Beaufort scale, moon phase and tide.

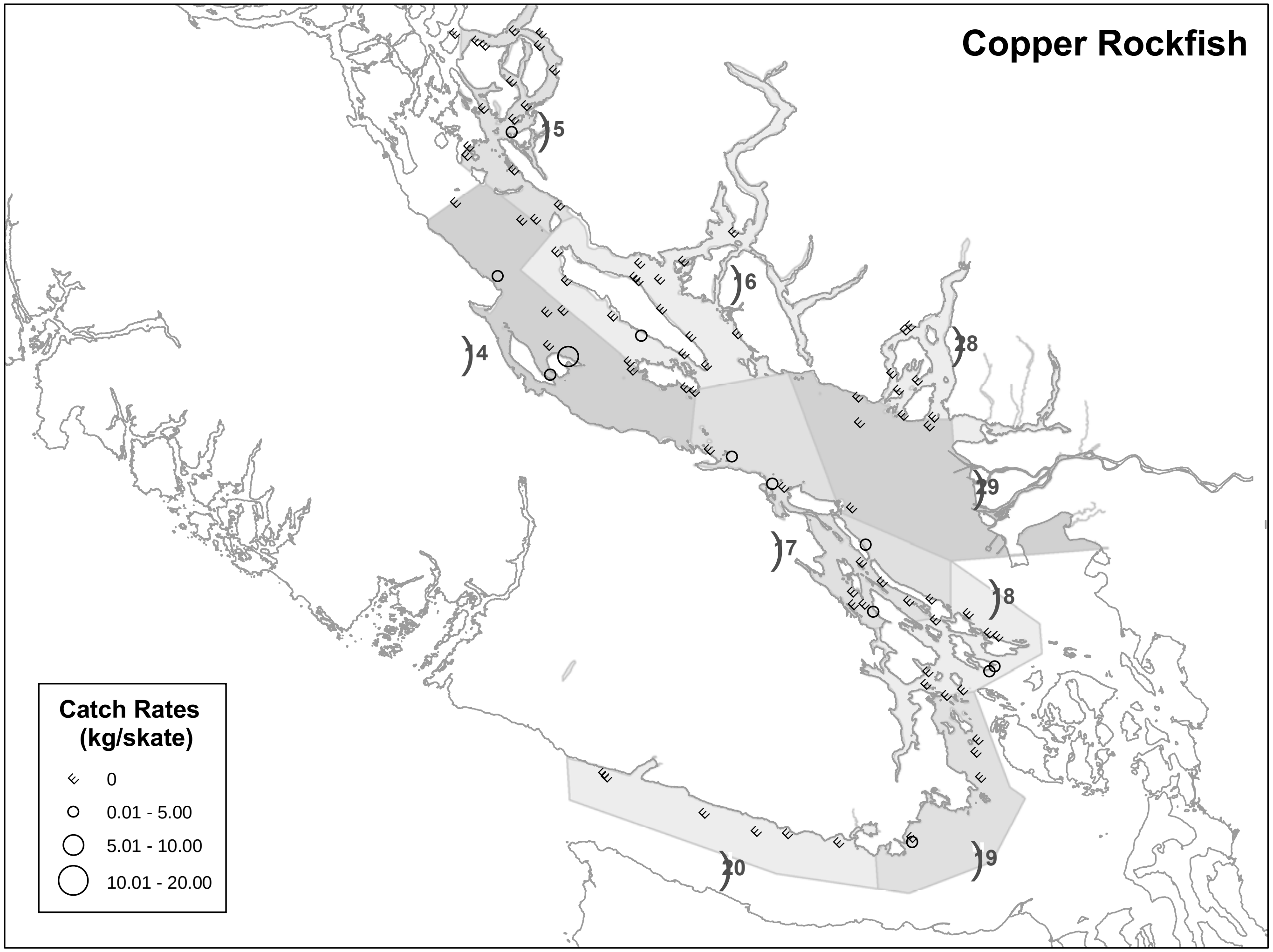


Figure 8. Spatial distribution of copper rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

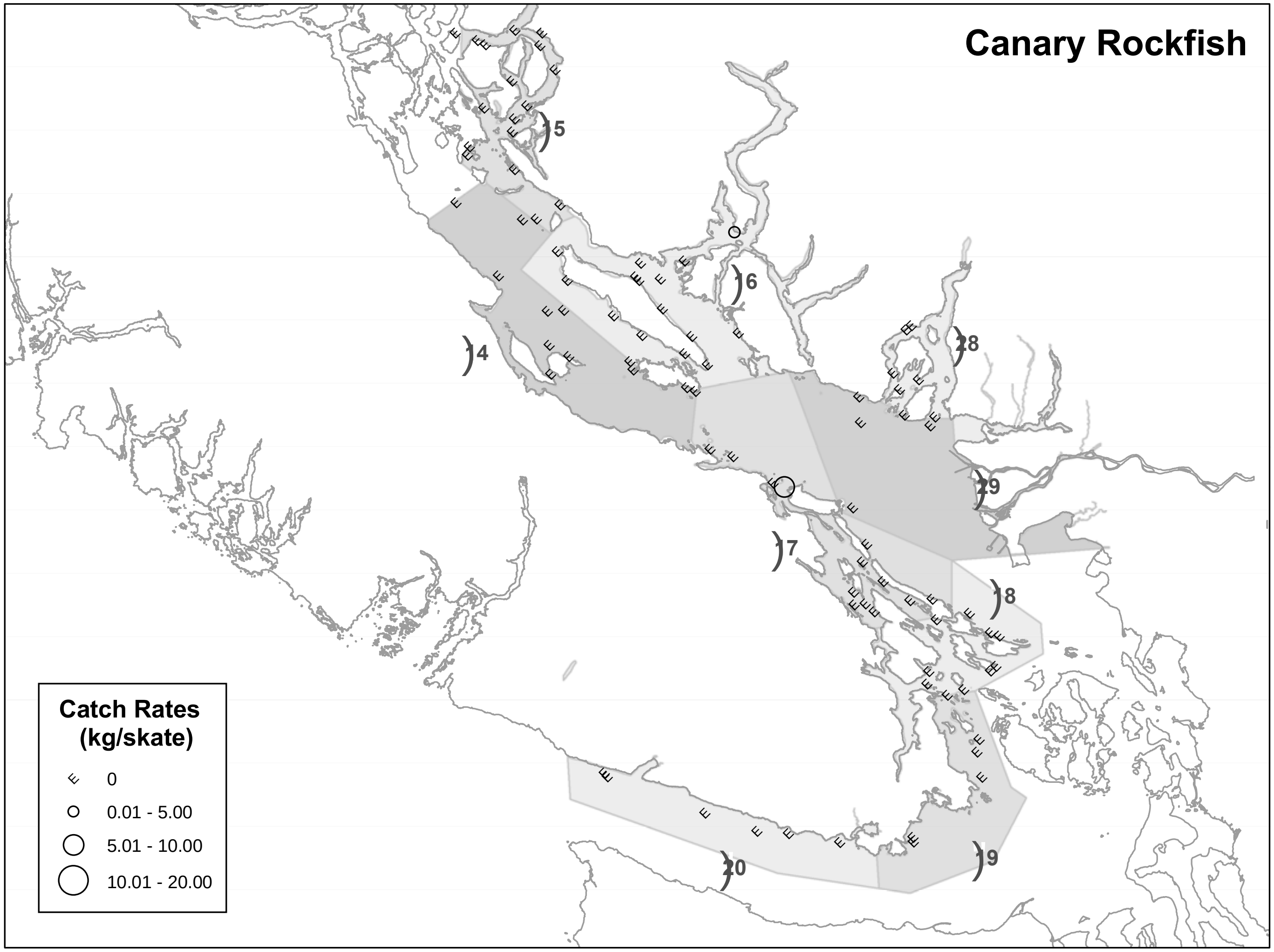


Figure 9. Spatial distribution of canary rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

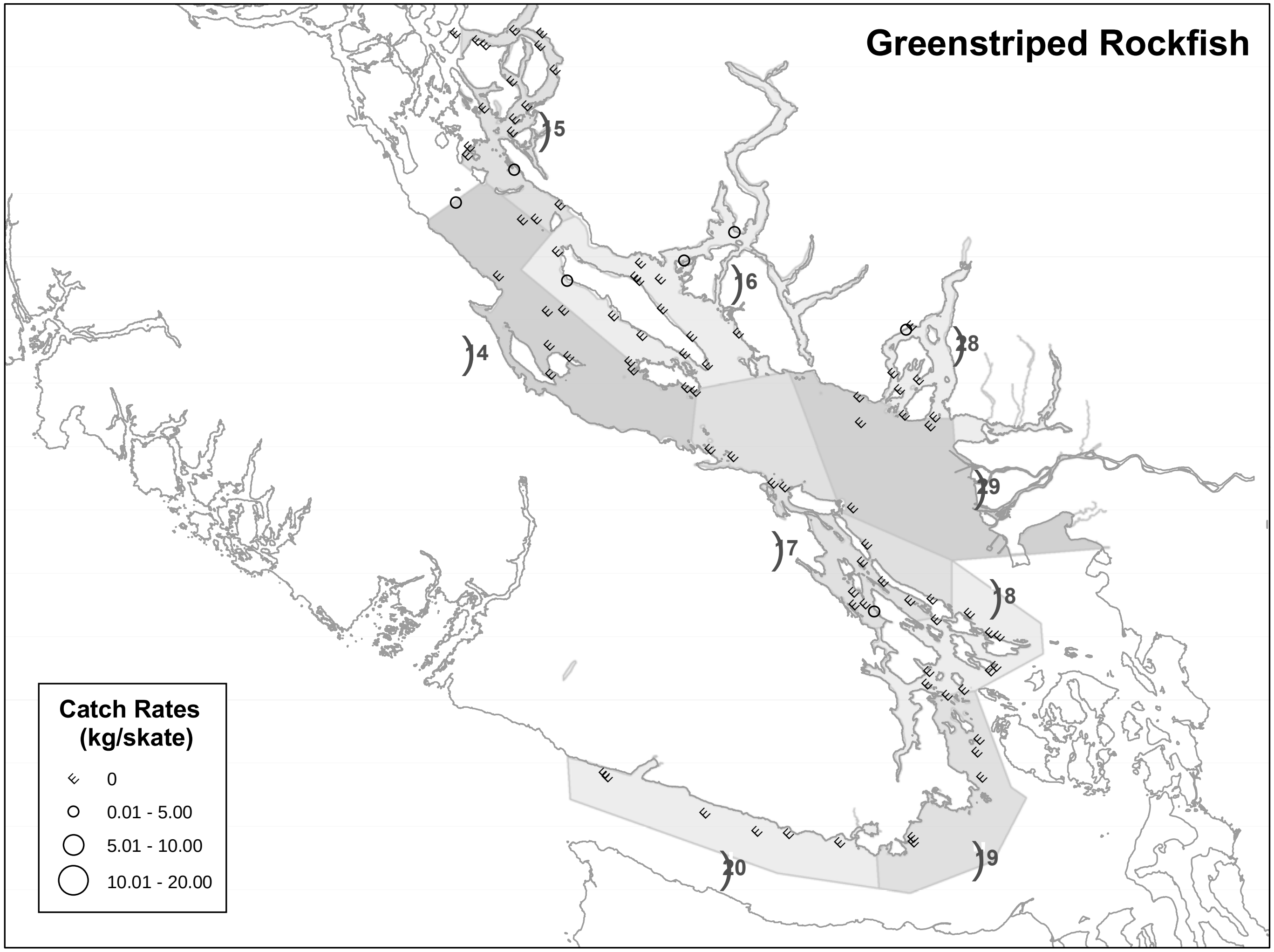


Figure 10. Spatial distribution of greenstriped rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

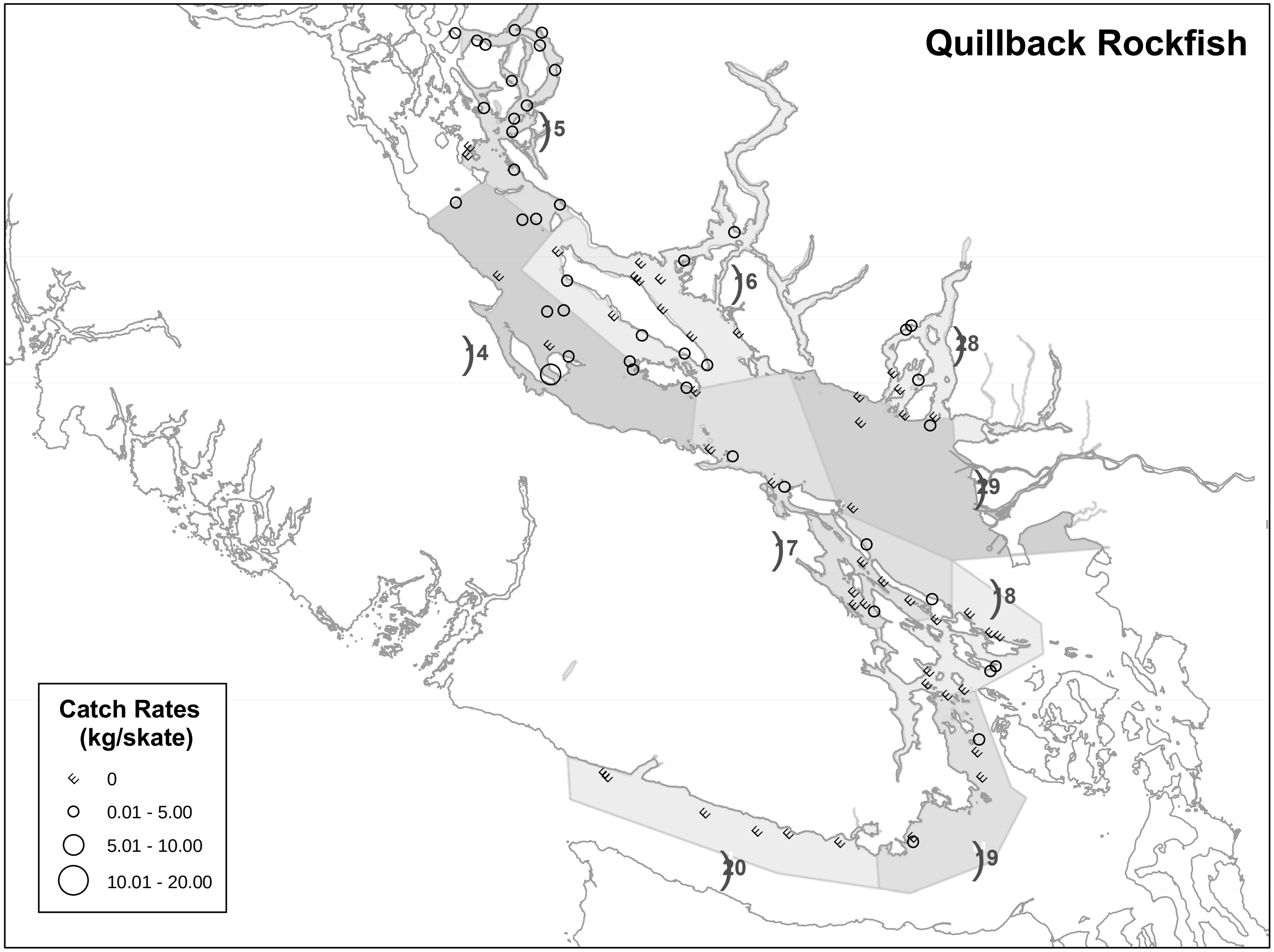


Figure 11. Spatial distribution of quillback rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

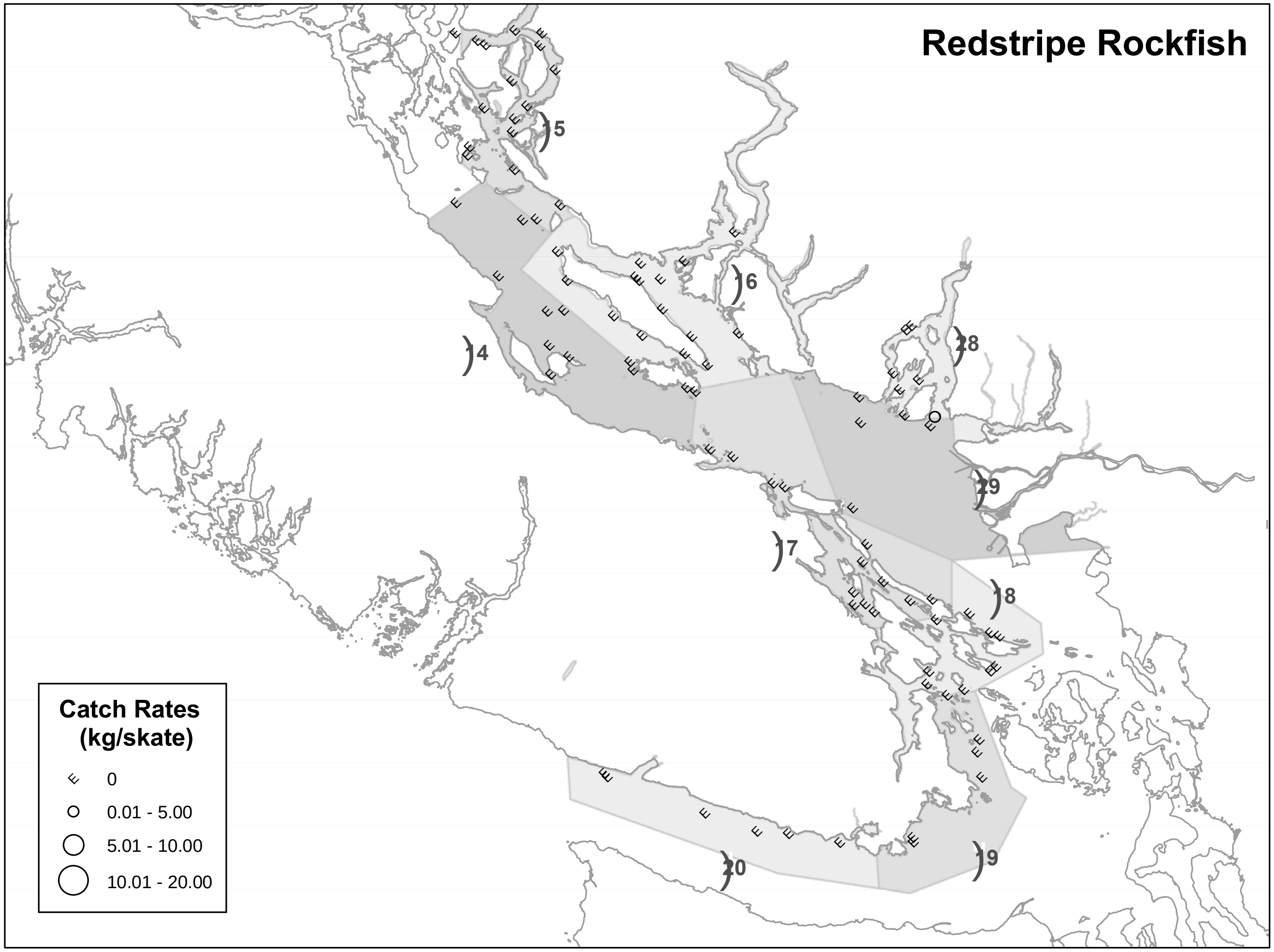


Figure 12. Spatial distribution of redstripe rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

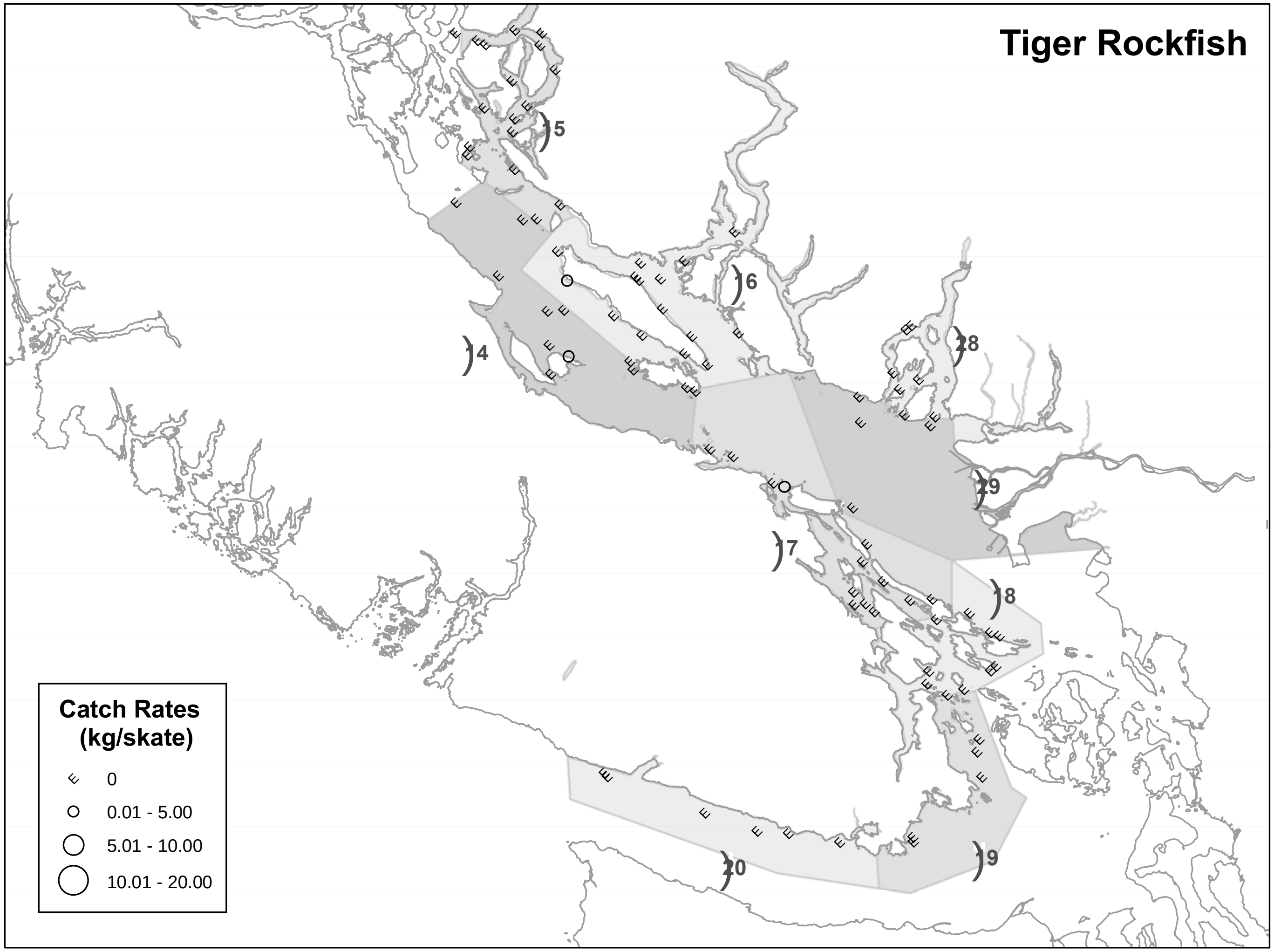


Figure 13. Spatial distribution of tiger rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

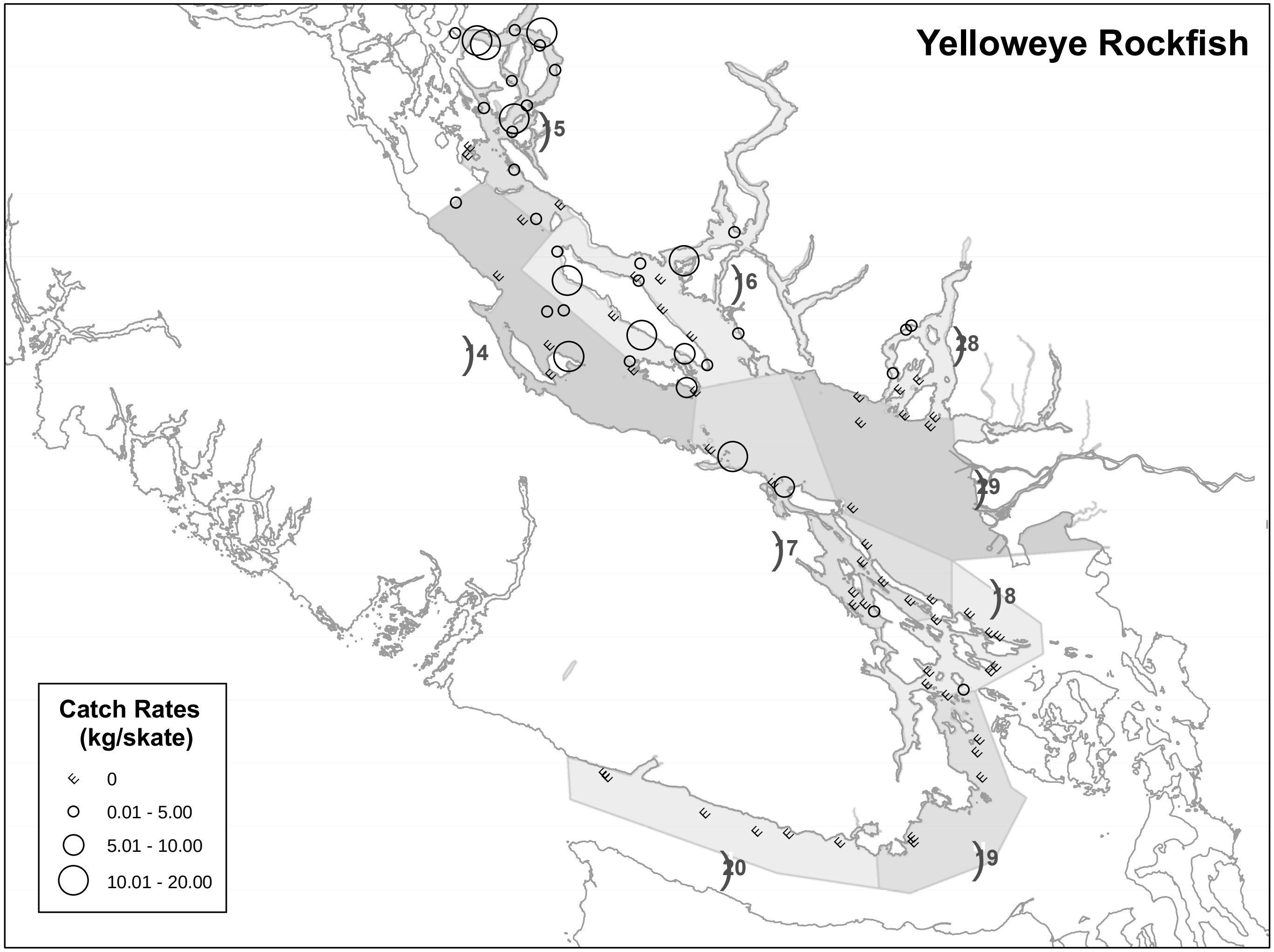


Figure 14. Spatial distribution of yelloweye rockfish catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

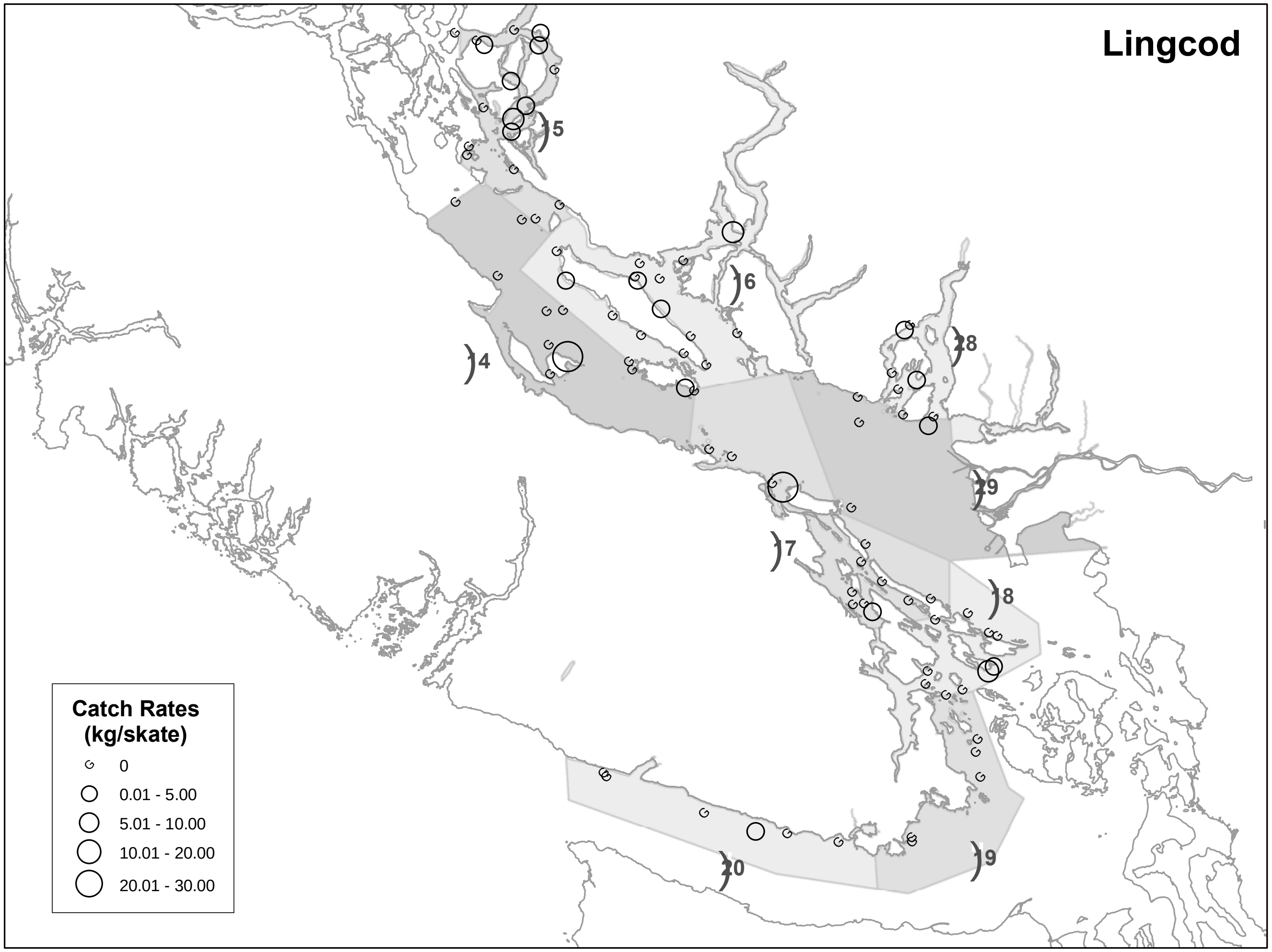


Figure 15. Spatial distribution of lingcod catch rates in units of kilograms per skate for all sites surveyed in 2005. Statistical areas are labelled with boxed numbers 14 – 20, 28 and 29, and their areas denoted with grey shading.

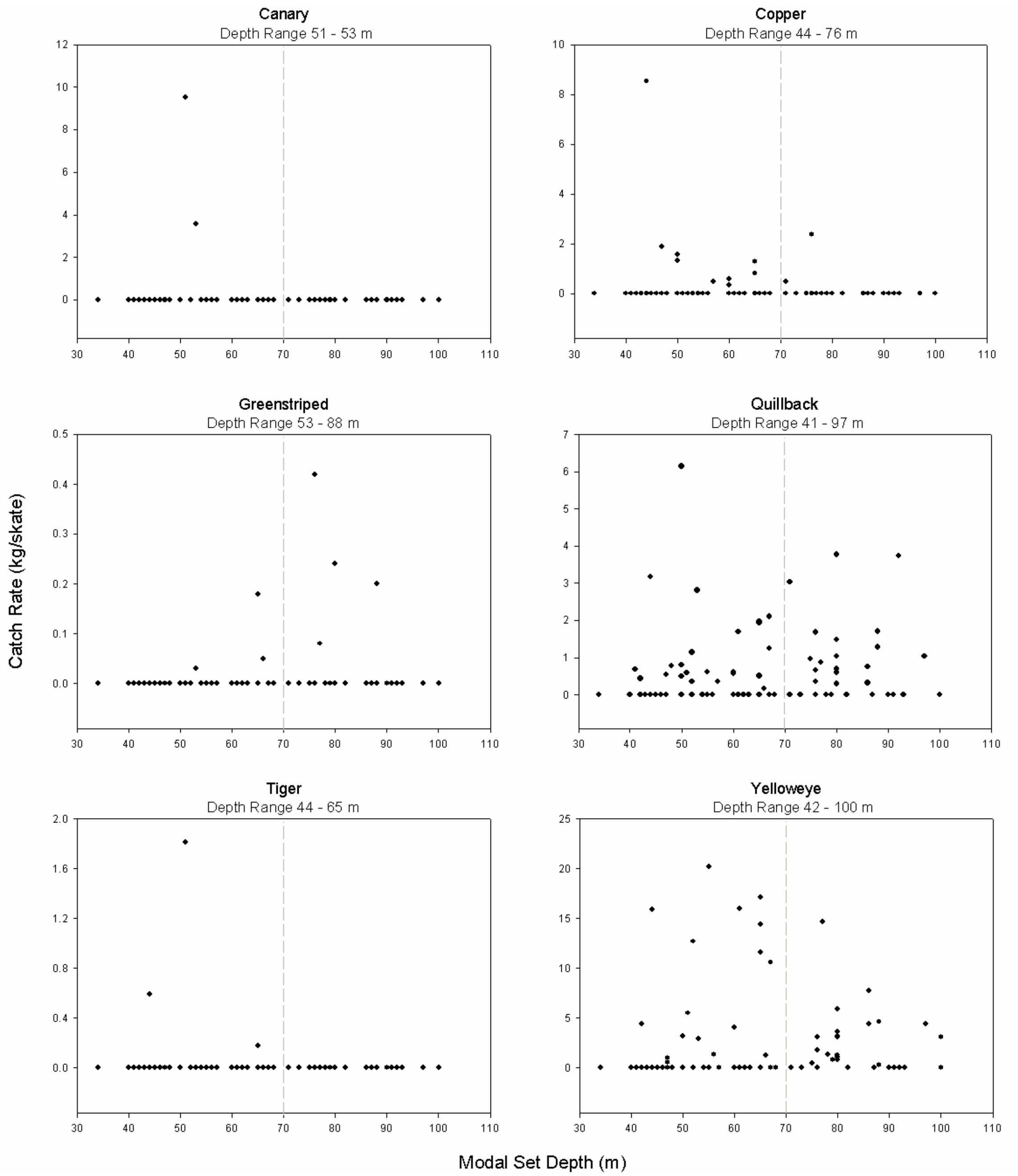


Figure 16. Relationships between catch rates (kg/skate) and modal set depth (m) for the six most frequently encountered rockfish on the survey. Depth ranges are for non-zero catch rates. The grey dotted line represents the boundary between the shallow stratum (41-70m) and the deep stratum (71-100m).

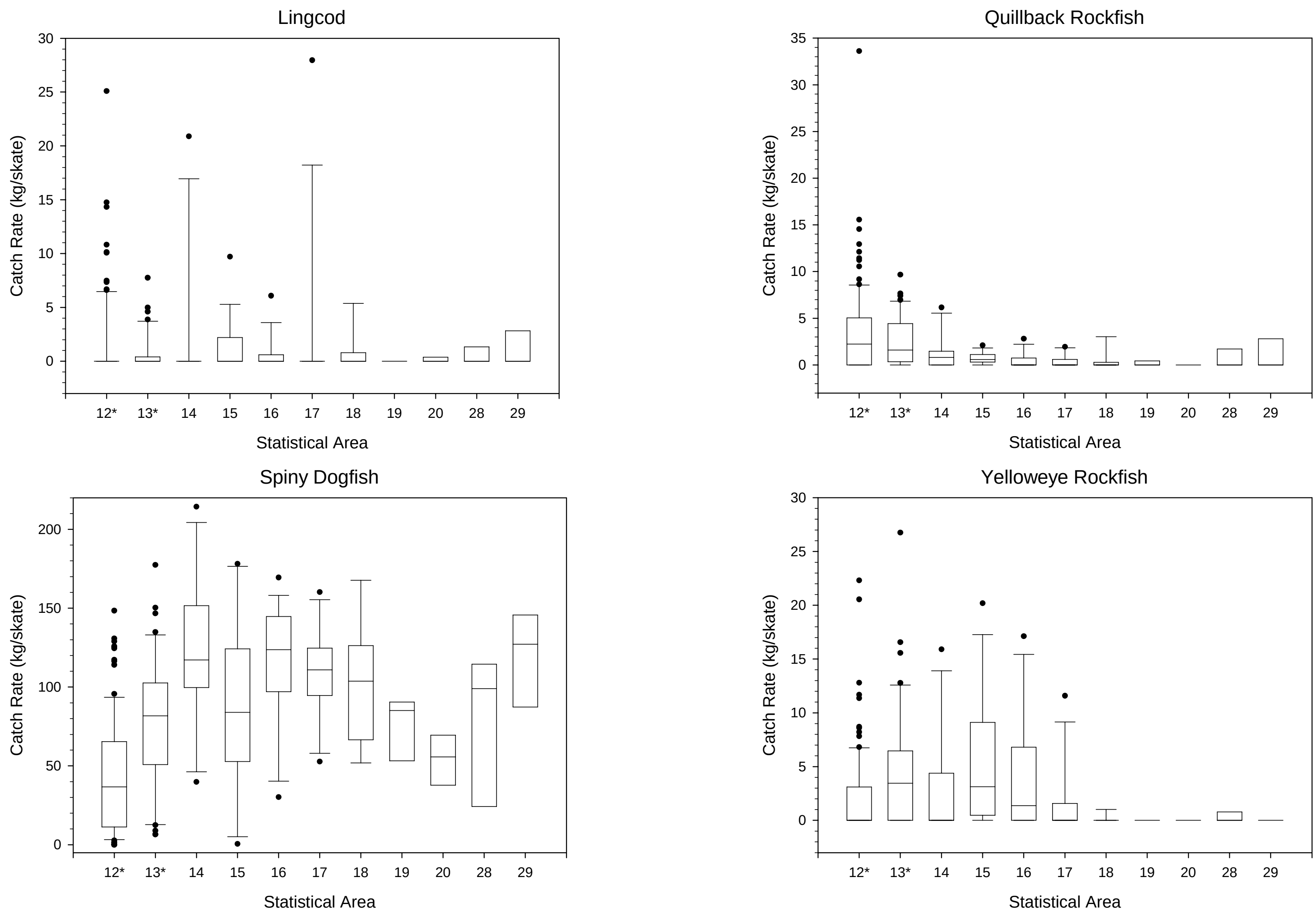


Figure 17. Lingcod, spiny dogfish, quillback and yelloweye rockfish catch rates (kg/skate) plotted by statistical area. *Data for statistical areas 12 and 13 were collected in 2003 and 2004, and all other areas were surveyed in 2005.

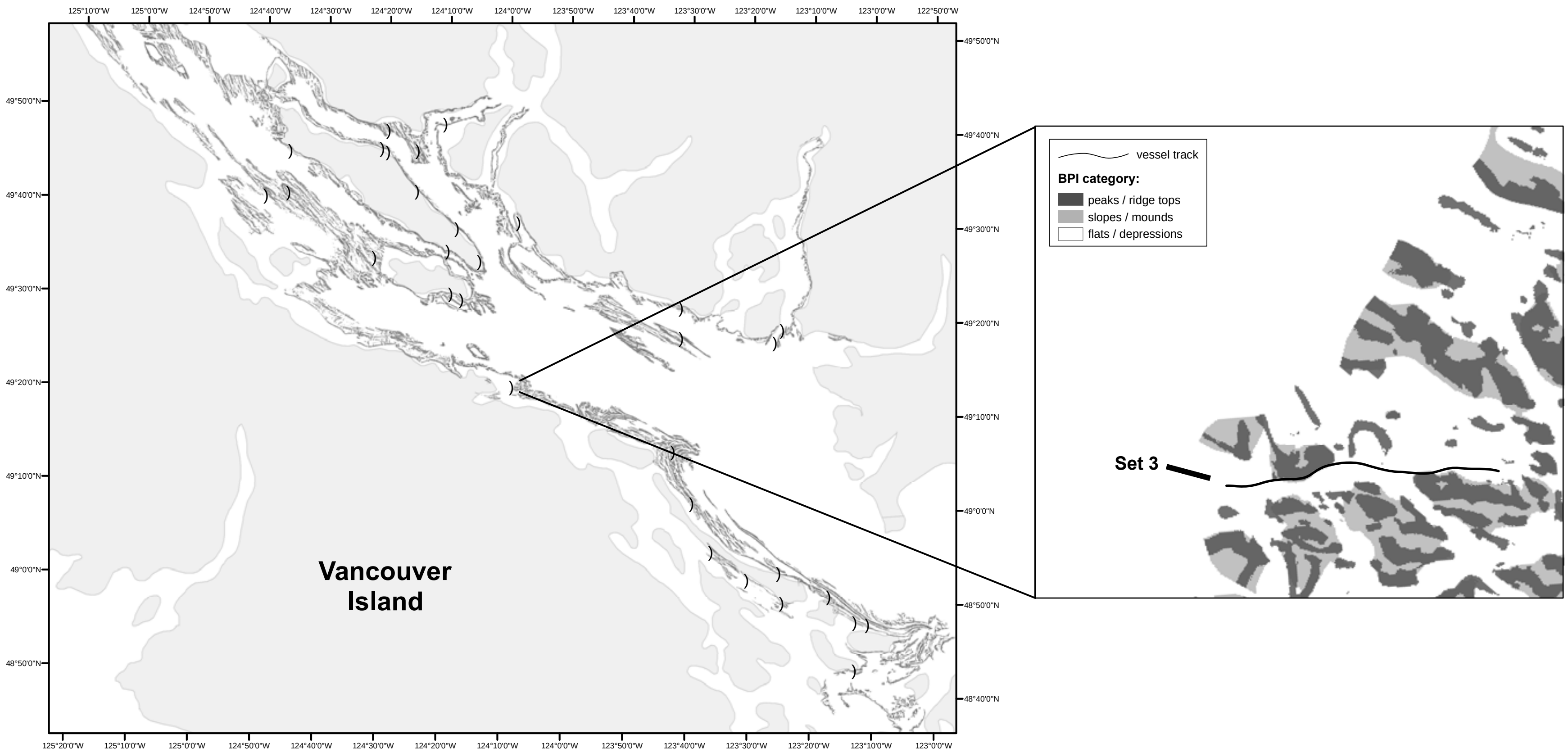


Figure 18. Location of the 31 survey blocks which were located in areas for which there was multibeam data and therefore included in the bathymetric position index analysis (left panel), and a close-up of one of the survey blocks (set 3) illustrating BPI categories and the vessel's track that was recorded during gear deployment (right panel).

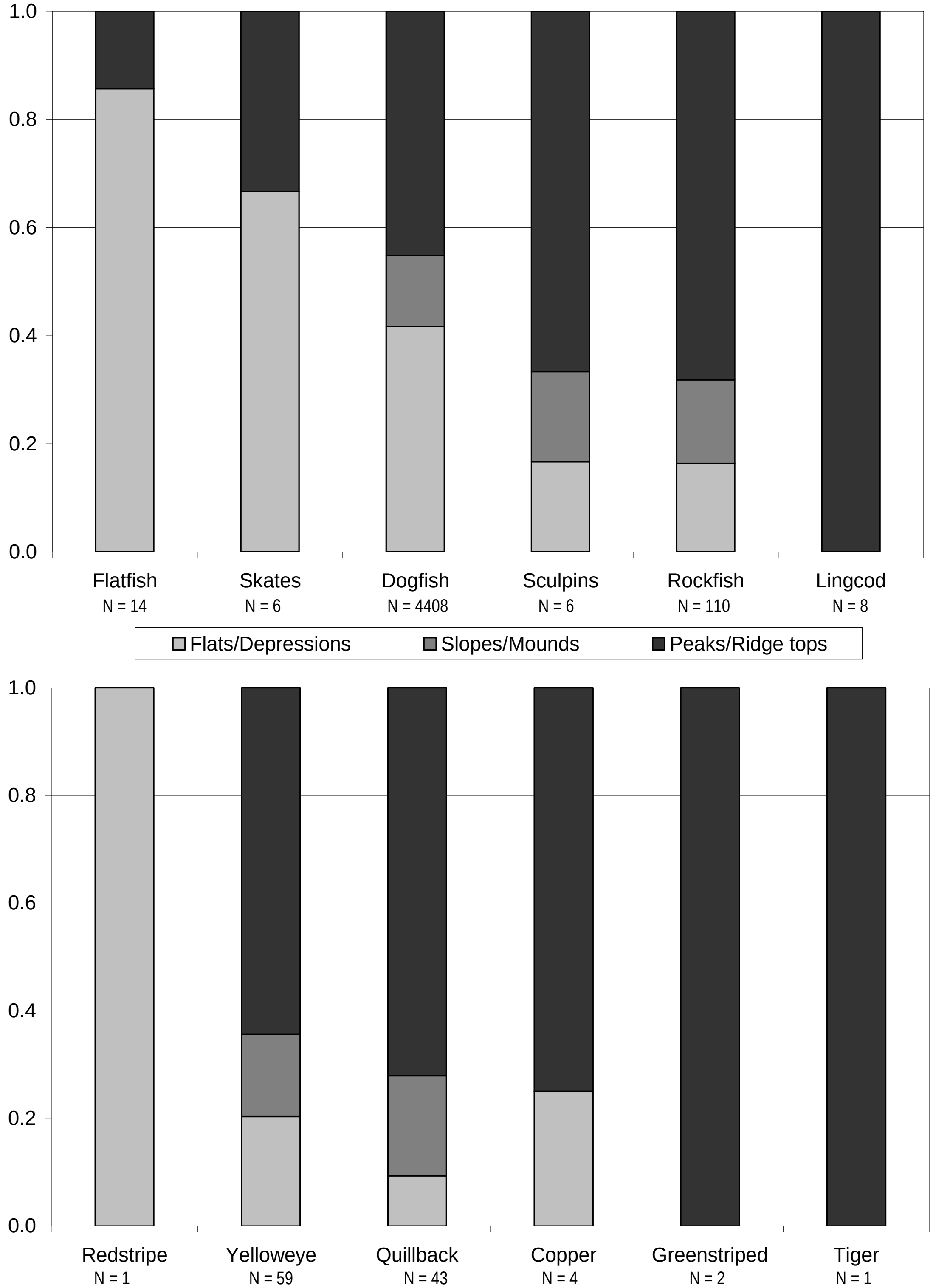


Figure 19. Proportion of hooks that landed on each of the three bathymetric position index categories: flats / depressions, slopes / mounds, and peaks / ridge tops for hooks that yielded catch (i.e. not including empty hooks). The top panel illustrates proportions for prominent groundfish species and species groups, the bottom panel illustrates proportions for each rockfish species encountered on the survey, and 'N' indicates the number of fish observations.

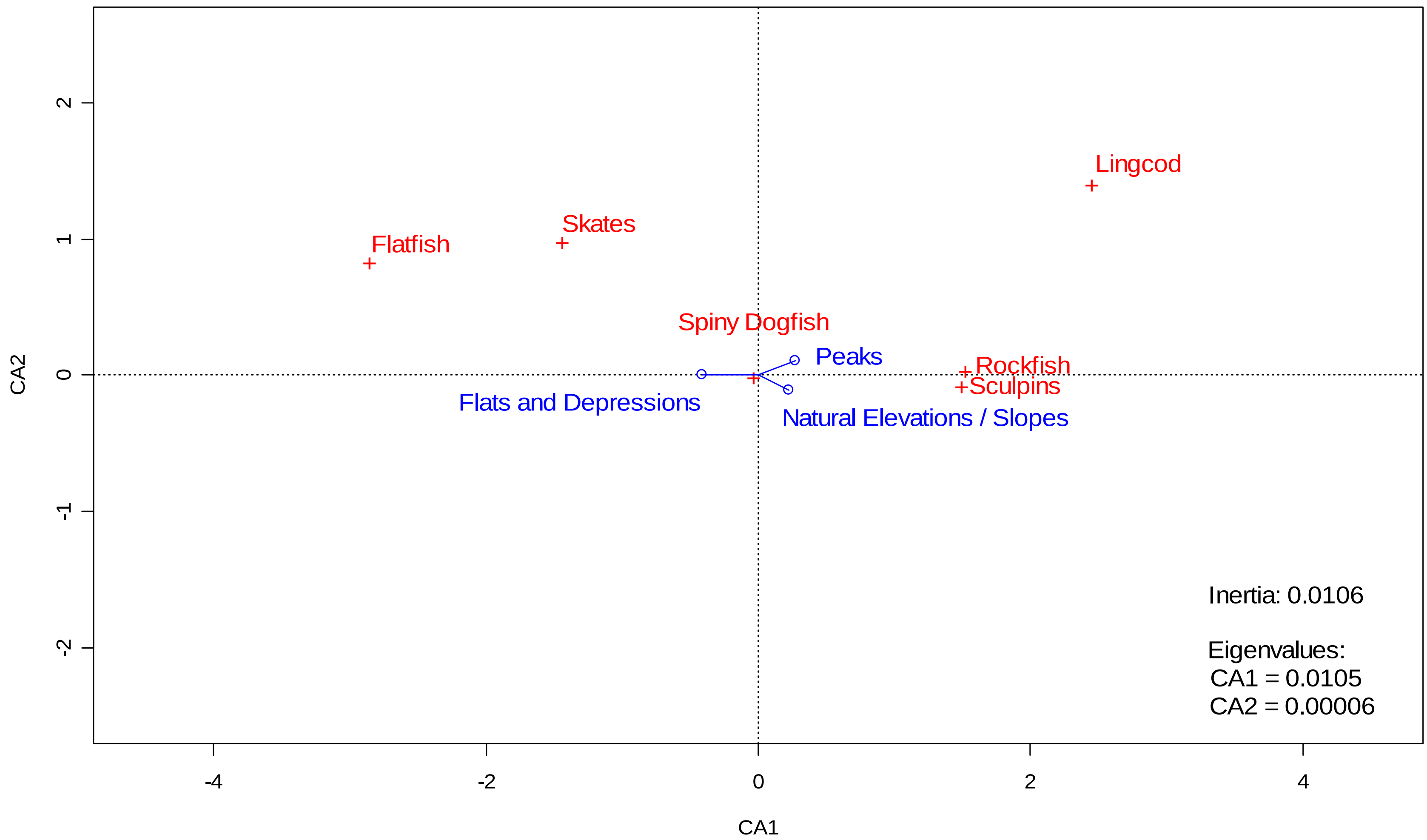


Figure 20. Correspondence analysis showing the relationship between species and species groups catch rates (#fish/hook) and bathymetric position index category.

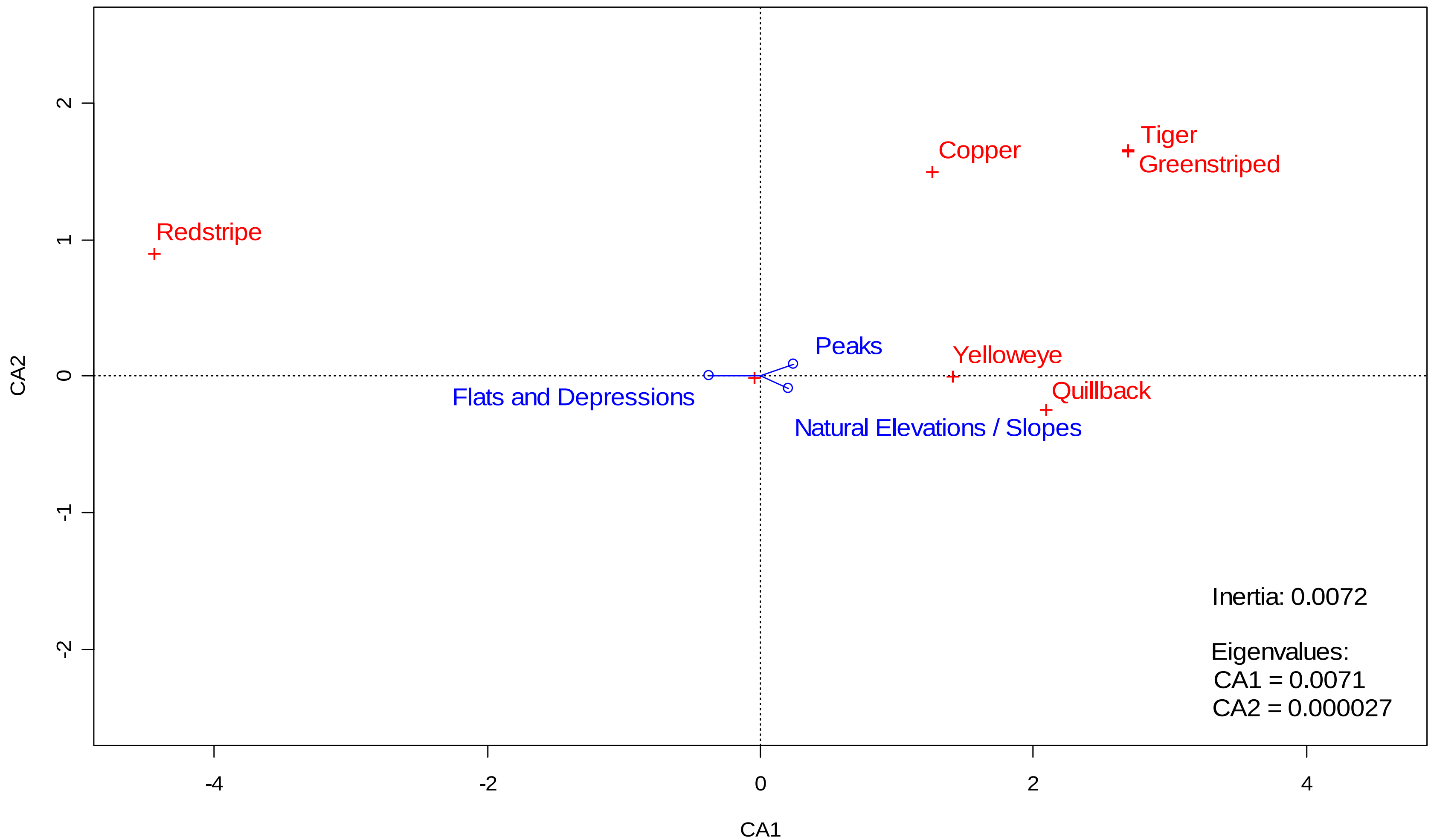


Figure 21. Correspondence analysis showing the relationship between rockfish species catch rates (#fish/hook) and bathymetric position index category.

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Appendix A. Set Specifications.

Set #	Date	Start Latitude	Start Longitude	End Latitude	End Longitude	Travelled Distance (km)	Min Depth (m)	Max Depth (m)	Modal Depth (m)	Begin Deployment Time	End Deployment Time	Begin Retrieval Time	End Retrieval Time	Soak Time (mins)	Number of Hooks
1	11-Aug-05	49 21.25	123 91.93	49 20.45	123 90.90	1.254	38	57	50	8:09 AM	8:20 AM	10:21 AM	10:48 AM	121	226
2	11-Aug-05	49 19.77	123 87.50	49 20.47	123 88.58	1.139	44	77	51	9:05 AM	9:15 AM	11:17 AM	11:49 AM	122	222
3	11-Aug-05	49 27.77	124 06.18	49 29.03	124 07.05	1.062	52	79	65	1:48 PM	1:58 PM	3:59 PM	4:17 PM	121	227
4	11-Aug-05	49 30.30	124 13.78	49 29.83	124 12.47	1.130	56	71	61	2:56 PM	3:07 PM	5:08 PM	5:26 PM	121	229
5	12-Aug-05	49 43.85	124 18.20	49 44.35	124 19.40	1.037	70	99	90	7:51 AM	8:00 AM	10:01 AM	10:17 AM	121	207
6	12-Aug-05	49 45.02	124 21.08	49 45.10	124 22.60	1.098	68	90	80	8:57 AM	9:09 AM	11:09 AM	11:27 AM	120	225
7	12-Aug-05	49 50.28	124 39.82	49 52.60	124 40.38	1.077	43	52	50	12:41 PM	12:51 PM	2:52 PM	3:10 PM	121	219
8	12-Aug-05	49 52.30	124 41.20	49 52.65	124 40.05	1.046	76	85	80	1:30 PM	1:40 PM	3:44 PM	4:05 PM	124	227
9	12-Aug-05	49 49.93	124 69.70	49 49.42	124 68.70	0.918	43	60	50	5:21 PM	5:30 PM	7:31 PM	7:49 PM	121	225
10	13-Aug-05	49 54.27	124 62.83	49 53.88	124 61.60	1.032	39	52	44	9:39 AM	9:48 AM	11:48 AM	12:06 PM	120	222
11	13-Aug-05	49 57.17	124 70.47	49 56.80	124 69.10	1.065	40	44	42	10:32 AM	10:40 AM	12:41 PM	12:57 PM	121	223
12	13-Aug-05	49 64.53	124 69.78	49 65.22	124 70.73	0.964	71	87	80	1:52 PM	2:00 PM	4:00 PM	4:16 PM	120	227
13	13-Aug-05	49 64.85	124 63.67	49 65.18	124 64.93	1.055	40	45	42	2:34 PM	2:44 PM	4:45 PM	5:02 PM	121	238
14	13-Aug-05	49 72.33	124 62.33	49 72.87	124 62.70	0.978	56	88	65	5:30 PM	5:39 PM	7:39 PM	7:58 PM	120	230
15	14-Aug-05	49 62.97	124 46.23	49 63.55	124 47.23	0.985	51	81	65	7:06 AM	7:15 AM	9:16 AM	9:31 AM	121	223
16	14-Aug-05	49 58.37	124 35.55	49 57.83	124 34.57	1.013	58	79	65	8:06 AM	8:16 AM	10:16 AM	10:33 AM	120	225
17	14-Aug-05	49 52.62	124 21.05	49 52.13	124 19.93	0.994	55	104	86	11:19 AM	11:28 AM	1:29 PM	1:46 PM	121	227
18	14-Aug-05	49 50.48	124 12.65	49 49.70	124 12.30	0.945	76	93	80	12:16 PM	12:26 PM	2:26 PM	2:44 PM	120	227
19	15-Aug-05	49 73.57	124 87.28	49 74.08	124 88.38	1.009	45	54	50	2:11 PM	2:20 PM	4:20 PM	4:41 PM	120	223
20	15-Aug-05	49 92.47	125 01.25	49 91.68	125 00.95	0.951	64	100	80	5:59 PM	6:08 PM	8:07 PM	8:25 PM	119	227
21	16-Aug-05	50 31.75	124 97.65	50 31.30	124 96.53	0.957	57	85	80	9:08 AM	9:17 AM	11:16 AM	11:33 AM	119	222
22	16-Aug-05	50 30.37	124 90.22	50 30.70	124 91.50	0.988	54	84	61	9:52 AM	10:00 AM	12:00 PM	12:16 PM	120	226
23	16-Aug-05	50 29.25	124 86.65	50 28.70	124 85.62	0.979	47	75	55	12:40 PM	12:48 PM	2:49 PM	3:06 PM	121	228
24	16-Aug-05	50 32.00	124 75.85	50 31.72	124 74.57	0.967	55	84	76	1:44 PM	1:54 PM	3:55 PM	4:11 PM	121	214
25	16-Aug-05	50 30.67	124 66.50	50 30.17	124 65.67	1.000	48	70	52	4:39 PM	4:48 PM	6:48 PM	7:05 PM	120	226
26	17-Aug-05	50 22.12	124 61.70	50 22.98	124 61.57	0.982	39	96	75	7:50 AM	7:59 AM	10:00 AM	10:17 AM	121	224
27	17-Aug-05	50 28.08	124 67.45	50 27.65	124 66.35	0.992	45	88	86	8:35 AM	8:44 AM	10:47 AM	11:04 AM	123	223
28	17-Aug-05	50 19.83	124 78.00	50 20.35	124 79.28	0.958	53	97	97	12:21 PM	12:30 PM	2:30 PM	2:46 PM	120	225
29	18-Aug-05	49 98.57	124 79.20	49 99.27	124 79.18	1.010	51	87	66	12:17 PM	12:27 PM	2:27 PM	2:45 PM	120	221
30	18-Aug-05	50 03.30	124 96.40	50 04.08	124 95.73	0.979	36	51	45	3:35 PM	3:44 PM	5:43 PM	5:59 PM	119	219
31	18-Aug-05	50 04.65	124 94.73	50 04.93	124 93.25	1.090	59	95	73	4:15 PM	4:24 PM	6:24 PM	6:43 PM	120	225
32	19-Aug-05	50 14.13	124 89.47	50 14.68	124 90.22	0.826	62	103	80	6:50 AM	7:00 AM	9:00 AM	9:20 AM	120	224
33	19-Aug-05	50 07.58	124 78.92	50 07.72	124 77.73	0.918	30	58	47	7:57 AM	8:08 AM	10:07 AM	10:26 AM	119	230
34	19-Aug-05	50 14.08	124 73.05	50 14.53	124 72.35	0.810	34	64	50	11:14 AM	11:24 AM	1:24 PM	1:43 PM	120	225
35	19-Aug-05	50 11.17	124 77.75	50 11.52	124 76.85	0.828	45	86	67	12:46 PM	12:55 PM	2:54 PM	3:14 PM	119	229
36	20-Aug-05	49 87.35	124 71.73	49 87.90	124 72.57	0.851	75	97	88	7:17 AM	7:26 AM	9:23 AM	9:42 AM	117	223
37	20-Aug-05	49 86.65	124 77.32	49 86.83	124 78.52	0.924	42	49	48	7:59 AM	8:08 AM	10:06 AM	10:26 AM	118	237
38	20-Aug-05	49 89.68	124 63.15	49 90.03	124 64.08	0.971	28	46	41	11:08 AM	11:16 AM	1:14 PM	1:30 PM	118	223
39	20-Aug-05	49 79.32	124 64.78	49 80.22	124 65.15	0.918	52	80	60	12:08 PM	12:18 PM	2:17 PM	2:35 PM	119	219
40	21-Aug-05	49 81.07	123 99.97	49 81.65	124 00.60	0.783	40	68	53	6:37 AM	6:46 AM	8:41 AM	8:58 AM	115	220
41	21-Aug-05	49 75.22	124 19.43	49 75.37	124 18.40	0.762	62	108	77	7:39 AM	7:48 AM	9:50 AM	10:06 AM	122	223
42	21-Aug-05	49 74.75	124 35.13	49 75.30	124 35.95	0.852	72	79	78	10:54 AM	11:02 AM	12:58 PM	1:14 PM	116	223
43	21-Aug-05	49 71.67	124 37.13	49 71.87	124 38.53	0.890	76	107	100	12:09 PM	12:19 PM	2:17 PM	2:35 PM	118	225
44	21-Aug-05	49 70.95	124 35.63	49 71.42	124 36.52	0.828	53	70	56	1:37 PM	1:46 PM	3:47 PM	4:02 PM	121	221
45	22-Aug-05	49 70.85	124 27.52	49 70.20	124 26.77	0.932	80	97	87	7:04 AM	7:13 AM	9:15 AM	9:31 AM	122	226

Appendix A. Set Specifications (continued).

Set #	Date	Start Latitude	Start Longitude	End Latitude	End Longitude	Travelled Distance (km)	Min Depth (m)	Max Depth (m)	Modal Depth (m)	Begin Deployment Time	End Deployment Time	Begin Retrieval Time	End Retrieval Time	Soak Time (mins)	Number of Hooks
46	22-Aug-05	49 63.60	124 28.37	49 63.07	124 27.72	0.776	47	72	67	8:01 AM	8:11 AM	10:10 AM	10:27 AM	119	223
47	22-Aug-05	49 56.57	124 18.15	49 56.07	124 17.30	0.845	65	86	76	11:04 AM	11:14 AM	1:12 PM	1:29 PM	118	222
48	22-Aug-05	49 56.85	124 01.30	49 59.23	124 01.47	0.763	82	111	100	12:09 PM	12:19 PM	2:19 PM	2:35 PM	120	220
49	23-Aug-05	49 39.70	123 58.67	49 39.47	123 57.70	0.783	78	86	82	8:14 AM	8:25 AM	10:24 AM	10:43 AM	119	224
50	23-Aug-05	49 34.38	123 59.10	49 33.90	123 58.25	0.878	44	56	46	9:22 AM	9:32 AM	11:29 AM	11:44 AM	117	224
51	23-Aug-05	49 32.28	123 33.85	49 33.00	123 33.50	0.808	92	98	92	12:49 PM	12:58 PM	2:59 PM	3:16 PM	121	224
52	23-Aug-05	49 34.45	123 31.53	49 34.90	123 30.58	0.988	48	89	62	1:46 PM	1:55 PM	3:34 PM	4:09 PM	99	224
53	24-Aug-05	49 42.93	123 37.13	49 43.60	123 37.55	0.828	52	81	67	7:15 AM	7:24 AM	9:20 AM	9:36 AM	116	223
54	24-Aug-05	49 35.07	123 43.38	49 35.82	123 43.28	0.918	36	53	47	8:12 AM	8:22 AM	10:21 AM	10:36 AM	119	225
55	24-Aug-05	49 41.00	123 44.07	49 41.28	123 44.87	0.672	57	68	62	11:08 AM	11:16 AM	1:15 PM	1:37 PM	119	222
56	24-Aug-05	49 45.17	123 46.45	49 45.82	123 46.88	0.770	55	83	79	12:02 PM	12:12 PM	2:11 PM	2:30 PM	119	224
57	25-Aug-05	49 55.28	123 39.98	49 54.97	123 41.08	0.891	34	94	88	6:45 AM	6:55 AM	8:55 AM	9:14 AM	120	223
58	25-Aug-05	49 55.78	123 37.52	49 55.48	123 36.48	0.843	49	90	80	7:35 AM	7:44 AM	9:44 AM	10:02 AM	120	223
59	26-Aug-05	49 14.28	123 63.63	49 13.75	123 64.30	0.792	72	78	76	7:58 AM	8:07 AM	10:05 AM	10:26 AM	118	224
60	26-Aug-05	49 04.90	123 59.58	49 05.58	123 60.12	0.841	53	65	60	9:00 AM	9:09 AM	11:08 AM	11:24 AM	119	225
61	26-Aug-05	49 00.90	123 62.00	49 01.30	123 63.03	0.882	45	51	47	12:25 PM	12:34 PM	2:31 PM	2:46 PM	117	226
62	26-Aug-05	48 96.00	123 55.35	48 95.45	123 54.57	0.847	73	80	76	1:13 PM	1:22 PM	3:20 PM	3:36 PM	118	224
63	27-Aug-05	48 93.82	123 65.63	48 94.42	123 66.35	0.822	48	61	54	6:59 AM	7:08 AM	9:07 AM	9:24 AM	119	228
64	27-Aug-05	48 90.88	123 65.78	48 91.57	123 66.37	0.912	90	92	91	7:43 AM	7:51 AM	9:50 AM	10:06 AM	119	225
65	27-Aug-05	48 91.40	123 61.88	48 91.87	123 62.77	0.877	40	64	40	10:23 AM	10:32 AM	12:31 PM	12:48 PM	119	228
66	27-Aug-05	48 89.30	123 59.27	48 90.10	123 59.63	0.898	51	87	76	11:15 AM	11:25 AM	1:24 PM	1:43 PM	119	222
67	27-Aug-05	48 90.60	123 46.33	48 91.13	123 47.25	0.931	65	79	71	2:50 PM	2:58 PM	4:58 PM	5:16 PM	120	219
68	28-Aug-05	48 86.05	123 37.35	48 86.47	123 38.35	0.858	39	45	43	7:04 AM	7:14 AM	9:13 AM	9:31 AM	119	225
69	28-Aug-05	48 91.42	123 37.52	48 91.88	123 38.68	1.004	50	53	52	10:22 AM	10:32 AM	12:27 PM	12:45 PM	115	224
70	28-Aug-05	48 86.55	123 24.58	48 87.08	123 25.62	0.957	62	89	71	11:22 AM	11:31 AM	1:29 PM	1:48 PM	118	225
71	28-Aug-05	48 81.58	123 18.08	48 82.03	123 18.98	0.667	40	45	44	2:22 PM	2:31 PM	4:30 PM	4:51 PM	119	219
72	29-Aug-05	48 74.20	123 17.30	48 73.52	123 17.80	1.014	29	104	60	7:09 AM	7:18 AM	9:17 AM	9:32 AM	119	221
73	29-Aug-05	48 73.12	123 19.22	48 72.93	123 20.23	0.795	65	109	71	7:52 AM	8:01 AM	10:03 AM	10:17 AM	122	218
74	29-Aug-05	48 81.03	123 14.70	48 81.45	123 15.73	0.894	93	95	93	12:05 PM	12:13 PM	2:12 PM	2:27 PM	119	222
75	30-Aug-05	48 68.27	123 34.70	48 67.35	123 34.68	1.030	49	62	61	7:09 AM	7:18 AM	9:19 AM	9:41 AM	121	223
76	30-Aug-05	48 69.38	123 29.20	48 68.67	123 29.73	0.914	42	66	47	7:55 AM	8:04 AM	10:11 AM	10:33 AM	127	220
77	30-Aug-05	48 71.38	123 41.57	48 71.28	123 42.68	0.839	40	49	44	11:07 AM	11:16 AM	1:15 PM	1:31 PM	119	219
78	30-Aug-05	48 73.60	123 41.22	48 73.95	123 40.55	0.635	49	52	52	12:20 PM	12:29 PM	2:29 PM	2:46 PM	120	219
79	31-Aug-05	48 57.18	123 24.57	48 56.28	123 23.97	1.116	62	95	76	7:22 AM	7:32 AM	9:31 AM	9:48 AM	119	227
80	31-Aug-05	48 54.02	123 26.13	48 53.27	123 25.90	0.889	62	64	63	8:27 AM	8:37 AM	10:39 AM	10:55 AM	122	225
81	31-Aug-05	48 48.03	123 24.52	48 47.47	123 23.87	0.839	49	53	52	11:19 AM	11:29 AM	1:28 PM	1:45 PM	119	226
82	1-Sep-05	48 34.33	123 51.20	48 34.90	123 50.57	0.784	43	79	57	10:17 AM	10:27 AM	12:27 PM	12:44 PM	120	224
83	1-Sep-05	48 34.97	123 76.58	48 34.52	123 75.40	0.581	34	37	34	2:23 PM	2:32 PM	4:31 PM	4:49 PM	119	220
84	2-Sep-05	48 37.57	123 95.13	48 37.87	123 96.35	0.965	72	77	76	7:45 AM	7:55 AM	9:54 AM	10:13 AM	119	224
85	2-Sep-05	48 38.73	123 05.63	48 39.05	123 06.88	1.003	53	72	63	8:30 AM	8:40 AM	10:45 AM	10:59 AM	125	224
86	2-Sep-05	48 43.50	124 23.88	48 43.27	124 22.78	0.864	87	90	90	12:11 PM	12:20 PM	2:22 PM	2:43 PM	122	225
87	3-Sep-05	48 54.58	124 59.00	48 54.75	124 58.50	0.885	67	69	68	7:27 AM	7:36 AM	9:37 AM	10:36 AM	121	225
88	3-Sep-05	48 53.65	124 57.75	48 53.90	124 58.97	0.937	85	87	87	8:08 AM	8:18 AM	10:21 AM	10:36 AM	123	227
89	4-Sep-05	48 35.28	123 51.10	48 36.02	123 50.70	0.830	54	60	55	2:38 PM	2:46 PM	4:46 PM	5:02 PM	120	219

Appendix B. Description of Beaufort scale sea state categories.

Beaufort Scale	Description
0	Calm, winds <1 knot, sea like mirror
1	Light air, winds 1 - 3 knots, ripples, no foam crests
2	Light breeze, winds 4 - 6 knots, small wavelets
3	Gentle breeze, winds 7 - 10 knots, cress breaking
4	Moderate breeze, winds 11 - 16 knots, whitecaps
5	Fresh breeze, winds 17 - 21 knots, moderate waves-spray
6	Strong breeze, winds 22 - 27 knots, large waves
7	Moderate gale, winds 28 - 33 knots, sea heaps up
8	Fresh gale, winds 34 - 40 knots, moderately high waves
9	Strong gale, winds 41 - 47 knots, high waves, spray
10	Whole gale, winds 48 - 55 knots, overhanging crests, sea white
11	Storm, winds 56 - 63 knots, exceptionally high waves
12	Hurricane, winds 64 - 118 knots, sea white