Fishery-at-a-Glance Night Smelt

Scientific Name: *Spirinchus starksi*

Range: Night Smelt are distributed coast-wide from southeast Alaska to Point Arguello, Santa Barbara County.

Habitat: Night Smelt occur in the surf and in depths from the surface to approximately 400 feet (122 meters).

Size (length and weight): Night Smelt measure less than 6 inches total length (140 millimeters) weighing to 11 grams. Males are slightly longer and heavier than females.

Life span: Night Smelt are short lived and believed to reach a maximum of 2 to 3 years.

Reproduction: Spawning occurs in the surf along open coast coarse sand beaches from January to September. Eggs are fertilized in the wash of the surf, adhere to sand grains, and sink. Hatching occurs in approximately 2 weeks.

Prey: Night Smelt feed on small crustaceans—primarily gammarid amphipods and mysid shrimp.

Predators: Night Smelt provide forage for a wide range of predators, including Striped Bass, Redtail Surfperch, salmon, Harbor Seals, California Sea Lions, terns, gulls, and cormorants.

Fishery: Commercial and recreational fisheries are shore-based.

Area fished: Historically, fishing occurred from Moss Landing, Monterey County to the Oregon border. Currently, fishing occurs from San Mateo County to Del Norte County.

Fishing season: Fishing occurs during the spawning season—January to September.

Fishing gear: Fishermen fish from shore using A-frame dip nets.

Market(s): Landed fish are sold for human consumption and aquarium food.

Current stock status: No formal stock assessments exist for Night Smelt. Although catch rates have increased on average since the early 2000s, it is undetermined if this increase in the index is due to increased abundance or changes in fishermen behavior. Climate change has the potential to cause spawning habitat losses due to sea level rise by changing beach slope and eroding beaches

Management: The fishery is primarily managed through gear and area restrictions. Vehicle beach access is constrained by federal, state, and county parks.

1 The Species

1.1 Natural History

1.1.1 *Species Description*

The family of true smelts (*Osmeridae)*, is comprised of 12 species; seven of these species occur in California's coastal and estuarine waters: Night Smelt (*Spirinchus starksi)*, Longfin Smelt (*S. thaleichthys)*, Surf Smelt (*Hypomesus pretiosus)*, Delta Smelt (*H. transpacificus),* Eulachon (*Thaleicthys pacificus)*, and Whitebait Smelt (*Allosmerus elongatus)*. A non-native species, Wakasagi (*H. nipponensis),* was introduced into California reservoirs as a forage species for trout in 1959 and has become established in the San Francisco estuary (https://www.fws.gov/fisheries/ans/erss/highrisk/Hypomesus-nipponensis-WEB-7-31-2014.pdf).

Night Smelt are relatively small, silvery fish measuring less than 130 millimeters (mm) (<6 inches (in)) total length, silvery, and possess an adipose fin (Figure 1-1). They can be distinguished from other osmerids: Eulachon have striations on the gill cover; Wakasagi, Surf, and Delta Smelt maxillaries do not extend beyond the middle or edge of the eye; Whitebait Smelt have a large canine on the vomer; and Longfin Smelt have a maxillary to cranial slope angle of 68 to 90° (Fitch and Lavenberg 1971; Miller and Lea 1972).

Figure 1-1. Night Smelt (*Spirinchus starksi*) on display at a seafood market in Monterey. Photo credit: Ken Oda CDFW.

Night Smelt have been found from Point Arguello, Santa Barbara County to Shelikof Bay, southeast Alaska (Figure 1-2) (Miller and Lea 1972, Love 2011).

Figure 1-2. Night Smelt *Spirinchus starksi* range. Map data: SIO, NOAA, U.S. Navy, NGA, GEBCO. Image Landsat Copernicus. Google 2018. US Department of State Geographer.

They appear along coarse sandy beaches often in proximity to river or creek mouths in north central to northern California (Fitch and Lavenberg 1971; Slama 1994; Miller and Gotshall 1965;). Night Smelt have been noted in surface waters to 420 feet (ft) (128 meters (m)) (Sweetnam and others 2001) and may have appeared as bycatch in the Pink Shrimp (*Pandalus jordani),* fishery; however, Osmerids were not identified to species in samples (Hannah and Jones 2007). In Washington, Night Smelt were

recently documented in the Salish Sea, which is comprised of a system of straits—Puget Sound, Georgia Strait, and Juan de Fuca Strait (Paquin and others 2014).

Little is known of Night Smelt movement in California. Night Smelt aggregate annually nearshore to spawn on coastal beaches in California as early as January and through September (Sweetnam and others 2001; Slama 1994). Post-spawning adult and larval migrations are unknown. The bycatch of Osmerids noted above in the Pink Shrimp trawl fishery occurred in May to September with abundance spikes occurring in June (Hannah and Jones 2007).

1.1.2 *Spawning Season, Fecundity, and Reproduction*

In California, Night Smelt spawn along sandy open coast and pocket beaches primarily during January to September (Fitch and Lavenberg 1971; Sweetnam and others 2001; CDFW unpublished data). Prior to spawning, samples of fish taken offshore yielded sex ratios of 1:1 (Sweetnam and others 2001). Sexes segregate nearshore with males dominating school compositions; samples ranged from 2% females in February to 14% in August (H.T. Harvey and Associates and others 2015; Nielsen and others 2017). At peak spawning, Fitch and Lavenberg (1971) reported that the ratio of males to females approached 8:1 and increased to 100:1 during spawning runs.

Fecundity data for Night Smelt are limited. Slama's (1994) samples contained an average of 1,972 eggs per female, with a maximum of 3,794 mature eggs per female. Slama (1994) hypothesized fecundities were biased low by fish that were in the process of spawning and/or had recently spawned. The maximum number of immature eggs (3,271) was close to the maximum number of mature eggs (3,794) but the ratio of immature eggs to mature eggs was nearly 3:1. Thus, Slama suggested that Night Smelt may be fractional spawners where females spawn eggs as they develop in multiple spawning events. Eggs had a bimodal size distribution: mature eggs averaged 1.2 mm in diameter and immature eggs measured 0.3 mm. Slama suggested that Night Smelt may not only fractionally spawn, but also that females may hold eggs until the following spawning season.

During spawning, females release their eggs over coarse sand in the wash, closely followed by dense schools of males (Fitch and Lavenberg 1971). The fertilized eggs adhere to coarse sand grains and pebbles, sink, and are subsequently covered by layers of sand by wave action (Fitch and Lavenberg 1971; Slama 1994; Leet and others 2001). Under these conditions, spawning lower on the beach slope would minimize desiccation and thermal stress on developing embryos, and possible predation of adults (Langness and others 2015; Martin 2001). Quinn and others (2012) determined that survival rates were higher for Surf Smelt embryos deposited on lower elevation transects. Embryos generally hatch after 2 weeks (Fitch and Lavenberg 1971; Leet and others 2001). There is no information in the literature regarding larval or juvenile movements.

1.1.3 *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. There are no estimates of natural mortality for Night Smelt. Natural mortality of the European Smelt (*Osmerus eperlanus)*, a boreal member of the Osmeridae, inhabiting the North and Baltic Seas were determined by Lillelund (1960) as cited by Belyanina (1969) (Figure 1-3).

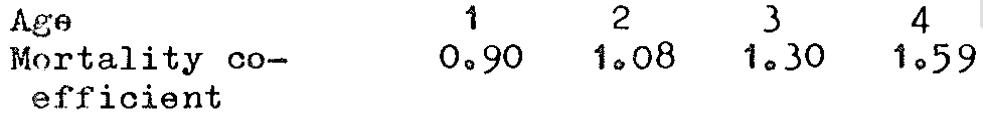


Figure 1-3. Natural mortality estimates for European Smelt, *Osmerus eperlanus*, of the Elbe river from Belyanina (1969).

1.1.4 *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.

Very little is known of Night Smelt growth. Slama (1994) used scale annuli and determined a maximum age of 2 years (yr) in his samples; however, this method has not been validated for age analysis. H. T. Harvey and Associates and others (2015) were unable to determine ages by surface reading otoliths and suggested other ageing methods be investigated such as sectional polishing (McFarlane and others 2010). Slama (1994), H. T. Harvey and Associates and others (2015), and Nielsen and others (2017) collected different length modes, standard length (SL) versus total length (TL), respectively. Datasets indicated that males were slightly larger than females on average (Table 1-1).

Table 1-1. Summary of Night Smelt length weight data (Slama 1994, H. T. Harvey and others 2015, and Nielsen and others 2017).

Investigator	Year(s)	Male Length	Male Weight (g)	Female Length	Female Weight (g)
Slama	1992/1993	98-99 mm SL	10.1	90-92 mm SL	7.86
H. T. Harvey	2014	123 mm TL	N/A	113 mm TL	N/A
Nielsen	2014/2015	117-122 mm TL	10.4-10.8	106-114 mm TL	7.4-7.8

Length/weight relationships were presented by Slama (1994) and H. T. Harvey and Associates and others (2015). Both datasets found males were slightly heavier than females for a given length; however, samples were collected during spawning events which the authors acknowledged likely confounded results of length/weight relationship analyses by including fish that had partially or completed spawning. Linear models shown below, were fitted to total length and weight for each sex (H. T. Harvey and Associates and others 2015):

$$\log(Length_{male}) = -10.74 + 2.74\ x\ \log(Weight_{male})$$
$$\log(Length_{female}) = -11.8 + 2.94\ \mathrm{x}\ \log(Weight_{female})$$

1.1.5 *Size and Age at Maturity*

Night Smelt length frequency analyses of spawning fish indicated that unimodal distributions were comprised solely of age 2 individuals or that age/length frequency analyses required higher resolution to detect additional cohorts (Slama 1994, H. T. Harvey and Associates and others 2015). As noted above, Slama (1994) used scale annuli that have not been validated as an ageing technique for smelt and H. T. Harvey and Associates and others (2015) were unsuccessful in surface ageing otoliths. Sampled males were approximately 10 mm (0.4 in) longer in SL and TL than females.

1.2 Population Status and Dynamics

1.2.1 *Abundance Estimates*

There are no estimates of abundance for Night Smelt. Fisheries catch records have been collected since 1916 (Leet and others 1992). “Smelt” landings prior to 1969 represented not only true smelts (Osmeridae) but silversides (Atherinidae). Beginning in 1969, Atherinids were separated into their own market category. True smelt landings after 1969 contained Night Smelt but also Whitebait Smelt until 1977 when landings were then sorted to species; however, it is unlikely that Whitebait Smelt contributed significantly to true smelt landings (Leet 2001). In that context, beginning in 1990, landing receipt data used to calculate catch per unit effort indices, e.g., catch per receipt, are assumed to be Night Smelt (Figure 1-3).

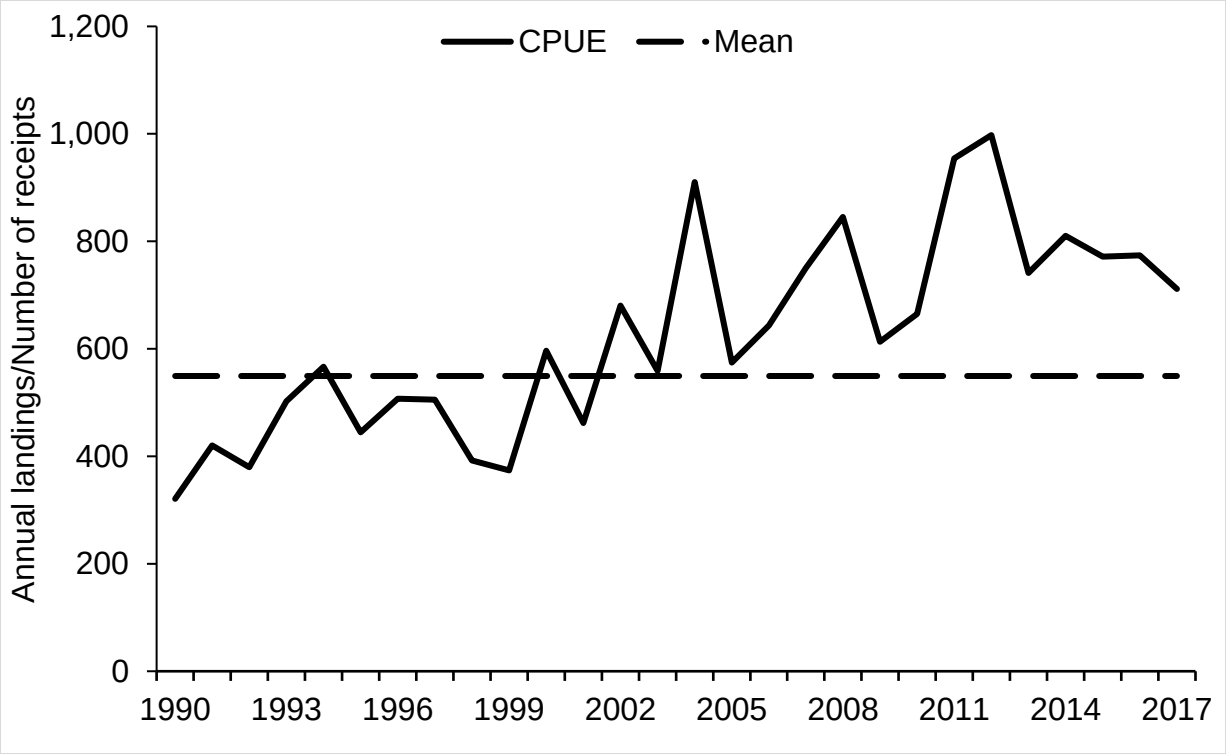


Figure 1-4. Night Smelt (*Spirinchus starksi*), catch per unit effort (CPUE) indices: 1990 to 2017 (CDFW unpublished data).

Although catch rates have increased on average since the early 2000s, it is undetermined if this increase in the index is due to increased abundance or changes in fishermen behavior (e.g., fishing cooperatively using one vehicle to transport their catch to market and co-mingling their catches) (Kathryn Meyer, CDFW, personal communication).

1.2.2 *Age Structure of the Population*

Work by Slama (1994), H. T. Harvey and Associates and others (2015), and Nielsen and others (2017) indicate that local spawning aggregations are comprised of 2-year-old cohorts in the Eureka port complex. Slama (1994) analyzed scales which have not been validated as an ageing method for Night Smelt. H. T. Harvey (2015) took otoliths which are pending ageing with a validated method. However, length frequency analysis yield unimodal distribution. Night Smelt were sampled in 2015 by the Department in fishery-independent surveys (FIS) in San Mateo County—sample sizes were very small and fish were not aged; however, length distribution appeared to be unimodal (Figure 1-4).

Figure 1-5. Night Smelt *Spirinchus starksi* from fisheries independent sampling San Mateo County, California in 2015. Photo credit: Kristine Lesyna CDFW.

Currently, there are no FIS or market sampling targeting Night Smelt in California.

1.3 Habitat

Very little is known regarding Night Smelt habitat requirements between hatching on sandy beaches to their reappearance as spawning adults (H. T. Harvey and Associates and others 2015). Observer data from the Pink Shrimp fishery operating in depths ranging from 240 to 750 ft (73 to 229 m) indicate that osmerids occur over the continental shelf (Leet and others 2001, Hannah and Jones 2007). Slama (1994) noted in a personal communication with Mulligan (1994) that Night Smelt routinely appeared in research bottom trawls over sandy substrate off Eureka. Determining habitat usage to the species level of the Osmeridae is complicated by difficulties in identification for all life stages: embryos, larvae, juveniles, and adults (H. T. Harvey and Associates and others 2015, Langness and others 2014, Langness and others 2015). Open coast spawning habitat for Night Smelt overlaps with that of Surf Smelt on the same beaches; therefore, identifying embryos to the species level would require genetic testing and analysis (Paquin and others 2014, Langness and others 2015).

The primary spawning habitat for Night Smelt in California occurs along open coast sandy beaches. These are characterized by high energy surf conditions, tidal flow, turbulence, and seasonally strong winds and currents, with varying beach slope and swash zones (Allen and Pondella 2006, Nielsen and others 2013, Dugan and others 2015, Nielsen and others 2017). These factors, in addition to primarily night usage of the surf zone by Night Smelt, further confound efforts to conduct traditional FIS with scuba or beach seine along many central and northern California coast locations (Allen and Pondella 2006).

Night Smelt spawning locations in California have not been well documented in the literature beyond Humboldt and Del Norte counties (H. T. Harvey Associates and

others 2015; Nielsen and others 2015). Miller and Gotshall (1965) conducted statewide recreational surveys from 1957 to 1962 and noted Osmerid fishery locations with the assistance of Department enforcement and California State Parks staff, and the public from the Oregon-California border to Monterey Bay (Table 1-2).

Table 1-2. Summary of surf netting sites identified by Miller and Gotshall (1965) in Ocean Fishing Map of Del Norte, Humboldt, and Mendocino Counties, Ocean Fishing Map of Sonoma and Marin Counties, and Ocean Fishing Map of San Francisco, San Mateo and Santa Cruz Counties and the Elkhorn Slough Area of Monterey County.

Location	County
Pelican State Beach	Del Norte
Tolowa Dunes State Beach	Del Norte
Enderts Beach	Del Norte
Wilson Creek Beach	Del Norte
Klamath River Beach	Del Norte
Gold Bluff area	Humboldt
Redwood Creek	Humboldt
Luffenholtz Beach	Humboldt
Mad River Beach	Humboldt
Humboldt north spit	Humboldt
Humboldt south spit	Humboldt
Eel River Beach	Humboldt
Centerville Beach	Humboldt
Mattole River	Humboldt
Usal Creek	Mendocino
Jackass Creek	Mendocino
Cottoneva Creek	Mendocino
Juan Creek	Mendocino
Wilson Creek	Mendocino
Howard Creek	Mendocino
DeHaven Creek	Mendocino
Wages Creek	Mendocino
South Kibesillah Gulch	Mendocino
Westport-Union Beach	Mendocino
Ten Mile Beach	Mendocino
MacKerricher State Beach	Mendocino
Virgin Creek	Mendocino
Pudding Creek	Mendocino
Manchester State Beach	Mendocino
Alder Creek Beach	Mendocino
Garcia River	Mendocino
Russian Gulch	Sonoma
Russian River	Sonoma
Blind Beach	Sonoma
Shell Beach	Sonoma
Wrights Beach	Sonoma
Portuguese Beach	Sonoma
Salmon Creek Beach	Sonoma
Estero de Americano	Sonoma
Dillon Beach area	Sonoma
Dunes State Beach	San Mateo

Francis State Beach	San Mateo
Miramontes Beach	San Mateo
Purisima Creek Beach	San Mateo
Martin's Beach	San Mateo
Greyhound Rock area	Santa Cruz
Scott Creek Beach	Santa Cruz
Davenport Landing	Santa Cruz
Zmudowski State Beach	Monterey
Moss Landing jetty area	Monterey

More than 80% of the spawning locations listed above are in proximity to sources of freshwater outflow. This is consistent with outer coast Osmerid spawning survey observations in Washington (Langness and others 2014; Langness and others 2015). Langness and others (2015) hypothesized that freshwater outflows may reduce embryo mortality from desiccation and heat stress by cooling spawning substrates.

It is unclear if Night Smelt have preferences for specific beach attributes; however, they were not found as frequently along beaches characterized by fine sand and mildly sloped faces (H. T. Harvey and Associates 2015). Langness and others 2015 noted that the highest egg counts in their open coast beach surveys occurred in June when egg deposits occurred over a wider linear range suggesting a possible correlation with spawning success; however, it is important to note that eggs were not identified to species at the time.

1.4 Ecosystem Role

1.4.1 *Associated Species*

Although Night Smelt usually are not caught by hook-and-line, this mode of recreational fishing or FIS along the sandy shores where Night Smelt occur can indicate associated species. Miller and Gotshall (1965) sampled all modes of anglers from the Oregon border to Point Arguello (all within the documented range of Night Smelt) in the late 1950s and sampled fishermen at Mad River beach. Miller and Gotshall (1965) indicated that hook-and-line anglers landed primarily Walleye, Silver, and Redtail Surfperch (*A. rhodoterus)* on sandy beaches in Humboldt and Del Norte counties. They noted surf netters landing Night Smelt, Surf Smelt, Pacific Herring (*Clupea pallasii)*, as well as Redtail Surfperch.

Department staff has conducted routine FIS using hook-and-line along sandy beaches from Del Norte to San Luis Obispo counties, some of these beginning as early as 2007 (Department unpublished data). Associated species are summarized by four general areas: 1) Since 2007, from Santa Cruz to San Luis Obispo counties, hook-and-line catches were dominated by Barred Surfperch (*Amphistichus argenteus)* and included: Silver Surfperch (*Hyperprosopon ellipticum)*, Walleye Surfperch (*H. argenteum)*, Calico Surfperch (*A. koelzi)*, Striped Bass (*Morone saxatilis)*, Jacksmelt (*Atherinopsis californiensis)*, and California Halibut (*Paralichthys californicus)*. Data were also collected by limited beach seines on Monterey Bay beaches. In addition to the species listed above, other species caught in proximity of known Monterey Bay Night Smelt spawning locations included Pacific Sardine (*Sardinops sagax)*, Sand Sole

(*Psettichthys melanostictus)*, and Kelp Perch (*Brachyistius frenatus)* (CDFW unpublished data).

2) Since 2008, from San Mateo to Sonoma County, common species caught included: Barred, Silver, and Walleye Surfperch, Striped Seaperch (*Embiotoca lateralis)*, Black Perch (*Embiotoca jacksoni)*, Striped Bass, and Jacksmelt. 3) Pilot FIS hook-and-line surveys were conducted on Mendocino County beaches beginning in 2016. Species collected included Redtail, Calico, Silver, and Walleye Surfperch, and Striped Seaperch. 4) The Department initiated hook-and-line FIS in Humboldt and Del Norte counties in 2012, continuing through 2016, including collaborative work in 2014 and 2015 (Nielsen and others 2017). The only species reported caught were Redtail and Silver Surfperch.

Common species appearing in California Recreational Fisheries Survey (CRFS) beach/bank surveys conducted in 2005 to 2016 in Humboldt and Del Norte counties included: Surf Smelt, Black Rockfish (*Sebastes melanops)*, Striped Seaperch, Silver Surfperch, Kelp Greenling (*Hexagrammos decagrammus)*, Jacksmelt, and Shiner Perch (Figure 1-5).

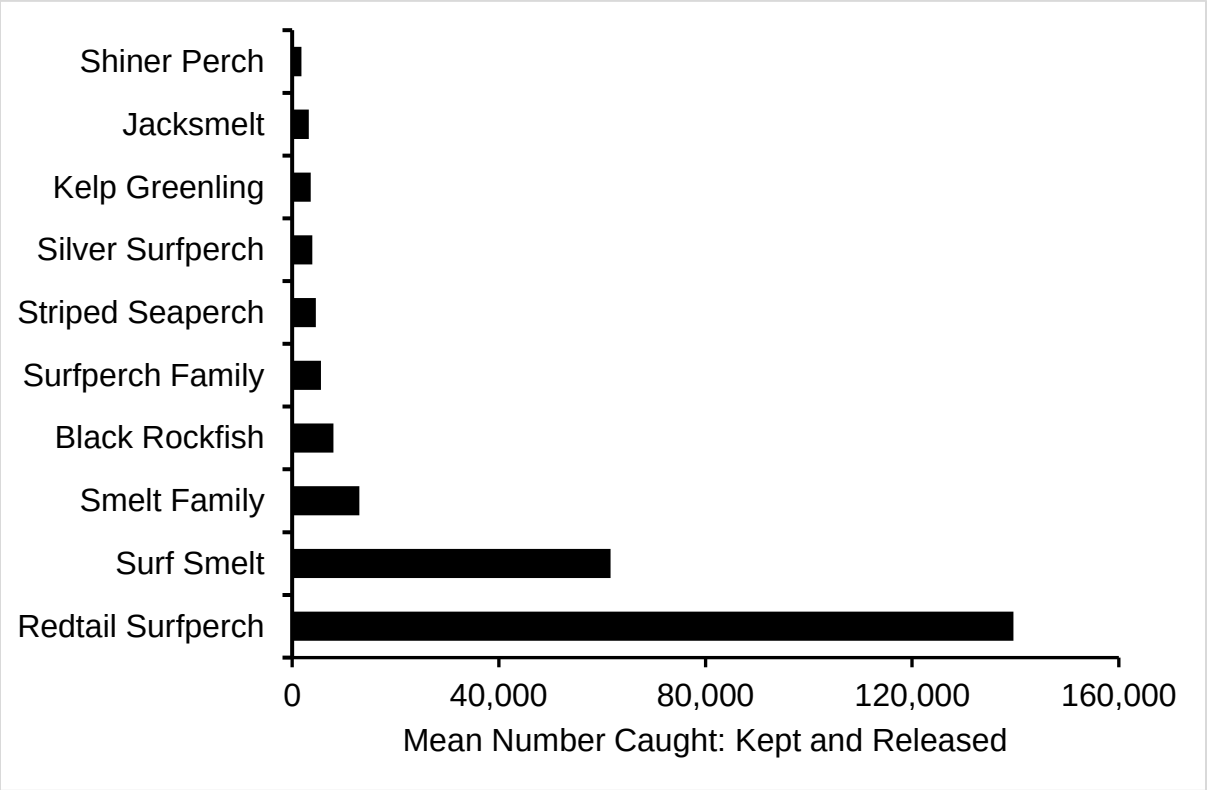


Figure 1-6. Mean number of finfish caught by Humboldt and Del Norte counties beach/bank anglers from 2005 to 2017. Data source: RecFIN.

As noted in section 1.1.1, osmerids were identified as bycatch in the Pink Shrimp fishery operating on discrete grounds composed of sandy and “green mud” bottoms (Leet and others 2001; Hannah and Jones 2007). Osmerids were not identified to the species level. In addition to osmerids other bycatch (i.e. associated species) included the following: Pacific hake (*Merluccius productus)*, Sablefish (*Anoplopoma fimbria)*, Hagfish (*Eptatretus spp.)*, Arrowtooth Flounder (*Atheresthes stomias)*, Dover sole

(*Microstomus pacificus)*, Slender Sole (*Eopsetta exilis)*, Pacific sanddab (*Citharichthys sordidus)*, Rex Sole (*Errex zachirus)*, Darkblotched Rockfish (*Sebastes crameri)*, Splitnose Rockfish (*S. diploproa)*, Rougheye Rockfish (*S. aleutianus)*, Pacific Ocean Perch (*S. alutus)*, miscellaneous Sebastes spp., Shortspine Thornyhead (*Sebastolobus alascanus)*, miscellaneous flatfish, and unidentified skates (Rajidae).

1.4.2 *Predator-prey Interactions*

Mid-level schooling pelagic fish play a critical role in the marine food web, providing forage for a range of predatory fish, birds, and mammals (Langness and others 2015; Penttila 2007; Simenstad and others 1979). Osmerids are forage for a variety of species including marine mammals, birds, and commercially and recreationally harvested marine fish. Predatory fish include Striped Bass, California Halibut, Pacific Bonito *(Sarda chiliensis)*, Lingcod (*Ophiodon elongatus)*, salmon (*Onchorhynchus* spp.), rockfishes (*Sebastes* spp.), Kelp Bass (*Paralabrax clathratus)*, Barred Sand Bass (*P. nebulifer)*, and Leopard Shark (*Triakis semifasciata)* (Oda and Crane 2013, Thomas 1967). Osmerids also fall prey to birds such as Great Blue Heron (*Ardea Herodias*), Least Tern (*Sternula antillarum*), Caspian Tern (*Hydroprogne caspia*), Forster's Tern (*Sterna forsteri*), cormorants (*Phalacrocorax* spp.), Common Loon (*Gavia immer)*; and various gulls. Marine mammals that forage on osmerids include Harbor Seals (*Phoca vitulina*), California Sea Lions (*Zalophus californianus*), and, in estuaries, North American River Otters (*Lontra canadensis)* (H. T. Harvey and others 2015; Leet 2001).

The diet of Night Smelt has not been well-studied. Slama (1994) reported the stomach contents of Night Smelt taken on Freshwater Beach, Humboldt County in 1992 and 1993. Food items consisted of the following: Onuphidae (a family of polychaete worms); crustaceans composed of gammarid amphipods, mysids, Crangon spp., and diastylid cumacea; larval smelt; and fish embryos. He noted higher frequencies of crustaceans consumed by males and a higher proportion of onuphids eaten by females.

1.5 Effects of Changing Oceanic Conditions

Environmental conditions play a critical role in reproductive patterns and distribution of marine organisms and, consequently, the fisheries that they support (Radovich 1961, Parrish and others 1981). Significant changes in ocean current flow and water temperatures, for example during El Niño events, are attributed to displacing or shifting species within faunal groups (Parrish and others 1981). Water temperature directly affects metabolic functions, preferred food availability, and the distribution of predators (Radovich 1961). Figure 1-6 presents Night Smelt commercial landings as the deviation from the historic average landing per receipt multiplied by 25 for scaling purposes; this is a form of CPUE. These are plotted against the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center's Oceanic Niño Indices (ONI). The relationship is unclear; despite the strong 2015 to 2016 El Niño, the long-term average CPUE index (1980 to 2017) has been above average every year since 2003.

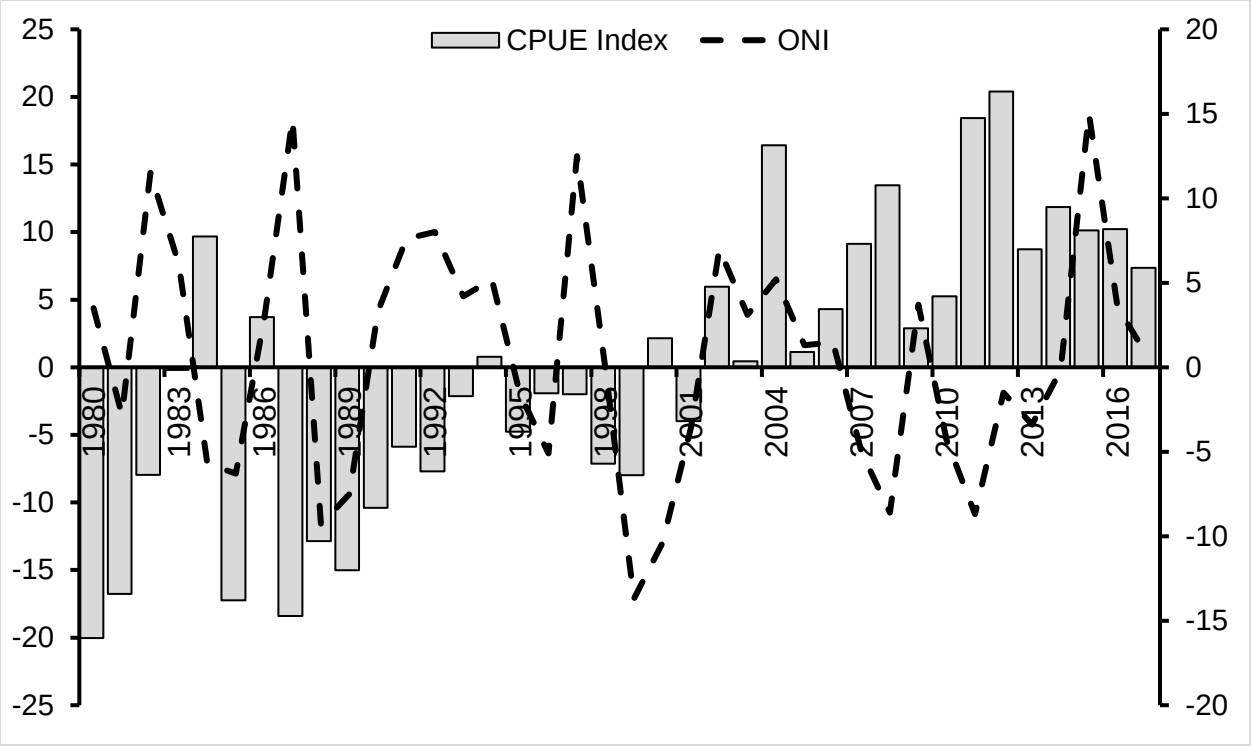


Figure 1-7. Commercial landings receipt deviations from long-term mean multiplied by 25 for scaling purposes versus Oceanic Niño Indices (ONI) from 1980 to 2017. Source: NOAA, MLDS.

CPUEs may be influenced by other factors related to the market, e.g., demand and market orders, as well as changes in fishing practices. Eureka-area fishermen work cooperatively to "share" the limited number of beach access permits by pooling vehicles and co-mingling landings (H. T. Harvey and Associates and others 2015; Kathryn Meyer, CDFW, personal communication).

Climate change has the potential to cause spawning habitat losses due to sea level rise by changing beach slope and eroding beaches (Slama 1994). Beaches that were fished for Night Smelt historically in Pacifica, California have been greatly reduced in width with extensive erosion of adjacent cliffs (CDFW unpublished information). The impact of these types of changes in the ocean environment on the population dynamics of Night Smelt currently are unknown.

2 The Fishery

2.1 Location of the Fishery

Night Smelt have been harvested in California along sandy beaches from the Oregon border to Moss Landing (Monterey County) in Monterey Bay (Figure 2-1).

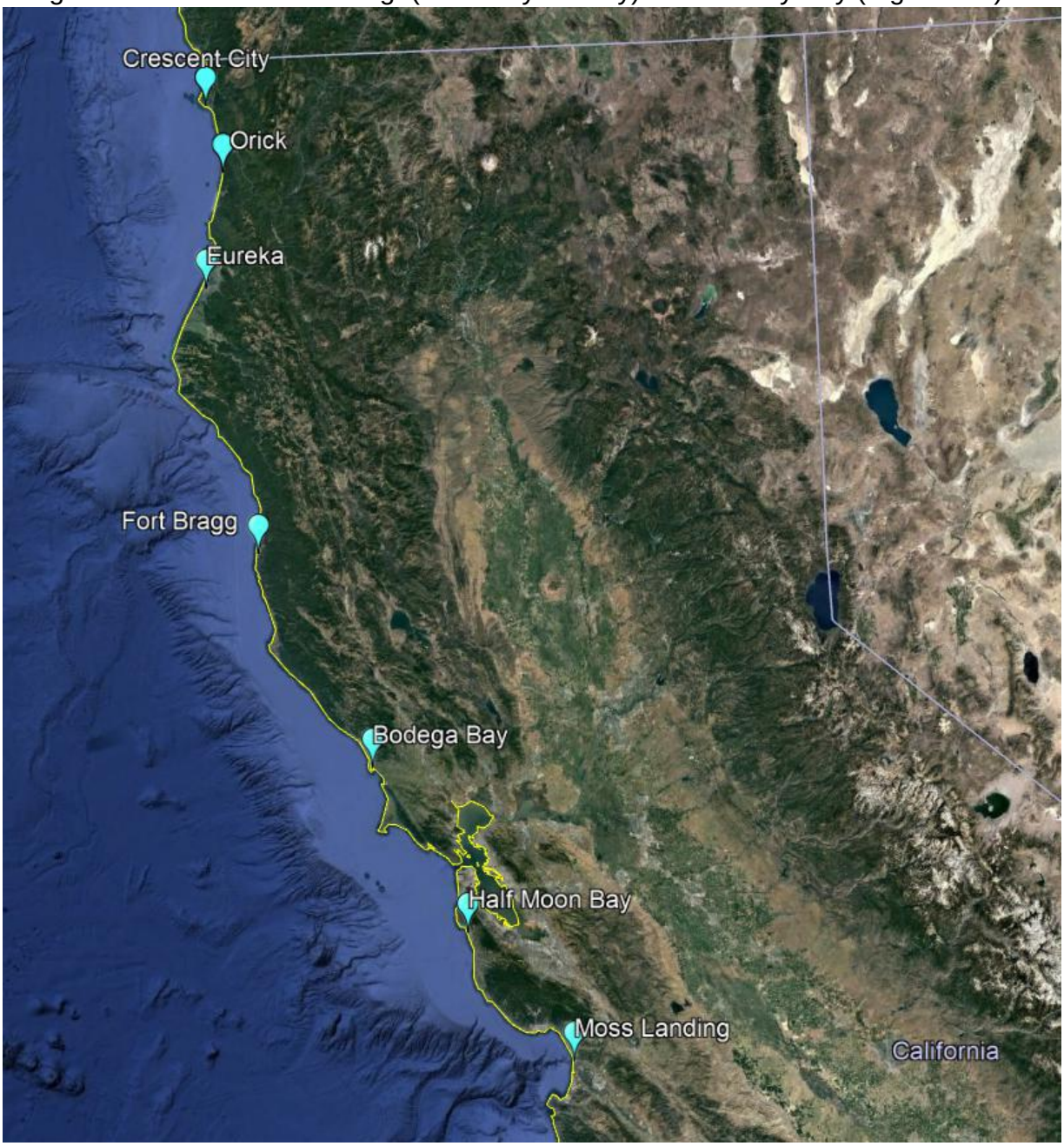


Figure 2-1. California ports and locations of Night Smelt fisheries. Data LEDEO-Columbia, NSF, NOAA @Google. Image Landsat/Copernicus. Data SIO, NOAA, U.S. Navy, NGA, GEPCO. Date extracted: 24 October 2018.

The primary ports of landing since 1980 are Eureka and Crescent City. Over 95% of commercial Night Smelt landings occur in Humboldt and Del Norte county ports (Figure 2-2).

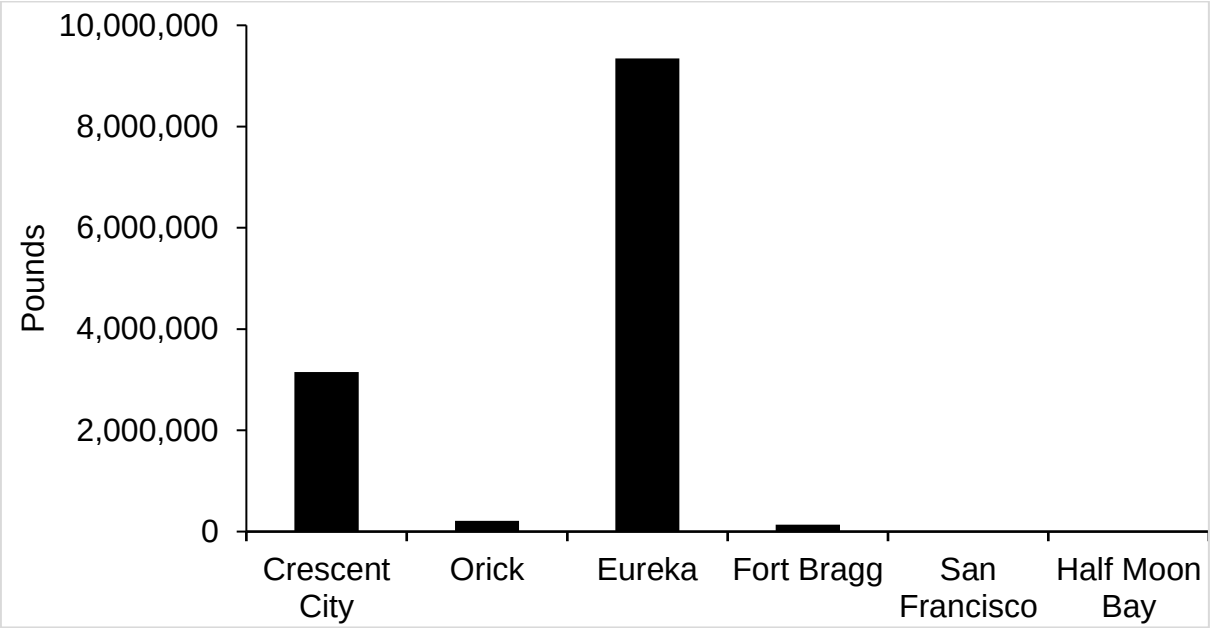


Figure 2-2. Cumulative commercial Night Smelt landings by port from 1980 to 2017. Source: CDFW Marine Landings Database System (MLDS).

2.2 Fishing Effort

There are no estimates of commercial or recreational fishing effort for the Night Smelt fishery other than the number of commercial fishermen submitting landing receipts each year (see below); vessels are not used, fishing logs are not required, and fishing occurs, primarily, during darkness. Although Department enforcement staff routinely patrol beaches during nighttime hours, biological staff do not normally conduct angler/fishermen interviews at night due to personal safety issues. Commercial landings are tracked; however, there are no records of unsuccessful fishing trips or hours spent scouting.

2.2.1 *Number of Vessels and Participants Over Time*

The number of commercial Night Smelt fishermen have declined over time. Based on fish receipt data from 1988 to 2017, the number of participants peaked in 1996 at 517, followed by a precipitous decline. Since 2001 the number of participants has been relatively low, with as few as 15 in 2007 (Figure 2-3).

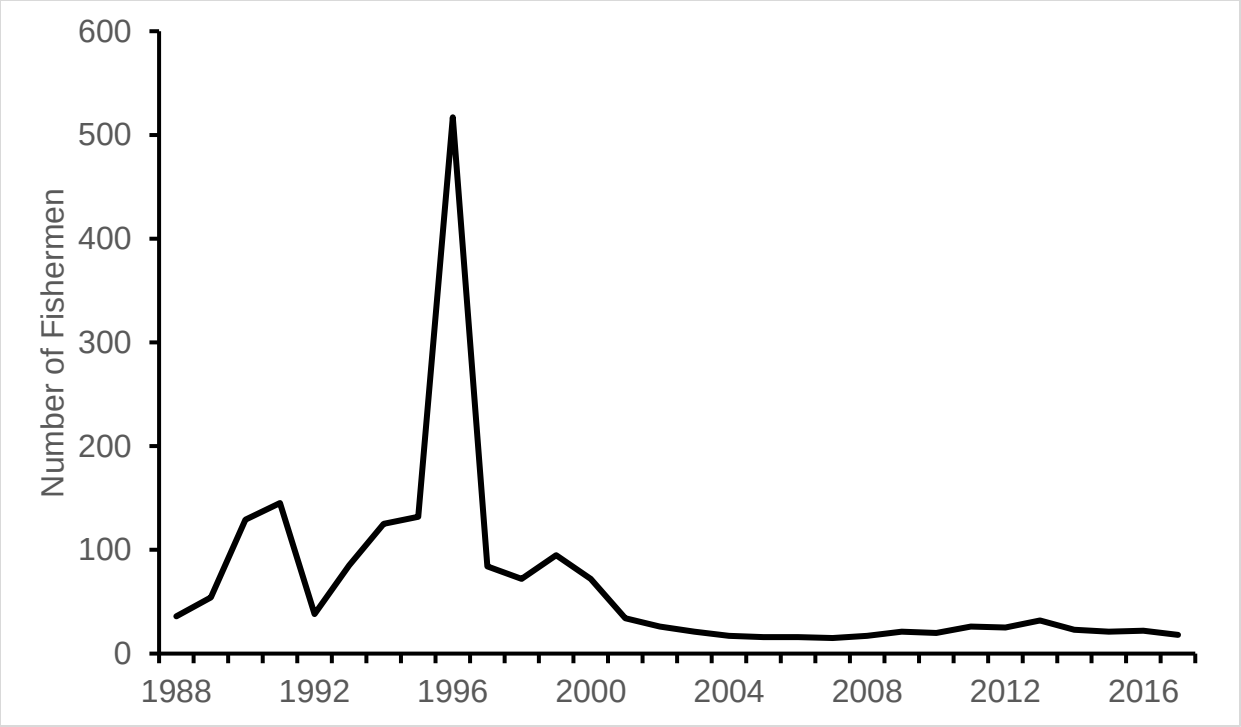


Figure 2-3. Number of commercial Night Smelt fishermen statewide from 1988 to 2017. Source: CDFW.

Historically, the number of commercial fishermen fluctuated with changes in regulations in other fisheries, for example, closures for gill net rockfish (1992) and salmon (2003), when fishermen looked to alternative fisheries for sources of income (Leet and others 2001). Due to the shore-based nature of the fishery and the night time as well as tide-related availability of Night Smelt, the expectation of limited landings is a disincentive for many commercial fishermen. Most fishermen were part-time participants who fished to supplement their income, fished as the tide and conditions allowed, or fished seasonally when fish were more abundant and available. Following the 1996 “boom” when effort spiked, participation gradually declined primarily due to attrition as fishermen left the fishery for economic reasons. This in turn was partly due to a significant increase in license fees in the early 1990s.

2.2.2 Type, Amount, and Selectivity of Gear

Commercial and sport fishermen use similar gear to take Night Smelt. A-frame dip nets are used throughout both fisheries (Figure 2-4).

Figure 2-4. A-frame dip net. Photo credit: Kristine Lesyna CDFW.

A-frame are typically constructed of materials such as wood dowels, milled hardwood boards, and square aluminum bars. A crossbar is fitted for the user to lift the net with one hand while the other grasps the point of the “A.” The net frame is held in a “V” position, then lowered just behind a cresting wave, allowing smelt to push into the bag of the net. The fisherman, depending on the steepness of the slope, may reposition the net to catch fish heading back to sea (Department unpublished information). Two person “jump” nets or beach seines, and Hawaiian throw or cast nets are used commonly for Surf Smelt rather than for Night Smelt, along the San Mateo County coast (Miller and Gotshall 1965).

2.3 Historical Landings in the Recreational and Commercial Sectors

2.3.1 *Recreational*

Recreational Night Smelt effort and catch are unknown. The recreational Night Smelt fishery occurred historically from Moss Landing to the Oregon border (Miller and

Gotshall 1965). Miller and Gotshall (1965) surveyed surf netting activities from 1957 to 1959 and observed Night Smelt taken from Smith River beach, Del Norte County to Scott Creek beach, Santa Cruz County. They estimated 5,140 net-days (fishermen effort) in 1958 at Luffenholtz Beach, Trinidad and only 100 net-days the following year. They also conducted instantaneous day time counts of surf netters by airplane in 1957 and 1958 and calculated effort and landing estimates of Surf Smelt. however, no Night Smelt were landed at their sampling sites, Luffenholtz and Mad River Beach, during day time. At present, the Department's CRFS documents angler catch composition data based on angler interviews and sampled catches statewide; however, the Night Smelt fishery is primarily active during night time hours when fishermen are not interviewed due to personal safety policies for science staff.

2.3.2 *Commercial*

Commercial fishery landings data are available from 1916 to 2017. Prior to 1927, "smelt" landings included a combination of true smelt (Osmeridae) and silversides (Atherinidae)—see section 1.2.1. Since 1998, annual landings during most years have ranged between approximately 200,000 and 400,000 pounds (lb) (89.3 to 178.6 metric tons (mt)). Commercial statewide Night Smelt landings in 2017 totaled 288,028 lb (130.6 mt) with an ex-vessel value of $187,335.

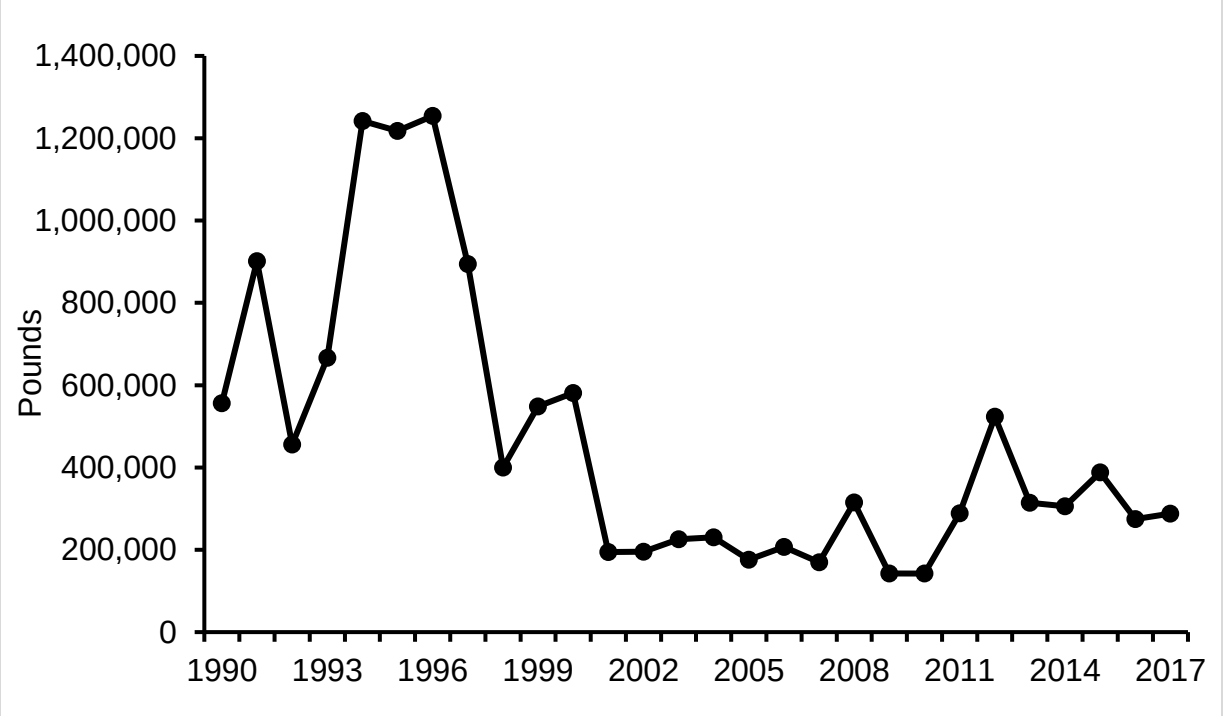


Figure 2-5. Commercial Night Smelt landings in California: 1990 to 2017. Source: CDFW MLDS.

2.4 Social and Economic Factors Related to the Fishery

The average statewide ex-vessel price for unprocessed whole Night Smelt in 2017 was $0.55 per pound. Ex-vessel prices fluctuated between 1980 and 2003 and have increased significantly since then (Figure 2-6).

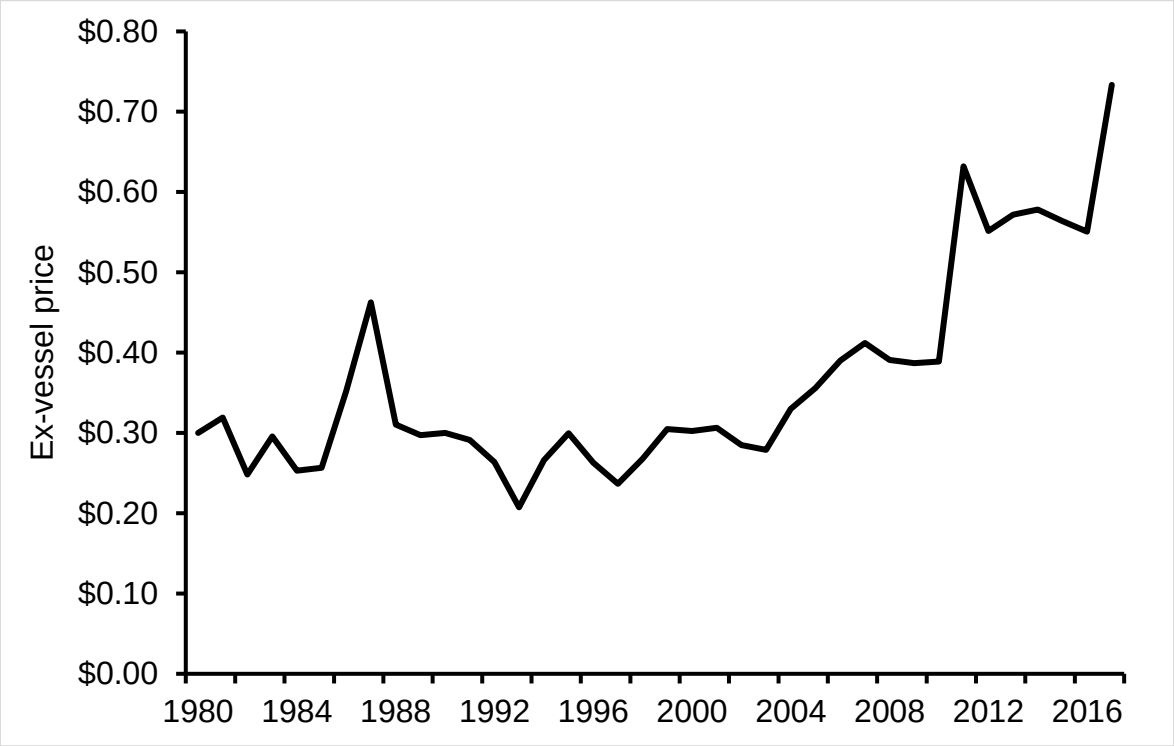


Figure 2-6. Ex-vessel pricing for Night Smelt. Data source: CDFW MLDS.

The commercial Night Smelt as well as other surf fisheries—Barred and Redtail Surfperch, have become artisanal over time. Less than 20 fishermen landed Night Smelt in 2017 compared to approximately 120 statewide in 1996. Interest in the fishery waned for some fishermen who entered the fishery after becoming displaced due to regulatory changes resulting in fishery closures. Others purchased commercial licenses prior to the mid-1990s when license fees increased from $50 to $90 in 1992 and again to $96.50 in 2004 and may have left commercial fishing for economic reasons. Some commercial fishermen were recreational anglers who also purchased commercial licenses which authorize them to switch to commercial fishing and sell their catch. Unlike boat-based fisheries, the landings of shore-bound sandy beach fishermen are limited to beaches that can be accessed by four-wheel drive vehicles or offered good catch rates within reasonable hiking distance of vehicles. Vehicle usage within the Night Smelt range are restricted to select beaches in Sonoma, Mendocino, Humboldt, and Del Norte counties.

Shore based fisheries require relatively little capital for participation and gear. Expenses are low relative to boat-based fisheries. Commercial osmerid fishermen often

are equipped identically to recreational angler—using A-frame nets that may/or may not be larger in size. Most commercial fishermen live within the county that they fish and sell their catch to local fish buyers in recent years, primarily in Eureka. San Mateo County fishermen sell their catch to buyers in San Francisco and/or Sausalito.

3 Management

3.1 Current Management Measures

Osmerids are managed solely by the Department. The California State Legislature adopted Fish and Game Code (FGC) §8395 which authorized the California Fish and Game Commission (Commission) to adopt regulations for managing the Night Smelt resource and commercial fisheries. Below, is a list of regulatory measures in the California Code of Regulations (CCR) Title 14:

- CCR Title 14 § 1.42—limits the greatest dimension of a dip net to 6 ft, excluding the handle
- CCR Title 14 § 28.45—established a 25-lb recreational limit in the aggregate for Surf Smelt (Night Smelt, Day Fish, Whitebait Smelt). “Day Fish” is the colloquial name for Surf Smelt .
- CCR Title 14 § 28.80—authorizes the use of dip nets, baited hoop nets, and Hawaiian throw nets, and specifies the dimensions of hoop nets
- CCR Title 14 § 28.85—authorizes the use and specifies the dimensions of beach nets north of Point Conception for taking smelt (Surf, Night, and Whitebait).
- CCR Title 14 § 111—conforms with Federal regulations, Title 50, Code of Federal Regulations, Part 600.745, which prevents the development of new large-scale directed commercial fisheries for designated forage fish species (including Osmeridae). It limits the take of designated forage fish species or species groups from “directed commercial fishing” vessels to 10 metric tons per trip and 30 metric tons per calendar year and does not apply to shore-based fisheries.

3.1.1 *Overview and Rationale for the Current Management Framework*

Historically, Night Smelt fisheries were not actively managed, closely monitored, or studied (H. T. Harvey and Associates 2015). Management measures were limited to gear specifications and marine protected area (MPA) closures prior to the implementation of CCR Title 14 § 111—see above. The commercial fishery is open access, and there are no catch limitations or seasonal closures for this shore-based fishery.

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

Currently, there are no criteria in place to identify when Night Smelt fisheries are "overfished" or in decline. Aside from commercial landing receipts, there are no other available datasets to evaluate the status of Night Smelt in California. Small, short-lived, pelagic fishes such as sardine and anchovy, are prone to fluctuations in abundance whether they are fished or not, and despite the implementation of precautionary management strategies (McClatchie and others 2018). Night Smelt are short-lived, mature at 2 yr, and have the capability to rebound quickly when environmental conditions are favorable (Slama 1994).

3.1.1.2 *Past and Current Stakeholder Involvement*

As part of the Office of Administrative Law's (OAL) rulemaking process, fishing regulations, recreational and commercial, are adopted pursuant to the Administrative Procedures Act (APA). New regulations and regulation change proposals are submitted to the Commission by interested parties which include the public, agencies, and stakeholders. Regulation change proposals may be submitted to the FGC by email, hard copy mail, oral testimony, or by letter at public meetings and scoping sessions. Interested parties notified by the Commission can review and comment on regulation proposals. https://oal.ca.gov/rulemaking_process/regular_rulemaking_process/

Stakeholders, such as the California Commercial Beach Fishermen's Association, have collaborated with the Department in conducting limited-term studies collecting field data on Night Smelt (H. T. Harvey and Associates and others 2015).

3.1.2 *Target Species*

3.1.2.1 *Limitations on Fishing for Target Species*

Aside from the directed Department fisheries conservation measures described below, the ability to access beaches with motorized vehicles impacts commercial fishermen. Fishermen using vehicles on specific beaches are required to have a vehicle use and/or parking permit issued by a jurisdictional agency such as California Department of Parks and Recreation (DPR) and Redwood National Park. Off-road vehicle access by motorized vehicles on sandy beaches is extremely limited. With few exceptions, e.g., Oceano Dunes (San Luis Obispo County), beaches with motorized vehicle access are located within Sonoma to Del Norte counties. As a result, recreational fishing effort tends to be concentrated near vehicle parking areas, leaving remote stretches of beach less impacted by human activities, including fishing, or on beaches where vehicle access and commercial fishing are authorized.

The lack of motorized vehicle access also self-restricts landings to what recreational and non-permitted commercial fishermen are willing to carry or cart to their vehicles. DPR and the National Park Service (NPS) restrict and cap the number of

vehicle access permits issued as well as the beaches authorized for their use within Humboldt and Del Norte counties.

Other factors limiting take of Night Smelt include:

- Commercial and recreational fishermen do not target Night Smelt during daylight hours.
- Market demand is limited.
- Surf, weather, and tide conditions constrains fishing effort.
- Night Smelt abundance changes seasonally.
- Private property and de facto MPAs restrict fishermen access.
- Night Smelt gear, e.g., A-frame nets, are custom-made and not widely available.
- Locating smelt schools is limited to eyesight, using spotlights to see fish tumbling in the wash, or systematically sampling while covering stretches of beach.

3.1.2.1.1 *Catch*

The existing commercial fishery is shore-based and exempt from landing limits imposed by 14 CCR § 111 (b)(2)(A) and (B) which limits boat-based targeted fisheries for osmerids to 10 mt per day and 30 mt per annum. Recreational fishermen are limited to 25 lb per day, and 25 lb in possession, of “Surf Smelt” which includes Night, Surf, and Whitebait Smelt in the aggregate (14 CCR § 28.45).

3.1.2.1.2 *Effort*

There are no statutes or regulations limiting the number of commercial fishery participants; however, vehicle access permits are issued to a limited number of fishermen by Department of Parks and Recreation and National Park Service for beaches where the fishery operates (H.T. Harvey and Associates and others 2015).

3.1.2.1.3 *Gear*

The primary gear used by commercial and recreational fishermen to take Night Smelt are A or V-frame dip nets (Bonnott 1930; Kroeber and Barrett 1960; Miller and Gotshall 1965).

3.1.2.1.4 *Time*

There are no regulatory time constraints on taking Night Smelt; however, Night Smelt appear in the surf during their spawning season from January to September, during dusk to night time hours.

3.1.2.1.5 *Sex*

It is not possible to determine the sex of Night Smelt externally—both sexes may be taken

3.1.2.1.6 *Size*

There are no size restrictions for Night Smelt.

3.1.2.1.7 *Area*

There are no area closures, other than specified MPAs, prohibiting taking Night Smelt.

3.1.2.1.8 *Marine Protected Areas*

Pursuant to the mandates of the Marine Life Protection Act (Fish and Game Code §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.

Even though the use of MPAs as a fishery management tool was not one of the primary goals of the Marine Life Protection Act, they function as one for the following reasons: they serve as permanent spatial closures to fishing if the species of interest is within their boundaries and is prohibited from harvest. 2) they function as comparisons to fished areas for relative abundance and length or age/frequency of the targeted species; 3) they serve as ecosystem indicators for species associated with the target species, either as prey, predator, or competitor, and; 4) many of the MPAs served to displace fishing effort when they were implemented.

Although the network was not designed specifically to protect Night Smelt, many MPAs have significant amounts of their preferred habitat—shallow subtidal open-coast soft bottom. Table 3-1 lists MPAs from north to south that may contain Night Smelt spawning habitat.

Table 3-1. Marine Protected Areas listed north to south within the Night Smelt range containing potential habitat.

Marine Protected Areas	County
Pyramid Point State Marine Conservation Area (SMCA)	Del Norte
Reading Rock SMCA	Humboldt
Samoa SMCA	Humboldt
South Cape Mendocino State Marine Reserve (SMR)	Mendocino
Sea Lion Gulch SMR	Mendocino
Double Cone Rock SMCA	Mendocino
Ten Mile SMR	Mendocino
Ten Mile Beach SMCA	Mendocino

Ten Mile Estuary SMCA	Mendocino
Navarro River Estuary SMCA	Mendocino
Russian River State Marine Recreational Management Area (SMRMA)	Sonoma
Russian River SMCA	Sonoma
Estero Americano SMRMA	Sonoma
Estero de San Antonio SMRMA	Marin
Point Reyes SMR	Marin
Estero de Limantour SMR	Marin
Drakes Estero SMCA	Marin
Pillar Point SMCA	San Mateo
Año Nuevo SMR	Santa Cruz
Natural Bridges SMR	Santa Cruz
Elkhorn Slough SMR	Monterey

3.1.2.2 *Description of and Rationale for any Restricted Access Approach*

The commercial and recreational fishery are open access.

3.1.3 *Bycatch*

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," 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.

Bycatch in the Night Smelt catch included Redtail Surfperch, Shiner Perch (*Cymatogaster aggregata)*, and steelhead (*Salmo gairdnerii)* (H. T. Harvey and Associates and others 2015).

3.1.3.1 *Amount and Type of Bycatch (Including Discards)*

There are limited data on Night Smelt fishery bycatch. Miller and Gotshall (1965) observed Night Smelt fishermen for three nights at Mad River Beach, Humboldt County. They determined that 99% of the catch was composed of Night Smelt. Bycatch species consisted of Surf Smelt, Pacific Herring, and Redtail Surfperch.

H. T. Harvey and Associates and others (2015) also observed limited bycatch. In subsamples of commercially harvested Night Smelt, five Redtail Surfperch were documented. During an FIS, one Shiner Perch and one steelhead smolt were documented (both fish were released alive). The catches of Shiner Perch and Steelhead were considered unprecedented catches by commercial fishermen. The authors theorized that these catches were due to fishing in proximity to a creek mouth.

The southern distinct population segment of Eulachon is listed as Threatened under the Endangered Species Act. Eulachon are reported to be rare in Mad River,

Redwood Creek and the Klamath River (Sweetnam and others 2001, Moyle 2002); no Eulachon were observed in fisheries independent or dependent catches (Miller and Gotshall 1965; H. T. Harvey and Associates and others 2015, Nielsen and others 2017). Longfin Smelt is listed as threatened under the California Endangered Species Act in 2009; however, federal listing was considered but precluded.
https://www.wildlife.ca.gov/Conservation/Fishes/Longfin-Smelt
Longfin Smelt are primarily an estuarine species and unlikely caught by the Night Smelt fisheries from shore (H. T. Harvey and Associates and others 2015).

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

Bycatch in the Night Smelt fishery with traditional A- or V-frame dip nets and cast or throw nets is reported low (H.T. Harvey and Associates and others 2017; Slama 1994; Miller and Gotshall 1965; CDFW unpublished data). Based on existing data, there are no compelling reasons to implement measures to further reduce low levels of bycatch in the Night Smelt fisheries.

As described in Section 1.1.1, Night Smelt may have appeared as bycatch in the Pink Shrimp (*Pandalus jordani),* fishery; however, Osmerids were not identified to species in samples (Hannah and Jones 2007).

3.1.4 *Habitat*

3.1.4.1 *Description of Threats*

To identify specific threats to Night Smelt habitat, it is essential to examine historic and contemporary distribution information within their range (Garwood 2017) and evaluate potential proximal habitat threats. If site data exist, such as for Gold Bluffs beach, specific threats may be known. Generally, very little is known of Night Smelt habitat beyond contemporary sandy beach spawning locations associated with commercial and recreational fishing activity from Moss Landing (Monterey County) to the Oregon-California border (Miller and Gotshall 1965; H.T. Harvey and Associates and others 2015; CDFW unpublished data). Osmerids were noted as bycatch in the Ocean Shrimp trawl fishery operating off the northern California coast in 230 to 643 ft (70196 m) off Pt. Blanco in May to September 1995 (Hannah and Jones 2007).

Potential threats to Night Smelt spawning ground habitat include erosion, mechanical compaction of spawning substrate, beach development, lagoon breaches and resulting discharges, and pollution—chemical, suspended material, and thermal sources (Squire 1992; Leet and others 2001). Threats to continental shelf habitat are not well known. El Niño events have been linked to displacement of species to cooler water and to sources of forage and have contributed to collapses of pelagic fisheries (Radovich 1961; Fieldler and others 1986;Tegner and Dayton 1987). Harmful algal blooms (HAB) have caused temporary closures of fisheries as well as fish kills (Anderson and others 2000; Jester and others 2009).

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

No measures are to minimize any adverse effects on habitat caused by fishing. A- or V-frame dip nets (Figure 2-4) must contact the substrate while fishing. The net frame is positioned downward with the tips of the net frame in contact with the sand—the netting composing the "bag" of the net is left trailing to the side of the fisherman (Figure 3-1). When the frame is lifted with the tips of the net frame above the horizon, the fish tumble down toward the bottom end of the bag. Contact of the net and frame is brief, and impacts are short-term and temporary.

Figure 3-1. Night Smelt sampling with an V-frame dip net in Pacifica, California. Photo credit: Kristine Lesyna CDFW.

3.2 Requirements for Person or Vessel Permits and Reasonable Fees

The mission of the Department is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. The Department is charged with the administration and enforcement of the FGC and Title 14. Most of the revenue for the Department comes from the Fish and Wildlife Preservation Fund, with a limited amount from other sources (General Fund, Sport Fish Restoration Act, Environmental License Plate Fund, and grants). The Fish and Wildlife Preservation Fund is supported by the

sale of sport fishing and hunting licenses, commercial licenses, fish landing taxes, and fines and penalties assessed for violation of Fish and Wildlife laws. Table 3-3 lists the relevant licenses for individuals required to take and/or sell Night Smelt for commercial purposes.

Table 3-2. Commercial license and permit fees related to the Night Smelt fishery: April 1, 2018 to March 31, 2019.

Title	Fee	Description
Resident Commercial Fishing License	$141.11	Required for any resident 16 years 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.
Nonresident Commercial Fishing License	$417.75	Required for any nonresident 16 years 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.
Fish Receiver's License	$798.25	Any person who purchases or receives fish for commercial purposes from a commercial fisherman not licensed as a fish receiver must obtain a Fish Receiver's License.
Fisherman's Retail License	$101.97	A commercial fisherman is required to have this license only if he/she sells all or a portion of his/her catch to ultimate consumers.
Fish Wholesaler's License	$541.50	Any person who, for the purpose of resale to persons other than the ultimate consumer, purchases or obtains fish from a person licensed to engage in the activities of a fish receiver, fish processor, fish importer or fish wholesaler, is required to obtain a Fish Wholesaler's License.
Fish Processor's License	$798.25	Any person who processes fish for profit and who sells to other than the ultimate consumer must obtain a Fish Processor's License.

A total of $1,354 of revenue was generated by 2017 commercial fish landing taxes for Night Smelt based on the current tax rate of $0.0047 per pound.

An undetermined proportion of recreational fishing revenue contributes to Night Smelt fisheries since recreational licenses fees are not species specific. Recreational license fees vary based on residency and term of the license selected, e.g., annual or single/multiple day, or lifetime (Table 3-4).

Table 3-3. Recreational license fees related to the surfperch fishery: April 1, 2018 to March 31, 2019.

Title	Fee	Description
Resident Sport Fishing	$48.34	Available for any resident 16 years of age or older.
Nonresident Sport Fishing	$130.42	Available for any non-resident 16 years of age or older.

Reduced-Fee Sport Fishing License - Disabled Veteran	$7.21 at CDFW Offices $7.56 from license agents	Available for any resident or nonresident honorably discharged disabled veteran with a 50 percent or greater service-connected disability. After you prequalify for your first Disabled Veteran Reduced Fee Sport Fishing License, you can purchase disabled veteran licenses anywhere licenses are sold.
Reduced-Fee Sport Fishing License – Recovering Service Member	$7.21	Available for any recovering service member of the US military. The Recovering Service Member Reduced-Fee Sport Fishing License is only available at CDFW License Sales Offices.
Reduced Fee Sport Fishing License - Low Income Senior	$7.21	Available for low-income California residents, 65 years of age and older, who meet the specified annual income requirements. The Reduced-Fee Sport Fishing License for Low Income Seniors is only available at CDFW License Sales Offices.
Free Sport Fishing License - Low Income Native American	NO FEE	Available for any American Indian or lineal descendant whose household income does not exceed federal poverty guidelines. The Free Sport Fishing License for Low Income Native Americans is only available at CDFW License Sales Offices.
One-day Sport Fishing License	$15.69	Allows a resident or nonresident to fish for one specified day. One-day sport fishing licenses are exempt from the Ocean Enhancement Validation requirement.
Two-day Sport Fishing License	$24.33	Allows a resident or nonresident to fish for two consecutive days. Two-day sport fishing licenses are exempt from the Ocean Enhancement Validation requirement.
Ten-day Nonresident Sport Fishing License	$48.34	Allows a nonresident to fish for ten consecutive days.
Lifetime Ages 0-9 Ages 10-39 Ages 40-61 Ages 62+	 $533.25 $871.25 $785.00 $533.25	Available to residents of California. Lifetime fishing licensees receive an annual sport fishing license each year for life. Lifetime Fishing Packages must first be purchased from a CDFW License Sales Office. See Lifetime License Information for more detail.

4 Monitoring and Essential Fishery Information

4.1 Description of Relevant Essential Fishery Information

FGC §93 defines essential fishery Information (EFI) as “information about fish life history and habitat requirements; the status and trends of fish populations, fishing effort, and catch levels; fishery effects on age structure and on other marine living resources and users, and any other information related to the biology of a fish species or to taking in the fishery that is necessary to permit fisheries to be managed according to the requirements of this code.”

Habitat-related monitoring is conducted by NOAA’s Pacific Fisheries Environmental Laboratory (PFEL) https://www.pfeg.noaa.gov/pfel/about_pfel.html) and provides data products and environmental forecasts to fishery managers. This information has been used to development changes in regulations and quota adjustments for other fisheries managed by the Department, for example, Pacific Herring.

Coastal water quality is monitored by local and state agencies. The California Department of Public Health Phytoplankton Monitoring Program coordinates volunteers to collect water samples for laboratory analysis to detect levels of toxic phytoplankton, e.g., *Pseudo-nitzschia* https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/Shellfish/Phytoplankton-Monitoring-Program.aspx). Coastal pelagic species fisheries were closed temporarily due to elevated domoic acid concentrations in Northern Anchovy (*Engraulis mordax),* and Pacific Sardine. Although Night Smelt are not currently included in domoic acid testing, they are readily available for analysis on the north coast when other routinely sampled fisheries, e.g., Northern Anchovy and Pacific Sardine, are inactive or closed.

Beaches are occasionally closed due to contamination issues or due to chemical spills. County Departments of Health Services, for example, in Monterey County, sample beach water monthly to monitor levels of biological contaminants and pollutants to prevent the public from contracting waterborne diseases. As a result, fishing access to beaches may be impaired or prohibited within affected areas. Persistent unfavorable water conditions, e.g., “red tide”, may hinder fishing success but also cause fishermen to avoid impacted locations and shift effort to other beaches where conditions a favorable (CDFW unpublished data).

4.2 Past and Ongoing Monitoring of the Fishery

4.2.1 *Fishery-dependent Data Collection*

At present, monitoring of the commercial Night Smelt fishery by Department fishery managers and enforcement officers consists solely of analysis of landing receipts, which are state-issued sales receipts, also referred to as “fish tickets.” Landing receipt data are analyzed on a weekly basis to evaluate the fishery for current effort and participation. Parameters include weight of the finfish landed by market category

(general groupings of fish that may or may not be species specific), price paid to the fisherman by market category, date the fish were landed, type of gear used to harvest the fish, port of landing, and general location where the fish was harvested. Landing receipts are entered into the MLDS database which is queried for Night Smelt landings monthly by Department staff and analyzed for CPUE and amount landed.

Historically, recreational angler surveys were conducted by the Department. A recreational fisherman survey conducted by the Department (Miller and Gotshall 1965) documented catch and/or effort on beaches from the Oregon border to Point Arguello, Santa Barbara County. The multi-state Marine Recreational Fisheries Statistics Survey (MRFSS) and now the CRFS have conducted recreational angler interviews since 1980, with some interruptions of the shore-based sampling. CRFS collects data on species composition, length, weight, and sex, when possible, from beach surveys (as well as other fishing modes) statewide. However, due to fishermen targeting Night Smelt solely during night time hours, Night Smelt catch and effort have not been documented in MRFSS/CRFS surveys.

H. T. Harvey and Associates and others (2015) collected fisheries dependent in in 2014 in Humboldt and Del Norte counties: "The goals of the study were: (1) to provide baseline life history information including size and age structure, sex ratio, and length-to-weight relationships, (2) to evaluate changes in these life history parameters over the course of a fishing season, and across the spatial extent of the night smelt fishing grounds in northern California, (3) to characterize the physical aspects of night smelt spawning habitat, and (4) to provide a bycatch assessment of the 2014 night smelt harvest in Humboldt and Del Norte counties."

4.2.2 *Fishery-independent Data Collection*

The Department conducted several FIS using recreational A-frame nets on San Mateo County beaches in 2015 and 2016. The goal was to collect life history information at the southern end of their range and document spawning locations. Data In addition to collecting fisheries dependent data, H. T. Harvey and Associates and other (2015) conducted FIS at Luffenholtz Beach, Humboldt County.

5 Future Management Needs and Directions

5.1 Identification of Information Gaps

Identifying, obtaining, and maintaining EFI data are vital to staff conducting assessments on fish stocks from fishery dependent and independent sources. The primary goal is to develop appropriate measures to ensure resource sustainability. Existing information gaps include:

- Recreational fishery EFI
- Species identification of embryos
- Movement and distribution of larval and pre-spawning adults
- Responses to changes in environmental conditions
- Population age structure
- Impacts of harmful algal blooms

These information gaps and their priority for management are summarized in Table 5-1 and further described below.

Table 5-1. Informational needs for Night Smelt and their priority for management.

Type of information	Priority for management	How essential fishery information would support future management
Recreational fishery EFI	High	Contemporary information on location, effort, and take. Life history information such as age at first maturity age composition, would inform assessment of status of stocks.
Species identification of embryos and larvae	High	Distinguishing Night Smelt from Surf Smelt embryos and larvae would allow relative levels of annual recruitment to be determined.
Movement and distribution of larvae and pre-spawning adults	Medium	This information could assist with estimating fishery impact, if any, to the immature portion of the fished population.
Response to changes in environmental conditions	Medium	Management can be better informed if it was known that stocks respond to oceanic regime shifts by being unavailable to the fishery at times.
Population age structure	Medium	Knowing if the fished population is comprised of a single or multiple age classes will allow an estimate of fishing mortality.

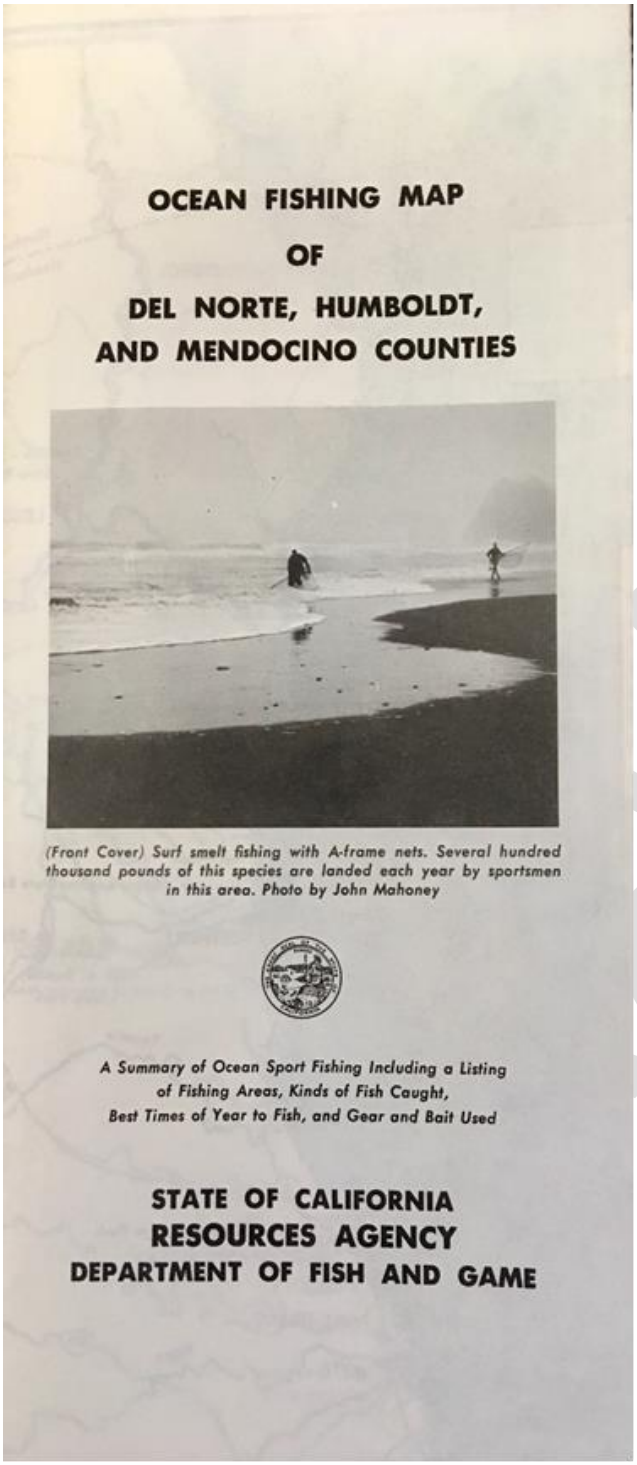
5.2 Research and Monitoring

5.2.1 *Potential Strategies to Fill Information Gaps*

5.2.1.1 *Recreational Fishery and FIS*

The primary information gap regarding the Night Smelt fishery is EFI data on the contemporary recreational fishery. MRFSS and CRFS do not sample night time fishermen due to safety issues. To manage the Night Smelt fishery appropriately, collecting EFI relevant to the recreational fishery is vital. A comprehensive night time fisherman survey conducted along beaches from Monterey to Del Norte counties in combination with a FIS to collect life history data, e.g., age structures, could fill existing knowledge voids identified by prior work (Slama 1994, H. T. Harvey and Associates and others 2015).

Locations identified in Table 1-1 could be used as starting points for initial sampling sites. The beaches were fished historically for Night and Surf Smelt and identified from a series of Ocean Fishing Maps printed by the Department in the 1960s (Figure 5-1). Data collected by the Northern California Marine Sport Fish Survey, a Dingell-Johnson Federal Aid project, conducted from 1957 to 1962 was used in their production (Miller and Gotshall 1965). These locations could be evaluated as potential study sites for future studies while providing data from areas that have not been fished for many years. See section 5.2.2.2.



OCEAN FISHING MAP

OF

DEL NORTE, HUMBOLDT,
AND MENDOCINO COUNTIES

(Front Cover) Surf smelt fishing with A-frame nets. Several hundred thousand pounds of this species are landed each year by sportsmen in this area. Photo by John Mahoney

A Summary of Ocean Sport Fishing Including a Listing of Fishing Areas, Kinds of Fish Caught, Best Times of Year to Fish, and Gear and Bait Used

STATE OF CALIFORNIA
RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Figure 5-1. Historic Ocean Fishing Map of Del Norte, Humboldt, and Mendocino Counties.

5.2.1.2 *Species Identification of Embryos*

Since Night and Surf Smelt often spawn on the same beaches in California (Miller and Gotshall 1965; CDFW unpublished data), identifying the species for embryos collected in spawning ground surveys is critical to interpret sample data and identify important spawning habitat. Genetic identification of the embryos would enable positive identification of Night, Surf, and possibly Whitebait Smelt (Langness and others 2015). In Washington, open coast Osmerid spawning ground surveys were conducted in 2014 and 2015 (Langness and others 2014, Langness and others 2015); however, the embryos were not genetically identified.

5.2.1.3 *Movement and Distribution of Larval and Pre-spawning Adults*

Currently, little is known regarding movement of Night Smelt offshore. Osmerids have been identified as bycatch in the Pink Shrimp fishery off the Oregon coast (Hannah and Jones 2007) and were reported in research bottom trawls operated off Eureka over sandy bottom (Slama 1994). Coastal trawl abundance surveys could be used to determine seasonal migration patterns, capture samples for life history data analysis, and develop abundance indices provided samples are identified to the species level. Fisheries independent trawl surveys may provide important EFI for coastal spawning Night, Surf, Whitebait Smelt, and Eulachon.

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, 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.

5.2.2.1 *Response to changes in environmental conditions*

There are several areas relative to EFI collection for Night Smelt that the Department lacks capacity. As described previously, El Niño/La Niña events were thought to impact Night Smelt fisheries causing declines in commercial landings in Osmerids (Miller and Gotshall 1965). A large-scale tagging and recovery program of could be used to determine if Night Smelt distribution changes relative to water temperature, and develop an understanding of their seasonal movements. A partnership with stakeholders, non-government organizations, and researchers could entail assisting Department staff with tagging and recovery efforts and develop or adapting an existing mobile or online application to log tag returns and document catches as well as distribute information. However, the efficacy of marking and recapturing fish as small as Night Smelt requires determination. A Washington Department of Fish and Wildlife pilot study successfully marked and recaptured Surf Smelt using elastomeric tags (Dionne

2018). Dionne (2018) reported a 3-week survival rate of 92%. Night Smelt are significantly smaller in size than Surf Smelt and survival of tagged fish may be an issue.

5.2.2.2 *Population age structure*

Determination of Night Smelt age structure requires a broad geographical approach. The Department does not have staffing capacity to monitor all aspects of Night Smelt fisheries over their entire geographic range and, as previously stated, conducts no night monitoring. Counties in which night time sampling is needed are Del Norte, Humboldt, Mendocino, Sonoma, Marin, San Francisco, San Mateo, Santa Cruz, and Monterey. Current CRFS policies do not provide for samplers to work during night time hours. To address this issue, possible options include: undertake a short-term pilot study using Department staff in lieu of CRFS samplers to document take and effort data; develop an online night fishing survey program for fishermen to report their fishing location, effort, and catch on the Department recreational fishing report card website; identify funding to initiate a collaborative study to monitor Night Smelt fisheries and include collecting life history information, documenting and sampling the recreational fisheries (Nielsen and others 2017).

Determining population age structure Night Smelt were aged from scales (Slama 1994) and H.T. Harvey and Associates and others 2015 collected otoliths; however, scale and otolith annuli analyses have not been validated as ageing methods for Night Smelt (H. T. Harvey and Associates and others 2015). Current ageing techniques and technology can be evaluated and applied to determine ages of sampled fish including sectioning/polishing otoliths, captive age validation studies, and confocal laser microscopy.

5.3 Recommendations for any Management Changes

No further management changes are recommended at this time.

5.4 Climate Readiness

Historically, fluctuations in the Night Smelt commercial landings were attributed to “natural causes” (Miller and Gotshall 1965). Although Night Smelt commercial landings and average CPUE have generally increased since 2010, these values declined slightly in 2016 and 2017 (Figure 2-5). It is unclear if Night Smelt distribution shifted north with prevailing currents from the south in 2015 in response to El Niño (Radovich 1961), spawned on beaches that offered suitable habitat (Slama 1994), or declined in abundance. El Niño neutral or mild La Niña conditions occurred in 2017 and are forecasted for 2018, which may result in relatively stable oceanic conditions.

The Department monitors notices from various online sources including: NOAA’s PFEL https://www.pfeg.noaa.gov/whats_new.html and the National Weather Service Climate Prediction Center http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml to increase awareness of imminent El Niño and La Niña events. The Department monitors the commercial fishery by analyzing landing receipts submitted by fish buyers monthly; this

may reflect possible environment changes affecting Night Smelt fisheries—both positive and negative.

It is unknown what impacts climate change will have on the ports of landing providing the infrastructure supporting the Night Smelt fishery. Night Smelt commercial fisheries are considered “artisanal” and relatively few fishermen land their fish daily. Since fishing is from shore and no vessels are required, these fishermen require less infrastructure, e.g., slips, fuel, ice, than other fisheries requiring vessels.

The Commission and the Department have the authority to adopt emergency regulations under the APA process https://oal.ca.gov/regulations/emergency_regulations/. If circumstances instigated by climate related changes evolve in the Night Smelt fishery to warrant emergency action, the APA process can be abbreviated and closures, for example, may be implemented relatively quickly.

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