REVIEW OF SELECTED CALIFORNIA FISHERIES FOR 2013: COASTAL PELAGIC FINFISH, MARKET SQUID, GROUNDFISH, HIGHLY MIGRATORY SPECIES, DUNGENESS CRAB, BASSES, SURFPERCH, ABALONE, KELP AND EDIBLE ALGAE, AND MARINE AQUACULTURE

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SUMMARY

In 2013, commercial fisheries landed an estimated 165,072 metric tons (t) of fish and invertebrates from California ocean waters (fig. 1). This represents an increase of almost 2% from the 162,290 t landed in 2012, but still an 11% decrease from the 184,825 t landed in 2011, and a 35% decline from the peak landings of 252,568 t observed in 2000. The preliminary ex-vessel economic value of commercial landings in 2013 was $254.7 million, increasing once again from the $236 million generated in 2012 (8%), and the $198 million in 2011 (29%).

Coastal pelagic species (CPS) made up four of the top five volume fisheries in 2013. California market squid continued to be the largest volume, and second highest value fishery in the state with over 104,363 t landed and an ex-vessel value of approximately $73.7 million; an increase of 7% and 15% respectively from 2012. For the fourth season in a row, market squid landings were projected to reach the seasonal catch limit of 107,048 t. Accordingly, the Department of Fish and Wildlife (Department) closed the fishery with a total of 104,267 t landed for the open portion of the 2013–14 season. Pacific mackerel emerged as California's third largest volume fishery with 8,066 t landed worth $1.5 million in ex-vessel revenue, which continues an increasing trend from 3,485 t in 2012 ($872,820) and 1,357 t in 2011. For the first time since 1993, the Pacific mackerel fishery ranked as the largest among the four federally managed CPS finfish (Pacific sardine, Pacific mackerel, jack mackerel, and northern anchovy), comprising nearly 37% of the total volume and 35% of the total value. The Pacific sardine fishery has long been one of the largest in the state. However, in 2013 it dropped to the fourth largest in volume and thirteenth in value, landing 7,074 t worth $1.6 million. In 2012 it was the second largest in volume (23,037 t) and eighth largest in value ($5.1 million). The recommended harvest guideline (HG) for 2013 season was 66,495 t based on a biomass estimate of 659,539 t, which was a decrease from the 2012 recommended HG of 109,409 t based on a biomass estimate of 988,385 t. In 2013 northern anchovy surpassed red sea urchin as the fifth largest volume fishery. Landings of northern anchovy were 6,005 t with an ex-vessel revenue of greater than $1.0 million. When compared to landings in 2012, this represents a 141% and 191% increase in volume and value, respectively. Nearly all (93.6%; 5,621.5 t) of California's 2013 northern anchovy catch was landed in the Monterey port area. Landings of jack mackerel remained relatively low with 892 t landed; however, this represents a 515% increase over 2012 landings of 145 t.

Dungeness crab ranked as California's second largest volume fishery with 14,066 t landed, an increase from 11,696 t landed in 2012, and it continued to dominate as the highest valued fishery in the state with an ex-vessel value of over $88.7 million, increasing from $85.6 million in 2012. The 2012–13 season in the northern management area was the second consecutive season to be delayed as late as January 15, the maximum allowed by law. Central California coast crab usually molt earlier than northern crab, and the area is not subject to opening delays by statute. The 2013–14 season is the first season to employ trap limits, implementing a program created by Senate Bill 369 passed in 2011. The trap limit program places a cap on the number of traps a vessel can fish dependent on where the vessel places among the seven trap tiers.

More than 90 species of bottom-dwelling marine finfish are included in the federally-managed groundfish fishery. The species that comprise the groundfish fishery are diverse and complex; their primary distributions range from nearshore depths to deep offshore habitats. In 2013, California's commercial groundfish landings totaled 6,443 t, worth an estimated ex-vessel value of $17.4 million. This represents an increase in landings (5%; 6,162 t) and a decrease in ex-vessel value (3%; $17.9 million) compared to 2012. An estimated 2,021 t of groundfish were taken by the recreational fishery in 2013 which represents a 22% increase compared to 2012 (1,656 t). Since 2007, the Department has conducted an extensive outreach and education campaign to educate the public on the use of descending devices to minimize mortality of discarded fish and increase post release survival. In 2012, the Pacific Fishery Management Council (Council) decided to examine the issue of accounting for

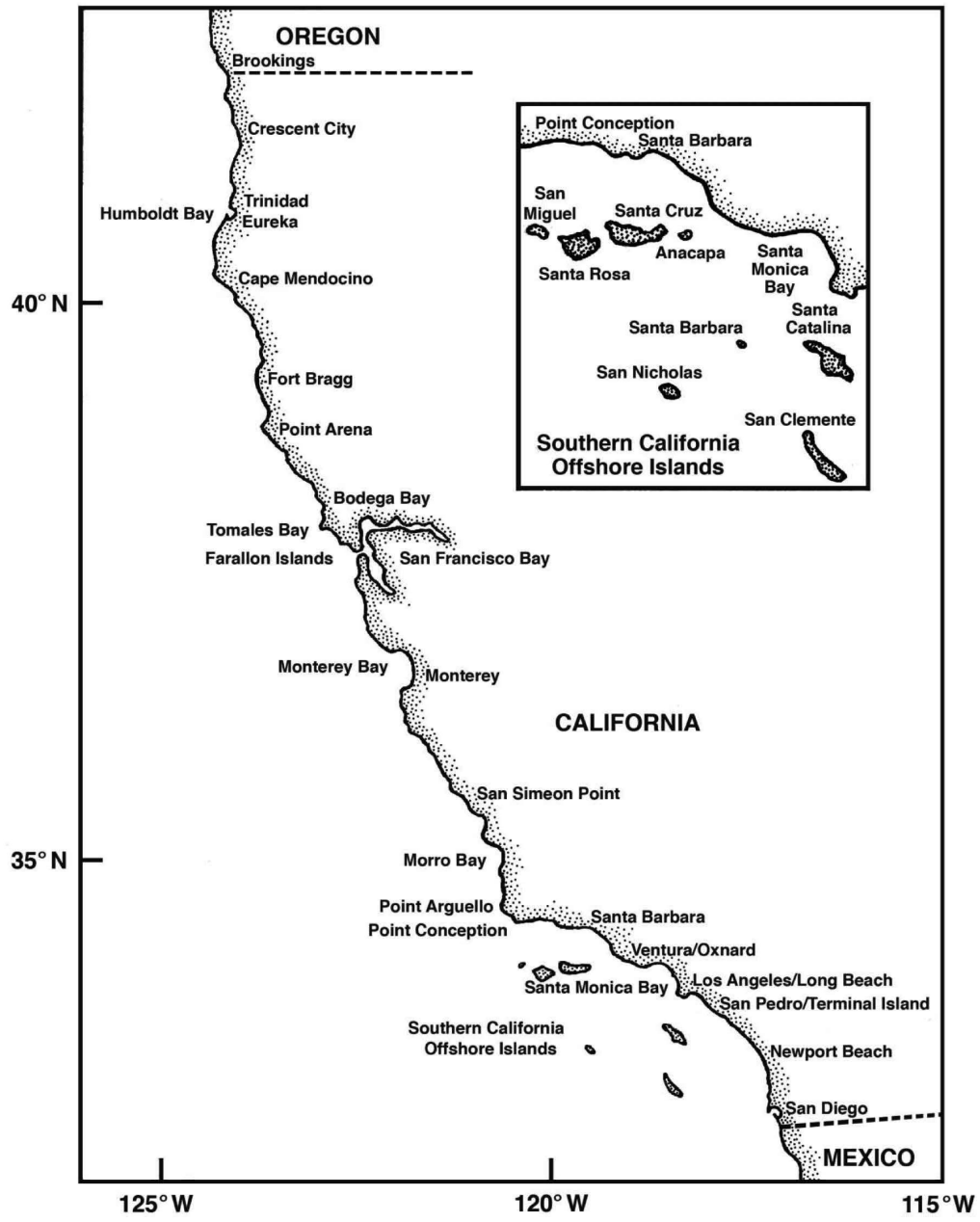

Figure 1. California ports and fishing areas.

descending devices use in groundfish management. The Council agreed that differential mortality rates for each species of rockfish associated with the use of a descending device was a priority that needed to be accounted for in modeling and management.

Highly Migratory Species fisheries (HMS) landed a total of 963 t with a combined ex-vessel value of nearly $4.1 million. Of all species that are federally regulated under the West Coast Highly Migratory Species Fishery Management Plan (HMS FMP), swordfish commands the highest price-per-pound and brings in the highest total revenue of all HMS species landed in California. In 2013, there were 525 t of swordfish landed with an ex-vessel value of nearly $2.7 million.

During the first half of the twentieth century, kelp bass, barred sand bass, and spotted sand bass were targeted by both recreational and commercial fishermen. In 1953, due to concerns regarding declining catch, commercial take of these basses was prohibited and a minimum size limit was established for recreational take. Bag limits for the basses first began in 1939 and have fluctuated over the years, but have remained the same since 1975. Due to concerns from the Department and the public regarding the continued declining catch, a thorough analysis of the

saltwater bass fishery was recently conducted. In March 2013, the Commission implemented new size and bag limits for all three species.

The surfperch assemblage includes seaperch and perch, and encompasses 24 species. Many of California's marine surfperch are the target of a modest commercial fishery in central and northern California (11.6 t in 2013) and a sizable recreational fishery throughout the state. The surfperch fisheries in California are solely managed by the Department. No formal stock assessments have been completed for surfperch and the fisheries are considered data-poor; however, there is no indication that surfperch stocks are in decline based on the best available data. Although surfperch stocks do not appear to be declining, their low fecundity and mating and spawning aggregations may cause them to be more vulnerable to fishing. Water pollution and changing sea temperature can also cause vulnerability.

The recreational red abalone fishery in northern California is the largest in the world, with over 30,000 participants annually. The average annual take between 2002 and 2012 was approximately 254,000 red abalone, with fishing effort centered on the coastal counties of Sonoma and Mendocino. The fishery is actively managed by the state under the Abalone Recovery and Management Plan (ARMP) using traditional fishery management strategies as well as an innovative adaptive management approach incorporating density survey data in decision making. In northern California, fishery-independent density surveys are conducted triennially at eight (fished) index sites to assess whether fishing regulations are maintaining densities through time. Catch from these sites accounts for ~48% of the total fishery catch. These index sites were chosen to provide early warning for declines in density in the fishery overall. The ARMP harvest control rules provide for reductions in take and site closures if overall densities across the index sites fall below established baselines.

There are 87 administrative kelp beds located offshore of California's mainland and surrounding the Channel Islands. The administrative kelp beds contain giant or bull kelp or a combination of both. Along the California coast perennial giant kelp is most abundant south of San Francisco (San Mateo County). Bull kelp is an annual alga found offshore from central to northern California, with greater amounts of bull kelp in northern California. Giant kelp harvested during the January 1–December 31, 2013 harvest season was 3,305 t (reported landings include a nominal amount of bull kelp). During this time the majority of giant kelp was harvested from boats using small mechanized harvesters or by hand to provide food for aquacultured abalone. Commercial edible algae harvesting includes a variety of marine algae. In 2013, the total reported commercial harvest of edible algae was 17 t, up slightly from the annual average of 14 t reported from 1997 to 2013. The commercial harvest of edible algae is regional, with 90% of the harvest occurring along the north coast (Alder Creek in Mendocino County to the California/Oregon border) during 2000–13. Recreational harvest of giant and bull kelp and other edible algae for personal use is also permitted. Amendments to the regulations governing the commercial harvest of giant and bull kelp were implemented in 2013. The regulation amendments were Phase One of a three phase process. Phase Two will address commercial marine algae license fees and royalty rates. Phase Three will follow with a focus on marine algae management policies including marine algae harvest methods.

California's commercial marine aquaculture industry consists of the production of five oyster species, clams, mussels, and abalone. In California, the Department manages 21 state water bottom leases for marine aquaculture, totaling 1,952 acres. Additional marine aquaculture operations occur on granted or privately owned tidelands, adding an addition 3,948 acres for a statewide total of 5,900 acres of water bottoms utilized for marine aquaculture. There are also marine aquaculture facilities established on privately owned uplands along the California coastline. Total shellfish production in 2013 (January through December) had the second highest recorded harvest in the 42 year history of landings, reaching a total of 828 t, all species combined. This resulted in a value of $24.2 million. Compared to 2012, there was a 19% increase in production in 2013, all species combined. The culture of Pacific oysters represented the largest production for the industry, resulting in 73% of the total production, and 70% of the total value in 2013.

Coastal Pelagic Finfish

Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*) form a finfish complex known as coastal pelagic species (CPS). These species are jointly managed by the Pacific Fishery Management Council (Council) and the National Marine Fisheries Service (NMFS) under the Coastal Pelagic Species Fisheries Management Plan (CPS FMP). In 2013, total commercial landings for these species equaled 22,036 t (table 1), with a combined ex-vessel revenue of over $4.3 million. When compared to landings in 2012, this represents a 25% and 23% decrease in volume and value, respectively. For the first time since 1993, the Pacific mackerel fishery ranked as the largest among these four species in 2013, comprising 36.6% of the total volume and 35% of the total value.

Pacific Sardine. The Pacific sardine fishery in California has long been one of the largest in the state. In 2013 it was the fourth largest in volume and thirteenth largest

TABLE 1
Landings of Coastal Pelagic Species in California (metric tons)

Year	Pacific sardine	Northern anchovy	Pacific mackerel	Jack mackerel	Unspecified mackerel	Pacific herring	Herring roe	Market squid	Total
1977	2	101,132	3,316	47,615		5,286		12,811	170,163
1978	1	11,439	8,241	34,349	48	4,473		17,145	75,696
1979	51	48,880	22,404	21,548	301	4,257		19,982	117,424
1980	21	42,946	25,739	24,181	56	8,061		15,385	116,389
1981	34	52,308	35,257	17,778	132	5,961		23,510	134,980
1982	2	42,150	17,667	19,618	18,398	10,604		16,308	124,747
1983	1	4,427	17,812	9,829	23,659	8,024		1,824	65,576
1984	1	2,889	26,043	9,149	18,038	3,847		564	60,532
1985	6	1,626	18,149	6,876	19,624	7,984		10,275	64,540
1986	388	1,535	22,095	4,777	25,995	7,658		21,278	83,727
1987	439	1,390	26,941	8,020	19,783	8,420		19,984	84,978
1988	1,188	1,478	30,127	5,068	20,736	8,641		37,233	104,471
1989	837	2,449	21,067	10,746	26,661	9,296		40,893	111,950
1990	1,664	3,208	31,077	3,223	9,039	7,436		28,447	84,094
1991	7,587	4,014	31,680	1,693	339	7,347		37,389	90,048
1992	17,950	1,124	18,574	1,209	3	6,319		13,110	58,289
1993	15,346	1,958	11,798	1,673		3,846	0	42,722	77,345
1994	11,644	1,789	10,008	2,704	0	77	2,874	55,508	84,603
1995	40,328	1,886	8,625	1,728		3	4,664	72,433	129,667
1996	32,559	4,421	9,597	2,178	4	249	5,162	80,784	134,954
1997	43,246	5,718	18,398	1,160	1	0	9,147	70,387	148,057
1998	42,956	1,457	20,515	824		0	2,009	2,895	70,656
1999	59,493	5,179	8,688	953	0		2,279	91,950	168,542
2000	53,612	11,754	21,916	1,269	0	26	3,450	118,816	210,843
2001	51,894	19,277	6,925	3,624	1	0	2,768	86,385	170,873
2002	58,354	4,643	3,367	1,006	2	0	3,324	72,920	143,615
2003	34,732	1,676	3,999	156	0	34	1,808	45,061	87,467
2004	44,305	6,793	3,570	1,027	0	60	1,581	41,026	98,362
2005	34,633	11,182	3,244	199		219	136	58,391	108,005
2006	46,577	12,791	5,891	1,167	0	37	694	49,159	116,316
2007	80,981	10,390	5,018	630	1	336	261	49,474	147,091
2008	57,806	14,285	3,530	274	0	131	626	38,101	114,754
2009	37,578	2,668	5,079	119	1	74	460	92,338	138,317
2010	33,658	1,026	2,056	310	0			129,904	166,954
2011	27,714	2,601	1,357	80	0		1,566	121,556	154,874
2012	23,037	2,488	3,485	145	0		1,482	97,078	127,715
2013	7,074	6,005	8,066	892	1	0	2,086	104,404	128,528

Data Source: Commercial Fisheries Information System (CFIS)

TABLE 2
Landings (metric tons) of Pacific sardine (*Sardinops sagax*) and Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*) at California port areas for 2013.

	Pacific sardine		Pacific mackerel		Jack mackerel		Northern anchovy	
Area	Landings	% Total	Landings	% Total	Landings	% Total	Landings	% Total
Monterey	823.2	11.7	0.1	0.0	0.0	0.0	5621.5	93.6
Santa Barbara	221.5	3.2	0.4	0.0	0.0	0.0	201.2	3.4
Los Angeles	5,987.9	85.1	7,226.2	100.0	889.1	100.0	180.9	3.0
Total	7,032.7	100	7,226.6	100	889.2	100	6,003.6	100

*Monterey totals include San Francisco landings; Los Angeles totals include Oceanside landings.

in value, landing 7,073.5 t and generating an ex-vessel revenue of $1.6 million (fig. 2). This was a 69% decrease from 2012 (23,003 t). Commercial landings of sardine averaged 42,280 t over the thirteen year period from 2001–13. Nearly all (96.8%) of California's 2013 sardine catch was landed in Los Angeles (85.1%, 5,987.9 t) and Monterey (11.7%, 823.2 t) port areas (table 2). California exported 5,679.1 t of sardine product worth over $5.1 million. Twenty-six countries received sardine product from California; Australia and Thailand received the majority at 30% and 15%, respectively.

While the fishery ranges from Baja California, Mexico, north to British Columbia, Canada, the majority of landings have occurred in southern California and northern Baja California since the 1980s. Landings of sardine have steadily increased in the Pacific Northwest and Canada since the recent expansion of the sardine fishery in 1999. Combined landings of Pacific sardine for

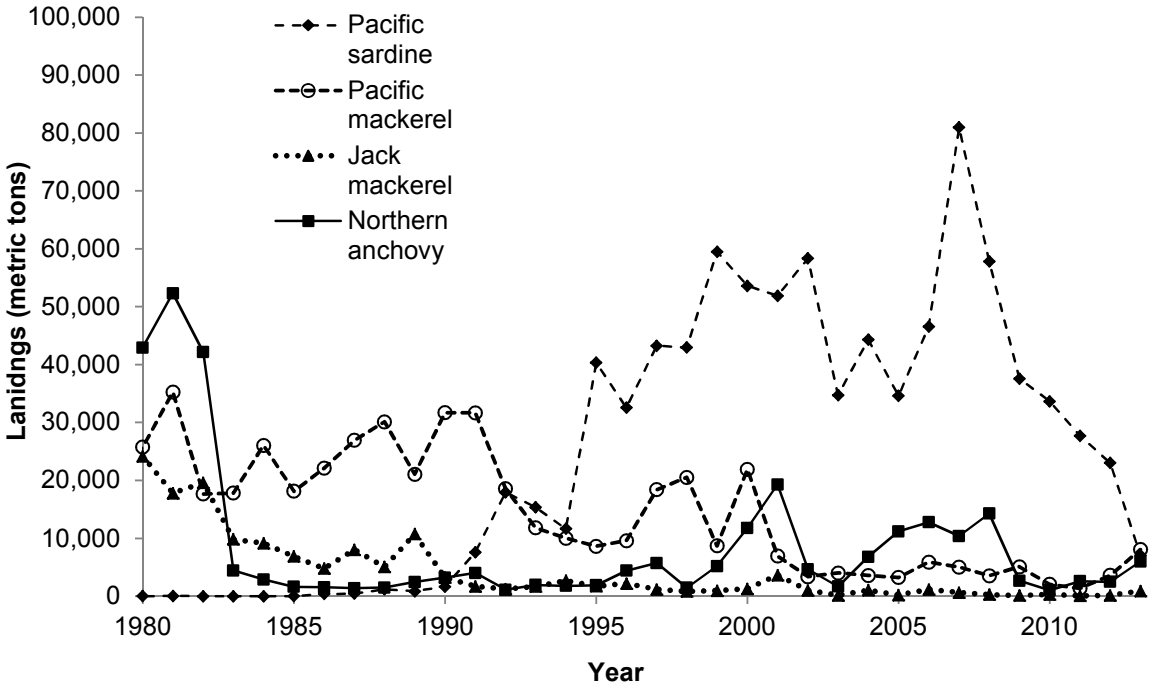

Figure 2. California commercial landings of Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*), 1980–2013.

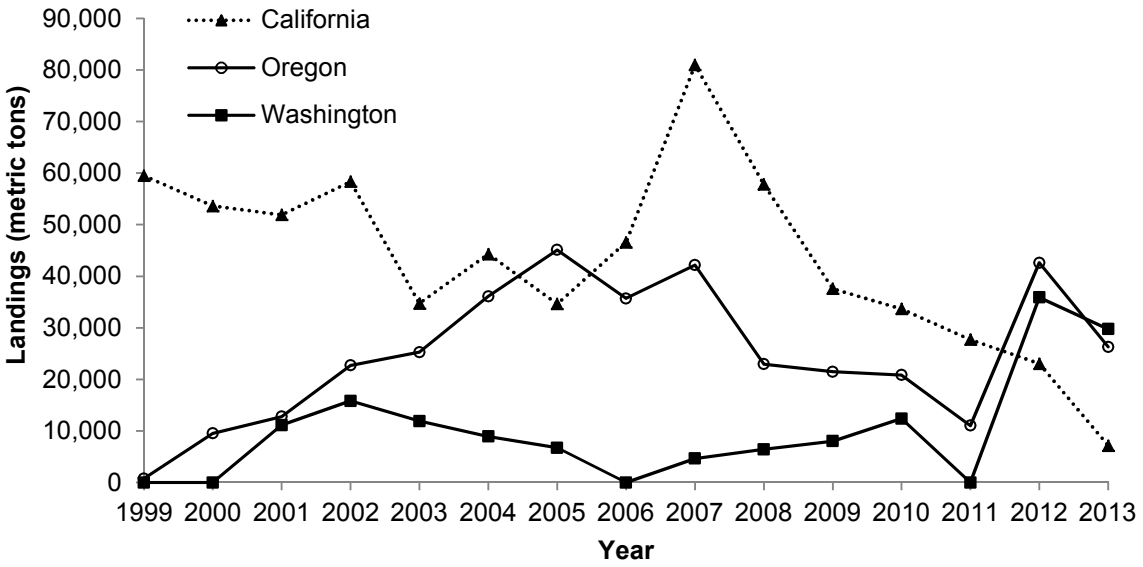

Figure 3. Commercial landings of Pacific sardine (*Sardinops sagax*) in California, Oregon, and Washington, 1999–2013.

California, Oregon, and Washington totaled 63,181.9 t, a 37.8% decrease from the 101,553.7 t landed in 2012 (fig. 3). The Pacific sardine harvest guideline (HG) for each calendar year is determined from the previous year's stock biomass estimate (of ≥1-year-old fish on 1 July) in US and Mexican waters. The recommended HG for 2013 season was 66,495 t based on a biomass estimate of 659,539 t. The Pacific sardine HG was apportioned coast-wide through the year with a 35% allocation of the annual HG from 1 January through 30 June, 40% (plus any portion not harvested) allocated from 1 July through 15 September, and the last 25% (plus any portion not harvested from the first two allocations) released on 15 September.

In 2013, the US West Coast fisheries harvested a large portion (95%) of the HG. The first allocation period (1 Jan–30 Jun) lasted through the entire allocation period, 180 days. The second period (1 Jul–14 Sep) lasted

52 days; the fishery was officially closed on 22 August. The third allocation period (15 Sep–31 Dec) also lasted the entire allocation period, 107 days.

Oregon landings appeared to be leveling off since 2008, experienced a large jump in 2012 and decreased in 2013. Landings of Pacific sardine totaled 26,288.4 t, a 38% decrease from 2012 (42,618.4 t). In 2013, Oregon exported 3,722 t of sardine product to 3 countries (Malaysia, Thailand, and China) worth $2.9 million.

Washington landings of Pacific sardine totaled 29,747.7 t in 2013, a decrease of 17% from 2012 (35,891.5 t). They exported 44,740.2 t of sardine product to 26 countries, totaling $39.9 million in revenue.

The recreational Pacific sardine catch as sampled from the California Recreational Fisheries Survey (CRFS) was 77 t (731,170 fish). The majority (99%) of the fish landed were from manmade structures, such as piers. While the tonnage was slightly larger than the 74 t caught in 2012, there was a 29% decrease in the number of fish.

In November 2013, the start date of the 12 month Pacific sardine fishery was changed from 1 January to 1 July; this changed the fishing season from one based on a calendar year (1 January–31 December) management cycle to a fishing season (1 July–30 June) cycle. This change will better align the timing of the research and science required for annual stock assessments with the annual management schedule. A one-time interim harvest period from 1 January 2014 through 30 June 2014 was established with an allocation of 5,446 t to allow targeted fishing to continue during the transition to the new management cycle.

Pacific Mackerel. In 2013, 8,065 t of Pacific mackerel were landed in California (table 1, fig. 2) generating over $1.5 million in ex-vessel revenue, and making it California's third largest volume fishery. This is a 124% increase in volume and a 67% increase in ex-vessel revenue from 2012. Industry exported 2,040.9 t of mackerel product, valued at $1.9 million, mainly for human consumption, to 16 countries. Australia (898.9 t) and the Philippines (625.1 t) received over 74% of this product.

Oregon reported landing 439.3 t of Pacific mackerel in 2013, with an ex-vessel revenue of $79,831. This is a 75% decrease from the 2012 catch of 1,779.2 t. No exports were reported for Oregon. Washington did not report any landings of Pacific mackerel in 2013.

At the start of the 2013–14 season, which runs from 1 July to 30 June the following year, the PMFC set the HG at 39,268 t, including a 13,089 t set-aside for incidental landings in other fisheries. Landings above the HG would be constrained by an incidental catch rate of 45% by weight when landed with other CPS.

The 2013 recreational Pacific mackerel catch as sampled from CRFS was 159 t (902,882 fish), a 21.5% decrease (27% by number of fish) from 2012. The majority (66%, 595,456 fish) of fish landed were from manmade structures; 29% of fish were landed on CPFVs.

Jack Mackerel. Jack mackerel has long been the smallest of the federally managed CPS finfish fisheries and represented 4% of the total landings of these fisheries in California for 2013. Landings of jack mackerel totaled 892 t in 2013, with an ex-vessel revenue of $178,686 for California (table 1, fig. 2). Landings in Oregon jumped dramatically in 2012 (95.5 t) and increased by 29% in 2013 (123.2 t), bringing an ex-vessel revenue of $12,358. Washington reported no landings of jack mackerel during 2013.

The 2013 recreational jack mackerel catch as sampled from CRFS was 4.25 t (22,208 fish), a 43.75% decrease (53% by fish) from 2012. A total of 16,466 fish were landed on manmade structures.

Northern Anchovy. Composed of three stocks, southern, central and northern, landings of northern anchovy in California have been reported since the early 1900s. Currently, northern anchovy are a monitored species under the CPS FMP. Studies of scale deposits on the sea floor suggest that their abundance has historically been quite large. Now used for animal food, live bait, and human consumption, anchovy was used mainly in a reduction industry to produce oil and fish meal in the 1900s. From the 1900s to the late 1970s, northern anchovy was a major component of California's commercial CPS fisheries. During periods of low sardine abundance, anchovy landings have increased, hitting a peak in the mid-1970s at over 100,000 t. However, commercial landings of northern anchovy have remained relatively low since the 1980s due to market constraints. Presently, landings of northern anchovy are modest, averaging 7,682 t per year over the last 13 years. Only occasionally landed in Oregon and Washington, the California fishery is harvested from the central stock, which ranges from San Francisco to northern Baja California.

Landings of northern anchovy in California for 2013 were 6,005 t with an ex-vessel revenue of greater than $1.0 million (table 1, fig. 2). When compared to landings in 2012, this represents a 141% and 191% increase in volume and value, respectively. Nearly all (93.6%; 5,621.5 t) of California's 2013 northern anchovy catch was landed in the Monterey port area (table 2). Exports of northern anchovy product from California totaled 268.3 t for an export value of $589,597. Five countries received anchovy product from California; Australia received the majority at over 87%. In 2013, Oregon and Washington reported landing 13 t and 116 t of anchovy, respectively (NOAA West Coast Region). Oregon did not report any anchovy exports in 2013. Washington exported 10 t of anchovy product to Canada, totaling $65,694 in revenue.

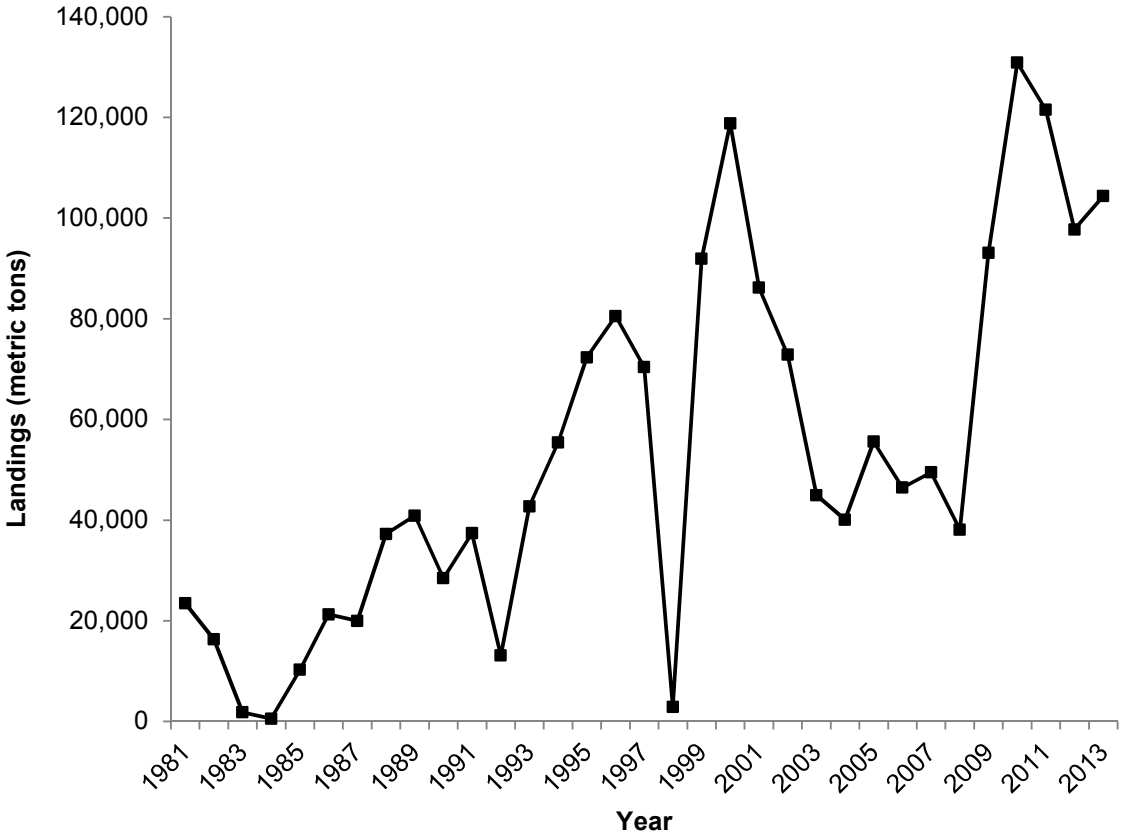

Figure 4. California commercial market squid (*Loligo (Doryteuthis) opalescens*) landings, 1981–2013.

The 2013 recreational northern anchovy catch as sampled from CRFS was 5 t (456,087 fish), a 765% increase (769,000% by fish) from 2012. The majority (98%) of the fish landed were from manmade structures, the remaining 2% of fish were landed from CPFVs.

California Market Squid

In 2013, market squid (*Loligo* (*Doryteuthis*) *opalescens*) continued to dominate commercial landings of marine species in California, contributing about 63% of the total tonnage and 29% of total ex-vessel value of all species landed. Landings of market squid in 2013 increased 7% compared to 2012 landings, from 97,733 t to 104,363 t (fig. 4). Ex-vessel value in 2013 increased 15% compared to 2012, from $63.9 million to $73.7 million. California fish businesses exported 71,452 t of market squid to 35 countries for a value of $104 million in 2013. The majority (86%) was shipped to just 3 countries but most (73%) went to China.

For the fourth season in a row, since the inception of the Market Squid Fishery Management Plan (MS FMP) in 2005, market squid landings were projected to reach the seasonal catch limit of 107,048 t. Accordingly, the Department of Fish and Wildlife (Department) closed the fishery on 18 October 2013, with a total of 104,267 t landed for the open portion of the 2013–14 season.

Commercial fishing for market squid is limited by fishery control rules set forth in the MS FMP. Vessels are required to have a permit to commercially fish for market squid. In 2013, there were 76 market squid vessel (purse or drum seine), 34 light boat (attracting), and 44 brail (or dip net) permits issued. Of the 76 vessel permits issued, 68 vessels were active in the fishery with 47 vessels contributing 95% of the landings. Other fishery control rules include a seasonal catch limit that starts April 1 and ends March 31 of the following year, weekend closures, spatial closures, and lighting restrictions.

Although the fishery has its historical origins in Monterey Bay, the fishery has been dominated by southern California landings (fig. 5). Of note is the increase in landings for Monterey, which has seen over 14,000 t in each of the last four seasons.

Market squid live less than a year and have been found in nearshore waters of the eastern Pacific Ocean from Baja California to the Gulf of Alaska. The population appears to fluctuate widely in abundance in response to short-term oceanographic events, like the El Niño Southern Oscillation. Ecologically, they are considered important as forage for other species, including predatory fishes, marine mammals, and seabirds.

A live bait fishery exists for market squid, largely to supply recreational fishing in southern California. The live bait fishery is a low-volume, high-value endeavor,

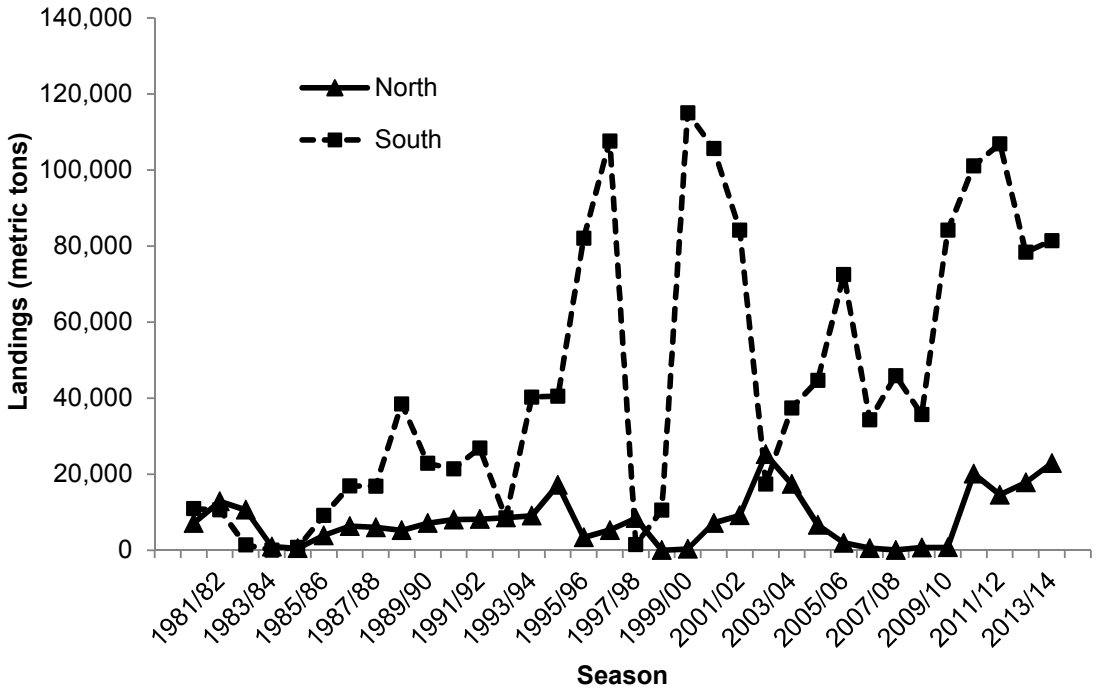

Figure 5. Comparison of market squid (*Loligo (Doryteuthis) opalescens*) landings for northern and southern fisheries by fishing season (1 April–31 March), from 1980/81 to 2013/2014 seasons.

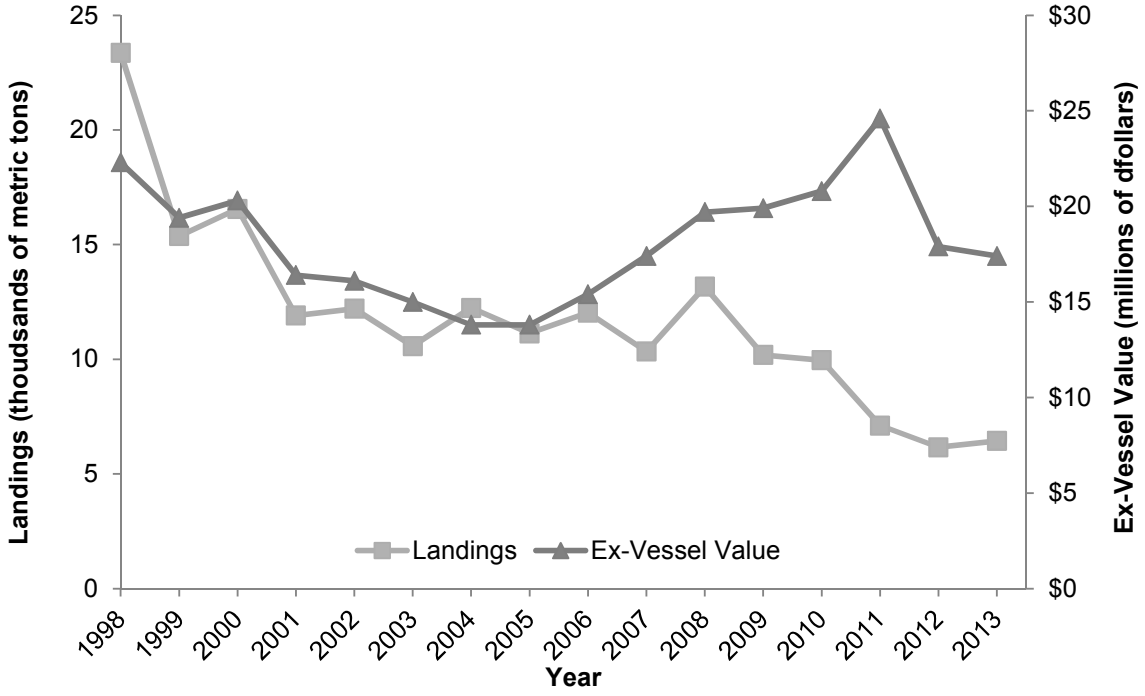

Figure 6. California commercial groundfish landings, 1998–2013.

as recreational anglers are willing to pay up to $60 for a "scoop" of live squid, which averages 10 lbs.

Groundfish

More than 90 species of bottom-dwelling marine finfish are included in the federally-managed groundfish fishery. The species that comprise the groundfish fishery are diverse and complex; their primary distributions range from nearshore depths to deep offshore habitats. "Groundfish" species include all rockfishes in the Scorpaenidae family, flatfishes such as Dover sole (*Microstomus pacificus*) and petrale sole (*Eopsetta jordani*),

TABLE 3
California commercial groundfish landings (in metric tons) and ex-vessel value in 2013 with comparisons to 2012. The top species by weight for the Flatfishes and Rockfishes are represented in the table.

	2013		2012		% change from 2012	% change from 2012
	Harvest (mt)	Value ($)	Harvest (mt)	Value ($)	(mt)	($)
Flatfishes						
Dover sole	2,218	$2,143,990	2,151	$1,936,707	3%	11%
Petrale sole	470	$1,321,525	222	$697,277	112%	90%
Arrowtooth flounder	118	$26,824	99	$23,815	19%	13%
English sole	49	$39,777	23	$21,091	112%	89%
Rex sole	45	$42,920	48	$40,913	–5%	5%
Sand sole	15	$37,774	18	$49,233	–13%	–23%
Other flatfishes	28	$24,679	24	$48,743	15%	–49%
Total Flatfishes	2,944	$3,637,489	2,585	$2,817,779	14%	29%
Rockfishes						
Chilipepper	322	$472,897	236	$362,174	37%	31%
Blackgill rockfish	72	$146,033	127	$369,358	-43%	–60%
Bank rockfish	52	$110,088	11	$23,480	370%	369%
Black rockfish	36	$159,878	24	$105,557	48%	51%
Brown rockfish	28	$422,334	26	$363,624	8%	16%
Vermilion rockfish	23	$142,335	17	$103,475	36%	38%
Gopher rockfish	23	$392,733	23	$370,588	1%	6%
Other rockfishes	100	$751,094	179	$821,693	-44%	–9%
Overfished species						
Bocaccio	16.5	$39,700	12.37	$28,765	33%	38%
Canary rockfish	1.6	$3,474	0.56	$817	190%	325%
Cowcod	0.2	$191	0.08	$74	131%	159%
Darkblotched rockfish	4.2	$6,204	6.51	$9,602	–36%	–35%
Pacific ocean perch	0.05	$56	0.07	$67	–22%	–17%
Yelloweye rockfish	0.01	$30	0.003	$3	337%	1006%
Total Rockfishes	679	$2,647,047	663	$2,559,276	2%	3%
Roundfishes						
Sablefish	1,375	$7,014,561	1,627	$9,007,673	–15%	–22%
Lingcod	64	$294,396	48	$208,735	34%	41%
Cabezon	29	$361,832	31	$363,917	–5%	–1%
Kelp greenling	5	$70,790	5	$68,598	8%	3%
Pacific whiting	4	$212	4	$1,876	3%	–89%
Total Roundfishes	1,478	$7,741,790	1,714	$9,650,799	–14%	–20%
Scorpionfish, California	3	$28,399	4	$41,671	–32%	–32%
Sharks & Skates	172	$145,009	184	$161,885	–6%	–10%
Thornyheads	1,085	$3,114,120	914	$2,641,905	19%	18%
Other Groundfish	84	$68,466	99	$52,604	–15%	30%
Total Groundfish	6,443	$17,382,320	6,162	$17,925,918	5%	–3%

*Petrale sole was declared overfished in 2009
Data Source: CFIS (CMASTR) Extraction Date: 04/28/2014

roundfishes such as sablefish (*Anoplopoma fimbria*) and lingcod (*Ophiodon elongatus*), and various sharks and skates. These groundfish species are distributed between 39 federal 'management units,' consisting of species or species groups, to help facilitate management measures that balance biological and economical goals.

Commercial Fishery. In 2013, California's commercial groundfish landings totaled 6,443 t, worth an estimated ex-vessel value of $17.4 million. This represents an increase in landings (5%; 6,162 t) and a decrease in ex-vessel value (3%; $17.9 million) compared to 2012. During the last decade, groundfish landings declined by 39% (6,443 t in 2013 versus 10,573 t in 2003); yet the ex-vessel value increased nearly 16% ($17.4 million in 2013 versus $15.0 million in 2003). Although annual landings declined, the fishery experienced an increase in value over the past decade (fig. 6). The majority (80%) of groundfish landed in California, worth 57% of the ex-vessel value, was landed between the California/Oregon border and the Monterey Bay area. In the groundfish fishery the majority (77%) of landings by weight were made by trawl gear, followed by hook and line and trap gear (23%). However, hook and line and trap gear generated 57% of the ex-vessel value. The majority (86%) of trips were made with hook and line and trap gear while trawl gear was used to a lesser extent (13%); other gears comprised the remainder. In 2013, landings of Dover sole, sablefish, thornyheads (*Sebastolobus altivelis* and *S. alascanus*), petrale sole and chilipeper (*Sebastes goodei*) continued to be the top

species by weight, with 2,218 t, 1,375 t, 1,079 t, 470 t and 322 t landed respectively. These species comprised 85% of the groundfish landings. Groundfish landings in 2013 were mostly comprised of flatfishes (46%), followed by roundfishes (23%), thornyheads (17%) and rockfish (11%). The "other" groundfish species category was comprised of grenadier (Macrouridae) which accounted for 83 t (table 3). Chilipepper was the top rockfish species by weight in 2013, with landings of 322 t worth an ex-vessel value of $472,962. Unlike high-volume, high-value species such as sablefish, nearshore rockfishes are generally a low-volume, high-value commodity in California—brown rockfish (*S. auriculatus*), gopher rockfish (*S. carnatus*) and grass rockfish (*S. rastrelliger*) were worth a combined ex-vessel value of $1,079,359 with landings of 28 t, 23 t and 13 t respectively. Restricted access and the live fish market are primarily responsible for the high market value of the nearshore fishery. In 2013 the top grossing nearshore species were grass rockfish, black-and-yellow rockfish (*S. chrysomelas*) and gopher rockfish; valued at approximately $21,100/t, $17,200/t and $17,000/t, respectively. By contrast, chilipepper (a non-nearshore rockfish) was valued at approximately $1,500/t.

Landings of overfished rockfish species, which accounted for <1% of the groundfish landings in 2013, increased compared to 2012 (23 t versus 20 t). In both years the predominant specie was bocaccio (*S. paucispinis*), which accounted for 73% and 63% of the total overfished rockfish species landings in 2013 and 2012, respectively. Strong year classes and an increase in abundance are likely causes of the increased bocaccio encounters in recent years. Management measures to protect overfished species have greatly reduced landings over the past decade.

Recreational Fishery. The Recreational Fisheries Information Network (RecFIN) Program stores recreational data from California, Oregon, and Washington. RecFIN incorporates data from two recreational fishery sampling programs in California—the Marine Recreational Fisheries Statistical Survey (MRFSS), which operated from 1980 to 2003, and the California Recreational Fisheries Survey (CRFS) initiated by the Department of Fish and Wildlife (Department) in 2004. These data, which are available from 1980 to the present, represent the best available information on recreational catch in California. CRFS data indicate that California anglers targeting groundfish participated in an estimated 863,000 trips in 2013, a small decrease (<1%) from 2012 (867,000 trips). The predominant gear type used in the California recreational groundfish fishery is hook and line.

An estimated 2,021 t of groundfish were taken by the recreational fishery in 2013 (table 4), which represents a 22% increase compared to 2012 (1,656 t). The top five species were lingcod, black rockfish (*S. melanops*), vermilion rockfish (*S. miniatus*), bocaccio, and California scorpionfish (*Scorpaena guttata*), which accounted for approximately 62% of the groundfish catch by weight; in 2012, the same five species comprised 57% of the catch. In 2013, the majority (51%) of groundfish catches occurred in Central California (Point Conception to Cape Mendocino), where lingcod was the most frequently encountered. In southern California (south of Point Conception), anglers took 40% of the groundfish catch with California scorpionfish being the most frequently encountered. Lastly, northern California (Cape Mendocino to the California/Oregon border) accounted for 9% of the catch, with black rockfish being the most frequently encountered.

Barotrauma. Barotrauma is a pressure-related injury that occurs in fish due to the inability to release gasses

TABLE 4
Comparison of recreational groundfish catch in California in 2013 and 2012 (does not include discards and only includes catch greater than 5 mt).

Species	2013 Harvest (mt)	2012 Harvest (mt)	% Change from 2012
Lingcod	433	281	54%
Black rockfish	363	210	73%
Vermilion rockfish	211	220	–4%
Bocaccio	131	125	5%
California scorpionfish	112	116	–3%
Blue rockfish	106	52	104%
Copper rockfish	99	80	24%
Pacific sanddab	86	66	30%
Brown rockfish	82	70	17%
Yellowtail rockfish	56	53	6%
Gopher rockfish	41	52	–21%
Cabezon	39	43	–9%
Starry rockfish	24	23	4%
Olive rockfish	20	32	–36%
Kelp rockfish	19	19	1%
Widow rockfish	18	5	257%
Squarespot rockfish	17	4	314%
Speckled rockfish	16	10	55%
Flag rockfish	14	14	1%
Leopard shark	14	35	–60%
Kelp greenling	14	13	5%
Treefish	13	11	19%
Canary rockfish	13	13	–4%
Greenspotted rockfish	11	18	–38%
China rockfish	10	14	–28%
Grass rockfish	10	21	–53%
Honeycomb rockfish	9	6	53%
Chilipepper	7	8	–9%
Spiny dogfish	7	3	134%
Black-and-yellow rockfish	6	5	16%
Rosy rockfish	6	6	–8%
Other groundfish	16	28	–43%
Total Groundfish	2,021	1,656	22%
Angler Trips			
Bottomfish Effort	863,339	867,096	0%

Data source: RecFIN Date Extracted: 04/24/2011

that expand in the swim bladder when brought up from depth. Some visible symptoms of barotrauma include a swollen or tight belly, an everted stomach and/or rectum, and distended and/or "crystallized" eyes; non-visible symptoms may include hemorrhaging and tearing of the swim bladder. Research has shown that symptoms of barotrauma (e.g., everted stomachs, eyes) can be reversed when the fish is returned to depth; many of these symptoms disappear and internal injuries can heal allowing the fish to survive.

Among groundfish, rockfish (*Sebastes* spp.) are especially susceptible to barotrauma and as a result can suffer high mortality rates. When released at the surface, excessive buoyancy caused from gas expansion diminishes the fish's ability to submerge on its own. Often these fish are left floating on the surface where they may succumb to thermal shock, suffocation, and/or predation.

Not all species are affected by barotrauma equally. Factors such as morphology (e.g., elasticity or thickness of swim bladder) and position in the water column (midwater versus benthic) may affect the severity of barotrauma injury. Depth of capture, however, appears to be the most likely factor affecting the severity of injury. Returning fish to depth as quickly as possible has been shown to increase survival compared to those released at the surface.

Devices that release fish at depth are known as 'descending devices' and many types are available. These devices can either be purchased or fabricated out of inexpensive materials such as a weighted milk crate tied to a rope or a sinker with an upturned barbless hook attached. While each device may look different, they all function similarly by securing a fish until it can be returned to depth, thereby allowing the gases inside the body to recompress and equalize so that the fish can swim away on its own. Although the use of descending devices is not mandatory, many anglers currently use them. The use of these devices has become more popular as information on their benefits and angler awareness has spread. This is in large part due to outreach programs conducted by a number of organizations, institutions, and agencies.

Since 2007, the Department has conducted an extensive outreach and education campaign to educate the public on the use of descending devices to minimize mortality of discarded fish and increase post-release survival. Some of these efforts involve distribution of donated descending devices and barotrauma informational fliers which recommend proper recompression techniques. While there are clear conservation benefits of using descending devices, mitigating barotrauma-induced mortality by using a descending device also has management implications.

Barotrauma in Management. Recreational groundfish seasons are structured to maximize fishing opportunities for healthy stocks while keeping within allowable limits for overfished species. Allowable limits for canary rockfish, cowcod, and yelloweye rockfish are low and constrain fishing opportunities in California. To ensure that catches stay within allowable limits for all species, all fish encountered in the recreational fishery (both taken and discarded) must be accounted for by fishery managers. The mortality rates used in catch forecasting and accounting models assumed the same mortality rates for fish released at the surface, regardless of whether or not a descending device was used. Although it had been acknowledged that descending devices reduce mortality of discarded rockfish, few data had been available to inform a lower mortality rate that could be used by fishery managers in estimating mortality of released fish.

In 2012, the Pacific Fishery Management Council (Council) decided to examine the issue of accounting for descending device use in groundfish management. The Council agreed that differential mortality rates for each species of rockfish associated with the use of a descending device was a priority that needed to be accounted for in modeling and management. Following extensive scientific scrutiny, revised mortality rates based on the most recent research were adopted in 2013 for use in management for canary rockfish, cowcod and yelloweye rockfish. These rates account for both short and long-term mortality and include buffers to accommodate unaccounted mortality. When a fish is released at depth using a descending device, mortality rates can be reduced by as much as one half depending on species and depth of capture. Therefore, applying depth dependent mortality rates which reflect the use of descending devices for these particular species will likely have the greatest management implications.

Data on descending devices use are collected by CRFS. In 2013, CRFS samplers began collecting data on descending device use for all rockfish discarded in boat fishing modes (private and charter). Effort is largely focused on boat based modes because they account for the majority of recreational encounters.

As overfished stocks continue to rebuild and encounters become more frequent, it becomes increasingly important that anglers use descending devices to return fish to depth. Increased survivorship from descending device use may help stocks rebuild more quickly and could result in increased fishing opportunities. However, any realized benefits from using descending devices ultimately depend on the number of anglers who use them properly. Although revised depth-dependent mortality rates are only applicable to a canary rockfish, cowcod, and yelloweye rockfish at this time, they could be expanded to include additional species in the recre-

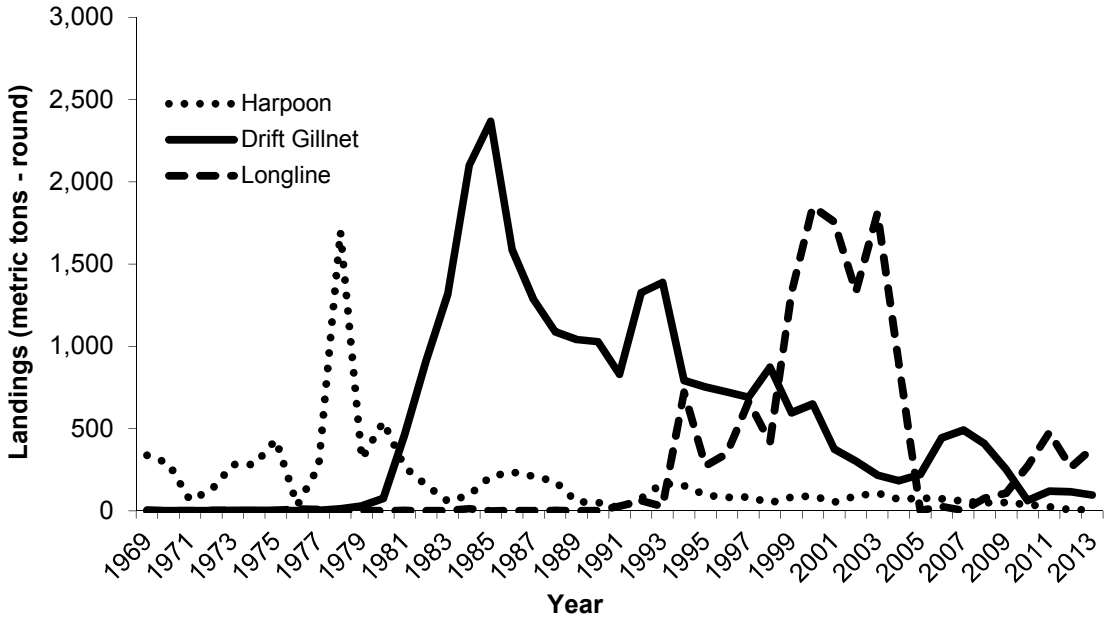

Figure 7. California swordfish (*Xiphias gladius*) landings by gear type, 1968–2013.

ational fishery and/or commercial fishery as more data becomes available.

Highly Migratory Species

Highly migratory species (HMS) encompass a suite of large, pelagic fishes which are generally targeted by multiple fisheries and desired for their high market value. Species that are federally regulated under the West Coast Highly Migratory Species Fishery Management Plan (HMS FMP) include swordfish, albacore tuna, yellowfin tuna, skipjack tuna, bluefin tuna, common thresher shark, shortfin mako shark, and dorado.

Swordfish. Swordfish (*Xiphias gladius*) is commercially harvested off of California with multiple gear types. It commands the highest price-per-pound and brings in the highest total revenue of all HMS species landed in California. While the majority of California-based vessels target swordfish with drift gill nets (DGN), fish landed by harpoon or handheld hook and line sell at a higher price. In 2013, 525.4 t of swordfish were landed in California at an overall ex-vessel average price of $7.33/kg ($3.33/lb); 1.2% by harpoon, 75.8% by hook and line and longline gears (the majority of which comes from Hawaiian longline vessels fishing outside of the US EEZ; only 1.2% were hand held hook and line), 18.5% by drift gill net (DGN) gear, and 4.6% by other miscellaneous gears (fig. 7). The average ex-vessel price by gear type was $19.84/kg ($9.02/lb), $7.41/kg ($3.37/lb), and $9.59/kg ($4.36/lb), for harpoon, hook-and-line/longline, and DGN, respectively. Ex-vessel revenue of California landed swordfish totaled almost $3.9 million (fig. 8). While there were no exports of swordfish, California alone imported almost 2,016 t of swordfish product from 14 countries, worth almost $16 million. There was no record of swordfish recreationally landed off California in 2013, and no records have been documented since 2007, according to data collected by the California Recreational Fishing Survey (CRFS) and Commercial Passenger Fishing Vessel (CPFV) logbooks.

Import levels are high despite the Eastern Pacific Ocean swordfish population being under fished and at levels above the minimum required to achieve maximum sustainable yield, mainly due to the numerous temporal and spatial regulations placed on the fishery. While DGN and longline gear types are efficient at catching marketable numbers of swordfish, their rate of bycatch has been highly scrutinized. Shallow-set longline is not an authorized gear type off of the West Coast, but the Hawaiian fishery has been reopened with the introduction of modified gear and bait configurations which have shown to reduce bycatch. Similarly, the DGN fishery has undergone multiple gear modifications such as net extenders to lower nets below the level most cetaceans travel at, as well as acoustic pingers which have proven to greatly reduce the interactions with marine mammals. While alternative gear types, such as harpoon, are as capable of landing swordfish, they are more artisanal in nature and cannot supply the domestic demand. Additionally, they use considerably more fuel than DGN and longline gears, introducing a different type of environmental impact. Research on other gear types such as buoy gear and deep set longline is being conducted, but as of yet, does not provide an efficient alternative to DGN and longline gear. The

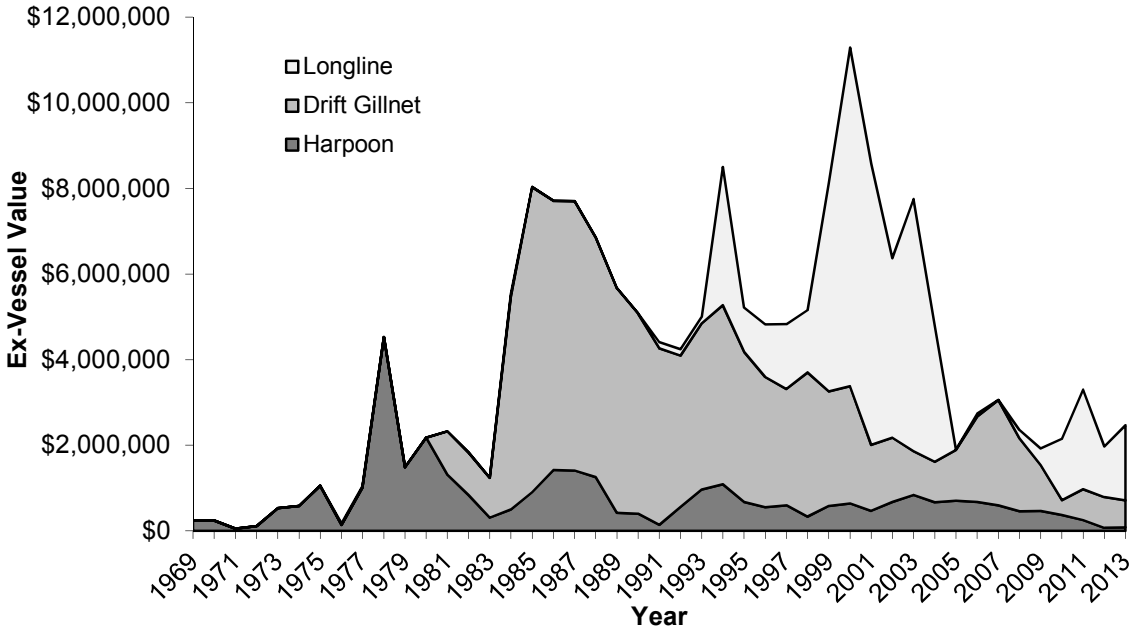

Figure 8. Annual ex-vessel value of California swordfish (*Xiphias gladius*) by gear type, 1969–2013.

"transfer effect" has been cited as a concern, in that while domestic swordfish fisheries may have bycatch, they are highly regulated to reduce the incidence of unintended catch, but the countries of imports may not manage their fisheries with the bycatch standards the US does. As a result, incidence of bycatch may in fact be higher for imported swordfish products than it is for the California fishery.

The Pacific Fisheries Management Council (PFMC) had directed the Highly Migratory Species Management Team (HMSMT) to evaluate the potential modification of the boundaries of the Pacific Leatherback Conservation Area (PLCA) to allow for additional fishing grounds for the DGN swordfish fleet. This Area Under Consideration (AUC), as it was termed, would open an area at the southeastern border of the PLCA, allowing for greater opportunity to target swordfish in a highly frequented area.

Albacore. Targeted by commercial and recreational fisheries off California, Washington, and Oregon, albacore tuna (*Thunnus alalunga*) comprises more than 95% of all HMS landed commercially on the West Coast, taken most often with troll and jig and bait gears. In 2013, commercial landings in California decreased by 50%, from 649 t in 2012 to 324 t valued at just over $1.1 million, at an average of $3.41/kg ($1.55/lb). This represented only 2.5% of the coast-wide total. Washington landings comprised 62%, with 7,983.3 t averaging $3.08/kg ($1.40/lb) and having an ex-vessel value of over $24.7 million, and Oregon landings were 4,629 t at $3.48/kg ($1.58/lb), valued at over $16 million. CPFV logs indicated 2,832 fish taken by party boats off of California, and CRFS recorded 303 landed by private vessels. Over 388 t of fresh and frozen albacore tuna was exported to ten different countries from California in 2013; the majority of fresh to Mauritius and the majority of frozen to Spain.

Yellowfin Tuna. In 2013, yellowfin tuna (*Thunnus albacares*) commanded the second highest average price-per-pound of all HMS, at $6.95/kg ($3.16/lb). Mainly taken by purse seine, commercial landings in California experienced a notable increase, as 6.2 t were landed this year alone, but <7 t had been landed the three previous years combined. Ex-vessel revenue for yellowfin tuna was $42,930. Around 71 t of fresh yellowfin tuna was exported in 2013, largely to Thailand, but also to Mexico and Canada. Opposite the increase in commercial landings, CPFV logbooks indicated that recreational catch decreased with 3,462 yellowfin landed by anglers on party boat vessels, representing an decrease of 21% the amount landed in 2012. CFRS estimated that no yellowfin tuna were landed by private vessels off of California in 2013, but the survey is for US waters only.

Skipjack Tuna. Both commercial and recreational landings of skipjack tuna (*Kastuwonus pelamis*) have been minimal for several years. In 2013, 0.5 t of skipjack was landed mainly by purse seine vessels, with an ex-vessel value of only $813. Frozen exports of skipjack to Thailand and China totaled around 542 t this year. The last three years saw no skipjack tuna caught off California by private boats, and only one was estimated to be landed this year from US waters based off CRFS. CPFV logs reported an estimated 59 fish; a 12% decrease from the 66 landed in 2012.

Bluefin Tuna. Off California, commercial landings of bluefin tuna (*Thunnus thynnus*) continued to decline in 2013. Taken by multiple gear types such as purse seine and periodically in DGN, bluefin landings decreased 92% from 118 t in 2011 and 43 t in 2012, down to 9.9 t landed in 2013. However, the ex-vessel price jumped dramatically from $2.24/kg ($1.02/lb) to $6.84/kg ($3.11/lb), making bluefin the third highest priced of commercial HMS landings. Conversely, CPFV logbook data indicated a increase in recreational landings, as 6,504 bluefin were reported as taken in California waters in 2013 (5,627 taken in 2012), with CRFS estimating only an additional 27 fish landed in US waters by private vessels, although this represents an increase from the 10 taken in 2012. California exported almost 10 t of fresh and 6 t of frozen bluefin products to Canada in 2013.

Common Thresher Shark. Common thresher shark (*Alopias vulpinus*) is the most valuable shark species taken in commercial HMS fisheries off of California. It is targeted in the DGN fishery and often landed incidentally in other gears. Landings in 2013 slightly decreased from those in 2012 from 66 t to 65.8 t. However, ex-vessel value increased, bringing in $200,190 at an average of $3.04/kg ($1.38/lb), increasing from $2.93/kg ($1.33/lb) in 2012. CPFV logs reported 37 threshers landed in 2013, while estimates from CRFS indicated private boat anglers landed around 77 common threshers from US waters, down from 372 in 2012.

Shortfin Mako Shark. Shortfin mako shark (*Isurus oxyrhincus*) is the second most commonly landed shark in commercial HMS fisheries. Landings increased to 30.6 t in 2013, nearly an 18% increase from the previous year. Shortfin mako are taken incidentally by many gear types, but are not directly targeted commercially. The average dressed weight price increased from $1.94/kg ($0.88/lb) in 2012 to $2.88/kg ($1.31/lb) in 2013, resulting in an ex-vessel value of $88,375. There were 128 shortfin mako sharks reported taken by party boat anglers on CPFV logs, which is consistent with numbers landed in 2012. CRFS reported an estimated 508 sharks taken by private sportfishing boats in US waters, a 22% decrease from 2012.

***Dorado* (dolphinfish).** While 2012 saw a three-fold increase in commercial landings of dorado (*Coryphaena hippurus*) from the previous year, 2013 landings were a substantial 90% decrease from 2012, with only 1 t landed, all on the US West Coast in California ports. Dorado is not generally targeted, but caught incidentally by longline gear, hook and line, and occasionally in DGN. Ex-vessel revenue from California caught dorado was just under $6,000, commanding $5.92/kg ($2.69/lb). Similar to the decrease in commercial landings, CPFV logs showed a decrease in landings as well, from 6,337 fish landed in 2012 to 1,807 fish in 2013; a 71% decrease. CRFS reported an estimated 133 fish landed by private vessels in US waters.

HMS Management. In 2012 the California Department of Fish and Wildlife (Department) responded to a petition to list the northeastern Pacific (NEP) population of great white sharks as endangered or threatened under California's Endangered Species Act (CESA). Department staff spent over a year reviewing the best available literature and research. In early 2014, the Department presented its evaluation to the California Fish and Game Commission (Commission) with the recommendation that listing under CESA was not warranted.

Dungeness Crab

The Dungeness crab, *Metacarcinus magister* (formerly *Cancer magister*), trap-based fishery spans the West Coast of North America from Alaska to central California. In California there are two distinct management areas, the northern and central, demarcated by the Sonoma/Mendocino county line. The commercial season in the central area begins November 15 and ends June 30, while it conditionally begins on December 1 and ends July 15 for the northern area, depending on the condition of the crab.

The Dungeness crab fishery, in recent years, has secured its place among California's most valued fisheries, being the highest valued fishery again in 2013 ($88.7 million) and second in volume to the market squid fishery (14,066 t) in volume. The fishery has brought in record landings in recent seasons including both the 2010–11 and 2011–12 seasons, with 12,497 t and 14,465 t landed, respectively (fig. 9). Although not record breaking, the 2012–13 crab season remained relatively high compared to the 10-season average of 9,060 t, with 11,054 t landed statewide. Generally the northern area contributes to the majority of total crab landed statewide and the 2012–13 season was no exception with 68% derived from the northern ports from Crescent City to Fort Bragg, and 32% landed from Bodega Bay south to Morro Bay. Four of the five highest recorded seasons for the entire fishery dating back to the 1915–16 season have occurred in the last eight seasons, starting with the 2004–05 season, ranking fourth at 11,445 t, and include this most recent 2012–13 season, ranking fifth in total Dungeness crab catch.

This past season also ranks second for the fishery in ex-vessel value of $68.9 million. Average ex-vessel value from the past 10 seasons of $44 million (not inflation-adjusted) has been steadily increasing over time during this period of high landings. The average price paid to fishers of $6.29/kg ($2.85/lb), is also higher than the 10-season moving average of $4.89/kg ($2.22/lb), and coupled with higher than average landings has resulted

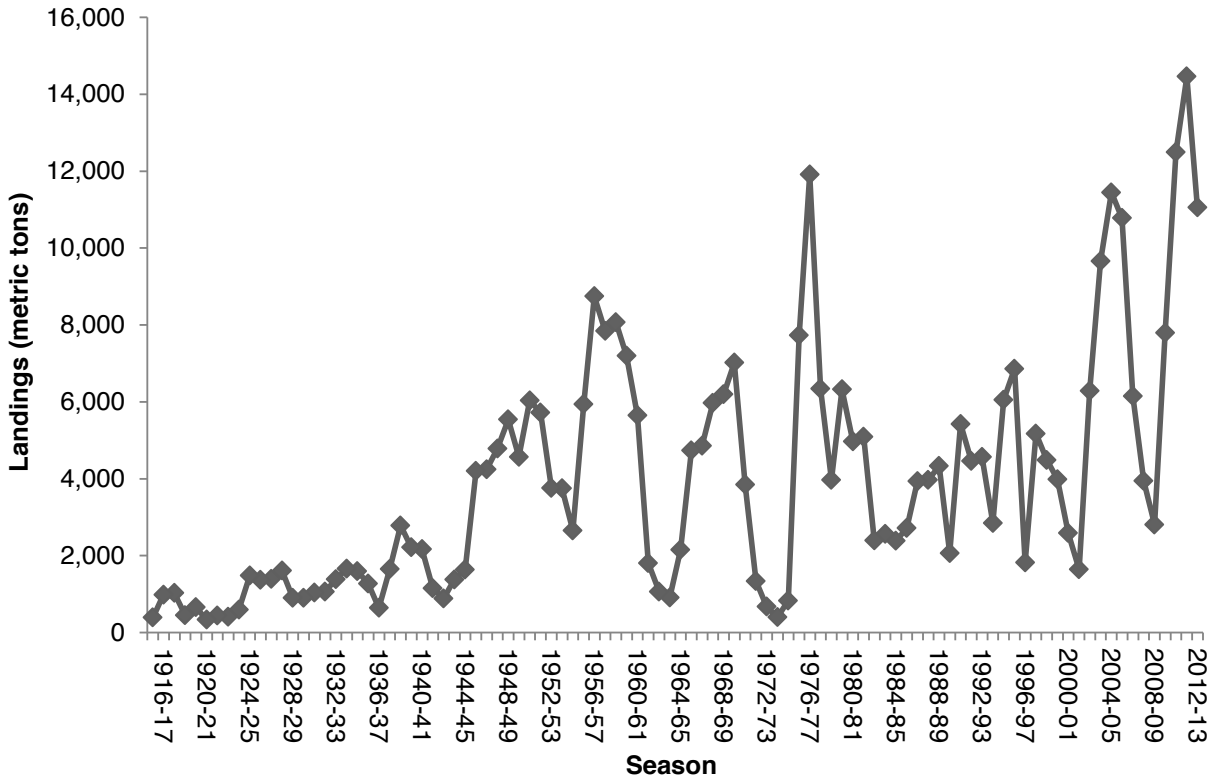

Figure 9. California commercial Dungeness crab (*Metacarcinus magister*) landings, 1912/13 season–2012/13 season.

in one of the highest total ex-vessel values for the fishery on record, at $95.5 million during the 2011–12 season.

Preliminary data from the 2013–14 season shows state landings exceeding 7,000 t (through March 2014), with the majority of crab coming from the central area. Although landings are lower than past seasons, the record high average price of $7.30/kg ($3.31/lb) has contributed to over $50 million brought in by that date.

The 2013–14 season is the first season to employ trap limits, implementing a program created by Senate Bill 369 passed in 2011. The trap limit program places a cap on the number of traps a vessel can fish dependent on where the vessel places among the seven trap tiers. Placement is based on historical landings during a 'window' period by the vessel. The highest tier is set at a maximum of 500 traps while the lowest tier is set at 175 traps. Permit holders were required to purchase Department-issued trap tags for each trap in their tier and an additional biennial permit before the start of the season. If they fail to do so their commercial Dungeness crab permit will no longer be valid, potentially removing latent permits from the fishery. With trap limits in place there may be an observable effect to the derby style nature of the fishery, the rush at the start of the season to catch as much crab as possible, when about 80% of the catch occurs in the first six to eight weeks of the fishery. From a fishery management perspective, trap limits will be a useful tool in tracking effort among fishery participants whereas before, the total number of traps in the fishery was not known.

The commercial fishery is regulated through the state legislature and is managed primarily on the basis of size, sex and seasonal restrictions. Dungeness crab also supports a popular sport fishery that is managed through the Fish and Game Commission with similar restrictions. Male crabs larger than 159 mm (6.25 in) carapace width (CW) are harvested commercially while up to 10 crabs of either sex and larger than 146 mm (5.75 in) CW can be taken daily by sport fishing, unless taken from a Commercial Passenger Fishing Vessel (CPFV) from Sonoma to Monterey Counties, then the bag limit is reduced to six and the minimum size must be 153 mm (6 in) CW. Data from the recreational take is limited or nonexistent but sampling from the California Recreation Fisheries Survey (CRFS) concentrated in Bay Area ports from November and December 2013 suggests that total take is less than 5% of the commercial fishery take.

Mature males typically molt on an annual basis in the summer months and then begin gaining weight in their new shells. The timing of this molt varies, but the December 1 fishery opening along most of the West Coast usually results in adequately filled out crab reaching the popular holiday markets. However, commencing

in the 1995–96 season the state legislature authorized an industry-funded preseason crab quality test to ensure crab meat has adequately filled the new hardened shell on the target opening date. The test is conducted in concert with tests in Washington and Oregon. The states then mutually agree, through the Tri-State Crab Committee (Tri-State), on whether to delay the opening of the season in order to let the crabs reach a standard body meat relative weight.

The 2012–13 season in the northern management area was the second consecutive season to be delayed as late as January 15, the maximum allowed by law. Central California coast crab usually molt earlier than northern crab, and the area is not subject to opening delays by statute. In the case of a northern season delay, 'fair start' statutes mandate that anyone fishing in the central area must wait 30 days after the delayed northern season opener to fish in those northern waters.

Of the approximately 570 vessels with a 2012 commercial Dungeness Crab Vessel Permit, 444 vessels made at least one landing in the 2010–11 season. Less than a quarter of these total permits are considered 'latent,' not actively participating in the fishery. Legislation restricted access to commercial Dungeness crab fishing permits beginning in 1995. A limited entry permit system was then enacted by the legislature with the provision that most permits are transferable. Even with trap limits in place, there is concern among some fishermen that an increase in the use of the latent permits sometime in the future could cause overfishing and worsen overcrowding on crab fishing grounds.

In 2008, legislation created the Dungeness Crab Task Force (task force), an advisory group comprised of Dungeness crab fishers from the major fishing ports, members from the Department, and nongovernmental organizations. The task force was reinstated with SB 369 and several meetings will take place between 2014 and 2016 to further discuss the future of Dungeness crab fishery management such as evaluating the trap limit program and whether to include the central management area in the Tri-State Committee process by adopting the preseason testing protocol. The task force is set to report initial recommendations to the Joint Committee on Fisheries and Aquaculture and the Department by January 2015, with final recommendations set for January 2017.

Basses

Three salt water bass species from the genus *Paralabrax* represent a few of the most important nearshore, target species for anglers fishing in the waters off of southern California. These fish are caught year-round, but the highest catch occurs from June through August which also corresponds with the peak of their spawning season. All three species are managed together under the same regulations.

During the first half of the twentieth century, kelp bass (*Paralabrax clathratus*), barred sand bass (*Paralabrax nebulifer*) and spotted sand bass (*Paralabrax maculatofasciatus*) were targeted by both recreational and commercial fishermen. Due to concerns regarding declining catch, commercial take of these basses was prohibited in 1953 and a 26.7 cm (10.5 in) total length (TL) minimum size limit was established. The minimum size limit was gradually increased to 30.5 cm (12 in) TL in 1959, and remained in effect until March 1, 2013. Bag limits for the basses first began in 1939 and have fluctuated over the years at 10, 15, and 20 fish aggregate limits with no more than 10 per species. The bag limit has remained at 10 fish in aggregate since 1975, until its recent change in March 1, 2013.

Due to concerns from the Department and the public regarding the continued declining catch, a thorough analysis of the saltwater bass fishery was recently conducted. Results from several fishery-independent and fishery-dependent data sets indicated that fishing pressure and unfavorable oceanographic conditions have contributed to declining bass populations. The Department recommended management changes, and in 2013, the Commission implemented a five fish aggregate bag limit as well as increasing the minimum size limit from 30.5 cm (12 in) to 35.6 cm (14 in) TL for all three *Paralabrax* species.

Kelp Bass. Kelp bass, often referred to as calico bass, are found in the nearshore habitat and have historically ranged from the Washington/Oregon border south to Bahia Magdalena Bay, Baja California, Mexico (BCM), but rarely occur north of Point Conception. Kelp bass typically inhabit shallow waters from the surface to 50 m (164 ft) and are often associated with high relief structures, including kelp. The breeding season for kelp bass occurs from April through November, with the peak in the summer months around the full moon. Kelp bass grow to 721 mm (28.4 in) and weigh up to 6.6 kg (14.5 lb).

Commercial Passenger Fishing Vessel (CPFV) catch records have been available since 1935, but all records before 1975 grouped all of the *Paralabrax* species into a single "rock bass" category. Based on recent information, it is highly likely that kelp bass made up most of the catch early on. Catch-per-unit-effort (CPUE), calculated from CPFV logbook data as the number of fish kept divided by the number of anglers on boats where at least one kelp bass was caught, fluctuated considerably from 1980 to 2013. From 1992 to 1999 CPUE decreased by 57% falling from 1.69 fish per angler to 0.72 fish per angler; the lowest level since 1984. Following this decline, CPUE increased to a peak of 1.51 fish per angler in 2004. Another negative trend occurred

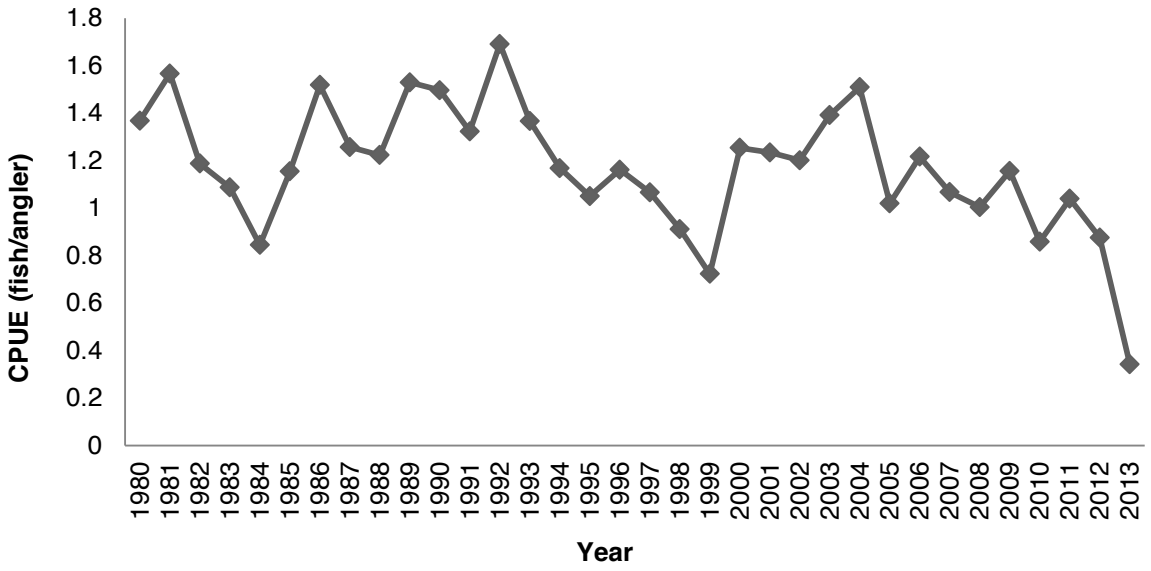

Figure 10. Catch-per-unit effort (CPUE) for kelp bass (*Paralabrax clathratus*) caught by CPFVs in southern California for trips where barred sand bass were caught. Data are based on CPFV logbooks (1980–2013) for fish caught in U.S. waters.

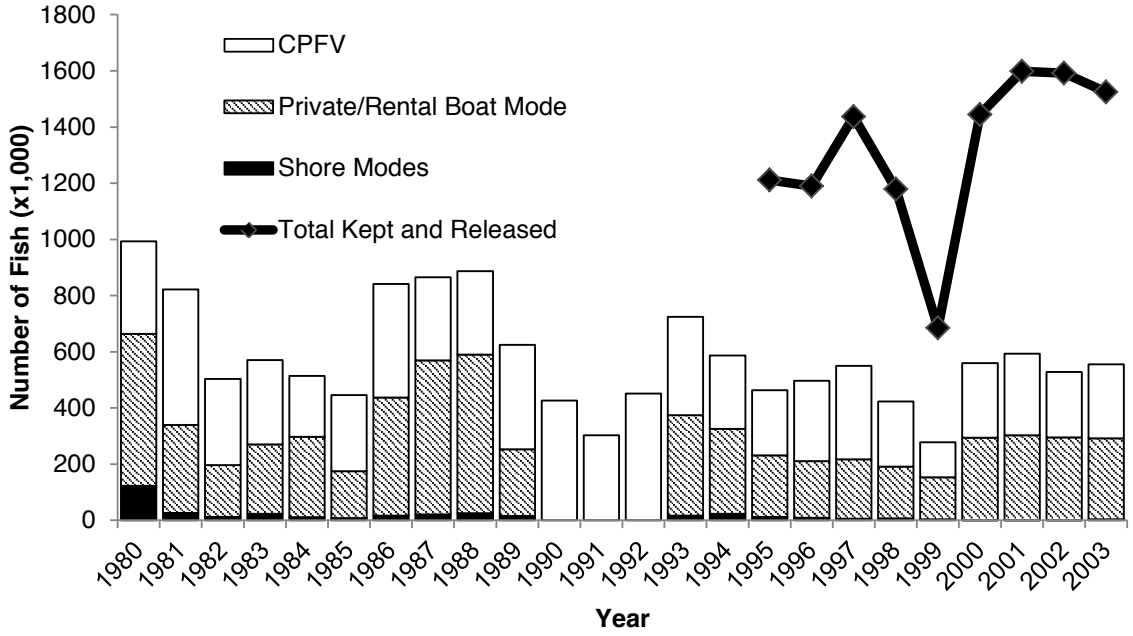

Figure 11. Recreational catch estimates of kelp bass (*Paralabrax clathratus*) in southern California in thousands of fish as reported by MRFSS for private/rental boats and shore modes, and by CPFV logbooks, 1980–2003. No recreational data from MRFSS were available from 1990–92 and for Jan–Feb 1995. Data for total combined catch with fish released alive were only available from 1995–2003.

between 2004 and 2012 with CPUE declining by 42% to 0.88 fish per angler. Declining CPUE continued into 2013 with CPUE declining by 61% to 0.34 fish per angler and reaching the lowest value since 1980 (fig. 10). The decline from 2012 to 2013 can be partially attributed to the increase in size limit for the basses.

Kelp bass are also targeted and caught by anglers fishing from shore modes as well as from private/rental boats. From 1980 to 2004, the Marine Recreational Fisheries Statistical Survey (MRFSS) collected historical size and total estimated catch data for kelp bass from beach/bank, manmade structures and private/rental boat modes, and historical size data from the CPFV fishery. In 2004, the California Recreational Fisheries Survey (CRFS) replaced MRFSS. Estimated catch data for CPFVs is available from the CPFV logbooks, however

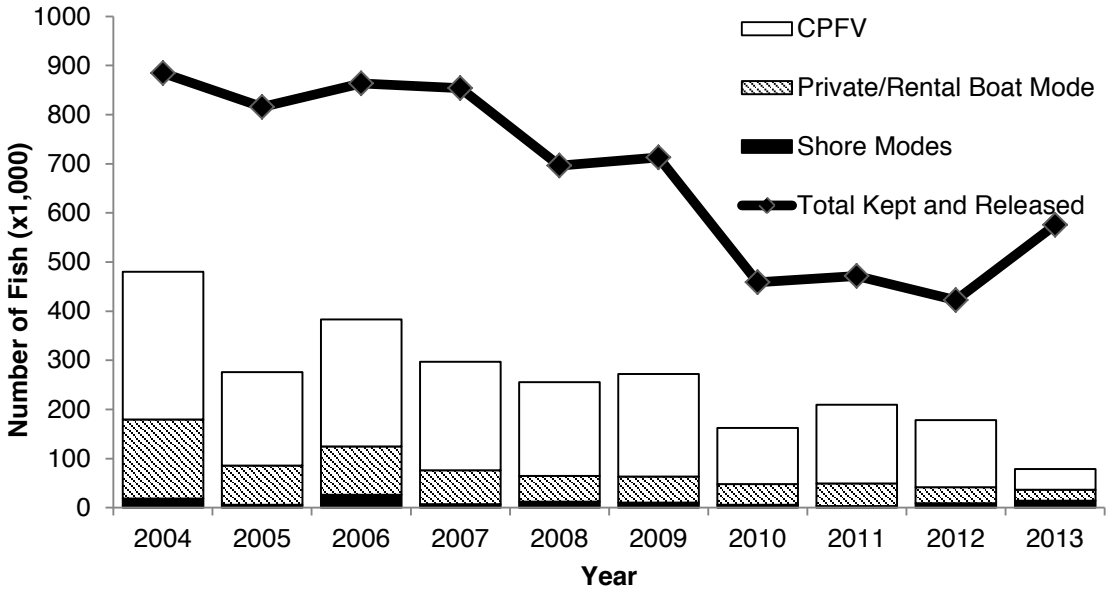

Figure 12. Recreational catch estimates of kelp bass (*Paralabrax clathratus*) in southern California in thousands of fish as reported by CRFS for private/rental boats and shore modes, and by CPFV logbooks for party/charter boats, 2004–13.

TABLE 5

Number of kelp bass (*Paralabrax clathratus*) kept by California commercial passenger fishing vessels (CPFVs) in southern California by port for 2012 and 2013 and 10-year average (2004–13). Data were taken from CPFV logbooks for fish caught in US waters.

CA ONLY	2012		2013		10-Year Average (2004–13)	
Port Name	No. Fish Caught	% Total	No. Fish Caught	% Total	No. Fish Caught	% Total
Oxnard/Channel Islands	13,328	10%	5,177	12%	15,041	8%
Redondo Beach	3,825	3%	265	1%	12,137	7%
San Pedro	19,551	14%	7,919	19%	28,970	16%
Long Beach	10,443	8%	5,607	13%	23,143	13%
Newport/Balboa	14,639	11%	3,405	8%	21,802	12%
Dana Point	27,460	20%	6,003	14%	27,801	15%
Oceanside	6,192	5%	1,553	4%	6,562	4%
Mission Bay	15,263	11%	4,446	11%	22,204	12%
San Diego	17,630	13%	4,283	10%	17,357	10%
Other	8,102	6%	3,599	9%	7,292	4%
Total CPFV Catch	136,433	100%	42,257	100%	182,308	100%

due to survey differences, MRFSS and CRFS party/charter estimates are not directly comparable. From 1980 to 2003, MRFSS data indicate that shore modes made up only 4% of the catch while private/rental boats and CPFVs made up 96% of the catch (fig. 11). More recent CRFS data indicate that shore modes made up a slightly greater percentage (14%) with private/rental boats and CPFV's accounting for 86% of the catch between 2004 and 2013 (fig. 12). Combined MRFSS and CPFV logbook data show a decrease of 44% from 992,900 fish in 1980 to 555,650 fish in 2003 (fig. 11). This decline continued between 2004 and 2012 as the number of fish kept showed a decrease of 63% from 480,500 fish in 2004 to 178,200 fish in 2012 (fig. 12). A 56% decrease in catch occurred from 2012 to 2013, partly due to the new regulation changes. CRFS samplers measured 37,786 kept kelp bass with an average TL of 356 mm (14 in) from 2004–13. Prior to 2013, the average TL was steadily decreasing to its lowest point in 2012 of 346.9 mm (13.7 in); the average TL increased to 389.8 mm (15.3 in) in 2013. This increase can be attributed to the new minimum size limit that went into effect in 2013.

Kelp bass have consistently been in the top ten species or species groups caught per year by southern California CPFV anglers during the past 20 years. Based on landings in 2013, kelp bass ranked tenth among all finfish species reported by CPFVs. This ranking comes even after regulatory changes in 2013 that limited kelp bass catch. On average, over the past 10 years, San Pedro

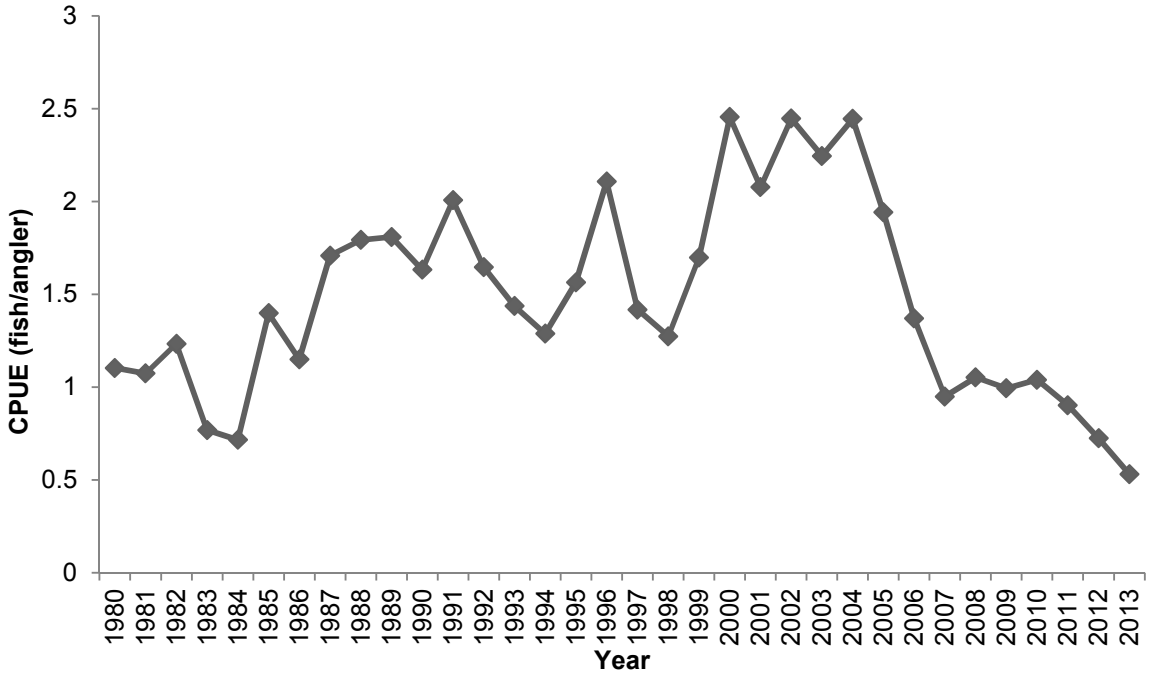

Figure 13. Catch-per-unit effort (CPUE) for barred sand bass (*Paralabrax nebulifer*) caught by CPFVs in southern California for trips where barred sand bass were caught. Data are based on CPFV logbooks (1980–2013) for fish caught in U.S. waters.

ranks first with 16% of total fish caught (table 5). The ports of Dana Point and Long Beach rank second and third with 15% and 13% of the catch, respectively. Other landings reporting substantial catch include Newport/Balboa with 12%, Mission Bay with 12%, and San Diego with 10%. While a majority of fish overall are caught in California waters, between 2004 and 2013 21% of fish kept by CPFVs from San Diego were taken from Mexican waters. From 2012 to 2013, there was an increase in Mexican caught fish from 14% to 36% for San Diego CPFVs.

Barred Sand Bass. Barred sand bass range from Santa Cruz, California south to Bahia Magdalena Bay, BCM; however, they are rarely found north of Point Conception. They inhabit waters from the shallow subtidal to 183 m (600 ft), but are most common in waters less than 30 m (100 ft) and are usually associated with sand/rock interfaces of deep reefs and artificial structures. The breeding season occurs between April and November, with July being the peak month of spawning. During the summer months sand bass form large breeding aggregations over sandy bottoms at depths of 15–30 m (~50–100 ft). They can grow to 647.7 mm (25.5 in) and 6 kg (13.2 lb).

Barred sand bass catch estimates are available from 1935 to present, but they were not differentiated until 1975. Prior to 1975, all three *Paralabrax* species were grouped into a single "rock bass" category. CPFV logbook data from 1980 to present show that barred sand bass CPUE has fluctuated, showing a steady increase starting in the mid-1980s increasing from 1.15 fish per angler in 1986 and peaking in 2000 with 2.46 fish per angler (fig. 13). From 2004 to 2012 CPUE substantially declined, decreasing by 70% from 2.45 fish per angler in 2004 to 0.72 fish per angler in 2012. From 2012 to 2013, CPUE decreased another 27% reaching a new low of 0.53 fish per angler. This decrease in 2013 is partly attributable to the increase in the minimum size for the basses.

In addition to CPFVs, barred sand bass are also caught by anglers fishing from other modes including shore (piers, jetties, and beach/bank) and private/rental boats. MRFSS data from 1980–2003 indicate that CPFVs made up 58% of the catch, with private/rental boats making up 41%, and shore modes making up 1%. CRFS data from 2004–13 indicate a similar trend, with shore modes making up 3% of the catch and CPFVs making up 70% of the catch. Combined MRFSS and CPFV logbook data representing all modes from 1980–2003 show a fluctuating trend with peak catches for kept fish in 1988 and 2002, with 1,295,022 and 1,253,900 fish, respectively (fig. 14). From 1995 to 2003 a large number of fish were released, which resulted in a peak total of kept and released fish of 2,893,476 in 2002; prior to 1995 CPFV logbook data do not include releases. The proportion of fish released differed by fishing mode with 80% for shore-based fishing, 63% for private/rental boats, and 12% for CPFVs. Combined CRFS and CPFV logbook data show a substantial decline between 2004 and 2013 of total kept and released fish for all modes.

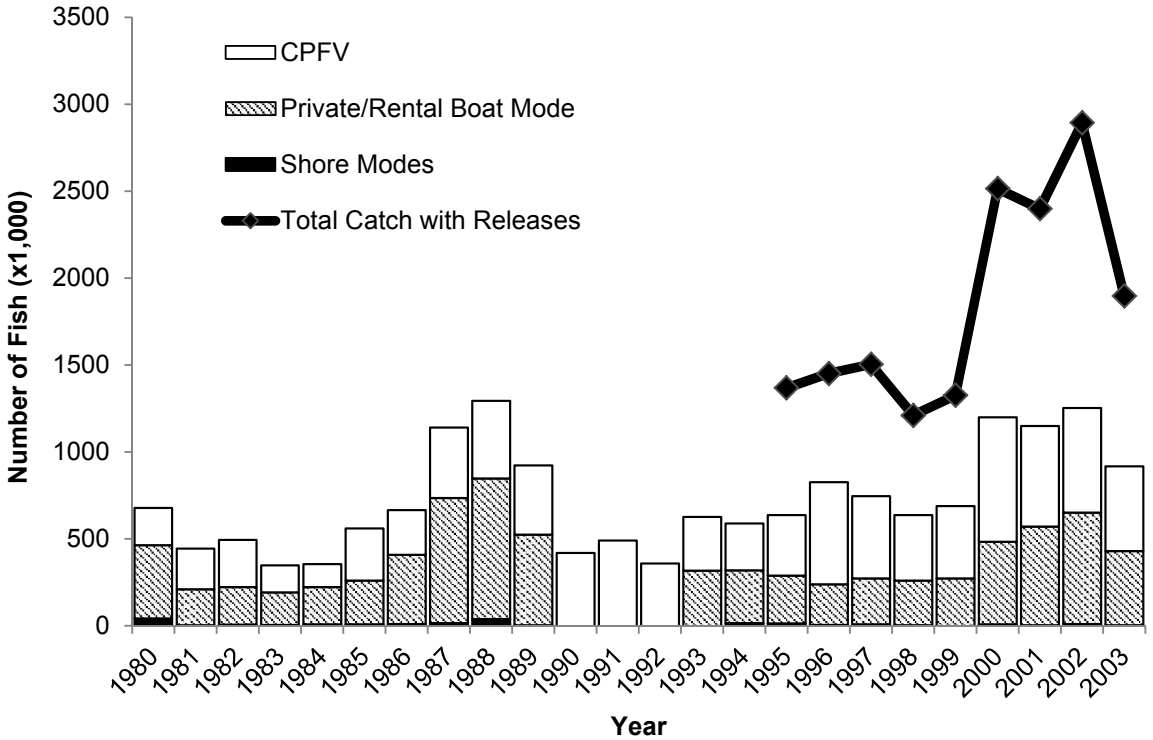

Figure 14. Recreational catch estimates of barred sand bass (*Paralabrax nebulifer*) in southern California in thousands of fish as reported by MRFSS for private/rental boats and shore modes, and by CPFV logbooks, 1980–2003. No recreational data from MRFSS were available from 1990–92 and for Jan–Feb 1995. Data for total combined catch with fish released alive were only available from 1995–2003.

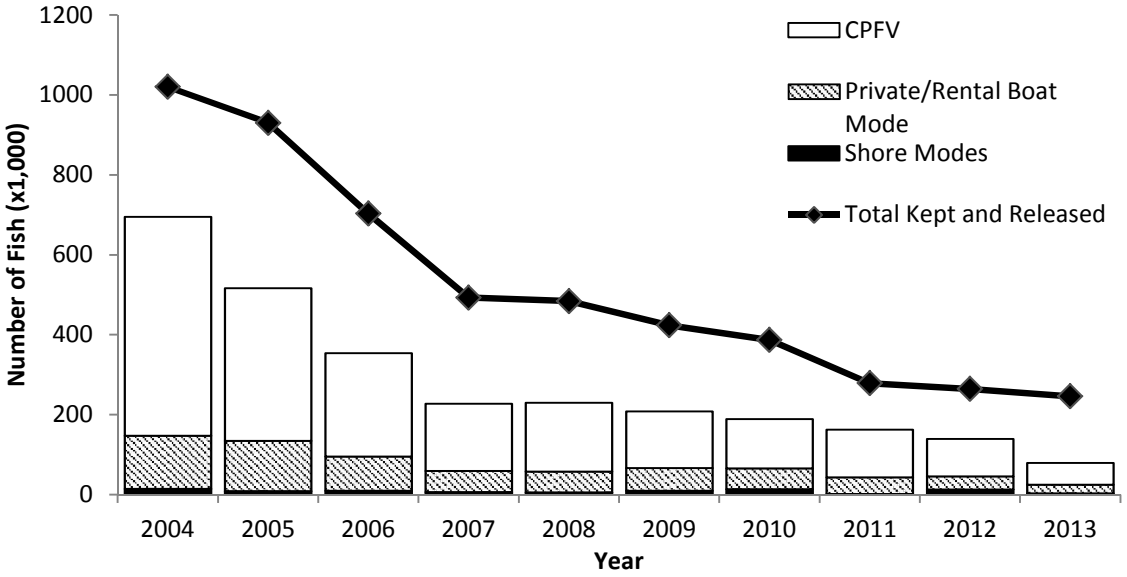

Figure 15. Recreational catch estimates of barred sand bass (*Paralabrax nebulifer*) in southern California in thousands of fish as reported by CRFS for private/rental boats and shore modes, and by CPFV logbooks for party/charter boats, 2004–13.

Between 2004 and 2012 the number of fish kept showed an 80% decrease from 694,900 in 2004 to 139,145 in 2012 (fig. 15). The increase in size limit between 2012 and 2013 resulted in a 43% decrease in catch. From 2004 to 2013, the number of kept and released fish also showed a substantial decline from the 2004 peak of 1,020,400 fish to 246,200 fish for all modes. The proportion of fish released between 2004 and 2013 was similar to 1980–2003 with shore modes releasing 86%, private/rental boats releasing 71% and CPFVs releasing 14%.

Between 2004 and 2013, CRFS samplers measured 43,476 kept barred sand bass with an average TL of

TABLE 6
Number of barred sand bass (*Paralabrax nebulifer*) kept by California commercial passenger fishing vessels (CPFVs) in southern California by port for 2012 and 2013 and 10-year average (2004-13). Data were taken from CPFV logbooks for fish caught in US waters.

CA ONLY	2012		2013		10-Year Average (2004-2013)	
Port Name	No. Fish Caught	% Total	No. Fish Caught	% Total	No. Fish Caught	% Total
Santa Barbara/Ventura	1,116	1%	405	1%	824	0%
Marina Del Rey	8,184	8%	5,529	10%	14,513	7%
Redondo Beach	2,741	3%	330	1%	13,864	7%
San Pedro	14,468	15%	7,130	13%	25,218	12%
Long Beach	29,213	30%	13,180	23%	48,945	24%
Newport/Balboa	17,057	17%	10,039	18%	38,888	19%
Dana Point	8,026	8%	3,616	6%	23,470	11%
Oceanside	1,998	2%	1,669	3%	8,451	4%
San Diego	8,685	9%	8,404	15%	14,842	7%
Other	6,768	7%	6,059	11%	19,124	9%
Total CPFV Catch	98,256	100%	56,361	100%	208,139	100%

374 mm (14.7 in). From 2004 to 2011, the average TL of fish fluctuated with peaks of 375 mm (14.8 in) in 2005 and 376 mm (14.8 in) in 2007 before reaching the highest point of 378 mm (14.9 in) in 2012. The 2013 TL size limit increase resulted in the largest TL of the ten year period with an average TL of 409 mm (16 in).

During the last 20 years, barred sand bass have consistently ranked among the top species caught per year by southern California CPFV anglers. Based on 2013 landing records, barred sand bass ranked fifth overall among all finfish species reported by CPFVs. This ranking comes after regulatory changes in 2013 that limited barred sand bass catch, and shows an improvement from the ranking of sixth overall in 2012. On average, over the past ten years, Long Beach ranks first with 24% of the total catch (table 6). The ports of Newport/Balboa and San Pedro ranked second and third with 19% and 12% of total catch, respectively. Other landings reporting substantial catch include Dana Point with 11% and Marina del Rey and San Diego with 7% each. A large number of kept fish on San Diego CPFVs come from Mexican waters. Between 2004 and 2013, 43% of the kept fish reported for the port of San Diego were taken from Mexican waters. When comparing catch data for 2013 with that of 2012, an increase in catch from Mexico can be seen, especially for CPFVs fishing out of San Diego. Overall, the catch taken from Mexican waters increased from 3% in 2012 to 17% in 2013, and for the port of San Diego increased from 43% to 50% from 2012 to 2013.

Spotted Sand Bass. Spotted sand bass range from Monterey, California to Mazatlán, Mexico including a substantial population located in the Gulf of California; however, this species is rarely found north of Santa Monica Bay. Populations in southern California are typically restricted to sandy or muddy bottom habitat within shallow bays, harbors, and lagoons that contain eelgrass, surf grass and rock relief for shelter. Adults are usually found to occupy waters ranging in depth from .6 m to 9.1m (2–30 ft), but specimens have been taken from as deep as 70 m (200 ft) in the Gulf of California. Spotted sand bass are primarily fished in Mission and San Diego Bays (San Diego County) and Newport and Anaheim Bays (Orange County). These areas provide a sheltered warm water habitat necessary for this generally subtropical species. Spotted sand bass grow to 560 mm (22 in) and 3.1 kg (6.8 lb).

Spawning typically begins in May and continues through early September, when spotted sand bass aggregate at or near the entrances of bays in southern California. Reproductive strategies of spotted sand bass are complex, with individuals from different regions employing different strategies such as protogynous hermaphrodism. Significant genetic and morphological differences have been found between the Gulf of California and southern California populations.

The spotted sand bass fishery has been popular with recreational shore and private skiff anglers beginning in the mid-1950s due to the fish's aggressive behavior and fighting ability. Accurate landings data were not available until the mid-1970s as a result of being grouped together with other *Paralabrax* species or not adequately reported. Surveys conducted by the Department on skiff fishing estimated that the annual catch of spotted sand bass in southern California ranged from 12,790 to 23,933 fish between 1976 and 1981. MRFSS estimates from 1980–2003 show that an average of 368,500 spotted sand bass were caught annually. During this time period peak catch (kept and released) occurred in 1986 with 603,950 fish and 2002 with 646,530 fish. The majority of the fish (91%) were caught by private/rental boats with shore based anglers catching 8% and CPFVs catching 1% (fig. 16). Estimates obtained from CRFS from 2004–13 show that an average of 294,600 fish were caught annually. During this period of time

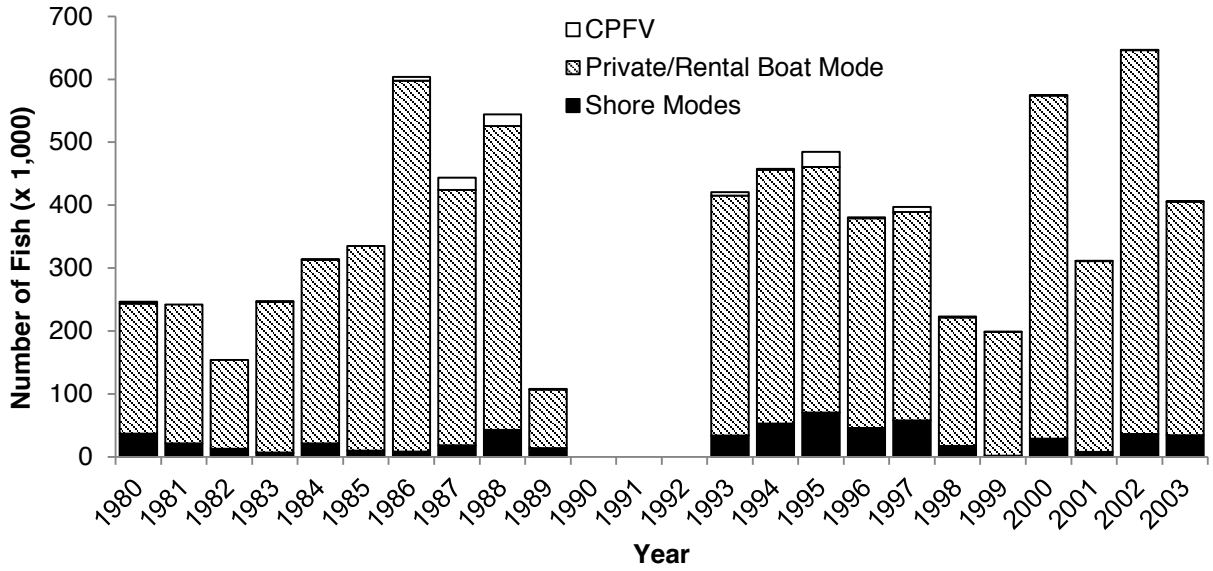

Figure 16. Recreational catch estimates of spotted sand bass (*Paralabrax maculatofasciatus*) in southern California in thousands of fish as reported by MRFSS for private/rental boats and shore modes, and by CPFV logbooks, 1980–2003. No recreational data from MRFSS were available from 1990–92 and for Jan–Feb 1995.

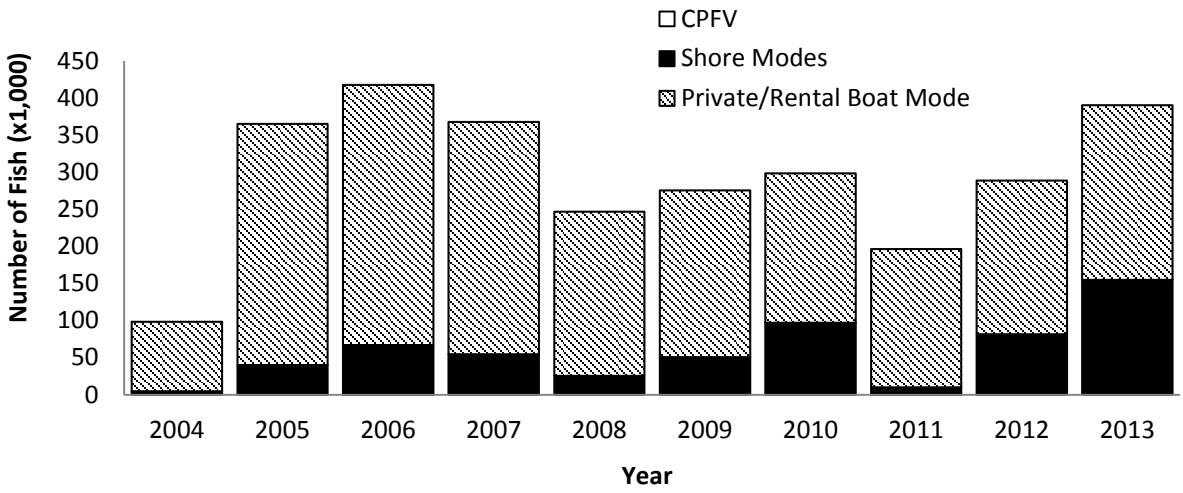

Figure 17. Recreational catch estimates of spotted sand bass (*Paralabrax maculatofasciatus*) in southern California in thousands of fish as reported by CRFS for private/rental boats and shore modes, and by CPFV logbooks for party/charter boats, 2004–13. CPFV catch is not apparent due to the small contribution to the total catch (<1%).

peak catch occurred in 2006 with 417,700 fish caught (kept and released) (fig. 17). CRFS data show a similar trend with private/rental boats comprising 80% of the catch and shore-based anglers and CPFVs comprising 20% and less than 1%, respectively. When looking at MRFSS catch estimates for the basses (kept and released) for all modes in California, spotted sand bass made up the smallest percentage of catch (8%); barred sand bass and kelp bass, made up 43% and 49%, respectively. CRFS catch estimate data show an increase in spotted sand bass catch (19%) relative to barred sand bass (36%) and kelp bass (45%). Although over the past two decades there has been increased fishing pressure put on spotted sand bass, a majority of fish caught are released. From 1980–2003, release rates from MRFSS data for spotted sand bass, kelp bass, and barred sand bass were 78%, 66%, and 54%, respectively. CRFS data from 2004–13 show that release rates have increased in more recent years with spotted sand bass having the highest release rate (95%) of the three *Paralabrax* species followed by kelp bass (73%) and barred sand bass (55%).

Surfperch

The surfperch assemblage is comprised of the family Embiotocidae, includes seaperch and perch, and encompasses 24 species. The complete assembly, collectively

known as surfperch, contains four species only found in waters around Japan and one species only found in freshwater and estuarine habitats in California. There are 19 species of marine surfperch inhabiting California's temperate coastal waters, representing the majority of the assemblage. The island perch (*Cymatogaster gracilis*) is now considered to be synonymous with the shiner perch (*C. aggregata*). The Guadalupe perch (*Brachyistius aletes*) is included in this count; however, it is very similar and possibly synonymous with the kelp perch (*B. frenatus*).

Extensive life history variation exists within the surfperch assemblage. However, all surfperch are viviparous—which means that the live young are retained until birth, all young are highly developed at parturition, and all adults have internal fertilization. There are specific mating and birthing seasons for surfperch, the timing of which depends on the species and often the latitude, and may be linked to water temperature. In general, mating occurs in the fall and parturition occurs in the summer. Many species aggregate to mate and to give birth and some species move inshore for these events. By definition, viviparous fish have low fecundity; however, fecundity increases with the length of the female.

Many of California's marine surfperch are the target of a modest commercial fishery in central and northern California and a sizable recreational fishery throughout the state. The surfperch fisheries in California are solely managed by the California Department of Fish and Wildlife (Department). Both the commercial and recreational fisheries are primarily shore-based and typically use similar hook and line gear, although there is a boat based hook and line commercial fishery in San Francisco Bay. Surfperch, depending on the species, are found in a variety of habitats; however, the fisheries mainly target surfperch on sandy beaches. Landings are highest when the surfperch are aggregated during the mating and parturition seasons.

No formal stock assessments have been completed for surfperch and the fisheries are considered data-poor; however, there is no indication that surfperch stocks are in decline based on the best available data. The Department has analyzed fishery trends such as catch-per-unit-effort (CPUE) and the average length at capture over time. In addition, the Department collects data on life history through fishery-independent surveys (FIS) and monitors the commercial and recreational fisheries.

Although surfperch stocks do not appear to be declining, their low fecundity and mating and spawning aggregations may cause them to be more vulnerable to fishing. Water pollution and changing sea temperature can also cause vulnerability.

Commercial Fishery. The commercial surfperch season is closed May 1 through July 31 statewide. This excludes shiner perch, which may be taken at any time of the year. The seasonal closure is intended to protect aggregating females during the parturition season and the end of the closure was extended in 2002 from July 14 to July 31 for this reason. Barred surfperch (*Amphistichus argenteus*), calico surfperch (*A. koelzi*), and redtail surfperch (*A. rhodoterus*) may not be fished commercially south of Point Arguello (redtail surfperch rarely occur there). There are no minimum size limits or bag limits for the commercial fishery.

The fishery primarily uses hook and line gear from shore, however, other gear types are occasionally used which include fish traps, A-frame dip nets, and beach seines. Redtail surfperch is the primary surfperch species landed from shore in Humboldt and Del Norte counties and barred surfperch is the primary surfperch species landed from shore in Monterey and San Luis Obispo Counties. The San Francisco Bay fishery is primarily conducted using skiffs to fish hard-bottom nearshore habitat and habitat near manmade structures. A wide variety of species commercially landed in this area includes, but is not limited to, striped seaperch, rainbow seaperch, rubberlip seaperch, black perch, pile perch, and shiner perch.

Surfperch are sold for human consumption within the US mainly in ethnic food markets. Some species of surfperch, mainly shiner perch, are used as live bait for California halibut (*Paralichthys californicus*) and striped bass (*Morone saxatilis*). Surfperch are landed live or dead, with the live fishery generally fetching a higher price per pound. In 2013, the commercial fishermen were paid an average of $2.00/lb for surfperch. The rainbow seaperch (*Hypsurus caryi*) averaged the highest price in 2013 at $4.50/lb, followed by the striped seaperch (*Embiotoca lateralis*) at $4.49/lb, then the rubberlip seaperch (*Rhacochilus toxotes*) at $3.38/lb, the black perch (*E. jacksoni*) at $3.17/lb, the barred surfperch at $2.91/lb, the pile perch (*Damalichthys vacca*) at $2.50/lb, the calico surfperch at $2.25/lb, and finally the redtail surfperch at $1.21/lb.

The Department mainly collects data on commercial landings through the monitoring of landing receipts. Prior to 1927, surfperch landings were grouped on the receipts with similar species such as blacksmith (*Chromis punctipinnis*), halfmoon (*Medialuna californiensis*), opaleye (*Girella nigricans*), and sargo (*Anisotremus davidsonii*). After 1927, these similar species were excluded from the surfperch category; however, the majority of surfperch landings still did not identify surfperch to species. Some surfperch landings are still not sorted to species. However, due to continuing Department efforts, the percentage of surfperch receipts that include unspecified surfperch has decreased in recent years. In 2013, 80% of landing receipts recorded surfperch landings to species.

The ports of San Francisco, Avila/Port San Luis, and Eureka had the most commercial landings in 2013 with

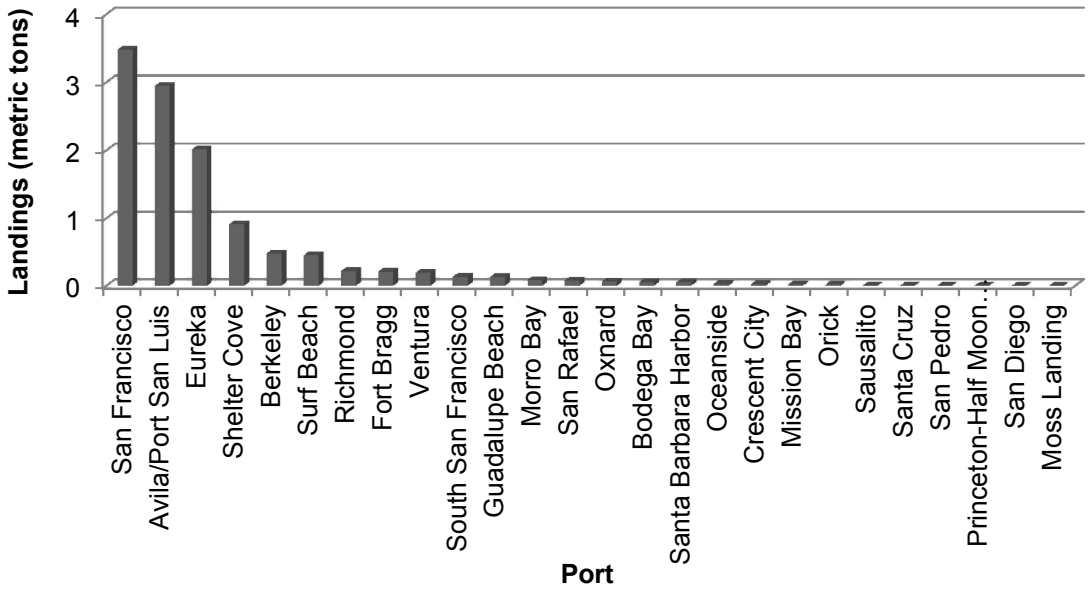

Figure 18. Commercial surfperch landings for all species by port, 2013.

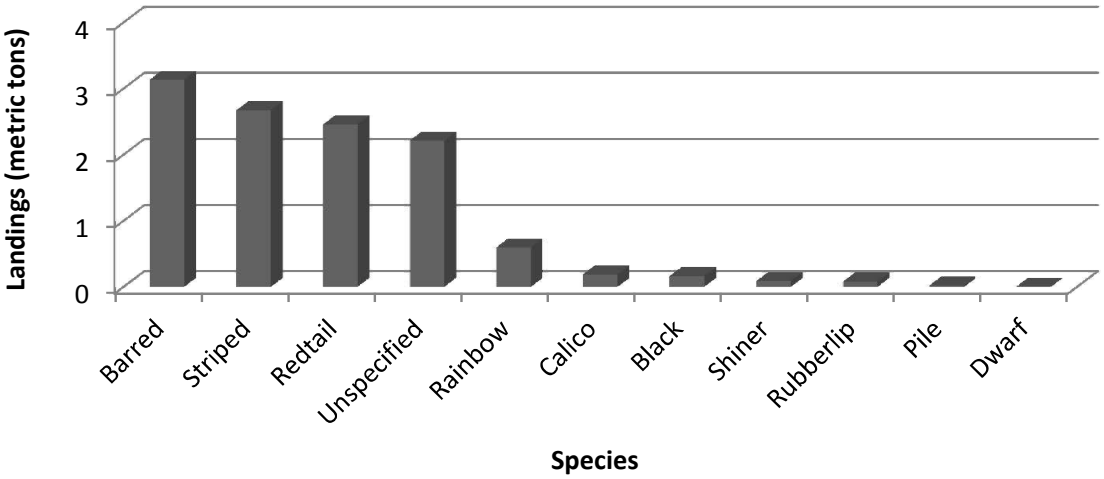

Figure 19. Statewide commercial surfperch landings by species, 2013.

total landings >1 t per port (fig. 18). Since the 1990s these ports account for 42% of all commercial surfperch landings by weight. There were 23 other ports with reported surfperch landings in 2013 that totaled <1 t per port (fig. 18). San Francisco area ports had the most landings for 2013 with a total of 4.4 t, northern California ports (Oregon/California border to Fort Bragg) followed with a total of 3.2 t, central California ports (Half Moon Bay to Avila/Port San Luis) totaled 3 t, and southern California ports (Santa Barbara county to the California/Mexico border) totaled 1 t.

The surfperch species with the most commercial landings (by weight) statewide in 2013 were the barred surfperch (27%), striped seaperch (23%), and redtail surfperch (21%) (figs. 19, 20). Since the 1990s these species have composed 64% of all commercial surfperch catch by weight, including those landings which were not identified to species. In 2013, 75% of commercial landings in ports in northern California (Oregon/California border to Fort Bragg) consisted of redtail surfperch, 61% of commercial landings in ports in the San Francisco Area consisted of striped seaperch, 82% of commercial landings in ports in central California (Half Moon Bay to Avila/Port San Luis) consisted of barred surfperch, and 63% of commercial landings in ports in southern California (Santa Barbara county to the California/Mexico border) consisted of barred surfperch (fig. 21). It is likely that the percentages of these primary species were actually higher due to the use of the "unspecified" market category.

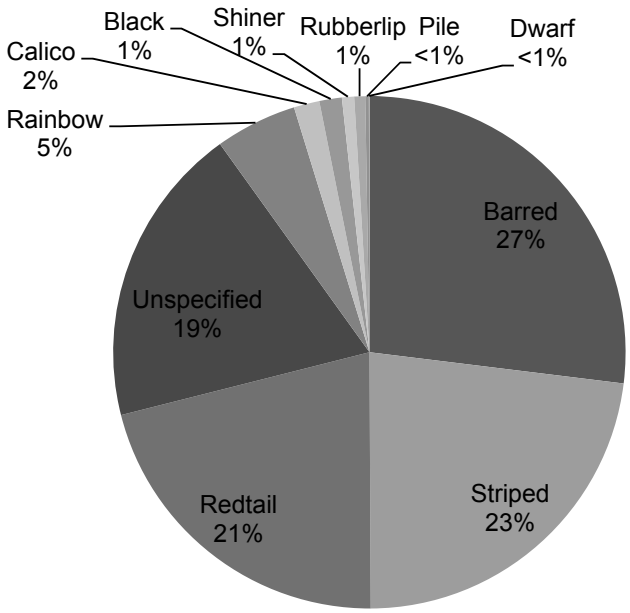

Figure 20. Statewide commercial surfperch landings shown as percentage of species by weight, 2013.

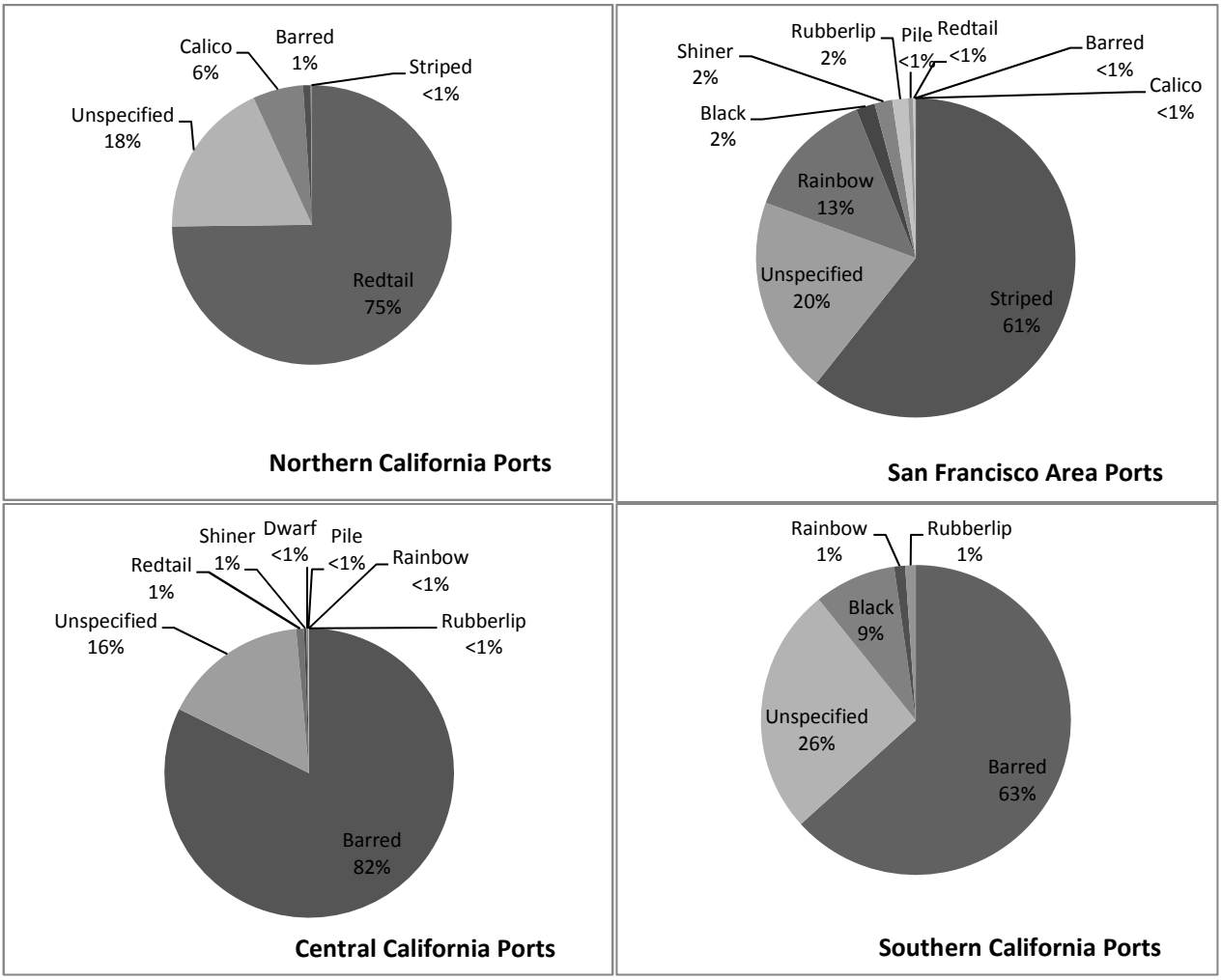

Figure 21. Commercial surfperch landings by port areas shown as percentage of species by weight, 2013.

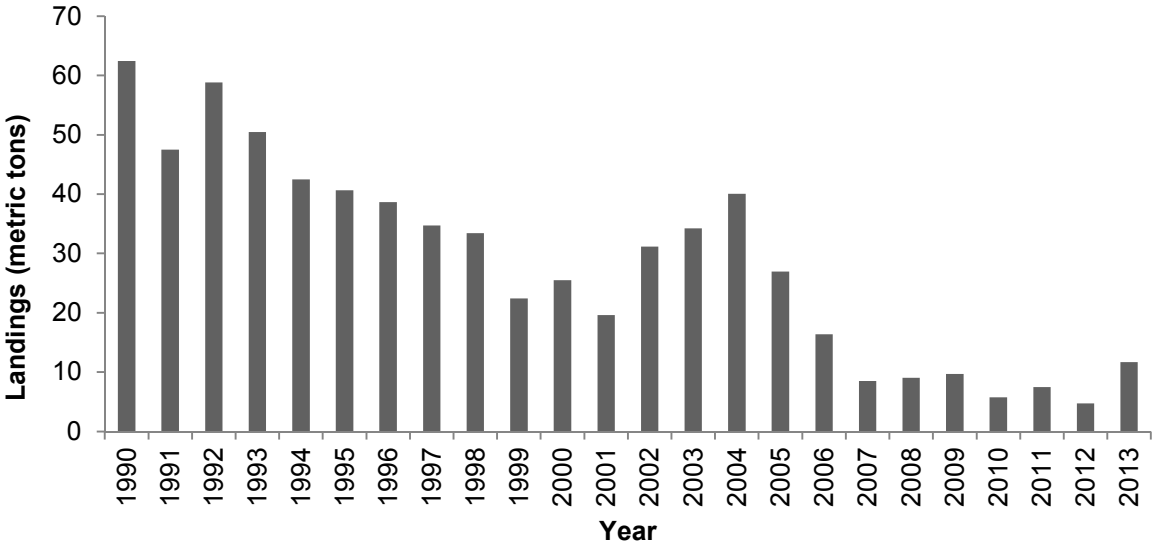

Figure 22. Historic commercial landings for all species of surfperch, 1990–2013.

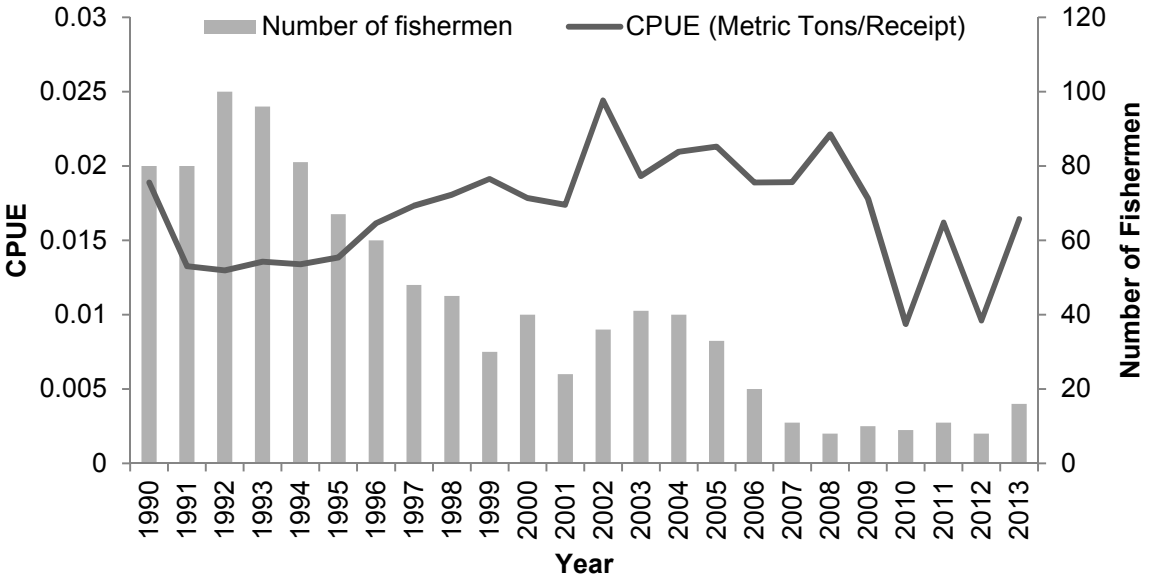

Figure 23. Annual CPUE (metric tons landed per receipt) for all species of surfperch compared with the number of commercial surfperch fishermen who made 10 or more landings per year, 1990–2013.

The total amount of surfperch landed commercially in 2013 was 11.6 t (fig. 22). The commercial surfperch fishery has shown a declining trend in the number of participants and overall annual landings over the last few decades, however, CPUE has remained relatively stable indicating that the decline in landings and participants (fishermen making 10 or more landings annually) is likely not due to a decline in surfperch stocks (fig. 23). The decline may be due to decreasing market demand, restrictions to the fishery such as the ban of vehicle use on most beaches, and possibly displacement of local fishermen due to recently implemented MPAs.

Recreational Fishery. The recreational surfperch season is open all year, except in San Francisco and San Pablo Bays where the season is closed April 1 through July 31. This excludes shiner perch which may be taken at any time of the year. The seasonal closure is intended to protect aggregating females during the parturition season. In San Francisco and San Pablo Bays, the daily bag limit is five surfperch, not including shiner perch. In all other areas, the daily bag limit is 20 surfperch; however, no more than 10 surfperch may be of any one species. This also excludes shiner perch. The daily bag limit for shiner perch is 20, and they may be taken

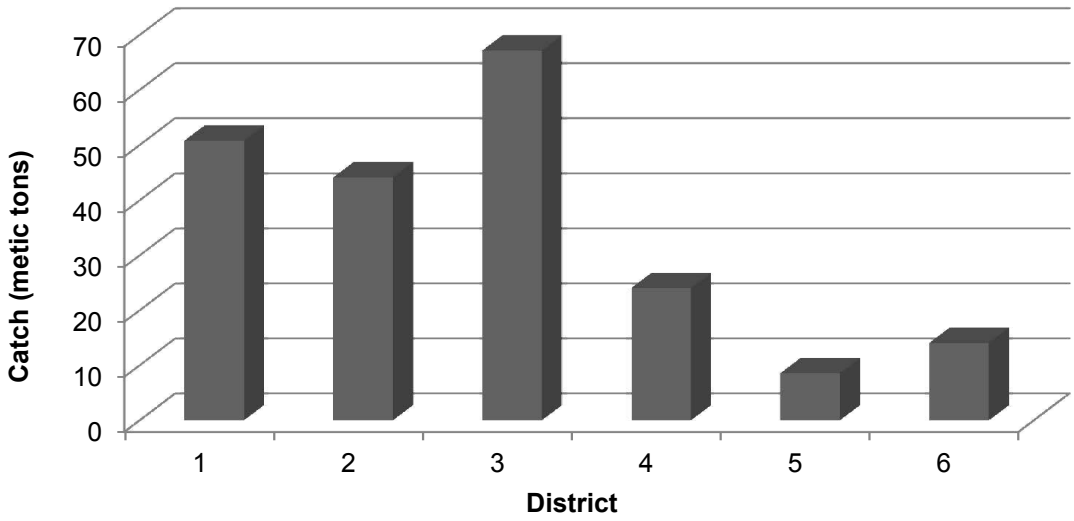

Figure 24. CRFS recreational catch estimates for all species of surfperch by District, 2013.

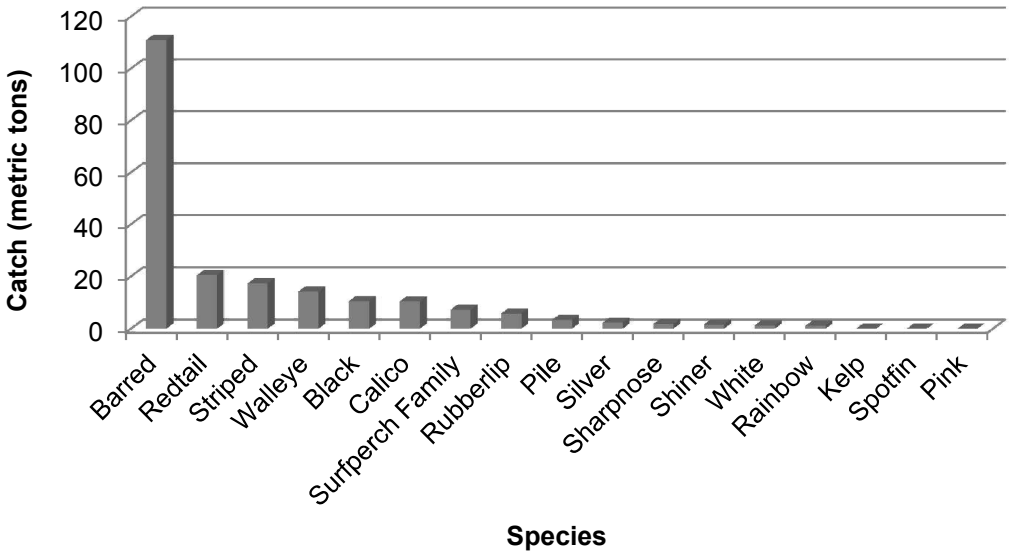

Figure 25. Statewide CRFS recreational surfperch catch weight estimates by species, 2013.

or possessed in addition to the overall daily bag limit of 20 finfish specified in the CCR, Title 14 §27.60(a). Only the redtail surfperch has a minimum size limit in the recreational fishery, which is 10.5 inches total length (TL).

Surfperch are valued by the recreational fishery for both consumption and catch-and-release fishing. The fishery primarily uses hook and line gear from shore on sandy beaches and rocky banks. Manmade structures such as piers, private or rental boats, and CPFVs also account for a small portion of surfperch caught using hook and line. There is also harvest by scuba and free divers using pole spear or spear gun.

Since 2004, the Department has mainly collected data on recreational surfperch catch through the California Recreational Fisheries Survey (CRFS). Previously, from 1981–89 and 1993–2003, recreational catch was monitored by the Marine Recreational Fisheries Statistics Survey (MRFSS). The CRFS has an improved sampling design, however, CRFS and MRFSS are sufficiently different surveys and catch estimates between them cannot be compared. Both CRFS and MRFSS are surveys which intercept recreational anglers during or after their fishing trips to determine species composition and catch rates. A telephone survey is used to estimate fishing effort for shore-based modes (beach/bank and manmade structures); these modes are responsible for the overwhelming majority of the catch of barred, redtail, calico, silver, and walleye surfperches. The CRFS separates California into six marine districts with the

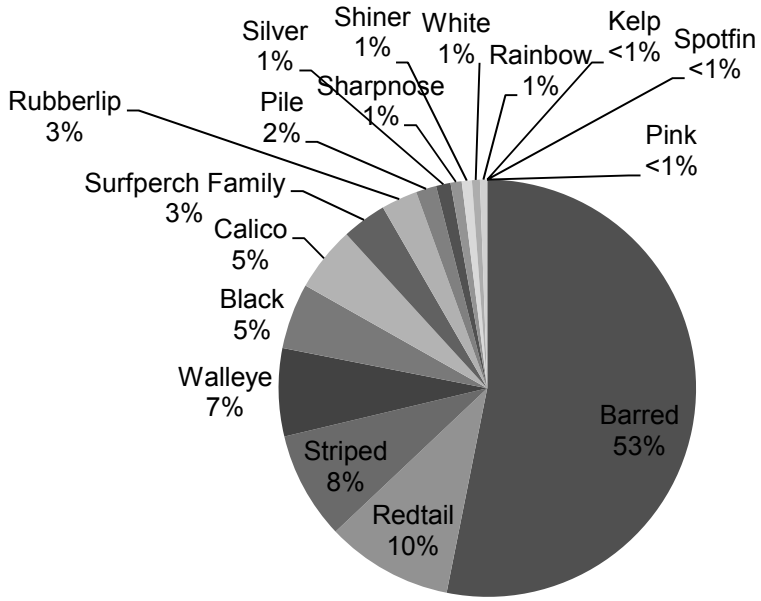

Figure 26. Statewide CRFS recreational surfperch catch estimates shown as percentage of species by weight, 2013.

following boundaries: District 1—Los Angeles, Orange, and San Diego counties; District 2—Ventura and Santa Barbara counties; District 3—Santa Cruz, Monterey, and San Luis Obispo counties; District 4—Marin, San Mateo, and the San Francisco Bay Area counties; District 5—Mendocino and Sonoma counties; and District 6—Del Norte and Humbolt counties. The districts with the highest estimated recreational catch for all surfperch species combined in 2013 were District 3 (67.19 t), District 1 (50.80 t), and District 2 (44.16 t) (fig. 24). Since 2004, these districts account for 75% of all recreational surfperch catch estimates. The catch for the remaining districts in 2013 were estimated as follows: District 4 (24.06 t), District 6 (14.09 t), and District 5 (8.58 t).

The surfperch species with the highest estimated recreational catch (by weight) statewide in 2013 were the barred surfperch (53%), redtail surfperch (10%), and striped seaperch (8%) (figs. 25, 26). Since 2004, these species have composed 66% of all recreational catch estimates. The primary species taken by District are as follows: barred surfperch (Districts 1, 2, and 3); redtail surfperch (Districts 4 and 6); and striped surfperch (District 5) (fig. 27). It should be noted that these figures display the recreational catch estimate percentage of each surfperch species caught by weight instead of by number of fish, so that the results can be compared to the commercial data, for which number of fish landed is not available. This is important because there are differences in size distribution among landed species of surfperch and therefore percentages by weight might be lower than percentages by number for small species. Smaller species include the silver surfperch, walleye surfperch, shiner perch, spotfin surfperch, kelp perch, sharpnose seaperch, and pink seaperch.

The total estimated recreational catch of surfperch far surpassed the total landings of the commercial surfperch fishery in 2013. The recreational catch estimate for 2013 was 208.9 t while the commercial fishery landings totaled 11.6 t. Since 2004, CRFS recreational catch estimates have been much higher than commercial landings every year (fig. 28).

Recreational CPUE north of Point Conception for barred surfperch, redtail surfperch, and striped seaperch varied in the beach and bank fishing mode from 2004 to 2013 with no trend (fig. 29). Similarly, recreational CPUE south of Point Conception for barred surfperch varied from 2004 to 2013 with no trend. Redtail surfperch and striped seaperch were not included in analyses south of Point Conception due to their low sample size. The average CPUE from 2004–13 for surfperch north of Pt. Conception are as follows: barred surfperch (.26), redtail surfperch (.09), and striped seaperch (.10). The average CPUE for barred surfperch south of Pt. Conception was (.34). CPUE for barred surfperch in both regions has been above average since 2011. The lack of downward trends in CPUE indicates that stocks for these important surfperch species are not declining, at least on the regional level for areas north and south of Point Conception.

Length frequency data are available for species of surfperch encountered during recreational data collection surveys. Barred surfperch length frequency distributions for shore based fishing modes north of Pt. Conception from CRFS measurements (fig. 30) have shown no trend and have been relatively consistent since 2004.

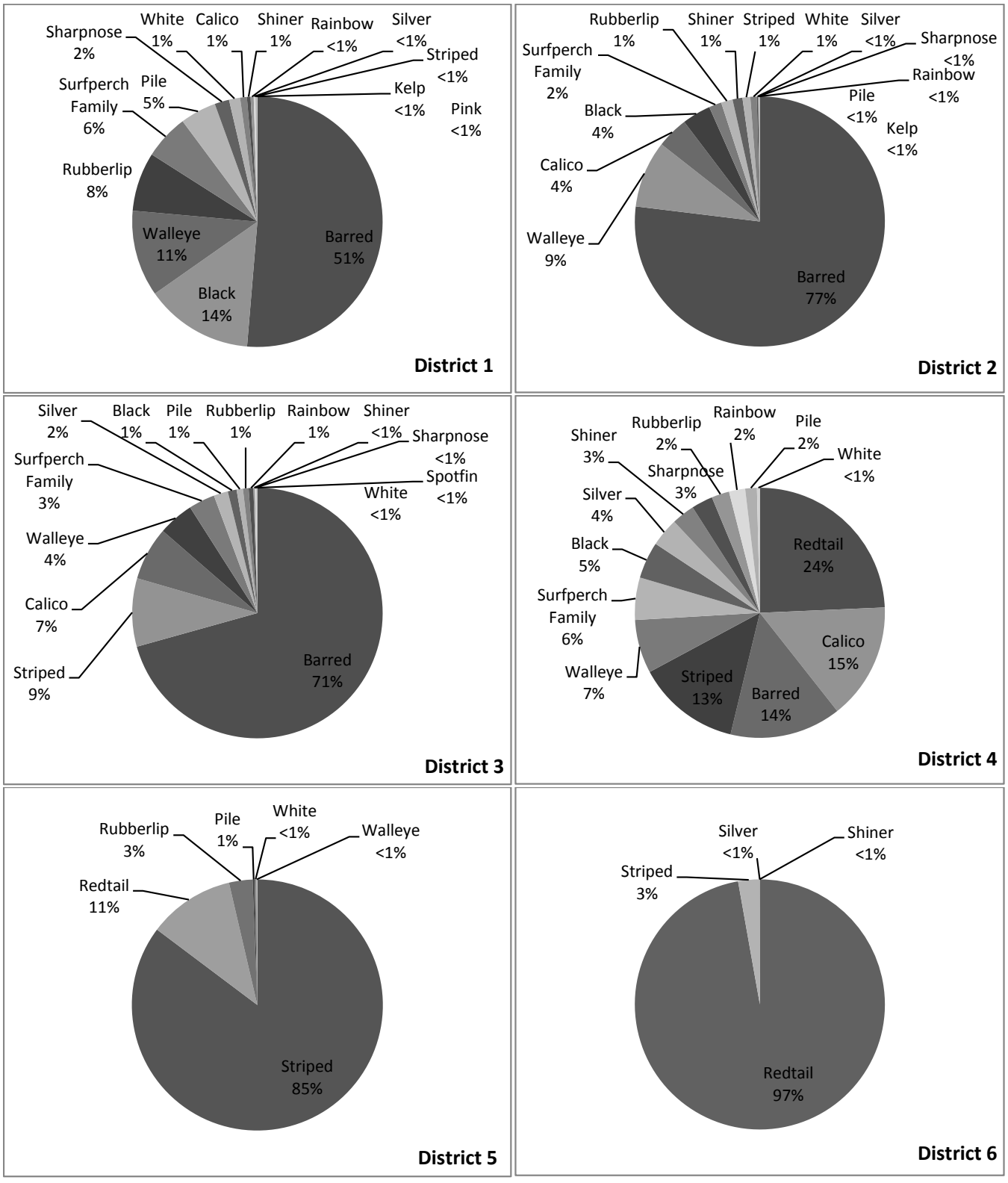

Figure 27. CRFS recreational catch estimates by district, shown as percentage of species by weight, 2013.

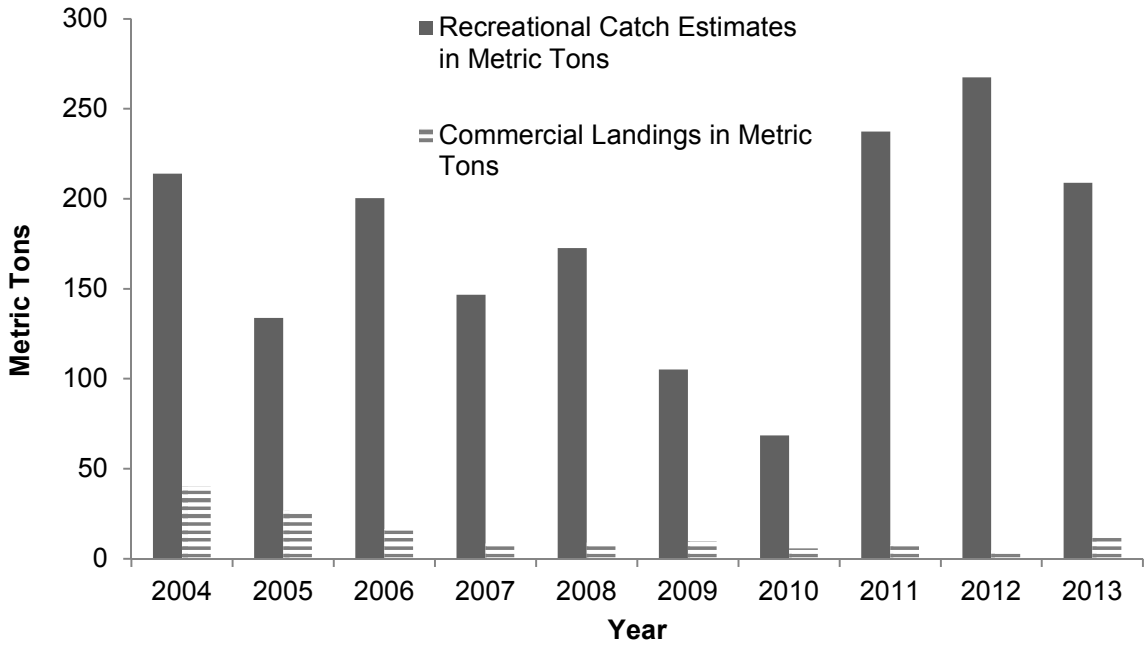

Figure 28. Annual CRFS recreational catch estimates or all species of surfperch compared to commercial landings for all species of surfperch, 2004–13.

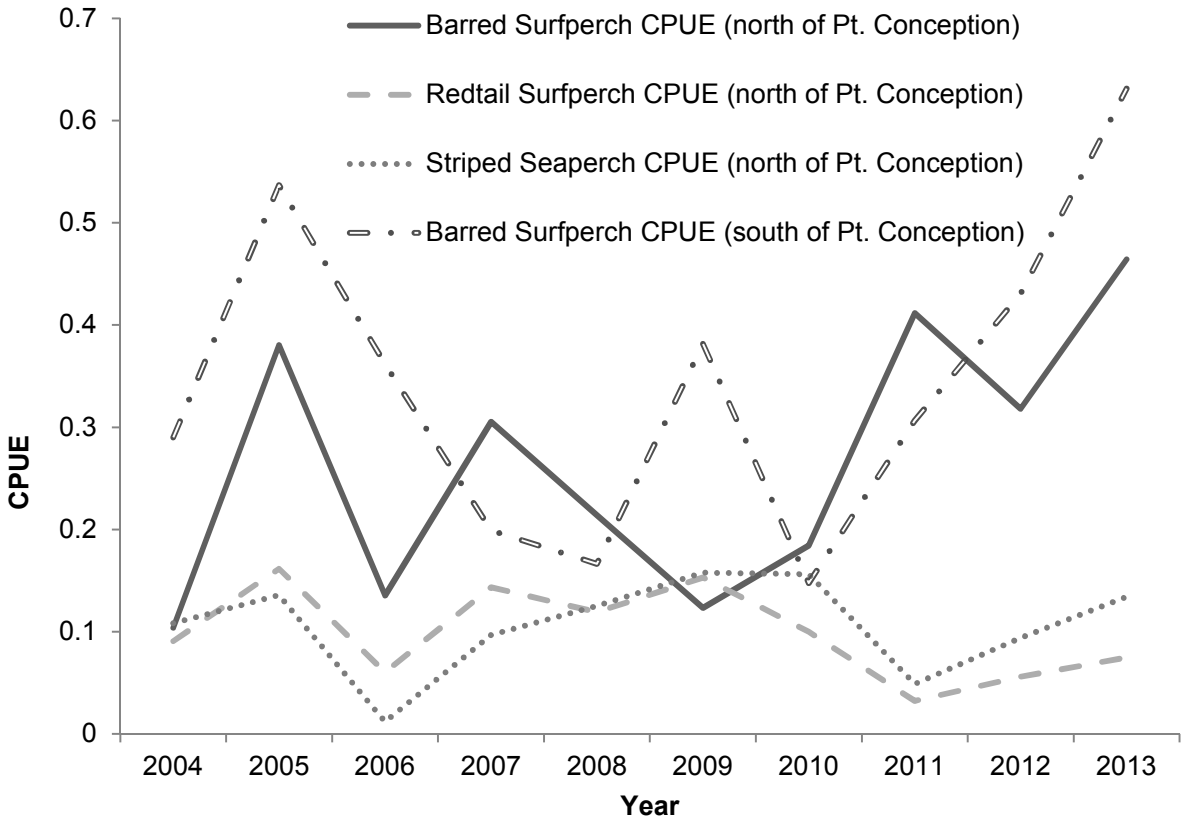

Figure 29. Recreational CPUE for barred surfperch, redtail surfperch, and striped seaperch north of Pt. Conception and barred surfperch south of Pt. Conception, in beach and bank fishing modes, 2004–13.

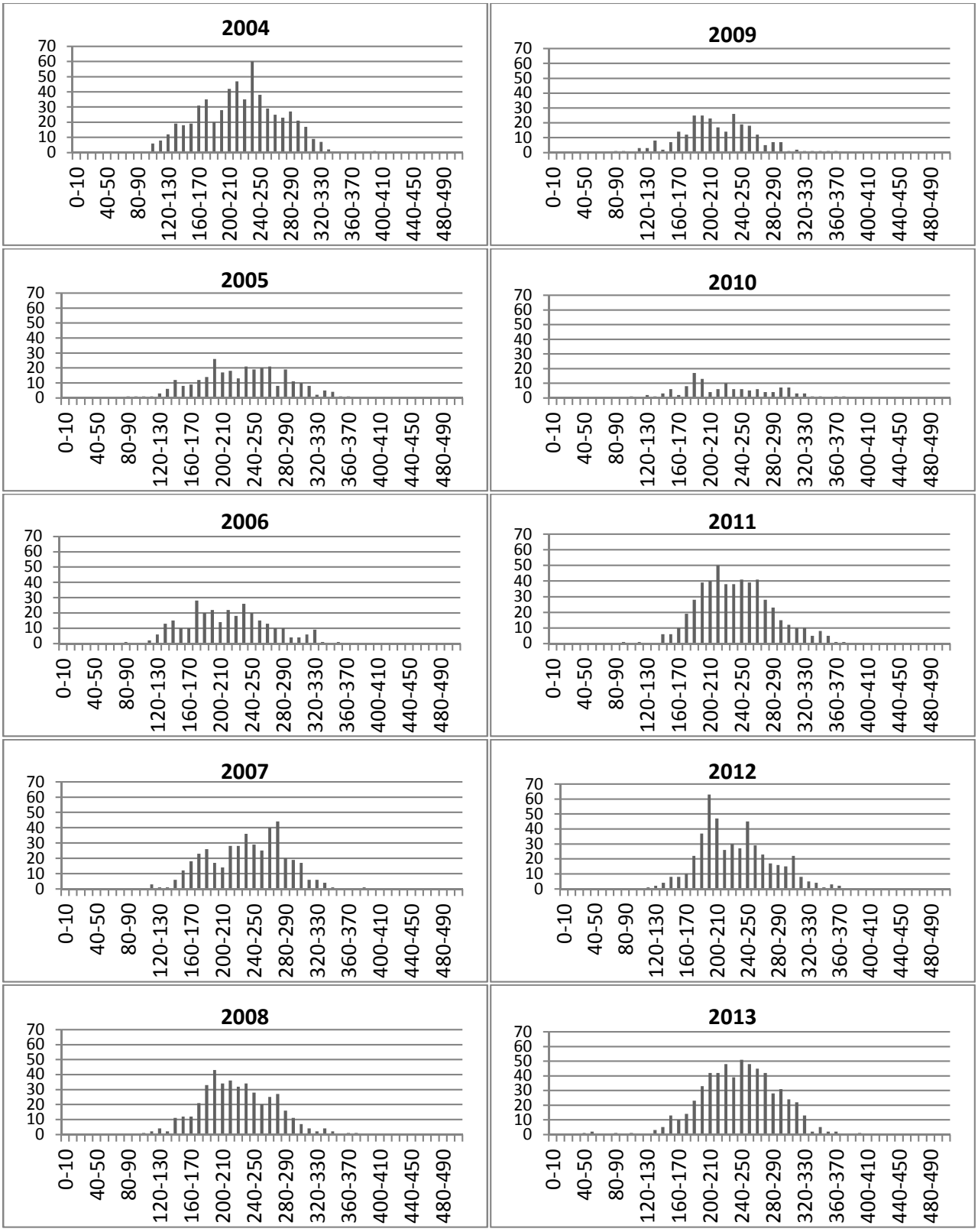

Figure 30. Length frequency distribution for barred surfperch caught from shore-based modes north of Pt. Conception, CRFS measurements, 2004–13. Length frequency bins are in 10 mm increments (X-axis) and the Y-axis shows the number of surfperch measured in each bin. Surfperch are displayed in fork length.

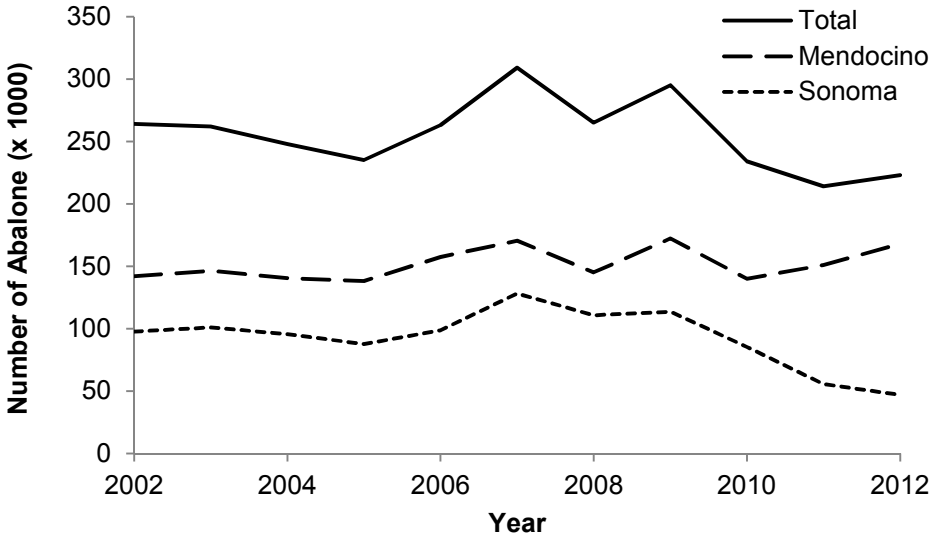

Figure 31. California recreational red abalone (*Haliotis rufescens*) catch, 2002–12.

Red Abalone

The recreational red abalone (*Haliotis rufescens*) fishery in northern California is the largest in the world, with over 30,000 participants annually. The average annual take between 2002 and 2012 was approximately 254,000 red abalone, with fishing effort centered on the coastal counties of Sonoma and Mendocino. Given the importance of this fishery to the local coastal economy, as well as to California's natural heritage, the state is actively managing the fishery to ensure the long-term sustainability of the resource. The fishery is managed under the Abalone Recovery and Management Plan (ARMP) using traditional fishery management strategies as well as an innovative adaptive management approach incorporating density survey data in decision making. The fishing season extends from April 1 to November 30, with an interim closure during the month of July. Only abalone >178 mm (>7 in) may be taken, either at low tide or by free diving. These regulations are designed to allow multiple years of reproduction prior to entering the fishery while also maintaining a depth refuge of abalone in deeper areas. Higher densities of abalone on the fishing grounds are also particularly important to maintain in order to avoid reduction in reproductive potential at low densities.

In northern California, fishery-independent density surveys are conducted triennially at eight (fished) index sites to assess whether fishing regulations are maintaining densities through time. Catch from these sites accounts for ~48% of the total fishery catch. These index sites were chosen to provide early warning for declines in density in the fishery overall. The ARMP harvest control rules reduce the take by 25% if the average density across the index sites drops 25% below the established baseline of 0.66 abalone m^2. Furthermore, a site closure and fishery reduction trigger was established at 0.25 abalone m^2 to avoid local impacts to reproduction due to low densities. Reductions in fishing pressure across the fishery are designed to lessen the impacts of potential shifts in fishing effort and to maintain a sustainable fishery.

Recently, densities at the index sites have declined due to a combination of fishing and non-fishing impacts. The catch in Sonoma and Mendocino counties was unusually high from 2006 to 2009, averaging 274,000 abalone, with a peak of 309,000 abalone in 2007 (fig. 31). Much of the increased fishing effort was directed at Fort Ross in Sonoma County, which peaked at >62,000 abalone in 2007. The average catch at Fort Ross prior to this period was almost half this level at 36,000 abalone. By 2009, surveyed densities in Fort Ross were reflecting this impact (density: 0.37 abalone m^2—a 36% decline from 2006 estimate). In response to concerns over declining densities at Fort Ross due to increased fishing pressure, Fort Ross was closed to abalone fishing during the first two months of the season (implemented in 2012).

In August 2011, a Harmful Algal Bloom (HAB) resulted in high abalone mortalities along the Sonoma County coast, further reducing densities of red abalone. In response, the Fish and Game Commission instituted an emergency closure of the fishery in Sonoma County in October. Following the HAB, surveys revealed that the abalone density (2009–12) had dropped to 0.47 abalone m^2, which is below the management trigger of 0.5 abalone m^2. The decline in red abalone density was driven by the decline in the Sonoma County portion of the fishery where the HAB event occurred (fig 32). In Sonoma County, the average abalone density at the four sites declined by 60% from 0.79 abalone m^2 (2003–07) to 0.31 abalone m^2 (2009–12) (ANOVA: $p < 0.001$). There was no significant decline in Men-

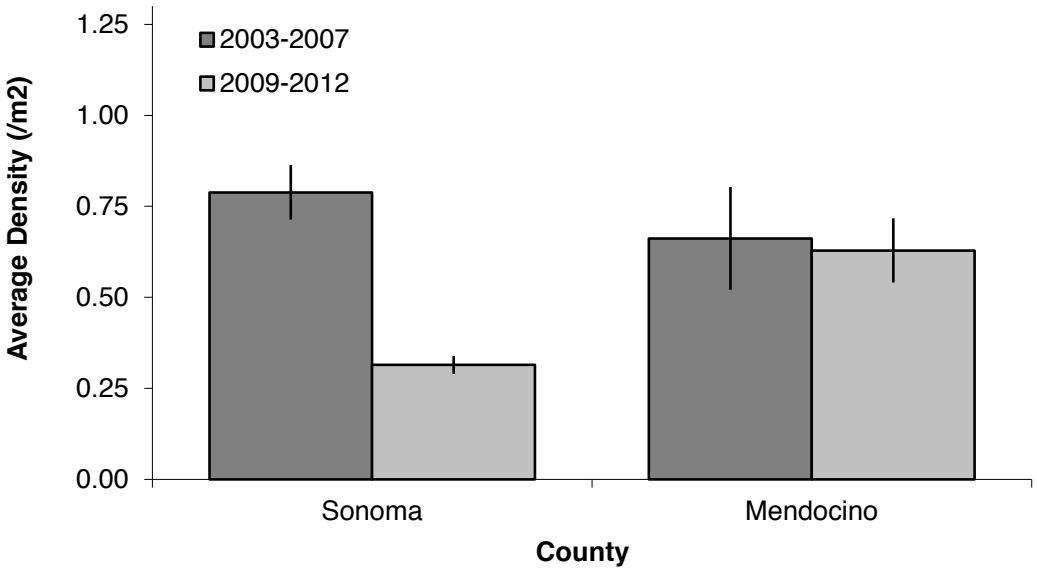

Figure 32. Average density of red abalone (*Haliotis rufescens*) from index site surveys in Sonoma and Mendocino counties, 2003–07 and 2009–12.

docino County, with average densities near 0.6 abalone m^2 in both time periods.

The decline in the fishery overall triggered management action to reduce the annual take from 24 to 18 abalone, with additional limitations in Sonoma County and south, where only 9 out of the 18 abalone may be taken. The daily start time was also delayed to 8:00 am, which reduces access during extreme low tide events. Fort Ross, historically the most popular abalone fishing site, was closed because the density had declined below the site closure trigger after the HAB event.

Report card data show reductions in overall take after the 2009 season, with effort shifting away from Sonoma County, prior to implementation of regulation changes in the 2014 season. The overall catch from 2012 (223,000 abalone) was 13% lower than the average catch from the prior 10 years (fig. 31). The 2012 catch in Mendocino County (152,000 abalone) was 11% higher than the prior 10-year average, while the catch in Sonoma County (82,000 abalone) was 50% lower. The proportion of the catch from Sonoma County has been steadily declining since 2010, from an average of 39% (2002–09) to 21% in 2012. Conversely, the proportion of the catch in Mendocino has been increasing, from an average of 57% (2002–09) to 75% in 2012.

These reductions in take in Sonoma County resulted from a combination of the heavy fishing pressure and HAB impacts on densities, as well as other circumstances that limited opportunities for abalone fishing in the county. Many popular state parks in Sonoma County reduced operations and closed parking access areas in 2010 due to budget cuts, reducing access to sites during popular low tide events in the spring. Newly adopted Marine Protected Areas (May 2010) also prohibited abalone take at a few sites in Sonoma County. In 2011, the adoption of the Automated License Data System (ALDS) for sales and reporting of abalone report cards limited individuals to purchasing only one card, resulting in fewer card sales and a reduction in catch. Abalone card sales dropped by 2,800 cards during the first year of the ALDS implementation, potentially indicating the number of illegal duplicate cards purchased in prior years. Adoption of the ALDS has also resulted in greater compliance with timely returns of report cards, so that catch estimates may be more quickly available than in years past.

The apparent shift in fishing effort toward Mendocino is concerning for future sustainability of those sites, although overall fishing pressure may drop in response to the most recent regulation changes in the 2014 season. The more rapid assessment of catch statistics as well as the continued density surveys will provide important insight into the future dynamics of this vital abalone fishery.

Kelp and Edible Algae

Perennial giant kelp (*Macrocystis pyrifera*) forests can be found worldwide in nearshore temperate oceans. On the West Coast of North America, giant kelp forests range from southeast Alaska to Baja California, Mexico. Along the California coast, giant kelp is most abundant south of San Francisco (San Mateo County) and generally grows attached to rocky substrate in depths from 6 meters (m) to more than 30 m. Bull kelp (*Nereocystis leutkeana*) is an annual alga that ranges offshore of the Pacific coast of North America and Asia. Along California, bull kelp can

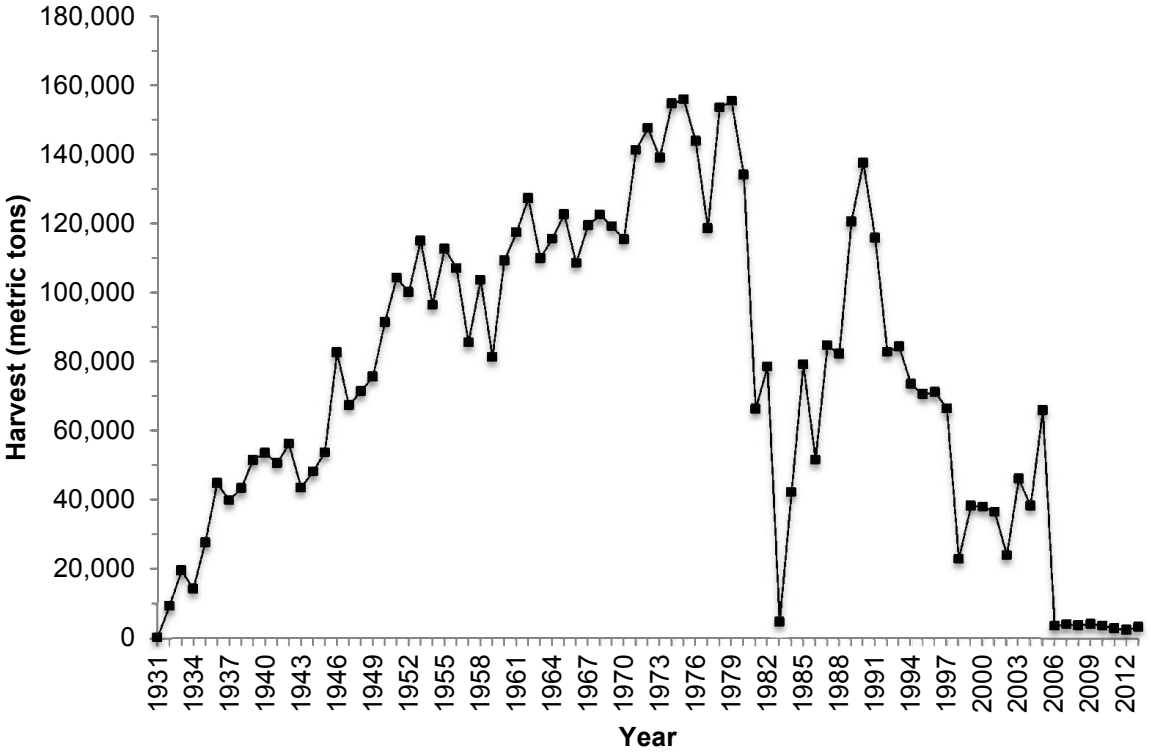

Figure 33. Commercial kelp harvest logbook data for giant and bull kelp, 1931–2013.

be found offshore from central to northern California, with greater amounts of bull kelp in northern California. Bull kelp attaches to rocky substrate in depths of 4 to 22 m.

Optimal conditions for giant kelp growth include cool ocean temperatures of 10° to 16° C and high nutrient availability. Bull kelp optimal growing conditions include high light availability (including intensity of light and photoperiod), nutrient availability, and water clarity. In general, both giant and bull kelp are affected negatively during El Niño events due to warm-water stress, along with reduced nutrient availability and large swells. Anthropogenic disturbances that inhibit giant and bull kelp growth include coastal development resulting in pollution, increased water turbidity which reduces light availability for photosynthesis, siltation which can hinder growth or bury young kelp, turbid warm water outflows from power plants, and wastewater discharges. As typical with other environments, the reduction of kelp forests is usually due to a combination of factors. While urchins can coexist in a thriving ecosystem with giant and bull kelp, the combination of poor kelp growing conditions and an increase in urchin populations can result in the formation of "urchin barrens," which can remove large amounts of kelp through overgrazing. The removal of urchin predators, such as the southern sea otter (*Enhydra lutris nereis*) in southern California has upset the giant kelp ecosystem balance. Furthermore, fishing activities have reduced urchin predators like the California sheephead (*Semicossyphus pulcher*) and California spiny lobster (*Panulirus interruptus*), and abalone, an urchin competitor.

There are 87 administrative kelp beds located offshore of California's mainland and surrounding the Channel Islands. The administrative kelp beds contain giant or bull kelp or a combination of both. The term "kelp" refers to both giant and bull kelp unless stated otherwise. Each of the administrative kelp beds fall within one of the following management categories: open (open to harvest by all commercial kelp harvesters), closed (commercial harvest of kelp is prohibited), leasable (available to harvest by commercial kelp harvesters, until an exclusive lease is granted by the California Fish and Game Commission [Commission] then only available to the lessee), and lease only (commercial harvest of kelp is prohibited unless an exclusive lease is granted by the Commission). Currently, of the 87 administrative kelp beds, 33 are open, 28 are available for lease, five are leased, three are lease-only beds, and 18 are closed to commercial harvest. Commercial harvesters of marine algae must abide by commercial algae harvest regulations (California Code of Regulations [CCR], Title 14, §165 and 165.5). Kelp harvesters may not cut attached kelp at a depth greater than four feet below the surface of the water at the time of harvest.

Commercial giant kelp harvesting offshore of California began in the early 1900s. By World War One, giant kelp was mostly harvested to extract potash and ace-

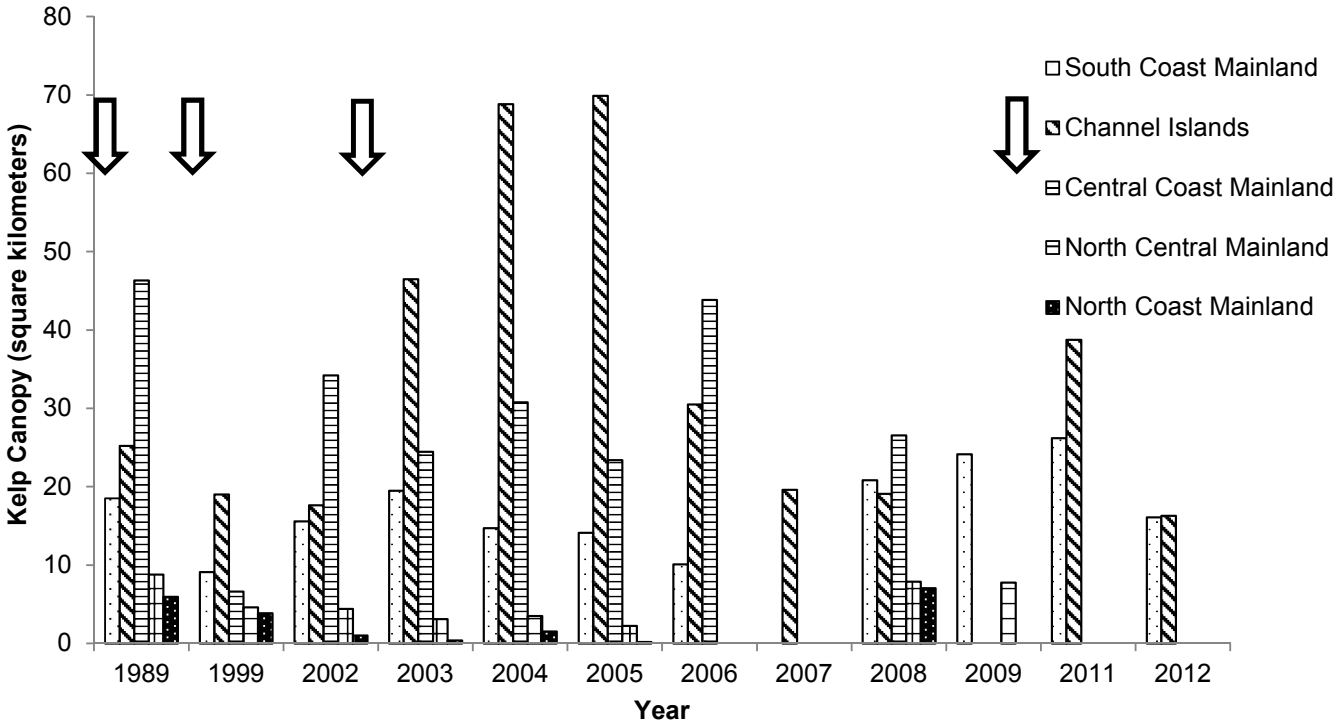

Figure 34. California Department of Fish and Wildlife aerial kelp surveys, 1989–2012 (surveys were not conducted during all years or in all regions). Regions: South coast mainland – Point Conception to the California/Mexico border; Central coast mainland – Pigeon Point to Point Conception; North central mainland – Alder Creek near Point Arena to Pigeon Point; and North coast –California/Oregon border to Alder Creek near Point Arena. Arrows represent strong (1987–88 and 1997–98) and moderate (2002–03 and 2009–10) El Niño events.

tone, which were used to manufacture explosives. After the war, giant kelp was commercially harvested for use in manufactured livestock and poultry food and as feed for aquacultured abalone. However, the majority of giant kelp harvested from 1929 to 2005 was used to extract algin. Algin is an effective thickening, stabilizing, suspending, and gelling agent and has been utilized in food products, the medical field, as well as industrial and cosmetic industries. Large-scale commercial harvesting of giant kelp in California last occurred in 2005, before ISP Alginates moved their operations overseas, with a harvest of 65,867 wet t (harvest includes other industries). From 2006 to 2013, the reported commercial harvest of giant kelp has remained relatively consistent, averaging 3,510 wet t per year. Reported landings include a nominal amount of bull kelp. Giant kelp harvested during the January 1–December 31, 2013 harvest season was 3,305 t (fig. 33). During this time the majority of giant kelp was harvested from boats using small mechanized harvesters or by hand to provide food for aquacultured abalone. Most of the current commercial giant kelp harvesting ranges from Santa Barbara County to Monterey County. Currently, there is no commercial giant or bull kelp harvest in northern California. Increased harvesting of giant kelp in California is speculated over the next few years due to a renewed interest in commercially harvesting giant kelp for a variety of uses including nutraceutical and cosmeceutical products, as functional food ingredients, and as a biofuel.

The California Department of Fish and Wildlife (Department) has conducted coast-wide (including the offshore Channel Islands) aerial surveys of giant and bull kelp. Aerial surveys were conducted in 1989 and 1999, no surveys occurred in 2000 and 2001. Annual surveys began in 2002, although some years and regions the surveys were not completed due to budget constraints. Geographic Information Systems (GIS) shapefiles of the aerial kelp surveys can be found on the Department webpage (http://www.dfg.ca.gov/marine/kelp.asp). Results of the aerial surveys are depicted in Figure 34.

Commercial edible algae harvesting includes a variety of marine algae. Eelgrass (*Zostera*) and surfgrass (*Phyllospadix*) are prohibited from commercial harvest. Edible algae harvest data from logbooks are available from 1997 to 2013; however, specific species and location information did not become available until 2000. In 2013, the total reported commercial harvest of edible algae was 17 t, up slightly from the annual average of 14 t reported from 1997 to 2013 (fig. 35). The commercial harvest of edible algae is regional, with 90% of the harvest occurring along the north coast (Alder Creek in Mendocino County to the California/Oregon border) during 2000–13.

Recreational harvest of giant and bull kelp and other

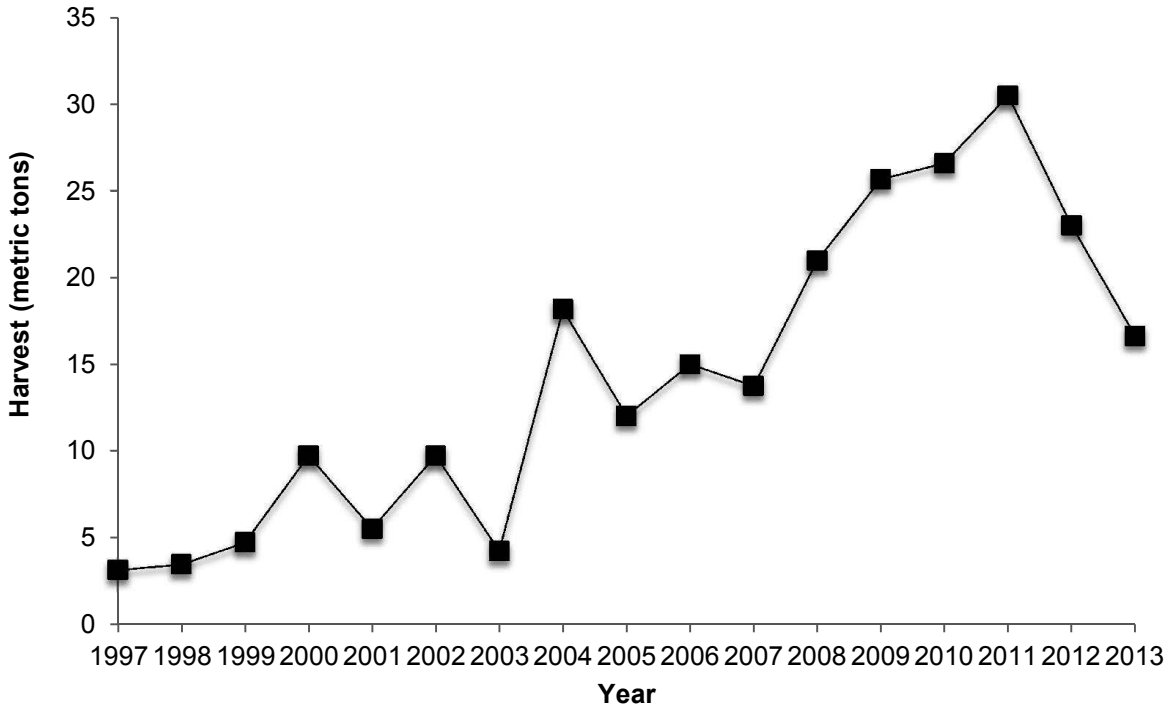

Figure 35. Commercial edible algae harvest logbook data, 1997–2013.

edible algae for personal use is permitted. Those harvesting for personal use must abide by regulations governing the recreational harvest. The daily bag limit for recreational harvesters of marine algae is 4.5 kg wet weight in the aggregate. Recreational harvesters are prohibited from harvesting eelgrass (*Zostera*), surfgrass (*Phyllospadix*), and sea palm (*Postelsia*).

Amendments to the regulations governing the commercial harvest of giant and bull kelp were implemented in 2013. The regulations can be found in CCR, Title 14, §165 and 165.5. These amendments: (a) clarify existing regulations; (b) update administrative kelp bed boundaries to reference coordinates of latitude and longitude; (c) eliminate the development plan requirement for lease holders; (d) require a Commission-approved kelp harvest plan for lease holders and for the mechanical harvest of kelp in all locations where harvest is allowed; (e) require current lease holders to provide additional information to meet the kelp harvest plan requirement; and (f) specify the information required in the kelp harvest plan. The regulation amendments were Phase One of a three phase process. Phase Two will address commercial marine algae license fees and royalty rates. Phase Three will follow with a focus on marine algae management policies including marine algae harvest methods.

Marine Aquaculture

The California Fish and Game Commission (Commission) have been given the authority to regulate certain aspects of commercial marine aquaculture on state lands or in state waters, specifically through the Fish and Game Code and Title 14 of the California Code of Regulations. The California Department of Fish and Wildlife (Department) has management responsibility over these aspects of the industry. A major feature of the Fish and Game Code is its provision for the allotment of State tidelands through the Commission. In California, the Department manages 21 state water bottom leases for marine aquaculture, totaling 1,952 acres. Additional marine aquaculture operations occur on granted or privately owned tidelands, adding an addition 3,948 acres for a statewide total of 5,900 acres of water bottoms utilized for marine aquaculture. There are also marine aquaculture facilities established on privately owned uplands along the California coastline. The Department's management authority also includes the registration of aquaculture facilities and species cultured within the state; the detection, control, and eradication of disease in aquaculture facilities, and the permitting and licensing of aquaculture-related activities, such as stocking, broodstock collection, and importation.

California's commercial marine aquaculture industry consists of the production of five oyster species, clams, mussels, and abalone. The Pacific oyster (*Crassostrea gigas*), originally from Japan, is the principal species cultured on the West Coast. The Kumamoto oyster (*Crassostrea sikamea*), also from Japan, is the second most popular species grown in California estuaries. The eastern oyster

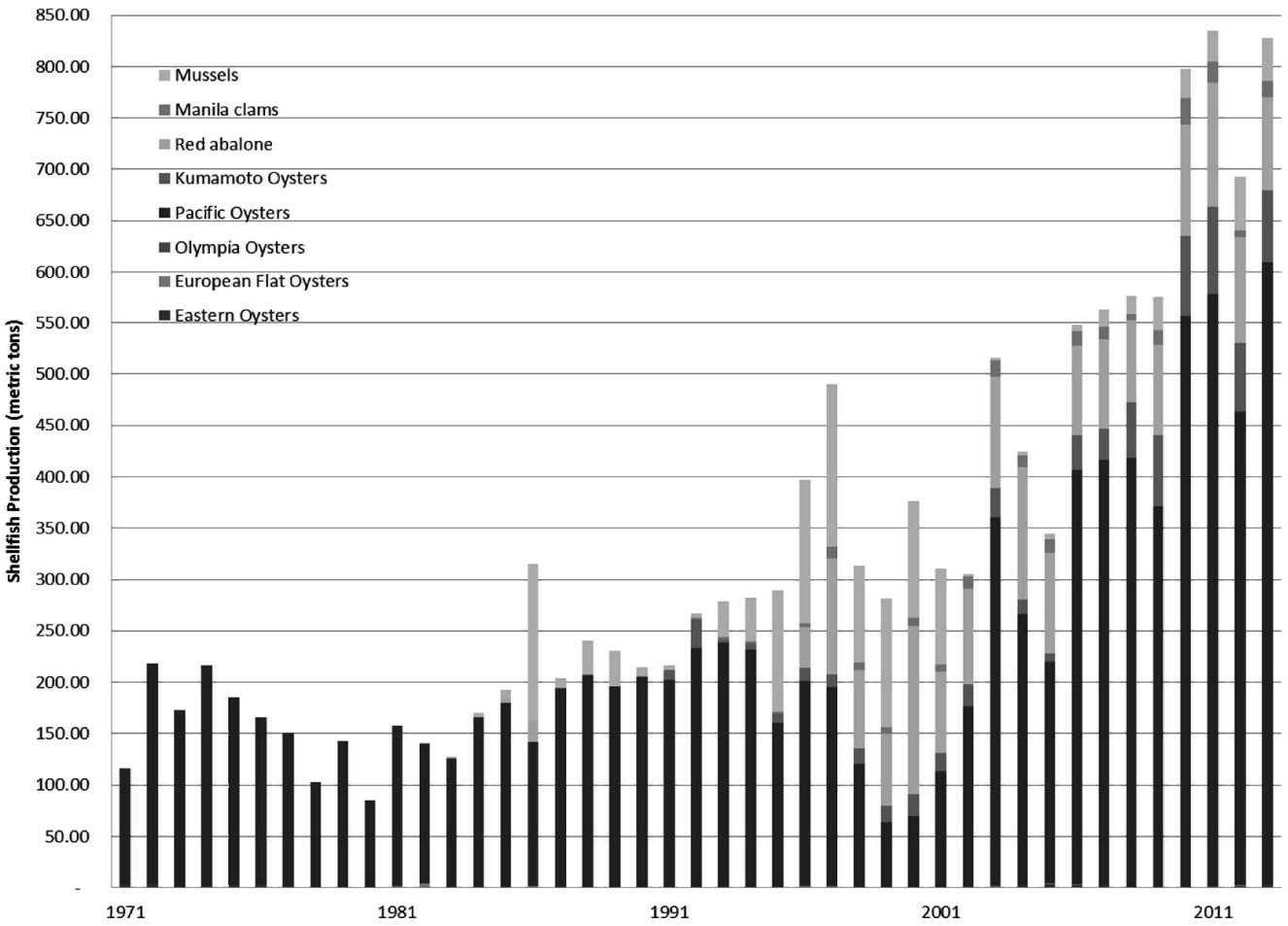

Figure 36. California commercial production of mussels (*Mytilus* spp.), Manila clams (*Venerupis philippinarum*), red abalone (*Haliotis rufescens*), kumamoto oysters (*Crassostrea sikamea*), Pacific oysters (*C. gigas*), Olympia oysters (*Ostrea lurida*), European flat oysters (*O. edulis*), Eastern oysters (*C. virginica*), 1971–2013.

(*Crassostrea virginica*), grown on the Atlantic and Gulf coasts of North America, accounts for most US oyster landings, but is just a small percentage of the oyster production in California. Two species of the genus *Ostrea* are cultivated to a lesser extent. The European flat oyster (*Ostrea edulis*) leads in production for this genus, while the Olympia oyster (*Ostrea lurida*), indigenous to the Pacific coast, has been the least important. Currently, the Manila clam (*Venerupis philippinarum*) is the only clam species grown commercially in California. Most mussel production in California comes from naturally set Mediterranean mussel or bay mussel seed (*Mytilus galloprovincialis* and *M. trossulus*, respectively). However, some growers acquire Mediterranean mussel seed from West Coast hatcheries, the same species that is cultured in Spain and most of Europe. Red abalone (*Haliotis rufescens*) is the mainstay of the commercial abalone industry, grown in either land-based tanks or in cages suspended in the water column.

Shellfish aquaculture is currently centered in nine areas along the coastline; Humboldt Bay, Tomales Bay, Drakes Estero, Santa Cruz, Monterey Bay, San Luis Obispo, Morro Bay, Santa Barbara, and Agua Hedionda Lagoon. Total shellfish production in 2013 (January through December) had the second highest recorded harvest in the 42 year history of landings, reaching a total of 828.24 t all species combined (fig. 36, table 7). This resulted in a value of $24.2 million. Compared to 2012, there was a 19% increase in production in 2013, all species combined. The culture of Pacific oysters represented the largest production for the industry, resulting in 73% of the total production, and 70% of the total value in 2013.

Oysters. The first commercial oyster beds were established in San Francisco Bay about 1851 when mature native (Olympia) oysters were shipped from Shoalwater Bay, Washington (Willapa Bay), and later from other bays in the Pacific Northwest and Mexico. Market demand for a larger half-shell product stimulated experiments in transporting the Eastern oyster from the Atlantic states to the West Coast. Cool summer water temperatures, however, prevented successful natural reproduction of the Eastern oyster. Soon after comple-

TABLE 7
Commercial shellfish production in California (metric tons).

Year	Eastern Oysters	European Flat Oysters	Olympia Oysters	Pacific Oysters	Kumamoto Oysters	Abalone	Clams	Mussels	Total Shellfish
1971	3.11	—	—	112.94	—	—	—	—	116.05
1972	4.01	—	—	214.58	—	—	—	—	218.59
1973	0.64	—	—	172.57	—	—	—	—	173.21
1974	1.22	—	—	215.46	—	—	—	—	216.69
1975	2.19	—	—	182.75	—	—	—	—	184.94
1976	3.36	—	—	162.87	—	—	—	—	166.23
1977	1.49	—	—	149.37	—	—	—	—	150.86
1978	0.23	0.09	—	102.32	—	—	—	—	102.65
1979	0.04	0.21	—	142.80	—	—	—	—	143.05
1980	0.05	0.18	—	84.51	—	—	—	—	84.74
1981	—	1.59	—	156.59	—	—	—	—	158.18
1982	—	4.03	—	136.41	—	—	—	0.02	140.46
1983	—	0.16	—	125.29	—	—	—	1.84	127.29
1984	—	—	—	165.68	—	—	—	4.80	170.48
1985	—	0.09	—	180.28	—	4.54	—	7.49	192.40
1986	—	1.15	—	140.65	0.03	20.10	—	153.01	314.94
1987	—	0.10	—	193.92	0.04	—	—	10.35	204.41
1988	—	0.02	—	207.09	0.10	0.30	—	33.38	240.89
1989	—	0.08	—	195.69	—	0.23	—	34.65	230.65
1990	—	0.48	0	204.82	0.08	—	—	9.75	215.13
1991	0.02	0.61	0.01	202.03	9.31	—	0.04	4.27	216.29
1992	0.05	0.30	0	232.61	28.18	—	1.22	5.14	267.49
1993	0.01	0.86	—	237.53	3.01	0.36	2.04	34.68	278.49
1994	0.32	0.48	—	230.63	6.17	0.60	1.69	42.75	282.64
1995	0.45	0.40	—	159.88	8.32	—	2.54	117.46	289.05
1996	0.61	0.45	—	200.21	12.78	39.62	3.78	139.82	397.28
1997	0.76	0.44	—	193.68	12.87	113.07	11.52	157.53	489.86
1998	0.67	0.08	—	120.01	15.01	76.60	7.08	94.30	313.75
1999	0.36	0.23	—	62.73	16.17	70.76	6.16	125.26	281.68
2000	0.07	—	—	69.57	21.81	163.29	7.72	113.55	376.01
2001	0.08	0.09	—	113.09	17.97	79.12	7.16	93.45	310.95
2002	1.20	0.64	—	174.98	20.57	93.65	11.53	2.93	305.50
2003	0.71	0.87	—	358.61	28.55	108.31	15.89	2.86	515.80
2004	2.00	0.32	—	263.94	14.02	128.98	11.35	3.93	424.54
2005	3.23	0.74	—	216.22	7.54	98.06	13.25	5.20	344.24
2006	2.69	0.15	—	403.95	33.79	87.15	13.60	6.52	547.86
2007	1.96	—	—	414.37	29.91	87.20	12.47	16.84	562.75
2008	0.65	0.04	—	417.24	54.32	80.22	6.07	17.75	576.29
2009	0.84	—	0.03	370.07	69.22	88.05	14.70	32.23	575.14
2010	0.27	—	0.05	556.78	77.96	108.83	25.09	28.40	797.37
2011	0.94	—	0.11	576.77	85.68	120.96	20.16	30.62	835.25
2012	1.86	0.58	—	461.48	66.11	103.86	6.78	52.46	693.13
2013	3.08	0.03	—	606.44	70.28	90.71	15.88	41.82	828.24

tion of the transcontinental railroad in 1869, shipments of Eastern oyster seed were made and transplanted in San Francisco Bay for further growth, marking the beginning of actual oyster raising in California. However, with California's population and industrial growth came a degradation of water quality in San Francisco Bay and by 1939 the last of the San Francisco Bay oysters were commercially harvested.

The commercial oyster industry and California Department of Fish and Game began conducting earlier experimental plantings using the Pacific oyster in Tomales Bay, Elkhorn Slough, Drakes Estero, Bodega Lagoon, and Morro, Newport, and San Francisco bays throughout the 1930s. Several Pacific oyster plantings proved successful, demonstrating that imported Pacific oyster seed could be grown commercially in California. Oyster culture is now centered on five major growing areas: Humboldt Bay, Tomales Bay, Drakes Estero, Morro Bay, and Agua Hedionda Lagoon.

In 2013 there was the largest production of oysters, 679.83 t worth $20.6 million. This was a 28% increase in production compared to 2012 (530.03 t). Commercial harvest of oysters averaged 481.57 t over the ten-year period from 2004–13 (fig. 37). In 2013, Humboldt Bay was the leading producer of oysters in California, representing 46% of the total oyster production, all species combined. Humboldt Bay produced 239.50 t of Pacific oysters, the highest production on record for this area since 1971, with a value of $6.7 million. In addition, 69.96 t of Kumamoto oysters were produced, a slight

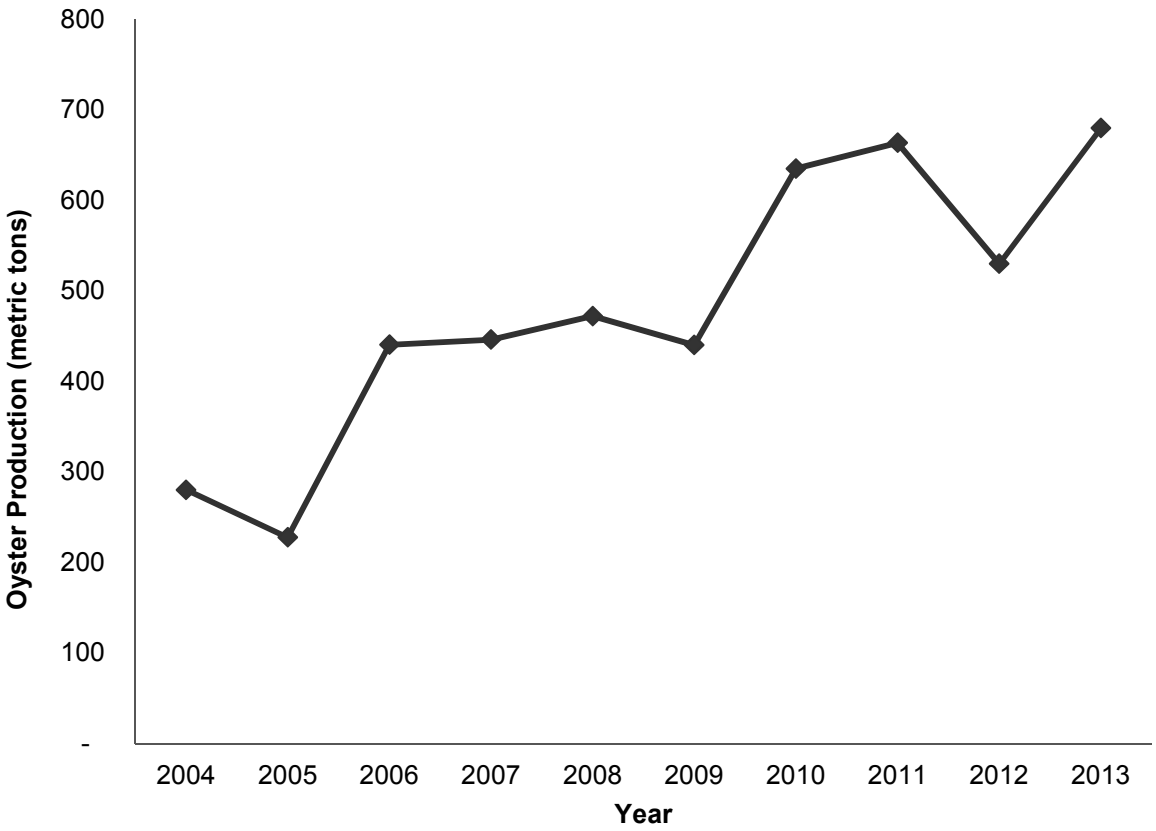

Figure 37. Commercial production of oysters in California, 2004–13.

decrease from a recent peak in 2011, totaling $3.5 million in value. Pacific oyster production in Tomales Bay reached 158.97 t, $4.4 million, a 1% decrease from last year's peak. Kumamoto oyster production in Tomales Bay decreased significantly to 0.32 t, a 95% decrease from the high in 2009, representing $16,400 in value. In addition, Tomales Bay harvested small amounts of Eastern and European flat oysters, 3.08 and 0.03 t, respectively, totaling $156,000 combined. Pacific oyster production in Drakes Estero reached 188.86 t, the highest production for this area. Value totaled $5.3 million, a 29% increase compared to the previous year for the estero. Pacific oysters are currently the only species of shellfish grown in Morro Bay and totaled 18.72 t, $520,800 in 2013, a decline of 24% from a recent peak in 2012 (table 8). Agua Hedionda Lagoon also cultivates Pacific oysters; however, data was unavailable in time for preparation of this report.

Clams. The Manila clam was unintentionally introduced to the West Coast with import of Pacific oyster seed in the 1930s, and has since become an important species to the aquaculture industry in California. The culture of clams in California began in 1981, but production levels were relatively low until the mid-1990s. While British Columbia and Washington are the largest commercial producers of adult Manila clams, Humboldt Bay, California, is the leading supplier of clam seed worldwide. Tomales Bay is the only growing area in California to produce adult Manila clams with 15.88 t and $175,100 in value for 2013.

Mussels. Experiments in culturing wild mussel seed stock and in developing hatchery and grow-out methods in the 1980s have greatly increased the importance of commercial mussel production, particularly the Mediterranean mussel, which occurs primarily in southern and south-central California. A related species, the bay mussel, occurs in northern California and hybrids of the two species are commonly found between Cape Mendocino and Monterey Bay. Tomales Bay, Santa Barbara, and Agua Hedionda Lagoon are the primary growing areas of mussels in California. Santa Barbara produced 32.58 t, $215,500, and Tomales Bay produced 9.24 t, $61,100 in 2013. This was a 20% decrease in statewide production of mussels compared to the peak 2012 (52.46 t). Data for mussel production in Agua Hedionda Lagoon was not available in time for preparation of this report.

Abalone. Pioneering efforts to mass cultivate abalone in California began about 45 years ago, with a peak in abalone production in 1997. Participation in

TABLE 8
Production (metric tons) and value of Eastern, European Flat, Pacific, and Kumamoto oysters in California shellfish growing areas for 2013.

	Eastern Oysters			European Flat Oysters			Pacific Oysters			Kumamoto Oysters			Totals		
Area	Production	Value	% Total	Production	Value	% Total	Production	Value	% Total	Production	Value	% Total	Production	Value	% Total
Drakes Estero	0	$0.00	0%	0	$0.00	0%	188.86	$5,253,466	27.78%	0	$0.00	0%	188.86	$5,253,466	27.78%
Humboldt Bay	0	$0.00	0%	0	$0.00	0%	239.50	$6,662,282	35.23%	69.96	$3,538,210	10.29%	309.46	$10,200,492	45.52%
Morro Bay	0	$0.00	0%	0	$0.00	0%	18.72	$520,825	2.75%	0	$0.00	0%	18.72	$520,825	2.75%
Santa Barbara	0	$0.00	0%	0	$0.00	0%	0.39	$10,859	0.06%	0	$0.00	0%	0.39	$10,859	0.06%
Tomales Bay	3.08	$155,610	0.45%	0.03	$650	0.00%	158.97	$4,422,029	23.38%	0.32	$16,380	0.05%	162.40	$4,594,669	23.89%
Total	3.08	$155,610	0.45%	0.03	$650	0.00%	606.44	$16,869,461	89.21%	70.28	$3,554,590	10.34%	679.83	$20,580,311	100.00%

the industry has declined since that time, which was due in part to disease impacts. However, interest in abalone aquaculture remains high, prompted in part by the closure of the commercial abalone fishery in 1997. Presently, the commercial culture of red abalone occurs in three main coastal areas: Santa Cruz area, Monterey Bay, and San Luis Obispo area. There is a high market demand and price for growing the farmed product and production had been steadily increasing since the decline with a recent peak in 2011 (120.96 t). However, more recent production has experienced a 25% decrease the past couple years, reaching 90.71 t in 2013, totaling $3.2 million for the industry.

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