Ridgeback Prawn, *Sicyonia ingentis*
Enhanced Status Report

Ridgeback Prawn, *Sicyonia ingentis.* (Photo Credit: David Ono, CDFW)

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Marine Region
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Enhanced Status Reports

The Marine Life Management Act (MLMA) is California's primary fisheries law. It requires the California Department of Fish and Wildlife (Department) to regularly report to the California Fish and Game Commission (Commission) on the status of fisheries managed by the state. The 2018 Master Plan for Fisheries expanded on this general requirement by providing an outline for Enhanced Status Reports (ESRs) that is based on the MLMA's required contents for Fishery Management Plans (FMPs). The goal of ESRs is to provide an overview of the species, fishery, current management and monitoring efforts, and future management needs, and provide transparency around data and information that is unavailable or unknown. ESRs can help to guide Department efforts and focus future partnerships and research efforts to address information gaps and needs to more directly inform management. It is also anticipated that some ESRs will be foundations for future FMPs by providing background information and focusing analyses and stakeholder discussions on the most relevant issues.

Table of Contents

List of Acronyms

ABC	Acceptable Biological Catch
ACL	Annual Catch Limit
BRD	Bycatch Reduction Device
CCR	California Code of Regulations
CFIS	Commercial Fisheries Information System
CFR	Code of Federal Regulations
CDFW	California Department of Fish and Wildlife
CL	Carapace Length
CPUE	Catch Per Unit Effort
EFI	Essential Fishery Information
ENSO	El Niño Southern Oscillation
ESR	Enhanced Status Report
FGC	Fish and Game Code
FMP	Fishery Management Plan
IPCC	Intergovernmental Panel on Climate Change
LOF	List of Fisheries
M	Natural Mortality
MLMA	Marine Life Management Act
MLPA	Marine Life Protection Act
MPA	Marine Protected Area
MRC	Marine Resources Committee
NCCOS	National Centers for Coastal Ocean Science
NGO	Non-Governmental Organization
NRC	National Research Council
NMFS	National Marine Fisheries Service
NWFSC	Northwest Fisheries Science Center
NOAA	National Oceanic and Atmospheric Administration
PFMC	Pacific Fishery Management Council
SCB	Southern California Bight
TL	Total Length
SCCWRP	Southern California Water Research Project
WCGOP	West Coast Groundfish Observer Program

List of Figures

List of Tables

List of Appendices

Fishery-at-a-Glance: Ridgeback Prawn

Scientific Name: *Sicyonia ingentis*

Range: Ridgeback Prawn are found in Monterey Bay, California to Isla Maria Madre, Mexico, including the Gulf of California. They are abundant in the Santa Barbara Channel, Santa Monica Bay, and off Baja California, Mexico.

Habitat: Ridgeback Prawn occupy subtidal depths (16 to 1,007 feet or 5 and 307 meters), but are most commonly found between 148 and 531 feet (45 and 162 meters) occurring on sand, shell, and green mud substrate. Highly suitable Ridgeback Prawn habitat occurs at depths between 131 and 525 feet (40 and 160 meters) and south of Point Conception (below 35°N).

Size (length and weight): Female Ridgeback Prawns reach a maximum length of 1.8 inches (4.5 centimeters) carapace length and 7.1 inches (18.0 centimeters) total length. Males reach a maximum 1.5 inches (3.7 centimeters) carapace length and 6.2 inches (15.7 centimeters) total length. Length-weight relationships for both sexes are equivalent.

Life span: Ridgeback Prawn are short-lived with a life span of about 4 to 5 years.

Reproduction: Ridgeback Prawn are dioecious and thus have separate male and female sexes. They are broadcast spawners, and both sexes can spawn as early as the first year of growth, but most spawn upon reaching 1.2 inches (3.05 centimeters) carapace length in the second year of growth. Spawning season lasts from June through October. Females spawn multiple times during the spawning season and produce an average of 86,000 eggs a season.

Prey: Ridgeback Prawn feed on organic surface sediments, diatoms, infaunal polychaetes, gastropods, and crustaceans.

Predators: Several species of sea robins and groundfish prey on Ridgeback Prawn. Other likely predators include octopus, sharks, halibut, and bat rays.

Fishery: Ridgeback Prawn are commercially important. In 2017, more than 383,800 pounds (174 metric tons) were landed in California and generated about $923,400 in revenue. Average ex-vessel price has varied between $0.50 and $2.62 per pound since 1974, and was $2.39 in 2017.

Area fished: The Ridgeback Prawn fishery spans from Santa Barbara County to San Diego County, with most of the activity occurring in the Santa Barbara Channel. Ports within Santa Barbara and Ventura counties received the majority of the landings from year to year.

Fishing season: The Ridgeback Prawn fishery is closed during the peak spawning months from June 1 to September 30.

Fishing gear: Bottom trawl is used to fish for Ridgeback Prawn. Bottom trawling includes use of single-walled or double-walled nets equipped with a bycatch reduction device via single or double rigged trawl vessel. There is a minimum mesh size of 1.5 inch (2.54 centimeters) for single-walled cod ends or 3 inch (7.62 centimeters) for double-walled cod ends; net mesh may be no less than 1.375 inches (3.5 centimeters) measured inside the knot.

Market(s): Ridgeback Prawn are sought for domestic consumption, and either sold fresh or live to prevent “blackening” – a discoloration that forms after death that lowers consumer appeal.

Current stock status: No current estimates of Ridgeback Prawn population abundance in California exist. Recruitment appears to be influenced by oceanographic conditions, especially the El Niño Southern Oscillation. Warmer water years have generally resulted in greater biological productivity.

Management: Ridgeback Prawn is a state-managed fishery. Trawling for ridgeback is allowed in federal waters only. No quota or catch limits exist, and gear must contain a bycatch reduction device. Since April 2006, bottom trawlers targeting Ridgeback Prawn have been required to use a rigid-grate fish excluder device to minimize bycatch. Other management measures include seasonal and area closures, gear restrictions, logbook requirement, bycatch limits, and a federal observer program.

1 The Species

1.1 Natural History

1.1.1 Species Description

Ridgeback Prawn (*Sicyonia ingentis*) emerged as a commercially important species in California in the late 1970s. They have big bulbous eyes, a hard and stony exoskeleton, and a slender body consisting of two regions: the cephalothorax and abdomen. The carapace (hard protective shell over the cephalothorax) has a short slender rostrum (a horn-like projection) on the front edge that reaches over the tips of the eyes and bears two sets of feelers (antennules and antennae), mouthparts, and five pairs of pereiopods (walking legs) on the underside (Figure 1-1a). The abdomen consists of six segments: a pair of pleopods (swimming legs) are present on five of the anterior abdominal segments and the sixth segment bears a tail fan (uropod and telson) (Figure 1-1b). The carapace and dorsal part of the abdomen is reddish-brown in color and walking legs are white with some reddish patches (Hendrickx 1984). A prominent ridge along the upper (dorsal) midline portion of the abdomen distinguishes the Ridgeback Prawn from other species (U.S. Department of Commerce 2008).

a) b)

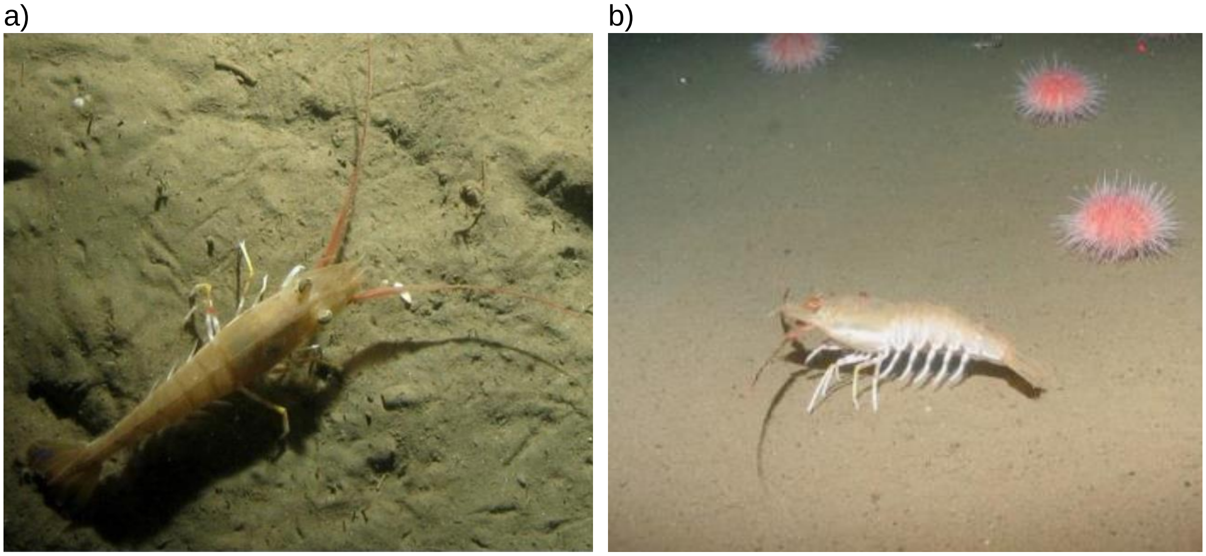

Figure 1-1. Ridgeback Prawn a) dorsal view showing the prominent ridge and b) lateral view (Reproduced from Lindholm et al. 2015a).

1.1.2 Range, Distribution, and Movement

Ridgeback Prawn range from Monterey Bay, California, to Isla Maria Madre, Mexico, at depths between 16 and 1,007 feet (ft) (5 and 307 meters (m)) (Perez Farfante 1985) (Figure 1-2). Major concentrations in southern California occur in the Santa Barbara Channel, Santa Monica Bay, and waters off Oceanside (Stull et al. 2001). This distribution of abundance also is reflected by the areas where they are fished commercially (See section 2.1). Other pockets of abundance are found off Baja California, Mexico. Ridgeback Prawns undertake a gradual offshore ontogenetic migration until maturity, with larger individuals found in deeper depths (NMFS 1983). After settlement, movement of adult Ridgeback Prawn within their home range is believed to be relatively small; thus, it is assumed that there is little or no adult movement and intermixing between the main pockets of abundance in southern California (CDFG 2001).

Figure 1-2. Geographic range of Ridgeback Prawn. This species occurs from Monterey Bay, California, to Isla Maria Madre, Mexico, at depths between 16 and 1,007 ft (5 and 307 m).

1.1.3 Reproduction, Fecundity, and Spawning Season

Unlike many other shrimp species that are protandrous hermaphrodites that change from male to female during their life cycle and brood eggs, Ridgeback Prawn are dioecious (having separate male and female sexes) and are broadcast spawners. Females store packets of sperm deposited by the males and release both the eggs and sperm into the water column where fertilization and embryonic development occurs. Spawning can occur after the first year of growth, but it is assumed that all Ridgeback Prawns are mature at 1.2 inches (in) (3.1 centimeters (cm)) Carapace Length (CL) in their second year of growth (CDFG 2001; CDFG 2008).

The spawning season takes place from June through October. Individuals can spawn multiple times during this period, and females are known to produce an average of 86,000 eggs during the spawning season (Anderson et al.1985a). Observations of spawning events indicate that Ridgeback Prawn spawn in the water column at night during a new moon (CDFG 2001). Anderson et al. (1985a) observed that both sexes molt prior to and after the spawning season in the spring and late fall. A majority of females display synchronous molting immediately following the spawning season, but molting patterns of males are less discernible throughout the year. Molting is rarely observed in either sex during the summer months (Anderson et al. 1985a).

1.1.4 Natural Mortality

Determining the natural mortality (M) of marine species is important for understanding the health and productivity of their stocks. Natural mortality results from all causes of death not attributable to fishing such as old age, disease, predation or environmental stress. Natural mortality is generally expressed as a rate that indicates the percentage of the population dying in a year. Fish with high natural mortality rates must replace themselves more often and thus tend to be more productive. Natural mortality along with fishing mortality result in the total mortality operating on the fish stock.

Little information on natural mortality exists for this species. It is estimated Ridgeback Prawn can live up to 4 or 5 years (yr) (Sunada 1984; Anderson et al. 1985b; CDFG 2001; CDFG 2008), which suggests a relatively high rate of natural mortality. Similar to other species of penaeid shrimps, predation is likely the primary source of mortality for juvenile Ridgeback Prawns. Individuals typically recruit into the fishery at age 1 yr, although the majority of the catch documented were composed of 2 and 3 yr old prawns (Sunada 1984; Anderson et al. 1985b; CDFG 2001). In the absence of fishing mortality, natural mortality factors include predation, disease, competition, senescence, and environmental stressors.

1.1.5 Individual Growth

Individual growth of marine species can be quite variable, not only among different groups of species but also within the same species. Growth is often very rapid in young fish and invertebrates, but slows as adults approach their maximum size. The von Bertalanffy Growth Model is most often used in fisheries management, but other growth functions may also be appropriate.

Published growth estimates for Ridgeback Prawn are scarce. During development, Ridgeback Prawn experience a pelagic larval period in the water column then gradually metamorphose to a post-larval stage and settle to the bottom. The duration of development from spawning to post larval settlement is unknown (Wolotira et al. 1990).

It is estimated that juveniles range in size from 0.04 to between 0.8 and 0.9 in (0.1 to between 2.0 and 2.3 cm) (Wolotira et al. 1990). They molt periodically throughout their life, growing larger with each molt (See sections 1.1.3 and 1.2.2). While very little is known about the duration of successive life history stages (i.e., molt increment and frequency) for this species, males and females appear to exhibit different growth rates. Males grow slightly slower than females and reach a smaller maximum size (Anderson et al. 1985b). Males reach a maximum size of 1.5 in (3.7 cm) CL and 6.2 in (15.7 cm) Total Length (TL) while females reach a maximum size of around 1.8 in (4.5 cm) CL and 7.1 in (18.0 cm) TL (Sunada 1984; Perez Farfante 1985). The length to weight ratios for both sexes are equivalent (CDFG 2008).

1.1.6 Size and Age at Maturity

Ridgeback Prawn mature at around 0.9 in (2.3 cm) CL (Wolotira et al. 1990). Growth is not well understood, but it is thought that they reach this size between 1 and 2 years of age. It is unknown whether males and females mature at different sizes or ages.

1.2 Population Status and Dynamics

Ridgeback Prawn is considered a “data-poor” species because insufficient resources and data exist for assessing stock status. To an extent, commercial fisheries data can be used to provide an indication of overall abundance, fishing pressure, and recruitment success. While no estimates of biomass or maximum sustainable yield exist for Ridgeback Prawn, the landings may provide insight on the species’ wide fluctuation in availability (See section 2.2.1). Catch Per Unit Effort (CPUE) data also suggest fluctuations in abundance in response to changing environmental conditions (See section 1.5).

1.2.1 Abundance Estimates

No formal studies to determine the population status of Ridgeback Prawn have been conducted. However, there have been bottom trawl surveys performed by several city and county water quality agencies within the Southern California Bight (SCB) that provide anecdotal information on population abundance (Hendrickx 1984; Allen and Moore 1997; Allen et al. 1999, 2002, 2007, 2011; Stull et al. 2001; NCCOS 2005). Results from surveys conducted from 1971 to 1985 showed that Ridgeback Prawn was the second most abundant invertebrate species in the northern and central regions of the SBC on the outer shelf and upper slope of the continental shelf from 148 to 1,033 ft (45 to 315 m) (CDFG 2008). The Southern California Coastal Water Research Project (SCCWRP) conducted another series of large-scale bottom trawl surveys in the SCB in 1994, 1998, 2003, 2008 and 2013. Figure 1-3 shows Ridgeback Prawn abundance by stratum classification of areas sampled for each of the SCCWRP survey years. In 1994 and 2003, Ridgeback Prawn was the second most abundant species on the middle shelf from 85 to 394 ft (26 to 120 m) and the third most abundant macro-invertebrate species caught in the outer shelf from 331 to 656 ft (101 to 200 m). In 2013, Ridgeback Prawn was found to be one of the top ten most frequently occurring species in the SCB, collected in 25% of all trawl samples, and were the second most abundant species in samples taken in bays and harbors from 13 to 98 ft (4 to 30 m) and third most abundant species on the middle shelf (Walther et al. 2017).

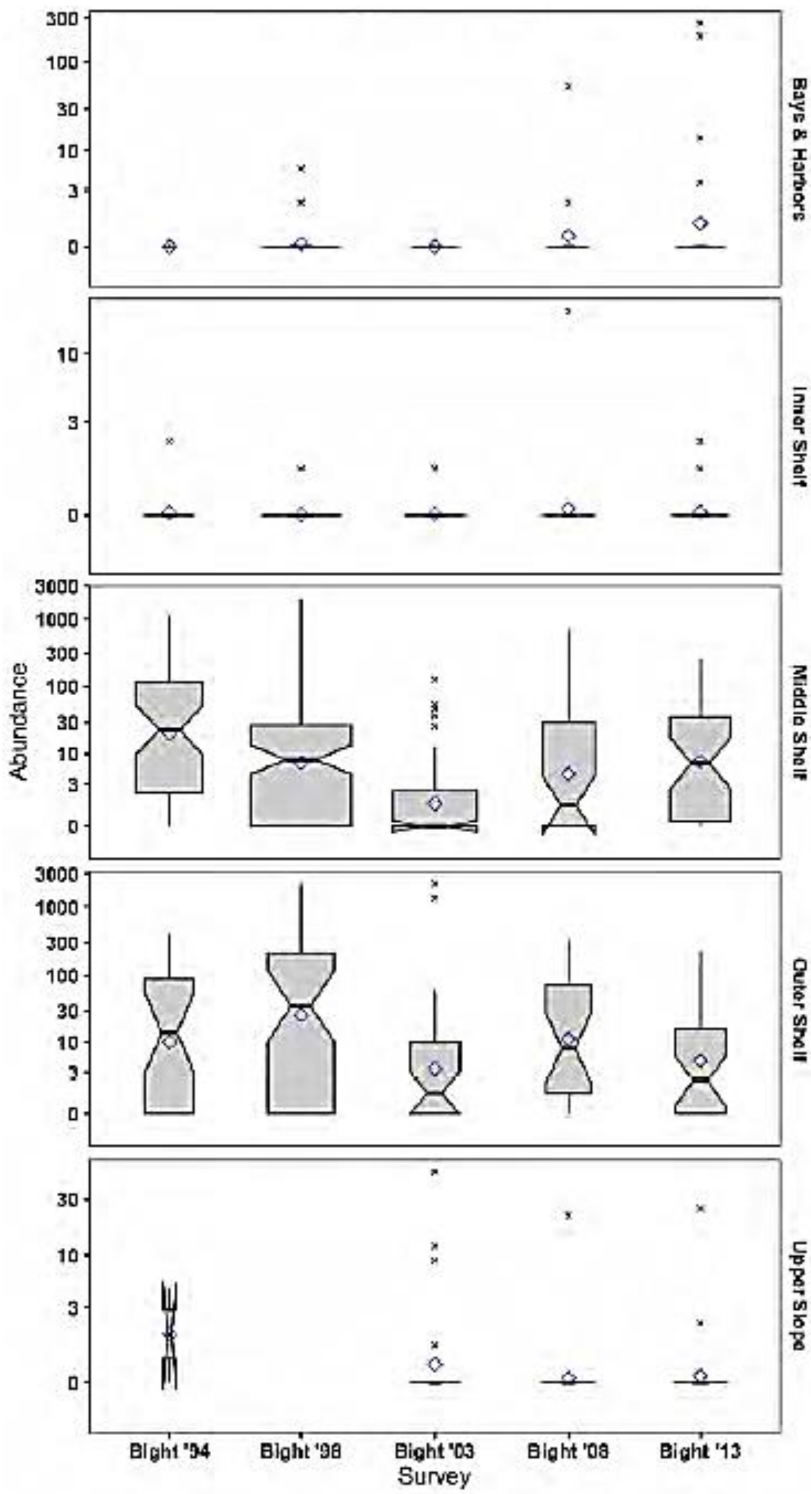

Figure 1-3. Abundance of Ridgeback Prawn by depth stratum and Southern California Coastal Water Research Project Southern California Bight survey year, 1994 to 2013. Abundance is measured as the number of individuals. Data are median, upper and lower quartiles, means (diamonds), 95% confidence intervals of the medial (notches), 1.5 times the interquartile range (whiskers), and outliers (“x”). Box width indicates relative sample size (Reproduced from Walther et al. 2017).

1.2.2 Age Structure of the Population

Age structure can be used to infer the magnitude of recruitment events as well as the total mortality experienced by the stock, and as a result can be a very informative indicator of population status. There has been a lack of age class monitoring for this species, but historic trawl surveys showed variations in size by depth, with adult Ridgeback Prawns found further offshore than juveniles. Anderson et al. (1985b) observed a narrow size range of 0.9 to 1.9 in (2.3 to 4.7 cm) CL offshore at a depth of 476 ft (145 m) and smaller size classes of less than 1 in (2.5 cm) CL at 197 ft (60 m). Shallower depths around 131 ft (40 m) yielded the smallest prawns ranging from 0.2 to 0.5 in (0.6 to 1.5 cm) CL, which were most likely newly settled juveniles (young-of-the-year) (Anderson et al. 1985b). Since adult Ridgeback Prawns collected in trawls at 476 ft (145 m) were as small as 0.9 in (2.3 cm), Anderson et al. (1985b) estimated newly settled individuals grow at a rate of 0.04 in (0.1 cm) per month, and enter the fishery 1 yr after settlement. They noted that while the youngest age of recruitment can be approximated, the variability in molt increment and molt frequency, as well as the ontogenetic movement into deeper waters as they age, makes it difficult to determine distinct age classes from the size distribution of Ridgeback Prawns. However, this study suggests that newly recruited cohorts can be determined, and the magnitude of recruits may be a useful population indicator in the future.

1.3 Habitat

Ridgeback Prawn occur primarily on soft bottom habitat composed of green mud, shell and sand (Figure 1-4), and can tolerate temperature and salinity gradients ranging from 39 to 86 degrees, Fahrenheit (ºF) (4 to 30 degrees, Celsius (ºC)) and 33 to 35 parts per thousand, respectively (Perez Farfante 1985). As noted in section 1.1.2, they are distributed between the inner to outer continental shelf between 16 and 1,007 ft (5 and 307 m), and most abundant at 180 to 269 ft (55 to 82 m) (Perez Farfante 1985).

Figure 1-4. Ridgeback Prawn on soft bottom habitat (Reproduced from Lindholm et al. 2015a).

Highly suitable habitat for Ridgeback Prawn occur over hard and soft substrates at depths between 131 and 525 ft (40 and 160 m) and south of Point Conception (below 35°N) (NCCOS 2005). A study of mid-depth rocky reef and soft-bottom ecosystems within marine protected areas across the SCB noted that they were most commonly observed at depths ranging from 459 to 656 ft (140 to 200 m) with bottom slopes of 10 to 20° (Lindholm et al. 2015a).

1.4 Ecosystem Role

As noted, Ridgeback Prawn is one of the most common benthic species in the SCB on the middle and outer shelf, and is ecologically important to the area, occupying a central position in the trophic structure. They are omnivorous bottom feeders that consume a wide variety of benthic organisms and are forage for a number of fish species (See section 1.4.2).

1.4.1 Associated Species

Bottom trawl surveys (Allen et al. 2011) of the SCB have found that Ridgeback Prawn commonly co-occur with English Sole (*Parophrys vetulus)* on the inner and outer shelf. On the middle and outer shelf, Ridgeback Prawn and Gray Sand Star (*Luidia foliolata*) were frequently found together, and were associated with California Sea Cucumber (*Parastichopus californicus*) and California Sea Slug (*Pleurobranchaea californica*) (Allen et al. 2011). Additionally, commercial landing receipt data provides information on associated species that are caught and landed with Ridgeback Prawn (i.e., incidentally caught species that are marketable and legal to retain in conjunction with Ridgeback Prawn). The composition of these species can vary from year to year, however, commercial landing records from 2013 to 2017 showed California Lizardfish (*Synodus lucioceps*), English Sole (*Parophrys vetulus*), White Croaker (*Genyonemus lineatus*), unspecified Rock Crab, and unspecified Sole were consistently in the top 10 species landed with Ridgeback Prawn. While these fish and invertebrate species were found to commonly co-occur with Ridgeback Prawn in trawl landings, potential interactions between these species and Ridgeback Prawn are not fully known.

1.4.2 Predator-prey Interactions

This species is a benthic omnivore that feeds on organic surface sediments, diatoms, infaunal polychaetes, gastropods, and crustaceans (CDFG 2008). In Baja California, several species of sea robins are known to prey on Ridgeback Prawn (CDFG 2001). In southern California, likely predators include rockfish, lingcod, sharks, rays and skates, halibut, and octopus (CDFG 2001; CDFG 2008).

1.5 Effects of Changing Oceanic Conditions

The reproduction and population structure of the Ridgeback Prawn appears to be strongly influenced by the El Niño Southern Oscillation (ENSO). ENSO is a naturally occurring climate cycle in which sea-surface temperatures in the equatorial Pacific Ocean fluctuate between a warming phase (El Niño) and a cooling phase (La Niña). El

Niño events occur once every 3 to 8 yr with varying intensity and last between 12 and 18 months (Chavez et al. 2017). An examination of both the commercial landing receipt and the trawl logbook data suggests a positive correlation between these oceanographic shifts in water temperature and catch success: biological productivity of Ridgeback Prawn is greatest during warm water phases and is depressed during the cooler water phases. After the two strongest ENSO events of the past 30 years, the 1982 to 1983 and the 1997 to 1998 events, Ridgeback Prawn landings along with CPUE dramatically increased 1 to 2 yr following these events (CDFG 2008). Since Ridgeback Prawn recruit into the fishery at around age 1 or 2 yr (Sunada 1984; Anderson el al. 1985b), warmer waters may positively influence reproductive success or juvenile survival.

Historically, these cool and warm water phases associated with ENSO have been consistent within the SCB. However, there has been unusual variability in recent years. From 2014 to 2016, the entire coast of California experienced a prolonged period of unusually warm sea surface temperatures that included a strong El Niño event in 2015 to 2016. Ridgeback Prawn landings increased steadily during this period of anomalously warm water conditions (See section 2.3.2).

2 The Fishery

2.1 Location of the Fishery

The Ridgeback Prawn commercial fishery occurs exclusively in California (Figure 2-1). The fishery operates primarily between depths of 50 and 660 ft (15 and 201 m), with an average depth of 489 ft (149 m). According to commercial trawl log data, 95% of trips fished within this depth range (California Department of Fish and Wildlife (CDFW) Marine Log System).

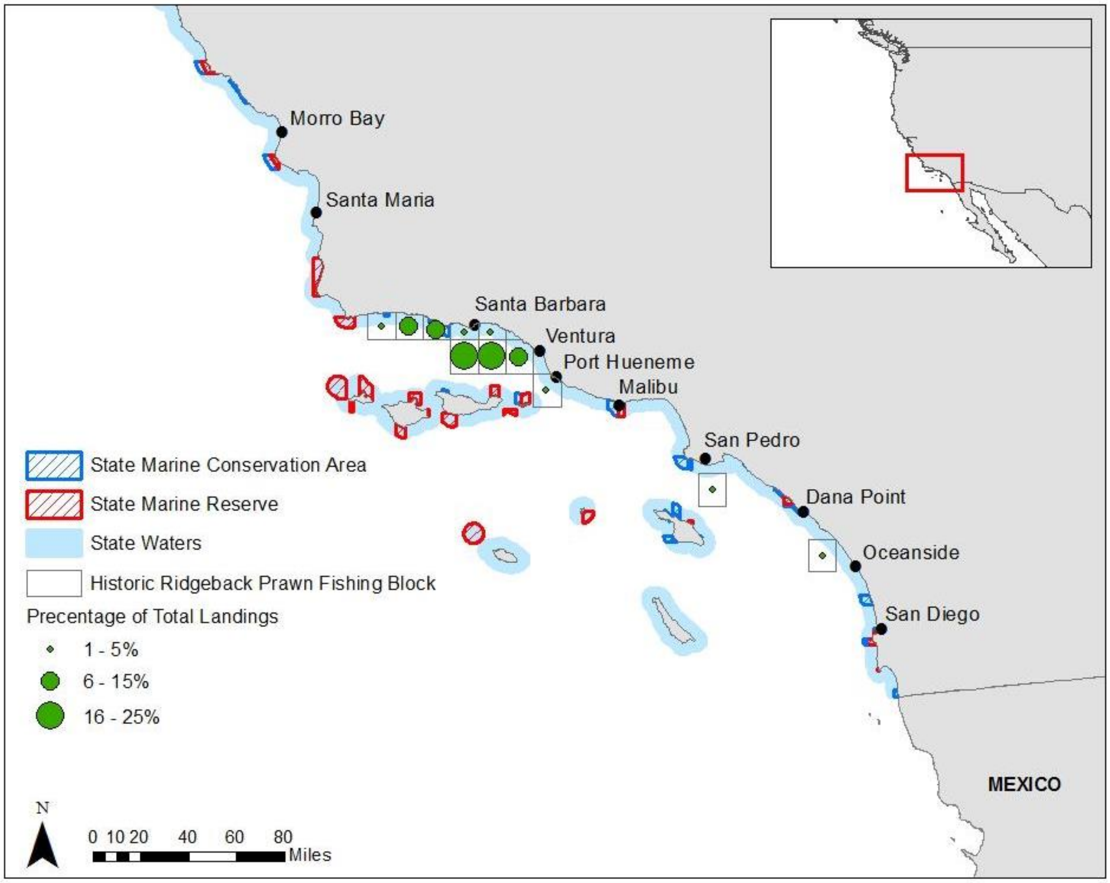

Figure 2-1. Ridgeback Prawn trawl locations by CDFW fishing blocks and the percentage of total landing by fishing block from 1974 to 2017 (CDFW Commercial Fisheries Information System (CFIS) 2018). Each fishing block is 10 by 10 nautical miles (18.52 kilometers (km) by 18.52 km).

The Santa Barbara Channel is considered the center of the fishery and ports within Ventura and Santa Barbara counties receive the majority of the Ridgeback Prawn landings from year to year (See section 2.4). In 1981, Morro Bay became the first port to record landings north of Santa Barbara. These vessels were most likely fishing in the Santa Barbara Channel and landing their catch in Morro Bay (CDFG 2008). By 1984, the fishery expanded south of Santa Barbara into waters adjacent to Los Angeles County and into San Diego County (CDFG 2008).

2.2 Fishing Effort

2.2.1 Number of Vessels and Participants Over Time

The commercial fishery for Ridgeback Prawn is currently open access with no limit on the number of permits issued. The Ridgeback Prawn trawl fishery began in the 1960s and was a minor fishery until 1978 due to market demand. The number of active vessels (vessels that made landings) trawling for Ridgeback Prawn increased between the late 1970s and mid-1980s, and peaked in 1988 at 58 vessels (Figure 2-2). After a drop in 1989, the number of active vessels fluctuated between 27 and 46 vessels until 2003. In 2007, participation declined to a low of ten active vessels. Since 2013, the number has remained relatively stable at around 16 to 18 vessels. More than one permit holder may operate from the same vessel. Figure 2-3 shows the number of trawl permits issued for Ridgeback Prawn, including active and inactive permits, over recent decades.

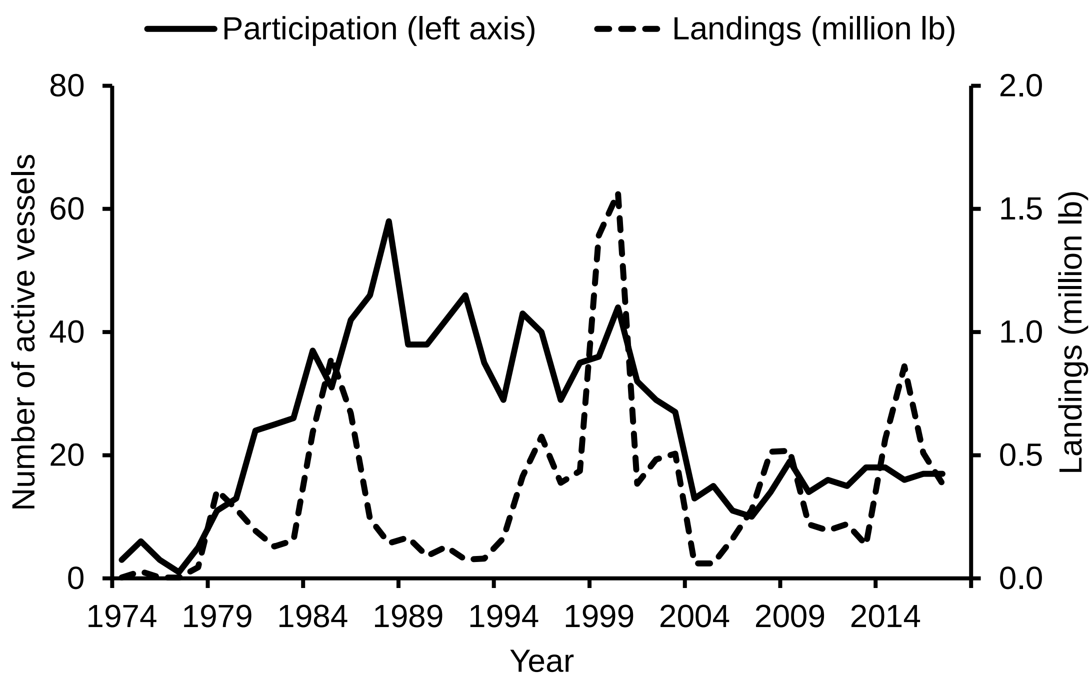

Figure 2-2. Commercial Ridgeback Prawn fishery number of active vessels and landings (million lb) from 1974 to 2017 (CDFW CFIS 2018).

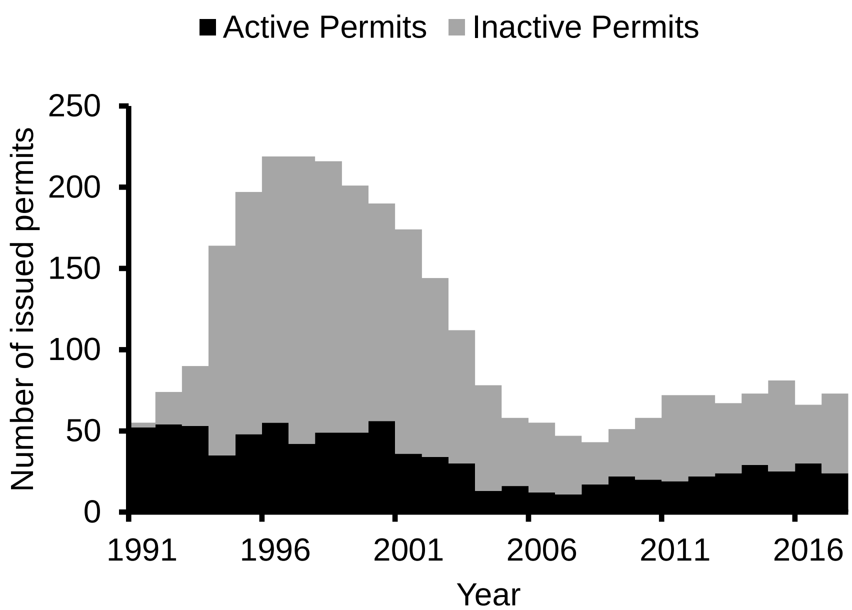

Figure 2-3. Commercial Ridgeback Prawn fishery number of issued permits and usage status from 1991 to 2017 (CDFW CFIS 2018).

Number of vessels in the fishery is a very simple measure of fishing effort (Nance 2004). Other measures of fishing effort include number of tows, fishing trips, and hours or days fished per season. Because the number of vessels fishing may vary from year to year in response to fluctuations in either abundance or price per pound, the number of tows, trips, or hours fished may be a more accurate and standardized way to measure fishing effort. Typically, the metrics used by the Department to determine the intensity of Ridgeback Prawn trawling efforts are tow hours and number of tows.

2.2.2 Type, Amount, and Selectivity of Gear

The average vessel length participating in the fishery between 2013 and 2017 is around 44 ft (13 m) with a range of 28 to 70 ft (8 to 21 m). The primary gear used in the fishery is a single-rig trawl (Figure 2-4a). Typically, mesh sizes for the single-rig trawl range from 1.75 to 2.25 in (4.5 to 5.7 cm) (CDFG 2008). Very few vessels in the fishery use double-rig gear (Figure 2-4b). While catch efficiency of a double-rigged vessel is as much as 60% higher than a single-rigged vessel, double-rigged gear is not preferred in this fishery due to higher operation costs when the harvestable biomass is not available in high concentration (CDFG 2008).

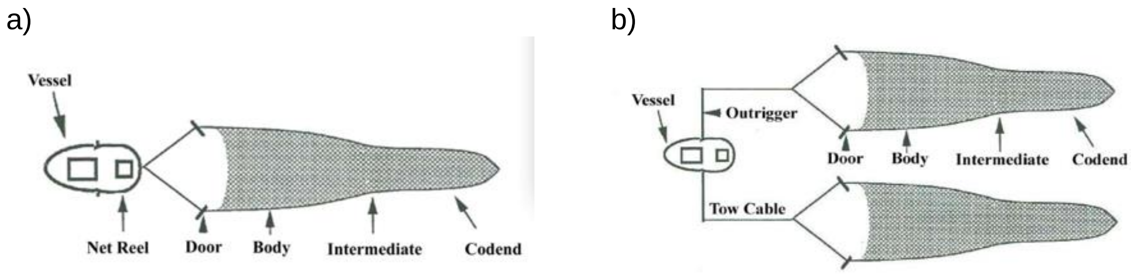

Figure 2-4. Diagrams of a) a single-rigged vessel pulling one otter trawl, and b) a double-rigged vessel pulling two otter trawls, both of which are used in the Ridgeback Prawn commercial fishery (Reproduced from Jones et al. 1996).

Since 2006, a Bycatch Reduction Device (BRD) is required for all trawl nets used in shrimp and prawn fisheries to minimize bycatch pursuant to Fish and Game Code (FGC) Section §8841. Currently, a rigid-grate fish excluder device is the approved type of BRD for the Ridgeback Prawn fishery (Figure 2-5). No other type of BRD has been approved for Ridgeback Prawn trawling at this time. The rigid-grate excluder however, is not the preferred BRD by fishery participants because it becomes damaged when wrapped on the net reel (CDFG 2008). A rigid-grate excluder with a hinge allowing the grate to fold or bend as the net is wrapped in the net reel alleviates this problem and meets the BRD requirement.

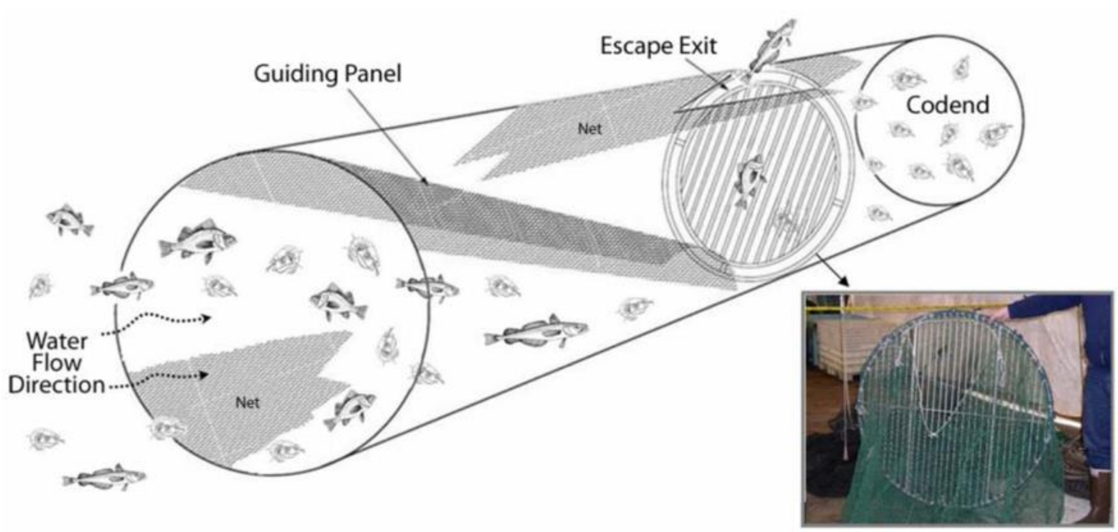

Figure 2-5. Diagram of a rigid-grate excluder approved for use in the Ridgeback Prawn fishery. The diagram depicts shrimp traveling through the BRD, and larger fish being deflected by the BRD and guided through the escape hatch (Photo Credit: Robert Hannah, ODFW).

2.3 Landings in the Recreational and Commercial Sectors

2.3.1 Recreational

This species may be taken for recreational purpose in a shrimp or prawn trap. South of Point Conception, trap openings may not exceed 0.5 in (1.27 centimeters (cm)) in any dimension. For traps fished north of Point Conception, trap openings are limited to five in in any dimension. The recreational limit is 35 per day, and there is no closed season or size limit for Ridgeback Prawn. Effort and catch are believed to be minimal, although recreational fishery surveys have not been conducted for this species.

2.3.2 Commercial

The fishery for Ridgeback Prawn originated in the early 1960s as incidental catch in trawls for groundfish species. It was a minor fishery until 1978, with annual landings below 5,000 lb (2,268.0 kilograms (kg)) from 1974 to 1977 (except for 1975 when landings exceeded 28,000.0 lb (12,700.6 kg)). Landings increased dramatically in 1979 to over 356,000.0 lb (161,478.8 kg) due to increased market demand. Since then, landings have fluctuated with two major peaks (Figure 2-6). Landings peaked at nearly 900,000.0 lb (408,232.8 kg) in 1985 and a reached a record high at about 1.6 million lb (725,747.2 kg) in 2000 with an ex-vessel value of about $473,000 and $1.8 million, respectively. Landings subsequently declined and reached a low of about 60,500.0 lb (27,442.3 kg) in 2004. Notably, only 17% of permits issued in 2004 fished that year, which constituted a 57% drop in the number of active participants from 2003. After a period of alternating highs and lows, Ridgeback Prawn landings reached a recent high of about 860,600.0 lb (390,361.3 kg) in 2015, valued at an all-time high of $2.1 million (ex-vessel value), but have since declined to about 384,000.0 lb (174,179.3 kg) in 2017 with an ex-vessel value of about $923,000.

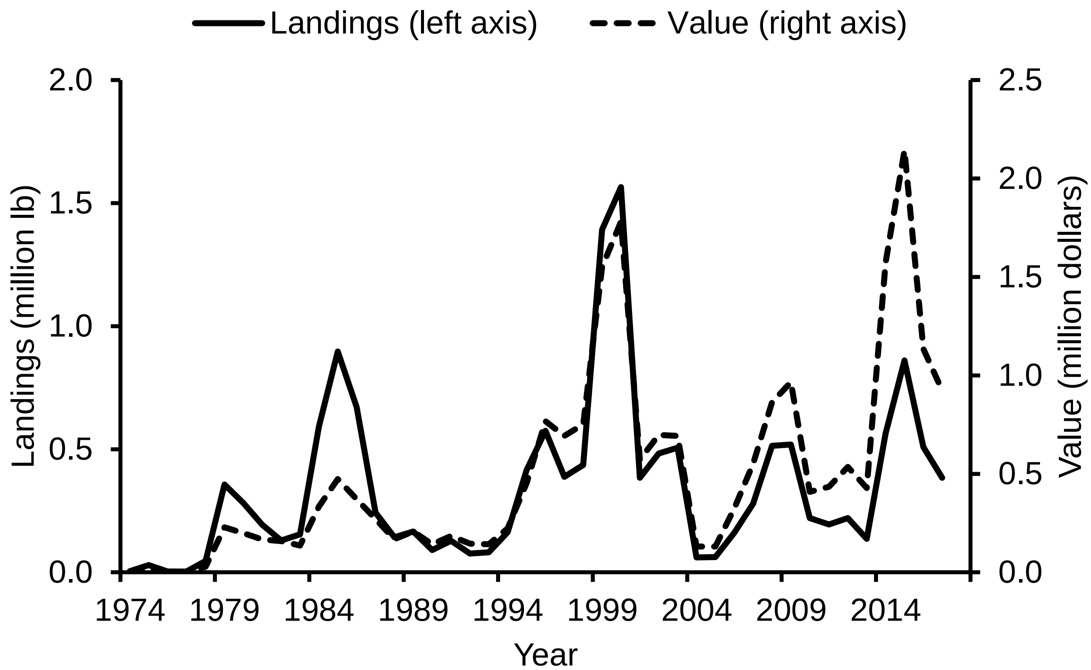

Figure 2-6. Ridgeback Prawn landings (million lb) and value (million dollars) from 1974 to 2017 (CDFW CFIS 2018).

Ridgeback Prawn trawl logs, required since 1986, show that the reported CPUE in pounds per tow hour varies from season to season with the abundance of prawn (Figure 2-7). During the 1984 to 1985 fishing season, CPUE peaked at 251.0 lb (113.9 kg) per hour then steadily declined to 33.0 lb (15 kg) per hour by the 1992 to 1993 season. Since the 1992 to 1993 season, CPUE has fluctuated with peaks in seasons 1994 to 1995 and 1999 to 2000 at 176 and 203.0 lb (80 and 92 kg) per hour, respectively. After reaching a 20 yr record low of 32.0 lb (14.5 kg) per hour during the 2004 to 2005 season, CPUE climbed to 104.0 lb (47.2 kg) per hour by the 2006 to 2007 season which is the most recent data available. Logbook data after the 2006 to 2007 season were entered as staffing allowed with data gaps for the 2007 to 2008 season and for the seasons between 2011 to 2014.

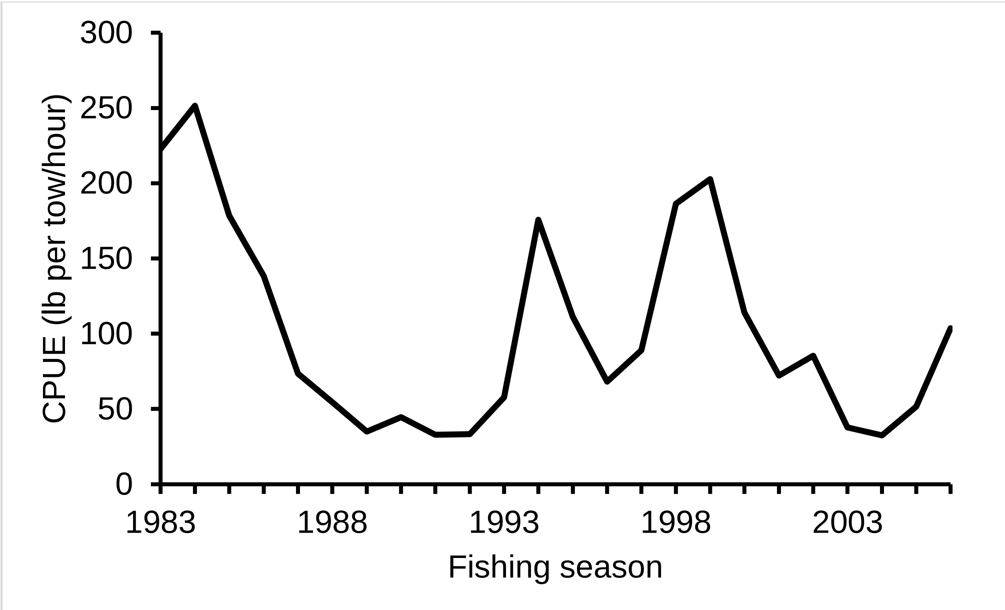

Figure 2-7. Seasonal CPUE for the Ridgeback Prawn fishery from 1983 to 2006 (CDFW Commercial Trawl Logbook 2018). The fishing season, denoted by the start year, runs from October 1 to May 31.

2.4 Social and Economic Factors Related to the Fishery

In the early years of the fishery, Ridgeback Prawn proved difficult to market. When Ridgeback Prawn die, enzymes in the prawn causes breakdown of the flesh that results in a “blackening” discoloration of the head and body of the prawn. This discoloration reduces visual appeal and marketable value of the product. Since the 1980s, new handling techniques were developed, such as keeping the prawn chilled or selling them live (Price et al. 1996). These improved handling techniques enabled the product to expand beyond the local landing ports to markets throughout southern California (CDFG 2008).

The economic importance of Ridgeback Prawn throughout its distribution is shown in Figure 2-8 by the percentage of landings (by weight) by county in California. Historically, the majority of the landings have come from landing ports in Santa Barbara County (56%), followed by Ventura County (35%). The remaining 10% of Ridgeback Prawn landings are from ports in Los Angeles, San Luis Obispo, and San Diego counties at 7%, 2%, and 1%, respectively. Since 2005, there has been a shift in the regional distribution of landing activity. With an exception in 2010, landings from Ventura County has exceeded Santa Barbara County by an average of 52% annually. Prior to 2005, the annual total of Ridgeback Prawn landed in ports in Ventura County was on average 67% less than Santa Barbara County.

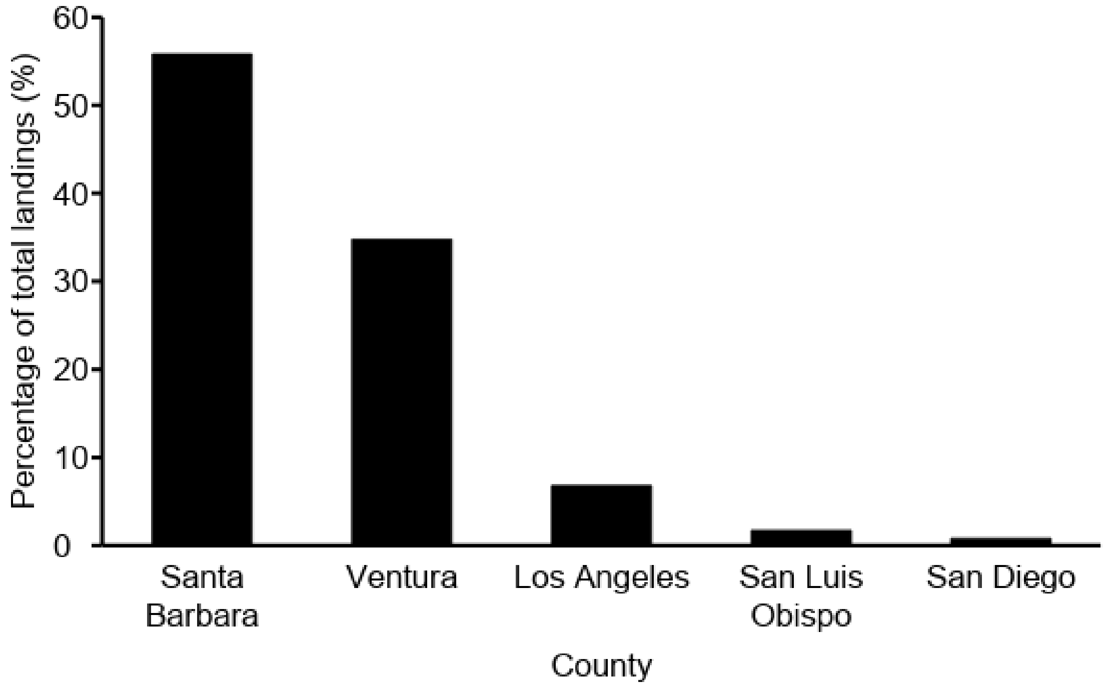

Figure 2-8. Ridgeback Prawn percentage of total landings by county from 1974 to 2017 (CDFW CFIS 2018).

Commercial Ridgeback Prawn catch volumes and economic values are reflected in the price per pound (Table 2-1). This fishery has relatively low volume, but high value when compared to the California fishery for Pacific Ocean Shrimp (*Pandalus jordani)* (CDFG 2008). The ex-vessel price-per-pound of Ridgeback Prawn has increased from an average of $0.59 per lb ($1.30 per kg) in the 1970s to an average of $2.32 per lb ($5.10 per kg) since 2010. In 2017, the ex-vessel price for all Ridgeback Prawn averaged $2.39 per lb ($5.25 per kg). Since the species does not freeze well, Ridgeback Prawn are primarily sold live or as fresh whole prawns. Live prawn accounted for 92% of the landings in 2017 and sold for an average ex-vessel price of $2.66 per lb ($5.85 per kg).

Table 2-1. Landings (lb), ex-vessel value and average price-per-pound for Ridgeback Prawn, 2000 to 2017 (CDFW CFIS 2018)

Year	**Pounds**	**Ex-vessel value (US dollars)**	**Average price-per-pound (US dollars)**
2000	1,565,009	$1,780,712	$1.09
2001	384,092	$572,128	$1.47
2002	482,405	$697,557	$1.39
2003	505,746	$692,006	$1.39
2004	60,548	$131,366	$1.96
2005	61,241	$130,849	$2.04
2006	160,870	$324,347	$2.02
2007	278,534	$550,575	$2.07

2008	514,291	$862,622	$1.90
2009	518,359	$965,300	$2.05
2010	219,609	$408,258	$2.02
2011	194,087	$433,989	$2.26
2012	220,353	$535,437	$2.20
2013	135,983	$427,474	$2.62
2014	564,544	$1,573,423	$2.55
2015	860,563	$2,143,520	$2.27
2016	508,936	$1,134,723	$2.26
2017	383,814	$923,435	$2.39

3 Management

3.1 Past and Current Management Measures

The commercial trawl fishery for Ridgeback Prawn is a state managed fishery. The Commission first established regulations for the fishery in 1965 to allow the take of prawns with trawl nets and by 1967, a directed fishery for Ridgeback Prawn operated under a prawn trawl permit regulated with area restrictions, gear specifications, and incidental catch limits for non-targeted species (CDFG 2001; CDFG 2008). Following a 1981 decline in landings, the Commission adopted a seasonal closure (June 1 through September 30) in 1983 to protect Ridgeback Prawn during their peak spawning months. That same year, a depth restriction was also implemented to prevent trawling in any waters less than 150 ft (CDFG 2008).

Since 1983, three changes to bottom trawling regulations have affected the Ridgeback Prawn fishery. In 2000, area and depth closures that were implemented to protect overfished groundfish stocks further restricted trawling effort for Ridgeback Prawn; however, these regulations were subsequently repealed in 2008 based on changes in management authorities. Federal groundfish regulations under the purview of the National Oceanic and Atmospheric Administration (NOAA) Fisheries and Pacific Fishery Management Council (PFMC) now prescribe closed areas, depth constraints, and bycatch limits for Ridgeback Prawn trawling activities in waters 3 to 200 nautical miles from shore. In 2004, the State Legislature approved Senate Bill 1459, adding FGC §8841 to statute, which granted the Commission management authority over all state-managed commercial bottom trawl fisheries not managed under a federal or state fishery management plan and prohibited bottom trawling in state waters beginning January 1, 2008, except in those waters specifically authorized in §120, Title 14, CCR and FGC §8842. In 2006, the use of a BRD became mandatory to fish commercially for prawn and shrimp. The configuration of the BRD and effects on bycatch levels are discussed in sections 2.2.2 and 3.1.3, respectively.

3.1.1 Overview and Rationale for the Current Management Framework

The Ridgeback Prawn fishery is currently managed under a suite of regulations to promote sustainability. These include:

1. Requirement of a fishery-specific commercial permit for Ridgeback Prawn (§120, 120.3, and 705, Title 14, CCR) for management of the resource.
2. Authorized fishing areas (§120, Title 14, CCR and FGC §8842) to protect sensitive seafloor habitats and minimize conflict with other users.
3. Logbook requirement (§§120 and 190, Title 14, CCR) to monitor catch location and effort information.
4. Seasonal closure from June 1 through September 30 (§120.3, Title 14, CCR) to protect spawning female and juvenile Ridgeback Prawns.
5. Possession limits for incidental catch (§120, Title 14, CCR and FGC §8842) to reduce bycatch impacts.

6. Minimum mesh size of 1.5-in for single-walled cod ends or 3-in for double-walled cod ends (§120.3, Title 14, CCR) to allow for escapement of small 0 and 1 year old prawn.
7. BRD requirement (FGC §8841) to minimize bycatch of rockfish and other groundfish.
8. Requirement to cooperate with the federal groundfish observer program (FGC §8841) to collect information on discarded catch and bycatch of groundfish species.

3.1.1.1 Criteria to Identify When Fisheries Are Overfished or Subject to Overfishing, and Measures to Rebuild

Currently, there is no direct reference point for determining whether the stock is “overfished” nor are there procedures in place specific to the Ridgeback Prawn fishery to halt overfishing when it is found to be occurring. However, yields per unit area (e.g., fishing block) and CPUE represent two indicators of exploitation. The yield of Ridgeback Prawn per unit area may reflect changes in the spatial distribution of fishing that can be indicative of trends in Ridgeback Prawn abundance. Moreover, long term increases or decreases in CPUE may provide an indication of whether or not populations of Ridgeback Prawn are being overfished. A decline in both yield per unit area and CPUE can reflect a state of over-exploitation, which may warrant additional investigation by the Department or management changes for the Ridgeback Prawn fishery.

3.1.1.2 Past and Current Stakeholder Involvement

Engaging the public in management, research, and decision-making is a central tenet of the MLMA. Often, stakeholder involvement occurs during regulation changes affecting the Ridgeback Prawn fleet. Stakeholders are consulted on the development or amendment of regulations, and public comments and input are taken into consideration at all stages of the Commission’s regulatory process. Stakeholders may also recommend that a regulation be added, amended, or repealed by submitting a petition to the Commission. Stakeholders also are encouraged to participate in the Commission’s Marine Resources Committee (MRC) meetings. The goal of the MRC is to allow greater time to investigate issues before they are brought up at full Commission meetings.

Currently, there are two stakeholder-identified issues for further consideration by the Commission concerning the Ridgeback Prawn resource. First, the Commission received a petition in August 2014 to reinstate an incidental take allowance (50.0 lb (26.7 kg) or 15% by weight) for Ridgeback Prawn in State trawl fisheries that was removed from §120.3, Title 14, CCR in 2008. This petition has been put on hold pending further review by Department and Commission staff (See section 5.2.2). Second, a concern was raised by some fishery participants about overfishing and the potential for overcapitalization in the Ridgeback Prawn fishery at ~~a~~an MRC meeting in July 2017, which may warrant further investigation by the Department (See section 5.2.2).

3.1.2 Target Species

3.1.2.1 <u>Limitations on Fishing for Target Species</u>

3.1.2.1.1 <u>Catch</u>

There is no quota currently in place for Ridgeback Prawn.

3.1.2.1.2 <u>Effort</u>

The fishery is currently open access with no cap on the number of permits that can be issued. Other than the closed season, there is no limit on tow hours.

3.1.2.1.3 <u>Gear</u>

Ridgeback Prawn may only be taken by otter trawl nets for commercial purposes. The minimum mesh size for trawl nets with single-walled bag or cod end is 1.5 in (3.81 cm) in length or 3.0 in (7.62 cm) in length for trawl nets with double-walled bag or cod end. The primary gear used in the fishery is a single-rig shrimp trawl with a single-walled net with mesh sizes ranging from 1.75 to 2.25 in (4.5 to 5.7 cm) (CDFG 2008). The net mesh may be no less than 1.375 in (3.49 cm) measured inside the knot. In addition, the net must be equipped with an approved BRD.

3.1.2.1.4 <u>Time</u>

The fishery is closed from June 1 to September 30 to protect Ridgeback Prawns during peak spawning months.

3.1.2.1.5 <u>Sex</u>

There is no restriction on the sex of Ridgeback Prawn that can be retained.

3.1.2.1.6 <u>Size</u>

There are no restrictions on the size of Ridgeback Prawn that can be retained.

3.1.2.1.7 <u>Area</u>

Trawling for Ridgeback Prawn is allowed only in waters that extend beyond three nautical miles off the coast of California.

3.1.2.1.8 <u>Marine Protected Areas</u>

Pursuant to the mandates of the Marine Life Protection Act (FGC §2850), the Department redesigned and expanded a network of regional MPAs in state waters from 2004 to 2012. The resulting network increased total MPA coverage from 2.7% to 16.1% of state waters. Along with the MPAs created in 2002 for waters surrounding the Santa Barbara Channel Islands, California now has a statewide scientifically-based ecologically connected network of 124 MPAs. The MPAs contain a wide variety of habitats and depth ranges.

Marine Protected Areas (MPAs) created under the Marine Life Protection Act were not designed for fisheries management purposes however, they present related opportunities and considerations including the following:

1. They serve as long-term spatial closures to fishing if the species of interest is within their boundaries and is prohibited from harvest.
2. They can function as comparisons to fished areas for relative abundance and length or age/frequency of the targeted species.
3. They can serve as ecosystem indicators for species associated with the target species, either as prey, predator, or competitor.
4. To varying degrees, they displaced fishing effort when they were implemented.

Trawling for Ridgeback Prawn occurs outside of state waters (Figure 2-1); therefore, the MPAs in state waters are not a significant management consideration.

3.1.2.2 Description of and Rationale for Any Restricted Access Approach

The fishery is currently open access. If it should become necessary to limit the number of persons or vessels that may be engaged in the take of Ridgeback Prawn or limit the catch allocation for each fishery participant, a control date was established in regulations (§120.4, Title 14, CCR) for a restricted access Ridgeback Prawn trawl fishery. Specifically, §120.4, Title 14, CCR states: “A control date of January 1, 1999, is established for the purpose of developing a restricted access Spot, Ridgeback, and Golden Prawn trawl fishery. Only those vessels which have made at least one Spot, Ridgeback, or Golden Prawn landing with trawl gear before this date may be considered for inclusion in the restricted access trawl fishery.” The purpose of the control date is to inform all current and potential fishery participants that a restricted access program may be considered at a future date for this fishery, and that participation after the control date may not qualify for inclusion in the program. The restricted access approach is intended to balance the fishing capacity of the commercial fleet with the size of the resource in a way that results in an economically viable and sustainable fishery. The Commission has yet to institute a restricted access program for the Ridgeback Prawn trawl fishery and has the authority to revisit the control date for determining qualifications for a restricted access program.

3.1.3 Bycatch

3.1.3.1 Amount and Type of Bycatch (Including Discards)

The Fish and Game Code (FGC §90.5) defines bycatch as “fish or other marine life that are taken in a fishery but which are not the target of the fishery.” Bycatch includes “discards” (FGC §90.5), defined as “fish that are taken in a fishery but are not retained because they are of an undesirable species, size, sex, or quality, or because they are required by law not to be retained” (FGC §91). The term “Bycatch” may include fish that, while not the target species, and are desirable and are thus retained as incidental catch, and does not always indicate a negative impact.

Until recently, data on the amount and type of bycatch, including discards, in the Ridgeback Prawn trawl fishery have been unknown due to limited observer coverage for at-sea monitoring of the Ridgeback Prawn fleet. In 2017, the Ridgeback Prawn trawl fishery was included in the West Coast Groundfish Observer Program (WCGOP) for the first time since 2005. The observed portion of total Ridgeback Prawn landings was 11% in 2017 (Somers et al. 2018b). The 2017 WCGOP estimates of landings and discard of observed species in the Ridgeback Prawn fishery are summarized in Appendix A.

Federal fishery observers have noted that bycatch includes various species of fish and invertebrates. For fish species, California Lizardfish (*Synodus lucioceps*) had the highest bycatch catch level, followed by Pacific Sanddab (*Citharichthys sordidus*), White Croaker (*Genyonemus lineatus*), English Sole (*Parophrys vetulus*), and Pacific Hake (also known as Pacific Whiting, *Merluccius productus*) (Appendix A). For invertebrate species, unidentified Squat Lobster had the largest level of bycatch, followed by unidentified urchin, unidentified sea star, Red Rock Crab (*Cancer productus*), and unidentified nudibranch (Appendix A). Similarly, the five most consistently captured species reported on commercial Ridgeback Prawn landing receipts from 2013 to 2017 were California Lizardfish (*Synodus lucioceps*), English Sole (*Parophrys vetulus*), White Croaker (*Genyonemus lineatus*), unspecified Rock Crab, and unspecified Sole (See section 1.4.1).

Table 3-1 provides the estimated total catch of non-target species and percent discarded in 2017 for the Ridgeback Prawn fishery as well as bycatch ratios (i.e., non-target species to target species) by species group by weight. The catch could be divided into four major components: Ridgeback Prawn (39.7 %), other invertebrates (7.9%), finfish (48.9%), and other (including egg cases and mixed unsampled catch, 3.6%). Non-target species comprised about 60% of the estimated total catch, of which only about 14% was retained and landed in 2017 (NWFSC 2018). The overall ratio of bycatch to Ridgeback Prawn is 1.52. The bycatch ratios produced for non-target invertebrates and finfish species are between 0.01 to 1 and 1.23 to 1 (Table 3-1).

Table 3-1. Estimated total catch of non-target species (metric ton), percent discarded, and bycatch ratios (non-target species: target species) by weight in the Ridgeback Prawn fishery, 2017 (NWFSC 2018). Zeros represent values rounded to zero.

	Total catch (metric ton)	**Percent of total catch**	**Percent discarded**	**Bycatch ratio**
TARGET SPECIES				
Ridgeback Prawn	185.61	39.66	13.43	--
NON-TARGET SPECIES				
Other Invertebrates	36.80	7.86	85.68	0.20:1
Finfish	228.76	48.88	92.89	1.23:1
Federally Managed Groundfish[a]	105.55	22.55	96.71	0.57:1
Flatfish	72.65	15.52	95.71	0.39:1
Rockfish	12.71	2.72	97.97	0.07:1
Roundfish	18.29	3.91	99.48	0.10:1
Sharks	0.42	0.09	100	0:1
Skates	1.48	0.32	99.39	0.01:1
All other fish (non-Federally managed groundfish)	123.21	26.33	89.63	0.66:1
Other[b]	16.84	3.60	0.01	0.09:1
Total	468.02	100	57.47	1.52

a. Federally Managed Groundfish constitute species and species group managed under the Federal Pacific Coast Groundfish Fishery Management Plan, including 60-plus rockfish (all genera and species from the family Scorpaenidae (*Sebastes, Scorpaena, Sebastolobus, and Scorpaenodes* occurring in waters off Washington, Oregon, and California), 12 flatfish species, 6 roundfish species, and some sharks and skates.

b. Other comprise of mixed unsampled catch and egg cases.

Over 90 species of marine finfish are managed or monitored under a Federal West Coast Groundfish Fishery Management Plan that is administered by the PFMC. Federally managed groundfish species comprised 22.6% of the total estimated catch, which is about 46% of the estimated finfish catch in the Ridgeback Prawn fishery in 2017. Flatfish had the highest bycatch ratio of 0.39 to 1 compared to other federally managed groundfish species with bycatch ratios of less than or equal to 0.10 to 1, but the lowest level of discard (Table 3-1).

3.1.3.2 Assessment of Sustainability and Measures to Reduce Unacceptable Levels of Bycatch

Discard Mortality

Due to the average depth at which Ridgeback Prawn trawling occurs, it is assumed that the mortality of captured groundfish species with swim bladders, particularly rockfish, is 100% due to barotrauma. Discard mortality of other species is unknown.

Impact on Fisheries that Target Bycatch Species

While species with little to no commercial value are discarded, incidental take allowances in §120, Title 14, CCR and FGC §8842 permit Ridgeback Prawn vessel operators to retain and sell commercially valuable species. For marine invertebrates such as Spot Prawn (*Pandalus platyceros*) and Sea Cucumber, trawl loads of ridgeback prawn “shall not contain more than 50 lb without restriction or 15%, by weight, of Spot Prawns” (§120(e)(3), Title 14, CCR), and “any amount of Sea Cucumbers taken incidentally while prawn or shrimp trawling may be possessed if the owner or operator of the vessel possesses a permit to take Sea Cucumbers pursuant to §8405 of the FGC” (§120(e)(2), Title 14, CCR). Between 2010 and 2017, around 21% of Ridgeback Prawn permit holders also possess a Sea Cucumber Trawl Permit. However, less than 1% of the species retained and landed with Ridgeback Prawn were comprised of Sea Cucumber, except from 2011 to 2013, where on average, 4% of the associated catch on Ridgeback Prawn landing receipts were Sea Cucumber.

For finfish, “it is unlawful to possess in excess of 1,000 lb [(453.6 kg)] of incidentally taken fish per trip” when fishing for Ridgeback Prawn (FGC §8842(c)). Also, limits on incidental take of west coast groundfish species specified in federal regulations of Title 50 Code of Federal Regulations (CFR) Part 660 apply to state-managed trawl fisheries, including the Ridgeback Prawn fishery, pursuant to § 189, Title 14, CCR (§120(e)(1), Title 14, CCR). Currently, vessels participating in the Ridgeback Prawn fishery may land no more than 300 lb (136.1 kg) of groundfish per trip in accordance with 50 CFR Part 660, Subpart F. In addition, species specific limits apply and the amount of groundfish landed may not exceed the amount of Ridgeback Prawn landed, except for Spiny Dogfish. Spiny Dogfish are limited by the 300 lb/trip overall groundfish limit. The daily trip limits for Sablefish coastwide and Thornyheads south of Point Conception and the overall groundfish “per trip” limit may not be multiplied by the number of days of the trip. These measures are in place to minimize impacts to fisheries that target the bycatch species.

Bycatch of Overfished, Threatened, or Endangered Species

Certain bycatch species, such as those that are depleted, overfished, threatened, or endangered, require special consideration to ensure that the recovery and rebuilding efforts for those species are not undermined. Each year, the National Marine Fisheries Service (NMFS), in consultation with the PFMC, sets harvest limits for overfished species based on the respective stock assessments and rebuilding plans. Table 3-2 shows the bycatch levels for the Ridgeback Prawn fishery of overfished species that are rebuilding or have recently been rebuilt as well as each species’ Acceptable Biological Catch (ABC) and Annual Catch Limit (ACL) specified in federal regulations (50 CFR Part 660, Subpart C) for 2017. As the estimated catch and retention levels from the Ridgeback Prawn fishery are well below the harvest specifications (i.e. ABC and ACL), the fishery is unlikely to impede the ability of overfished stocks to rebuild.

Table 3-2. Estimated bycatch (metric ton) of overfished species in the Ridgeback Prawn fishery and their ABC and ACL as specified in federal regulations (50 CFR Part 660, Subpart C) for 2017. Bycatch data adapted from NWFSC 2018.

Common name	Species	Status	Total bycatch (metric ton)	Percent of bycatch retained	Acceptable biological catch (metric ton)	Annual catch limit (metric ton)
Bocaccio Rockfish	*Sebastes paucispinis*	Rebuilt 2017	0.15	0.91	1,924	741
Canary Rockfish	*Sebastes pinniger*	Rebuilt 2015	0.01	0.00	1,526	1,526
Cowcod Rockfish	*Sebastes levis*	Rebuilding as of 2016	0.07	0.00	64	10
Darkblotched Rockfish	*Sebastes crameri*	Rebuilt 2017	0.01	0.00	653	653
Lingcod	*Ophiodon elongatus*	Rebuilt 2005	0.40	13.58	1,144	1,144
Petrale Sole	*Eopsetta jordani*	Rebuilt 2015	1.26	33.81	3,013	3,013

Bycatch of Sea Birds and Marine Mammals

The California shrimp trawl fishery, which includes Ridgeback Prawn, is classified as a Category III fishery (i.e., fisheries with a remote likelihood of marine mammal interaction or no known serious injuries or mortalities with marine mammals) by the NMFS on its List of Fisheries (LOF). The LOF reflects information on interactions between commercial fisheries and marine mammals. There were no recent documented interactions between marine mammals and the Ridgeback Prawn fishery (NOAA Fisheries 2018). Additionally, low rates of interactions resulting in mortalities rates with sea birds have been observed in bottom trawl fisheries; most interactions were birds feeding on catch and some boarding vessels (PFMC 2016).

Measures to Reduce Bycatch

As noted in sections 2.2.2 and 3.1.1, the use of a BRD has been required for the fishery since 2006 to reduce the number and volume of bycatch species. However, the degree of regulatory compliance with respect to the use of BRDs by Ridgeback Prawn trawlers is currently unknown. The use of BRDs in Pacific Ocean Shrimp (*Pandalus jordani*) trawl fishery have resulted in a large reduction of finfish bycatch of between 66 and 85% from historical (pre-BRD) levels (Hannah and Jones 2007). Hannah and Jones (2007) found that mandatory BRD use has also changed the species composition of the bycatch, shifting from mostly large-bodied fishes, some of which are commercially valuable, to mostly juveniles and smaller-bodied species of little to no commercial value. As such, it is important to verify and enforce the use of BRDs in the Ridgeback Prawn fishery to ensure the fleet is implementing sustainable fishing practices (See section 5.2.2). Ridgeback Prawn vessels are also subject to federal restrictions on daily and trip limits for incidental catches of federally managed groundfish as well as area closures in the form of Rockfish Conservation Areas to protect rockfish and other overfished species from potential for interaction with trawl gear.

3.1.4 Habitat

3.1.4.1 Description of Threats

The impacts from bottom trawling on benthic, or seafloor, habitats and sensitive species are complex. It is widely believed that bottom trawling causes a loss or alteration of important habitats by scouring, crushing, burying, or exposing marine flora and fauna and greatly reducing the complexity and diversity of the seafloor. However, a recent study by Lindholm et al. (2015b) found trawling impacts are context dependent, depending on the type of gear used, the types of habitats trawled, and how often trawling occurs. Furthermore, recovery after disturbance varies with habitat characteristics, frequency and intensity of disturbance, and species composition (NRC 2002). Relatively stable habitats, such as hard bottom and dense mud, experience the greatest changes and have the slowest recovery rates compared to less consolidated coarse sediments in areas of high natural disturbance (NRC 2002). Soft bottom habitats, such as those where Ridgeback Prawn are fished, are relatively resilient to trawl gear (NRC 2002). The NMFS indicates that impacts by bottom trawl gear in soft bottom habitat areas where Ridgeback Prawn trawling occurs (i.e., soft bottom habitat) have the lowest sensitivity classification for impacts to seafloor habitat, and the recovery time after perturbation is estimated to be less than 1 yr (NMFS 2005). In addition, Lindholm and others (2015b) suggest negligible effects to certain soft bottom habitats (primarily mud and sand) when small footrope trawl gear with a footrope diameter of less than or equal to 8 in (20 cm) are used, as required by federal bottom trawling regulations and consequently used in the Ridgeback Prawn fishery (J. Vestre, personal communication, October 17, 2018).

3.1.4.2 Measures to Minimize Any Adverse Effects on Habitat Caused by Fishing

The MLMA emphasizes the importance of habitat protection as a means of preserving healthy and productive marine resources. To achieve the habitat conservation goal of the MLMA, Ridgeback Prawn management in California should contain “measures that, to the extent practicable, minimize adverse effects on habitat caused by fishing” (CDFW 2008). Current management measures described in section 3.1.1, such as gear limitations, seasonal closures, and area restrictions are intended to reduce potential impacts on habitat and other ecosystem effects of Ridgeback Prawn trawling activities. For example, gear limitations as discussed in section 3.1.4.1 generally mitigate the effects of fishing gear contact on seafloor habitats. Moreover, seasonal closures which protect spawning female and juvenile Ridgeback Prawns also provide temporary protection from fishing gear disturbances and allow for potential recovery of the habitat. Fishing area restrictions provide more permanent protection for sensitive habitats, in which some or all biological resources are protected from removal or disturbance.

3.2 Requirements for Person or Vessel Permits and Reasonable Fees

Requirements and fees for persons or vessels fishing for Ridgeback Prawn are described in the FGC and Title 14 of the CCR. Fishermen are required to have the appropriate licenses to fish either commercially or recreationally in California waters. Each license is categorized based on the fishermen's residency status (i.e., a resident is any person who has resided continuously in the State of California for six months or more immediately prior to the date of their application for a license or permit, any person on active military duty with the Armed Forces of the United States or auxiliary branch thereof, or any person enrolled in the Job Corps). Table 3-3 provides the description of the license types, boat registration types, and permit required to fish commercially for Ridgeback Prawn and the associated fees (all fees include a nonrefundable 3% application fee, not to exceed $7.50 per item (§700.4, Title 14, CCR)). Table 3-4 provides the description of the license types and validation required to fish recreationally for Ridgeback Prawn and the associated fees (fees include 5% license agent handling fee and 3% nonrefundable application fee).

Table 3-3. Commercial fishing license fees for Ridgeback Prawn valid from April 1, 2019 to March 31, 2020. (Accessed June 17, 2019. https://www.wildlife.ca.gov/Licensing/Commercial/Descriptions).

License	Fee	Description
Resident Commercial Fishing License	$145.75	Required for any resident 16 yr of age or older who uses or operates or assists in using or operating any boat, aircraft, net, trap, line, or other appliance to take fish for commercial purposes, or who contributes materially to the activities on board a commercial fishing vessel.
Non-Resident Commercial Fishing License	$431.00	Required for any nonresident 16 yr of age or older who uses or operates or assists in using or operating any boat, aircraft, net, trap, line, or other appliance to take fish for commercial purposes, or who contributes materially to the activities on board a commercial fishing vessel.
Commercial Boat Registration (Resident)	$379.00	Required for any resident owner or operator for any vessel operated in public waters in connection with fishing operations for profit in this State; or which, for profit, permits persons to sport fish.
Commercial Boat Registration (Non-resident)	$1,122.00	Required for any nonresident owner or operator for any vessel operated in public waters in connection with fishing operations for profit in this State; or which, for profit, permits persons to sport fish.
Golden Prawn and Ridgeback Prawn Permit	$45.84	Required for the operator of a vessel to use or possess trawl nets to take golden or ridgeback prawns in ocean waters.

Table 3-4. Annual recreational fishing license fees for Ridgeback Prawn from January 1 to December 31, 2019. (Accessed June 17, 2019. https://www.wildlife.ca.gov/Licensing/Fishing).

License	Fee	Description
Resident Sport Fishing	$49.94	Required for any resident 16 yr of age or older to fish.
Non-resident Sport Fishing	$134.74	Required for any non-resident 16 yr of age or older to fish.
Ocean Enhancement Validation	$5.66	Required to fish in ocean waters south of Point Arguello (Santa Barbara County). An Ocean Enhancement Validation is not required when fishing under the authority of a One or Two-Day Sport Fishing License.

4 Monitoring and Essential Fishery Information

4.1 Description of Relevant Essential Fishery Information

The biology of Ridgeback Prawn is not well documented. Little biological information exists for this species, making determination of sustainable harvest levels difficult. Currently, no biological or environmental indicators are tracked for use in management of this fishery in California. Instead, fishery-dependent indicators are used to evaluate the sustainability and environmental impacts of the Ridgeback Prawn fishery (See section 4.2.1) and determine whether additional management actions are necessary.

4.2 Past and Ongoing Monitoring of the Fishery

4.2.1 Fishery-dependent Data Collection

The Department's primary source of information on the fishery comes from monitoring commercial effort and catch data from Ridgeback Prawn trawl logs and landing receipts. All commercial trawl operators targeting Ridgeback Prawn are required to record the date, start and end location, time, depth, and duration of trawl tows, total catch by species market category, gear used, and other pertinent fishing information. Fishery managers and enforcement officers use state-issued landing receipts, referred to as fish tickets, to monitor fishery landings. Data collected by fish tickets include:

- fishermen and vessel information
- date the fish was landed
- port of landing
- commercial fishing block where the fish were harvested
- weight (in pounds) landed by market category
- price paid to the fisherman by market category
- condition of the fish when sold
- type of gear used to harvest the fish

Fishery-dependent indicators such as CPUE (e.g., catch per tow hour) is considered a reasonable proxy of overall Ridgeback Prawn abundance, and the spatial extent of fishing activities provides information about the patterns of exploitation.

The fishery has also been subject to observation under a federal at-sea program that collects fisheries data for the management of groundfish. The WCGOP monitors effort and landings, including the species makeup of both retained and discarded species, allowing for close monitoring of bycatch levels to ensure that they remain within acceptable levels, especially with regard to sensitive species such as rebuilding rockfish populations. The WCGOP had provided observer coverage for this fishery from 2001 to 2005; however, observer coverage was redirected to other higher priority fisheries in subsequent years (NWFSC 2017). In 2017, a pilot study was initiated to estimate incidental groundfish catch in the Ridgeback Prawn fishery. As noted in section 3.1.3.1, WGCOP coverage of the Ridgeback Prawn fleet was 11% in 2017 (Somers et al. 2018b).

4.2.2 Fishery-independent Data Collection

A Department program to collect fishery-independent data does not exist for the Ridgeback Prawn fishery at this time. However, some potentially useful sources of additional information on Ridgeback Prawn is provided in Table 4-1. These sources could help fill information gaps in the Department's understanding of Ridgeback Prawn which would be helpful for designing future studies.

Table 4-1. Potential sources of additional information on Ridgeback Prawn.

Data source	**Organization**	**Program**	**Summary of research/monitoring activity**
Abundance and distribution data associated with environmental quality monitoring in the Southern California Bight (SBC)	Southern California Coastal Water Research Project (SCCWRP)	SCB Regional Monitoring Program	Bottom trawl surveys were first conducted by SCCWRP in 1994 and reprised approximately every 5 years to provide a comprehensive regional characterization of the trawl-caught finfish and megabenthic invertebrate communities in the SCB.
Discard and bycatch data associated with federal groundfish monitoring	Pacific States Marine Fisheries Commission (PSMFC)/ National Marine Fisheries Service (NMFS)	West Coast Groundfish Observer Program (WCGOP)	The WCGOP observed the California prawn fishery from 2002 to 2005, covering vessels targeting Coonstripe, Ridgeback, and Spotted Prawn, but this data has not been used in discard estimations. In 2017, the WCGOP observed the Ridgeback Prawn portion of the prawn fishery as a pilot study, and fleet-wide discard estimates were derived from at-sea observations and landing receipt data (Somer et al. 2018a).

There are likely other sources of information on Ridgeback Prawn that were not discovered or included in Table 4-1. The Department would welcome information from local agencies, federal agencies, and academic institutions to identify and track general trends relevant to Ridgeback Prawn management.

5 Future Management Needs and Directions

5.1 Identification of Information Gaps

According to the MLMA, management of marine resources is to be based upon the best available scientific information and other relevant information. Presently, there is very little information available on the biology, ecology, and population status of Ridgeback Prawn to estimate appropriate reference points for management of the fishery in California. Fishery-dependent data, such as landings, alone do not provide reliable indicators of resource condition and status because many factors influence fishing effort and subsequent landings (Culver et al. 2010). Acquiring Essential Fishery Information (EFI) (e.g., biology of fish, population status and trends, fishing effort, catch levels, and impacts of fishing) that is currently not available or is incomplete for the Ridgeback Prawn fishery is important to determine if the current levels of fishing effort and harvest are sustainable and whether the stocks are robust enough to support the fishery over the long term. Information needs for the fishery, along with their priority for management is summarized in Table 5-1.

Table 5-1. Informational needs for Ridgeback Prawn and their priority for management.

Type of information	Priority for management	How essential fishery information would support future management
Multi-year Ridgeback Prawn trawl bycatch (catch retained and discarded)	High	Provides information for management of bycatch, including the proportion and composition of species retained and discarded, which could be used to improve fishing practices (i.e., use of or modification of bycatch reduction devices to reduce discards) and development of incidental catch quotas. Adequate evaluation of bycatch will require multi-year data sets.
BRD research and development	High	Research on the differences and efficiency of a variety of BRD types and configurations will better inform management measures to reduce bycatch and promote compliance with the mandatory use of these devices in the Ridgeback Prawn fishery.
CPUE	High	Provides information on long-term increases or decreases in the catch rate. If catch decreases but effort stays the same, it suggests a change in the productivity of the stock. The decline in catch rate with increasing effort can also indicate overcapitalization in the fishery. Commercial logbooks have been used by the Department to provide estimates of CPUE. However, effective monitoring of CPUE will require more complete time series data of logbook records.
Ecological interactions	Medium to High	Provides information on ecosystem structure and dynamics to track changes in interactions over time between Ridgeback Prawn and their environment, habitat, and other organisms. Changes in spatial distribution with time can provide information on environmental drivers of abundance.
Age, size, and sex composition of catch	Medium	New, improved information needed to understand recruitment, growth, survival, and selectivity of fishing gear. Specifically: • The age composition of the catch was believed to be primarily 2 and 3 year old (Sunada 1984; Anderson et al. 1985b), it may be important to determine if that is still the case. • Monitoring the number of 1 year old Ridgeback Prawns can provide the Department with an index of recruitment and indicate when recruitment may be especially low or especially high in the coming year. This could help identify environmental factors that contribute to recruitment success or failure. These environmental indicators may then be used for management. • Additional sex-specific information on the size/age at maturity and sex ratio of catch to determine whether females, which grow faster than males, are more vulnerable to the fishing gear.
Effects of fishing on habitats	Medium	Impacts abundance and diversity of fish and invertebrate species. Builds upon current understanding of habitat sensitivity and vulnerability in terms of their resilience to disturbances from fishing activities.
Abundance	Medium	Analyze the SCCWRP trawl surveys described in section 1.2.1 as fishery-independent index of abundance.

5.2 Research and Monitoring

5.2.1 Potential Strategies to Fill Information Gaps

Biological Research

Despite its commercial value, little research on the biology and ecology of Ridgeback Prawn has been conducted since the 1980s. Additional research is important to help obtain and refine the EFI for future population assessments and management. For instance, sampling the size/sex composition at sea or dockside would provide opportunities to collect information on recruitment and growth rates. Additional fishery independent sampling of inshore locations during late/early winter could be helpful to understand the distribution of juveniles, which may not be reflected in the catch due to mesh sizes and fishing locations. This type of sampling may be valuable to develop a recruitment index that can be used to derive biological thresholds to inform fishery management. Analysis of spatial distribution and environmental correlates of abundance is also needed to anticipate impacts of environmental change to the stock. In addition to current Ridgeback Prawn fishery indicators which are primarily based on commercial landings (i.e., effort and catch) data, developing other potential indicators related to climate, environmental, and oceanographic conditions are likely to be useful in monitoring variability and changes in Ridgeback Prawn resource that may affect the fishery. Research on bycatch composition, importance of Ridgeback Prawns as a food source to other species in the community, and habitat impacts of trawling are also needed to assess the need for effort controls.

Update Fishery Data Collection Systems

Long-term, consistent at-sea monitoring of Ridgeback Prawn is essential to collect reliable and robust scientific data needed for management. Information collected by fisheries observer programs can be used to understand fishing activities, patterns, and gear use. This information can also help verify regulatory compliance, as well as monitor the amount and disposition of catch and bycatch. While a 100% observer coverage of the fleet may be infeasible due to associated costs and other capacity constraints, the use of electronic monitoring technologies like gear sensors and video technology to capture information on fishing location, effort, catch, and discards, can help supplement the work of fishery observers/at-sea monitors, automate data to reduce observer costs, and provide for more comprehensive at-sea monitoring in the future.

The Department has also embarked on a comprehensive series of projects to develop electronic reporting for commercial marine fisheries, including Shrimp/Prawn Trawl Log (form DFW 120) for Ridgeback Prawn. When completed, the projects will include web-based user interfaces that offer commercial fishermen the option to submit electronic fishing activity records instead of paper logs. The use of electronic logs will likely result in more accurate fisheries data, provide for ease of information storage, and improve the availability of data for research and management.

5.2.2 Opportunities for Collaborative Fisheries Research

The Department has collaborated in the past and will continue to work with outside entities such as academic organizations, non-governmental organizations (NGO), citizen scientists, and both commercial and recreational fishery participants to help fill information gaps related to the management of state fisheries. The Department will also reach out to outside persons and agencies when appropriate while conducting or seeking new fisheries research required for the management of each fishery.

The Department is interested in developing collaborative programs with fishermen and scientists from other agencies, academic institutions, and NGOs to increase the quantity and quality of data being used to make management decisions. Experimental research and monitoring are areas for potential collaboration to collect EFI. Collaborative monitoring and information sharing can be used to correlate fluctuations in the fishery that may occur with changes in environmental conditions or fishing-related impacts.

Collaborative fishery research can also be used to evaluate the efficiency of various management alternatives or test specific management-related technology innovations. These can include, but are not limited to, gear innovations, monitoring tools, and other technological advances. For example, further outreach and research is needed to verify and ensure that required BRDs are used and are effective at reducing bycatch in the Ridgeback Prawn fishery. As noted in section 2.2.2., the approved rigid grate is not the best type of BRD for use on trawl vessels with net reels due to damage when wrapped on the net reel. A rigid grate excluder that incorporates a hinge (hinged rigid grate) allowing it to fold as it is wrapped on the reel, meets the current BRD requirement and is likely a better option for the ridgeback fishery. Partnership with fishery participants via experimental fishing permits can facilitate testing of alternative BRDs in order to demonstrate the most effective BRD for Ridgeback Prawn trawl vessels, which can improve fishing practices and increase regulatory compliance to minimize the bycatch of sensitive species. Additionally, fishery partnerships and collaborations with fishermen, NGOs, academic, and the technology sector can help develop and test new data collection approaches or technologies for real-time, electronic monitoring of the fishery (See section 5.2.1). If successful, the Department can implement these data collection approaches or technologies to effectively support fishery management efforts.

5.3 Opportunities for Management Changes

This section is intended to provide information on changes to the management of the fishery that may be appropriate, but does not represent a formal commitment by the Department to address those recommendations. ESRs are one of several tools designed to assist the Department in prioritizing efforts and the need for management changes in each fishery will be assessed in light of the current management system, risk posed to the stock and ecosystem, needs of other fisheries, existing and emerging priorities, as well as the availability of capacity and resources.

Bycatch Management

The MLMA requires that the Department manage commercial fisheries in a way that “limits bycatch to acceptable types and amounts, as determined for each fishery” (FGC §7056(d)). If the type or amount of bycatch is deemed unacceptable, management measures may be required to minimize the bycatch and discard mortality. Bycatch management measures may include:

- modifying gear design, materials, and configurations;
- placing limits on the number of individuals or weight of bycatch (catch limits can include zero quotas and required release);
- placing spatial and temporal restrictions on fishing and certain gear types at a time of year and/or in a geographic location when bycatch is expected;
- implementing incentives or disincentives related to bycatch to encourage fishermen to innovate their practices to avoid bycatch; and/or
- improving monitoring and enforcement (CDFW 2018).

Additionally, research and testing of new gear technology and methods may result in new information that could further bycatch reductions and promote greater BRD compliance in the Ridgeback Prawn fishery (See section 5.2.2). The use of new methods, technologies, and BRDs that are equally, if not more, effective as the current approved rigid-grate excluder should be considered for future management of the fishery.

Restricted Access Program

As discussed in section 3.1.2.2, the Ridgeback Prawn trawl fishery is currently open access, with no cap on the number of permits issued. In 2000, the Commission adopted regulations that set a control date of January 1, 1999, for entry into a restricted access program for the fishery. Should a restricted access program be necessary in the future, the Commission has the authority to revisit the control date for determining eligibility for participating in a restricted access fishery for Ridgeback Prawn.

Stakeholder Participation

Stakeholder engagement and participation in fishery management is key to helping both the Department and Commission identify areas in the fishery that need management attention and/or action. As noted in section 3.1.1.2, the Department intends to investigate concerns that some fishery participants have regarding overcapitalization of the fishery and the need to limit fishing effort, including placing a time limit on the time of day that trawling can occur (i.e.; from sunrise to sunset) or a limit on the amount of time (e.g., trips or days) that can be spent at sea by the fleet. The Department may make recommendations regarding whether effort restrictions are needed and the most appropriate methods for effort control.

Other Ridgeback Prawn resource related petitions received from stakeholders includes a request in 2014 to reinstate an incidental take allowance for Ridgeback Prawn in the State trawl fisheries (See section 3.1.1.2). This petition has been put on hold by the Commission due to a Department concern regarding take of Ridgeback Prawn from fishing grounds prohibited in FGC §8842. Based upon interpretation of the FGC, there may be a need for clarification of the Ridgeback Prawn trawling regulations to address incidental take of Ridgeback Prawn in other State trawl fisheries.

5.4 Climate Readiness

Climate change is a shift in global climate pattern characterized by increasing global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007). These physical changes may in turn effect ecosystem productivity and function, species abundances and distributions, habitat use and availability, and cues that some species rely on that indicate changes in the season (CDFW 2018). This possibility underscores the need for more research to understand how normal climatic fluctuations have affected Ridgeback Prawn stocks in the past in order to help managers prepare for and respond to climate change.

Currently, the Department collects information on commercial Ridgeback Prawn fishing effort and landings that can potentially be used to determine if any trend in abundance and distribution of the resource could be attributable to shifts in climate rather than annual fluctuations in the environment. However, our current understanding of Ridgeback Prawn fishing effort is restricted by limited time series data (See section 2.3.2). As such, a critical first step in readying the Ridgeback Prawn fishery for climate change is to improve the availability of logbook data to adequately calculate CPUE and effectively detect trends in the fishery on relevant timescales. The move toward electronic logbooks (See section 5.2.1) will improve the timeliness of that data and the ability by the Department to manage the fishery. Additionally, a consistent fishery monitoring and sampling program for the Ridgeback Prawn fishery will be important for detecting impacts due to climate change and designing potential new management approaches to facilitate adaptation and resilience in the fishery under changing climate conditions.

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Appendices

A Estimated total (retained and discard) catch of non-target species (metric ton (mt)), discard weight (mt), and percent discarded in the Ridgeback Prawn fishery, 2017 (NWFSC 2018). Zeroes represent values rounded to zero.

Common name	Scientific name	Total catch (metric ton)	Discard weight (metric ton)	Percent discarded
Invertebrates				
Anemone Unid	*Actiniaria*	0.10	0.10	100
Armed Box Crab	*Platymera gaudichaudii*	0.77	0.77	100
Bivalves Unid	*Bivalvia*	0.39	0	0.80
Black Coral	*Antipatheria*	0.01	0.01	100
Bobtail Squid	*Sepiolida*	0.05	0.05	100
Brittle/Basket Star Unid	*Ophiuroidea*	0.26	0.26	100
Brown Box Crab	*Lopholithodes foraminatus*	1.41	1.41	100
California King Crab	*Paralithodes californiensis*	0.78	0.78	100
California Sea Cucumber	*Parastichopus californicus*	0.95	0.95	100
Crab Unid	*Brachyura/Anomura*	0.33	0.07	20.48
Decorator/Spider Crab Unid	*Majidae*	0.01	0.01	100
Hermit Crab Unid	*Paguridae*	0	0	100
Horny Gorgonians	*Holaxonia*	0	0	100
Invertebrate Unid	*Animalia*	1.74	1.74	100
Irregular Echinoids	*Echinoidea*	0.41	0.41	100
Isopod Unid	*Isopoda*	0.04	0.04	100
Jellyfish Unid	*Scyphozoa*	0.07	0.07	100
King Crab Unid	*N/A*	0.03	0	0
Mantis Shrimp	*Stomatopoda*	0	0	100
Market Squid	*Loligo opalescens*	1.32	0	0
Mollusk Unid	*Mollusca*	0.01	0.01	100
Nudibranch Unid	*Nudibranchia*	2.68	2.68	100
Octopus Unid	*Octopoda*	0.16	0.11	68.04
Orange Sea Pen	*Ptilosarcus gurneyi*	0.01	0.01	100
Pacific Rock Crab	*Cancer antennarius*	0.01	0.01	100
Red Rock Crab	*Cancer productus*	2.84	0.02	0.62
Salp Unid	*Taliacea*	0.87	0.87	100
Sea Cucumber Unid	*Holothuroidea*	1.27	1.22	96.01
Sea Pens	*Pennatulacea*	0.04	0.04	100
Sea Snail Unid	*Gastropoda*	0.48	0.48	100

Common name	Scientific name	Total catch (metric ton)	Discard weight (metric ton)	Percent discarded
Sea Star Unid	*Asteroidea*	3.09	3.09	100
Shrimp Unid	*Caridea*	0.51	0.34	67.98
Spiny Lithode Crab	*Acantholithodes hispidus*	0.02	0.02	100
Spot Prawn	*Pandalus platyceros*	0.21	0.03	12.55
Squat Lobster Unid	*Galatheidae*	9.41	9.41	100
Tunicate Unid	*Tunicata*	2.05	2.05	100
Urchin Unid	*Echinoidea*	4.01	4.01	99.97
Worm Unid	*Sipuncula*	0.02	0.02	100
Yellow Rock Crab	*Cancer anthonyi*	0.44	0.44	100
Finfish				
Bat Ray	*Myliobatis californica*	1.59	1.54	97.06
Bigmouth Sole	*Hippoglossina stomata*	1.08	1.08	99.72
Brown Smoothhound Shark	*Mustelus henlei*	0.01	0.01	100
California Halibut	*Paralichthys californicus*	2.09	0.05	2.33
California Lizardfish	*Synodus lucioceps*	36.34	36.34	100
California Tonguefish	*Symphurus atricauda*	0.01	0.01	100
Combfish Unid	*Zaniolepis*	0.01	0.01	100
Croaker Unid	*Sciaenidae*	0.02	0	0
Cusk-eel Unid	*Ophidiidae*	0.17	0.17	100
Eelpout Unid	*Zoarcidae*	5.17	5.17	100
Fantail Sole	*Xystreurys liolepis*	0.46	0.31	66.88
Hagfish Unid	*Myxinidae*	0.02	0.02	100
Hornyhead Turbot	*Pleuronichthys verticalis*	1.73	1.73	100
Longfin Sanddab	*Citharichthys xanthostigma*	1.78	1.78	100
Longspine Combfish	*Zaniolepis latipinnis*	14.80	14.80	100
Mackerel Unid	*Scombridae*	0.01	0	0
Midshipman (Toadfish) Unid	*Batrachoididae*	10.40	10.40	100
Non-Eulachon Smelt Unid	*Non-Eulachon Osmeriformes*	0.03	0.03	100
Non-Humboldt Squid Unid	*Teuthida*	0.36	0.36	100
Northern Anchovy	*Engraulis mordax*	0.36	0.34	92.79
Pacific Angel Shark	*Squatina californica*	7.09	6.73	94.96
Pacific Argentine	*Argentina sialis*	0.02	0.02	100
Pacific Butterfish	*Peprilus simillimus*	0.56	0.56	100
Pacific Electric Ray	*Torpedo californica*	2.60	2.60	100
Pacific Hagfish	*Eptatretus stouti*	0.01	0.01	100
Pacific Sardine	*Sardinops sagax*	0.01	0	10.56

Common name	Scientific name	Total catch (metric ton)	Discard weight (metric ton)	Percent discarded
Pink Surfperch	*Zalembius rosaceus*	0.83	0.83	100
Plainfin Midshipman	*Porichthys notatus*	6.95	6.95	100
Poacher Unid	*Agonidae*	0.27	0.27	100
Queenfish	*Seriphus politus*	0.01	0	0
Redtail Surfperch	*Amphistichus rhodoterus*	0.01	0.01	100
Sculpin Unid	*Cottidae*	0.10	0.08	78.71
Shark Unid	*Squaliformes*	0.07	0	0
Shiner Surfperch	*Cymatogaster aggregata*	0	0	100
Shortspine Combfish	*Zaniolepis frenata*	0.75	0.75	100
Skate Unid	*Rajidae*	1.03	0.02	2.08
Slender Sole	*Lyopsetta exilis*	2.49	2.49	100
Smooth Stargazer	*Kathetostoma averruncus*	0.14	0.14	100
Specklefin Midshipman	*Porichthys myriaster*	0.62	0.62	100
Splitnose Searobin	*Bellator xenisma*	0	0	100
Spotted Cusk-eel	*Chilara taylori*	0.06	0.06	100
Surfperch Unid	*Embiotocidae*	0.03	0.03	100
Swell Shark	*Cephaloscyllium ventriosum*	0.04	0.04	100
Triggerfish Unid	*Balistidae*	0	0	100
White Croaker	*Genyonemus lineatus*	23.08	14.08	60.99
Federally Managed Groundfish[a]				
Arrowtooth Flounder	*Atheresthes stomias*	0.01	0.01	100
Aurora Rockfish	*Sebastes aurora*	0.06	0.06	100
Bank Rockfish	*Sebastes rufus*	0	0	100
Big Skate	*Raja binoculata*	0	0	100
Black Rockfish	*Sebastes melanops*	0	0	0
Bocaccio Rockfish	*Sebastes paucispinis*	0.15	0.15	99.09
Brown Rockfish	*Sebastes auriculatus*	0.02	0.01	72.95
Cabezon	*Scorpaenichthys marmoratus*	0.02	0.01	79.65
Calico Rockfish	*Sebastes dalli*	0.10	0.10	100
California Scorpionfish	*Scorpaena guttata*	0.92	0.77	84.51
California Skate	*Raja inornata*	1.09	1.09	100
Canary Rockfish	*Sebastes pinniger*	0.01	0.01	100
Chilipepper Rockfish	*Sebastes goodei*	0.65	0.65	100
Copper Rockfish	*Sebastes caurinus*	0.02	0.02	100
Cowcod Rockfish	*Sebastes levis*	0.07	0.07	100
Curlfin Sole	*Pleuronichthys decurrens*	0.07	0.06	95.85
Darkblotched Rockfish	*Sebastes crameri*	0.01	0.01	100
Dover Sole	*Microstomus pacifcus*	10.52	10.52	99.94

Common name	Scientific name	Total catch (metric ton)	Discard weight (metric ton)	Percent discarded
English Sole	*Parophrys vetulus*	22.80	22.00	96.47
Flag Rockfish	*Sebastes rubrivinctus*	0.01	0.01	100
Flatfish Unid	*Pleuronectiformes*	2.92	1.88	64.47
Freckled Rockfish	*Sebastes lentiginosus*	0.02	0.02	100
Greenblotched Rockfish	*Sebastes rosenblatti*	0.08	0.08	100
Greenspotted Rockfish	*Sebastes chlorostictus*	0.02	0.02	100
Greenstriped Rockfish	*Sebastes elongatus*	0.05	0.05	100
Halfbanded Rockfish	*Sebastes semicinctus*	4.14	4.14	100
Kelp Rockfish	*Sebastes atrovirens*	0	0	100
Lingcod	*Ophiodon elongatus*	0.40	0.35	86.42
Longnose Skate	*Raja rhina*	0.39	0.38	97.67
Mexican Rockfish	*Sebastes macdonaldi*	0.02	0.02	100
Pacific Hake	*Merluccius productus*	17.09	17.05	99.79
Pacific Sanddab	*Citharichthys sordidus*	33.75	33.66	99.73
Petrale Sole	*Eopsetta jordani*	1.26	0.83	66.19
Redstripe Rockfish	*Sebastes proriger*	0.01	0.01	100
Rex Sole	*Glyptocephalus zachirus*	0.57	0.57	100
Rock Sole	*Lepidopsetta*	0.11	0	0
Rosy Rockfish	*Sebastes rosaceus*	0	0	100
Sablefish	*Anoplopoma fmbria*	0.05	0.05	95.70
Sanddab Unid	*Citharichthys*	0.63	0	0
Shelf Rockfish Unid	*N/A*	0.67	0.63	93.91
Shortbelly Rockfish	*Sebastes jordani*	0.03	0.03	100
Shortspine/Longspine Thornyhead	*Sebastolobus*	0.01	0	0
Slope Rockfish Unid	*N/A*	0.05	0.01	17.35
Soupfin Shark	Soupfn Shark	0.04	0.04	100
Speckled Rockfish	*Sebastes ovalis*	0	0	100
Spiny Dogfish Shark	*N/A*	0.38	0.38	100
Splitnose Rockfish	*Sebastes diploproa*	0.02	0.02	100
Spotted Ratfish	*Hydrolagus colliei*	0.73	0.73	100
Squarespot Rockfish	*Sebastes hopkinsi*	0.05	0.05	100
Stripetail Rockfish	*Sebastes saxicola*	4.96	4.96	100
Swordspine Rockfish	*Sebastes ensifer*	0	0	100
Vermilion Rockfish	*Sebastes miniatus*	0.57	0.56	97.94
Other				
Egg Case Unid	*N/A*	0	0	100
Unidentified Mixed Species	*N/A*	16.84	0	0

a. Federally Managed Groundfish constitute species and species group managed under the Federal Pacific Coast Groundfish Fishery Management Plan.