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Spatial and temporal fishing patterns at the outer banks of the Southern California Bight

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Abstract.—We analyzed recreational and commercial catch records from 1980 to 2009 for the fishing blocks associated with the 5 southern offshore banks of the Southern California Bight (Cortes Bank, Tanner Bank, Northeast Bank, Cherry Ridge, and Garrett Ridge). Recreational fishers and divers targeted pelagic taxa (e.g., tunas and Yellowtail) but instead landed more benthic taxa (e.g., rockfishes, Ocean Whitefish, and California Sheephead). For the commercial fisheries, pelagics (Bluefin Tuna, Albacore, Skipjack, Yellowfin Tuna, Pacific Bonito, and Swordfish) were the most important taxa and represented a significant proportion (8%–27%) of the landings of these fishes in the bight. These fishes were caught primarily at Cortes and Tanner Banks, which together only represent 3.7% of the fishing grounds in the region. In addition, this proportion of catch of these critical species has been significantly increasing at the outer banks during this period. Based on their geography and physical oceanography, we propose that these offshore banks comprise a unique habitat for pelagic resources in the Southern California Bight.

Resumen.—Analizamos los registros de pesca comercial y deportiva, desde el año 1980 al 2009, de los bloques de pesca asociados a las cinco riberas marítimas del sur de la bahía del sur de California (Ribera Cortes, Ribera Tanner, Ribera del noreste, Cherry Ridge, y Garrett Ridge). El blanco de los pescadores y de los buzos deportivos fueron los taxa pelágicos (e.g., atunes y cola amarilla), aunque se encontraron más taxa bentónicos (e.g., lubina rayada atlántica, blanquillo fino y vieja de California). Para los pescadores comerciales, los taxa pelágicos (atún azul, atún blanco, listado, atún de aleta amarilla, bonito del pacífico oriental, y pez espada) resultaron de mayor importancia y representaron una proporción significativa (8%–27%) de sus pescas en la bahía. Estos peces fueron capturados principalmente en las riberas Cortes y Tanner, que representan solamente 3.7% de las zonas de pesca de la región. Además, el porcentaje de captura de estas especies clave se incrementó significativamente en las afueras de los bloques durante este período. Basándonos en su geografía y en su oceanografía física, creemos que estos bancos marítimos constituyen un hábitat singular para los recursos pelágicos de la Bahía del Sur de California.

Along the outer reaches of the Southern California Bight (SCB) are 5 offshore banks and seamounts (Cortes Bank, Tanner Bank, Northeast Bank, Cherry Ridge, and Garrett Ridge; Fig. 1). Due to a variety of physical oceanographic and geologic properties, these features are distinctive in the region. The tops of these offshore banks are most similar to island habitats without the emergent land masses (Emery 1960). For example, Cortes Bank has 1359.6 ha and Tanner Bank has 63.2 ha of shallow subtidal (<30 m) reef habitat. Cortes Bank ranks sixth after Santa Rosa (9087.5 ha), San Nicolas (5249.9 ha), Santa Cruz (4837.7 ha), San Clemente (3593.2 ha), and San Miguel (3461.8 ha) Islands for shallow water reef habitat among the Channel Islands, representing ~4.53% of offshore reefs in the SCB (Pondella et al. 2015). The 3 other prominent, relatively shallow features are Cherry Bank (28 m), Garrett Ridge (39 m), and Northeast Bank (108 m). Surrounding these ridges and banks are basins and canyons (San Nicolas, East Cortes, West Cortes, and Tanner). The basins have sill depths from 1100 m to 1400 m and basin depths to 1979 m (Emery 1960).

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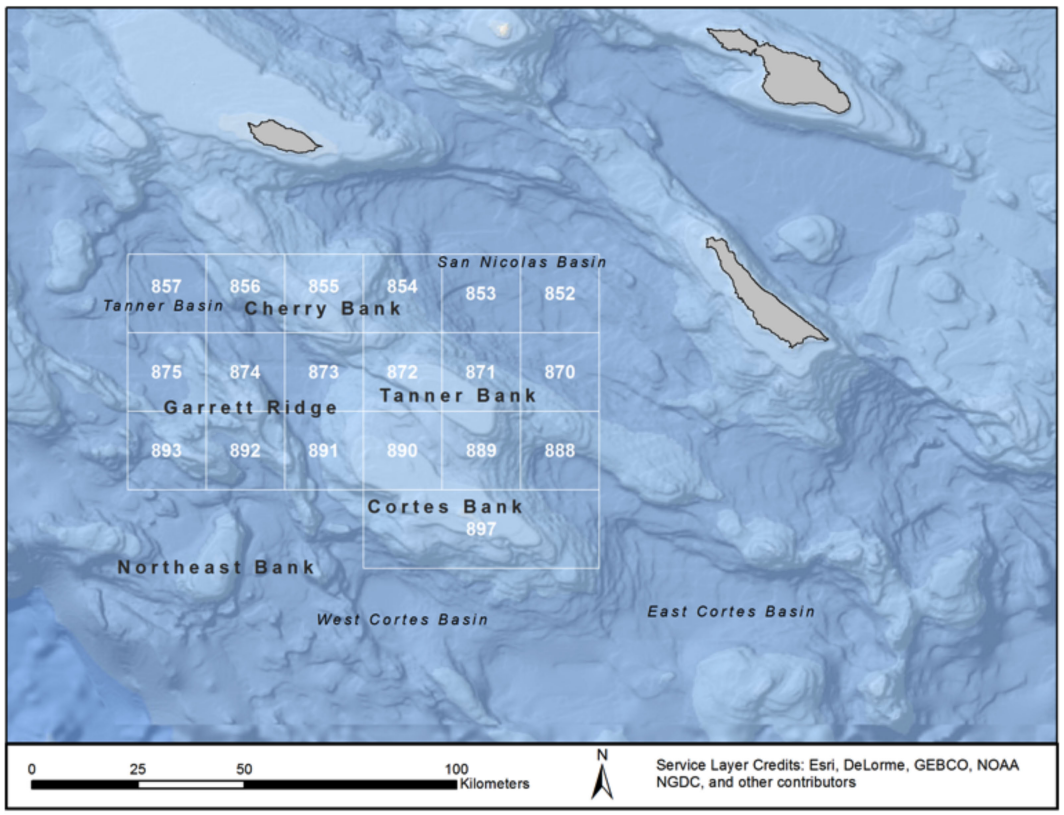

Fig. 1. Bathymetric map including the offshore banks of the Southern California Bight with an overlay of the fishing blocks analyzed in this study.

This region, referred to in the geological literature as the California Continental Borderlands, lies at the southern edge of the SCB, which is floored by a ~300-km-wide region of extensively faulted and extended continental crust comprising Mesozoic metamorphic and intrusive igneous rock, as well as Neogene sedimentary and volcanic units (Crouch and Suppe 1993). It differs markedly from the continental shelf north of Point Conception, the northern border of the SCB, which is typically <100 km wide. Seismic evidence (Lekic et al. 2011) shows that the entire thickness of the Pacific Plate (i.e., the continental crust plus the uppermost mantle) has been extended and thinned. Differential subsidence along the many faults that cut the California Continental Borderlands has produced the distinctive topography of islands and outer banks separated by ~1-km-deep basins. Thus, these banks and ridges lie on the outer edge of an atypical section of the continental shelf further offshore than any other similar feature in California and provide a variety of marine habitats because of their stark bathymetry.

Oceanographically, the SCB occurs within the broader context of the California Current, which is a major equatorward alongshore current flowing along the eastern boundary of the North Pacific Ocean. The circulation is driven by basin-scale forcing and is amplified along the coast by the formation of an equatorward jet due to coastal upwelling (Auad et al. 2011). This coastal upwelling of deep, cold, nutrient-rich water subsidizes primary productivity in the form of phytoplankton and benthic macrophytes, thus allowing rich biological communities to flourish both offshore and directly along the coastline of the U.S. West Coast and along the west coast of Mexico's Baja California. The geographic configuration of the SCB results in the formation of a large counter-clockwise eddy landward of the main equatorward flow (Hickey 1992),

generally described as a poleward surface inshore countercurrent along the coast and a poleward undercurrent (California Undercurrent) that flows northward at a depth of approximately 200 m along the continental slope (Dong et al. 2009). Temporal and mesoscale spatial variability due to seasonal changes and local wind forcing result in the weakening and even reversal of the inshore countercurrent during spring upwelling season, yet strengthen poleward flow during summer and into fall (Bray et al. 1999). This circulation pattern coupled with the complex bathymetry of the SCB results in strong abiotic gradients within the SCB. The shallow offshore banks in the southwest portion of the SCB are exposed to the main offshore portion of the equatorward-flowing California Current as well as the poleward-flowing California Undercurrent, depending on depth. When currents interact with the steep and complex bathymetry of seamounts and banks, increased vertical mixing results in turbulent upwelling that brings nutrient-rich deep water near the surface where it boosts both pelagic and benthic communities.

Because of the geological and oceanographic intricacies of this region, the SCB represents a transitional zone between the warm temperate San Diegan fauna and the cool temperate Oregonian fauna, dramatically increasing the overall diversity in the region (Allen and Horn 1978, Pondella et al. 2005). These biogeographic regions are generally described in 2-dimensional space throughout the SCB. Due to the range in depth and location with respect to the California Current, however, the offshore banks support warm water taxa in their extensive shallow reaches and cool water taxa at depth. Layering on the pelagic faunal components creates a vibrant, diverse, and productive ecosystem that is not replicated anywhere else in the region, the state, or the Pacific Northwest (Genin and Boehlert 1985). Furthermore, the considerable distance from the mainland and inhabited islands has provided this area with a partial refuge from the intense commercial and recreational harvest of marine organisms that occurs at shallow water reefs along the mainland and the Channel Islands.

Fish surveys were conducted at Tanner and Cortes Banks between 1997 and 2002 using the manned research submersible Delta to examine rockfish populations (Yoklavich et al. 2007, Love et al. 2009). Yoklavich et al. (2007) found that Tanner and Cortes Banks were the hot spot in terms of total abundance and biomass of Cowcod (*Sebastes levis*) among the major offshore rock banks they surveyed. Cowcod were previously declared as overfished by the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration and estimated to be at 7% of their unfished biomass (Butler et al. 2003). Tanner and Cortes Banks represent important habitat in the SCB for this and other important commercial rockfish species.

The outer banks have long supported valuable economic interests because of their high productivity and access to various habitats. These banks form a potentially strong link between habitat conservation and health of productive and sustainable fisheries. California's ocean economy is the largest in the United States with a total gross state product of 21.4 billion USD in 2000 (Kildow and Colgan 2005). While this economy is strong, there have been marked declines in the fishing industry, and nearly half of its landings by weight are from Southern California (Kildow and Colgan 2005). The offshore banks are also extensively used by scuba charters, commercial passenger fishing vessels (CPFV), commercial fishers, recreational fishers, divers, and most recently surf charters. Considering the curve of the Southern California coastline, the relatively uniform distance to these banks from ports throughout the SCB creates numerous access points for high-value overnight excursions for similar prices (Pendleton and Rooke 2006). As an example of the economic importance of fishing in the region, total expenditures for charter and private boats alone in Southern California have been estimated to average almost 400 million USD annually (Gautam et al. 1996), with a significant amount of this effort focused on the offshore banks.

Considering these factors, we analyzed 29 years (1980–2009, omitting 1985) of spatially explicit commercial and recreational landings data from the SCB (Perry et al. 2010, Zellmer et al. 2018) and examined the hypothesis that the dynamic and productive nature of these seamounts and banks disproportionately supports pelagic fisheries, especially commercial fisheries.

TABLE 1. Top 22 taxa representing 99% of reported catches by recreational fishers by fishing block from 1980 to 2009.

	Fishing block																			
Taxa	852	853	854	855	856	857	870	871	872	873	874	875	888	889	890	891	892	893	897	TOTAL
Sebastes spp.	1438	1675	10,411	37,918	5076	495	3444	58,338	37,733	0	240	156	4295	20,541	17,111	341	857	1830	95,405	297,304
Thunnus alalunga	2613	406	1678	664	112	0	4263	1457	62	355	780	208	4057	1713	688	1159	1424	61	14,336	36,036
Caulolatilus princeps	60	51	14	126	21	54	1420	5240	1513	0	5	0	1973	1484	1413	0	0	75	22,024	35,473
Seriola lalandi	202	67	10	16	5	118	518	4497	575	138	14	0	598	668	768	297	287	147	16,425	25,350
Semicossyphus pulcher	31	1	1	0	221	50	511	2453	591	0	5	3	707	729	445	0	40	73	15,545	21,406
Sarda chiliensis	100	16	0	1	17	83	1110	3106	808	0	1	7	926	647	442	180	175	29	11,965	19,613
Panulirus interruptus	0	0	379	0	0	440	610	0	0	0	0	0	128	0	41	0	0	0	14,284	15,882
Paralabrax clathratus	79	220	15	585	492	1118	1134	2788	968	84	18	57	17	1252	1170	88	164	0	1294	11,543
Scorpaena guttata	20	10	0	1	13	33	458	875	142	0	112	75	394	718	713	4	17	29	7591	11,205
Thunnus albacares	52	0	18	31	0	44	6	2289	46	0	0	0	34	98	627	3	873	72	6865	11,058
Thunnus thynnus	204	24	73	22	0	1	543	1794	223	9	59	25	780	249	148	63	8	12	4552	8789
Scomber japonicus	64	481	0	0	452	0	145	1232	245	34	25	86	0	450	20	294	41	0	1756	5325
Sphyraena argentea	0	10	0	0	44	129	340	773	53	1	0	44	21	2215	72	35	112	0	106	3955
Katsuwonus pelamis	9	0	27	122	0	1	221	1166	48	0	12	0	104	164	93	0	49	8	1746	3770
Sebastes levis	13	18	242	1155	252	33	0	362	388	0	0	0	0	149	292	3	0	0	436	3343
Paralabrax nebulifer	105	201	0	0	636	0	595	260	47	0	18	639	0	172	13	45	109	7	79	2926
Sebastes paucispinis	16	0	0	0	0	0	131	283	2	0	0	0	327	26	0	0	0	37	1932	2754
Prionace glauca	0	0	1	2	0	0	0	1215	1020	0	0	0	0	0	0	0	0	15	0	2253
Medialuna californiensis	0	0	0	0	69	79	77	421	53	0	0	0	27	269	360	0	0	0	844	2199
Ophiodon elongatus	2	2	8	10	0	1	32	142	332	0	0	0	15	58	272	3	0	0	474	1351
Coryphaena hippurus	0	0	65	42	0	6	0	69	1	0	0	13	11	0	26	64	33	2	785	1117
Crassadoma gigantea	0	0	18	0	0	12	1	2	0	0	0	0	0	0	0	0	3	0	647	683
TOTAL	5008	3182	12,960	40,695	7410	2697	15,559	88,762	44,850	621	1289	1313	14,414	31,602	24,714	2579	4192	2397	219,091	52,335

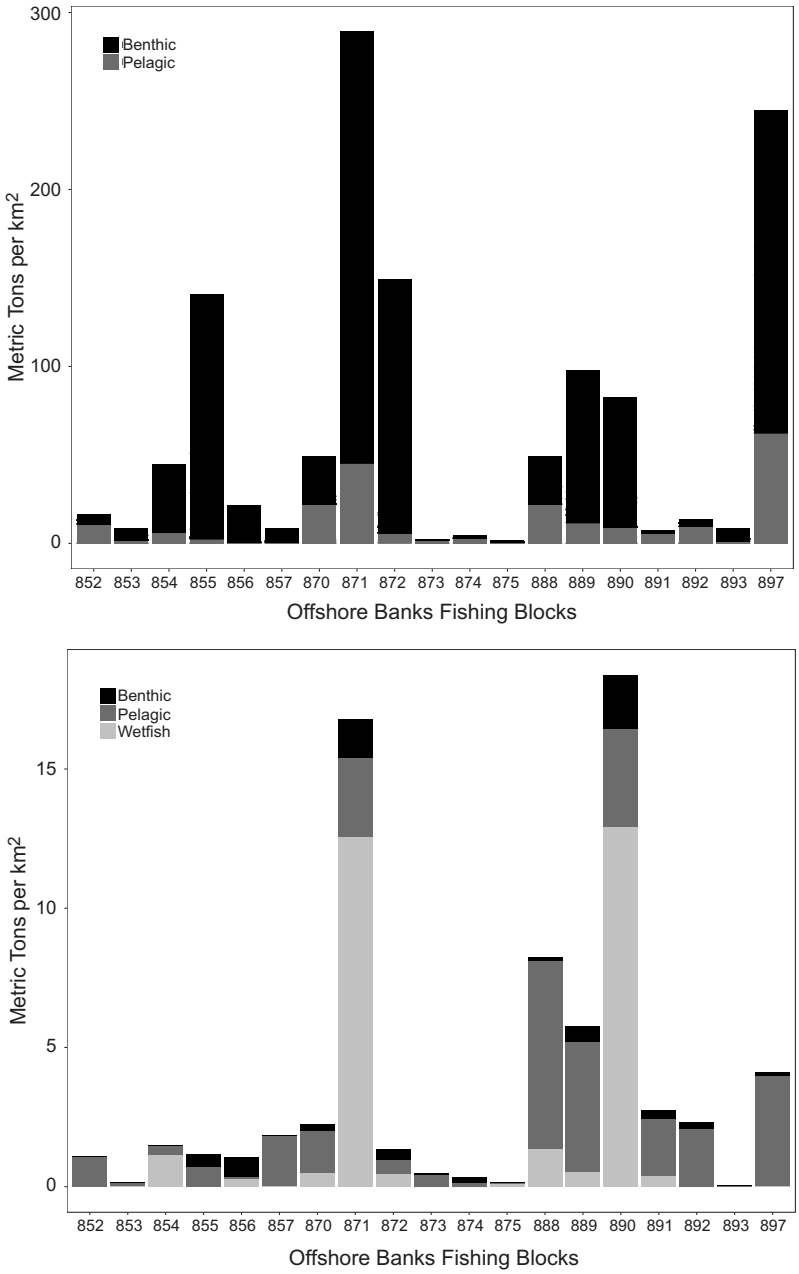

Fig. 2. Top 10 species caught by recreational fishers (top) and commercial fishers (bottom), grouped by associated habitat for each fishing block. Refer to Table 2 for ranks and species included in each group.

METHODS

Commercial and recreational fishing records were downloaded from the Pacific Coast Fisheries GIS Resource Database (Perry et al. 2010). The commercial fisheries data come from monthly tabulations of landing receipts collected by the California Department of Fish and Wildlife between 1972 and 2009 (Perry et al. 2010). The recreational fisheries data cover monthly harvests between 1980 and 2009 recorded in CPFV logbooks (Hill and Schneider 1999, Perry et al. 2010). We limited the data set to the years 1980–2009

Table 2. Top 10 taxa reported in recreational and commercial catches at offshore banks fishing blocks from 1980 to 2009, with habitat association group. MT = metric ton.

Rank	Recreational catch	Individuals per km^2	Group
1	Rockfish spp.	846.87	Benthic
2	Albacore Tuna	91.63	Pelagic
3	Ocean Whitefish	71.89	Benthic
4	Yellowtail	49.80	Pelagic
5	Pacific Bonito	40.24	Pelagic
6	California Sheephead	38.17	Benthic
7	Kelp Bass	37.00	Benthic
8	Yellowfin Tuna	22.41	Pelagic
9	California Spiny Lobster	21.97	Benthic
10	California Scorpionfish	19.91	Benthic
Rank	Commercial catch	MT per km^2	Group
1	Mackerel spp.	28.8898	Wetfish
2	Bluefin Tuna	8.9006	Pelagic
3	Albacore Tuna	7.2417	Pelagic
4	Rockfish spp.	5.8947	Benthic
5	Pacific Bonito	5.7968	Pelagic
6	Skipjack Tuna	4.9031	Pelagic
7	Yellowfin Tuna	3.7839	Pelagic
8	Swordfish	2.0075	Pelagic
9	Northern Anchovy	1.4873	Wetfish
10	Thresher Shark	1.3753	Pelagic

because CPFV data were only reported back to 1980 in the data set. Commercial and recreational data from 1985 were removed because no spatially explicit recreational data were available for that year. The data are all recorded in the California Department of Fish and Wildlife reporting blocks (blocks 643–916, excluding block 650), allowing us to spatially assign catch to the outer banks region (blocks 852–857, 870–875, 888–893, and 897) versus the remaining areas of the SCB. For each species, we tabulated the amount of harvest within spatial blocks encompassing the outer banks for both recreational and commercial fishers and compared these amounts to the other blocks in the SCB. We assessed linear trends in commercial catch over time using simple linear regression. All data were analyzed using R version 3.3.1 (R Core Team 2016).

Results

Recreational fishers target benthic and pelagic taxa on the banks, and these taxa are reported as the number of individuals caught (Appendix 1); the numbers caught within each of 19 fishing blocks from 1980 to 2009 are reported in Table 1. The most numerous group was the rockfishes (*Sebastes* spp.) representing 56.8% of the reported catch. Two species of rockfish, the Cowcod and Boccacio (*S. levis* and *S. paucispinis*) were individually reported while the rest of the species within the genus were recorded together. Rounding out the top 3 taxa are Albacore Tuna (*Thunnus alalunga*) and Ocean Whitefish (*Caulolatilus princeps*). Catches of 11,543 Kelp Bass (*Paralabrax clathratus*), a shallow reef species, were also reported. Pacific Bonito (*Sarda chiliensis*), California Sheephead (*Semicossyphus pulcher*), and Yellowtail (*Seriola lalandi*) represent 12.7% of the reported catch (ranks 4–6). Other important species are California Scorpionfish (*Scorpaena guttata*), Yellowfin Tuna (*Thunnus albacares*), Pacific Mackerel (*Scomber japonicus*), Bluefin Tuna (*Thunnus thynnus*), California Barracuda (*Sphyraena argentea*), and Skipjack (*Katsuwonus pelamis*). Of the remaining taxa, California spiny lobsters (*Panulirus interruptus; n* = 15,882) and rock scallops (*Crassadoma gigantea; n* = 683) were undoubtedly taken by scuba divers. Thus, the recreational fishers were targeting pelagic taxa (tunas and tuna-like fishes), deep reef taxa (e.g., rockfishes, Lingcod, Ocean Whitefish), and shallow reef taxa (e.g., California Sheephead, Kelp Bass, California spiny lobster; Fig. 2, Table 2).

Commercial fishers report their landings using the same fishing blocks, but catches are reported by weight. Of identified taxa, 27,765 metric tons representing 129 taxa were reported taken from the banks during this period (Appendix 2). The greater diversity is because of the multiple types of fishing gear employed (purse seines, hook and line, traps, trawls, longlines, gill nets, etc.), plus many of the rockfishes (*Sebastes* spp.) were recorded by species. The top 96.8% of the catch, comprising 25 taxonomic categories, is reported in Table 3. Commercial fishers targeted wetfish such as Jack Mackerel (*Trachurus symmetricus*), Chub Mackerel (*Scomber japonicus*), Northern Anchovy (*Engraulis mordax*), Pacific Sardine (*Sardinops sagax*), and market squid (*Doryteuthis opalescens*), reporting 6295 metric tons caught. The wetfish landed from this region, however, are only a small fraction (<0.01%) of the catch over the whole bight (Appendix 2). Because purse seines typically catch these species in high volume, a single catch can skew the analysis. Other important pelagic species (Common Thresher [*Alopias vulpinus*], White Seabass [*Atractoscion nobilis*], Opah [*Lampris*

TABLE 3. Top 25 taxa representing 96.8% of reported tonnage of catches by commercial fishers by fishing block from 1980 to 2009.

	Fishing block																			
Taxa	852	853	854	855	856	857	870	871	872	873	874	875	888	889	890	891	892	893	897	TOTAL
Thunnus thynnus	133	8	35	25	0	8	273	186	58	4	0	0	398	492	562	49	0	0	1029	3259
Trachurus symmetricus	0	0	0	0	1	0	0	621	0	0	0	0	31	33	2430	16	0	0	17	3149
Strongylocentrotus franciscanus	15	7	4	1	13	37	20	20	2	42	6	0[a]	3	8	122	12	1	0	210	523
Scomber/Trachurus	0	0	0	0	0	0	30	2502	22	0	0	33	0	0	178	0	0	0	0	2766
Thunnus alalunga	50	7	46	45	6	390	45	38	29	118	19	1	60	50	80	426	465	12	621	2506
Scomber japonicus	4	8	0	0	0	11	109	500	110	0	0	0	349	119	1128	104	0	0	7	2449
Katsuwonus pelamis	102	0	0	120	0	60	16	17	4	0	0	0	285	236	159	35	39	0	1029	2104
Sarda chiliensis	7	0	0	0	0	0	65	478	14	0	0	0	348	476	169	14	0	0	312	1884
Sebastes spp.	6	5	5	181	195	7	64	387	128	10	103	2	29	171	560	93	71	1	111	1768
Thunnus albacares	1	0	0	0	0	2	18	57	31	0	0	0	721	70	41	12	51	0	267	1272
Xiphias gladius	13	13	12	11	16	53	24	47	15	9	17	6	149	33	12	48	48	1	163	689
Alopias vulpinus	4	29	23	8	2	23	17	40	4	1	10	4	121	25	6	48	6	0	82	452
Engraulis mordax	0	0	332	0	84	0	0	0	0	0	0	0	11	0	0	0	0	2	0	429
Anoplopoma fimbria	0	4	8	16	1	44	62	2	2	4	38	0	2	1	1	0	0	0	0	186
Doryteuthis opalescens	0	16	0	0	0	2	52	0	41	0	0	0	62	0	0	0	0	0	2	175
Sebastes melanostomus	0	1	0	33	5	13	0	11	17	5	6	0	9	22	8	0	5	0	13	146
Atractoscion nobilis	1	0	2	0	0	1	1	11	3	0	0	1	1	9	20	0	0	0	93	144
Sebastes paucispinis	0	0	1	19	3	2	0	28	11	0	7	0	2	5	24	4	2	0	4	112
Isurus oxyrinchus	2	2	4	1	1	6	5	5	2	0	2	0	17	6	4	6	2	0	29	97
Lampris guttatus	1	2	1	2	1	6	4	3	1	1	1	0	25	3	2	6	4	0	33	95
Sardinops sagax	0	0	0	0	0	19	31	1	0	0	0	0	0	4	38	0	0	0	0	93
Panulirus interruptus	1	0	1	1	1	2	2	1	1	2	0	1	0	3	23	0	0	0	45	82
Semicossyphus pulcher	0	0	0	1	0	0	0	4	1	0	0	3	0	1	18	0	1	0	43	72
Sebastes levis	0	3	0	5	7	1	2	8	5	0	5	0	1	6	14	4	4	0	4	70
Seriola lalandi	0	0	0	0	0	0	2	2	1	1	1	0	2	3	15	0	0	0	26	53
TOTAL	339	103	473	471	335	687	845	4972	501	198	216	51	2625	1774	5613	878	700	17	4140	24,575

[a]Reported from fishing block 875 was 2395 metric tons of red urchin (*Strongylocentrotus franciscanus*), ranking the species third; however, block 875 ranges from depths of 512 m to 1380 m, clearly suggesting that this catch record was a recording error, so it was removed from the analyses.

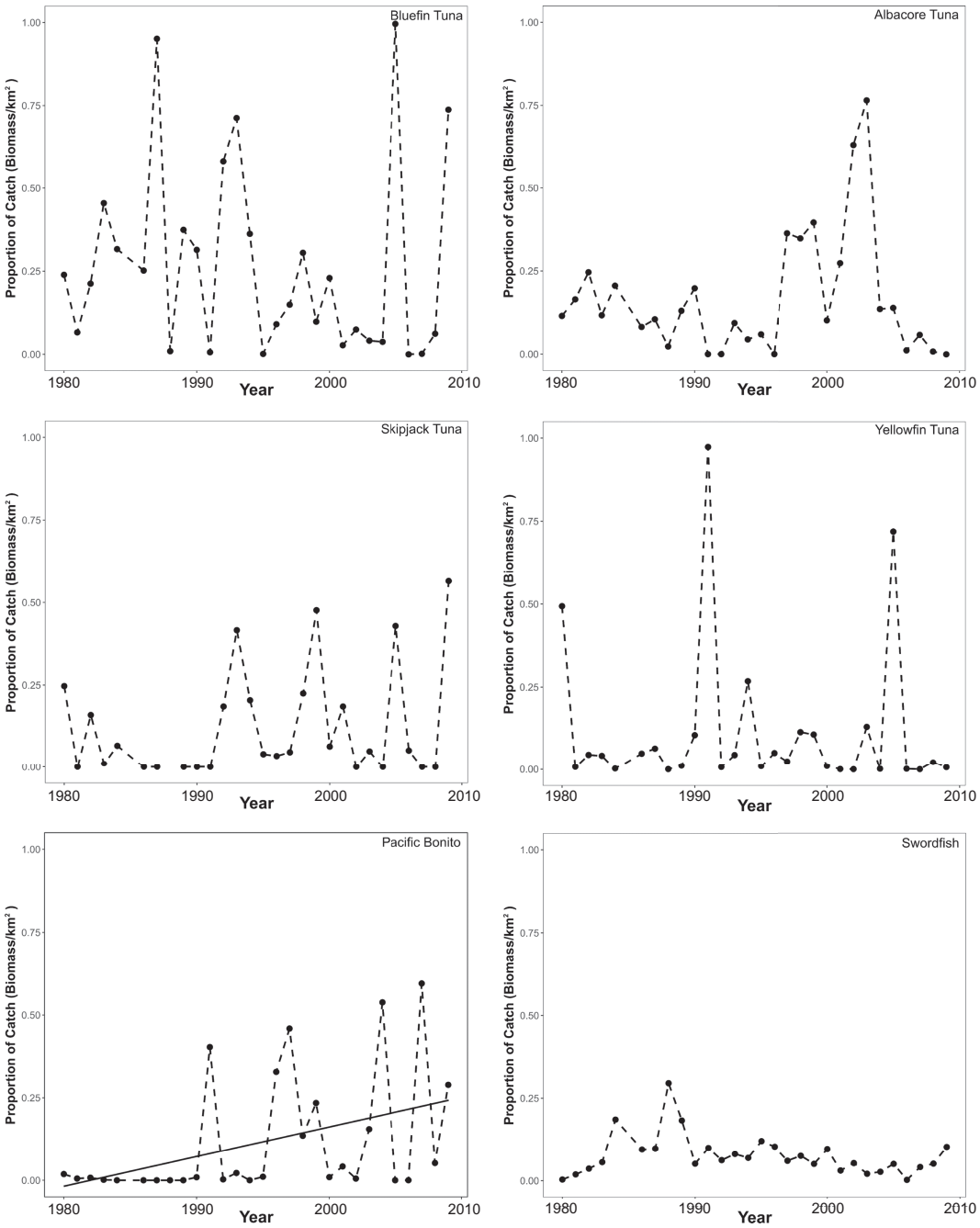

Fig. 3. Proportion of Bluefin Tuna, Albacore Tuna, Skipjack Tuna, Yellowfin Tuna, Pacific Bonito, and Swordfish caught at the Southern California offshore banks. Proportions are relative to the entire catch of the Southern California Bight. There was a significant increase in Pacific Bonito catch over time (Table 2).

guttatus], Shortfin Mako [*Isurus oxyrinchus*], and Bigeye Tuna [*Thunnus obesus*]) were also routinely caught in this region (11.5 metric tons).

The overall composition of the take was not consistent in the recreational fishery (Fig. 2, Table 2). Excluding wetfish, these fisheries

TABLE 4. Mean proportion and 95% CI of commercial catch from 1980 to 2009 at the Southern California offshore banks relative to the entire catch of the Southern California Bight for the individual and combined catch of various tunas and swordfish. Regression analysis (linear trend in catch over time; Fig. 3) statistics are also reported.

Taxa	Mean proportion	95% CI	Regression slope	95% CI	*P*	Adjusted R^2
Bluefin Tuna	0.27	0.16 to 0.37	−0.003	−0.016 to 0.010	0.61	0.03
Albacore Tuna	0.17	0.10 to 0.24	0.002	−0.006 to 0.011	0.51	0.02
Skipjack Tuna	0.12	0.59 to 0.19	0.004	−0.003 to 0.012	0.25	0.013
Yellowfin Tuna	0.11	0.03 to 0.20	−0.002	−0.012 to 0.008	0.69	0.03
Pacific Bonito	0.11	0.05 to 0.18	0.009	0.002 to 0.016	0.02	0.15
Swordfish	0.08	0.05 to 0.10	−0.002	−0.004 to 0.001	0.19	0.03

focused on 6 high-value pelagic taxa. These included the scombrids (Bluefin Tuna, Albacore, Skipjack, Yellowfin Tuna, and Bonito) and Swordfish (Xiphiidae). Relatively high percentages of the entire catch of these 6 taxa were caught at the offshore banks. In multiple years, 75%–100% of the Bluefin Tuna, Yellowfin Tuna, and Albacore caught in Southern California were reported from this region (Fig. 3). During the study period (1980–2009) there was a significant increase in Pacific Bonito catch (Table 4, Fig. 3) and relatively higher catches of Albacore and Skipjack Tuna in the 1990s and 2000s (Fig. 3). The increase in Albacore and Skipjack Tuna, however, was not significant (Table 4). The mean percentage of these species caught during the study period (1980–2009) at the offshore banks relative to the rest of the SCB ranged from 8% (Swordfish) to 27% (Bluefin Tuna), with 16%, on average, of all species being caught at the offshore banks (Table 4). The majority of the catch was from Cortes and Tanner Banks (fishing blocks 870–872, 888–890, and 897) representing 3.7% (2603 km^2 of 69,913 km^2) of the fishing grounds in the SCB.

DISCUSSION

Due to physical oceanographic patterns and geology, the Southern California offshore banks are the template for a unique environment. These seamounts and banks are bathed in the productive forces of the California Current and the Southern California Countercurrent and spatially provide a large proportion of the subtidal habitat in the bight (Emery 1960, Hickey 1992, Pondella et al. 2015). This subtidal habitat supports critical benthic resources, including the giant kelp (*Macrocystis pyrifera*) community, deeper hydrocoral (*Stylaster californicus*) communities, and deep coral habitats (Lewbel et al. 1981, Lissner and Dorsey 1986, Etnoyer and Morgan 2003, Yoklavich et al. 2013). The productivity and the uniqueness of these habitats support a vibrant ecosystem including marine birds, mammals, fishes, and invertebrates that are utilizing both benthic and pelagic resources (Butler et al. 2006, Oleson et al. 2007, Love et al. 2010, Maxwell et al. 2012, Douglas et al. 2014). It is therefore not surprising that the Southern California offshore banks are extensively accessed by recreational and commercial fishers.

Recreational fishers targeted pelagic and coastal pelagic taxa, primarily catching Albacore, Yellowtail, Pacific Bonito, Yellowfin Tuna, and Bluefin Tuna. However, benthic taxa dominated the catch numerically, with a focus on Rockfish, Ocean Whitefish, California Sheephead, Spiny Lobster, and Kelp Bass. Sportfishers typically target high-value pelagics at these offshore areas, but the greater landing numbers of benthic fishes indicate their availability; considering the distance from port (Zellmer et al. 2018), these taxa were likely targeted as alternatives when pelagic species were not being caught. Critical populations of Cowcod and Boccacio were historically targeted in this region by both commercial and recreational fishers (Butler et al. 2003, Yoklavich et al. 2007). Dive charters were also a significant component of these landings. Benthic resources such as spiny lobster and rock scallops, which can only be taken by divers, were clear indications of utilization by this sector. The bulk of the recreational fishery in Southern California is based on the mainland due to the proximity to port (Zellmer et al. 2018). Thus, the recreational catch at these banks and seamounts is comparatively low to the mainland catch, although multiday charters to this region represent a high commercial value to the local industry.

The utilization of this region by commercial fishers was more dramatic. Commercial fishers successfully targeted high-value pelagic fisheries with relatively lower take of benthic resources (Table 3). It should be noted that the Cowcod Conservation Area has limited the catch of benthic resources at a depth >20 fathoms (36.6 m) since 2001. The other significant fishery regulation change was the closure of the abalone (*Haliotis* spp.) fishery in 1997.

Conclusion

Based upon our review of the biological and physical data, the outer banks represent a unique set of habitats in the SCB. These environs support high-value recreational and commercial fishing interests. Specifically, this area is critical for commercial fisheries where pelagics (e.g., Bluefin Tuna, Albacore, Skipjack, Yellowfin Tuna, Pacific Bonito, Swordfish) were the most important taxa and represented a substantial proportion of the landings of these commercial pelagic fishes in the SCB. When comparing the surface area of fishable habitat relative to the rest of the bight, a disproportionate amount of these pelagic taxa were landed at Cortes and Tanner Banks. Because of their geography, physical oceanography, biology, and landings from recreational and commercial fisheries, these offshore banks compose a unique habitat in the region.

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APPENDIX 1. Recreationally caught taxa from offshore banks from 1980 to 2009 (excluding 1985). SCB = Southern California Bight. No. ind. = number of individuals.

Phylum	Class	Order	Family	Scientific name	Common name	No. ind. (Banks)	No. ind. (SCB)
Mollusca	Bivalvia	Ostreoida	Pectinidae	*Crassadoma gigantea*	rock scallop	683	188,295
	Gastropoda	Vetigastropoda	Haliotidae	*Haliotis corrugata*	pink abalone	38	319
				Haliotis fulgens	green abalone	10	1148
				Haliotis rufescens	red abalone	10	8332
	Cephalopoda	Teuthida	Ommastrephidae	*Dosidicus gigas*	Humboldt squid	28	460,637
		Octopoda	Octopodidae		unspecified octopus	10	885
Arthropoda	Malacostraca	Decapoda	Palinuridae	*Panulirus interruptus*	California spiny lobster	15,882	132,286
Chordata					unspecified fish	38	0
	Chondrichthyes				unspecified shark	9	783
		Lamniformes	Alopiidae	*Alopias vulpinus*	Common Thresher Shark	1	574
			Lamnidae	*Isurus oxyrinchus*	Shortfin Mako	51	4116
		Carcharhiniformes	Triakidae	*Galeorhinus galeus*	Tope	1	1500
			Carcharhinidae	*Prionace glauca*	Blue Shark	2253	19,261
		Rajiformes			unspecified ray	27	518
			Rhinobatidae	*Rhinobatos productus*	Shovelnose Guitarfish	8	690
	Actinopterygii	Anguilliformes	Muraenidae	*Gymnothorax mordax*	California Moray	1	81
		Scorpaeniformes	Scorpaenidae	*Scorpaena guttata*	California Scorpionfish	11,205	3,378,297
				Sebastes carnatus	Gopher Rockfish	62	30,018
				Sebastes caurinus	Copper Rockfish	187	152,624
				Sebastes flavidus	Yellowtail Rockfish	5	1490
				Sebastes goodei	Chilipepper	13	549
				Sebastes levis	Cowcod	3343	29,149
				Sebastes mystinus	Blue Rockfish	263	153,825
				Sebastes paucispinis	Bocaccio	2754	256,109
				Sebastes ruberrimus	Yelloweye Rockfish	2	3356
				Sebastes spp.	unspecified rockfish	297,376	17,336,556
			Anoplopomatidae	*Anoplopoma fimbria*	Sablefish	100	2722
			Hexagrammidae	*Ophiodon elongatus*	Lingcod	1351	200,533
			Cottidae	*Scorpaenichthys marmoratus*	Cabezon	388	42,551

APPENDIX 1. Continued.

Phylum	Class	Order	Family	Scientific name	Common name	No. ind. (Banks)	No. ind. (SCB)
Chordata	Actinopterygii	Perciformes	Polyprionidae	*Stereolepis gigas*	Giant Sea Bass	2	1166
			Epinephelidae		unspecified grouper	23	2205
			Serranidae	*Paralabrax clathratus*	Kelp Bass	11,543	8,655,998
				Paralabrax maculatofasciatus	Spotted Sand Bass	7	2104
				Paralabrax nebulifer	Barred Sand Bass	2926	10,927,991
			Malacanthidae	*Caulolatilus princeps*	Ocean Whitefish	35,473	1,959,032
			Carangidae	*Seriola lalandi*	Yellowtail Jack	25,350	1,197,707
				Trachurus symmetricus	Jack Mackerel	609	79,751
			Coryphaenidae	*Coryphaena hippurus*	Dolphinfish	1117	41,170
			Haemulidae	*Anisotremus davidsonii*	Sargo	48	24,596
			Sciaenidae	*Atractoscion nobilis*	White Seabass	167	104,113
				Genyonemus lineatus	White Croaker	228	343,173
				Umbrina roncador	Yellowfin Croaker	8	20,635
			Kyphosidae	*Girella nigricans*	Opaleye	9	27,575
				Medialuna californiensis	Halfmoon	2199	1,519,747
			Embiotocidae		unspecified surfperch	104	30,475
				Embiotoca jacksoni	Black Perch	1	3156
				Rhacochilus toxotes	Rubberlip Seaperch	4	1798
			Labridae	*Semicossyphus pulcher*	California Sheephead	21,406	885,904
			Sphyraenidae	*Sphyraena argentea*	Pacific Barracuda	3955	5,274,565
			Scombridae		unspecified tuna	3	288
				Katsuwonus pelamis	Skipjack Tuna	3770	148,715
				Sarda chiliensis	Pacific Bonito	19,613	5,225,758
				Scomber japonicus	Pacific Chub Mackerel	5325	9,574,229
				Thunnus alalunga	Albacore	36,036	293,738
				Thunnus albacares	Yellowfin Tuna	11,058	156,653
				Thunnus obesus	Bigeye Tuna	47	966
				Thunnus thynnus	Bluefin Tuna	8789	34,090
			Istiophoridae	*Kajikia audax*	Striped Marlin	3	441
		Pleuronectiformes	Paralichthyidae	*Paralichthys californicus*	California Halibut	103	154,671
				Citharichthys spp.	unspecified sanddab	10	819,840
			Pleuronectidae		unspecified righteye flounder	247	152
				Pleuronectes bilineatus	Rock Sole	3	975

APPENDIX 2. Commercially caught taxa from offshore banks from 1980 to 2009 (excluding 1985) in metric tons (MT). SCB = Southern California Bight.

Phylum	Class	Order	Family	Scientific name	Common name	MT (Banks)	MT (SCB)
Polychaeta					unspecified worm	0.53	2.82
Mollusca	Gastropoda				unspecified snail	0.01	201.88
		Vetigastropoda	Haliotidae	*Haliotis corrugata*	pink abalone	5.40	251.54
				Haliotis cracherodii	black abalone	20.84	1329
				Haliotis fulgens	green abalone	5.66	187.90
				Haliotis rufescens	red abalone	4.74	1372
				Haliotis sorenseni	white abalone	0.18	1.61
				Haliotis spp.	unspecified abalone	0.03	2.16
		Neogastropoda	Buccinidae	*Kelletia kelletii*	Kellet's whelk	0.25	585.12
	Cephalopoda	Teuthida	Loliginidae	*Doyrteuthis opalescens*	market squid	175.05	929,372
			Ommastrephidae	*Dosidicus gigas*	Humboldt squid	0.15	27.15
		Octopoda	Octopodidae		unspecified octopus	0.04	17.00
Arthropoda	Malacostraca	Decapoda	Callianassidae	*Neotrypaea californiensis*	pink ghost shrimp	0.23	18.83
			Brachyura[a]	*Metacarcinus magister*	Dungeness crab	0.66	106.02
				Cancer productus	red rock crab	0.08	312.59
					unspecified crab claws	30.09	19,098
			Crangonidae		unspecified shrimp	0.14	1.02
			Sicyoniidae	*Sicyonia ingentis*	ridgeback prawn	2.84	3,779
			Lithodidae	*Lopholithodes foraminatus*	brown box crab	0.22	12.90
			Epialtidae	*Loxorhynchus* spp.	spider crabs	0.37	765.30
			Pandalidae	*Pandalus jordani*	pink ocean shrimp	0.00	185.13
				Pandalus platyceros	spot prawn	35.11	1723
			Palinuridae	*Panulirus interruptus*	California spiny lobster	82.50	7112
Echinodermata	Echinoidea	Echinoida	Strongylocentrotidae	*Strongylocentrotus franciscanus*	red sea urchin	522	166,206[b]
				Strongylocentrotus purpuratus	purple sea urchin	7.49	271.09
	Holothuroidea				unspecified sea cucumber	5.14	3225
		Aspidochirotida	Stichopodidae	*Parastichopus parvimensis*	warty sea cucumber	0.76	1166
Chordata					unspecified fish	31.87	442.73
	Myxini	Myxiniformes	Myxinidae	*Eptatretus* spp.	unspecified hagfish	0.51	1079
	Chondrichthyes				unspecified shark	6.93	801.22
		Heterodontiformes	Heterodontidae	*Heterodontus francisci*	Horn Shark	0.01	7.82
		Lamniformes	Alopiidae	*Alopias pelagicus*	Pelagic Thresher	2.73	38.43
				Alopias superciliosus	Bigeye Thresher	10.06	177.39
				Alopias vulpinus	Common Thresher Shark	451.89	5666
			Lamnidae	*Isurus oxyrinchus*	Shortfin Mako	97.02	1608
		Carcharhiniformes	Triakidae	*Galeorhinus galeus*	Tope	18.20	789.51
				Mustelus henlei	Brown Smoothhound	1.53	41.75
				Triakis semifasciata	Leopard Shark	1.82	171.02
			Carcharhinidae	*Prionace glauca*	Blue Shark	0.94	224.11

APPENDIX 2. Continued.

Phylum	Class	Order	Family	Scientific name	Common name	MT (Banks)	MT (SCB)
Chordata	Chondrichthyes	Carcharhiniformes	Sphyrnidae	*Sphyrna zygaena*	Smooth Hammerhead	0.83	24.61
		Hexanchiformes	Hexanchidae		unspecified cow shark	0.24	0.26
				Hexanchus griseus	Bluntnose Sixgill Shark	0.04	0.18
		Squaliformes	Squalidae	*Squalus acanthias*	Spiny Dogfish	1.04	127.77
		Squatiniformes	Squatinidae	*Squatina californica*	Pacific Angel Shark	1.41	815.49
		Rajiformes			unspecified ray	0.04	10.92
			Rhinobatidae	*Rhinobatos productus*	Shovelnose Guitarfish	0.15	186.38
			Rajidae		unspecified skate	0.30	151.32
	Actinopterygii	Anguilliformes	Muraenidae	*Gymnothorax mordax*	California Moray	0.20	24.83
		Clupeiformes	Engraulidae	*Engraulis mordax*	Northern Anchovy	428.63	171,891
			Clupeidae	*Clupea pallasii (roe)*	Pacific Herring roe	0.25	6.83
				Sardinops sagax	Pacific Sardine	93.18	507,239
		Salmoniformes	Salmonidae	*Oncorhynchus tshawytscha*	Chinook Salmon	0.14	251.54
		Lampriformes	Lampridae	*Lampris guttatus*	Opah	94.56	940.22
		Gadiformes	Merlucciidae	*Merluccius productus*	Pacific Hake	0.01	12.38
		Mugiliformes	Mugilidae	*Mugil cephalus*	Striped Mullet	0.25	118.35
		Scorpaeniformes	Scorpaenidae	*Scorpaena guttata*	California Scorpionfish	5.29	507.47
				Sebastes atrovirens	Kelp Rockfish	0.00	1.77
				Sebastes auriculatus	Brown Rockfish	3.54	38.35
				Sebastes aurora	Aurora Rockfish	0.00	3.37
				Sebastes carnatus	Gopher Rockfish	1.27	62.65
				Sebastes caurinus	Copper Rockfish	3.06	52.84
				Sebastes chrysomelas	Black-and-yellow Rockfish	0.52	1.55
				Sebastes constellatus	Starry Rockfish	17.00	34.04
				Sebastes diploproa	Splitnose Rockfish	3.65	46.05
				Sebastes elongatus	Greenstriped Rockfish	0.05	4.34
				Sebastes entomelas	Widow Rockfish	2.10	55.30
				Sebastes flavidus	Yellowtail Rockfish	2.26	15.13
				Sebastes levis	Cowcod	70.47	328.99
				Sebastes melanops	Black Rockfish	0.37	6.21
				Sebastes melanostomus	Blackgill Rockfish	146.08	1420
				Sebastes miniatus	Vermilion Rockfish	1.89	53.37
				Sebastes nebulosus	China Rockfish	0.31	1.10
				Sebastes paucispinis	Bocaccio	111.52	1981
				Sebastes goodei	Chilipepper	9.84	112.61
				Sebastes paucispinis/goodei	Bocaccio/Chilipepper	187.77	1250
				Sebastes pinniger	Canary Rockfish	0.47	2.00
				Sebastes rastrelliger	Grass Rockfish	0.18	108.45
				Sebastes rosaceus	Rosy Rockfish	0.24	1.19
				Sebastes ruberrimus	Yelloweye Rockfish	20.30	120.96

Appendix 2. Continued.

Phylum	Class	Order	Family	Scientific name	Common name	MT (Banks)	MT (SCB)
Chordata	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastes rufus*	Bank Rockfish	1.30	21.81
				Sebastes serriceps	Treefish	0.21	3.95
				Sebastes spp.	unspecified rockfish	1938	11,135
				Sebastolobus alascanus	Shortspine Thornyhead	1.20	1082
				Sebastolobus altivelis	Longspine Thornyhead	0.83	210.91
				Sebastolobus spp.	unspecified thornyhead	1.13	445.33
			Anoplopomatidae	*Anoplopoma fimbria*	Sablefish	186.42	6310
			Hexagrammidae	*Ophiodon elongatus*	Lingcod	17.46	190.21
			Cottidae	*Leptocottus armatus*	Pacific Staghorn Sculpin	0.02	4.62
				Scorpaenichthys marmoratus	Cabezon	2.15	147.89
		Perciformes	Polyprionidae	*Stereolepis gigas*	Giant Sea Bass	4.71	63.39
			Epinephelidae		unspecified grouper	1.22	32.01
				Epinephelus analogus	Spotted Cabrilla	0.02	0.46
			Malacanthidae	*Caulolatilus princeps*	Ocean Whitefish	14.28	103.35
			Carangidae	*Seriola lalandi*	Yellowtail Jack	52.84	572.59
				Trachurus symmetricus	Jack Mackerel	3,149	90,113
			Coryphaenidae	*Coryphaena hippurus*	Dolphinfish	0.36	12.88
			Bramidae	*Brama japonica*	Pacific Pomfret	0.01	2.59
			Sciaenidae	*Atractoscion nobilis*	White Seabass	144.17	2233
				Genyonemus lineatus	White Croaker	2.87	2896
			Kyphosidae	*Medialuna californiensis*	Halfmoon	0.05	13.94
			Embiotocidae		unspecified surfperch	51.45	195.69
				Amphistichus argenteus	Barred Surfperch	0.02	1.15
			Pomacentridae	*Chromis punctipinnis*	Blacksmith	0.06	10.59
			Labridae	*Semicossyphus pulcher*	California Sheephead	71.51	1225

Appendix 2. Continued.

Phylum	Class	Order	Family	Scientific name	Common name	MT (Banks)	MT (SCB)
Chordata	Actinopterygii	Perciformes	Luvaridae	*Luvarus imperialis*	Louvar	3.89	29.88
			Sphyraenidae	*Sphyraena argentea*	Pacific Barracuda	0.63	1460
			Scombridae	*Acanthocybium solandri*	Wahoo	1.08	24.14
				Auxis rochei	Bullet Mackerel	0.11	143.96
				Euthynnus lineatus	Black Skipjack	0.22	206.35
				Katsuwonus pelamis	Skipjack Tuna	2103	56,483
				Sarda chiliensis	Pacific Bonito	1883	27,245
				Scomber japonicus	Pacific Chub Mackerel	2449	248,726
				Scomber/Trachurus	unspecified mackerel	2766	59,980
				Thunnus alalunga	Albacore	2506	14,485
				Thunnus albacares	Yellowfin Tuna	1272	57,855
				Thunnus obesus	Bigeye Tuna	11.52	384.64
				Thunnus thynnus	Bluefin Tuna	3259	13,211
				Thunnus spp.	unspecified tuna	30.60	1023
			Xiphiidae	*Xiphias gladius*	Swordfish	689.04	8,906
			Stromateidae	*Peprilus simillimus*	Pacific Pompano	0.05	98.11
		Pleuronectiformes			unspecified flatfish	2.32	317.91
			Paralichthyidae	*Paralichthys californicus*	California Halibut	10.65	4183
				Citharichthys spp.	unspecified sanddab	0.58	95.97
			Pleuronectidae		unspecified righteye flounder	0.05	5.59
				Eopsetta jordani	Petrale Sole	0.26	49.17
				Parophrys vetulus	English Sole	0.01	34.74
				Platichthys stellatus	Starry Flounder	2.16	3.06

[a]Infraorder

[b]2395 metric tons of red urchin (*Strongylocentrotus franciscanus*) were reported from fishing block 875, but this block ranges from depths of 512–1380 m, suggesting this result is a clear recording error and subsequently removed from the banks total and added to the SCB total.