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Fishes of Marine Protected Areas Near La Jolla, California

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Abstract.—The marine waters surrounding La Jolla, California have a diverse array of habitats and include several marine protected areas (MPAs). We compiled a list of the fish species occurring in the vicinity based on records of specimens archived in the Marine Vertebrate Collection (MVC) of the Scripps Institution of Oceanography (SIO). Collection of fishes from La Jolla in the MVC started in 1905, but greatly accelerated in 1944 when Carl L. Hubbs moved to SIO. By 1964, 90% of the 265 species recorded from the area had been collected and archived in the MVC. The fishes of La Jolla are dominated by species whose center of distribution is north of Point Conception (111 species), or between there and Punta Eugenia (96), with fewer species with southern distributions (57), and one exotic species. Reflecting the diversity of habitats in the area, soft-substrate species number 135, pelagic species 63, canyon-dwelling species 123 (including 35 rockfish species of the genus *Sebastes*), and hard-bottom species 140. We quantified the abundance of the latter group between 2002 and 2005 by counting visible fishes in transects along the rocky coastline of La Jolla, both within and adjacent to one of the region's MPAs. In 500 transects, we counted over 90,000 fishes representing 51 species. The fish communities inside and outside of the MPA were similar and, typical of southern California kelp forests, numerically dominated by Blacksmith, *Chromis punctipinnis* (Pomacentridae), and Señorita, *Oxyjulis californica* (Labridae). Natural history collections such as the MVC are important resources for conservation biology for determining the faunal composition of MPAs and surrounding habitats, and documenting both the disappearance and invasion of species.

The coastal environment in and around La Jolla, San Diego County, California is notable for its complex and diverse array of habitats within a relatively small area. These include kelp forests, rocky reefs, rocky intertidal, sandy beaches, sand and mud subtidal areas, eelgrass and surf-grass stands, pier pilings, and submarine canyons, as well as the pelagic environment. Because of the proximity of the La Jolla and Scripps submarine canyons, depths range to over 500 meters within less than 7 km of the coastline. These diverse habitats support a rich marine community, which has served as the focus of a

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variety of scientific investigations (e.g., Limbaugh 1955; Quast 1968; Craig et al. 2004; Brueggeman 2008).

The nearshore environment of La Jolla is especially important within the context of marine conservation because it houses a network of marine protected areas (MPAs) of varying size and age and with varying levels of use restrictions (Fig. 1). Historically, the first of these was the San Diego Marine Life Refuge established in 1957, which included the Scripps Coastal Reserve, a part of the University of California Natural Reserve system (McArdle 1997). Directly to the south is the San Diego-La Jolla Ecological Reserve (SDLJER), a small no-take reserve on the northern end of the La Jolla rocky coastline that was established in 1971. The San Diego-La Jolla Ecological Reserve Areas of Special Biological Significance was established in 1974 and largely overlapped the SDLJER (McArdle 1997). Recently the SDLJER was included in the Matlahuayl State Marine Reserve (CDFG 2013). In addition, the area on the southern part of the La Jolla peninsula was recently designated as the South La Jolla State Marine Reserve, and an area directly west of that was designated as the South La Jolla State Marine Conservation Area (CDFG 2013). These MPAs have a variety of use restrictions, but all recognize and seek to protect the biodiversity of this ecologically important region.

This study documents the fish fauna in and around this series of marine protected areas. The primary source of information on fishes occurring in the La Jolla area was the Scripps Institution of Oceanography's Marine Vertebrate Collection (MVC). The important roles of natural history collections such as the MVC to conservation biology have been widely documented (Allman 1994; Pyke and Ehrlich 2010; Drew 2011). These include compiling biotic inventories, documenting the loss or degradation of habitats and associated biota, documenting changes in the distribution and occurrence of native species, and documenting species invasions. In addition to compiling an inventory of fish species collected in the area and archived in the MVC, we report on diver surveys of the abundance and diversity of fishes in kelp forests, one of the most prominent habitats in the area, in and around the SDLJER (now the Matlahuayl State Marine Reserve) from 2002 to 2005.

Brief History of Fish Collecting in the La Jolla Area

The marine fishes of California have been studied for many decades and are well-known (Miller and Lea 1972, 1976; Hubbs et al. 1979; Love et al. 2005; Allen et al. 2006) with at least 519 species known from state waters (Horn et al. 2006). In addition to early collections of fishes from the San Diego area reported by Jordan and Gilbert (1880, 1881), the study of fishes in the San Diego region of southern California was begun in earnest with the *Albatross* surveys (Moring 1999) as reported by C.H. Gilbert (1890, 1896, 1915), as well as inventories by Eigenmann and Eigenmann (1890) and Eigenmann (1892).

The establishment of the Scripps Institution of Oceanography (SIO) in the San Diego region in 1903 and its subsequent move to La Jolla in 1905 marked a significant increase in the study of the region's biota (Hastings and Rosenblatt 2003). The on-site aquarium displayed many of the common shallow-water fish species of the area. In 1918, Percy S. Barnhart (Fig. 2A) was appointed as Collector and Curator of the Aquarium, and in 1926, Barnhart was elevated to the position of Curator of the Biological Collections, a position he held until 1948. Barnhart studied the local fishes leading to a publication on the fishes of southern California (Barnhart 1936), and he assembled a small collection of preserved specimens from the region that ultimately formed the basis of the SIO Marine Vertebrate Collection (MVC).

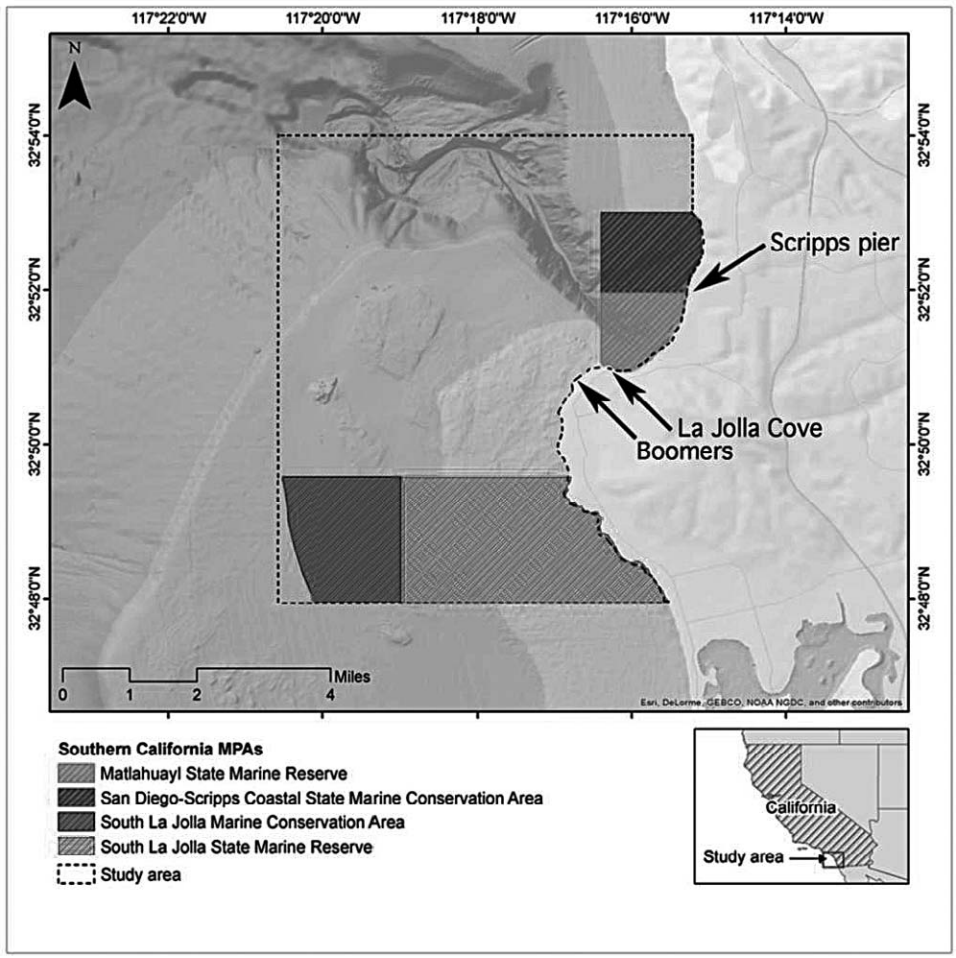

Fig. 1. Map of study area with MPAs designated. Kelp forest fishes were surveyed at La Jolla Cove and Boomers.

Knowledge of the ichthyofauna of the region greatly increased after 1944 when Carl L. Hubbs (Fig. 2B) moved to SIO and began actively archiving collections of fishes in the MVC. In negotiations regarding his forthcoming move from the University of Michigan to SIO, Hubbs wrote to then SIO Director Harald Sverdrup:

> ''I would no doubt want to put considerable emphasis on systematic and variational studies of west coast marine fishes, particularly those in which speciation would be correlated with oceanographical (sic) conditions…I would no doubt be interested in exploratory work, for instance with the fauna of the deep basins off the southern California coast. I will probably be interested too in detailed analyses of the distribution of fishes along the entire west coast, again as correlated with the oceanographic conditions.'' (Shor et al. 1987, pp. 226-227).

Before his arrival in October 1944, Hubbs convinced Sverdrup to invest in facilities to store his anticipated collection of fishes, leading to the ultimate establishment of the

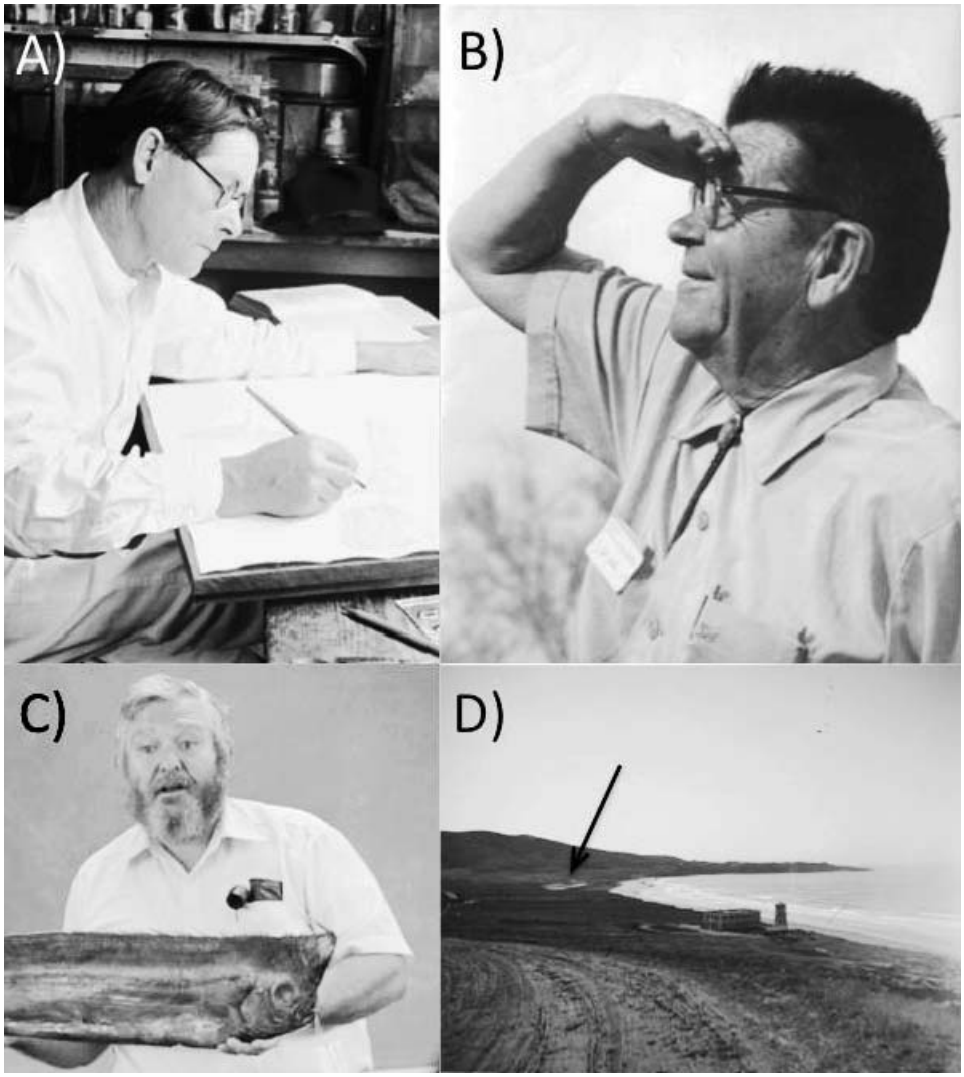

Fig. 2. Photos of A) Percy S. Barnhart, 1935; B) Carl L. Hubbs, 1973; C) Richard H. Rosenblatt, 1979; D) a view of La Jolla Shores and La Jolla peninsula looking southward from the SIO campus, circa 1910 (arrow indicates small embayment at La Jolla Shores). All images are from the Scripps Institution of Oceanography Archives, UC San Diego Library.

MVC (Shor et al. 1987). Hubbs wasted little time in collecting fishes from the surroundings of the SIO campus, amassing over 200 collections in his first year and over 500 by the end of the decade (Fig. 3).

Hubbs had another California project in mind when considering the move to La Jolla. In 1944 he wrote to W. I. Follett in Oakland, with whom he had been corresponding for a decade:

> "I look forward particularly to cooperating with you in making better known the California fish fauna. I no doubt will have new material published from time to time on the systematics and biology of the fishes but will definitely hope that you will

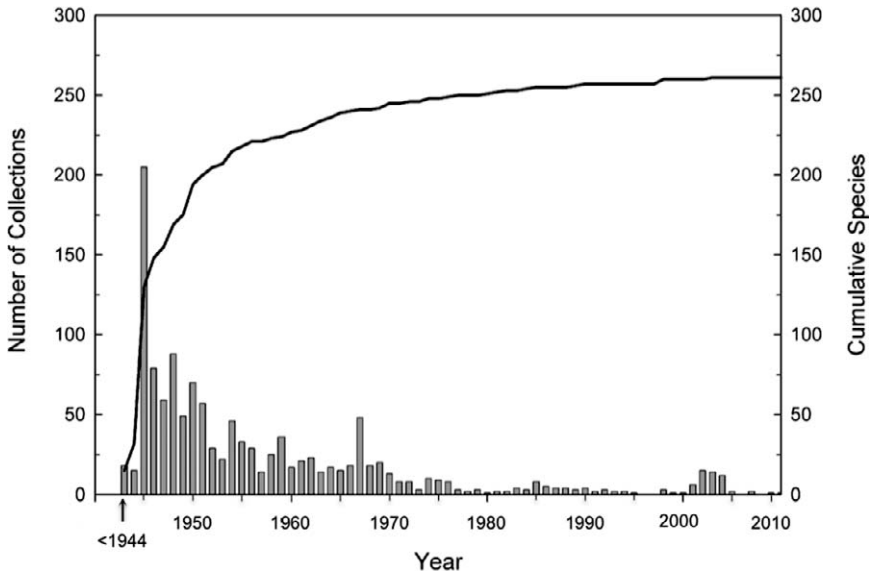

Fig. 3. Number of collections of fishes made within the study area and archived in the SIO Marine Vertebrate Collection by year (bars) and cumulative number of species recorded from those collections within the study area (line).

> maintain your plan to work toward a 'Fishes of California.' It will be a pleasure to make records and other information available for your project." (Shor et al. 1987, p. 227).

That project was published shortly after Hubb's death in 1979 (Hubbs et al. 1979).

In 1958, Professor and Curator Richard H. Rosenblatt (Fig. 2C) was hired to oversee the growing collection of fishes at SIO. He and other researchers and students at SIO actively collected fishes in and around the La Jolla region. By the end of 1969, over 1,000 collections and well over 3,000 lots of fishes from La Jolla had been archived in the MVC (Fig. 3). Local collecting of fishes declined after that time due to diverging research interests, and constraints of space in the MVC for storage of specimens. Since that time, the MVC has archived specimens of fishes from the La Jolla region primarily when new or unusual specimens become available, specimens from focused efforts associated with faunal inventories of the area (e.g., Craig et al., 2004; Craig and Pondella, 2006), and voucher specimens for the growing MVC tissue collection, established by H.J. Walker in 1993 (Hastings and Burton, 2008).

Materials and Methods

We compiled a list of fishes recorded from La Jolla, California based on specimens collected and archived in the MVC of the Scripps Institution of Oceanography, University of California San Diego (Table 1). We included all species collected less than 10 km from shore (east of 117°20.5′ W longitude) and from Torrey Pines State Beach southward to Tourmaline Beach (32°54′ N - 32°48′ N latitude). This area includes the entire rocky headland of La Jolla, as well as the primary conservation areas in the vicinity (Fig. 1). These include the San Diego-Scripps Coastal State Marine Conservation Area, the Matlahuayl State Marine Reserve, the South La Jolla State Marine Reserve and Marine Conservation Area (CDFG 2013).

While some collections date to the early 1900s and a few were made in recent years, most were made between 1944 and 1969 (Fig. 3). Archived specimens were collected using a wide variety of sampling methods and were taken from the beach or ocean surface to depths of over 500 meters. Species are listed in Table 1 arranged in taxonomic order. Common names of families and species follow those recognized by the American Fisheries Society (Page et al. 2013). Brief information on habitat or habitats occupied and special occurrences is provided for each species. Habitat type was divided into three categories as follows: *H = hard substrates*, including rocky reef, rocky intertidal, kelp forest, sides of pier pilings, boulders or any other type of hard substrate; *S = soft bottom*, including sand, mud, eelgrass and surfgrass; *P = pelagic,* including species that always swim well above the bottom, as well as those that periodically or regularly swim several meters above the bottom. Also indicated in Table 1 are the species collected in the La Jolla and Scripps Canyons from > 30 meters depth *(= Cn)*, and the species observed in transects conducted in and adjacent to the SDLJER (= *Tr*) between 2002 and 2005 (see below).

Frequency of occurrence is based on the number of lots (occurrences) of each species that have been archived in the MVC that were collected within the designated area, regardless of the abundance of the species. Common (*C*) species are those represented by eleven or more collections, uncommon (*U*) species were collected in the study area from three to ten times, and rare (*R*) species were collected only once or twice in the La Jolla study area. In a few cases, species that are known by us or reported by others to be more common in the study area than indicated by collection records are indicated with an asterisk (*). The biogeographic distribution of each species was designated based on the mid-point of the entire known range of the species. Range endpoints are from Horn et al. (2006), supplemented as needed based on published distribution records (e.g., Love et al. 2005). Southern species (*S*) are those whose range midpoint is south of Punta Eugenia on the outer coast of Baja California (27°50′ N), northern species (*N*) have range midpoints north of Point Conception (34°27′ N), and central species (*C*) have range midpoints between these well-established biogeographic barriers (Brusca and Wallerstein 1979; Horn et al. 2006).

Between 2002 and 2005, the abundance of fishes associated with kelp forests was visually surveyed at La Jolla Cove (within the SDLJER, now called the Matlahuayl State Marine Reserve) and an adjacent site (Boomers) a short distance beyond the reserve boundary (Fig. 1). Both sites have moderate relief rocky reefs (1-3 m high) scattered throughout the area and are dominated by red algal turf reefs and kelp forests (Parnell et al. 2005, 2006). Survey protocols were modeled after established techniques for assessing abundance and density of conspicuous fishes (McCormick and Choat 1987; Pondella et al. 2005). Randomly selected, quantitative belt transects were swum by two SCUBA divers for a period of 5 minutes over a distance of 50 m. All fishes (excluding pelagic species) observed within a two-meter window (i.e., one meter on either side of the diver and one meter above and below) along the transect were identified to species where possible, and the number of individuals was counted by each diver. If counts from the divers differed, the average was recorded. Each transect accounted for 100 m^2 of bottom area surveyed. Three replicate transects were conducted along rocky reef substrates at each of four depths (3 m, 6 m, 9 m, and 12 m) for a total of twelve transects at each site per survey period. Surveys were conducted every two months for a total of six periods per year between January 2002 and December 2005. At certain periods throughout the study, persistent foul weather prevented full surveys at each sample site, especially for the shallowest depth contours. However, at least six transects were conducted at every site during each sample period throughout the study except for July/August 2004 when continuous high surf precluded surveys at Boomers.

Table 1. List of fishes collected from La Jolla, California, and deposited in the SIO Marine Vertebrate Collection. Date = year of first MVC record from study area. Oc = frequency of occurrence in MVC collections from study area: C = common, 11 or more records; U = uncommon, 3 to 10 records; R = rare, 1 to 2 records; * indicates species known to be more common in the study area than collection records indicate (see text). Habitat (Hab) categories: H = hard bottom (reefs, etc); P = pelagic; S = soft bottom. "x" under Cn and Tr indicate, respectively, collection records for La Jolla or Scripps Canyons at > 30 meters depth, and occurrence in kelp forest transects in and around the Matlahuayl State Marine Reserve (formerly San Diego-La Jolla Ecological Reserve; see Table 3). SE = southern latitude endpoint of range (positive and negative values are north and south latitude, respectively); NE = northern latitude endpoint of range; mid = middle latitude of range. Distribution categories: So = southern, range midpoint south of Punta Eugenia; Ce = central, range midpoint between Punta Eugenia and Point Conception; No = northern, range midpoint north of Point Conception.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Myxiniformes										
Myxinidae – hagfishes										
Eptatretus mcconnaugheyi Wisner & McMillian, 1990	Shorthead Hagfish	1954	U	S	x	-	23	34	28.5	Ce
Eptatretus stoutii (Lockington, 1878)	Pacific Hagfish	1948	C	S	x	-	27	60	43.5	No
Chimaeriformes										
Chimaeridae – shortnose chimaeras										
Hydrolagus colliei (Lay & Bennett, 1839)	Spotted Ratfish	1945	C	S	x	-	28	60	44	No
Hexanchiformes										
Hexanchidae – cow sharks										
Hexanchus griseus (Bonnaterre, 1788)	Bluntnose Sixgill Shark	1974	R	P,H,S	x	x	31	53	42	No
Notorynchus cepedianus (Péron, 1807)	Broadnose Sevengill Shark	1948	U*	P,H,S	-	-	24	53	38.5	No
Squaliformes										
Squalidae – dogfish sharks										
Squalus suckleyi (Girard, 1855)	Pacific Spiny Dogfish	1945	C	P,S	x	-	26	60	43	No
Squatiniformes										
Squatinidae – angel sharks										
Squatina californica Ayres, 1859	Pacific Angel Shark	1945	C	H,S	x	-	24	60	42	No
Heterodontiformes										
Heterodontidae – bullhead sharks										
Heterodontus francisci (Girard, 1855)	Horn Shark	1945	C	H,S	x	x	24	36	30	Ce

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Lamniformes										
Alopiidae – thresher sharks										
Alopias vulpinus (Bonnaterre, 1788)	Thresher Shark	1945	C	P,H	-	-	27	50	38.5	No
Cetorhinidae – basking sharks										
Cetorhinus maximus (Gunnerus, 1765)	Basking Shark	1962	R	P	-	-	23	60	41.5	No
Lamnidae – mackerel sharks										
Carcharodon carcharias (Linnaeus, 1758)	White Shark	1945	U	P	-	-	-30	60	15	So
Isurus oxyrinchus Rafinesque, 1810	Shortfin Mako	1950	U*	P	x	-	-30	46	8	So
Carcharhiniformes										
Scyliorhinidae – cat sharks										
Cephaloscyllium ventriosum (Garman, 1880)	Swell Shark	1950	R*	H,S	-	-	-30	36	3	So
Triakidae – hound sharks										
Galeorhinus galeus (Linnaeus, 1758)	Tope	1945	C	P,H,S	-	x	26	55	40.5	No
Mustelus californicus Gill, 1864	Gray Smoothhound	1945	U	H,S	x	-	23	40	31.5	Ce
Mustelus henlei (Gill, 1863)	Brown Smoothhound	1945	U	S	x	-	23	40	31.5	Ce
Mustelus lunulatus Jordan & Gilbert, 1882	Sicklefin Smoothhound	1945	R	S	-	-	8	33	20.5	So
Triakis semifasciata Girard, 1885	Leopard Shark	1945	C	H,S	x	-	23	40	31.5	Ce
Carcharhinidae – requiem sharks										
Carcharhinus obscurus (Lesueur, 1818)	Dusky Shark	1963	R	P	-	-	18	33	25.5	Ce
Prionace glauca (Linnaeus, 1758)	Blue Shark	1945	C	P	x	-	-30	60	15	So
Rhizoprionodon longurio (Jordan & Gilbert, 1882)	Pacific Sharpnose Shark	1948	R	P	-	-	-10	33	11.5	So
Sphyrnidae – hammerhead sharks										
Sphyrna lewini (Griffith & Smith, 1834)	Scalloped Hammerhead	1981	R	P	-	-	8	34	21	So
Sphyrna zygaena (Linnaeus, 1758)	Smooth Hammerhead	1958	U	P	-	-	30	37	33.5	Ce
Torpediniformes										
Torpedinidae – torpedo electric rays										
Torpedo californica Ayres, 1855	Pacific Electric Ray	1949	R*	S	x	-	28	53	40.5	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Rajiformes										
Rhinobatidae – guitarfishes										
Platyrhinoidis triseriata (Jordan & Gilbert, 1880)	Thornback	1917	C	S	x	-	28	37	32.5	Ce
Rhinobatos productus Ayres, 1854	Shovelnose Guitarfish	1938	C	S	x	x	23	37	30	Ce
Zapteryx exasperata (Jordan & Gilbert, 1880)	Banded Guitarfish	1945	R*	S	-	x	9	33	21	So
Rajidae – skates										
Beringraja binoculata (Girard 1855)	Big Skate	1945	R	S	-	-	28	60	44	No
Raja inornata Jordan & Gilbert, 1881	California Skate	1945	C	S	x	-	8	48	28	Ce
Raja rhina Jordan & Gilbert, 1880	Longnose Skate	1946	U	S	x	-	28	60	44	No
Raja stellulata Jordan & Gilbert, 1880	Starry Skate	1950	U	S	x	-	32	60	46	No
Myliobatiformes										
Dasyatidae – whiptail stingrays										
Dasyatis dipterura (Jordan & Gilbert, 1880)	Diamond Stingray	1949	U	S	-	-	-5	50	22.5	So
Pteroplatytrygon violacea (Bonaparte, 1832)	Pelagic Stingray	1980	R	P	-	-	0	50	25	So
Urolophidae – round stingrays										
Urobatis halleri (Cooper, 1863)	Round Stingray	1945	C	H,S	-	x	8	40	24	So
Gymnuridae – butterfly rays										
Gymnura marmorata (Cooper, 1864)	California Butterfly Ray	1945	C	S	x	-	-10	34	12	So
Myliobatidae – eagle rays										
Myliobatis californica Gill, 1865	Bat Ray	1945	C	P,H,S	x	x	23	44	33.5	Ce
Anguilliformes										
Muraenidae – morays										
Gymnothorax mordax (Ayres, 1859)	California Moray	1945	C	H	-	-	25	34	29.5	Ce
Ophichthidae – snake eels										
Ophichthus triserialis (Kaup, 1856)	Pacific Snake Eel	1948	U	S	-	-	-10	40	15	So
Ophichthus zophochir Jordan & Gilbert, 1882	Yellow Snake Eel	1982	R*	S	-	-	-10	40	15	So
Congridae – conger eels										
Gnathophis cinctus (Garman, 1899)	Hardtail Conger	1952	R	S	-	-	23	34	28.5	Ce

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Nettastomatidae – duckbill eels										
Facciolella equatorialis (Gilbert, 1890)	Dogface Witch Eel	1948	R	P	-	-	7	34	21	So
Clupeiformes										
Engraulidae – anchovies										
Anchoa compressa (Girard, 1858)	Deepbody Anchovy	1963	R	P,S	-	-	31	35	33	Ce
Anchoa delicatissima (Girard, 1854)	Slough Anchovy	1950	U	P,S	-	-	24	33	28.5	Ce
Cetengraulis mysticetus (Günther, 1867)	Anchoveta	1945	R	P,S	-	-	-8	34	13	So
Engraulis mordax Girard, 1854	Northern Anchovy	1945	C	P,H,S	-	-	23	53	38	No
Clupeidae – herrings										
Clupea pallasii Valenciennes, 1847	Pacific Herring	1945	R	P	-	-	30	77	53.5	No
Etrumeus teres (DeKay, 1842)	Round Herring	1985	U	P	-	-	-33	37	2	So
Harengula thrissina (Jordan & Gilbert, 1882)	Flatiron Herring	1951	R	P	-	-	-10	32	11	So
Sardinops sagax (Jenyns, 1842)	Pacific Sardine	1945	C	P,H,S	-	-	23	55	39	No
Argentiniformes										
Argentinidae – argentines										
Argentina sialis Gilbert, 1890	Pacific Argentine	1977	R	P,S	-	-	23	44	33.5	Ce
Salmoniformes										
Salmonidae – trouts and salmons										
Oncorhynchus gorbuscha (Walbaum, 1792)	Pink Salmon	1945	R	P	-	-	32	60	46	No
Stomiiformes										
Sternoptychidae – Marine Hatchetfishes										
Argyropelecus sladeni Regan, 1908	Lowcrest Hatchetfish	1952	U	P	-	-	-33	58	12	So
Aulopiformes										
Synodontidae – lizardfishes										
Synodus lucioceps (Ayres, 1855)	California Lizardfish	1954	C	S	-	-	28	38	33	Ce
Alepisauridae – lancetfishes										
Alepisaurus ferox Lowe, 1833	Longnose Lancetfish	1965	U	P	-	-	-33	58	12	So

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Paralepididae – barracudinas										
Magnisudis atlantica (Kroyer, 1868)	Duckbill Barracudina	1955	U	P	-	-	-33	58	12	So
Lampridiformes										
Trachipteridae – ribbonfishes										
Trachipterus altivelis Kner, 1859	King-of-the-salmon	1970	U	P	-	-	-33	58	12	So
Ophidiiformes										
Ophidiidae – cusk-eels										
Chilara taylori (Girard, 1858)	Spotted Cusk-eel	1946	C	S	x	-	27	45	36	No
Ophidion scrippsae (Hubbs, 1916)	Basketweave Cusk-eel	1945	C	S	x	-	28	34	31	Ce
Bythitidae – viviparous brotulas										
Brosmophycis marginata (Ayres, 1854)	Red Brotula	1964	U	S	x	-	31	57	44	No
Gadiformes										
Merlucciidae – merlucciid hakes										
Merluccius productus (Ayres, 1855)	Pacific Hake	1939	C	P,S	x	-	24	60	42	No
Batrachoidiformes										
Batrachoididae – toadfishes										
Porichthys myriaster Hubbs & Schultz, 1939	Specklefin Midshipman	1945	C	H,S	-	-	24	34	29	Ce
Porichthys notatus Girard, 1854	Plainfin Midshipman	1946	C	H,S	x	-	22	57	39.5	No
Atheriniformes										
Atherinopsidae – New World silversides										
Atherinops affinis (Ayres, 1860)	Topsmelt	1944	C	P,H	-	x	23	50	36.5	No
Atherinopsis californiensis Girard, 1854	Jacksmelt	1945	C	P,H	-	x	28	44	36	No
Leuresthes tenuis (Ayres, 1860)	California Grunion	1945	C	P,H,S	-	-	24	37	30.5	Ce
Beloniformes										
Belonidae – needlefishes										
Strongylura exilis (Girard, 1854)	California Needlefish	1945	C	P	-	-	-10	37	13.5	So
Scomberesocidae – sauries										
Cololabis saira (Brevoort, 1856)	Pacific Saury	1945	C	P	-	-	20	60	40	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Exocoetidae – flyingfishes										
Cheilopogon heterurus (Rafinesque, 1810)	Blotchwing Flyingfish	1946	U	P	-	-	0	32	16	So
Cheilopogon pinnatibarbatus (Bennett, 1831)	Smallhead Flyingfish	1945	U	P	-	-	22	46	34	Ce
Cyprinodontiformes										
Fundulidae – topminnows										
Fundulus parvipinnis Girard, 1854	California Killifish	1951	R	S	-	-	24	35	29.5	Ce
Gasterosteiformes										
Aulorhynchidae – tubesnouts										
Aulorhynchus flavidus Gill, 1861	Tubesnout	1951	C	P,H,S	x	x	27	57	42	No
Syngnathiformes										
Syngnathidae – pipefishes										
Cosmocampus arctus (Jenkins & Evermann, 1889)	Snubnose Pipefish	1944	U	H,S	x	-	23	38	30.5	Ce
Syngnathus auliscus (Swain, 1882)	Barred Pipefish	1945	R	S	-	-	-8	34	13	So
Syngnathus californiensis Storer, 1845	Kelp Pipefish	1945	C	H,S	-	-	24	37	30.5	Ce
Syngnathus euchrous Fritzche, 1980	Chocolate Pipefish	1946	C	S	-	-	28	34	31	Ce
Syngnathus exilis (Osburn & Nichols, 1916)	Barcheek Pipefish	1945	C	S	-	-	24	38	31	Ce
Syngnathus leptorhynchus Girard, 1854	Bay Pipefish	1945	U	S	-	-	28	57	42.5	No
Macroramphosidae - snipefishes										
Macroramphosus gracilis (Lowe, 1839)	Slender Snipefish	1950	R	P,S	-	-	0	33	16.5	So
Scorpaeniformes										
Scorpaenidae – scorpionfishes										
Scorpaena guttata Girard, 1854	California Scorpionfish	1944	C	H,S	x	x	24	37	30.5	Ce
Sebastes alutus (Gilbert, 1890)	Pacific Ocean Perch	1947	U	H	x	-	32	60	46	No
Sebastes atrovirens (Jordan & Gilbert, 1880)	Kelp Rockfish	1945	C	H	x	x	27	37	32	Ce
Sebastes auriculatus Girard, 1854	Brown Rockfish	1945	C	H,S	x	x	26	57	41.5	No
Sebastes carnatus (Jordan & Gilbert, 1880)	Gopher Rockfish	1945	C	H	x	-	27	42	34.5	Ce
Sebastes caurinus Richardson, 1844	Copper Rockfish	1945	C	H	x	-	28	60	44	No
Sebastes chlorostictus (Jordan & Gilbert, 1880)	Greenspotted Rockfish	1945	C	S	x	-	28	47	37.5	No
Sebastes chrysomelas (Jordan & Gilbert, 1881)	Black-and-yellow Rockfish	1945	C	H	x	-	27	40	33.5	Ce

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Sebastes constellatus (Jordan & Gilbert, 1880)	Starry Rockfish	1945	C	H	x	-	24	40	32	Ce
Sebastes dallii (Eigenmann & Beeson, 1894)	Calico Rockfish	1946	C	H	x	-	27	37	32	Ce
Sebastes diploproa (Gilbert, 1890)	Splitnose Rockfish	1948	U*	S	x	-	28	61	44.5	No
Sebastes elongatus Ayres, 1859	Greenstriped Rockfish	1945	C	H,S	x	-	28	60	44	No
Sebastes ensifer Chen, 1971	Swordspine Rockfish	1949	U*	H,S	x	-	28	37	32.5	Ce
Sebastes entomelas (Jordan & Gilbert, 1880)	Widow Rockfish	1954	U	H	x	-	32	57	44.5	No
Sebastes eos (Eigenmann & Eigenmann, 1890)	Pink Rockfish	1945	U	H	x	-	28	37	32.5	Ce
Sebastes flavidus (Ayres, 1862)	Yellowtail Rockfish	1949	R	P,H	x	-	32	59	45.5	No
Sebastes goodei (Eigenmann & Eigenmann, 1890)	Chilipepper	1945	U	P,H	x	-	24	51	37.5	No
Sebastes hopkinsi (Cramer, 1895)	Squarespot Rockfish	1946	C	P,H	x	-	29	37	33	Ce
Sebastes lentiginosus Chen, 1971	Freckled Rockfish	1948	U	H	x	-	32	33	32.5	Ce
Sebastes levis (Eigenmann & Eigenmann, 1889)	Cowcod	1964	U	H	x	-	28	42	35	No
Sebastes melanostomus (Eigenmann & Eigenmann, 1890)	Blackgill Rockfish	1947	R	H	x	-	28	47	37.5	No
Sebastes miniatus (Jordan & Gilbert, 1880)	Vermilion Rockfish	1945	C	H	x	-	28	50	39	No
Sebastes mystinus (Jordan & Gilbert, 1881)	Blue Rockfish	1947	C	H	x	-	31	60	45.5	No
Sebastes ovalis (Ayres, 1862)	Speckled Rockfish	1946	U	H	x	-	31	42	36.5	No
Sebastes paucispinis Ayres, 1854	Bocaccio	1945	C	H	x	x	29	57	43	No
Sebastes rastrelliger (Jordan & Gilbert, 1880)	Grass Rockfish	1945	U	H	x	-	28	44	36	No
Sebastes rosaceus Girard, 1854	Rosy Rockfish	1948	C	H	x	-	27	48	37.5	No
Sebastes rosenblatti Chen, 1971	Greenblotched Rockfish	1948	C	H,S	x	-	28	37	32.5	Ce
Sebastes ruberrimus (Cramer, 1895)	Yelloweye Rockfish	1949	R	H	x	-	32	60	46	No
Sebastes rubrivinctus (Jordan & Gilbert, 1880)	Flag Rockfish	1945	C	H	x	-	32	60	46	No
Sebastes saxicola (Gilbert, 1890)	Stripetail Rockfish	1950	U*	S	x	-	27	57	42	No
Sebastes semicinctus (Gilbert, 1897)	Halfbanded Rockfish	1946	C	H,S	x	-	27	37	32	Ce
Sebastes serranoides (Eigenmann & Eigenmann, 1890)	Olive Rockfish	1947	C	H	x	x	28	41	34.5	Ce
Sebastes serriceps (Jordan & Gilbert, 1880)	Treefish	1945	C	H	x	x	28	37	32.5	Ce
Sebastes simulator Chen, 1971	Pinkrose Rockfish	1951	R	H,S	x	-	31	37	34	Ce
Sebastes umbrosus (Jordan & Gilbert, 1882)	Honeycomb Rockfish	1945	C	H	x	-	26	37	31.5	Ce
Sebastolobus alascanus Bean, 1890	Shortspine Thornyhead	1948	U	S	x	-	28	60	44	No
Triglidae – searobins										
Prionotus stephanophrys Lockington, 1881	Lumptail Searobin	1958	R	S	-	-	-10	46	18	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Epinephelidae – groupers										
Epinephelus analogus Gill, 1863	Spotted Cabrilla	1956	R	H	-	-	-10	34	12	So
Mycteroperca jordani (Jenkins & Evermann, 1889)	Gulf Grouper	1945	U	H	-	-	23	32	27.5	So
Mycteroperca xenarcha Jordan, 1888	Broomtail Grouper	1945	U	H	-	x	-5	37	16	So
Serranidae – sea basses										
Paralabrax clathratus (Girard, 1854)	Kelp Bass	1945	C	H	x	x	24	46	35	No
Paralabrax maculatofasciatus (Steindachner, 1868)	Spotted Sand Bass	1970	R*	S	-	x	23	36	29.5	Ce
Paralabrax nebulifer (Girard, 1854)	Barred Sand Bass	1945	C	H,S	x	x	24	37	30.5	Ce
Pronotogrammus multifasciatus Gill, 1863	Threadfin Bass	1984	U	H,S	x	-	-10	34	12	So
Perciformes										
Polyprionidae – wreckfishes										
Stereolepis gigas Ayres, 1859	Giant Sea Bass	1945	U*	H	-	x	30	40	35	No
Priacanthidae – bigeyes										
Pristigenys serrula (Gilbert, 1891)	Popeye Catalufa	1966	R	H	-	-	-10	34	12	So
Apogonidae – cardinalfishes										
Apogon pacificus (Herre, 1935)	Pink Cardinalfish	1998	R	H	-	-	0	32	16	So
Malacanthidae – tilefishes										
Caulolatilus princeps (Jenyns, 1840)	Ocean Whitefish	1945	C	H	x	-	-10	50	20	So
Lutjanidae – snappers										
Lutjanus peru (Nichols & Murphy, 1922)	Pacific Red Snapper	1989	R	H	-	-	-10	33	12	So
Haemulidae – grunts										
Anisotremus davidsonii (Steindachner, 1876)	Sargo	1945	C	H,S	-	x	24	37	30.5	Ce
Haemulon californiensis (Steindachner, 1876)	Salema	1945	C	H,S	-	x	-10	36	13	So
Sciaenidae – drums and croakers										
Atractoscion nobilis (Ayres, 1860)	White Seabass	1945	C	H,S	-	x	24	58	41	No
Cheilotrema saturnum (Girard, 1858)	Black Croaker	1945	C	H,S	-	x	24	34	29	Ce
Genyonemus lineatus (Ayres, 1855)	White Croaker	1945	U*	S	-	-	24	50	37	No
Menticirrhus undulatus (Girard, 1854)	California Corbina	1945	C	S	-	-	23	34	28.5	Ce
Roncador stearnsii (Steindachner, 1876)	Spotfin Croaker	1945	C	S	-	-	23	34	28.5	Ce

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Seriphus politus Ayres, 1860	Queenfish	1945	C	H,S	-	x	25	40	32.5	Ce
Umbrina roncador Jordan & Gilbert, 1882	Yellowfin Croaker	1945	C	S	-	-	23	34	28.5	Ce
Chaetodontidae – butterflyfishes										
Prognathodes falcifer (Hubbs & Rechnitzer, 1958)	Scythe Butterflyfish	1970	R	H	-	-	0	33	16.5	So
Kyphosidae – sea chubs										
Girella nigricans (Ayres, 1860)	Opaleye	1944	C	H	-	x	22	37	29.5	Ce
Hermosilla azurea Jenkins & Evermann, 1889	Zebraperch	1939	C	H	-	x	23	36	29.5	Ce
Medialuna californiensis (Steindachner, 1876)	Halfmoon	1944	C	H	-	x	23	41	32	Ce
Sphyraenidae – barracudas										
Sphyraena argentea Girard, 1854	Pacific Barracuda	1913	C	P,H	-	x	22	57	39.5	No
Sphyraena ensis Jordan & Gilbert, 1882	Mexican Barracuda	1998	R	P,H	-	-	0	33	16.5	So
Carangiformes										
Echeneidae – remoras										
Remora remora (Linnaeus, 1758)	Remora	1947	U	P	-	-	-30	37	3.5	So
Coryphaenidae – dolphinfishes										
Coryphaena hippurus Linnaeus, 1758	Dolphinfish	1952	R	P	-	-	-30	47	8.5	So
Carangidae – jacks										
Decapterus muroadsi (Temminck & Schlegel, 1844)	Amberstripe Scad	1960	R	P	-	-	0	36	18	So
Seriola lalandi Valenciennes, 1833	Yellowtail Jack	1946	U*	P,H	-	-	3	47	25	So
Trachurus symmetricus (Ayres, 1855)	Jack Mackerel	1945	C	P,H,S	x	-	24	57	40.5	No
Labriformes										
Labridae – wrasses										
Halichoeres semicinctus (Ayres, 1859)	Rock Wrasse	1905	C	H	-	x	23	34	28.5	Ce
Oxyjulis californica (Günther, 1861)	Señorita	1944	C	H,S	x	x	28	38	33	Ce
Semicossyphus pulcher (Ayres, 1854)	California Sheephead	1945	C	H	x	x	22	37	29.5	Ce
"Chromides"										
Embiotocidae – surfperches										
Amphistichus argenteus Agassiz, 1854	Barred Surfperch	1945	C	S	-	x	28	38	33	Ce
Amphistichus koelzi (Hubbs, 1933)	Calico Surfperch	1927	R	S	-	-	26	48	37	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Brachyistius frenatus Gill, 1862	Kelp Perch	1945	C	H,S	x	x	27	50	38.5	No
Cymatogaster aggregata Gibbons, 1854	Shiner Perch	1946	C	H,S	-	x	30	56	43	No
Embiotoca jacksoni Agassiz, 1853	Black Perch	1944	C	H,S	x	x	26	39	32.5	Ce
Embiotoca lateralis Agassiz, 1854	Striped Seaperch	1950	U	H,S	-	-	31	56	43.5	No
Hyperprosopon argenteum Gibbons, 1854	Walleye Surfperch	1945	C	H,S	-	x	28	50	39	No
Hypsurus caryi (Agassiz, 1853)	Rainbow Seaperch	1945	C	H,S	-	x	31	40	35.5	No
Micrometrus minimus (Gibbons, 1854)	Dwarf Perch	1944	C	H,S	-	x	28	38	33	Ce
Phanerodon atripes (Jordan & Gilbert, 1880)	Sharpnose Seaperch	1950	U	H,S	x	-	28	38	33	Ce
Phanerodon furcatus Girard, 1854	White Seaperch	1945	U	H,S	x	x	31	50	40.5	No
Rhacochilus toxotes Agassiz, 1854	Rubberlip Seaperch	1945	C	H	x	x	27	39	33	Ce
Rhacochilus vacca (Girard, 1855)	Pile Perch	1944	C	H	x	x	29	56	42.5	No
Zalembius roseus (Jordan & Gilbert, 1880)	Pink Seaperch	1950	U*	S	x	-	27	38	32.5	Ce
Pomacentridae – damselfishes										
Chromis punctipinnis (Cooper, 1863)	Blacksmith	1945	C	H	x	x	27	36	31.5	Ce
Hypsypops rubicundus (Girard, 1854)	Garibaldi	1945	C	H	-	x	24	36	30	Ce
Cottiformes										
Anoplopomatidae – sablefishes										
Anoplopoma fimbria (Pallas, 1814)	Sablefish	1947	U	S	x	-	28	60	44	No
Hexagrammidae – greenlings										
Hexagrammos decagrammus (Pallas, 1810)	Kelp Greenling	1956	R	H	x	-	32	55	43.5	No
Ophiodon elongatus Girard, 1854	Lingcod	1945	U	H,S	x	-	29	57	43	No
Oxylebius pictus Gill, 1862	Painted Greenling	1945	C	H	x	x	29	50	39.5	No
Zaniolepis frenata Eigenmann & Eigenmann, 1889	Shortspine Combfish	1937	C	S	x	-	27	43	35	No
Zaniolepis latipinnis Girard, 1858	Longspine Combfish	1951	C	S	-	-	27	43	35	No
Cottidae – sculpins										
Artedius corallinus (Hubbs, 1926)	Coralline Sculpin	1945	U	H	-	-	30	48	39	No
Artedius lateralis (Girard, 1854)	Smoothhead Sculpin	1951	U	H	-	-	30	55	42.5	No
Artedius notospilotus Girard, 1856	Bonyhead Sculpin	1944	U	H	x	-	30	48	39	No
Chitonotus pugetensis (Steindachner, 1876)	Roughback Sculpin	1947	U*	S	x	-	25	54	39.5	No
Clinocottus analis (Girard, 1858)	Woolly Sculpin	1945	C	H	-	-	27	39	33	Ce
Icelinus cavifrons Gilbert, 1890	Pit-head Sculpin	1953	U*	S	x	-	24	36	30	Ce

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Icelinus filamentosus Gilbert, 1890	Threadfin Sculpin	1969	R	S	x	-	32	54	43	No
Icelinus limbaughi Rosenblatt & Smith, 2004	Canyon Sculpin	1954	U	H,S	x	-	32	34	33	Ce
Icelinus quadriseriatus (Lockington, 1880)	Yellowchin Sculpin	1950	R	S	-	-	22	38	30	Ce
Icelinus tenuis Gilbert, 1890	Spotfin Sculpin	1965	R	S	-	-	28	50	39	No
Leiocottus hirundo Girard, 1856	Lavender Sculpin	1945	R	H	-	-	31	34	32.5	Ce
Leptocottus armatus Girard, 1854	Pacific Staghorn Sculpin	1945	U	S	-	-	30	56	43	No
Oligocottus rubellio (Greeley, 1899)	Rosy Sculpin	1944	C	H	-	-	30	40	35	No
Oligocottus snyderi Greeley, 1898	Fluffy Sculpin	1944	U	H	-	-	30	57	38.5	No
Orthonopias triacis Starks & Mann, 1911	Snubnose Sculpin	1950	R	H	-	-	29	37	33	Ce
Ruscarius creaseri (Hubbs, 1926)	Roughcheek Sculpin	1945	C	H	-	-	27	36	30.5	Ce
Scorpaenichthys marmoratus (Ayres, 1854)	Cabezon	1945	C	H	x	x	26	56	41	No
Agonidae – poachers										
Agonopsis sterletus (Gilbert, 1898)	Spearnose Poacher	1954	U*	S	x	-	27	35	31	Ce
Odontopyxis trispinosa Lockington, 1880	Pygmy Poacher	1954	R	S	x	-	28	57	42.5	No
Xeneretmus latifrons (Gilbert, 1890)	Blacktip Poacher	1950	U	S	x	-	30	49	39.5	No
Xeneretmus triacanthus (Gilbert, 1890)	Bluespotted Poacher	1965	R	S	-	-	30	52	41	No
Liparidae – snailfishes										
Careproctus melanurus Gilbert, 1892	Blacktail Snailfish	1990	R	S	x	-	32	54	43	No
Liparis mucosus Ayres, 1855	Slimy Snailfish	1946	U	H	-	-	29	50	39.5	No
Bathymasteridae – ronquils										
Rathbunella alleni Gilbert, 1904	Stripefin Ronquil	1954	C	H	x	-	29	38	33.5	Ce
Rathbunella hypoplecta (Gilbert, 1890)	Bluebanded Ronquil	1960	U	H	x	-	31	50	40.5	No
Ronquilus jordani (Gilbert, 1889)	Northern Ronquil	1974	R	H	-	-	33	59	46	No
Zoarcidae – eelpouts										
Eucryphycus californicus (Starks & Mann, 1911)	Persimmon Eelpout	<1944	R	S	-	-	33	37	35	No
Lycodes pacificus Collett, 1879	Blackbelly Eelpout	1950	R	S	x	-	31	58	44.5	No
Lyconema barbatum Gilbert, 1896	Bearded Eelpout	1965	R	S	-	-	30	42	36	No
Stichaeidae – pricklebacks										
Esselenichthys carli (Follett & Anderson, 1990)	Threeline Prickleback	1950	U	H,S	x	-	30	36	33	Ce
Esselenichthys laurae (Follett & Anderson, 1990)	Twoline Prickleback	1954	R	H,S	-	-	32	38	35	No
Plectobranchus evides Gilbert, 1890	Bluebarred Prickleback	1950	U	S	x	-	32	55	43.5	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Pholidae – gunnels										
Apodichthys fucorum Jordan & Gilbert, 1880	Rockweed Gunnel	1945	U	H,S	-	-	30	53	41.5	No
Ulvicola sanctaerosae Gilbert & Starks, 1897	Kelp Gunnel	1945	U	H,S	-	-	31	36	33.5	Ce
Anarhichadidae – wolffishes										
Anarrhichthys ocellatus Ayres, 1855	Wolf-eel	1946	U	H	x	-	32	57	44.5	No
Blenniiformes										
Labrisomidae – labrisomid blennies										
Alloclinus holderi (Lauderbach, 1907)	Island Kelpfish	1950	U	H	-	x	27	34	30.5	Ce
Cryptotrema corallinum Gilbert, 1890	Deepwater Blenny	<1944	R	H	-	-	30	34	32	Ce
Paraclinus integripinnis (Smith, 1880)	Reef Finspot	1917	C	H	-	-	24	34	29	Ce
Clinidae – kelp blennies										
Gibbonsia elegans (Cooper, 1864)	Spotted Kelpfish	1945	C	H	-	x	24	35	29.5	Ce
Gibbonsia metzi Hubbs, 1927	Striped Kelpfish	1944	C	H	-	-	27	50	38.5	No
Gibbonsia montereyensis Hubbs, 1927	Crevice Kelpfish	1949	U	H	-	-	31	53	42	No
Heterostichus rostratus Girard, 1854	Giant Kelpfish	1944	C	H	-	x	22	53	37.5	No
Chaenopsidae – tube blennies										
Neoclinus blanchardi Girard, 1858	Sarcastic Fringehead	1945	C	H,S	x	-	28	37	32.5	Ce
Neoclinus stephensae Hubbs, 1953	Yellowfin Fringehead	1953	C	H,S	x	-	27	36	31.5	Ce
Neoclinus uninotatus Hubbs, 1953	Onespot Fringehead	1963	R	H,S	x	-	32	38	35	No
Blenniidae – combtooth blennies										
Hypsoblennius gilberti (Jordan, 1882)	Rockpool Blenny	1915	C	H	-	-	24	34	29	Ce
Hypsoblennius jenkinsi (Jordan & Evermann, 1896)	Mussel Blenny	1915	C	H	-	-	16	34	25	So
Gobiesociformes										
Gobiesocidae – clingfishes										
Gobiesox eugrammus Briggs, 1955	Lined Clingfish	1955	U	H	-	-	29	33	31	Ce
Gobiesox maeandricus (Girard, 1858)	Northern Clingfish	1976	R	H	-	-	29	55	42	No
Gobiesox rhessodon Smith, 1881	California Clingfish	1944	C	H	x	-	27	35	31	Ce
Rimicola eigenmanni (Gilbert, 1890)	Slender Clingfish	1932	C	H	-	-	26	33	29.5	Ce
Rimicola muscarum (Meek & Pierson, 1895)	Kelp Clingfish	1945	U	H	-	-	31	52	41.5	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Gobiiformes										
Gobiidae – gobies										
Acanthogobius flavimanus (Temminck & Schlegel, 1845)	Yellowfin goby	2003	R*	S	-	-	-	-	-	-
Ilypnus gilberti (Eigenmann & Eigenmann, 1889)	Cheekspot Goby	1967	R	S	-	-	23	38	30.5	Ce
Lepidogobius lepidus (Girard, 1858)	Bay Goby	1950	R	S	-	-	28	50	39	No
Lethops connectens Hubbs, 1926	Halfblind Goby	1944	U	H	-	-	31	35	33	Ce
Lythrypnus dalli (Gilbert, 1890)	Bluebanded Goby	1946	C	H	x	x	23	36	29.5	Ce
Lythrypnus zebra (Gilbert, 1890)	Zebra Goby	1950	U	H	x	-	18	36	27	So
Rhinogobiops nicholsii (Bean, 1882)	Blackeye Goby	1946	C	H,S	x	x	27	53	40	No
Typhlogobius californiensis Steindachner, 1879	Blind Goby	1944	U	H	-	-	25	35	30	Ce
Acanthuriformes										
Luvaridae – louvars										
Luvarus imperialis Rafinesque, 1810	Louvar	1956	R	P	-	-	-33	48	8.5	So
Scombriformes										
Trichiuridae – cutlassfishes										
Lepidopus fitchi Rosenblatt & Wilson, 1987	Pacific Scabbardfish	1948	U	P	x	-	23	40	31.5	Ce
Scombridae – mackerels										
Auxis thazard (Lacepède, 1800)	Frigate Mackerel	1972	R	P	-	-	-10	33	11.5	So
Sarda chiliensis (Cuvier, 1832)	Pacific Bonito	1945	U	P	-	-	-30	57	13.5	So
Scomber japonicus Houttuyn, 1782	Pacific Chub Mackerel	1917	C	P	x	-	-30	57	13.5	So
Scomberomorus sierra Jordan & Starks, 1895	Pacific Sierra	1962	R*	P	-	-	-5	33	19	So
Xiphiiformes										
Istiophoridae – billfishes										
Istiophorus platypterus (Shaw, 1792)	Sailfish	1960	R	P	-	-	-30	32	1	So
Stromateiformes										
Centrolophidae – medusafishes										
Icichthys lockingtoni Jordan & Gilbert, 1880	Medusafish	1955	U	P	-	-	27	57	42	No

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Stromateidae – butterfishes										
Peprilus simillimus (Ayres, 1860)	Pacific Pompano	1960	R	P,S	-	-	25	49	37	No
Pleuronectiformes										
Paralichthyidae – sand flounders										
Citharichthys sordidus (Girard, 1854)	Pacific Sanddab	1946	C	S	x	-	23	60	41.5	No
Citharichthys stigmaeus Jordan & Gilbert, 1882	Speckled Sanddab	1945	C	H,S	x	-	23	60	41.5	No
Citharichthys xanthostigma Gilbert, 1890	Longfin Sanddab	1945	C	S	x	-	10	36	23	So
Hippoglossina stomata Eigenmann & Eigenmann, 1890	Bigmouth Sole	1945	C	S	x	-	23	37	30	Ce
Paralichthys californicus (Ayres, 1859)	California Halibut	1945	C	H,S	x	-	25	50	37.5	No
Xystreurys liolepis Jordan & Gilbert, 1880	Fantail Sole	1945	C	S	x	-	23	36	29.5	Ce
Pleuronectidae – righteye flounders										
Eopsetta jordani (Lockington, 1879)	Petrale Sole	1945	C	S	x	-	28	60	44	No
Glyptocephalus zachirus Lockington, 1879	Rex Sole	1950	U	S	-	-	28	60	44	No
Lepidopsetta bilineata (Ayres, 1855)	Rock Sole	1948	R	H,S	x	-	32	60	46	No
Lyopsetta exilis (Jordan & Gilbert, 1880)	Slender Sole	1948	U	S	-	-	28	51	39.5	No
Microstomus pacificus (Lockington, 1879)	Dover Sole	1950	R	S	-	-	23	60	41.5	No
Parophrys vetulus (Girard, 1854)	English Sole	1946	C	S	x	-	23	60	41.5	No
Pleuronichthys coenosus Girard, 1854	C-O Sole	1962	R	H,S	x	-	31	57	44	No
Pleuronichthys decurrens Jordan & Gilbert, 1881	Curlfin Sole	1952	U	S	-	-	28	60	44	No
Pleuronichthys guttulatus Girard, 1856	Diamond Turbot	1945	U	S	x	-	25	40	32.5	Ce
Pleuronichthys ritteri Starks & Morris, 1907	Spotted Turbot	1946	U	S	x	-	25	35	30	Ce
Pleuronichthys verticalis Jordan & Gilbert, 1880	Hornyhead Turbot	1945	U*	S	x	-	25	37	31	Ce
Cynoglossidae – tonguefishes										
Symphurus atricaudus (Jordan & Gilbert, 1880)	California Tonguefish	1961	R*	S	x	-	22	41	31.5	Ce
Tetraodontiformes										
Balistidae – triggerfishes										
Balistes polylepis Steindachner, 1876	Finescale Triggerfish	1950	U	H,S	-	-	-30	41	5.5	So
Ostraciidae – boxfishes										
Lactoria diaphana (Bloch & Schneider, 1801)	Spiny Boxfish	1952	U	P	-	-	0	34	17	So

Table 1. Continued.

Scientific name	Common name	Date	Oc	Hab	Cn	Tr	SE	NE	mid	Dist
Tetraodontidae – puffers										
Sphoeroides lobatus (Steindachner, 1870)	Longnose Puffer	1998	R	S	-	-	-33	34	0	So
Diodontidae – porcupinefishes										
Diodon holocanthus Linnaeus, 1758	Balloonfish	1959	R	P,H,S	-	-	-30	32	1	So
Molidae – molas										
Mola mola (Linnaeus, 1758)	Ocean Sunfish	1945	U	P	-	-	0	55	27.5	So

Table 2. Numbers of species recorded in the La Jolla region (Table 1; excluding one exotic species, the Yellowfin Goby, *Acanthogobius flavimanus*) by distribution and frequency of occurrence categories for all species and those found in selected habitats.

	Northern	Central	Southern	Total
All species				
Common	44	58	11	113
Uncommon	38	25	20	83
Rare	29	13	26	68
Total	111	96	57	264
Hard-bottom species				
Common	33	40	5	78
Uncommon	21	13	6	40
Rare	10	4	8	22
Total	64	57	19	140
Soft-bottom species				
Common	25	27	4	56
Uncommon	21	16	4	41
Rare	20	9	9	38
Total	66	52	17	135
Pelagic species				
Common	12	3	3	18
Uncommon	3	4	13	20
Rare	6	2	17	25
Total	21	9	33	63
Canyon species				
Common	31	32	5	68
Uncommon	20	17	3	40
Rare	13	2	0	15
Total	64	51	8	123

Results

Two hundred sixty-five species of fishes from 95 families have been recorded within the study area based on verified records in the MVC (Table 1). By 1964, 20 years after Hubbs had arrived at SIO, 238 of these species (90%) had been recorded from the immediate vicinity of La Jolla, a reflection of the intensive collecting effort made by Hubbs and associates before that time (Fig. 3). Of the 265 species recorded, 113 are common, 83 are uncommon, and 68 species are rare based on records in the MVC (Table 2; excluding one ''rare'' exotic species). The faunal composition of the region is typical of southern California fish communities in that it is primarily a mixture of warm-temperate and cool-temperate fishes (Hobson 1994; Horn et al. 2006). Species with central ranges number 96, those with northern ranges total 111, and those with southern ranges total 57 (Table 2). Most ''common'' species have range midpoints in the central region (58 species) or northern region (44) with relatively few (11) with southern range midpoints. ''Uncommon'' species are also dominated by species with central (25), and northern (38) ranges. Few ''rare'' species have central distributions (13) and more have northern (29) or southern (26) distributions. A single exotic species (*Acanthogobius flavimanus*, Gobiidae) rarely has been recorded from La Jolla.

Hard-bottom Species

The rocky-reef and kelp-forest fishes of La Jolla are perhaps the best-known group due to their visibility and the fact that they have been studied repeatedly there and elsewhere in the state (e.g., Limbaugh 1955; North and Hubbs 1968; Quast 1968; Feder et al. 1974; Kobayashi 1979; Ebeling et al. 1980; Shane 1996; Paddock and Estes 2000; Pondella et al. 2000; Froeschke et al. 2006). In our survey, 140 species associated with hard substrates were recorded from the study area (Table 1). The majority of these have northern (64 species) or central (57) distributions, while relatively few (19) have southern distributions (Table 2).

We recorded 51 of these species (excluding schooling species) in the 252 transects at La Jolla Cove and 248 transects at Boomers (Table 3). Although we counted well over 90,000 fishes (52,520 fishes at La Jolla Cove and 41,330 at Boomers), this represents only 36% of the hard bottom species recorded from the vicinity. This difference is attributable to several factors. For example, small, cryptobenthic species are rarely observed by divers, some hard-bottom species are restricted to depths greater than those surveyed by divers, the surveys extended for only four years compared to several decades of collecting in the area, and rare species are unlikely to be recorded during such surveys. The top twelve species by abundance are listed in Table 4. At both sites, the numerically dominant species were the Blacksmith, *Chromis punctipinnis* (Pomacentridae), and the Señorita, *Oxyjulis californica* (Labridae) and ten of the top twelve species were identical (Table 4). The mean density of all species of fishes over the entire sampling period at La Jolla Cove (mean = 1.95/100 m^2, SE = 0.29) and at Boomers (mean = 1.51, SE = 0.21) did not differ significantly ($t = 1.21$, $P > 0.05$). Throughout the study period, the abundance of Blacksmith and Señorita varied greatly and drove many of the overall changes in density. These cycles were characterized by large recruitment pulses, followed by increases in adult densities.

Soft-bottom Species

The fishes recorded from La Jolla include 135 species known to occur on or over soft substrates (Table 1). Similar to the hard-bottom fishes, this group is dominated by species with northern (66 species) or central (52) distributions, with relatively few (17) with southern distributions (plus one exotic). Excluding the exotic, twelve of these species are listed as ''resident bay'' species by Allen et al. (2006). Several La Jolla records for these are from the ''La Jolla Beach and Tennis Club,'' but these mostly date between 1950 and 1963, and these species have not (or rarely) been collected in the area since that time. For example, the Deepbody Anchovy, *Anchoa compressa,* is based on a single record (SIO 63-22 - large series) from 1963, the Slough anchovy, *Anchoa delicatissima,* is based on four records, one from 1950 (SIO 50-227, 1 specimen), two from 1951 (SIO 51- 37, 1 specimen; SIO 51-378, 10 specimens) and one from 2002 (SIO 02-26, 1 specimen), and the California Killifish, *Fundulus parvipinnis*, is based on a single specimen collected in 1951 (SIO 51-37). Historically there was a small embayment in the vicinity of the La Jolla Beach and Tennis Club that has since disappeared (Fig. 2D). Although common in other embayments in the San Diego region (Allen et al. 2002), this component of the ichthyofauna has been largely eliminated from the La Jolla area by this habitat alteration.

Pelagic Species

In addition to several coastal fish species that regularly swim in the water column (e.g., the silversides and some drums), the proximity of deep waters to the La Jolla coastline contributes to the local diversity of fishes as several oceanic species closely approach the

Table 3. Densities of fishes per 100 m^2 observed during belt transects in La Jolla Cove (A) and Boomers (B). Species are arranged alphabetically by genus and species name. Means, standard error (SE) and percent occurrence (O) represent six sampling periods for each year (except for Boomers 2003 with five).

A) La Jolla Cove

	2002			2003			2004			2005			2002-2005		
	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O
Alloclinus holderi	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Amphistichus argenteus	0	-	0	0	-	0	0	-	0	0.347	0.347	17	0.087	0.087	4
Anisotremus davidsonii	0.667	0.269	83	0.504	0.392	50	4.250	1.806	100	0.292	0.127	67	1.428	0.554	75
Atherinops affinis	0	-	0	0	-	0	0.639	0.545	33	0.022	0.022	17	0.165	0.139	12
Atherinopsis californiensis	3.750	3.427	33	0.708	0.708	17	0	-	0	0.139	0.139	17	1.149	0.876	17
Atractoscion nobilis	0.069	0.054	33	0	-	0	0	-	0	0	-	0	0.017	0.014	8
Aulorhynchus flavidus	1.083	2.573	17	0.028	0.028	17	0	-	0	0	-	0	0.278	0.263	8
Brachyistius frenatus	0.153	0.153	17	0.796	0.518	67	1.042	0.385	67	0.722	0.287	67	0.678	0.182	54
Cheilotrema saturnum	0.208	0.208	17	0	-	0	0.028	0.028	17	0.028	0.028	17	0.066	0.052	12
Chromis punctipinnis	76.361	14.075	100	47.370	11.480	100	96.861	32.763	100	108.86	30.677	100	82.362	12.289	100
Cymatogaster aggregata	0	-	0	0.083	0.083	17	0.333	0.333	17	0.097	0.062	33	0.128	0.085	17
Embiotoca jacksoni	1.986	0.312	100	1.384	0.300	100	1.778	0.283	100	2.038	0.348	100	1.794	0.155	100
Galeorhinus galeus	0.042	0.028	17	0	-	0	0.083	0.083	17	0.055	0.055	17	0.045	0.025	17
Gibbonsia elegans	0.014	0.014	17	0.014	0.014	17	0	-	0	0.014	0.014	17	0.010	0.006	12
Girella nigricans	7.389	2.254	100	8.292	2.895	100	12.764	3.521	100	5.419	1.187	100	8.466	1.340	100
Haemulon californiensis	0	-	0	0	-	0	3.333	3.333	17	0	-	0	0.833	0.833	4
Halichoeres semicinctus	7.722	2.097	100	3.606	0.547	100	5.653	1.494	100	6.611	1.088	100	5.898	0.735	100
Hermosilla azurea	0	-	0	0.292	0.275	33	0.736	0.736	17	0.167	0.108	33	0.299	0.193	21
Heterodontus francisci	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Heterostichus rostratus	0.125	0.085	33	0.116	0.041	67	0.750	0.618	83	0.122	0.077	67	0.278	0.157	62
Hexanchus griseus	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Hyperprosopon argenteum	1.347	1.314	33	0	-	0	0.972	0.624	33	0	-	0	0.580	0.361	17
Hypsurus caryi	0.264	0.113	83	0.222	0.159	50	0.125	0.096	33	0.247	0.076	100	0.215	0.268	67
Hypsypops rubicundus	13.583	2.263	100	10.903	2.153	100	13.361	1.755	100	16.500	1.953	100	13.587	1.037	100
Lythrypnus dalli	0	-	0	0	-	0	0.958	0.909	33	0	-	0	0.240	0.229	8
Medialuna californiensis	1.083	0.243	100	1.199	0.578	83	1.653	0.052	100	2.500	1.262	100	1.609	0.367	96
Micrometrus minimus	0.083	0.053	33	0.111	0.073	33	0.375	0.152	67	0.861	0.384	83	0.358	0.118	54
Mycteroperca xenarcha	0.014	0.014	17	0	-	0	0	-	0	0	-	0	0.003	0.003	4

Table 3. Continued.

A) La Jolla Cove

	2002			2003			2004			2005			2002-2005		
	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O
Myliobatis californica	0	-	0	1.037	1.037	17	0.028	0.028	17	0	-	0	0.266	0.259	8
Oxyjulis californica	29.597	9.147	100	42.005	23.735	100	97.056	20.271	100	52.678	7.767	100	55.334	9.429	100
Oxylebius pictus	0.028	0.017	33	0.014	0.014	17	0.153	0.097	33	0.050	0.023	50	0.061	0.026	33
Paralabrax clathratus	8.000	1.308	100	9.894	3.526	100	14.056	3.997	100	15.345	2.328	100	11.823	1.523	100
Paralabrax maculatofasciatus	0.014	0.014	17	0.083	0.083	17	0.028	0.028	17	0	-	0	0.031	0.022	8
Paralabrax nebulifer	0.528	0.178	83	2.056	0.443	100	1.625	0.911	67	2.433	1.308	100	1.660	0.415	87
Phanerodon furcatus	0.236	0.220	33	0	-	0	0.250	0.250	17	0.125	0.093	50	0.153	0.083	25
Rhacochilus toxotes	0.069	0.040	50	0.074	0.055	33	0.153	0.097	33	0.189	0.128	50	0.121	0.042	42
Rhacochilus vacca	0.056	0.035	33	0.319	0.273	33	0.083	0.057	33	0.083	0.30	67	0.135	0.069	42
Rhinobatos productus	0.014	0.033	17	0	0	0	0	-	0	0	-	0	0.003	0.003	4
Rhinogobiops nicholsii	0	-	0	0.069	0.069	17	0.056	0.041	33	0	-	0	0.031	0.020	12
Scorpaena guttata	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Scorpaenichthys marmoratus	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Sebastes atrovirens	0.139	0.063	67	0.69	0.045	33	0.403	0.232	50	0.414	0.333	67	0.256	0.101	54
Sebastes auriculatus	0	-	0	0	-	0	0.014	0.014	17	0	-	0	0.003	0.003	4
Sebastes paucispinis	0	-	0	0.153	0.153	17	0	-	0	0	-	0	0.038	0.038	4
Sebastes rastrelliger	0	-	0	0	-	0	0.042	0.042	17	0	-	0	0.010	0.010	4
Sebastes serranoides	0.111	0.272	17	0	-	0	0	-	0	0.014	0.014	17	0.031	0.028	8
Sebastes serriceps	0.014	0.014	17	0	-	0	0	-	0	0	-	0	0.003	0.003	4
Semicossyphus pulcher	3.653	0.552	100	5.551	1.338	100	6.972	2.350	100	7.769	1.417	100	5.986	0.793	100
Seriphus politus	0	-	0	0	-	0	0	-	0	0.028	0.028	17	0.007	0.007	4
Sphyraena argentea	1.653	0.836	50	1.046	1.013	33	0	-	0	0.042	0.042	17	0.685	0.339	25
Stereolepis gigas	0	-	0	0.028	0.028	17	0.028	0.028	17	0.180	0.121	50	0.059	0.033	21
Urobatis halleri	0	-	0	0	-	0	0	-	0	0	-	0	0	0	0
Zapteryx exasperata	0.014	0.014	17	0	-	0	0.014	0.014	17	0	-	0	0.007	0.005	8

Table 3. Continued.

B) Boomers

	2002			2003			2004			2005			2002-2005		
	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O
Alloclinus holderi	0.014	0.014	17	0	-	0	0	-	0	0	-	0	0.004	0.004	4
Amphistichus argenteus	1.250	1.250	17	0	-	0	0	-	0	0	-	0	0.326	0.326	4
Anisotremus davidsonii	0.816	0.398	67	1.236	0.881	50	1.261	0.525	80	0.700	0.243	83	0.984	0.270	70
Atherinops affinis	0	-	0	0	-	0	0.050	0.050	20	0.011	0.011	17	0.014	0.011	9
Atherinopsis californiensis	0.139	0.139	17	1.389	1.389	17	0	-	0	0	-	0	0.398	0.362	9
Atractoscion nobilis	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Aulorhynchus flavidus	0.083	0.083	17	0	-	0	0.233	0.233	20	0	-	0	0.072	0.054	9
Brachyistius frenatus	0.014	0.014	17	0.268	0.237	33	8.789	7.425	80	5.525	4.589	100	3.426	2.006	56
Cheilotrema saturnum	0.014	0.014	17	0	-	0	0.017	0.017	20	0.014	0.014	17	0.011	0.006	13
Chromis punctipinnis	46.806	10.016	100	34.569	11.096	100	55.994	30.932	100	72.880	32.705	100	52.413	11.123	100
Cymatogaster aggregata	0	-	0	0	-	0	0.022	0.022	20	0	-	0	0.005	0.005	4
Embiotoca jacksoni	1.797	0.415	100	2.856	0.678	100	3.928	0.885	100	3.703	1.375	100	3.034	0.461	100
Galeorhinus galeus	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Gibbonsia elegans	0	-	0	0.018	0.018	17	0.067	0.149	20	0	-	0	0.019	0.015	9
Girella nigricans	6.359	2.796	100	3.287	1.248	100	7.106	1.826	100	3.547	2.363	100	4.986	1.070	100
Haemulon californiensis	0.042	0.028	33	0	-	0	0	-	0	0	-	0	0.011	0.008	9
Halichoeres semicinctus	4.155	0.699	100	3.694	1.078	100	4.684	1.289	100	11.466	4.080	100	6.057	1.275	100
Hermosilla azurea	0.472	0.472	17	0.250	0.218	33	0.033	0.020	40	0.083	0.057	33	0.217	0.133	30
Heterodontus francisci	0	-	0	0.014	0.014	17	0	-	0	0.014	0.014	17	0.007	0.005	9
Heterostichus rostratus	0.093	0.024	100	0.056	0.035	33	0.139	0.093	60	0.080	0.022	83	0.090	0.023	70
Hexanchus griseus	0	-	0	0	-	0	0.017	0.017	20	0	-	0	0.004	0.004	4
Hyperprosopon argenteum	0.361	0.361	17	0	-	0	0	-	0	0	-	0	0.094	0.094	4
Hypsurus caryi	0.236	0.153	33	0.315	0.193	50	0.128	0.054	60	0.408	0.237	67	0.278	0.087	52
Hypsypops rubicundus	14.835	2.683	100	16.685	8.118	100	27.117	6.050	100	18.172	5.526	100	18.858	2.919	100
Lythrypnus dalli	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Medialuna californiensis	2.266	1.248	100	1.042	0.476	100	1.456	0.679	80	1.903	0.835	83	1.676	0.419	91
Micrometrus minimus	0.177	0.046	83	0.139	0.109	33	0.978	0.441	80	0.347	0.159	67	0.385	0.121	65
Mycteroperca xenarcha	0.014	0.014	17	0.028	0.028	17	0	-	0	0	-	0	0.011	0.008	9
Myliobatis californica	0	-	0	0	-	0	0	-	0	0.011	0.011	17	0.003	0.003	4

Table 3. Continued.

B) Boomers

	2002			2003			2004			2005			2002-2005		
	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O	Mean	SE	O
Oxyjulis californica	51.956	23.659	100	21.717	6.494	83	70.011	26.699	100	62.411	14.528	100	50.720	9.574	96
Oxylebius pictus	0.012	0.012	17	0.051	0.037	33	0.033	0.020	40	0	-	0	0.024	0.011	22
Paralabrax clathratus	7.367	2.127	100	5.861	1.725	100	8.055	2.165	100	11.558	3.924	100	8.215	1.323	100
Paralabrax maculatofasciatus	0	-	0	0.028	0.028	17	0	-	0	0.042	0.042	17	0.018	0.013	9
Paralabrax nebulifer	0.381	0.226	100	0.180	0.062	67	0.255	0.108	60	0.133	0.041	83	0.237	0.065	78
Phanerodon furcatus	0.292	0.275	33	0	-	0	0.089	0.089	20	0.292	0.275	33	0.171	0.100	22
Rhacochilus toxotes	0.228	0.064	100	0.055	0.055	17	0.339	0.318	40	0.139	0.028	83	0.184	0.069	61
Rhacochilus vacca	0.294	0.083	83	0.232	0.124	50	0.017	0.017	20	0.133	0.051	67	0.175	0.044	56
Rhinobatos productus	0	-	0	0.014	0.014	17	0.022	0.022	20	0	-	0	0.008	0.006	9
Rhinogobiops nicholsii	0.049	0.036	33	0.037	0.037	17	0	-	0	0	-	0	0.023	0.013	13
Scorpaena guttata	0	-	0	0	-	0	0	-	0	0.014	0.014	17	0.004	0.004	4
Scorpaenichthys marmoratus	0.012	0.012	17	0	-	0	0	-	0	0	-	0	0.004	0.004	4
Sebastes atrovirens	0.156	0.061	83	0.037	0.037	17	0.100	0.100	20	0.055	0.028	17	0.087	0.029	35
Sebastes auriculatus	0	-	0	0	-	0	0	-	0	0.014	0.014	17	0.004	0.004	4
Sebastes paucispinis	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Sebastes rastrelliger	0	-	0	0	-	0	0.017	0.017	20	0	-	0	0.004	0.004	4
Sebastes serranoides	0.778	0.626	33	0	-	0	0.050	0.050	20	0.014	0.014	17	0.217	0.168	17
Sebastes serriceps	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Semicossyphus pulcher	2.678	0.384	100	4.292	0.671	100	4.900	1.269	100	5.153	1.808	100	4.238	0.580	100
Seriphus politus	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0
Sphyraena argentea	0	-	0	1.250	1.250	17	0.150	0.150	20	0.028	0.028	17	0.366	0.326	13
Stereolepis gigas	0.014	0.014	17	0.028	0.028	17	0	-	0	0	-	0	0.011	0.008	9
Urobatis halleri	0.028	0.017	33	0	-	0	0.200	0.200	20	0	-	0	0.051	0.043	13
Zapteryx exasperata	0.028	0.017	33	0.042	0.042	17	0.033	0.033	20	0	-	0	0.025	0.013	17

Table 4. Rank order list of the top twelve species of fishes at two sites in La Jolla between 2002 and 2005.

	La Jolla Cove	Boomers
Chromis punctipinnis (Blacksmith)	1	1
Oxyjulis californica (Señorita)	2	2
*Hypsypops rubicundus (*Garibaldi)	3	3
Paralabrax clathratus (Kelp Bass)	4	4
Girella nigricans (Opaleye)	5	6
Halichoeres semicinctus (Rock Wrasse)	6	5
Semicossyphus pulcher (California Sheephead)	7	7
Embiotoca jacksoni (Black Perch)	8	9
Paralabrax nebulifer (Barred Sand Bass)	9	-
Medialuna californiensis (Halfmoon)	10	10
Anisotremus davidsonii (Sargo)	11	11
Haemulon californiensis (Salema)	12	-
Brachyistius frenatus (Kelp Perch)	-	8
Amphistichus argenteus (Barred Surfperch)	-	12

shoreline in this area. This includes several large, mobile species of chondrichthyan fishes (Klimley et al. 2002), flyingfishes (Exocoetidae), tunas (Scombridae), the Louvar (*Luvarus imperialis*), and the Ocean Sunfish (*Mola mola*), as well as small mesopelagic species such as the Lowcrest Hatchetfish (*Argyropelecus sladeni*, Sternoptychidae) that become stranded on shore during storms. Interestingly, of the 63 species classified as pelagic, the ''common'' species are dominated by species with northern distributions (12 of 18 species), while the ''uncommon'' and ''rare'' species are dominated by species with southern distributions (30 of 45 species; Table 2).

Canyon Species

Among the most striking features of the La Jolla coastal zone is the proximity of the La Jolla and Scripps submarine canyons to the coastline (Brueggeman 2008). The heads of these canyons come within a few hundred meters of the shore, and the canyons descend to depths of over 500 meters within 7 km of the coastline. These canyons include steep rock walls, as well as sand and mud substrates that support a variety of fishes. Species recorded there number 123, with 68 common, 40 uncommon, and 15 rare species (Table 2). The canyon ichthyofauna is dominated by species with northern (64 species) or central (51) distributions, with relatively few (8) species with southern distributions (Table 2).

Notable among the canyon species are a surprisingly large number of rockfishes: 35 species of the genus *Sebastes* have been collected from the La Jolla canyons (Table 1). In addition, a few relatively rare or poorly known species have been taken from this habitat including the Canyon Sculpin, *Icelinus limbaughi* (Rosenblatt and Smith 2004) and the Deepwater Blenny, *Cryptotrema corallinum*. Some of these species, although rarely collected within the study area, may be more common in similar, high-relief habitats in other portions of southern California (Love and Schroeder 2007).

Discussion

The present study compiles records of 265 species collected within the immediate vicinity of the marine protected areas of La Jolla. Thus, these MPAs have the potential to

provide some measure of protection for half of the 519 marine fish species recorded from state waters (Horn et al. 2006). This inventory is based exclusively on fish specimens collected within the designated study area and archived in the MVC. Other fish species are known to occur in the region and likely occur or have occurred sporadically within the study area. These include a number of species known to be common in the San Diego area (Allen et al. 2002) such as the bonefish *Albula* sp. (Albulidae), the Striped Mullet, *Mugil cephalus* (Mugilidae), the Shortfin Corvina, *Cynoscion parvipinnis* (Sciaenidae), and several species of gobies (e.g., *Clevelandia ios*, *Gillichthys mirabilis, and Quietula y-cauda*). In addition, a number of southern species of fishes have periodically been collected in the San Diego area, often in association with El Niño events (e.g., Lea and Rosenblatt 2000). These include species such as the Cortez Angelfish, *Pomacanthus zonipectus* (Pomacanthidae), and the Three Banded Butterflyfish, *Chaetodon humeralis* (Chaetodontidae), which have been observed (but not collected) within the La Jolla study area (Lea et al. 1989; Pondella et al. 1998). As predicted more than a half century ago (Hubbs 1948), these records suggest that the number of southern species in the La Jolla area will likely increase as a result of climate change.

Natural history collections, especially those with a regional focus, are critical resources for documenting the biodiversity of particular areas. Sampling regimes of most natural history collections are not, however, designed with conservation biology in mind. Instead they traditionally have focused on the discovery and description of new species, creating biotic inventories for particular regions, and documenting species distributions. Few natural history collections are capable of documenting changes in the abundance of particular organisms because they typically lack repeated, quantitative samples from the same sites. They may, however, provide information on the occurrence and relative abundance of cryptic fishes that are often overlooked by diver surveys and other quantitative sampling methods. Also, because of the long time-scale represented in many natural history collections, they provide a more complete inventory of species occurring in an area than is typically available from ecological surveys alone.

In some cases, natural history collections provide insight into the importance of particular habitats to the overall diversity within a region. For example, this survey highlights the importance of the La Jolla submarine canyon as habitat for a number of rockfish species and other rare and poorly known deep-water fishes. In addition, natural history collections can document long-term changes in species composition. The historical collections in the MVC document the demise of one ecological component in La Jolla, bay species, via habitat destruction, and the appearance of an exotic species in the area. In contrast, quantitative ecological surveys such as visual surveys conducted by divers, are key to documenting the abundance and short-term changes in abundance of readily visible reef species and thus they are important in evaluating the performance of MPAs (Agardy 1997). These surveys supplement data from natural history collections on the temporal trends of species abundances, including those of importance to recreational and commercial fisheries.

The role of natural history collections in conservation biology would be facilitated by periodic resampling of key habitats and archiving of collected specimens on a regular basis. The extent to which this may be possible is dependent upon staffing of collections, available resources for collection and storage of specimens, and area restrictions on collecting activities. Resampling using historically successful methods may be problematic in many instances as collecting methods may be difficult to repeat. For example, many of the collections in the La Jolla and Scripps Canyons were made by Hubbs prior to

extensive coastal development in the area. He was able to use collecting methods that are now impractical, including dispersal of large amounts of rotenone or discharge of explosives at depth. These are unthinkable in the current environment of dense human populations and activities in the area, and regulations protecting the region's biota. Instead, newer technologies such as submersibles and ROVs may be applied (Starr et al. 2008; Lindholm et al. 2012; Stierhoff et al. 2013), but these often provide low resolution of species identities and rarely reveal small or cryptic species. While the MPAs within the La Jolla region and those in other areas appropriately limit collecting within their boundaries, managers should be encouraged to permit reasonable levels of collection of specimens as long as the specimens are archived in a suitable natural history collection where they will be available to future generations of researchers.

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