BIOGEOGRAPHY OF THE TRAWL-CAUGHT FISHES OF CALIFORNIA AND AN EXAMINATION OF THE POINT CONCEPTION FAUNAL BREAK

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ABSTRACT

We analyzed fish data from 2332 trawls collected from depths between 55 and 1280 m off the coast of California. For the 732 species known from California, including 283 species (~39% of the California ichthyofauna) in this study, very few were contained by the faunal break at Point Conception, with 21% limited from the south and only 4% from the north. The South Central Coast generally had a stronger relationship with Monterey Region rather than the Southern California Bight. There was discrete variation of species assemblages among previously defined continental shelf and slope zones and within these zones biogeographic patterns were based upon latitude. However, the overall biogeographic pattern was not determined by Point Conception for all soft bottom habitats. Biogeographic breaks based upon latitude were less evident at depth, especially below 500 m.

INTRODUCTION

Faunal breaks and biogeographic provinces are defined by some geographic or environmental feature or features that serve to limit movement across boundaries. For the nearshore environment in the eastern Pacific, they were originally determined and described based upon the distribution of reef fishes, with the discontinuity of reef habitat coupled with physical oceanographic processes supporting unique communities (Hubbs 1960; Hastings 2000; Horn et al. 2006). During regime shifts, organisms move latitudinally along the coast (i.e., Hubbs 1948; Radovich 1961). Thus, understanding these biogeographic provinces, the organisms contained within them and the processes that maintain them, is insightful for determining changes during various regime shift and climate change scenarios. Point Conception has long been considered such a barrier, as it separates the southern, warm-temperate shelf fauna from the cool-temperate region to the north (Garth 1955; Hubbs 1948; Horn and Allen 1978; Allen and Smith 1988; Horn et al. 2006). The thermal discrepancy across this barrier is based on geographic and latitudinal phenomena that are present during normal conditions (Hickey 1993). The offshore displacement of the cool south-flowing California Current occurs at Point Conception where the California coastline turns to the east to form the Southern California Bight and the cool California Current continues southward, largely to the west of the California Channel Islands. Point Conception also marks the northern extension of the warmer Southern California Counter Current, formed as a north-flowing eddy at around 31°N latitude (Maloney and Chan 1974). The resultant effect can be a relatively sharp temperature change, which marks one of the more recognized biogeographic boundaries for coastal fishes and separates the warm-temperate San Diegan region and the cool-temperate Oregonian region (Horn et al. 2006).

Faunal zones for coastal fishes are generally defined by latitudinal range limits (Horn et al. 2006). The problem with published range limits for species is that they often reflect unusual events and thus extend much further than the region that the species can successfully inhabit. Here, we examine this factor by using a unique data set from bottom trawls collected annually by the National Marine Fisheries Service from 2003 to 2010 in the coastal waters of California between the depths of 55 and 1280 m (Keller et al. 2012). We describe the differences in species composition across this boundary on the continental slope as well as the continental shelf. We include three regional sampling areas to examine the characteristics of the Point Conception faunal break: the Southern California Bight (SCB), here limited to the waters between the Mexican border and Point Conception; the South Central Coast (SCC) region, between Point Conception and Lopez Point, California; and the Monterey region (MONT), Lopez Point to Point Mendocino (fig. 1). Here, we examine the patterns of species composition relative to these biogeographic boundaries and discuss the validity of Point Conception as a biogeographic barrier for these communities.

MATERIALS AND METHODS

Standardized otter trawls were conducted from 2003 to 2010 (Keller et al. 2012). We categorized these data into three regions based on latitude: SCB (32°–34.4°N); SCC (34.5°–35.9°N), and MONT (36°–40.5°N) (fig. 1). The West Coast Groundfish Slope/Shelf Bottom Trawl Survey design started out using the 5 latitudinal INPFC

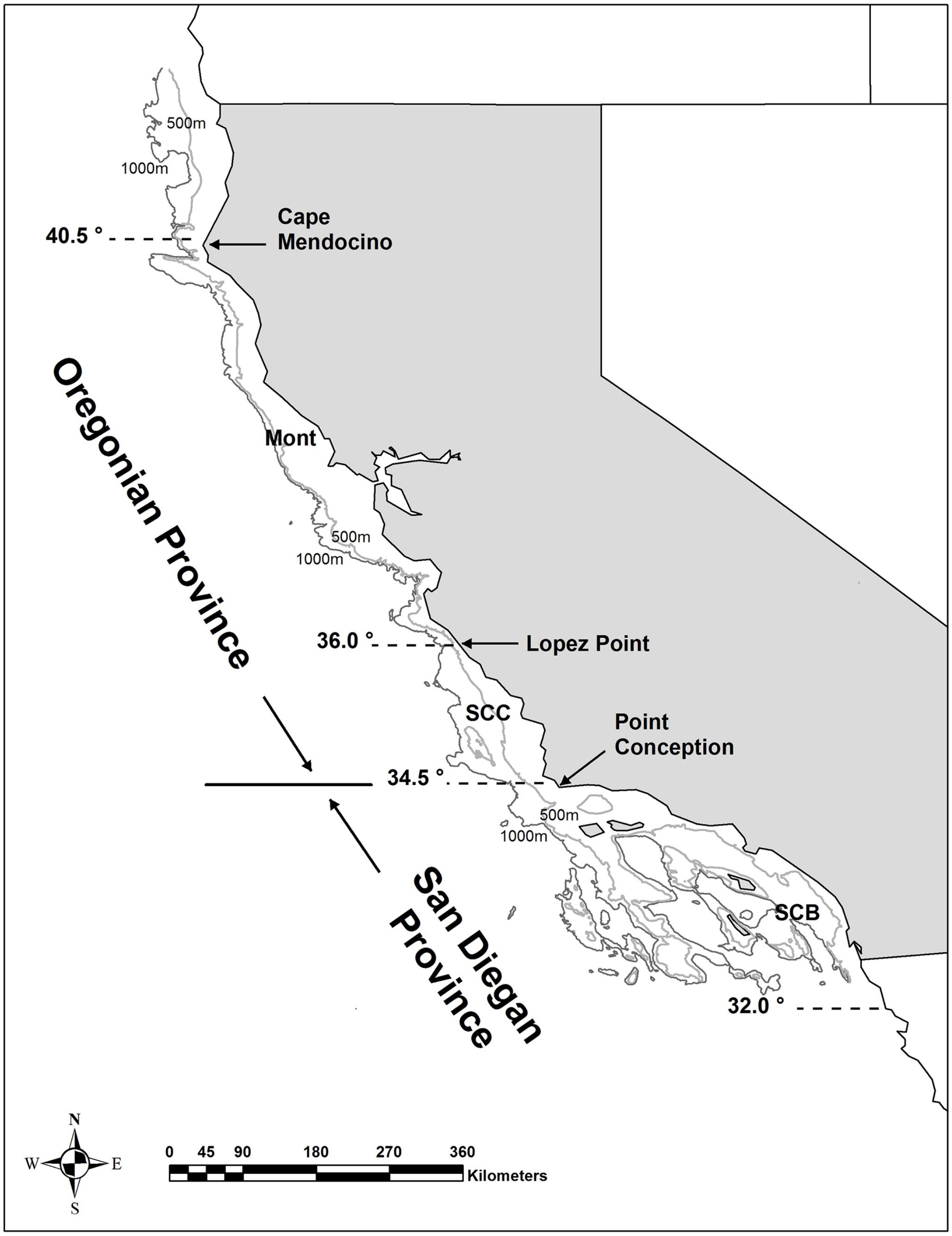


Figure 1. California biogeographic regions and latitudinal points used in the trawl analyses. MONT = Monterey Region, SCC = South Central Coast, SCB = Southern California Bight.

strata in 2003, but changed to a single coastal division at 34°30'N (Point Conception) beginning in 2004. Because this trawl program used the INPFC limits for the Conception region that rounds Point Conception and extends north to Lopez Point, we designated the area between Point Conception and Lopez Point as the South Central Coast. Numerical fish density was calculated by dividing the estimated number of fishes captured by the area (ha) swept by each trawl (Miller and Schiff 2012). All fishes taken were included in the overall catch data and summaries, but only fishes identified to species were included in the assemblage analyses. We did not exclude epi- or mesopelagic species. Rank-order data systems were used to characterize differences between regions based upon abundance (top 10, 15, and 20 species), index of community importance (ICI), and species value (Bond et al. 1999). For each criterion, the rank order was calculated and numbered. These rank orders were then summed for each species, re-ranked and compared using Kendall's tau rank association statistic. Rank order models were created for each biogeographic region by using each region as the primary ranking in each analysis.

Multivariate analyses were used to identify differences in the fish assemblages across regions and depth ranges and to identify the taxa contributing to the patterns. The data from 283 species were first screened for species that were recorded from less than five trawls or had a total catch across all trawls of less than 10 individuals. The data from these specesies were not analyzed as these less abundant species could influence the analysis, which was intended to focus on major faunal seperations. The remaining 190 taxa (67%) were summarized by categorizing each trawl by latitude and depth. There were 16 latitude categories, encompassing 0.5° of latitude between 32.5° and 40.0°N. The area furthest to the south in latitude 32.0° was not included because it was only sampled from 2007 to 2010 resulting in a total of only 25 trawls. To provide a clean separation at Point Conception the category for latitude 34.0° only included trawls through latitude 34.449°, while the category for latitude 34.5° included trawls from latitude 34.450° through latitude 34.999°. The trawls were also categorized into the three regions described above with four latitude categories in the SCB (32.5–34.0), three latitude categories in the SCC (34.5–35.5), and nine latitude categories in the MONT region (36.0–40.0). The data sets were also assigned to four depth classes based on the depths of the trawls. The classes were <200 m, 201–500 m, 501–1000 m, and >1000 m, which corresponded to the shelf, upper slope, slope, and deep water habitats from Allen and Pondella (2006). The data on the estimated number per hectare for each species for all of the trawls within each half latitude and depth category were averaged resulting in 59 sample groups. There were only 59 and not 64 categories because no trawling was conducted at depths deeper than 200 m for the 37.5° latitude category and deeper than 1000 m for the 38.0° and 38.5° latitude categories.

The summarized biomass data from the 59 sample groups were analyzed using PRIMER VERSION 6.1.12 (© 2009 PRIMER-E Ltd.). The data were transformed as $\sqrt{(x_{ij})}$, then used to calculate Bray-Curtis measures of similarity. Some of the analyses were done on all 59 samples, while other analyses only analyzed the data within each of the four depth categories. The Bray-Curtis similarities among samples were analyzed using nonmetric multidimensional scaling (MDS) and run on the entire data set as well as subsets of the data representing the samples within each of the five depth categories. The ANOSIM routine was used to determine if statistically significant differences observed in the MDS could be detected among groups of samples categorized by depth class and region (Clarke and Gorley 2006). When significant differences among depth groups were detected, the SIMPER routine was used to determine the relative contribution of individual taxa to the average dissimilarity within and among groups that could have contributed to the significant difference detected. The same approach was used for determining the contribution of each taxon to the average dissimilarity (D_{jk}) between groups. The samples were also separated by latitude and separate MDS analyses of the samples within each depth class were used to summarize the relationships among samples within each group. The RELATE routine was used to test if the rank order of samples by latitude for each depth class was significantly correlated with rank order of sample similarities using a Spearman rank correlation with the probabilities of the computed values compared against correlations based on 3,000 random permutations of the sample orders (Clarke and Gorley 2006). A significant value indicated a consistent pattern of change in species composition with latitude.

RESULTS

From 2003 to 2010, 2332 trawls (SCB = 897, SCC = 529, MONT = 906) sampled 4,223 ha (SCB = 1,598, SCC = 987, MONT = 1.638) at depths from 56 to 1269 m (table 1) and included 283 species (38.7%) of the 732 species known to occur within the trawled depths from the Mexican border to Cape Mendocino, 232 of the 669 known from the SCB (34.7%), 182 of 528 from the SCC (34.5%), and 211 of 538 from the MONT (39.2%) (Love et al. 2005; Horn et al. 2006; and Appendix 1). Of the total 732 species known to occur across the sampled regions, 549 species (75%) were known to cross the barrier at Point Conception with the crossing to the south less restrictive. For the 283 species, 155 were not taken north of the SCB (77 stopped by or before reaching the barrier) and 28 species of the SCC and MONT were not taken south of the barrier (the SCB). There were differences in sampling effort for each region (table 1) due to the size of the regions with MONT spanning the largest latitudinal distance (4.5°). After the first two years, the sampling effort was relatively consistent among the regions across years (table 1). The average number of trawls and area sampled over the eight years were similar for the SCB and MONT, which were both consistently higher than the sampling effort in the SCC region. The mean depth was relatively deep for six of the eight years (excluding 2003 and 2004) for the SCB, relatively shallow for MONT, and intermediate for the SCB. The top species collected therefore would reflect this difference and not necessarily a temporal change. Only the SCB has mean depths that do not vary significantly by year.

TABLE 1
Summary of trawl data by biogeographic region and year. Depths are in meters.

Region	Year	N	Area (ha)	Mean ha/trawl	Trawl Depths (m) Mean	Max.	Min.	Total No. Taxa	Density (Fish/ha)	Biomass (kg/ha)
SCB	2003	72	139.3	1.94	436.9	1209	59	124	300.0	36.4
	2004	83	160.8	1.94	468.4	1206	58	130	636.7	57.6
	2005	117	214.7	1.84	485.0	1230	60	158	791.1	64.8
	2006	125	226.8	1.81	483.2	1246	61	158	516.6	49.6
	2007	124	218.8	1.76	462.8	1224	59	152	494.2	54.1
	2008	119	199.3	1.68	448.9	1184	61	147	440.7	47.6
	2009	123	201.3	1.64	423.4	1196	62	153	514.4	51.3
	2010	134	236.8	1.77	464.3	1242	61	161	610.8	56.3
	Total	**897**	**1597.8**							
	Mean	**112**	**199.7**	**1.80**	**459.1**	**1217**	**60**	**148**	**538.1**	**52.2**
SCC	2003	41	76.3	1.86	367.3	1159	56	100	563.6	113.2
	2004	46	92.9	2.02	453.3	1039	57	95	570.3	104.9
	2005	63	124.3	1.97	528.2	1154	61	105	632.3	105.6
	2006	58	110.1	1.90	587.6	1269	63	119	425.7	96.9
	2007	79	152.0	1.92	585.6	1241	68	109	423.8	105.9
	2008	75	133.0	1.77	516.2	1206	59	102	450.3	108.1
	2009	87	151.1	1.74	521.4	1184	66	117	562.9	138.2
	2010	80	147.0	1.84	547.6	1256	59	117	506.3	100.5
	Total	**529**	**986.7**							
	Mean	**66**	**123.3**	**1.88**	**513.4**	**1189**	**61**	**108**	**516.9**	**109.2**
MONT	2003	96	191.3	1.99	395.2	1240	59	133	1168.5	307.8
	2004	91	171.7	1.89	308.3	1145	62	132	1083.6	284.6
	2005	105	186.4	1.77	266.7	1208	60	122	1086.0	249.2
	2006	127	242.1	1.91	392.8	1240	59	133	637.3	167.5
	2007	100	169.5	1.70	365.0	1237	64	132	533.7	153.8
	2008	140	248.6	1.78	383.4	1200	60	137	608.1	137.3
	2009	119	201.5	1.69	381.9	1244	60	134	595.9	134.0
	2010	128	227.0	1.77	354.1	1222	57	131	518.8	109.0
	Total	**906**	**1638.1**							
	Mean	**113**	**204.8**	**1.81**	**355.9**	**1217**	**60**	**132**	**779.0**	**192.9**

*2003 was the first year of the current survey design. The survey extent increased from the previous slope-only survey design to include the entire shelf, the survey design itself was new, and a completely new data collection system was launched. In addition, in 2004 the survey team executed two surveys, the next iteration of the slope/shelf survey and the 2004 iteration of the triennial shelf survey. Since the survey team did not have the resources to execute them both at previous levels, both efforts were scaled down to schedules that could be met by the survey crew. Consequently, fewer tows were executed by the slope/shelf survey in 2003 and 2004 and the level of species identification expertise was likely lower than that accumulated in later survey years.

There were 21 previously unreported range extensions in this data set (table 2). Forty-eight species were taken only from north of Point Conception (SCC and MONT), while 37 were only taken to the south (SCB). Only 15 of the 182 species caught in the SCC were not taken to the north or south. When evaluating differences based on depth restricted analyses, the following number of unique species were recorded by depth for the MONT and SCB regions: 31 and 36 species, respectively from sampling done in <200 m; 15 and 21 species, respectively from 200 to 500 m; 6 and 20 species, respectively from 500 to 1000 m; and 9 and 10 species, respectively from >1000 m. Ten of these depth-unique species show some evidence of latitudinal submergence by a shift to deeper water to the south: *Eptatretus stouti*, *Argyropelecus affinis*, and *Tactostoma macropus* from the shelf to 200 to 500 m; *Albatrossia pectoralis, Careproctus cypseluris, Careproctus gilberti, Paraliparis dactylosus*, and *Symbolophorus californiensis* from 200–500 m to depths of 500 to 1000 m; and *Dicrolene filamentosa* from 500 to 1000 m to >1000 m.

For the SCB, fish density (fish/ha) fluctuated from 300 (2003) to 791.1 (2005). For MONT, the density was high, 1168.5 fish/ha, in 2003 and decreasing to 518.8 fish/ha by 2010. Only *Parmaturus xaniurus* exhibited a strong increase in MONT while a large group of species decreased (*Albatrossia pectoralis*, *Alosa sapidissima*, *Antimora microlepis, Argentina sialis, Citharichthys sordidus*, *Coryphaenoides acrolepis*, *Cymatogaster aggregata*, Engraulis *mordax*, *Genyonemus lineatus*, *Glyptocephalus zachirus*, *Hydrolagus colliei*, *Lycodapus pacificus*, *Microgadus proximus*, *Microstomus pacificus*, *Peprilus simillimus*, *Raja rhina*, *Raja inornata*, *Sebastolobus altivelis*, *Sebastes goodei*, *Zalembius rosaceous*, and *Zaniolepis latipinnis*). Fluctuating fish density in the SCC was also observed. There were notable decreases in *Citharichthys sordidus*, *Sebastes goodei*, *Zaniolepis latipinnis*, and *Sebastes saxicola*. *Bothrocara brunneum* appeared to have increased. The MONT region usually

TABLE 2
Summary of range extensions. These new records should be viewed with caution as, with the exception of *Paraliparis pectoralis*, no voucher specimens appear to exist.

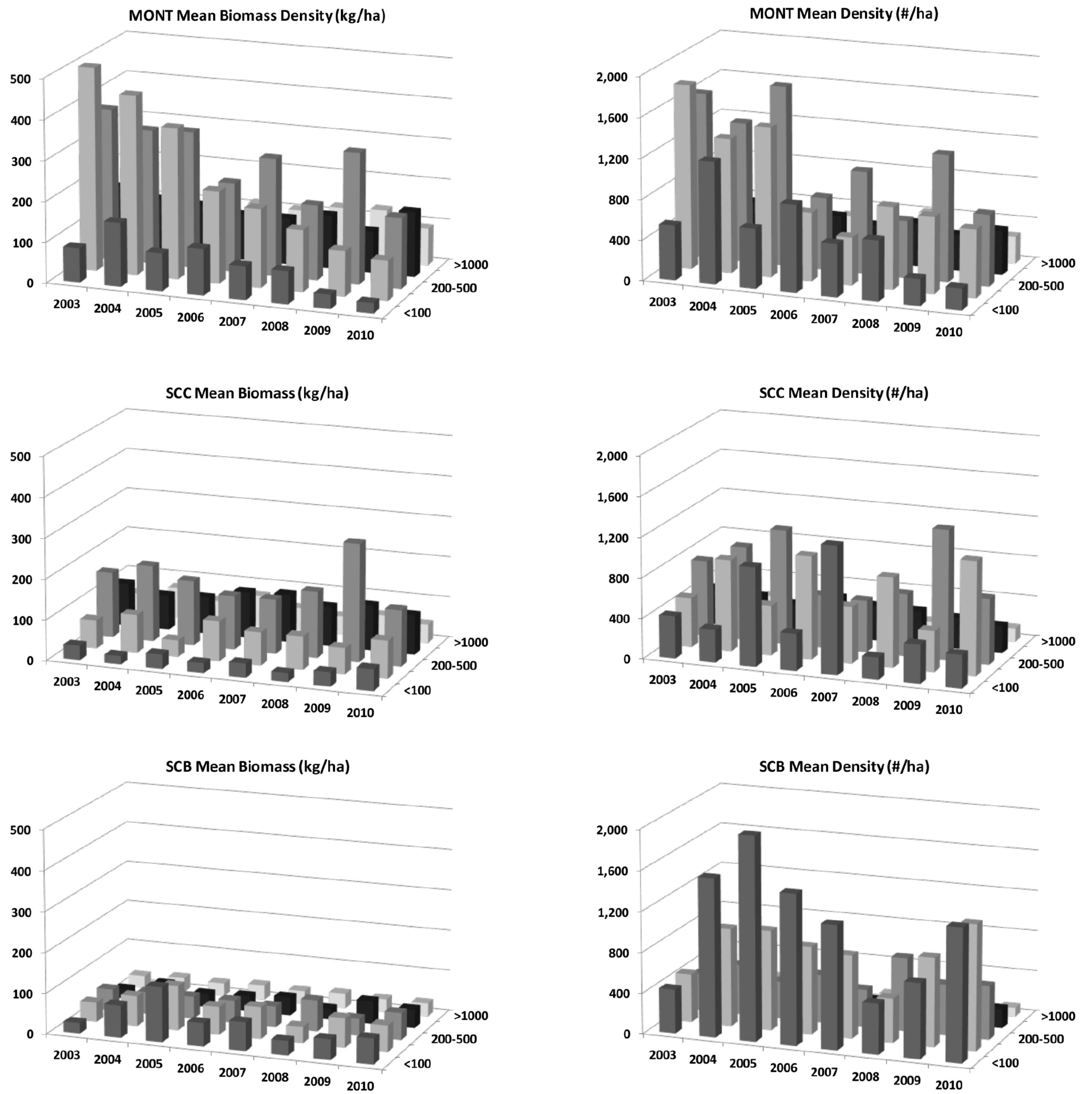
Species	Latitude	Longitude	Haul ID#	Previous Range (Love et al. 2005)
Bajacalifornia burragei	40.01382569	–124.6504954	803018107	north to southern California (ca 34°N)
Bathyagonus nigripinnis	34.58354301	–120.8804930	1003008194	central California (36°46'N)
Bathyraja aleutica	36.22119179	–122.2063941	703008139	south to Cape Mendocino (N border of Monterey region)
Borostomias panamensis	36.19269648	–122.2185127	1003008132	Chile to Point Conception (34°26'N)
Careproctus colletti	35.61484980	–121.7713301	803010132	northern California (38°42'N)
Careproctus cypselurus	33.36436250	–120.0692875	603008157	central Calif. (34°44'N)
Careproctus gilberti	33.74998625	–120.2019863	1003010186	off Morro Bay (35°10'N)
Caulophryne jordani	36.08399248	–121.9417120	1003017134	north to southern California (ca 34°N)
Clinocottus acuticeps	33.41295591	–117.6828199	803010189	off Big Sur River (36°16'N)
Coryphaenoides cinereus	35.502447655	–121.0987997	703008156	Monterey Bay (ca 36°44'N)
Dasycottus setiger	37.79513550	–122.8823967	303010115	Aleutian chain south to WA
Elassodiscus caudatus	34.67268167	–121.1444792	1003018150	central California (36°54'N)
Elassodiscus tremebundus	33.35561367	–117.8534293	703017187	Japan to Aleutian Islands
Enophrys bison	33.29758333	–118.3936708	703010175	Monterey Bay (ca 36°44'N)
Hippoglossoides elassodon	32.92147324	–117.2941441	503008199	Monterey (ca 36°35'N)
Oneirodes thompsoni	32.44645325	–118.5887397	803010180	northern California (41°20'N, 144°10'W)
Paraliparis dactylosus	32.64158399	–118.4368472	703017178	"central California"
Paraliparis pectoralis	32.43177857	–118.4049071	903008173	Monterey (36°44'N, 122°18'W)
Rhinoliparis attenuatus	32.80213030	–119.9753069	803018167	Monterey Bay (ca 36°44'N)
Stomias atriventer	36.38721489	–122.0663930	503017142	"central California" in Moser 1996, but clearly to at least Cape Mendocino
Thaleichthys pacificus	33.96905327	–118.6554909	303010152	Point Conception (34°26'N)

had the highest fish and biomass density, especially from 2003–05 with a general decrease from 2003 to 2010 (fig. 2). Biomass did not decrease radically by year in the SCC or SCB, but there was a decrease in biomass to the south. While the shallowest depths had the lowest biomass in MONT and the SCC, this was not the case in the SCB. Though the SCB has the lowest numerical and biomass density, it had the highest species richness.

There was marked interannual variation of some individual species densities by region (fig. 3). *Porichthys notatus*, other than a decrease in catch in the MONT from 2003 to 2004, exhibited no regional separation, and its density was relatively constant throughout the study. A representative species from SCB, *Nezumia liolepis*, was relatively absent in MONT, with generally low densities in SCC with a slight decline over time in SCB. Another characteristic SCB species, *Zalembius rosaceus*, was observed at low densities in SCC and MONT and high densities in SCB. The density shift contrasted with *Lycenchelys crotalinus*, a characteristic species of MONT, which had its highest densities in the north, intermediate densities in SCC, and lowest densities in SCB. *Merluccius productus*, another characteristic MONT taxon, had relatively high catches in MONT and lower but similar densities at SCC and SCB. *Bothrocara brunneum*, a characteristic taxon of SCC, had a similar pattern with higher densities in the SCC, especially in 2009 and relatively low densities for the remainder of the study. *Glyptocephalus zachirus*, which was a characteristic species of SCC + MONT, had density values in those two regions that were higher than those in SCB and that showed an apparent declining trend over time. Finally, *Lycodapus pacificus* densities increased and overlapped in SCC and SCB and were relatively low in MONT, and could be considered a characteristic species of both SCC and SCB.

Using the rank order of abundance, the only significant correlation detected was a negative relationship for SCC and MONT rankings for the top ten species (table 3) ($K\tau = -0.598$, $p = 0.019$). No significant correlations were detected for the other rank order tests based upon abundance. In the depth restricted analyses using the same model based upon abundance, no significant correlations were detected between regions for the trawls in the two shallowest depth groups. A significant correlation was detected for the 500–1000 m depth group between SCC and MONT using the MONT model ($K\tau = 0.347$, $p = 0.032$). For the deepest trawls (>1000 m), a significant correlation was detected between SCB and MONT in SCC model ($K\tau = 0.654$, $p < 0.001$) and SCB and SCC in the MONT model ($K\tau = 0.364$, $p = 0.025$).

In the ICI analysis of the trawls on the shelf (<200 m), a significant negative correlation was detected between SCC and MONT regions for the MONT model ($K\tau = -0.343$, $p = 0.029$), and a positive correlation between SCB and MONT for the SCB model ($K\tau = 0.364$, $p = 0.025$). For the trawls in the 200–500 m depth groups, a significant correlation was detected between SCC and MONT in the SCB model ($K\tau = 0.417$, $p = 0.01$). No significant correlations were detected for the data for the



MONT Mean Biomass Density (kg/ha)

MONT Mean Density (#/ha)

SCC Mean Biomass (kg/ha)

SCC Mean Density (#/ha)

SCB Mean Biomass (kg/ha)

SCB Mean Density (#/ha)

Figure 2. Mean biomass densities (kg/ha) and numerical (#/ha) densities of trawl caught fishes in three California biogeographic regions: MONT = Monterey, SCC = South Central California, SCB = Southern California Bight by depth zone (m).

500 to 1000 m depth group, while >1000 m, significant correlations were detected between SCC and MONT for all the models (MONT, Kτ = 0.584, p < 0.001; SCC, Kτ = 0.831, p < 0.001; SCB, Kτ = 0.883, p < 0.001).

For the species value analyses of the trawls from the shelf depths (<200 m), the only correlations detected were a positive one between MONT and SCC (Kτ = 0.597, p < 0.001) and negative between MONT and SCB (Kτ = 0.416, p = 0.01) using the SCB model. No significant correlations were detected for the 200–500 m depth, while for the deeper two depth groups, a significant correlation was detected between MONT and the SCC using the SCB based model (Kτ = 0.315, p = 0.05) and the SCC model (Kτ = 0.503, p = 0.002). Similarly, at >1000 m for the SCB and MONT regions, a significant correlation was detected using the SCB

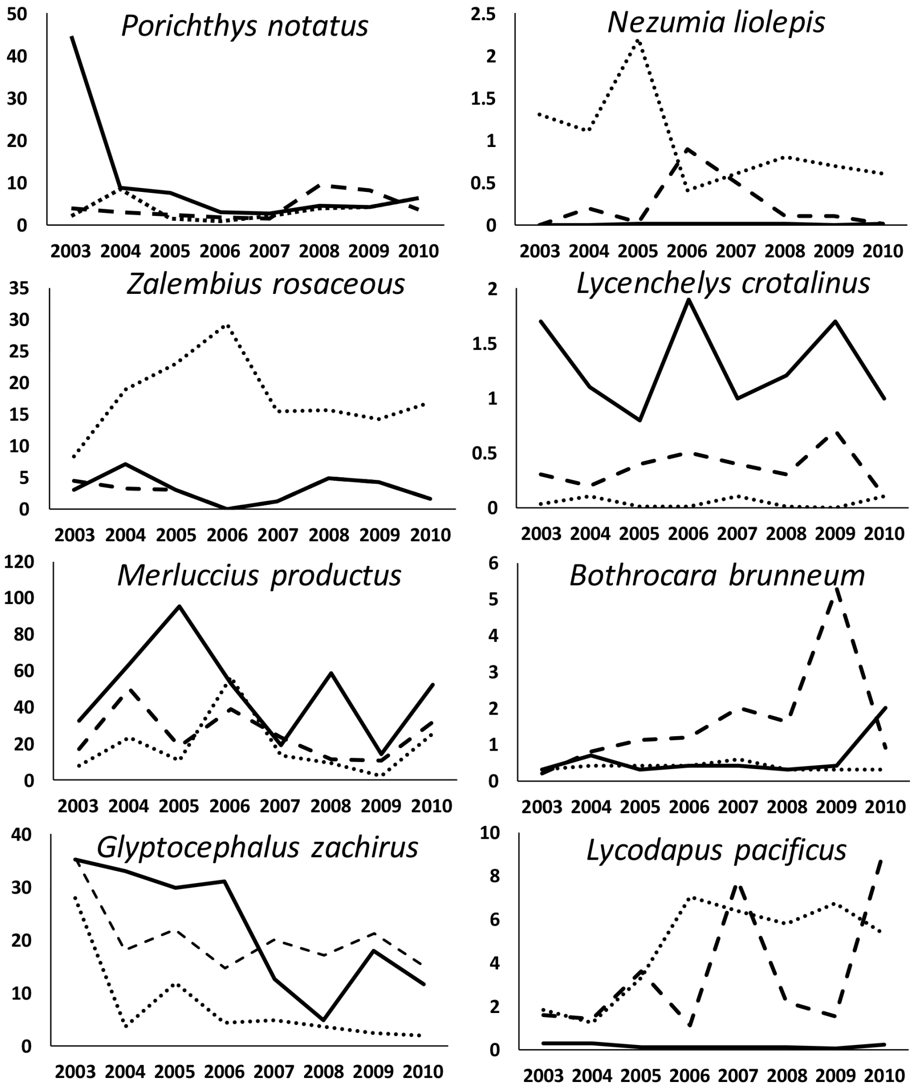


Figure 3. Annual mean density (#/ha) for representative species of biogeographic groupings: Unaligned *Porichthys notatus*; SCB *Nezumia liolepis* and *Zalembius rosaceous*; MONT *Lycenchelys crotalinus* and *Merluccius productus*; SCC *Bothrocara brunneum*; SCC + MONT *Glyptocephalus zachirus*; and, SCC + SCB *Lycodapus pacificus*. Solid line = MONT, hatched line = SCC and dotted line – SCB.

TABLE 3
Summary of the correlations from rank orders by abundance, index of community importance (ICI), species value (p levels: * = 0.5, ** ≤0.01, * ≤0.001).**

	55–200 m			200–500 m			500–1000 m			>1000 m		
	MONT vs SCC	SCC vs SCB	MONT vs SCB	MONT vs SCC	SCC vs SCB	MONT vs SCB	MONT vs SCC	SCC vs SCB	MONT vs SCB	MONT vs SCC	SCC vs SCB	MONT vs SCB
Abundance												
MONT	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	*	NS
SCC	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	***
SCB	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ICI												
MONT	NS–	NS	NS–	NS	NS	NS	NS	NS	NS	***	NS	NS
SCC	NS–	NS–	NS–	NS	NS	NS	NS	NS	NS	***	NS	NS
SCB	NS	*	NS	*	NS	NS	NS	NS	NS	***	NS	NS
Species Value												
MONT	NS	NS–	NS	NS	NS	NS	NS	NS–	NS	**	NS	NS
SCC	NS	NS	NS	NS	NS	NS	**	NS	NS	**	NS	NS
SCB	***	NS	*	NS	NS–	NS–	**	NS	NS	NS	NS	***

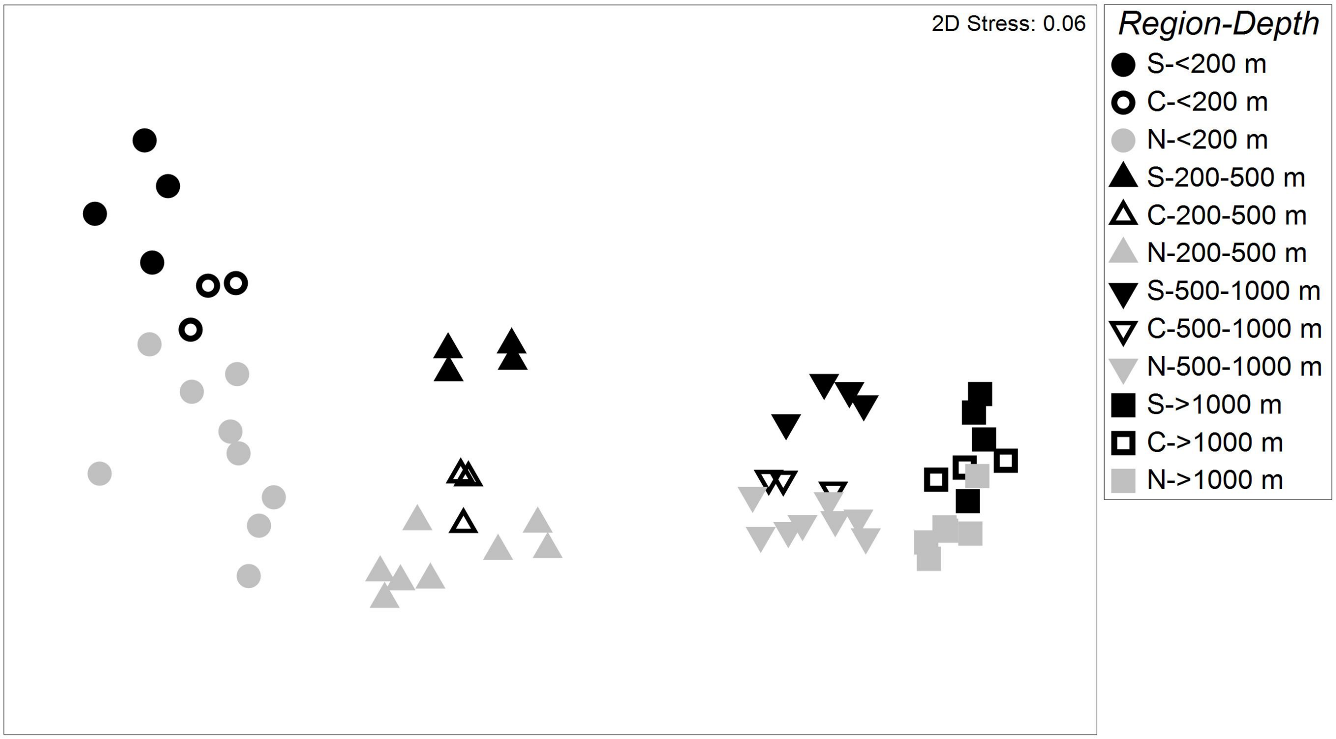


Figure 4. Multidimensional scaling analysis of Bray-Curtis dissimilarity matrix of square root transformed counts per hectare for 190 taxonomic groups from samples averaged into 59 groups representing the samples within four depths (samples from <200 m, 200–500 m, 500–1000 m, and >1000 m) within each half-latitude. The samples within the half-latitude classes are labeled by geographic region (S = half-latitude classes south of Point Conception, C = half-latitude classes from central California from Point Conception north to Lopez Point, and N = half-latitude classes from northern California north of Lopez Point). 2D stress = 0.6.

TABLE 4

SIMPER analysis showing taxa contributing to the similarity among samples within depth groups. The taxa were ranked by their percent contribution. The 15 taxa with the highest percentage contributions were listed as well as the number contributing up to 90% of the similarity within each group. The average similarity for the samples within each group is also presented.

Rank	<200 m Average = 54.2	%	200–500 m Average = 61.2	%	500–1000 m Average = 71.4	%	>1000 m Average = 72.3	%
1	*Citharichthys sordidus*	10.71	*Sebastes diploproa*	14.71	*Sebastolobus altivelis*	26.77	*Sebastolobus altivelis*	25.32
2	*Sebastes goodei*	17.39	*Microstomus pacificus*	25.35	*Microstomus pacificus*	38.77	*Coryphaenoides acrolepis*	37.79
3	*Sebastes saxicola*	23.97	*Sebastes saxicola*	34.27	*Alepocephalus tenebrosus*	45.71	*Alepocephalus tenebrosus*	47.92
4	*Merluccius productus*	30.19	*Glyptocephalus zachirus*	41.47	*Sebastolobus alascanus*	51.38	*Antimora microlepis*	54.43
5	*Sebastes jordani*	36.29	*Merluccius productus*	48.02	*Apristurus brunneus*	57.01	*Microstomus pacificus*	59.39
6	*Parophrys vetulus*	41.39	*Sebastes jordani*	52.46	*Anoplopoma fimbria*	61.43	*Sebastolobus alascanus*	63.98
7	*Sebastes semicinctus*	45.38	*Sebastolobus alascanus*	56.47	*Bothrocara brunneum*	63.84	Bathylagidae	68.52
8	*Zalembius rosaceus*	48.97	*Lyopsetta exilis*	60.26	*Coryphaenoides acrolepis*	66.21	*Albatrossia pectoralis*	72.64
9	*Squalus suckleyi*	52.28	*Lycodes cortezianus*	63.81	*Merluccius productus*	68.50	*Anoplopoma fimbria*	76.58
10	*Hydrolagus colliei*	55.53	*Raja rhina*	66.85	*Embassichthys bathybius*	70.58	*Embassichthys bathybius*	79.86
11	*Glyptocephalus zachirus*	58.12	*Sebastes aurora*	69.83	*Antimora microlepis*	72.49	*Bothrocara brunneum*	82.77
12	*Porichthys notatus*	60.66	*Hydrolagus colliei*	72.63	*Careproctus melanurus*	74.24	*Bathyraja trachura*	85.17
13	*Eopsetta jordani*	63.16	*Sebastolobus altivelis*	75.19	*Raja rhina*	75.94	*Apristurus brunneus*	86.85
14	*Sebastes elongatus*	65.45	*Anoplopoma fimbria*	77.54	*Lycenchelys crotalinus*	77.60	*Lampanyctus* spp.	88.07
15	*Lyopsetta exilis*	67.66	*Squalus suckleyi*	79.48	Bathylagidae	79.16	Myxinidae	89.18
	19 others		8 others		10 others		1 other	

model (Kτ = –0.551, p < 0.001) and between the SCC and MONT using the other two models (SCC, Kτ = 0.449, p = 0.006; MONT, Kτ =0.492, p = 0.002). Thus, the rank correlation for these two depth groups generally unites the SCC region with the MONT region to the north but at the deepest depth it also correlates with the SCB region. At the deepest depth grouping, all three models are based almost completely on the same species.

In the MDS analysis there was a clear and significant separation among the four depth categories (ANOSIM; Global R = 0.884; p ≤ 0.01; fig. 4). While the horizontal axis showed a separation among depth groups,

TABLE 5

SIMPER analysis showing taxa contributing to the average dissimilarity between the following adjoining depth groups: a) <200 m and 200–500 m, b) 200–500 m and 500–1000 m, and c) 500–1000 m and >1000 m. The taxa are ranked by their percentage contribution with the 10 taxa with the highest percentage contributions listed as well as the number contributing up to 90% of the total within each group. The average abundances for each group are based on the square root transformed data used in the analysis. The average dissimilarities between each pair of depth groups are also presented.

a) Average Dissimilarity = 65.9	Abundance			
Taxa	<200 m	200–500 m	% Contribution	Cumulative %
Sebastes diploproa	1.10	13.43	7.82	7.82
Citharichthys sordidus	10.55	1.19	5.84	13.66
Sebastes jordani	6.82	8.63	5.11	18.77
Sebastes semicinctus	7.98	0.62	4.64	23.41
Microstomus pacificus	2.57	9.47	4.47	27.88
Sebastes goodei	6.96	3.17	3.56	31.45
Sebastes saxicola	6.25	8.82	2.95	34.39
Zalembius rosaceus	4.34	0.07	2.68	37.07
Glyptocephalus zachirus	2.77	6.71	2.64	39.71
Merluccius productus	6.69	5.29	2.57	42.28
52 others				

b) Average Dissimilarity = 69.6	Abundance			
Taxa	200–500 m	500–1000 m	% Contribution	Cumulative %
Sebastes diploproa	13.43	0.09	10.89	10.89
Sebastolobus altivelis	2.73	13.62	9.09	19.98
Sebastes saxicola	8.82	0.00	7.15	27.12
Sebastes jordani	8.63	0.00	6.72	33.85
Glyptocephalus zachirus	6.71	1.31	4.44	38.28
Microstomus pacificus	9.47	7.33	3.62	41.90
Merluccius productus	5.29	1.35	3.33	45.23
Lyopsetta exilis	3.68	0.08	3.02	48.25
Alepocephalus tenebrosus	0.08	3.56	2.92	51.16
Hydrolagus colliei	3.12	0.19	2.44	53.61
42 others				

c) Average Dissimilarity = 41.8	Abundance			
Taxa	500–1000 m	>1000 m	% Contribution	Cumulative %
Microstomus pacificus	7.33	2.74	10.37	10.37
Coryphaenoides acrolepis	1.66	6.20	10.10	20.47
Sebastolobus altivelis	13.62	10.79	9.67	30.15
Apristurus brunneus	2.88	0.84	4.48	34.62
Antimora microlepis	1.09	2.64	3.41	38.03
Albatrossia pectoralis	0.67	2.00	2.92	40.96
Merluccius productus	1.35	0.02	2.89	43.85
Glyptocephalus zachirus	1.31	0.00	2.72	46.57
Parmaturus xaniurus	1.12	0.03	2.42	48.99
Bathylagidae	0.92	1.98	2.42	51.41
40 others				

the vertical axis showed a gradient based on geographic region and latitudinal variation within each depth category. The shallowest depth group (samples <200 m) had the greatest variation among samples and separation among geographic regions (S = SCB, C = SCC, and N = MONT). In the SIMPER analysis (fig. 4), differences were reflected in the variation among the samples within each depth category. The average similarity among samples within groups was highest for the >1000 m depth group (72.3%), while only 54.2% for the <200 m depth group (table 4). Taxa groups with the largest contribution to the similarities among groups varied by depth group, with the number of taxa contributing to the similarity within groups being highest for the <200 m depth group. These disparities likely contributed to the higher variability and lower average similarity among the samples within this depth group and contrasts with the lower variability, higher average similarity, and fewer number of taxa for the deepest >1000 m depth category.

The SIMPER analysis was also used to determine the taxa responsible for the dissimilarities between adjoining depth groups, for example between the <200 m and 200 to 500 m depth groups (table 5). The largest dissimilarity was calculated between the 200 to 500 m and the 500 to 1000 m depth groups (average dissimilarity = 69.6). This was reflected in the average abundances for those two

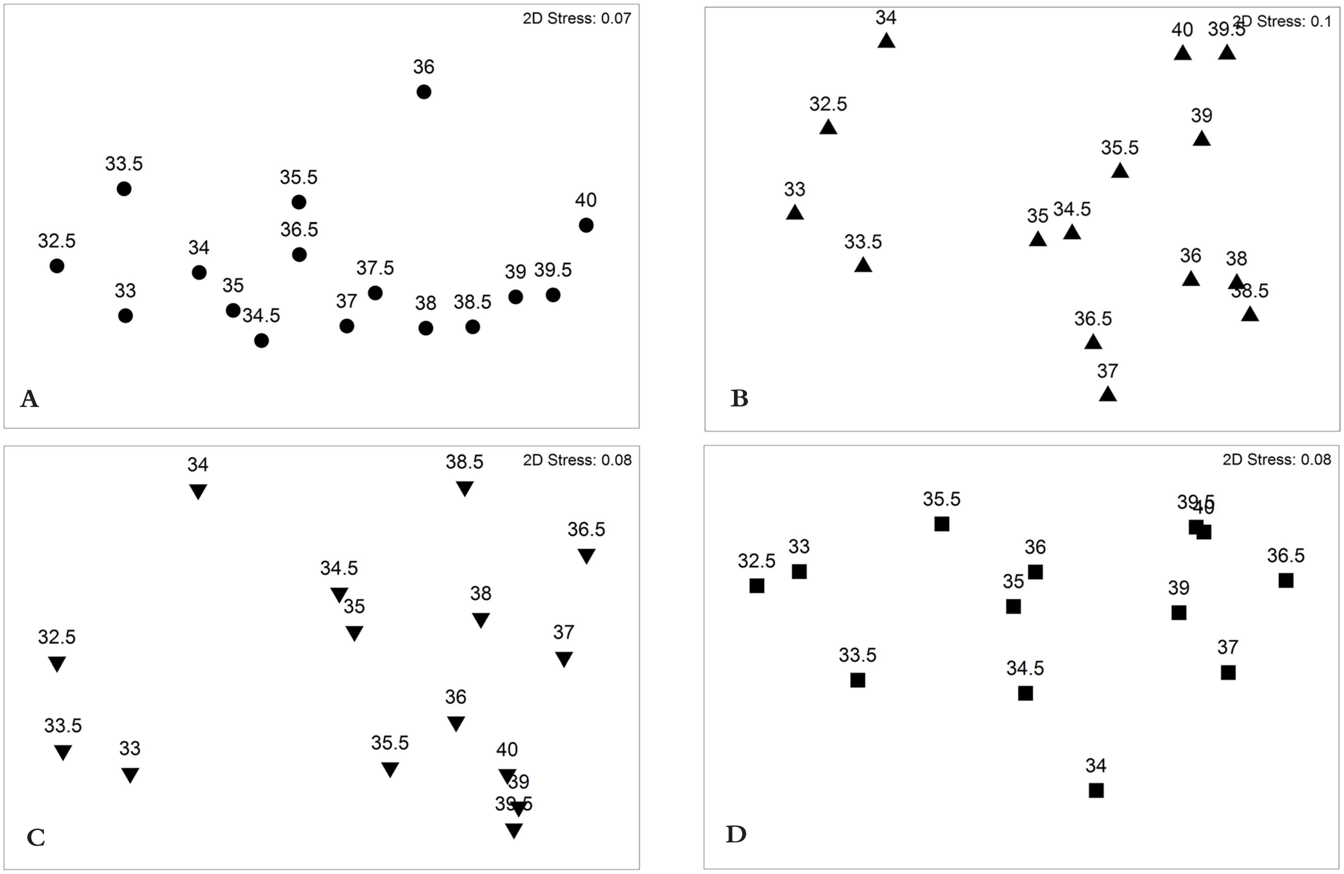


Figure 5. Multidimensional scaling analysis of Bray-Curtis dissimilarity matrix of square root transformed counts per hectare for 190 taxonomic groups from samples averaged into 59 groups representing the samples within four depths (samples from <200 m, 200–500 m, 500–1000 m, and >1000 m) within each half-latitude. The half-latitude groups are labeled in the MDS results for the four depths along with the 2D stress values for the MDS and the PRIMER RELATE analysis test statistic and p-value: a) samples from <200 m (n = 16; 2D stress = 0.07; ρ = 0.84, p <0.01), b) samples from 200–500 m (n = 15; 2D stress = 0.1; ρ = 0.70, p <0.01), c) samples from 500–1000 m (n = 15; 2D stress = 0.08; ρ = 0.67, p <0.01), and d) samples from >1000 m (n = 13; 2D stress = 0.08; ρ = 0.67, p <0.01).

groups that show a distinct shift in the fauna between the two depths that was less distinct for the other two group comparisons (table 5b). For example, the results for the three rockfishes, which were very abundant in the trawls at depths between 200 to 500 m, but almost totally replaced by *Sebastalobus alascanus* in the 500 to 1000 m trawls. These four taxa contribute almost 34% to the total difference between the two depth groups.

The geographic variation shown in the MDS analysis (fig. 4) was analyzed in more detail for each depth group. The samples included in the MDS analyses for each depth group were categorized by their geographic location within each half degree of latitude (fig. 5). All four depth ranges had a statistically significant latitudinal gradient, but the shallowest depth group (<200 m) had the strongest relationship between the rank order based on Bray-Curtis distances among samples and rank order based on latitude. The test statistic for the RELATE procedure for the other three depth groups were similar in value and showed more grouping of samples than shown in the <200 m depth group.

Although all four depth categories had a significant trend consistent with latitudinal variation, the pattern was different for the four groups. The RELATE test value was higher and the pattern of latitudinal variation strongest for the <200 m depth, but no clear break at Point Conception was detected between latitude groups 34.0 and 34.5 (fig. 5a). The break at Point Conception was strongest in the data for the 200 to 500 m depth (fig. 5b), but also apparent in the data from the 500–1000 m depth (fig. 5c). The break at Point Conception was not present in the data from the >1000 m depth category (fig. 5d), which also has the lowest RELATE test value. The results from the MDS for the deepest depth category appear to form three groups with the latitudinal groups around Point Conception more similar to the other data from the SCC.

In the SIMPER analysis for the three geographic regions for the four depth groups, the ten taxa responsible for the greatest degree of similarity within the regional groupings were very similar for all of the depth groups except for the shallowest group (<200 m)

TABLE 6

PRIMER SIMPER analysis showing taxa contributing to the similarity among samples within the south (SCB), central (SCC), and north (MONT) geographic regions for the a) <200 m depth class, b) 200–500 m, c) 500–1000 m, and d) >1000 m depth classes. The 10 taxa with the highest percentage contributions per group are ranked as cumulative percentages, including the number of additional taxa contributing up to 90% of the similarity within each group. The average similarity for the samples within each group for each depth class is also presented.

	SCB		SCC		MONT	
50–200 m						
	Avg. = 68.2		Avg. = 69.3		Avg. = 60.9	
1	*Sebastes semicinctus*	13.88	*Citharichthys sordidus*	11.43	*Sebastes goodei*	10.71
2	*Citharichthys sordidus*	24.24	*Sebastes jordani*	18.58	*Citharichthys sordidus*	18.83
3	*Zalembius rosaceus*	32.06	*Merluccius productus*	24.79	*Merluccius productus*	26.61
4	*Peprilus simillimus*	39.79	*Sebastes semicinctus*	30.58	*Sebastes saxicola*	33.70
5	*Sebastes jordani*	44.47	*Sebastes saxicola*	36.20	*Parophrys vetulus*	39.66
6	*Genyonemus lineatus*	47.91	*Zalembius rosaceus*	41.16	*Squalus suckleyi*	45.59
7	*Sebastes saxicola*	51.06	*Peprilus simillimus*	45.62	*Sebastes jordani*	50.03
8	*Hydrolagus colliei*	53.69	*Sebastes goodei*	50.03	*Eopsetta jordani*	54.30
9	*Parophrys vetulus*	56.30	*Porichthys notatus*	54.30	*Glyptocephalus zachirus*	58.48
10	*Zaniolepis latipinnis*	58.64	*Parophrys vetulus*	57.64	*Microstomus pacificus*	62.06
	29 other taxa		20 other taxa		19 other taxa	
200–500 m						
	Avg. = 68.1		Avg. = 78.0		Avg. = 66.2	
1	*Sebastes diploproa*	11.19	*Sebastes diploproa*	18.51	*Microstomus pacificus*	13.99
2	*Sebastes jordani*	21.83	*Microstomus pacificus*	27.04	*Sebastes diploproa*	27.16
3	*Lyopsetta exilis*	28.50	*Sebastes saxicola*	35.02	*Sebastes saxicola*	38.51
4	*Merluccius productus*	35.14	*Merluccius productus*	42.16	*Glyptocephalus zachirus*	46.89
5	*Microstomus pacificus*	41.33	*Glyptocephalus zachirus*	47.73	*Merluccius productus*	51.98
6	*Sebastes saxicola*	46.48	*Sebastes aurora*	51.77	*Sebastolobus alascanus*	55.70
7	*Glyptocephalus zachirus*	51.45	*Parmaturus xaniurus*	55.64	*Lycodes cortezianus*	59.42
8	*Sebastolobus alascanus*	55.73	*Sebastes jordani*	59.46	*Raja rhina*	62.66
9	*Sebastolobus altivelis*	59.87	*Raja rhina*	63.25	*Hydrolagus colliei*	65.77
10	*Citharichthys sordidus*	63.32	*Anoplopoma fimbria*	66.24	*Squalus suckleyi*	68.80
	20 other taxa		11 other taxa		11 other taxa	
500–1000 m						
	Avg. = 74.1		Avg. = 82.1		Avg. = 77.5	
1	*Sebastolobus altivelis*	25.18	*Sebastolobus altivelis*	23.34	*Sebastolobus altivelis*	26.70
2	*Microstomus pacificus*	33.05	*Microstomus pacificus*	34.32	*Microstomus pacificus*	41.51
3	*Sebastolobus alascanus*	40.68	*Sebastolobus alascanus*	39.92	*Alepocephalus tenebrosus*	48.19
4	*Alepocephalus tenebrosus*	47.48	*Alepocephalus tenebrosus*	45.42	*Apristurus brunneus*	53.84
5	*Apristurus brunneus*	52.18	*Apristurus brunneus*	50.41	*Anoplopoma fimbria*	58.31
6	*Nezumia stelgidolepis*	56.00	*Anoplopoma fimbria*	55.15	*Sebastolobus alascanus*	62.58
7	*Anoplopoma fimbria*	59.39	*Parmaturus xaniurus*	59.15	*Coryphaenoides acrolepis*	65.88
8	*Nezumia liolepis*	62.74	*Sebastes aurora*	61.74	*Embassichthys bathybius*	69.07
9	*Merluccius productus*	65.52	*Raja rhina*	64.30	*Lycenchelys crotalinus*	72.06
10	*Bothrocara brunneum*	67.95	*Coryphaenoides acrolepis*	66.64	*Antimora microlepis*	74.32
	19 other taxa		17 other taxa		10 other taxa	
>1000 m						
	Avg. = 73.2		Avg. = 79.2		Avg. = 78.6	
1	*Sebastolobus altivelis*	25.74	*Sebastolobus altivelis*	22.17	*Sebastolobus altivelis*	26.78
2	*Alepocephalus tenebrosus*	39.52	*Coryphaenoides acrolepis*	36.24	*Coryphaenoides acrolepis*	43.58
3	*Antimora microlepis*	45.97	*Alepocephalus tenebrosus*	47.11	*Alepocephalus tenebrosus*	50.26
4	*Coryphaenoides acrolepis*	52.20	*Antimora microlepis*	53.83	*Antimora microlepis*	56.30
5	*Microstomus pacificus*	56.94	Bathylagidae	58.78	*Albatrossia pectoralis*	61.44
6	*Sebastolobus alascanus*	61.56	*Albatrossia pectoralis*	63.30	*Microstomus pacificus*	66.42
7	Bathylagidae	65.57	*Sebastolobus alascanus*	67.44	*Sebastolobus alascanus*	70.60
8	*Bathyraja trachura*	69.29	*Anoplopoma fimbria*	71.49	*Embassichthys bathybius*	74.73
9	*Anoplopoma fimbria*	72.94	*Microstomus pacificus*	75.30	*Anoplopoma fimbria*	78.83
10	*Bothrocara brunneum*	76.31	*Bothrocara brunneum*	78.43	Bathylagidae	82.91
	7 other taxa		8 other taxa		4 other taxa	

(table 6). While fishes such as *Citharichthys sordidus* were important in defining the similarity among the samples for all three geographic groups at the <200 m depth, other fishes such as *Genyonemus lineatus* and *Hydrolagus colliei* only occurred in the top ten for the SCB group (table 6). A clear shift was seen in the importance of some of the fishes moving from south to north, such as *Sebastes saxicola*. The number of taxa contributing to the similarity within geographic groups also decreased from south to north for all of the depth groups except for the deepest, >1000 m group. These results, especially for the shallowest <200 m samples reflected the strong gradient seen in the MDS results (figs. 4 and 5). The SIMPER analysis for the geographic regions within each depth class (fig. 5) was consistent with the differences observed in each of the separated depths.

DISCUSSION

In this study, little effect of the Point Conception barrier was shown in the occurrence of taxa in each biogeographic area (Appendix I). Declines in fish density were largely limited to the cooler MONT region, which could have been negatively affected by temperature or other environmental changes that might not have adversely affected the warm temperate species of the SCB, and/or perhaps greater fishing pressure. These presence/absence data were important as this approach is the usual method for documenting faunal breaks. These data showed that most of the identified species were not abundant in their region of occurrence and probably of limited importance to the assemblage in each region. Further, only 16 of the 85 fishes that these data show did cross the barrier were listed in the literature as limited by the barrier, suggesting that their absence in either region was a result of limited sampling. Better information can be derived from the regional abundance data for species not entirely delimited by the regional barrier. Many California fish species were not captured in this trawl program (at least 451 of the 732 species) and some of these may actually be relatively common but patchy enough in distribution to be missed by this level of sampling intensity.

Using nine models for each ranking and depth, we found correlations in only 15 of the 108 comparisons (4 depths, nine models, and 3 rankings) of rank orders between regions by depth (table 3). Thus, 83% of the rank order comparisons imply a distinct separation between regions, providing strong support for the effectiveness of the Point Conception barrier. Only six positive correlations were found between rankings at shelf depths (17%), one for 200 to 500 m (3%), seven for 500–1000 m (19%) and nine for >1000 m (25%). We must note that the probabilities presented were not adjusted for multiple comparisons. If this adjustment was made, there would be, at most, 7 significant correlations (table 3). With the exception of the upper slope, which shows the strongest regional separation, correlations become more common as the depth increases, suggesting a less effective barrier with depth, but fewer species occupy these depths, which could affect this outcome. The number of correlations varies little between models: ten for the MONT model, seven for the SCC model, and eight for the SCB model. The system used to calculate rank orders also varied in number of positive correlations, four using abundance, five using the index of community importance, and eight using species value. The models rarely agreed on the regional correlations. The regional separation based on rank order was greatest at the 200 to 500 m depth, but this depth also had the greatest differences among the top ten species for the different ranking systems. Only one significant correlation was detected at the 200–500 m depth, while at the deeper two depth categories, a significant correlation was detected between MONT and the SCC in the SCB based model and in the SCC model suggesting mixing in this cooler water of the two northern regions but not south of Point Conception. For the ICI, the significant correlations were between the coolest region, MONT, and the SCC (all models, >1000 m), between the MONT and SCC (SCB model, 200 to 500 m) and SCC and SCB (SCB model, <200 m).

At the <200 m and 200–500 m depths, only 7 correlations were detected between regions, supporting the effectiveness of the regional barriers. A significant correlation was detected at the 500–1000 m depth between the SCC and MONT using the MONT model indicating that in the cooler, deeper waters some mixing is occurring. At the deepest sampling depths (>1000 m), a significant correlation was detected between the SCB and MONT in the SCC model and the SCB and SCC in the MONT model, also indicating greater mixing between the regions at depth. Using the rank order of abundance, we detected a significant correlation for the comparison of the SCC and MONT rankings for the top ten species. No significant correlations were detected for the other eight tests. This lack of correlation suggested that a barrier is in place, and perhaps that the SCC and MONT regions were most closely allied.

Rank-order analysis of the data also separated the regions, but the relationships were not highly correlated among the three rank order systems (density, density and fidelity, density, and fidelity and mean weight), used in the study. When not evaluated by depth, none of the comparisons showed a positive correlation between regions. The other rank order comparisons separated the species of each region by depths: 50 to 200 m, 200 to 500 m, 500 to 1000 m, and greater than 1000 m. In this case, there were 108 tests of correlation, and only 14%

of the rank orders showed a positive correlation, the remaining 86% showed no significance or a negative correlation, both supporting regional separation. The two depths below 500 m had a higher number of correlations (11) while those above 500 m had only 4. Interestingly, the upper slope (200 to 500 m) had only 1 correlation. Based upon these rank-order analyses, the regions were basically distinct though less so with depth.

The results of the multivariate analysis also support the Point Conception barrier. The MDS shows the faunal assemblages in the four depth categories were distinct and clearly represented the largest conponent of the variation among the sample groups (fig. 4). Within each of the depth groups there was a strong latitudinal gradient (figs. 4 and 5). The strongest relationship was detected in the shallowest depth, which did not show a break between the latitudinal groups south (34.0) and north (34.5) of Point Conception. This difference may be due to greater variation in water temperatures in the surface waters that cause some mixing of species across the barrier because the results showed a clear separation between the latitudinal groups north and south of Point Conception for the upper slope and 500 to 1000 m depth groups. The latitiudinal groups in the SCB were distinct for all the depth categories except for the greater than 1000 m depths, where the latitudinal relationship was also less apparent.

The species identified as important to the similarity of the samples within each region for each depth support the latitudinal change in assemblage (table 6). For example, *S. semicinctus*, *Zalembius rosaceus*, and *Peprilus simillimus* are all identified as important contributing species to the SCB at depths <200 m. All three of these species dropped off in abundances in the two regions to the north. They were replaced by species such as *S. goodei* that increased in abundance from the SCB to MONT. In contrast, a species such as *C. sordidus* was in approximately equal abundance in all three regions at this depth and was an important contributor to the assemblage in all three regions. These results help explain the gradual latitudinal change seen for the samples collected at <200 m.

The separation between the SCB and the other regions for the 200 to 500 m, and 500 to 1000 m depths (figs. 5b and 5c) was also explained by the changes in species assemblages across the regions. The five species with the largest contributions to the similarity among the samples within the groups were almost identical for SCB and MONT (tables 6b and 6c). These species account for approximately 50% or greater of the similarity within the groups. A different suite of species was associated with the SCB for the 200 to 500 m depth (table 6b). At the 500 to 1000 m depth the top five species were similar across all three regions (table 6c), but other species associated with the SCB, such as *Nezumia stelgidolepis* and *N. liolepis* showed steep declines in abundance between the SCB and SCC, while species such as *Sebastolobus altevelis* and *Microstomus pacificus* showed sharp increases between the two regions. The separation of SCC from the other two regions was likely due to the reduced differences in abundance between the SCC and MONT relative to the changes between the SCB and SCC in these, and other, species.

One of the problems in drawing too strong of a conclusion regarding the Point Conception barrier using these data is the absence of any sampling in shallow water less than 50 m in depth, which was emphasized in earlier studies. Our study did not include sampling of fishes in shallow water habitats such as nearshore reefs, kelp beds, and tide pools. C. Klepado (Scripps Institution of Oceanography) provided us with a list of 74 species taken by University of California collectors in tide pools within the SCB and SCC regions (1950 to 2001). Of these, only 26 (35%) were recorded in our study. Similarly, shallow water species from soft substrate were rare. Love et al. (1986) presented data on shallow trawls at three sites in the SCB: San Onofre, Redondo Beach, and Ormond Beach (maximum depth 18.3 m). At the shallowest depth (6.1 m), 46% of the recorded species were not present in these data, while at 12 m and at 18.3 m, 43.8% and 35.4%, respectively, were not recorded. Similarly, Miller and Shiff (2012), in their analyses of the four SCB trawl surveys since 1994, list 89 species; 39 (43.8%) of these were not taken in this study in the SCB. These SCCWRP data were taken using small 7.6 m head-rope shrimp trawls that are fished primarily in waters between 5 and 200 m. These data included fewer species than in our study, and also many smaller fishes from shallower depths (Allen 2006).

CONCLUSIONS

While the NOAA-NMFS study was designed to evaluate fishery resources, it also provides unique insights into the patterns of variation in the the soft-bottom fish assemblages on our coast. Generally, shallow-water assemblages exhibited greater regional preferences than the deep outer shelf and slope assemblages, where the variation in temperature and habitat at depths is not as evident as it is in shallower environs. It would be interesting to be able to correlate annual changes in species to changes in site oceanographic conditions, but this would require a similar sampling effort among years and regions and that was not the goal of the program.

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APPENDIX I

Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
CEPHALASPIDOMORPHI			
Petromyzontiformes			
Lampetra tridentata	1	1	1
MYXINI			
Myxiniformes			
Eptatretus deani	1	1	1
Eptatretus stoutii	1	1	1
Myxine circifrons	1	1	1
CHONDRICHTHYES			
Chimaeriformes			
Harriotta raleighana	1	0	0
Hydrolagus colliei	1	1	1
Hexanchiformes			
Clamydoselachus anguineus	1	1	0
Hexanchus griseus	1	1	1
Notorynchus cepedianus	1	1	1
Squaliformes			
Centroscyllium nigrum	1	1	0
Echinorhinus cookei	1	1	1
Somniosus pacificus	1	1	1
Squalus suckleyi	1	1	1
Squatiniformes			
Squatina californica	1	1	1
Heterodontiformes			
Heterodontus francisci	1	1	1
Orectolobiformes			
Rhincodon typus	1	1	1
Lamniformes			
Alopias pelagicus	1	0	0
Alopias superciliosus	1	0	0
Alopias vulpinus	1	1	1
Cetorhinus maximus	1	1	1
Carcharodon carcharias	1	1	1
Isurus oxyrinchus	1	1	1
Lamna ditropis	1	1	1
Megachasma pelagios	1	1	0
Mitsukurina owstoni	1	0	0
Odontaspis ferox	1	1	0
Carchariniformes			
Apristurus brunneus	1	1	1
Apristurus kampae	1	1	1
Cephaloscyllium ventriosum	1	1	1
Parmaturus xaniurus	1	1	1
Galeorhinus galeus	1	1	1
Mustelus henlei	1	1	1
Mustelus californicus	1	1	1
Triakis semifasciata	1	1	1
Carcharhinus brachyurus	1	0	0
Carcharhinus longimanus	1	0	0
Carcharhinus obscurus	1	0	0
Prionace glauca	1	1	1
Sphyrna lewini	1	0	0
Sphyrna tiburo	1	0	0
Sphyrna zygaena	1	1	1
Torpediniformes			
Torpedo californica	1	1	1
Rajiformes			
Bathyraja abyssicola	1	1	1
Bathyraja aleutica	0	0	1
Bathyraja interrupta	1	1	1
Bathyraja kincaidii	1	1	1
Bathyraja spinosissima	1	1	1
Bathyraja trachura	1	1	1
Raja binoculata	1	1	1
Raja inornata	1	1	1
Raja rhina	1	1	1
Raja stellulata	1	1	1
Platyrhinoidis triseriata	1	1	1
Rhinobatos productus	1	1	1
Zapteryx exasperata	1	1	0
Gymnura marmorata	1	0	0
Myliobatiformes			
Myliobatis californica	1	1	1
Pteroplatytrygon violacea	1	1	1
Urobatis halleri	1	1	1
Dasyatis dipterura	1	1	0
ACTINOPTERYGII			
Acipenseriformes			
Acipenser medirostris	1	1	1
Acipenser transmontanus	1	1	1
Albuliformes			
Albula sp. A	1	1	1
Notacanthus chemnitzii	1	1	1
Elopiformes			
Elops affinis	1	0	0
Anguilliformes			
Gymnothorax mordax	1	0	0
Muraena argus	1	0	0
Gnathophis cinctus	1	0	0
Myrophis vafer	1	0	0
Derichthys serpentinus	1	0	0
Facciolella equatorialis	1	0	0
Ophichthus triserialis	1	1	1
Ophichthus zophochir	1	1	1
Avocettina bowersii	1	1	1
Avocettina infans	1	1	1
Nemichthys larseni	1	1	1
Nemichthys scolopaceus	1	1	1
Serrivomer sector	1	1	1
Serrivomer jesperseni	1	1	1
Serrivomer samoensis	1	0	0
Venefica tentaculata	1	1	1
Saccopharyngiformes			
Cyema atrum	1	1	1
Saccopharynx lavenbergi	1	1	1
Eurypharynx pelecanoides	1	1	1
Clupeiformes			
Alosa sapidissima	1	1	1
Anchoa compressa	1	1	0
Anchoa delicatissima	1	0	0
Cetengraulis mysticetus	1	0	0
Clupea pallasii	1	1	1
Dorosoma petenense	1	1	1
Engraulis mordax	1	1	1
Etrumeus teres	1	1	1
Harengula thrissina	1	0	0
Opisthonema libertate	1	0	0
Opisthonema medirastre	1	0	0
Sardinops sagax	1	1	1
Siluriformes			
Bagre panamensis	1	0	0
Argentiniformes			
Alepocephalus tenebrosus	1	1	1
Argentina sialis	1	1	1
Bajacalifornia burragei	1	0	0
Bathylagoides wesethi	1	1	1
Bathylagus pacificus	1	1	1
Bathylychnops exilis	1	1	1
Conocara salmoneum	1	0	0
Dolichopteryx longipes	1	0	0
Holtbyrnia latifrons	1	1	1
Leptochilichthys agassizi	1	1	1
Leuroglossus stilbius	1	1	1
Macropinna microstoma	1	1	1

APPENDIX I, Continued

Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
Maulisia argipalla	1	1	1
Maulisia mauli	1	1	?
Mentodus eubranchus	1	1	1
Mirorictus taningi	1	1	?
Nansenia candida	1	1	1
Nansenia crassa	1	1	?
Narcetes stomias	1	1	1
Pseudobathylagus milleri	1	1	1
Sagamichthys abei	1	1	1
Talismania bifurcata	1	1	1
Salmoniformes			
Allosmerus elongatus	1	1	1
Hypomesus pretiosus	1	1	1
Spirinchus starksi	1	1	1
Spirinchus thaleichthys	1	1	1
Thaleichthys pacificus	0	1	1
Oncorhynchus clarki	0	0	1
Oncorhynchus gorbuscha	1	1	1
Oncorhynchus keta	1	1	1
Oncorhynchus kisutch	1	1	1
Oncorhynchus mykiss	1	1	1
Oncorhynchus tshawytscha	1	1	1
Stomiiformes			
Cyclothone acclinidens	1	1	1
Cyclothone alba	1	1	1
Cyclothone pallida	1	1	1
Cyclothone pseudopallida	1	1	1
Cyclothone signata	1	1	1
Diplophos proximus	1	0	0
Diplophos taenia	1	1	1
Gonostoma atlanticum	1	1	1
Argyropelecus affinis	1	1	1
Argyropelecus hemigymnus	1	1	1
Argyropelecus lychnus	1	0	0
Argyropelecus sladeni	1	1	1
Aristostomias scintillans	1	1	1
Bathophilus brevis	1	0	0
Bathophilus flemingi	1	1	1
Borostomias panamensis	1	1	1
Chauliodus macouni	1	1	1
Ichthyococcus elongatus	1	1	1
Ichthyococcus irregularis	1	1	1
Idiacanthus antrostomus	1	1	1
Idiacanthus fasciola	1	1	1
Malacosteus niger	1	1	1
Neonesthes capensis	1	1	1
Opostomias mitsuii	0	1	1
Photonectes margarita	1	1	1
Sternoptyx diaphana	1	1	1
Vinciguerria nimbaria	1	0	1
Vinciguerria poweriae	1	1	0
Woodsia nonsuchae	1	0	0
Alepisaurus ferox	1	1	1
Anotopterus nikparini	1	1	1
Arctozenus risso	1	1	1
Benthalbella dentata	1	1	1
Lestidiops pacificus	1	1	1
Lestidiops ringens	1	1	1
Lestidium nudum	1	1	1
Magnisudis atlantica	1	1	1
Scopelosaurus harryi	1	1	1
Stomias atriventer	1	1	1
Tactostoma macropus	1	1	1
Synodus lucioceps	1	1	1
Myctophiformes			
Bolinichthys pyrsobolus	1	0	0
Ceratoscopelus townsendi	1	1	1
Diaphus theta	1	1	1
Diogenichthys laternatus	1	0	0
Diogenichthys atlanticus	1	1	1
Electrona risso	1	1	1
Hygophum reinhardti	1	0	0
Lampadena urophaos	1	1	1
Lampanyctus jordani	1	1	1
Lampanyctus steinbecki	1	1	1
Loweina rara	1	1	1
Myctophum nitidulum	1	1	0
Nannobrachium bristori	1	1	1
Nannobrachium ritteri	1	1	1
Nannobrachium valdiviae	1	1	1
Notoscopelus resplendens	1	1	0
Protomyctophum crockeri	1	1	1
Scopelengys tristis	1	1	1
Stenobrachius leucopsarus	1	1	1
Stenobrachius nannochir	0	0	1
Symbolophorus californiensis	1	1	1
Taaningichthys bathyphilus	1	1	1
Taaningichthys paurolychnus	1	0	0
Tarletonbeania crenularis	1	1	1
Triphoturus mexicanus	1	1	1
Triphoturus nigrescens	1	1	1
Lampridiformes			
Desmodema lorum	1	1	?
Lampris guttata	1	1	1
Stylephorus chordatus	1	1	1
Trachipterus altivelis	1	1	1
Trachipterus fukuzakii	1	1	?
Zu cristatus	1	0	0
Ophidiiformes			
Brosmophycis marginata	1	1	1
Cataetyx rubrirostris	1	1	1
Chilara taylori	1	1	1
Dicrolene filamentosa	1	0	1
Lamprogrammus niger	0	1	1
Ophidion scrippsae	1	1	1
Sciadonus pedicellaris	1	1	1
Spectrunculus grandis	1	1	1
Gadiformes			
Albatrossia pectoralis	1	1	1
Antimora microlepis	1	1	1
Caelorinchus scaphopsis	1	1	1
Coryphaenoides acrolepis	1	1	1
Coryphaenoides cinereus	0	0	1
Coryphaenoides filifer	1	1	1
Coryphaenoides leptolepis	1	1	1
Gadus macrocephalus	1	1	1
Halargyreus johnsonii	0	0	1
Malacocephalus laevis	1	1	1
Melanonus zugmayeri	1	1	1
Merluccius productus	1	1	1
Merluccius angustimanus	1	0	0
Microgadus proximus	1	1	1
Nezumia liolepis	1	1	1
Nezumia stelgidolepis	1	1	1
Physiculus rastrelliger	1	1	1
Theragra chalcogramma	0	0	1
Batrachoidiformes			
Porichthys myriaster	1	0	0
Porichthys notatus	1	1	1
Lophiiformes			
Antennarius avalonis	1	0	0
Caulophryne jordani	1	0	0
Caulophryne polynema	1	0	0
Chaenophryne draco	1	1	1

APPENDIX I, Continued

Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
Chaenophryne longiceps	1	1	1
Chaenophryne melanorhabdus	1	1	1
Cryptopsaras couesii	1	1	1
Dolopichthys longicornis	1	1	1
Dolopichthys pullatus	1	0	0
Gigantactis gargantua	1	0	0
Gigantactis macronema	1	0	0
Gigantactis microdontis	1	0	0
Gigantactis savagei	1	0	0
Gigantactis vanhoeffeni	1	1	1
Himantolophus nigricornis	1	1	1
Himantolophus sagamius	1	1	1
Linophryne coronata	1	0	0
Linophryne racemifera	1	0	0
Lophiodes caulinaris	1	1	0
Lophiodes spilurus	1	1	1
Melanocetus johnsonii	1	1	1
Oneirodes acanthias	1	1	1
Oneirodes basili	1	0	0
Oneirodes eschrichtii	1	0	0
Oneirodes thompsoni	0	0	1
Zalieutes elater	1	1	1
Mugiliformes			
Mugil cephalus	1	1	1
Atheriniformes			
Atherinops affinis	1	1	1
Atherinopsis californiensis	1	1	1
Leuresthes tenuis	1	1	1
Beloniformes			
Cheilopogon heterurus	1	0	0
Cheilopogon pinnatibarbatus	1	1	1
Fodiator acutus	1	0	0
Euleptorhamphus viridis	1	0	0
Hyporhamphus naos	1	0	0
Hyporhamphus rosae	1	0	0
Cololabis saira	1	1	1
Strongylura exilis	1	1	1
Cyprinodontiformes			
Fundulus parvipinnis	1	1	0
Stephanoberyciformes			
Barbourisia rufa	1	1	1
Cetichthys parini	1	1	0
Cetostoma regani	1	1	1
Ditropichthys storeri	1	1	1
Eutaeniophorus festivus	1	1	1
Melamphaes acanthomus	1	0	0
Melamphaes longivelis	1	0	0
Melamphaes lugubris	1	1	1
Melamphaes parvus	1	1	1
Poromitra crassiceps	1	1	1
Poromitra megalops	1	0	0
Poromitra oscitans	1	1	?
Rondeletia loricata	1	1	1
Scopeloberyx robustus	1	1	1
Scopelogadus mizolepis	1	1	1
Beryciformes			
Anoplogaster cornuta	1	1	1
Zeiformes			
Zenopsis nebulosa	0	1	1
Gasterosteiformes			
Aulorhynchus flavidus	1	1	1
Cosmocampus arctus	1	1	1
Gasterosteus aculeatus	1	1	1
Hippocampus ingens	1	0	0
Macroramphosus scolopax	1	0	0
Syngnathus auliscus	1	0	0
Syngnathus californiensis	1	1	1
Syngnathus euchrous	1	0	0
Syngnathus exilis	1	1	1
Syngnathus leptorhynchus	1	1	1
Scorpaeniformes			
Scorpaena guttata	1	1	1
Scorpaena mystes	1	0	0
Scorpaenodes xyris	1	0	0
Sebastolobus alascanus	1	1	1
Sebastolobus altivelis	1	1	1
Sebastes aleutianus	1	1	1
Sebastes alutus	0	0	1
Sebastes atrovirens	1	1	1
Sebastes auriculatus	1	1	1
Sebastes aurora	1	1	1
Sebastes babcocki	1	1	1
Sebastes borealis	0	1	1
Sebastes brevispinis	1	1	1
Sebastes carnatus	1	1	1
Sebastes caurinus	1	1	1
Sebastes chlorostictus	1	1	1
Sebastes chrysomelas	1	1	1
Sebastes constellatus	1	1	1
Sebastes crameri	1	1	1
Sebastes crocotulus	1	1	1
Sebastes dalli	1	1	1
Sebastes diploproa	1	1	1
Sebastes elongatus	1	1	1
Sebastes emphaeus	0	0	1
Sebastes ensifer	1	1	1
Sebastes entomelas	1	1	1
Sebastes eos	1	1	1
Sebastes flavidus	1	1	1
Sebastes gilli	1	1	1
Sebastes goodei	1	1	1
Sebastes helvomaculatus	1	1	1
Sebastes hopkinsi	1	1	1
Sebastes jordani	1	1	1
Sebastes lentiginosus	1	0	0
Sebastes levis	1	1	1
Sebastes macdonaldi	1	1	0
Sebastes maliger	1	1	1
Sebastes melanops	1	1	1
Sebastes melanosema	1	1	1
Sebastes melanostomus	1	1	1
Sebastes miniatus	1	1	1
Sebastes mystinus	1	1	1
Sebastes nebulosus	1	1	1
Sebastes nigrocinctus	1	1	1
Sebastes ovalis	1	1	1
Sebastes paucispinis	1	1	1
Sebastes phillipsi	1	1	1
Sebastes pinniger	1	1	1
Sebastes proriger	1	1	1
Sebastes rastrelliger	1	1	1
Sebastes rosaceous	1	1	1
Sebastes rosenblatti	1	1	1
Sebastes ruberrimus	1	1	1
Sebastes rubrivinctus	1	1	1
Sebastes rufinanus	1	0	0
Sebastes rufus	1	1	1
Sebastes saxicola	1	1	1
Sebastes semicinctus	1	1	1
Sebastes serranoides	1	1	1
Sebastes serriceps	1	1	1
Sebastes simulator	1	1	1
Sebastes umbrosus	1	1	1
Sebastes wilsoni	1	1	1

APPENDIX I, Continued

Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
Sebastes zacentrus	1	1	1
Bellator xenisma	1	?	?
Prionotus stephanophrys	1	1	1
Anoplopoma fimbria	1	1	1
Erilepis zonifer	0	0	1
Hexagrammos decagrammus	1	1	1
Hexagrammos lagocephalus	0	1	1
Ophiodon elongatus	1	1	1
Oxylebius pictus	1	1	1
Pleurogrammus monopterygius	1	1	1
Zaniolepis frenata	1	1	1
Zaniolepis latipinnis	1	1	1
Rhamphocottus richardsonii	1	1	1
Artedius corallinus	1	1	1
Artedius fenestralis	0	1	1
Artedius harringtoni	1	1	1
Artedius lateralis	1	1	1
Artedius notospilotus	1	1	1
Ascelichthys rhodorus	0	1	1
Chitonotus pugetensis	1	1	1
Clinocottus acuticeps	0	0	1
Clinocottus analis	1	1	1
Clinocottus embryum	1	1	1
Clinocottus globiceps	1	1	1
Clinocottus recalvus	0	0	1
Cottus aleuticus	0	1	1
Cottus asper	1	1	1
Enophrys bison	0	0	1
Enophrys taurina	1	1	1
Hemilepidotus hemilepidotus	0	0	1
Hemilepidotus spinosus	1	1	1
Icelinus burchami	1	1	1
Icelinus cavifrons	1	1	1
Icelinus filamentosus	1	1	1
Icelinus fimbriatus	1	1	1
Icelinus limbaughi	1	0	0
Icelinus oculatus	1	0	0
Icelinus quadriseriatus	1	1	1
Icelinus tenuis	1	1	1
Jordania zonope	0	1	1
Leiocottus hirundo	1	0	1
Leptocottus armatus	1	1	1
Oligocottus maculosus	1	1	1
Oligocottus rimensis	1	1	1
Oligocottus rubellio	1	1	1
Oligocottus snyderi	1	1	1
Orthonopias triacis	1	1	1
Paricelinus hopliticus	1	1	1
Radulinus asprellus	1	1	1
Radulinus boleoides	1	1	1
Radulinus taylori	0	0	1
Radulinus vinculus	1	1	0
Ruscarius creaseri	1	1	1
Scorpaenichthys marmoratus	1	1	1
Synchirus gilli	1	1	1
Zesticelus profundorum	1	1	1
Blepsias cirrhosus	0	1	1
Nautichthys oculofasciatus	1	1	1
Dasycottus setiger	0	0	1
Psychrolutes phrictus	1	1	1
Agonomalus mozinoi	0	1	1
Agonopsis sterletus	1	1	1
Agonopsis vulsa	1	1	1
Anoplagonus inermis	0	0	1
Bathyagonus alascanus	0	0	1
Bathyagonus infraspinatus	0	0	1
Bathyagonus nigripinnis	0	0	1
Bathyagonus pentacanthus	1	1	1
Bathyagonus swanii	0	1	1
Chesnonia verrucosa	0	0	1
Odontopyxis trispinosa	1	1	1
Pallasina barbata	0	0	1
Podothecus accipenserinus	0	0	1
Stellerina xyosterna	1	1	1
Xeneretmus latifrons	1	1	1
Xeneretmus leiops	1	1	1
Xeneretmus ritteri	1	0	0
Xeneretmus triacanthus	1	1	1
Careproctus colletti	0	0	1
Careproctus cypselurus	0	1	1
Careproctus gilberti	0	1	1
Careproctus melanurus	1	1	1
Careproctus ovigerus	1	1	1
Elassodiscus caudatus	0	0	1
Elassodiscus tremebundus	0	0	1
Liparis florae	1	1	1
Liparis fucensis	0	1	1
Liparis mucosus	1	1	1
Liparis pulchellus	0	0	1
Nectoliparis pelagicus	1	1	1
Paraliparis albescens	0	0	1
Paraliparis cephalus	0	0	1
Paraliparis dactylosus	0	1	1
Paraliparis deani	0	0	1
Paraliparis nassarum	1	0	0
Paraliparis pectoralis	0	0	1
Paraliparis rosaceous	1	1	1
Paraliparis ulochir	1	?	1
Psednos cathetostomus	1	0	0
Rhinoliparis attenuatus	0	0	1
Rhinoliparis barbulifer	1	?	?
Perciformes			
Morone saxatilis	1	1	1
Howella brodiei	1	1	1
Stereolepis gigas	1	1	1
Mycteroperca jordani	1	0	0
Mycteroperca xenarcha	1	1	1
Epinephelus analogus	1	0	0
Epinephelus niphobles	1	1	0
Hemanthias signifer	1	0	0
Paralabrax clathratus	1	1	1
Paralabrax maculatofasciatus	1	1	1
Paralabrax nebulifer	1	1	1
Serranus aequidens	1	0	0
Pristigenys serrula	1	1	1
Apogon atricaudus	1	0	0
Apogon guadalupensis	1	0	0
Caulolatilus affinis	1	0	0
Caulolatilus princeps	1	1	1
Nematistius pectoralis	1	0	0
Echeneis naucrates	1	0	0
Phtheirichthys lineatus	1	0	0
Remora australis	1	1	1
Remora brachyptera	1	0	0
Remora osteochir	1	0	0
Remora remora	1	1	1
Remorina albescens	1	1	1
Coryphaena hippurus	1	1	1
Caranx caballus	1	1	1
Caranx sexfasciatus	1	0	0
Caranx vinctus	1	0	0
Chloroscombrus orqueta	1	0	0
Decapterus muroadsi	1	1	1
Naucrates ductor	1	1	1

APPENDIX I, Continued
Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
Selene brevoortii	1	0	0
Selene peruviana	1	0	0
Seriola lalandi	1	1	1
Seriola rivoliana	1	0	0
Trachinotus paitensis	1	0	0
Trachinotus rhodopus	1	0	0
Trachurus symmetricus	1	1	1
Uraspis helvola	1	0	0
Brama orcini	1	0	0
Pteraclis aesticola	1	1	1
Taractes asper	1	1	1
Taractichthys steindachneri	1	0	0
Caristius macropus	1	1	1
Lutjanus argentiventris	1	0	0
Lutjanus colorado	1	1	0
Lutjanus novemfasciatus	1	1	0
Lobotes pacificus	1	0	0
Anisotremus davidsoni	1	1	1
Conodon serrifer	1	0	0
Haemulon flaviguttatum	1	0	0
Microlepidotus inornatus	1	0	0
Xenistius californiensis	1	1	1
Calamus brachysomus	1	0	0
Polydactylus approximans	1	1	1
Polydactylus opercularis	1	0	0
Atractoscion nobilis	1	1	1
Cheilotrema saturnum	1	0	0
Cynoscion parvipinnis	1	0	0
Genyonemus lineatus	1	1	1
Menticirrhus undulatus	1	0	0
Roncador stearnsi	1	0	0
Seriphus politus	1	1	1
Umbrina roncador	1	0	0
Pseudupeneus grandisquamis	1	0	0
Chaetodon humeralis	1	0	0
Prognathodes falcifer	1	0	0
Girella nigricans	1	1	1
Hermosilla azurea	1	1	1
Kyphosus analogus	1	0	0
Medialuna californiensis	1	1	1
Sectator ocyurus	1	0	0
Amphistichus argenteus	1	1	1
Amphistichus koelzi	1	1	1
Amphistichus rhodoterus	0	1	1
Brachyistius frenata	1	1	1
Cymatogaster aggregata	1	1	1
Embiotoca jacksoni	1	1	1
Embiotoca lateralis	1	1	1
Hyperprosopon anale	1	1	1
Hyperprosopon argenteum	1	1	1
Hyperprosopon ellipticum	1	1	1
Hypsurus caryi	1	1	1
Micrometrus aurora	1	1	1
Micrometrus minimus	1	1	1
Phanerodon atripes	1	1	1
Phanerodon furcatus	1	1	1
Rhacochilus toxotes	1	1	1
Rhacochilus vacca	1	1	1
Zalembius rosaceus	1	1	1
Abudefduf troschelii	1	0	0
Azurina hirundo	1	0	0
Chromis alta	1	0	0
Chromis punctipinnis	1	1	1
Hypsypops rubicundus	1	1	1
Halichoeres semicinctus	1	1	0
Oxyjulis californica	1	1	1
Semicossyphus pulcher	1	1	1
Nicholsina denticulata	1	0	0
Rathbunella alleni	1	1	1
Rathbunella hypoplecta	1	0	0
Ronquilus jordani	1	1	1
Bothrocara brunneum	1	1	1
Bothrocara molle	1	1	1
Derepodichthys alepidotus	1	1	1
Eucryphycus californicus	1	1	1
Lycenchelys callista	1	?	1
Lycenchelys camchatica	1	1	1
Lycenchelys crotalinus	1	1	1
Lycodapus dermatinus	1	?	1
Lycodapus endemoscotus	1	1	1
Lycodapus fierasfer	1	1	1
Lycodapus mandibularis	1	1	1
Lycodes brevipes	1	1	1
Lycodes cortezianus	1	1	1
Lycodes diapterus	1	1	1
Lycodes pacificus	1	1	1
Lyconema barbatum	1	1	1
Melanostigma pammelas	1	1	1
Taranetzella lyoderma	1	1	1
Anoplarchus insignis	0	0	1
Anoplarchus purpurescens	1	1	1
Cebidichthys violaceus	1	1	1
Chirolophis decoratus	1	1	1
Chirolophis nugator	1	1	1
Ernogrammus walkeri	1	1	1
Esselenichthys carli	1	1	1
Esselenichthys laurae	1	1	1
Kasatkia seigeli	0	1	1
Lumpenopsis clitella	1	0	0
Lumpenus sagitta	0	0	1
Phytichthys chirus	1	1	1
Plagiogrammus hopkinsi	1	1	1
Plectobranchus evides	1	1	1
Poroclinus rothrocki	1	1	1
Xiphister atropurpureus	1	1	1
Xiphister mucosus	1	1	1
Cryptacanthodes aleutensis	0	0	1
Cryptacanthodes giganteus	0	0	1
Apodichthys flavidus	1	1	1
Apodichthys fucorum	1	1	1
Apodichthys sanctaerosae	1	1	1
Pholis clemensi	0	0	1
Pholis schultzi	0	1	1
Anarrhichthys ocellatus	1	1	1
Zaprora silenus	1	1	1
Scytalina cerdale	0	1	1
Trichodon trichodon	0	0	1
Ammodytes hexapterus	1	1	1
Kathetostoma averruncus	1	1	0
Chiasmodon niger	1	1	1
Dysalotus oligoscolus	1	0	0
Kali indica	1	1	1
Kali normani	1	0	0
Alloclinus holderi	1	0	0
Cryptotrema corallinum	1	0	0
Paraclinus integripinnis	1	0	0
Gibbonsia elegans	1	1	0
Gibbonsia metzi	1	1	1
Gibbonsia montereyensis	1	1	1
Heterostichus rostratus	1	1	1
Chaenopsis alepidota	1	0	0
Neoclinus blanchardi	1	1	1
Neoclinus stephensae	1	1	1
Neoclinus uninotatus	1	1	1

APPENDIX I, Continued
Presence (1) versus absence (0) by biogeographic region.

	SCB	SCC	MONT
Hypsoblennius gentilis	1	1	1
Hypsoblennius gilberti	1	1	0
Hypsoblennius jenkinsi	1	1	0
Plagiotremus azaleus	1	0	0
Icosteus aenigmaticus	1	1	1
Gobiesox eugrammus	1	0	0
Gobiesox maeandricus	1	1	1
Gobiesox papillifer	1	0	0
Gobiesox rhessodon	1	1	0
Rimicola cabrilloi	1	0	0
Rimicola dimorpha	1	0	0
Rimicola eigenmanni	1	0	0
Rimicola muscarum	1	1	1
Synchiropus atrilabiatus	1	0	0
Dormitator latifrons	1	0	0
Acanthogobius flavimanus	1	1	1
Clevelandia ios	1	1	1
Ctenogobius sagitta	1	0	0
Eucyclogobius newberryi	1	1	1
Gillichthys mirabilis	1	1	1
Ilypnus gilberti	1	1	1
Lepidogobius lepidus	1	1	1
Lethops connectens	1	1	1
Lythrypnus dalli	1	1	0
Lythrypnus zebra	1	1	1
Quietula y-cauda	1	1	0
Rhinogobiops nicholsii	1	1	1
Tridentiger trigonocephalus	1	0	1
Typhlogobius californiensis	1	1	0
Chaetodipterus zonatus	1	0	0
Luvarus imperialis	1	1	1
Sphyraena argenteum	1	1	1
Sphyraena ensis	1	0	0
Diplospinus multistriatus	1	1	0
Lepidocybium flavobrunneum	1	1	1
Ruvettus pretiosus	1	1	1
Aphanopus intermedius	1	1	1
Assurger anzac	1	0	0
Lepidopus fitchi	1	1	1
Benthodesmus pacificus	0	0	1
Trichiurus nitens	1	0	0
Auxis rochei	1	0	0
Auxis thazard	1	0	0
Euthynnus affinis	1	0	0
Euthynnus lineatus	1	1	0
Katsuwonus pelamis	1	1	1
Sarda chilensis	1	1	1
Scomber japonicus	1	1	1
Scomberomorus concolor	1	1	1
Scomberomorus sierra	1	0	0
Thunnus alalunga	1	1	1
Thunnus albacares	1	1	0
Thunnus obesus	1	1	1
Thunnus orientalis	1	1	1
Xiphias gladius	1	1	1
Istiophorus platypterus	1	0	0
Makaira indica	1	0	0
Makaira nigricans	1	0	0
Tetrapturus angustirostris	1	0	0
Tetrapturus audax	1	0	0
Icichthys lockingtoni	1	1	1
Cubiceps baxteri	1	0	0
Cubiceps capensis	1	0	0
Cubiceps paradoxus	1	0	0
Psenes Pellucidus	1	0	0
Tetragonurus cuvieri	1	1	1
Peprilus simillimus	1	1	1
Pleuronectiformes			
Atheresthes stomias	1	1	1
Citharichthys sordidus	1	1	1
Citharichthys stigmaeus	1	1	1
Citharichthys xanthostigma	1	1	1
Embassichthys bathybius	1	1	1
Engyophrys sanctilaurentii	1	0	0
Eopsetta jordani	1	1	1
Glyptocephalus zachirus	1	1	1
Hippoglossina stomata	1	1	1
Hippoglossoides elassodon	0	0	1
Hippoglossus stenolepis	1	1	1
Isopsetta isolepis	1	1	1
Lepidopsetta bilineata	1	1	1
Lyopsetta exilis	1	1	1
Microstomus pacificus	1	1	1
Paralichthys californicus	1	1	1
Parophrys vetulus	1	1	1
Platichthys stellatus	1	1	1
Pleuronichthys coenosus	1	1	1
Pleuronichthys decurrens	1	1	1
Pleuronichthys guttulata	1	1	1
Pleuronichthys ritteri	1	1	1
Pleuronichthys verticalis	1	1	1
Psettichthys melanostictus	1	1	1
Reinhardtius hippoglossoides	0	1	1
Xystreurys liolepis	1	1	1
Symphurus atricauda	1	1	1
Tetraodontiformes			
Balistes polylepis	1	1	1
Chilomycterus reticulatus	1	0	0
Diodon holocanthus	1	0	0
Diodon hystrix	1	0	0
Lagocephalus lagocephalus	1	1	1
Lactoria diaphana	1	1	1
Mola mola	1	1	1
Ranzania laevis	0	1	1
Sphoeroides annulatus	1	0	0
Sphoeroides lobatus	1	0	0
Xanthichthys mento	1	0	0
Regional Total	**669**	**527**	**538**
Grand Total			**732**