Draft Conservation Plan for California's Commercial Dungeness Crab Fishery

December 2021 Draft

California Department of Fish and Wildlife

Marine Region

Table of Contents

CHAPTER 1. INTRODUCTION AND BACKGROUND

1.1 Background

The California Department of Fish and Wildlife (CDFW) has prepared this Conservation Plan (CP) to support its application for an Incidental Take Permit (ITP) under Section 10 of the federal Endangered Species Act (ESA). The ITP would provide authorization for limited incidental take of Covered Species by the California commercial Dungeness crab fishery. This CP describes a comprehensive strategy to monitor, minimize, and mitigate entanglements of certain ESA-listed whales and sea turtles in commercial Dungeness crab fishing gear off the coast of California.

Whale and sea turtle entanglements are reported to the National Marine Fisheries Service (NMFS) through either the West Coast Regional Office (WCRO) or the Southwest Fisheries Science Center (SWFSC). WCRO receives and confirms reports of large whale entanglements and tracks a variety of metrics associated with each large whale entanglement including location, gear type, timing, and response efforts. SWFSC is responsible for receiving and confirming reports of human interactions with sea turtles, which include but are not limited to entanglements. NMFS has confirmed 517 entanglements of large whales in fishing gear of various types off the United States West Coast (West Coast) between 1982 and 2020 (data from Saez et al. 2021), and 65 sea turtle fishery interactions between 1981 and 2020 (NMFS SWFSC Sea Turtle Stranding Database, shared April 27, 2021). Entanglement events in fixed gear (i.e., trap and gillnet fisheries) have been confirmed for blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae)*, killer whales (*Orcinus orca*), minke whales (*B. acutorostrata*), and sperm whales (*Physeter macrocephalus*) as well as leatherback sea turtles (*Dermochelys coriacea*). Fishery interactions have also been documented for green turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*), hawksbill turtles (*Eretmochelys imbricata*), and olive ridley turtles (*Lepidochelys olivacea*). Blue whales, fin whales, sperm whales, leatherback sea turtles, green turtles, loggerhead turtles, hawksbill turtles, and olive ridley turtles are protected under ESA throughout their range. Certain Distinct Population Segments (DPS) of humpback whales, killer whales, and gray whales are also protected under ESA (see Section 1.3.1).

The number of confirmed large whale entanglements off the West Coast (across all gear types) increased sharply in 2014, from an average of 8.2 per year from 1982–2013 to an average of 36 per year from 2014-2020 (data from Saez et al. 2021; Figure 1-1). While the number of confirmed entanglements has decreased from the highs of 53 and 56 in 2015 and 2016, respectively, entanglements in recent years still remain above pre-2014 levels (2018, n= 46; 2019, n = 25; 2020, n = 17). The increased number of entanglements is likely due to a combination of factors, including changes in the abundance and distribution of whales and forage, shifting patterns in human activities, and increased public awareness and reporting.

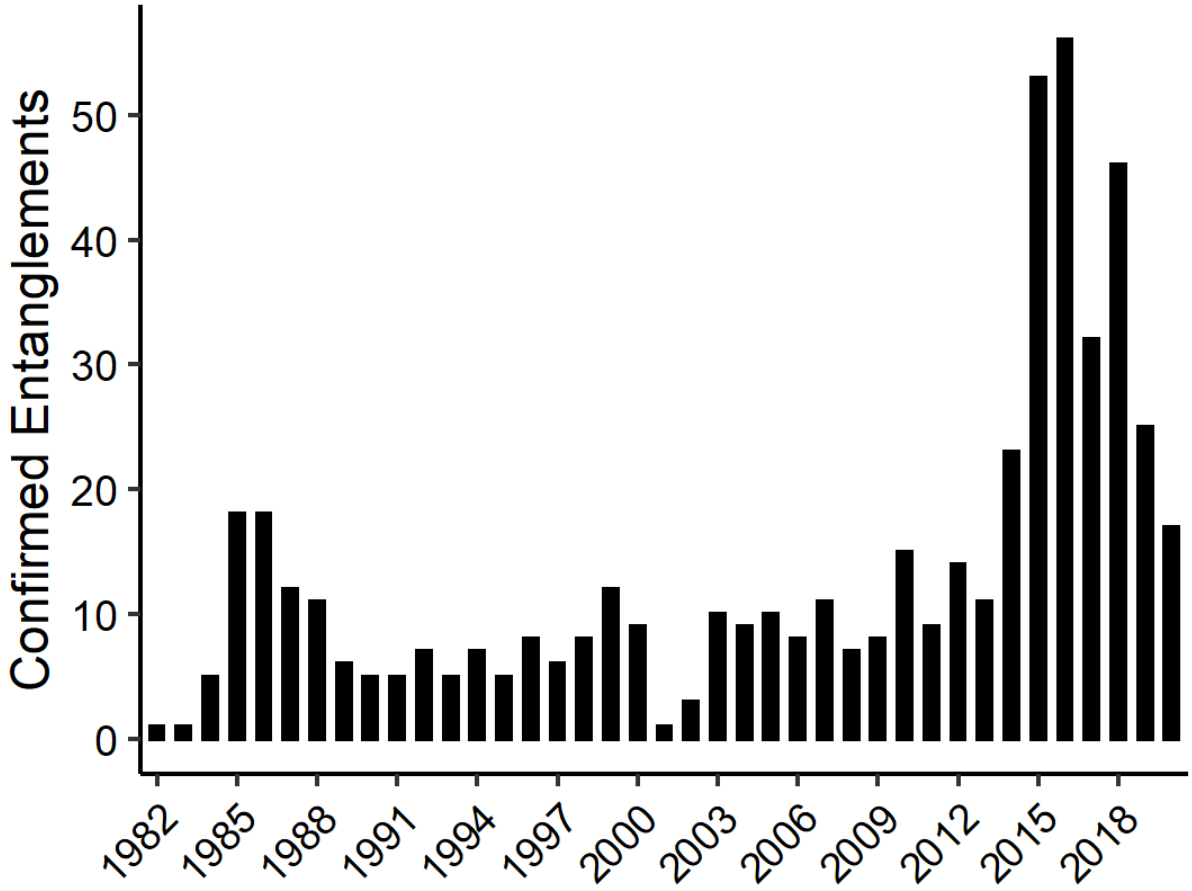

Figure 1-1. Annual number of confirmed large whale entanglement reports off the West Coast, 1982-2020. Created with data from Saez et al. 2021.

Reports of sea turtle interactions with fishing gear also increased during this period. Between 1981 and 2015, zero to three fishery interactions were reported each year. Reported interactions increased to seven in 2016 and 2017, and eight in 2018. However, the cause of this increase is not well understood. Reports declined during 2019 (n = 3) but increased again in 2020 (n = 7).

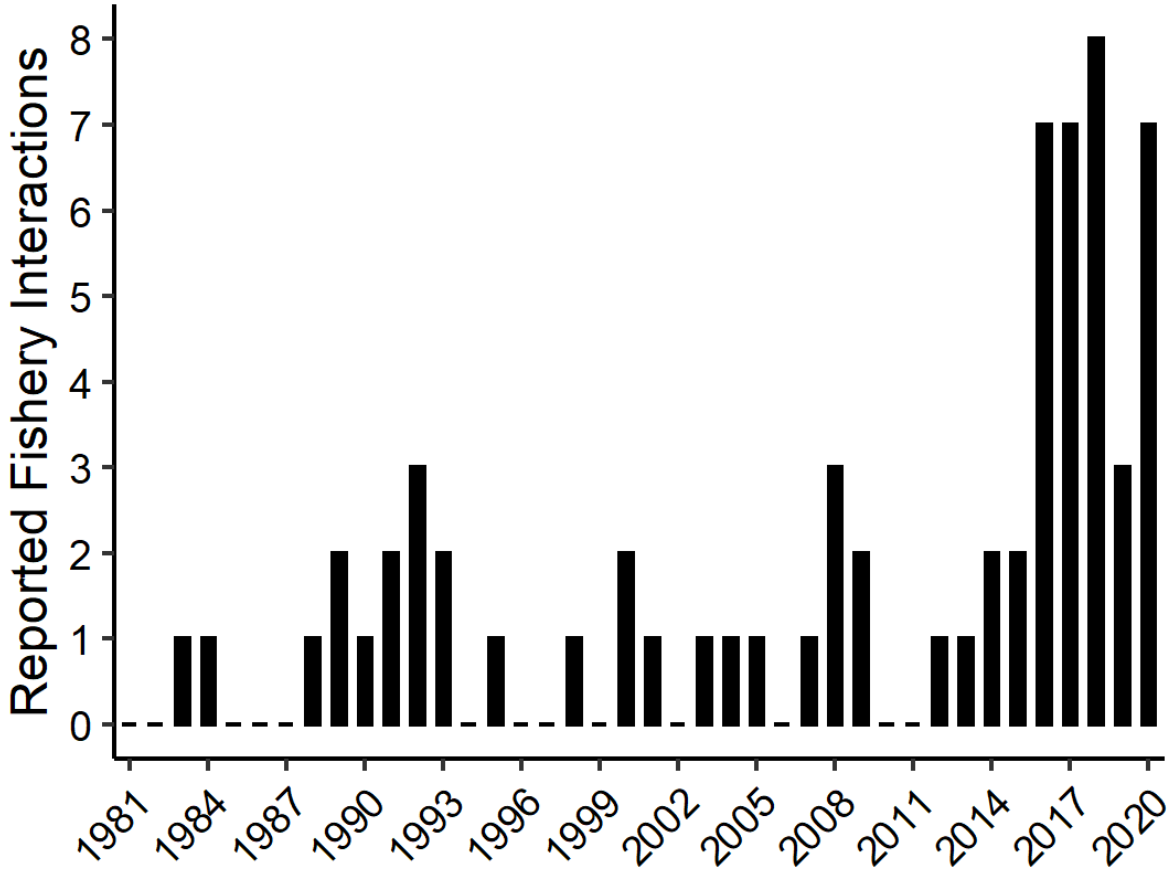

Figure 1-2. Annual number of reported fishery interactions with turtles off the West Coast, 1981-2020. Created with information from the NMFS SWFSC Sea Turtle Stranding Database, shared April 27, 2021.

Nearly half (44%) of confirmed West Coast large whale entanglements between 1982 and 2020 involved unknown gear types (data from Saez et al. 2021). Of the instances where gear can be identified (n = 290), about a third (n = 100, 34%) involved gillnet, a gear type used in multiple fisheries (including state managed, federally managed, and international fisheries adjacent to U.S. waters) targeting species such as white sea bass, swordfish, and salmon. In terms of gear which can be identified to a specific fishery, commercial Dungeness crab gear is the most common (n = 99, 34%), of which 60% (n = 59) involved gear set in California.

Compared to large whales, available information regarding fishery attribution is much more limited for sea turtles. Of the 65 reported fishery interactions between 1981 and 2020, nearly half (46%, n = 30) are reported as hook and line gear, and 18 (27%) don't have enough information to specify a gear category. The only two sea turtle interactions attributed to specific fisheries were both leatherback sea turtles; one in California rock crab gear (found dead), and one in California commercial Dungeness crab gear (released alive by the reporting fisherman).

1.2 ITP Applicant

CDFW is a state agency within California's executive branch and is the state trustee agency for fish and wildlife resources. CDFW is headed by a Director and personnel and functions are spread amongst a variety of offices, branches, divisions, programs, and regions. Key units

within CDFW whose scope of work includes marine life entanglement issues are briefly described below.

CDFW's Marine Region is responsible for protecting, maintaining, enhancing, and restoring California's marine ecosystems for their ecological values and their use and enjoyment by the public through good science and effective communication. Within the Marine Region, the Invertebrate Management Program oversees development and implementation of scientific and regulatory programs to assess and manage fisheries targeting invertebrate species (e.g., Dungeness crab) and their associated ecosystem impacts. The Marine Region's Pelagic Fisheries and Ecosystem Program oversees management issues related to sea turtles, including proposed listings under CESA. Because of the direct link to the Dungeness crab fishery, overseeing implementation of the CP will be one of the Invertebrate Management Program's primary responsibilities.

CDFW's Law Enforcement Division (LED) enforces regulations adopted by CDFW or the California Fish and Game Commission, as well as statutory mandates from the California Legislature. The Office of General Council (OGC) advises and reports to the Director on legal matters and provides in-house legal services to CDFW divisions and regions for, among other things, a variety of resource management and conservation issues. The Regulations Unit (RU) assists staff throughout CDFW with developing new and amended regulations in support of broader program goals. The Data and Technology Division (DTD) maintains CDFW's webpages and electronic databases, oversees IT equipment and software acquisitions, and manages CDFW's biogeographic data resources. The License and Revenue Branch (LRB) issues licenses and permits for recreational and commercial fishing activities, aquaculture, and scientific collection in support of educational and research projects. The Office of Communications, Education, and Outreach (OCEO) prepares and distributes press releases and other official CDFW communications regarding important actions by CDFW, including those affecting operations of commercial fisheries. Furthermore, administrative staff within each CDFW unit provide strategic support for essential functions such as procurement, contracts, and personnel management.

1.3 Regulatory Framework

Even though ESA establishes the fundamental regulatory framework for this CP, both state and other federal laws are relevant to the CP. These laws include the California Endangered Species Act (CESA), the Marine Mammal Protection Act (MMPA), the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), various provisions of the California Fish and Game Code (Fish & G. Code) and California Code of Regulations (Cal. Code Regs.), the California Administrative Procedure Act (California APA), and the Federal Administrative Procedure Act (Federal APA).

1.3.1 Endangered Species Act

ESA is the primary federal law that protects living resources at risk of extinction. The statute requires federal agencies to prevent additional declines in, and support recovery of, species that are listed under the act as either in danger of extinction throughout all or a significant portion of their range ("endangered") or as likely to become endangered in the foreseeable future ("threatened"). ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (Title 16, US Code (USC) Section 1532(16)).

Under Section 4 of ESA, NMFS is responsible for listing most marine species and designating critical habitat for the species that become listed. The agency is also responsible for monitoring and evaluating the status of listed species, as well as developing and implementing recovery plans for them. Section 9 includes a broad prohibition on take of listed species, which is defined to include activities which "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" a member of a species (16 USC § 1538).

For some species, such as blue whales, the entire species may be listed as endangered or threatened throughout its range under ESA. Other times, however, a subspecies or "distinct population segments (DPS)" of a species may be listed (16 USC § 1532 subdivision (subd.) (16)), as is the case with humpback whale, where only certain DPS are listed as threatened or endangered. A DPS designation is guided by the distinctness and significance of a population, as well as whether the population's status warrants listing under the standards of the statute (61 Federal Register (FR) 4722). Once a DPS has been listed as endangered or threatened, it is afforded the same protection as other listed species.

Section 10 provides a process to permit take of listed species incidental to otherwise lawful activities, such as commercial fisheries (16 USC § 1539 subd. (a)(1)(B)). To issue such a permit, NMFS requires a Section 10(a)(1)(B) application and a CP for the impacted species (16 USC § 1539 subd. (a)(2)). Accordingly, this CP will accompany a Section 10(a)(1)(B) permit application submitted to NMFS. A CP must discuss the following:

- The impact which will likely result from such taking
- What steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps
- What alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized
- Such other measures that NMFS may require as being necessary or appropriate for purposes of the plan

Before issuing an ITP under Section 10, NMFS must comply with the consultation requirements in Section 7 (16 USC § 1536 subds. (a) and (b)) to ensure issuing the permit will not jeopardize the continued existence of the listed species or result in the destruction or adverse modification of any designated critical habitat. In the case of marine mammals, the Secretary of Commerce must also evaluate whether the taking is authorized under Section 101(a)(5) of MMPA (16 USC § 1371 subd. (a)(5)) and any measures necessary to ensure such compliance (16 USC § 1536 subd. (b)(4)(C)).

1.3.2 California Endangered Species Act

CESA is the California counterpart to the federal ESA. CESA operates similarly to ESA by prohibiting the import, export, take, possession, purchase, and sale of species that are listed under the act as threatened or endangered (Fish & G. Code Section 2080). CESA contains provisions that allow CDFW to permit incidental take of listed species if certain conditions are met (Fish & G. Code § 2081 subd. (b)), as well as take for scientific, educational, or management purposes (Fish & G. Code § 2081 subd. (a)). In October 2021, the California Fish and Game Commission listed the leatherback sea turtle, which forages in California state waters, as an endangered species under CESA.

1.3.3 Marine Mammal Protection Act

MMPA establishes a national policy of preventing additional decline and supporting rebuilding and recovery of marine mammal populations. Under MMPA, NMFS is responsible for evaluating the status of marine mammal species and developing conservation plans for species or stocks designated as depleted (16 USC § 1383 subd. (b)), developing stock assessment reports to evaluate stock status (16 USC § 1386), coordinating responses to marine mammal standings and entanglements (16 USC §§ 1421 and 1421 subd. (b)), assessing mortality and serious injury of incidental anthropogenic interactions with marine mammals arising from commercial fisheries (16 USC § 1387), and issuing permits and authorizations for take of marine mammals (16 USC §§ 1373 and 1374).

MMPA generally prohibits "take" of marine mammals in US waters, which is defined as activities which "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 USC § 1362). The law also provides limited exemptions to the take prohibition by authorizing several types of take permits. Section 101(a)(5)(E) allows permitting for incidental take of certain stocks listed under ESA by commercial fishing vessels (16 USC § 1371 subd. (a)(5)(E)). To issue such a permit, the Secretary of Commerce must find, among other things, that the incidental mortality and serious injury from the permitted commercial fishing activity will have a "negligible impact" on protected marine mammals (16 USC § 1371 subd. (a)(5)(E)). The negligible impact standard is described further in Sections 4.3 and 4.3.1.

1.3.4 National Environmental Policy Act and California Environmental Quality Act

NEPA requires every federal agency to use all practicable means and measures to protect environmental values and makes environmental protection a part of its mandate (42 USC §§ 4321-4370 subd. (m-12)). The statute requires every federal agency to conduct a formal environmental analysis when taking an action that significantly affects the environment (42 USC § 4332).

CEQA is the California state counterpart to NEPA. CEQA generally requires state and local government agencies to inform decision makers and the public about the potential environmental impacts of proposed projects. CEQA also requires those agencies to reduce potentially significant impacts to a less than significant level, unless such mitigation or alternatives are infeasible (California Public Resources Code §§ 21000-21189.3). Information regarding the CEQA analysis for this CP will be made available on CDFW's Whale Safe Fisheries webpage.

1.3.5 California Fish and Game Code and California Code of Regulations

Primary management authority for the commercial Dungeness crab fishery rests with the California Legislature, which has enacted several statutes constraining allowable fishing activity. Certain statutes have expressly delegated authority for specific aspects of fishery management to CDFW, which has then adopted implementing regulations. Therefore, legislative statutes (codified in Fish & G. Code) and CDFW regulations (codified in Cal. Code Regs, Title 14 (Tit. 14)) jointly provide the management framework for this fishery.

The commercial Dungeness crab fishery in California is mainly regulated by Fish & G. Code §§ 8275 *et seq* and implementing regulations in Cal. Code Regs., Tit. 14 §§ 132.1-132.8. These provisions address season dates, a trap limit program, ability for delays of the fishery due to crab meat quality, and permitting structure. Some specific statutes and regulations that provide

relevant authority to CDFW and important context for understanding the construction of this CP are highlighted below:

- Fish & G. Code § 5523 authorizes CDFW to restrict the commercial take of Dungeness crab due to human health risks.
- Fish & G. Code § 8276.1 authorizes CDFW to restrict the commercial take of Dungeness crab due to the risk of marine life entanglement; with implementing regulations found in Cal. Code Regs., Tit. 14, § 132.8.
- Fish & G. Code § 8276.2 allows CDFW to delay the commercial Dungeness crab season in specified fishing districts when the quality of crab is poor.
- Fish & G. Code § 8276.5 prescribes the trap limits for commercial Dungeness crab vessel permit holders; with implementing regulations found in Cal. Code Regs., Tit. 14, §§ 132.1 and 132.2.
- Fish & G. Code § 8279.1 prohibits commercial Dungeness crab fishery participants from fishing in areas where openings are delayed either due to human health risks, poor crab meat quality, or entanglement risk for 30 days if these participants have already fished in other areas.
- Fish & G. Code § 9002.5 requires CDFW to develop a program that facilitates retrieval of lost and abandoned commercial crab traps following the end of the fishing season; with implementing regulations found in Cal. Code Regs., Tit. 14, § 132.7.
- Fish & G. Code § 9004 describes gear servicing requirements, specifically that each trap shall be raised, cleaned, and serviced at intervals not to exceed 96 hours and that no trap shall be abandoned in the waters of the state.
- Fish & G. Code § 9005 requires every commercial fishing trap to be marked with a buoy.

1.3.6 California Administrative Procedure Act

The California APA (Government Code §§ 11340-11365) establishes rulemaking procedures and standards for California state agencies. Unless otherwise exempt, the adoption of every regulation must comply with the requirements of the California APA. The law is designed to provide the public with a meaningful opportunity to participate in the adoption of state regulations and to ensure that regulations are clear, necessary, and legally valid. State regulations must also be adopted in compliance with relevant regulations implementing the California APA (Cal. Code Regs., Tit. 1, §§ 1-280).

1.3.7 Federal Administrative Procedure Act

Federal agencies are also subject to statutorily prescribed administrative requirements through the federal Administrative Procedure Act (Federal APA; 5 USC §§ 500 *et seq.*). While most rulemaking and rule implementation described in this CP fall under state jurisdiction, and are thus managed pursuant to the California APA, the CP, ITP, and the accompanying NEPA documents are subject to review and approval by NMFS. These approval decisions are in turn required to meet the decision-making standards described in Federal APA and are subject to judicial review (see 5 USC §§ 701-706).

1.4 Covered Species

Trap gear from the California, Oregon, Washington and tribal commercial Dungeness crab fisheries are known to interact with blue whales, gray whales, humpback whales, and killer whales, as well as leatherback sea turtles (Saez et al. 2021). Between 1982 and 2020, there were 66 humpback whale, 26 gray whale, 3 blue whale, 2 killer whale, and 1 leatherback sea turtle interactions with commercial Dungeness crab gear. CDFW requests take coverage for the following ESA-listed species under this ITP (Covered Species):

- Humpback whale– Central America DPS and Mexico DPS
- Blue whale
- Leatherback sea turtle

The humpback whale was originally listed under ESA in June 1970, and in April 2015 NMFS proposed revising the listing status to designate 14 DPS. On September 8, 2016, the Central America DPS and Mexico DPS, which are both known to occur along the California coast (see Chapter 3) were listed as endangered and threatened, respectively (81 FR 62259). Multiple interactions have also been documented with the blue whale, which was listed as endangered on July 30, 1970 (35 FR 18319). The leatherback sea turtle was listed as endangered under ESA on April 10, 1970 (35 FR 5691). While only one leatherback sea turtle interaction has been documented in this fishery, the species is included as a Covered Species due to extremely low population abundance and demonstrated potential for interactions with California Dungeness crab fishing gear.

The following ESA-listed species are not proposed for coverage under this ITP, as further detailed below:

- Gray whale
- Killer whale
- Fin whale
- California sea otter *(Enhydra lutris)*

The gray whale was originally listed in December 1970, but in 1994 NMFS de-listed the Eastern North Pacific DPS (59 FR 31094). The Western North Pacific DPS, which occurs primarily off Russia and Japan, remains endangered. However, the likelihood of these individuals interacting with commercial Dungeness crab gear is low. The latest stock assessment suggests that the population has at most 290 individuals, which is much lower than the Eastern North Pacific DPS stock abundance estimate of 26,960 individuals (Carretta et al. 2021), although an updated abundance estimate from Steward and Weller (2021) indicates a decline to 20,580 individuals in the Eastern North Pacific DPS due to recent unusual mortality events. Even if the entire Western North Pacific DPS migrates to the West Coast, absent further information there is only a 1% chance that a given entanglement will involve a member of that stock. Given the low likelihood of entanglements between the California commercial Dungeness crab fishery and the endangered Western North Pacific DPS, and the de-listed status of the Eastern North Pacific DPS, gray whales are not included as a Covered Species under this CP.

Under MMPA there are currently eight recognized killer whale populations in the Pacific: Eastern North Pacific Alaska Resident; Eastern North Pacific Northern Resident; Eastern North Pacific Southern Resident; West Coast Transient; Gulf of Alaska, Aleutian Islands, and Bering

Sea Transient; AT1 Transient; Eastern North Pacific Offshore; and Hawaiian (Carretta et al. 2021). Only three of these stocks have members that are known to visit California waters: Eastern North Pacific Offshore, Eastern North Pacific Southern Resident, and West Coast Transient. Of these, only the Southern Resident DPS, the same individuals comprising the Eastern North Pacific Southern Resident stock under MMPA, is listed as endangered under ESA (70 FR 69903). There have been two confirmed killer whale entanglements in California commercial Dungeness crab trap gear since 1982; one in 2015, and one in 2016 (Saez et al. 2021). However, there has been no indication that these entanglements involved members of the Southern Resident population (Carretta et al. 2021). Animals from this population are the rarest killer whales found off the California coast, consisting of just more than 12% of the individuals, and the 2020 stock assessment for the Southern Resident stock puts the known total fishery mortality and serious injury for the stock at zero (Carretta et al. 2021). Because of the low likelihood of entanglement of this ESA-listed DPS by the fishery, killer whales are not included as a Covered Species under this CP.

Six fin whale entanglements have been documented off the West Coast since 1982, and none of them have been confirmed as California commercial Dungeness crab gear (Saez et al. 2021). Of these entanglements, one was confirmed as drift gillnet gear and five were categorized as unknown gear. Due to the rarity of these entanglements, and lack of documented entanglements with trap gear, fin whales are not included as a Covered Species under this CP.

California sea otters are listed under ESA and listed as depleted under MMPA. California sea otters are also fully protected under California state law (Fish & G. Code § 4700). Mortality or serious injury due to interactions with trap gear is rare, with five mortalities known to have occurred in California since the mid-1970s (Hatfield et al. 2011, USFWS 2021). Of these mortalities, one was confirmed in rock crab gear, two in lobster gear, and two in suspected sablefish gear. These mortalities were due to drowning when the otter entered the trap, rather than entanglement in the line or buoys. There is no direct evidence of mortality or serious injury from the Dungeness crab fishery, and sea otters are not included as a Covered Species under this CP. Any future evidence of take by the Dungeness crab fishery would require further consideration by CDFW.

1.5 Tribal Governments

On December 23, 2019 CDFW provided formal notice to California tribal governments regarding the development of this Conservation Plan and associated regulations. CDFW requested preliminary input by February 1, 2020. CDFW staff also provided a brief update during the January 17, 2020 Fish and Game Commission Tribal Committee meeting in Los Alamitos, California.

CDFW provided additional formal notice to California tribal governments on July 26, 2021 to provide an update to tribes on preparation of the CP. The notice invited Tribal governments to request consultation or to contact CDFW staff for questions related to the CP development by September 1, 2021.

Three tribal governments contacted CDFW during preparation of this CP and one requested additional information about the scope of the rulemaking but did not request additional follow-up. As of mid-October 2021, no requests for government-to-government consultation have been received.

1.6 Stakeholder Involvement

1.6.1 California Dungeness Crab Fishing Gear Working Group

CDFW, the California Ocean Protection Council (OPC), and NMFS first convened the California Dungeness Crab Fishing Gear Working Group (Working Group) in 2015 to address marine life entanglements from the California Dungeness crab fishery. The group consists of a broad cross-section of key stakeholders, including fishermen and environmental organizations. In dealing with a problem as uncertain and dynamic as marine life entanglements, the Working Group provides critical transparency and the input necessary to establish effective programs.

The Working Group has been instrumental in making recommendations to state management agencies and the California Legislature regarding actions to reduce entanglement risk. Its most significant achievement to date has been testing and development of the management structure of the Risk Assessment and Mitigation Program (the RAMP; see Section 5.2). CDFW has provided routine updates to, and solicited feedback from, the Working Group during development of this CP and the associated regulations implementing the RAMP. The Working Group provided feedback on key aspects of this CP, including triggers for management action, avoidance/minimization measures, and other aspects of the Conservation Program described in Chapter 5 prior to submission of a preliminary draft CP to NMFS in May 2020. In addition to public scoping meetings, CDFW conducted additional targeted outreach with this group prior to official submission of the ITP application. The Working Group's role in implementing this CP is discussed further in Chapters 5-7.

1.6.2 Other Outreach

In March 2019, CDFW created a dedicated Whale Safe Fisheries webpage where updates about the ITP process were posted. CDFW also created a listserv where the interested public could sign up for updates regarding development of the CP, and a dedicated email account where individuals could send comments regarding CDFW's Whale Safe Fisheries efforts.

CDFW notified commercial fishery participants of this CP's development and invited their comments in outreach newsletters mailed in October 2019, 2020, and 2021. Updates were also provided at public meetings of the Dungeness Crab Task Force (DCTF) in October 2019 and 2020, and the California Legislature's Joint Committee on Fisheries and Aquaculture in November 2019 and March 2020.

CDFW also conducted a webinar meeting in March 2020 during which staff provided a pre-notice preview of the proposed RAMP regulations and provided updates regarding the overall ITP process. Invitations were broadly distributed to commercial and recreational Dungeness crab fishery participants, harbormasters, the Working Group, and environmental interest groups. Around 80 individuals attended, including several Working Group members.

CHAPTER 2. PROJECT DESCRIPTION AND ACTIVITIES COVERED BY THE PERMIT

This Chapter describes the Plan Area and Permit Area (Section 2.1), provides an overview of the Covered Activities (Section 2.2), and identifies CDFW's requested permit term (Section 2.3). Covered Activities are further described in Chapters 5 and 8.

2.1 Plan and Permit Area

Commercial Dungeness crab fishing depths are dependent on multiple factors, including fishing location, time of year, and to a lesser extent, the vessel type. Fishing locations are dependent on the time of year, home port, and access to processing facilities. In practice, traps are rarely if ever deployed in waters deeper than 600 feet (100 fathoms), with average maximum fishing depths of 240 feet (40 fathoms) reported to CDFW. Additionally, the fishery occurs almost exclusively north of Point Conception (CDFW 2020a). However, individual fishermen may decide to set gear in other areas, and gear could be moved by ocean currents, other vessels, or entangled marine life beyond the typical fishing grounds. CDFW jurisdiction over the fishery extends throughout the entire US Exclusive Economic Zone (EEZ) off California (16 USC § 1856 note). Therefore, CDFW has defined the Plan and Permit Area as encompassing the entirety of the EEZ south of the California/Oregon border (Figure 2-1).

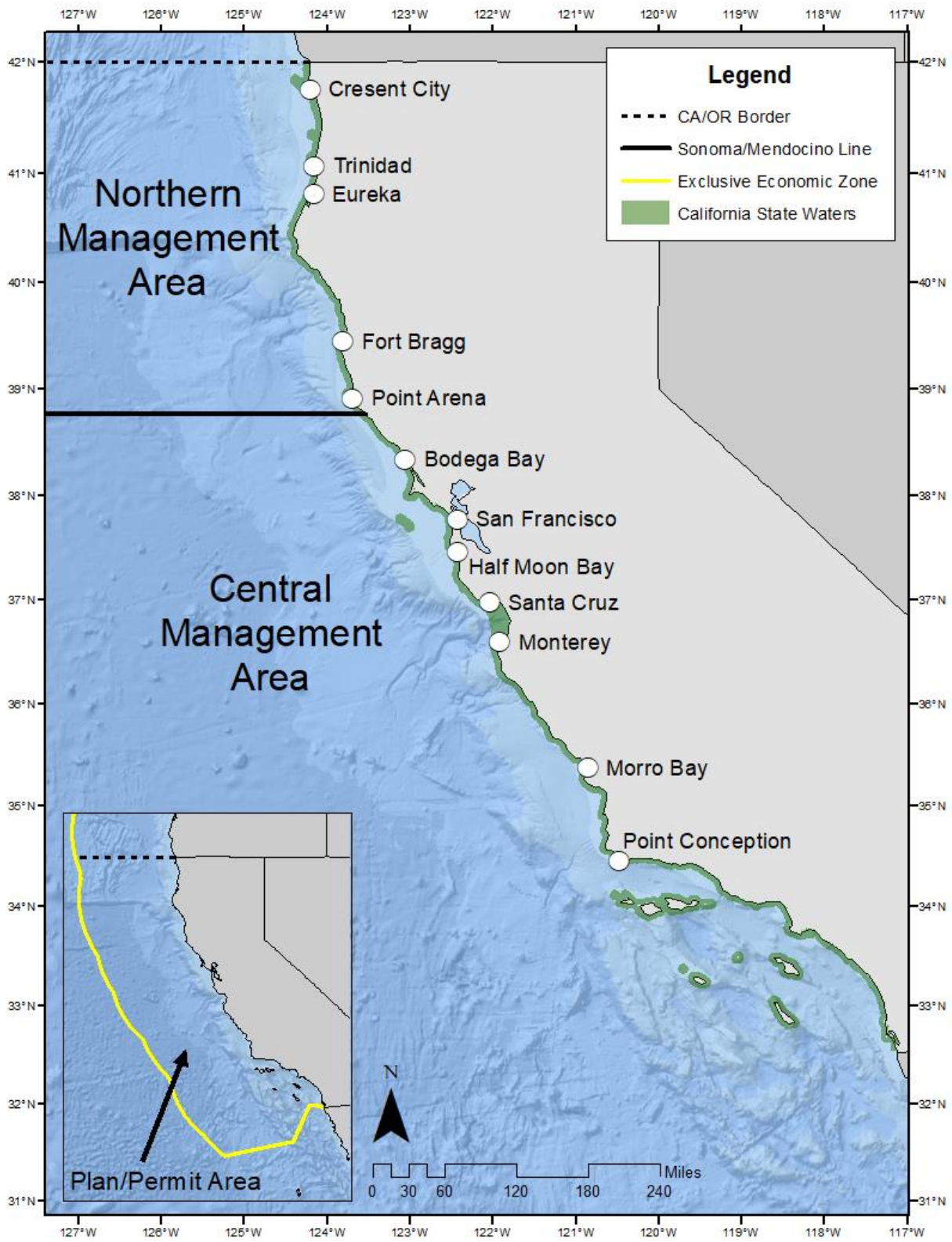

Figure 2-1: Northern and Central Management Areas within the Plan and Permit Area, along with key landmarks. California state waters, shown in green, generally extend to 3 nautical miles offshore but extend farther in some areas (e.g., Monterey Bay).

2.2 Covered Activities

The California commercial Dungeness crab fishery began in the mid-1800s, and over time developed into one of the most valuable commercial fisheries in the state (Wild and Tasto 1983). Crab is the most important species group by both revenue and number of active vessels for Crescent City and Eureka, and is among the highest contributors for other ports in northern and central California (Harvey et al. 2021). While multiple crab species are harvested in California, Dungeness crab constitutes the highest percentage of both landings and ex-vessel value. Among ports in California, Bodega Bay is particularly reliant upon this fishery (Magel et al. 2020). Since 2010, the fishery has regularly exceeded $50 million in ex-vessel value each season (CDFW 2020a). Landings then enter the larger California seafood economy, which generated over $22.8 billion in sales and supported nearly 125,000 jobs in 2016 (NMFS 2018a).

2.2.1 Targeted Species

Adult Dungeness crab (*Metacarcinus magister*) prefer sandy to silty substrates shallower than 300 feet (50 fathoms; CDFW 2020a), and fishing activity is concentrated within this habitat type. These highly productive crustaceans take about three to five years to reach the minimum legal size of 6.25 inches. Seasonal landings are dependent on crab production cycles with decadal variability, resulting in large fluctuations from year to year.

2.2.2 Gear Configuration

The fishery uses traps constructed from two circular iron frames, 3 to 3.5 feet in diameter, connected by spokes on the outer edges (Figure 2-2). The frame is wrapped with strips of rubber and the entire frame is covered with stainless steel wire mesh.

Figure 2-2. Stacked commercial Dungeness crab gear. Photo by Morgan Ivens-Duran (CDFW).

Every trap or string of traps must be marked with a buoy (Fish & G. Code § 9005), and the operator of a Dungeness crab trap must mark the buoy with their commercial fishing license number (Fish & G. Code § 9006). Buoys are connected to a vertical line, and the fleet typically uses blue steel-type line, also known as "floating line" (Figure 2-2), but recently participants have been switching to neutral buoyancy lines. The amount of line used is dictated by the depth where the trap will be deployed, with additional scope to compensate for tidal changes, swell, and currents. Additional trailer buoys may be employed, depending on the participant's preference for the added buoyancy of the line at the surface to facilitate recovering trap gear. Fish & G. Code § 9012 prohibits connecting multiple traps with a common line in Districts 6, 7, 8, and 9 (NMA). Requiring each trap to be individually buoyed helps CDFW enforce its trap limit program. However, this requirement prevents the use of multi-trap "trawls" which are common in East Coast trap fisheries (Figure 2-3).

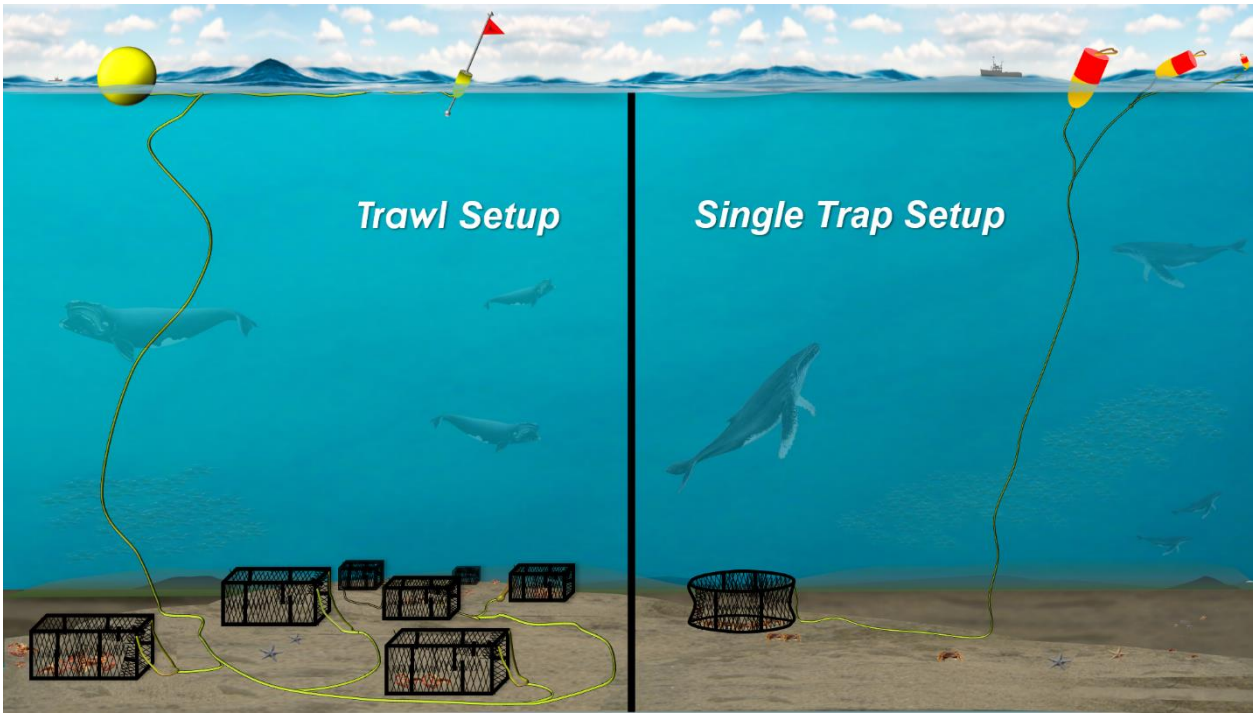

Figure 2-3. Side-by-side comparison of trawl vs single trap set up. Whale images courtesy of NOAA Fisheries.

In response to marine life entanglement issues, CDFW adopted regulations in October 2018 restricting the amount of line and buoys that can be attached to each trap (Cal. Code Regs., Tit. 14 § 132.6). Fishermen commonly use trailer buoys to provide additional flotation in high current locations and to increase gear visibility. This rule stipulates no more than two trailer buoys may be used, and the distance from the front end of the main buoy to the tail end of the last trailer buoy cannot exceed 24 feet when a trap is fished in depths less than or equal to 35 fathoms, or 36 feet when fishing in depths greater than 35 fathoms (Figure 2-4). Regular LED patrol activity indicates high compliance with this requirement.

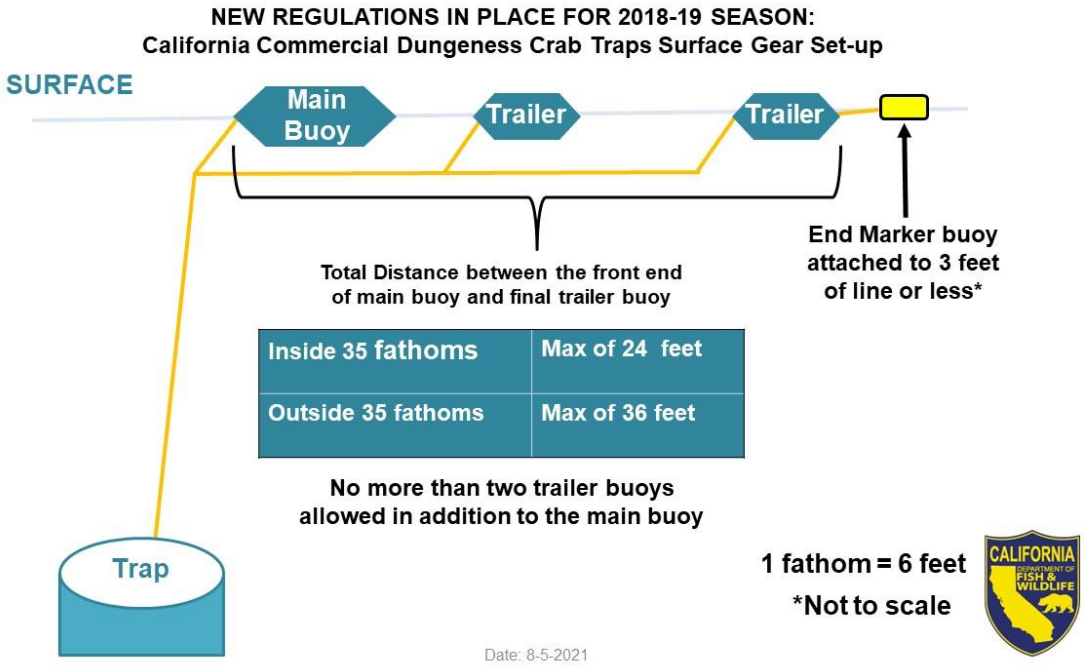

Figure 2-4. Schematic showing surface gear restrictions in place as of October 2018. Credit: CDFW.

2.2.3 Fishing Vessel Permits and Trap Limits

The California Legislature first implemented a restricted access program in 1995, capping the fishery at 681 permits (AB 3337, Hauser, 1994). A trap limit program to further control effort was established in 2013 (SB 369, Evans, 2011). Dungeness crab vessel permitholders were divided into seven tiers based on their total California Dungeness crab landings from the 2003-04 through 2007-08 seasons. Those in the highest tier (Tier 1) were allotted 500 traps, and those in the lowest tier (Tier 7) were allotted 175 traps. Trap allotments are enforced with biennial buoy tags marked with the permit number. Originally implemented due to concerns about overcapacity and latent permits, the unique gear marking has allowed commercial Dungeness crab gear to be more easily identified when involved in a marine life entanglement. In 2020, 548 permits were renewed across the seven tiers (Table 2-1) for the 2020-21 fishing season.

Table 2-1. Number of Dungeness Crab Permits Renewed in 2020 by Trap Tier (CDFW Automated License Data System 2021).

Tier	Trap Number	Number of Permits
1	500	57
2	450	53
3	400	57
4	350	55
5	300	55
6	250	164
7	175	107

2.2.4 Monitoring Landings

All catch taken under a California commercial fishing license must be reported on a commercial landing receipt (commonly called a “fish ticket”; Fish & G. Code § 8043). These landing receipts include vessel and commercial fishing license information, pounds caught by species, unit price, catch location, port of landing, and fish business information. These documents are then submitted by the commercial fish business to CDFW via an electronic platform (eTix, maintained by the Pacific States Marine Fisheries Commission (PSMFC)) within 3 business days of the landing, allowing managers to have access to near-real time information on fishing activity.

2.2.4.1 Trap Estimates

Landing receipts require identification of the fishing vessel, which can be combined with permitting information from the state’s Automated License Data System to identify the vessel’s permit tier and trap allotment. However, the number of deployed traps is not reported on landing receipts. Historically, this has made it difficult for CDFW to quantify the amount of gear used in the fishery.

CDFW has three methods to quantify gear usage. The first method is to identify the total number of issued permits and sum the associated trap limits to estimate the maximum amount of gear that could be fished. The second method is to identify which vessels participated in the fishery (i.e., “active” vessels that made landings) and sum the associated trap limits to estimate the maximum amount of deployed gear. The third method relies on a new requirement for fishery participants to self-report trap usage (see Section 5.2.2.7) to estimate the number of deployed traps. Because not all vessels with active permits participate in the fishery, and participating vessels do not always fish their full trap allotment, the first two methods likely overestimate the amount of actual gear in the water. Because there was not full compliance with the new reporting requirement, the third method likely underestimates the amount of gear deployed during the 2020-21 season. CDFW expects the actual number of traps deployed during the 2020-21 season falls between the self-reported (95,267) and active vessel (117,525) estimates.

2.2.4.2 Location of Catch

Catch location, which is assumed to correlate with where gear is deployed, is reported by selecting the CDFW fishing block where the majority of catch occurred (see Figures 2-5 and 2-6). The size of these reporting blocks varies, with smaller blocks nearshore and larger blocks offshore, but in all instances provides a coarse understanding of where gear is deployed.

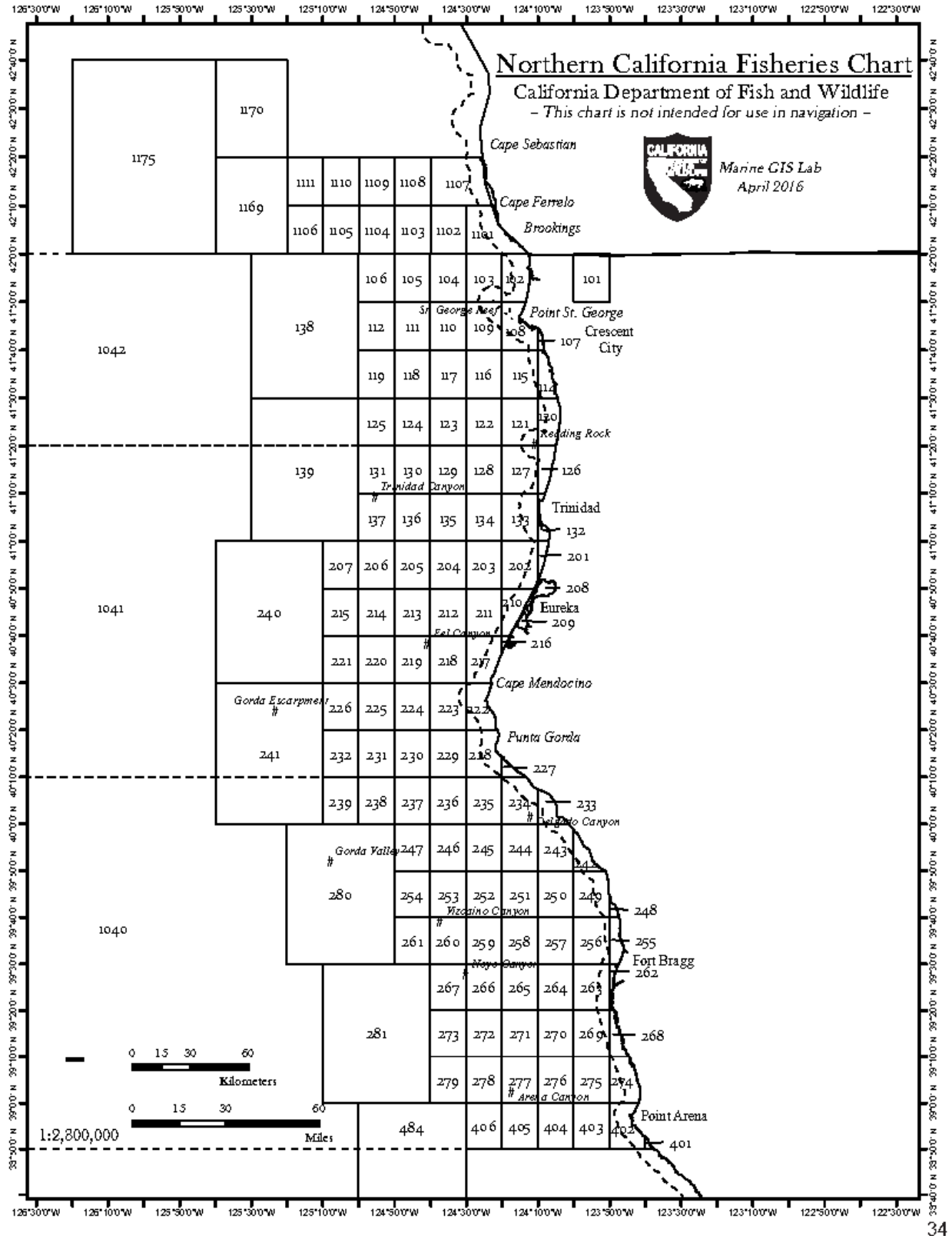

Figure 2-5. CDFW Fishing Blocks, Northern California.

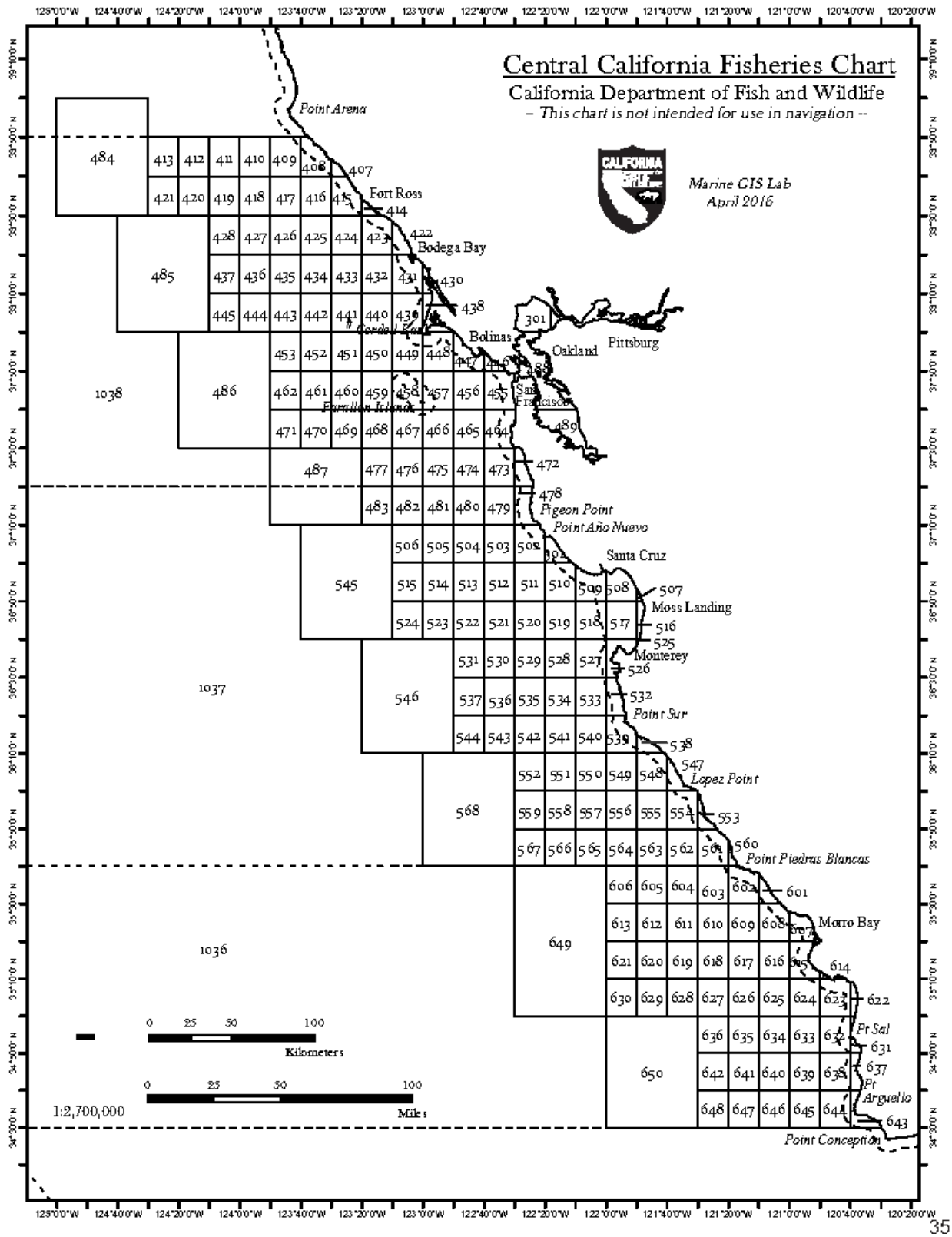

Figure 2-6. CDFW Fishing Blocks, central California.

2.2.5 Fishery Management Areas and Timing

Historically, the fishery was divided into two areas at the Sonoma-Mendocino county line. The Northern Management Area (NMA) extends from the Sonoma-Mendocino county line to Oregon, and the Central Management Area (CMA) extends from the Sonoma-Mendocino county line to Mexico (Figure 2-7). The scheduled season runs from December 1 to July 15 in the NMA, and from November 15 to June 30 in the CMA (Fish & G. Code § 8276). However, the Director of CDFW may delay the season opening for part or all of the NMA due to low crab meat quality (Fish & G. Code § 8276.2), close any area due to biotoxin risk (Fish & G. Code § 5523), and (more recently) restrict fishing activity in any area due to elevated marine life entanglement risk (Fish & G. Code § 8276.1 and Cal. Code Regs., Tit. 14 § 132.8). The interactions between these three provisions (quality, biotoxin risk, and entanglement risk) generate uncertainty regarding the timing and duration of the fishing season (Figure 2-7).

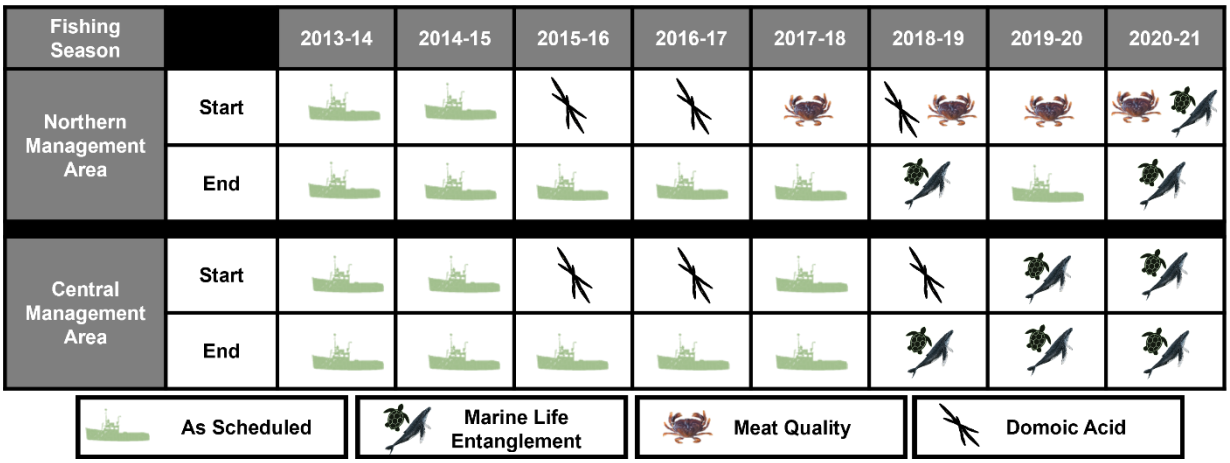

Figure 2-7. Summary of Dungeness crab season timing during the 2013-14 through 2020-21 fishing seasons. On time openings and closures are represented with a green vessel. Delays or early closures are represented with whale and turtle icons (marine life entanglement risk), crab icons (low meat quality), or plankton icons (elevated levels of *Pseudo-nitzchia* caused domoic acid).

Regardless of the actual start date, a majority of landings occur within the first two months of a given season (Figure 2-8).

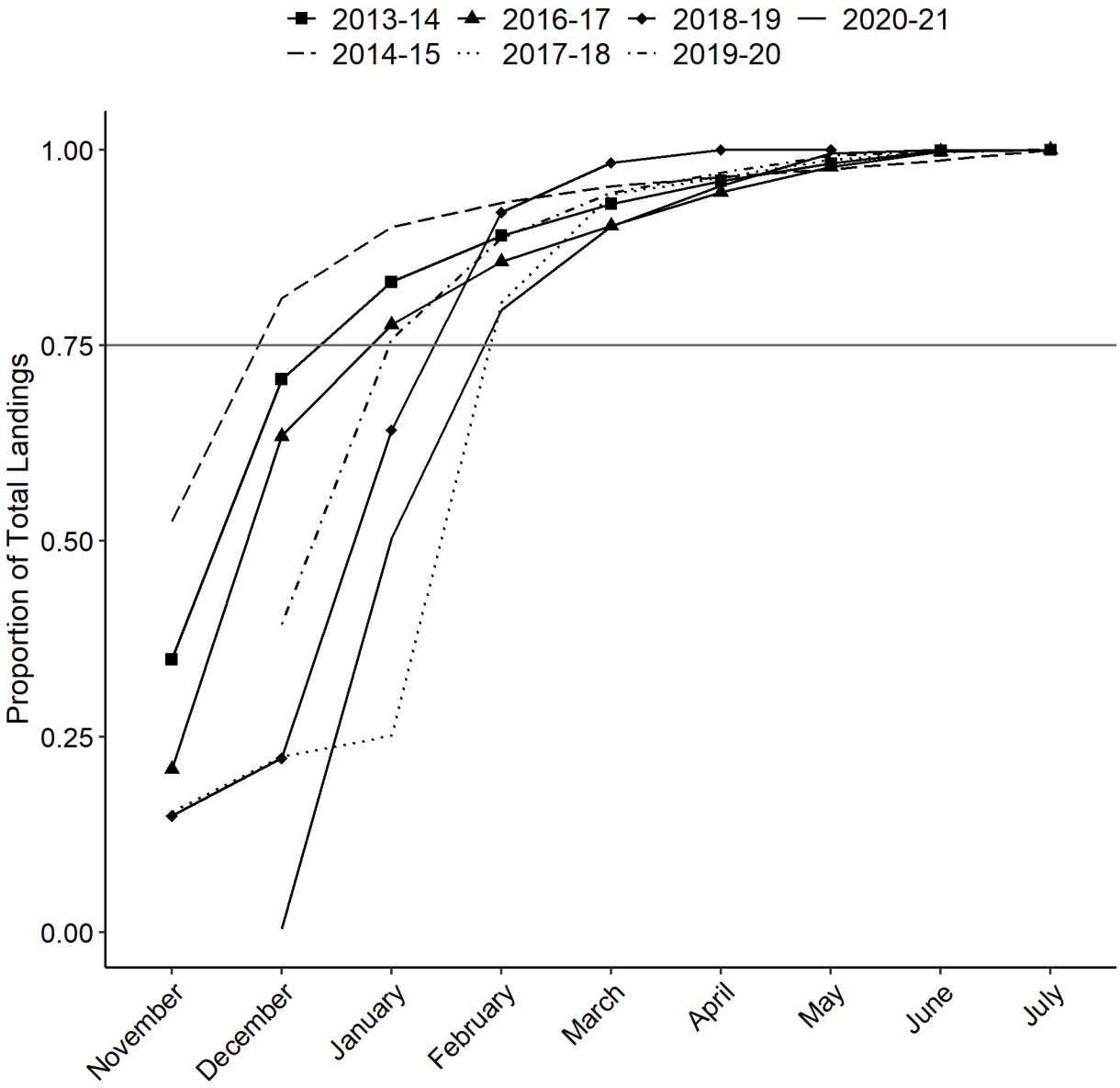

Figure 2-8. Proportion of cumulative pounds of Dungeness crab landed by month between 2013-14 and 2020-21 (not including 2015-16 disaster season). Note: the 2018-19 season ended April 15. Source: CDFW Marine Landings Data System.

2.2.6 Spatial Trends in Fishing Activity

The relative importance of an individual port or management area during any given Dungeness crab fishing season is largely driven by the interannual variability in crab production within nearby fishing grounds, although a small number of vessels will transit a substantial distance between the area where crab was harvested and the port of landing. Historical CDFW Dungeness crab landings data are available beginning with the 1915-16 fishing season. Since the mid-1940s, the bulk of Dungeness crab landings have been made into ports within the NMA, although during the last decade there has been an increase in the proportion of landings made into CMA ports (Figure 2-9).

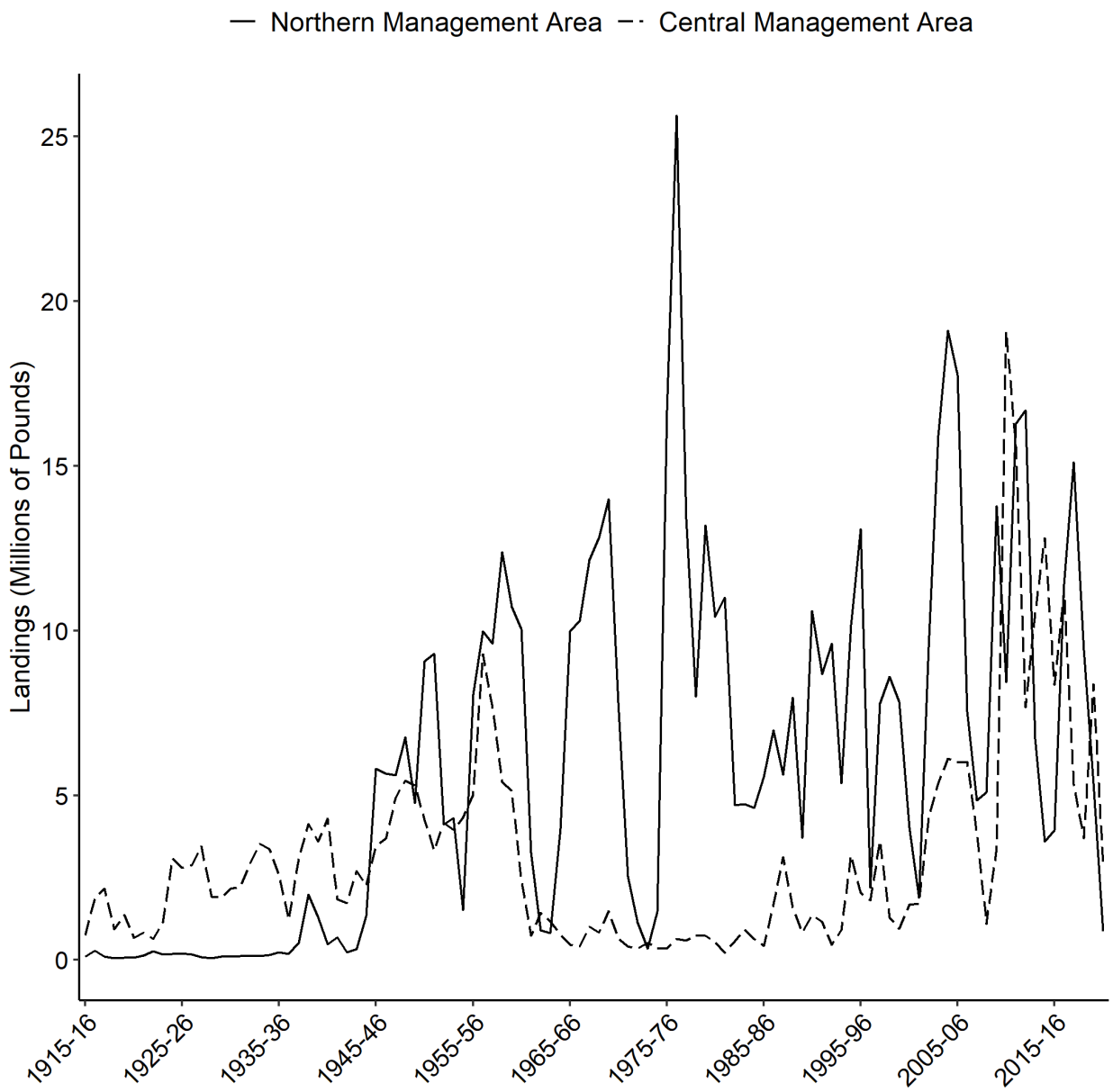

Figure 2-9. California Dungeness crab landings in millions of pounds from the 1915-16 to the 2020-21 fishing seasons within the NMA (solid line) and CMA (dashed line).

In addition to crab landings volume, examining the number of permitted vessels which make landings into each port (active vessels) during January and February and their associated trap limits provides another method for evaluating fishing activity. Focusing on January and February captures the time period with the most vessel activity while reducing overlap of vessels which transit to more than one port area over the course of the fishing season.

The relative contribution of landings by port region to the total number of active vessels between the 2016-17 and 2020-21 fishing seasons is shown in Figure 2-10, with about a third to half of active vessels landing in the ports of Crescent City, Trinidad, and Eureka within the NMA, and a similar proportion landing in Bodega Bay, San Francisco and Half Moon Bay within the CMA.

This is in contrast to ports in Mendocino County (e.g., Fort Bragg and Point Arena) and from Monterey Bay south that have a smaller proportion of active vessels (≤10%).

Figure 2-10 also displays the maximum number of traps those vessels may have deployed during each fishing season. While the trap estimates are based on port of landing rather than catch area, CDFW anticipates these traps would mostly be found near these ports and inside the 100-fathom depth contour.

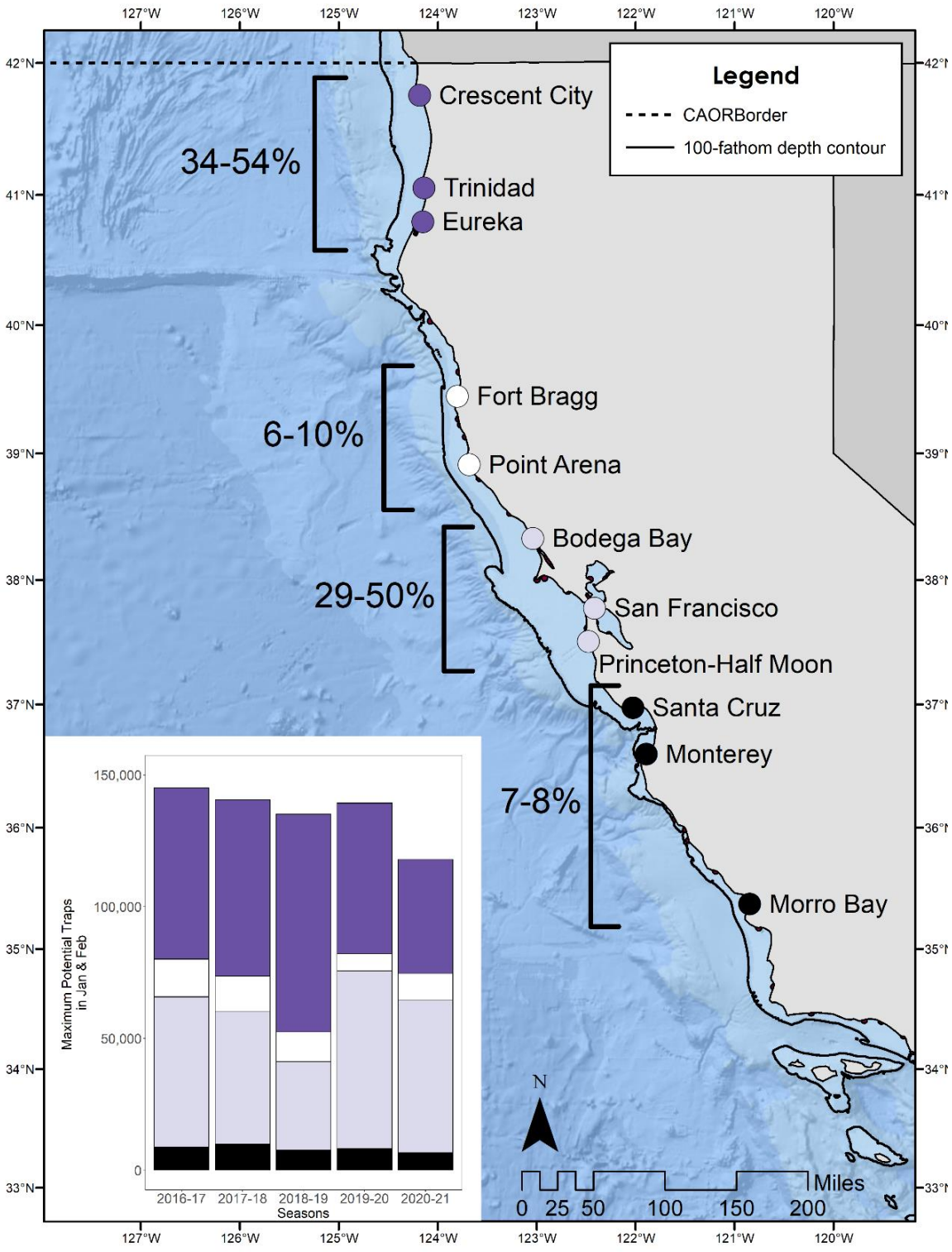

Figure 2-10. Map of California showing 100-fathom depth contour (black line) along port regions. Numbers adjacent to each port region show the range in percent of the active fleet that made at least one landing in the port region during January and February over the past five fishing seasons of 2016-17 to 2020-21. Bar graph in lower left shows the estimated number of maximum potential traps by fishing season that the active vessel permits represent during the same time period, color coded by port region.

2.3 Permit Duration

CDFW is requesting a 21-year renewable ITP. Based on initial consultation with NMFS during preparation of this CP, this permit duration allows the permit term to align with required MMPA authorizations which must occur every three years; provides sufficient time to implement the Conservation Program described in Chapter 5 and evaluate the adaptive management framework described in Chapter 6; and provides a measure of predictability for fishery participants. Additionally, this period will likely encompass multiple large-scale oceanographic regimes, which Santora et al. (2020) has directly linked to episodic fluctuations in entanglement frequency. By the end of the 21-year period, additional research will likely become available to further inform the conservation of the Covered Species and development of future CPs. CDFW also notes that fishery managers in Oregon and Washington are seeking ITPs with similar permit terms.

CHAPTER 3. ENVIRONMENTAL SETTING AND BIOLOGICAL RESOURCES

This Chapter briefly summarizes available information regarding the oceanographic and ecological conditions of waters off California (Section 3.1) as well as the biology, migratory patterns, and foraging activity of blue whales (Section 3.2), humpback whales (Section 3.3), and leatherback sea turtles (Section 3.4).

3.1 Seasonal and Interannual Dynamics of the California Current System

The waters off California are part of the California Current System (CCS), a highly productive coastal ecosystem spanning the West Coast of North America from British Columbia to Baja California (Talley et al. 2011). The dynamics of the CCS have been described in detail by several sources (e.g., Huyer 1983; Lynn and Simpson 1987; Hickey 1979; Marchesiello et al. 2003; Checkley and Barth 2009) and are briefly summarized here.

The CCS is comprised of the California Current, the California Undercurrent, the Davidson Current, and the Southern California Countercurrent (Hickey 1979). Like other eastern boundary current systems, the CCS experiences significant, sustained upwelling events driven by large-scale wind and circulation patterns (Carr and Kearns 2003; Talley et al. 2011). Upwelling occurs when warmer surface water is pushed offshore and replaced by deeper, nutrient-rich water. This influx of nutrients into the euphotic zone fuels high levels of biological production, particularly in shelf and shelf-break habitats, supporting high densities of migratory seabirds and marine mammals as well as resident fish species including groundfish, salmon, sardine, and mackerel (Carr and Kearns 2003; Field et al. 2006).

The California Current Integrated Ecosystem Assessment (CCIEA) team identifies three basin-scale oceanographic phenomenon which influence dynamics of the CCS: El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO; Harvey et al. 2021). ENSO has three states: neutral, El Niño, and La Niña. During ENSO neutral years, a low atmospheric pressure center forms over Northern Australia and Indonesia and a high-pressure center forms over Peru (WHOI 2021). The resulting trade winds move warm surface waters from the eastern Pacific to the western Pacific, driving upwelling along the coast of South America. During El Niño, the high-pressure system over the western Pacific weakens, allowing warm surface waters to move from the western Pacific towards South America, reducing upwelling and productivity in the eastern Pacific. During La Niña, trade winds strengthen, intensifying upwelling in the eastern Pacific. The CCIEA tracks ENSO conditions via the Oceanic Niño Index (ONI), which is a 3-month running mean of sea surface temperature (SST) anomalies in the Nino 3.4 region (120°-150° W. longitude and 5° N. latitude-5° S. latitude). ONI values above 0.5º Celsius (C) indicate El Niño conditions and values below -0.5ºC indicate La Niña conditions. The cycling between El Niño, La Niña, and ENSO-neutral conditions is variable in both periodicity and intensity, but typically recurs every two to 10 years.

The PDO also reflects anomalies in SST, with positive values (warmer temperatures) indicating lower productivity and lower values (colder temperatures) reflecting higher productivity conditions (Harvey et al. 2021). Cycling between the warm and cool phases of the PDO occurs on longer timescales than ENSO, typically on 20-30 year intervals (WHOI 2021).

The NPGO is an index of sea surface height, indicating basin-scale circulation patterns. Positive NPGO values are associated with higher flows of nutrient-rich subarctic waters towards the equator, supporting more productive coastal ecosystems, and negative NPGO values are

associated with decreased contributions of subarctic waters and lower productivity (Harvey et al. 2021).

Skogsberg (1936) defined three distinct oceanographic periods in the Monterey Bay: (1) a spring/summer "upwelling season", (2) a summer/fall "oceanic season", and (3) a winter "Davidson Current season", and suggested these trends apply to the CCS more broadly. Subsequent investigations have documented latitudinal trends in upwelling phenology (onset, duration, and intensity) within the CCS as well as substantial interannual variation (Bograd et al. 2009; Brady et al. 2017). Persistent, low-magnitude upwelling occurs nearly year-round below Point Conception, and the upwelling season shortens with increasing latitude. Between Point Conception and Cape Mendocino, relatively consistent upwelling of a moderate magnitude occurs from March to October. The highest magnitude upwelling is seen north of Cape Mendocino between April and October, with a peak in July. Complex coastal topography (e.g., capes, points, and peninsulas) and bathymetry (e.g., banks, and canyons) can alter upwelling patterns and associated productivity (Huyer 1983; Marchesiello et al. 2003; Checkley and Barth, 2009). Upwelling phenology is also impacted by basin-scale changes in oceanographic circulation, including ENSO and PDO (Bograd et al. 2009; Santora et al. 2011). Specifically, increased advection of southern source water associated with El Niño events can result in dramatic declines in productivity and shifts in community structure, while during the cold phases of ENSO, the coastal ecosystem is characterized by intensified transport of nutrient-rich northern waters and increased productivity (Checkley and Barth 2009).

Variations in large-scale atmospheric forcing can also influence upwelling dynamics and ecosystem productivity in the CCS. The North Pacific High (NPH) is a semi-permanent area of high pressure (> 1020 Pascals) in the North Pacific Ocean, and variation in both the size and location of the NPH affects the timing and strength of coastal upwelling off California (Schroeder et al. 2013). Winter NPH values (January – February mean) provide an early indication of likely upwelling conditions and resulting biological productivity during the spring and summer.

Climate change may alter historical upwelling dynamics. Brady et al. (2017) anticipate that in the latter half of the 21st century, seasonal upwelling in the CCS will be characterized by a more intense spring transition (shift from downwelling to upwelling) and a reduction in total seasonal upwelling. These changes could lead to higher, rather than lower, productivity if more moderate levels of upwelling recalibrate the balance between advection and available nutrients.

Between 2014 and 2016, typical seasonal dynamics in the Northeast Pacific were disrupted by a Large Marine Heatwave (LMH) event colloquially known as "The Blob." Driven by changes in sea level pressure (Bond et al. 2015), this LMH event had profound impacts on ocean circulation patterns which cascaded throughout the ecosystems of the CCS. Upwelling in 2014 was dramatically delayed and was among the weakest and shortest since the 1990s (Peterson and Bond 2015), decreasing primary productivity and impacting the abundance, species richness, and distribution of key prey species such as copepods and krill (reviewed by Cavole et al. 2016).

Warm SST caused by the LMH, northward transport of *Pseudo-nitzchia australis*, and the onset of seasonal upwelling in spring 2015 led to a massive phytoplankton bloom and large scale, unprecedented domoic acid event along the entire West Coast of North America (Cavole et al. 2016; McCabe et al. 2016). Due to health risks from consumption of domoic acid, the 2015-16 season opening of the California commercial Dungeness crab fishery was delayed until March

26, 2016 in the CMA, and the NMA did not fully open until May 26, 2016. As discussed in Section 2.2.5, in a typical fishing season, the vast majority of Dungeness crab landings are made within the first eight weeks of the season opening, with declining landings thereafter. During the 2015-16 season, a majority of landings (presumably accompanied by the maximum potential amount of deployed trap gear) did not occur until April, May and June (Figure 3-1).

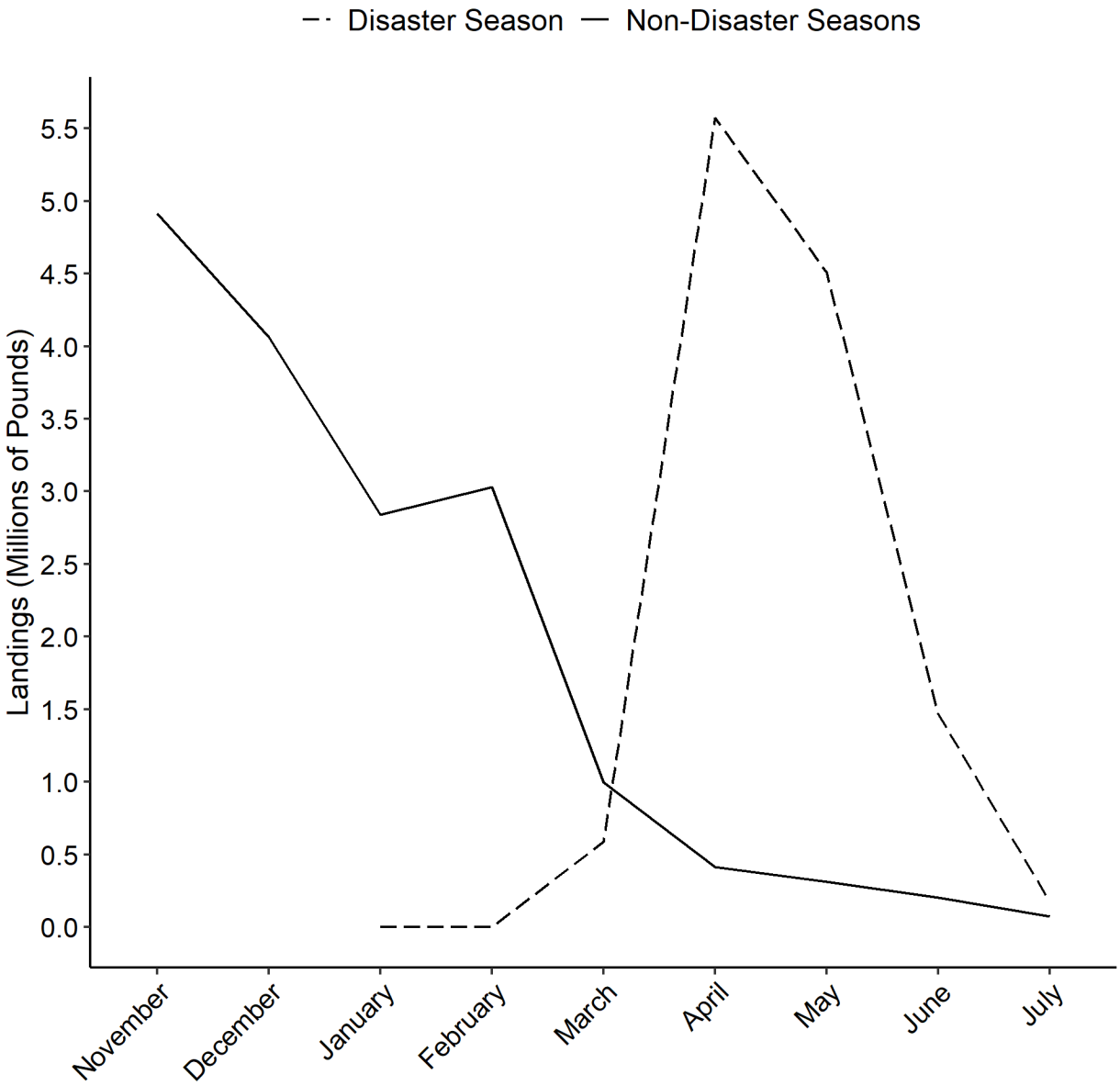

Figure 3-1. Monthly landings during the 2015-16 "Disaster Fishing Season" (dashed line) as compared to average monthly landings during the "Non-Disaster Fishing Seasons" of 2013-14, 2014-15, 2016-17, 2017-18, 2018-19, and 2019-20 (solid line).

The restricted upwelling in the 2015-16 period also compressed available forage into a relatively narrow band along the coast (Santora et al. 2020). When large whales arrived off the California coast, their distribution was similarly compressed into nearshore areas where active Dungeness crab fishing was occurring. The convergence of these factors likely contributed to the record

number of confirmed large whale entanglements along the West Coast in 2016 (n = 56), 22 (39%) of which involved California commercial Dungeness crab gear.

The 2014-16 LMH has since been followed by three additional heatwave events in the CCS (Harvey et al. 2021). Jacox et al. (2018) suggest that while the 2014-16 LMH was primarily driven by a confluence of complementary natural processes, these were exacerbated by long-term trends of anthropogenic warming. While the geographic scale, intensity, and duration of the 2014-16 LMH was unprecedented, CDFW anticipates these types of warm water events will continue to occur, and should be considered as part of the environmental context for this CP.

3.2: Blue Whales

Blue whales are broadly distributed amongst the world's ocean and are listed at the species level under ESA. The Society for Marine Mammalogy currently recognizes five subspecies of blue whale: *B. m. musculus* in the North Atlantic and North Pacific Oceans; *B. m. intermedia* in the Antarctic; *B. m. brevica* in the sub-Antarctic southern Indian Ocean and southwestern Pacific Ocean*; B. m. indica* in the northern Indian Ocean; and an un-named subspecies in the southeastern Pacific Ocean (NMFS 2020a). For purposes of management under MMPA, NMFS divides the North Pacific population of *B. m. musculus* into Eastern North Pacific (ENP) and Central North Pacific (CNP) stocks (Carretta et al. 2020). Based on a line-transect survey conducted in 2014, Caretta et al. (2020) estimated abundance of the ENP stock as 1,496 whales, with a minimum abundance estimate of 1,050 whales. In contrast, Calambokidis and Barlow (2020) used photo-identification data collected through 2018 to estimate the current abundance of the ENP stock as 1,898 individuals, with a minimum population estimate of 1,767 individuals.

Blue whales undertake seasonal migrations between breeding and foraging grounds and are generally more abundant off California during the summer months (Reilly et al. 1990; Mate et al. 1999; Forney and Barlow 1998; Bailey et al. 2009; Abrahms et al. 2019a; NMFS 2020a). Models of blue whale presence (Hazen et al. 2016) and suitable habitat (Abrahms et al. 2019b) support this finding, with limited presence or suitable habitat during the winter and early spring, an increase within the Southern California Bight (SCB) during April, May and June, and northwards expansion during the late summer and early fall before retracting southwards towards the SCB. Hazen et al. (2016) found the highest predicted blue whale densities in the SCB and between Monterey and Humboldt Bay within 300 km of shore, and Abrahms et al. (2019b) found hotspots of suitable habitat within the SCB, Monterey Bay, Gulf of the Farallones, Cape Mendocino, and Cape Blanco.

Blue whales depart summer foraging areas in December and follow the continental margin until they reach one of three wintering areas: the southern tip of Baja, the Gulf of California, or west of the Costa Rica Dome (Bailey et al. 2009). During the northward migration, which begins in March or April, blue whales make extended stops off Baja before arriving off California in June. Area Restricted Search (ARS) behaviors indicate the Gulf of the Farallones, SCB, northern Coast of Baja, and off the tip of Baja are key foraging areas. Palacios et al. (2019) also documented a key foraging area between Cape Mendocino and Cape Blanco, and that ARS behavior decreased within these foraging areas during warm phases of the PDO.

Even during years with lower productivity, blue whales still exhibit strong site fidelity (Palacios et al. 2019), consistent with recent findings indicating blue whale migration is driven by a combination of memory and environmental cues. Abrahms et al. (2019a) found that blue whale

migratory movements in the Northeastern Pacific were significantly correlated with 10-year average values of peak chlorophyll-a, targeting areas with predictably high-quality prey resources rather than those with the highest contemporaneous productivity. This memory-driven focus on long-term average trends in resource availability may be detrimental as climate change drives shifts in phenology, latitudinal range, and vertical distribution of prey species. Szesciorka et al. (2020) found a combination of ocean conditions and memory drove timing of blue whale movements between the winter breeding and summer foraging grounds. Blue whales arrived in the SCB earlier if conditions during the prior year were cooler and arrived later if conditions had been warmer than average.

Calambokidis et al. (2015) identified nine Biologically Important Areas (BIAs) off the West Coast where blue whale foraging is common (Figure 3-2). Together, the nine BIAs represent 2% of the waters off the West Coast while encompassing 87% of blue whale sightings between 1986 and 2011. All of these BIAs are located off California and six are located within the SCB, which underscores the importance of the Plan Area for this species. Three BIAs north of Point Conception (Monterey Bay to Pescadero, Gulf of the Farallones, Point Area to Fort Bragg) overlap with traditional Dungeness crab fishing grounds. Based on available sightings information, Calambokidis et al. (2015) concluded blue whales generally arrive in these areas in July or August and depart in October or November. However, near-daily shore-based observations between 1993 and 2016 indicate a trend of earlier arrivals and increased residence time at the Farallon Islands (Ingman et al. 2021). The initial arrival of blue whales has shifted from early September to mid-May. While blue whales are also departing earlier (in early rather than mid-October), the extended residency of blue whales overlaps to a greater extent with the commercial Dungeness crab season, which can contribute to increased entanglement risk.

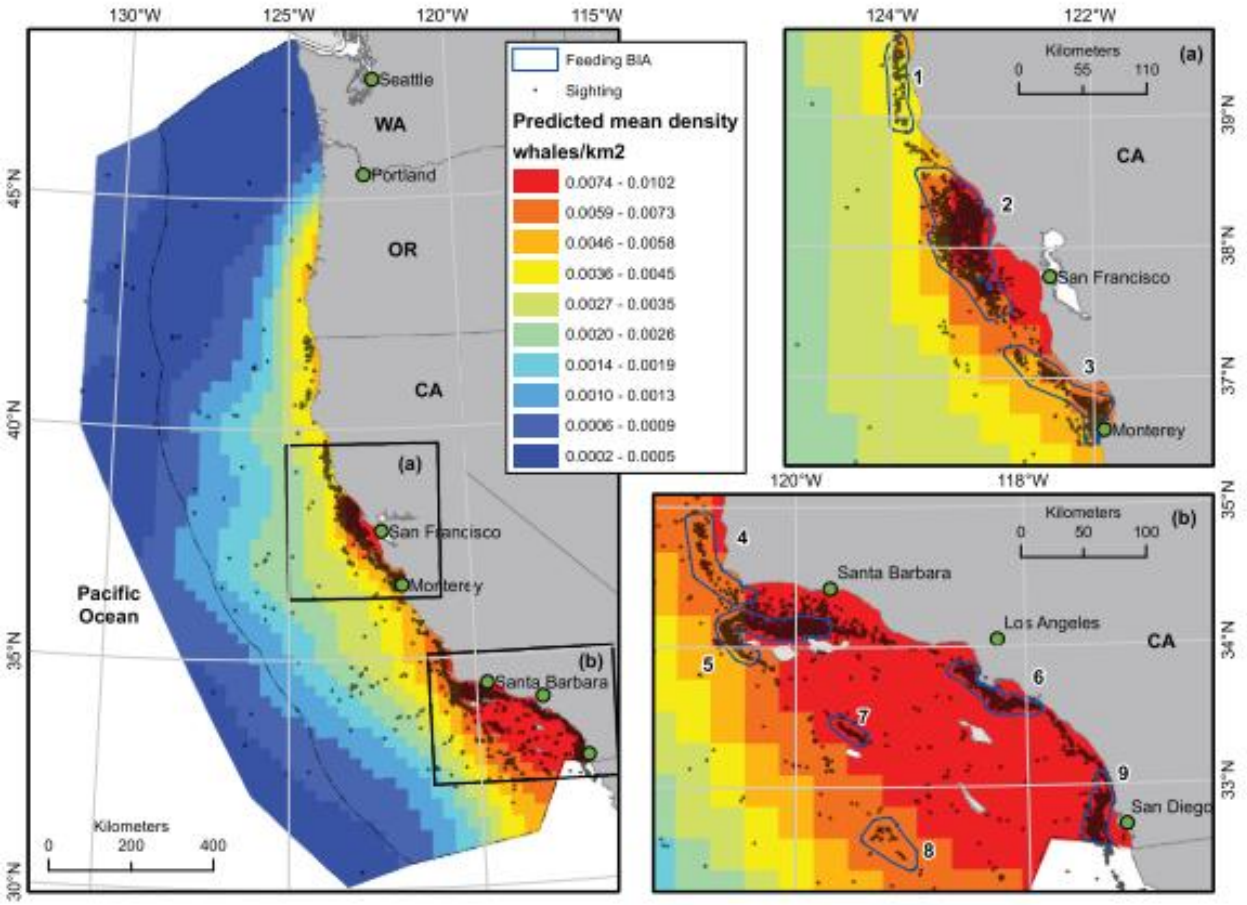

Figure 3-2. BIAs for blue whales off the West Coast, from Calambokidis et al. 2015. Cooler colors (blues) indicate lower predicted mean density, while warmer colors (reds) indicate higher predicted mean density. Black dots represent individual blue whale sighting locations, over which BIA boundaries are shown.

Krill species are a foundational component of CCS trophic structure, with substantial interannual variation in abundance. Field et al. (2006) estimated that much of the energy flow in the northern CCS between primary producers and tertiary consumers is filtered through krill. This is certainly true for blue whales, which exclusively consume these small euphausiids. In particular, blue whales forage selectively on high-density patches of large *Thysanoessa spinifera* and *Euphausia pacifica*, even when other size classes or species are more abundant (Croll et al. 2005). Near the Channel Islands, *E. pacifica* is more common near or offshore the 200m shelf edge, while *T. spinifera* is more common in shelf waters shallower than 150m (Fiedler et al. 1998).

Blue whales can conduct multiple feeding lunges at depths exceeding 200m before returning to the surface (Croll et al. 2001; Calambokidis et al. 2007). Blue whales shift from deeper foraging dives during daylight hours to shallower dives at night, tracking the vertical migration of their prey (Fiedler et al. 1998; Croll et al. 2001; Calambokidis et al. 2007).

The stretch of coast between the California-Oregon border and Point Sur generally experiences the strongest upwelling within the CCS, as well as the most variability from year to year (Bograd et al. 2009). On average, the area south of Point Sur experiences less upwelling than the area

immediately to the north, but upwelling tends to last longer and is more consistent (Bograd et al. 2009). As upwelling strength increases, nutrient availability and abundance of phytoplankton species upon which krill feed also increases (Croll et al. 2005). However, stronger upwelling also increases the likelihood of advection, with krill being transported away from favorable habitat. Santora et al. (2011) found hotspots of high krill abundance during May and June in areas of moderate upwelling, particularly between Point Reyes and Point Conception (Figure 3-3).

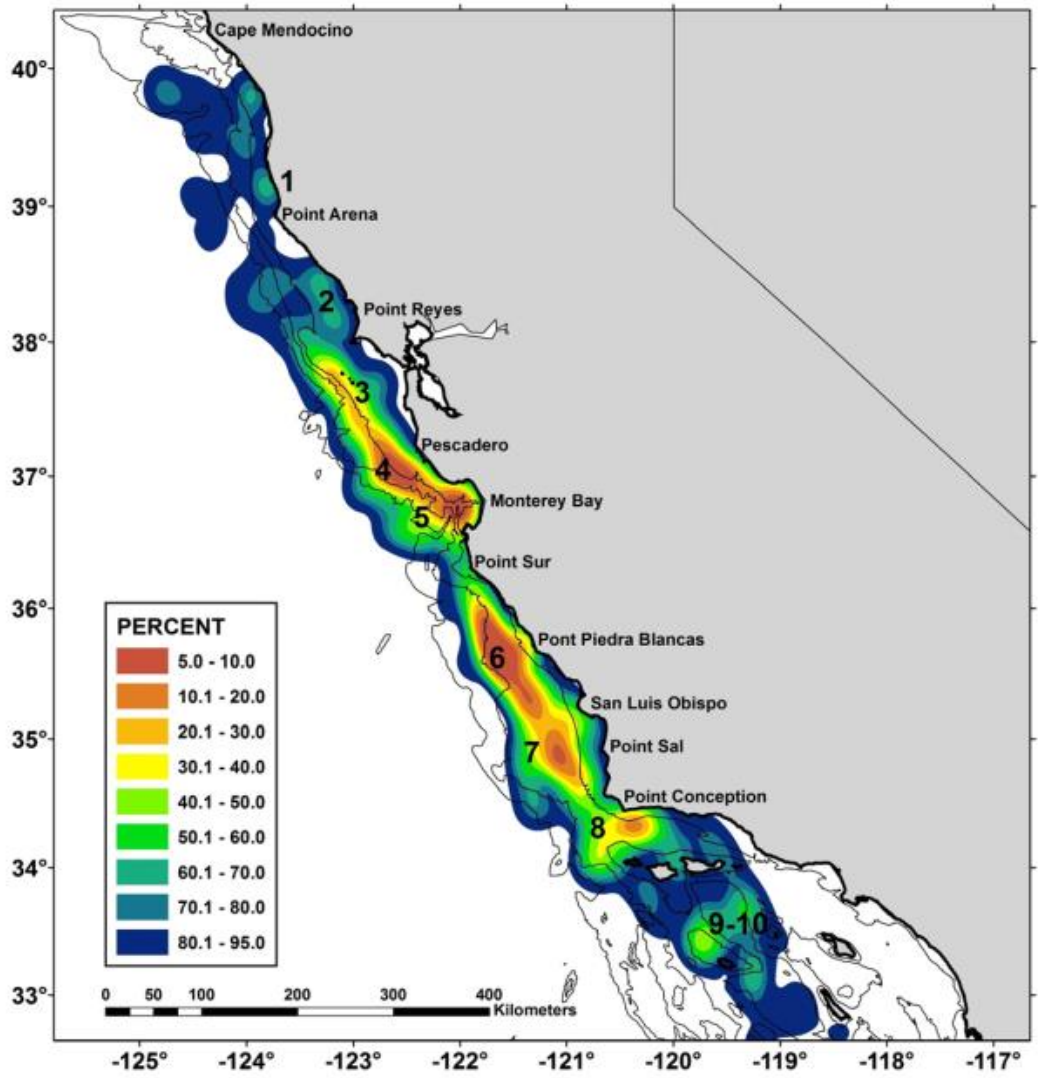

Figure 3-3. Krill hotspots along the California coast during May-June, 2004-2009, depth contours denote 200m, 1000m, and 2000m isobaths, respectively; percent value denotes the relative krill abundance of an area as a percentile within all sampled areas; areas in the 5th to 20th percentiles are considered “high,” and areas in the 20th to 40th percentile are considered “medium”. From Santora et al. 2011.

3.3 Humpback Whales

Humpback whales are broadly distributed amongst the world’s ocean. No formally designated subspecies currently exist, consistent with Rice (1998). However, more recently Jackson et al. (2014) recommended defining distinct subspecies for each major ocean basin (North Pacific,

North Atlantic, Southern hemisphere). Bettridge et al. (2015) solicited the expert opinion of the Committee on Taxonomy of the Society for Marine Mammalogy, who indicated that a taxonomic revision of the humpback whale would likely accord subspecies status to the North Pacific, North Atlantic, and Southern Hemisphere populations. However, at this time humpback whales remain classified as a single species.

For the purpose of management under MMPA, NMFS has defined four stocks of humpback whales, three of which occur in the North Pacific. NMFS recognizes a single stock of humpback whales along the West Coast (the California/Oregon/Washington stock) comprised of two feeding groups, one which forages off California and Oregon and one which forages off Northern Washington and southern British Columbia (Carretta et al. 2020). Based largely on mark-recapture data from 2011-2014, Caretta et al. (2021) provides an abundance estimate of 2,900 whales for the CA/OR/WA stock, with a minimum abundance estimate of 2,784. In contrast, Calambokidis and Barlow (2020) used photo-identification data collected through 2018 to estimate the abundance of the CA/OR/WA stock as 4,973 whales, with a minimum abundance estimate of 4,776.

NMFS has designated 14 DPS worldwide (Figure 3-4), four of which are located within the North Pacific (Hawaii, Central America, Mexico, and Western North Pacific). A recent comprehensive review of humpback whale habitat utilization within the North Pacific has confirmed that while the California/Oregon/Washington stock is comprised of members from the Hawaii, Central America, and Mexico DPS, only individuals from the Mexico and Central America DPS are found off California (NMFS 2020b). The Mexico DPS breeds along the Pacific coast of mainland Mexico and the Revillagigedo Islands, and feeds along a broad swath of the Northeastern Pacific Ocean from Central California to the Aleutian Islands (81 FR 62260). The Central America DPS breeds along the Pacific coasts of Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua and feeds almost exclusively off California and Oregon (81 FR 62260).

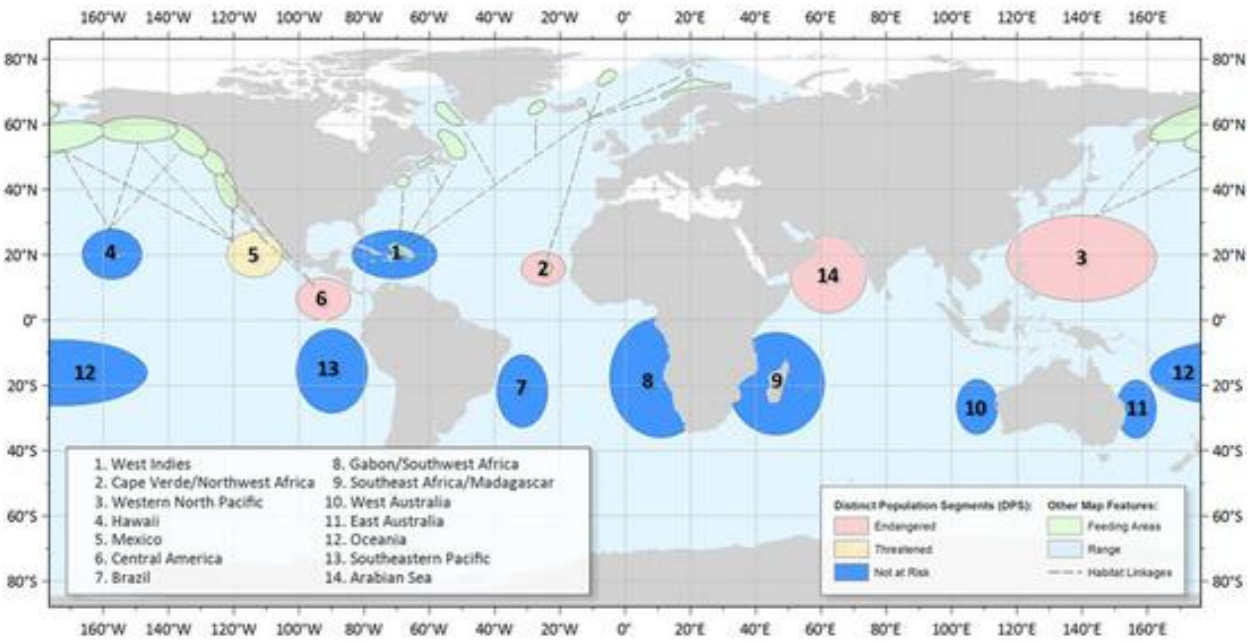

Figure 3-4. Map showing locations of 14 Humpback Whale Distinct Population Segments breeding and feeding areas. Source: https://www.fisheries.noaa.gov/species/humpback-whale, accessed 2/21/2020.

The most recent attempt at connecting humpback whales which forage in the North Pacific to their winter breeding grounds was conducted by the International Whaling Commission in 2021 (Wade 2021; Figure 3-5). Wade estimated 57.7% of the humpback whales feeding off California and Oregon originate from the Mexico DPS, with the remainder (42.3%) originating from the Central America DPS. This movement analysis also indicated that the waters off California and Oregon are disproportionately important for the Central America DPS – 96.7% of that DPS forages here, compared to 21.3% of the Mexico DPS.

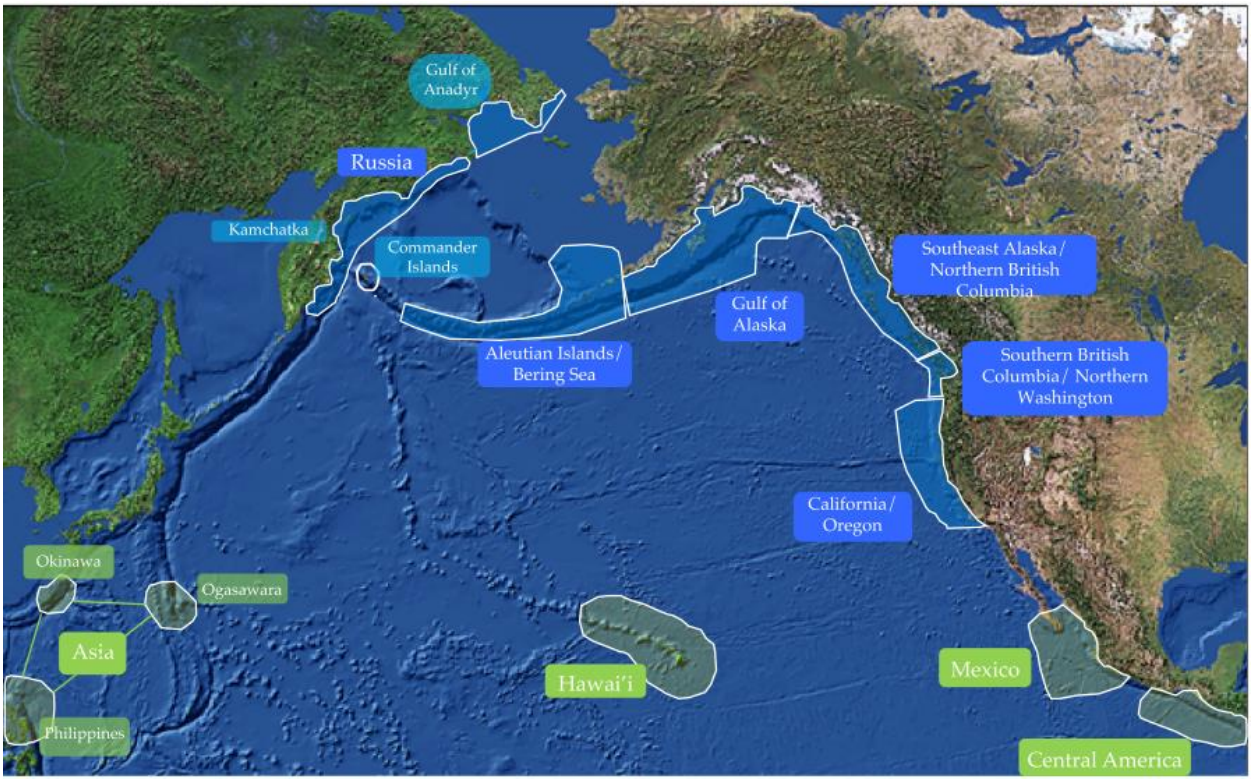

Figure 3-5. Regional strata used by Wade 2021, with six summer foraging areas designated in blue and four winter areas designated in green. Subareas within Asia and Russia are identified by lighter shading. Polygon boundaries roughly enclose the spatial extent of survey effort for each area.

While this analysis is based on a study conducted between 2004-2006, Yates (2021) stipulates Wade (2021) should be considered the best available science regarding mixing proportions of the Mexico, Central America, and Hawaii DPS along the West Coast. When combined with the Calambokidis and Barlow (2020) abundance estimates, Yates (2021) estimates the current abundance of the Central America DPS as 2,006 individuals, the current abundance of the Mexico DPS as 6,981 individuals, and the current abundance of the Demographically Independent Population (DIP) of the Mexico DPS which forages off California and Oregon as 2,770 individuals.

Identifying individuals and their source DPS is rarely possible in real time during an entanglement response or during post-hoc forensic review (personal communication, Pieter Folkens, May 1, 2020). Genetic tissue sample collection is not always possible due to the hazard of approaching an entangled whale and safety considerations for the response team. Furthermore, only four individuals on the West Coast are currently authorized as Level 4 members of the West Coast Large Whale Entanglement Response Program and able to collect tissue samples allowing for genetic analysis. High-quality photographs of the flukes or dorsal fins can be compared to identification databases but can be difficult to acquire with available equipment or if the entanglement configuration restricts movement. Therefore, with the exception of evaluating DPS-specific impacts of proposed take (see Section 4.3.1), for purposes of this CP references to humpback whales (such as in the implementation of the Conservation Program in Chapter 5), refer to the CA/OR/WA stock as defined by MMPA, rather than the Central America or Mexico DPS.

Humpback whales rarely feed while on the breeding grounds and rely on seasonal foraging in temperate latitudes to replenish the energy stores needed to support migration and successful breeding (NMFS 2020b). Historical whaling records from Monterey and Trinidad in the early 20th century indicate mean body condition was lowest in March, increased through the summer, and peaked in October (Clapham et al. 1997). Humpback whales require high-density prey patches to build sufficient energy reserves (Friedlander et al. 2009; Hazen et al. 2009). The high energetic costs of lunge feeding compared to swimming at constant speed drive humpback whale foraging behavior (Goldbogen et al. 2008). Humpback whales are capable of completing multiple foraging lunges at depth during a single dive event, although as the number of lunges and dive duration increases, so does the subsequent surface interval (Kieckhefer 1992; Goldbogen et al. 2008). Humpback whales target the upper boundary of dense prey aggregations, possibly to minimize the energy costs from diving and searching at depth, and will alter their dive profiles to repeatedly sample high-quality prey patches before returning to the surface (Goldbogen et al. 2008; Friedlander et al. 2016).

Their main prey targets are euphausiids (particularly *E. pacifica* and *T. spinifera*) and small pelagic fish such as northern anchovy, Pacific herring, and Pacific sardine (Kieckhefer 1992; Clapham et al. 1997; Fleming et al. 2016; NMFS 2020b). The distribution and abundance of both krill and small pelagic fish are impacted by basin-scale and local oceanographic conditions and vary from year to year (Chavez et al. 2003). Acoustic and trawl surveys conducted during the spring and summer in the CCS show both interannual and seasonal variability in the distribution and abundance of these fish species, although anchovy exhibited higher geographic affinity and were consistently caught close to shore off the Columbia River mouth and Monterey Bay (Zwolinski et al. 2012, 2016, 2017). Fluctuations in upwelling can also modulate fine-scale distribution of prey species, with smaller, more discrete aggregations of krill and anchovy found during strong upwelling and more diffuse distribution during relaxation of upwelling conditions (Benoit-Bird et al. 2019). Anchovy and sardine spawning habitat also varies between years, although in general anchovy eggs are found closer to shore and concentrated within the Southern California Bight while sardine eggs are more abundant offshore and north of Point Conception (Reiss et al. 2008).

Unlike blue whales, humpback whales are generalist predators, switching prey species depending on their relative abundance and quality (Clapham et al. 1997; Fleming et al. 2016; Santora et al. 2020). Humpback whale diets are dominated by krill during years with low SST, positive NPGO and high upwelling, which result in elevated nutrient levels and higher krill abundance. Conversely, anchovy and sardines are more prevalent during years with higher SST, negative NPGO, and delayed upwelling.

Humpback whales are most common in relatively cool waters over the continental shelf and slope, remaining largely nearshore during the summer and fall and extending farther offshore during the winter and spring (Becker et al. 2017). Calambokidis et al. (2015) identified seven BIAs where humpback whales are commonly seen feeding (Figure 3-6). Together, the seven BIAs represent 3% of EEZ waters off the West Coast, while encompassing 89% of the humpback whale sightings between 1986 and 2011. Four of the BIAs are located off California (Fort Bragg to Point Arena, Gulf of the Farallones to Monterey Bay, Morro Bay to Point Sal, and the Santa Barbara Channel to San Miguel Island), underscoring the importance of the Plan Area for this species. There is also substantial overlap between these BIAs and traditional Dungeness crab fishing grounds.

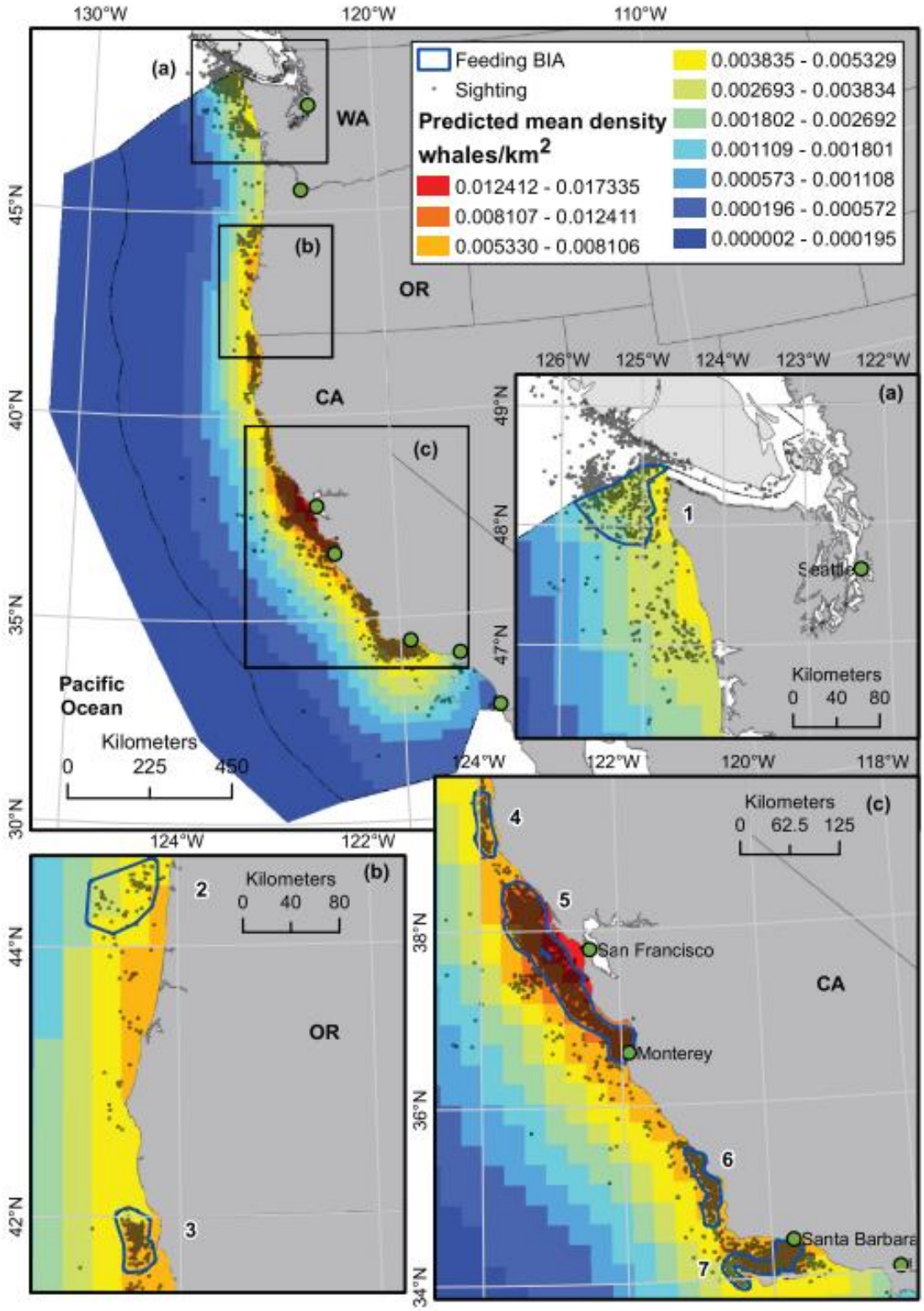

Figure 3-6. BIAs for humpback whales off the West Coast, from Calambokidis et al. 2005. Cooler colors (blues) indicate lower predicted mean density, while warmer colors (reds) indicate higher predicted mean density. Black dots represent individual humpback whale sighting locations, over which BIA boundaries are shown.

Based on available sightings information, Calambokidis et al. (2015) concluded humpback whales were most common from July to November between Fort Bragg and Monterey Bay, April to November between Morro Bay and Point Sal, and March to September from the Santa Barbara Channel to San Miguel Island. There is limited overlap between these periods and the scheduled timing of the commercial Dungeness crab season (see Section 2.2.5), although Forney and Barlow (1998) have documented some presence of humpback whales off California year-round. However, basin-scale oceanographic conditions may modify seasonal occurrence patterns. Daily observations at the Farallon Islands indicate humpback whales arrive earlier during years characterized by cool-phase PDO values and depart later during years with neutral or high NPGO values (Ingman et al. 2021). Additionally, similar to the trend for blue whales, Ingman et al. (2021) has documented a shift in the initial arrival of humpback whales from early October in 1993 to early June in 2016. The extended residency of humpback whales overlaps to a greater extent with the commercial Dungeness crab season, which can contribute to increased entanglement risk.

3.4 Leatherback Sea Turtles

Leatherback sea turtles are the largest and most widely distributed sea turtle species in the world. Of the sea turtles found north of Mexico, they have the most northern distribution and are frequently sighted between Northern Baja and Oregon, with occasional sightings off Washington, Canada, and Alaska (Stinson 1984). A recent status review of the leatherback sea turtle identified seven potential DPS (Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, and East Pacific), although no DPS have been formally designated under ESA (NMFS and USFWS 2020). Of the two populations within the Pacific Ocean Basin only the West Pacific population is known to forage within the CCS (Benson et al. 2011; Benson et al. 2020; NMFS and USFWS 2020), and is the primary focus of this CP.

The West Pacific population primarily nests on beaches along the north coast of the Bird's Head Peninsula in Indonesia, although nesting has also been documented in Papua New Guinea, Vanuatu, and the Solomon Islands (Benson et al. 2011; NMFS and USFWS 2020). The two main nesting beaches are Jamursa Medi and Wermon (Benson et al. 2011; Tapilatu et al. 2013). A large-scale satellite telemetry tagging effort by Benson et al. (2011) showed that while leatherback sea turtles utilize broad swaths of the Pacific Ocean basin, only those turtles nesting during the summer at West Papua, Indonesia forage within the CCS. Of the leatherbacks in the study, approximately 62% of the turtles nesting in West Papua move towards the North Pacific after nesting, with 27% eventually reaching the CCS. Of the turtles tagged within CCS foraging grounds, 97% eventually move towards the Eastern Equatorial Pacific, from which they either continue moving towards nesting beaches in the Western Pacific (28%) or return to the CCS after a two to three month overwintering period (72%).

Leatherback sea turtles first enter the CCS via the SCB in the spring, after which they travel through nearshore waters to foraging areas in central California (Benson et al. 2011). South of Point Conception, leatherback sea turtles first appear during May and June and are most common during the July – September "turtle season" (Stinson 1984). North of Point Conception, 87% of sightings are within this turtle season. Leatherback sea turtle abundance is positively correlated with Northern Oscillation Index values, and the timing of their arrival in California foraging areas is associated with upwelling (Benson et al. 2007; Eguchi et al. 2016). Leatherback sea turtle sightings are also associated with surface drifts of jellies, as well as

concentrations of albacore and bluefin tuna (Stinson 1984). Individuals begin to depart the CCS in October and November when water temperature begins to drop and productivity decreases (Thomas and Strub 2001; Benson et al. 2011). Approximately two-thirds (67.5%) of the leatherback sea turtles which forage off California are female (Benson et al. 2007) and they exhibit strong fidelity to foraging sites, with individuals returning to the CCS in subsequent years (Benson et al. 2011).

Within the CCS the primary leatherback sea turtle foraging area lies between Monterey Bay and Point Arena (Benson et al. 2011; Benson et al. 2020; Figure 3-7), where they have been observed feeding on *Chrysaora fuscescens, C. colorata,* and *Aurelia sp.* (Benson et al. 2007). This region is characterized by 14-16°C waters over the continental shelf (< 200m) with high levels of chlorophyll and low physical energy, supporting high concentrations of gelatinous prey within Northern Monterey Bay, the Gulf of the Farallones, and Point Reyes (Lenarz et al. 1995; Graham et al. 2001; Benson et al. 2011).

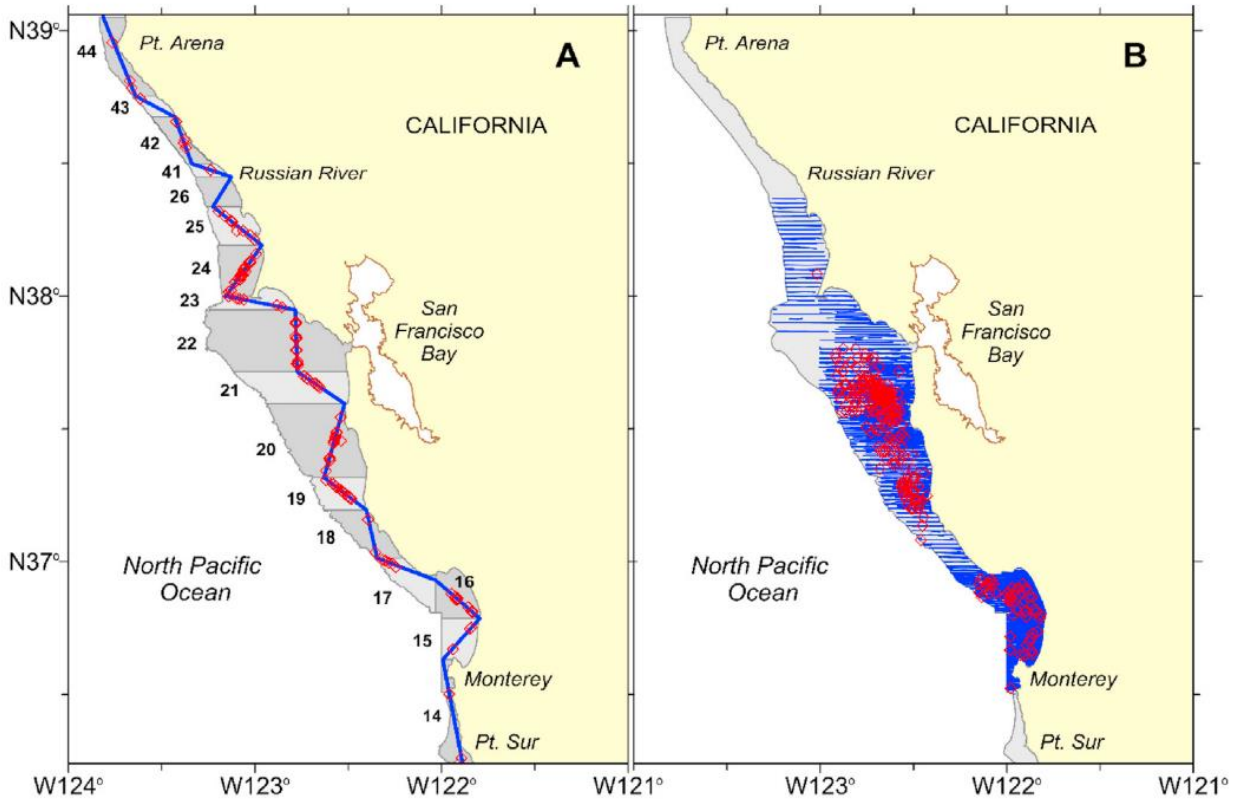

Figure 3-7. Aerial survey coverage (A) along harbor porpoise transects, 1990-2017 and (B) along adaptive fine-scale surveys that primarily covered waters from Monterey Bay to San Francisco, 2000-2017. Blue lines show transects; red diamonds show leatherback sea turtle sightings. Analysis strata are shown in alternating light and medium gray shading in panel (A), with stratum/transect numbers shown alongside. From Benson et al. 2020.

Studies of foraging leatherback sea turtles in the Atlantic Ocean indicate they are efficient and successful predators who consume 96 times their body weight in jellies each year, with higher proportions for juveniles and lower proportions for adults (Heaslip et al. 2012; Jones et al. 2012). Within Monterey Bay, between 1986 and 1991 the highest number of leatherback sea turtle sightings were during August and correlated with high SST (Starbird et al. 1993). While

leatherback sea turtle sightings occur seasonally regardless of ocean temperatures, during warmer years they are reported in greater numbers and over a longer period north of Point Conception (Stinson 1984).

Within the CCS, leatherback sea turtle abundance has declined by 5.6% annually between 1990 and 2017, with a total decline of 80% over that period (Benson et al. 2020). Benson et al. (2020) found no evidence for declines in habitat quality or prey availability within the CCS, although this decline is closely correlated with declines observed at the Jamursa Medi and Wermon nesting beaches by Tapilatu et al. (2013). The most recent estimate of West Pacific nesting female abundance is 1,277 individuals; however, this estimate relies on surveys from a subset of nesting beaches and should be viewed as an index rather than the total abundance of nesting females (NMFS and USFWS 2020).

CHAPTER 4. POTENTIAL BIOLOGICAL IMPACTS AND TAKE ASSESSMENT

While entanglements are only one activity that would be considered take under the definitions in ESA and MMPA (see Chapter 1), this CP's focus is the impact of Covered Activities on Covered Species resulting from entanglements in commercial Dungeness crab trap gear. Importantly, not all entanglements result in removal of the entangled individual animal from the population. Therefore, this CP uses the term "take" when discussing entanglements and "removal" when discussing entanglements which are known or expected to result in mortality and serious injury (M&SI).

This Chapter presents evaluations of both existing and recent take levels (Section 4.1). The Chapter also identifies the take amounts that CDFW is requesting pursuant to an ITP (Section 4.2), potential biological impacts of the requested take (Section 4.3), potential impacts of the Covered Activities on critical habitat for the Covered Species (Section 4.4), and cumulative effects and impacts of anthropogenic take (Section 4.5). CDFW does not anticipate any take resulting from CP monitoring or mitigation activities.

4.1 Existing Take Levels: 2014-2020

Unlike a development project, in which a new source of take is proposed, this CP and associated ITP application seek coverage for ongoing Covered Activities with a documented history of Covered Species take. Therefore, there is no clear starting point for evaluating take from the Covered Activities. Typically, ITPs which provide coverage for ongoing Covered Activities use prior take levels as the basis for determining requested take, with the presumption that take of a similar magnitude will continue for the duration of the permit. However, recent changes in entanglement reporting specificity, variable ecosystem conditions, and modifications and improvements to management approaches prior to submission of the ITP application (Figure 4-1) make it unlikely that prior take levels properly reflect the anticipated future take by the fishery, as further detailed below.

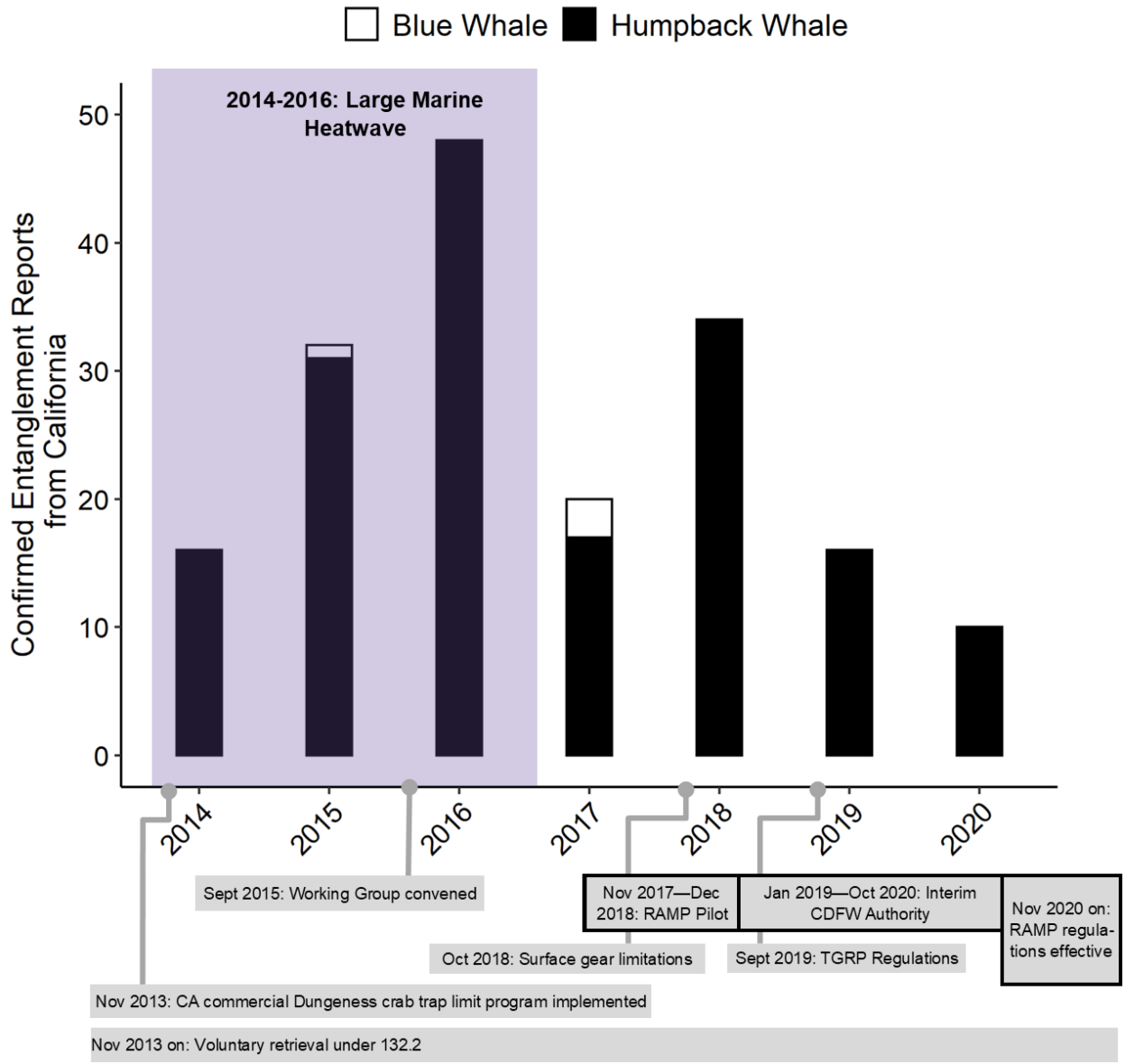

Figure 4-1. Annual confirmed entanglements of blue and humpback whales reported off California, all gear types, 2014-2020, with notes regarding ecosystem conditions, gear detectability, and key changes in Dungeness crab fishery management.

CDFW considered multiple factors to identify the period that best captures existing take levels. While sea turtle stranding records are available from 1981 on, and large whale entanglement records are available from 1982 on, NMFS has characterized 2013 as the beginning of the "modern era of entanglements" based on increased availability and quality of documentation for entanglement reports (Saez et al. 2021). Sea turtle stranding data began receiving additional scrutiny in 2015, with an increased focus on attributing leatherback sea turtle entanglements to specific fisheries, as is done for large whales (personal communication, Dan Lawson, June 4, 2021). Additionally, requirements to mark California commercial Dungeness crab gear with a unique buoy tag went into effect beginning with the 2013-14 season. When the main buoy is visible, or the gear can be retrieved by an entanglement response team, this unique tag makes it easier to attribute an entanglement to the commercial Dungeness crab fishery. Each state

uses different colors and shapes for their fishery's tags (Figure 4-2), allowing managers to attribute commercial Dungeness crab entanglements to either the California, Oregon, or Washington fishery. To account for the increased detectability of California commercial Dungeness crab gear involved in entanglements, CDFW uses the 2014 calendar year as the starting point to assess existing take levels.

Figure 4-2. From left to right: Examples of California, Oregon, and Washington commercial Dungeness crab buoy tags (tier specific and replacements). Color (for all three states) and shapes (for Washington) vary between seasons. Photos provided by Lauren Saez, NMFS.

4.1.1 Existing Covered Species Take Levels, All Fisheries and Reporting Areas

Confirmed entanglements (i.e., NMFS personnel were able to verify the entanglement occurred, and the entanglement is distinct from other reports) of large whales involving unidentified gear make it difficult to estimate total take by any given fishery. Of the 252 confirmed large whale entanglements reported off the West Coast between 2014 and 2020, slightly more than half (52%, n = 130) involved unknown gear (Table 4-1). Of those where the gear could be identified (n = 122), 60% (n = 73) involved commercial Dungeness crab gear.

Looking specifically at the Covered Species, of the seven confirmed blue whale entanglements reported off the West Coast between 2014 and 2020 four (57%) occurred in unidentified fishing gear and the other three (43%) occurred in commercial Dungeness crab gear. Of the 172 humpback whale entanglements reported off the West Coast during this period, 48% (n = 82) occurred in unidentified fishing gear. Of the 90 humpback whale entanglements where the gear could be identified, 64% (n = 58) were in commercial Dungeness crab gear, with the remainder occurring in netting (including gillnet) or other types of commercial (rock crab, lobster, sablefish, spot prawn) and recreational (Dungeness crab, spot prawn) trap gear.

Table 4-1. Fishery gear type for confirmed West Coast Region entanglement records by large whale species, 2014 – 2020, all reporting locations (created with data from Saez et al. 2021).

Fishery Type	Blue	Humpback	Other/Unidentified	Total
Dungeness crab commercial	3	57	12	72
Dungeness crab commercial + rock crab	0	1	0	1
Dungeness crab recreational	0	3	0	3
Gillnet	0	9	16	25
Lobster trap	0	1	0	1
Net	0	4	0	4
Other	0	1	1	2
Sablefish pot	0	4	0	4
Commercial spot prawn pot	0	9	0	9
Recreational spot prawn pot	0	1	0	1
Unknown	4	82	44	130
Grand Total	7	172	73	252
Annual Average	1	24.6	10.4	36

For sea turtles, data from the SWFSC stranding database indicate the majority of the 36 fishery interactions between 2014 and 2020 were with green sea turtles. For leatherback sea turtles during this period, one of the fishery interactions was with unspecified gear, one was with commercial Dungeness crab gear, and one was with commercial rock crab gear (Table 4-2).

Table 4-2. Gear descriptions for confirmed West Coast fishery interactions by sea turtle species, 2014-2020. Created from NMFS SWFSC Sea Turtle Stranding Database (4/27/2021) and unpublished data from NMFS West Coast Region Protected Resources Division (6/4/2021).

Gear Description	Leatherback	Other	Total
Dungeness crab commercial	1	0	1
Rock crab commercial	1	0	1
Hook & line	0	27	27
Hook & line + netting	0	1	1
Monofilament	0	2	2
Monofilament + braided line	0	1	1
Monofilament netting	0	2	2
Unspecified	1	0	1
Grand Total	3	33	36
Annual Average	0.4	4.7	5.1

Additional details regarding the process for confirming entanglements and identifying fishery gear sources are provided in Section 5.2.1.1.

4.1.2 Existing Covered Species Take Levels in the California Commercial Dungeness Crab Fishery

Between 2014 and 2020 there were 42 known humpback whale, three known blue whale, and one known leatherback sea turtle entanglements in California commercial Dungeness crab gear (Table 4-3).

Table 4-3. Confirmed entanglements in California commercial Dungeness crab gear by year for each Covered Species, 2014-2020. Created with data from Saez et al. 2021 and NMFS SWFSC Sea Turtle Stranding Database, 4/27/2021.

Year	Blue Whale	Humpback Whale	Leatherback Sea Turtle
2014	0	2	0
2015	0	7	0
2016	2	19	1
2017	1	3	0
2018	0	7	0
2019	0	3	0
2020	0	1	0
Grand Total	3	42	1
Annual Average	0.4	6	0.1

While there has been documented take of all three Covered Species in California commercial Dungeness crab gear, by far the highest number of entanglements have been of humpback whales. Of the 42 humpback whale entanglements in California commercial Dungeness crab gear, 28 (66.7%) occurred during the 2014-16 LMH. As noted in Section 3.1, this unprecedented LMH event led to an extended delay in the 2015-16 fishing season. Santora et al. (2020) directly connects the heatwave's impacts on fishery operations and Covered Species distributions with the dramatic increase in large whale entanglements documented in 2015 and 2016 (Figure 4-3). While the number of entanglements has since declined, the entanglements documented during this LMH were the impetus for CDFW's increasingly active management of the Dungeness crab fishery and request for an ITP.

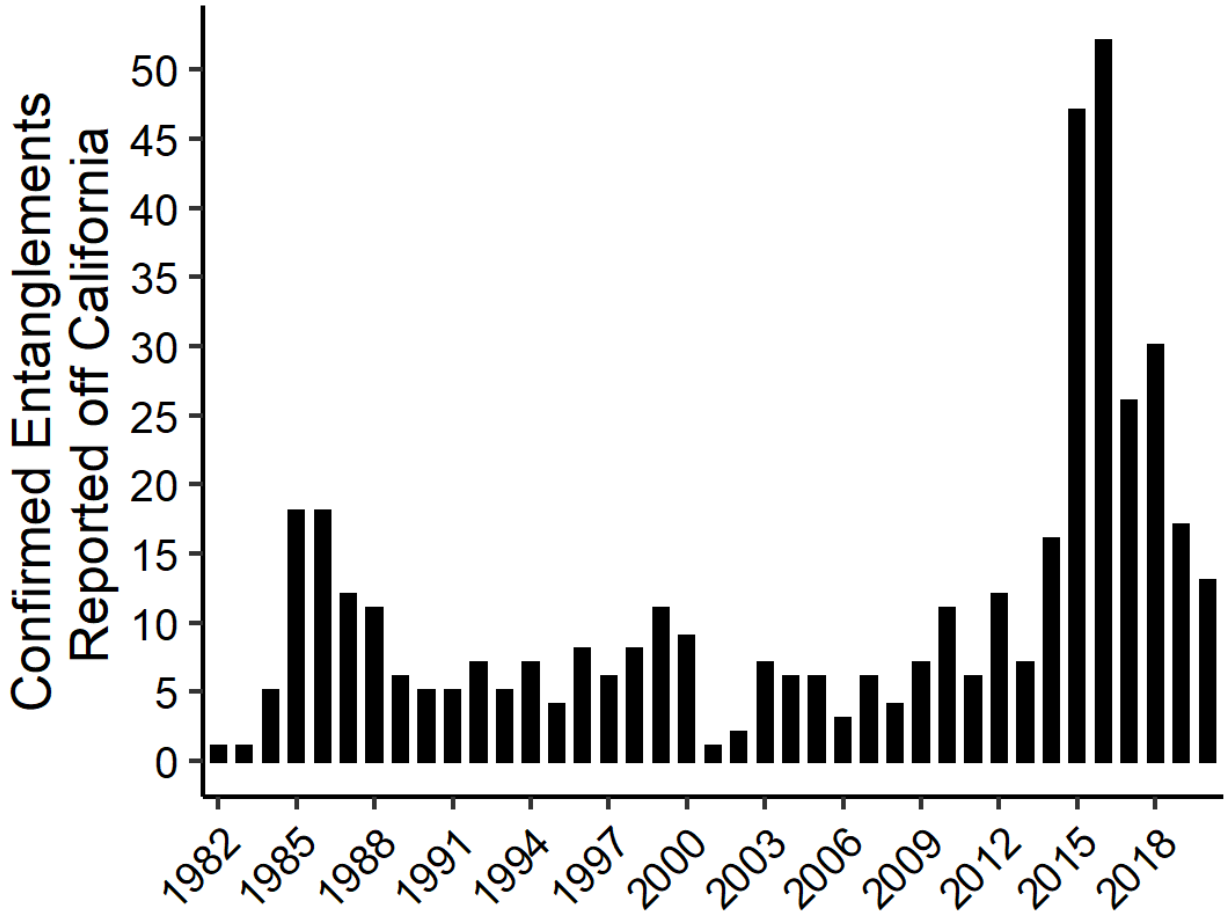

Figure 4-3. Confirmed large whale entanglements reported off California, all species and gear types, 1982 – 2020.

Driven by a growing need to address marine life entanglement issues following the 2014-16 LMH, CDFW has phased in management changes for the commercial Dungeness crab fishery. For example, the Working Group first piloted what would eventually become the RAMP (the primary conservation strategy described further in Section 5.2) during the 2017-18 fishing season to evaluate and respond to marine life entanglement risk. Initially, any changes in fishery operations due to elevated entanglement risk were made voluntarily by the fishing fleet. Midway through the 2018-19 RAMP pilot, the California Legislature passed Fish & G. Code § 8276.1 granting the Director interim authority to implement mandatory in-season management measures to mitigate entanglement risk for the commercial Dungeness crab fishery. The fishery was managed under this interim authority until November 1, 2020, when formal regulations implementing the RAMP became effective. The Trap Gear Retrieval Program (see Section 5.4) was established in September 2019 and implemented in 2020. Surface gear restrictions went into effect in October 2018 (see Section 2.2.2). Along with other elements of the Conservation Program described in Chapter 5, CDFW believes mandatory management measures will prevent the high number of entanglements seen during the 2014-16 LMH from happening during the permit term.

4.1.3 Recent Covered Species Take, 2019-2020

CDFW began active in-season management to reduce marine life entanglements in the commercial Dungeness crab fishery beginning in January 2019. These management measures are similar to those described in the Conservation Program in Chapter 5 and allow for a preliminary assessment of expected take once the Conservation Program is fully implemented.

Looking only at confirmed entanglements during 2019 and 2020, four humpback whales, zero blue whales, and zero leatherback sea turtles were entangled in California commercial Dungeness crab gear. Accounting for confirmed entanglements in unidentified gear reported off California, there were an additional 10 humpback whale entanglements reported off California during this period.

4.2 Requested Allowable Take of Covered Species

CDFW is requesting the following allowable take levels of Covered Species by the California commercial Dungeness crab fishery: up to nine humpback whales every three years, up to one blue whale every three years, and up to one leatherback sea turtle every 10 years. Over the requested 21-year term of the permit, this equates to a total of 63 humpback whales, seven blue whales, and two leatherback sea turtles. For purposes of determining whether these take thresholds have been reached, CDFW will also consider every two confirmed entanglements in Unknown Fishing Gear, as defined in Section 5.2.1.1.3, to constitute take of a single individual by the California commercial Dungeness crab fishery. As further described in Section 5.2.1.1.3, this apportionment is based on the relative abundance of vertical lines used in the commercial Dungeness crab fishery as compared to other trap fisheries operating off California.

In determining its requested take levels, CDFW looked at existing (Section 4.1.2) as well as more recent (Section 4.1.3) take levels. While the existing take levels between 2014 and 2020 are unacceptably high, CDFW believes the recent 2019-2020 period provides a more realistic representation of anticipated take levels during implementation of this CP. Applying the 50% apportionment to the recent take levels in Section 4.1.3, and assuming each of the entanglements in unidentified fishing gear were determined to have occurred in Unknown Fishing Gear, results in a two-year total of nine humpback whale entanglements assumed to be attributable to the California commercial Dungeness crab fishery. Assuming a constant rate of entanglement, this equates to a three-year total of 13.5 humpback whale entanglements for the fishery. This number of humpback whale entanglements exceeds the requested take level, however this is primarily driven by the entanglements in Unknown Fishing Gear. As described further in Section 5.2.1.1.3, CDFW expects new state gear marking requirements and enhanced forensic review efforts will reduce the number of entanglements classified as occurring in Unknown Fishing Gear. Additionally, CDFW anticipates full implementation of the Conservation Plan will further reduce overall entanglement rates.

There have been no confirmed entanglements of blue whales or leatherback sea turtles in California commercial Dungeness crab gear, or reported off California in unidentified fishing gear or Unknown Fishing Gear, during 2019 and 2020. While CDFW anticipates some amount of take of these two species over the permit term, these values suggest the management measures during this period, as augmented under a fully implemented CP, will be effective at maintaining low take levels for these species.

4.3 Anticipated Impacts of Taking

Pursuant to ESA, an ITP can only be issued if the proposed activities will not jeopardize the continued existence of any listed species (16 USC § 1536 subd. (a)(2)), among other requirements. Jeopardy exists when an agency action reasonably would be expected, directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild (50 CFR § 402.02). For humpback and blue whales, CDFW has utilized the MMPA Negligible Impact Threshold (NIT) to aid in analyzing impacts of the taking. The NIT is the amount of human-caused removal (i.e., take resulting in M&SI) below which impacts are expected to be negligible on a given stock. MMPA does not apply to leatherback sea turtles, and although Curtis et al. (2015) posits three potential thresholds against which to evaluate take of this species, neither these nor another equivalent standard have been adopted by NMFS. Given the additional conservation measures being implemented (as described in Chapter 5), CDFW anticipates decreased take of leatherback sea turtles; therefore, the requested take levels are lower than the average annual take by this fishery shown in Table 4-2.

4.3.1 Anticipated Impacts of Taking Blue Whales and Humpback Whales

For the purposes of this CP, CDFW analyzed maximum allowable take levels for blue whales and humpback whales using the NIT standard. The MMPA authorizations needed to receive an ITP for a commercial fishery can only be issued if such take will have a negligible impact on a species or stock (16 USC § 1371 subd. (a)(5)(E)). This is defined as an impact that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR § 216.103). In this analysis CDFW assumes activities which do not adversely impact annual rates of recruitment or survival (as required by MMPA) are also unlikely to appreciably reduce the likelihood of survival and recovery of the species (as required by ESA). Additionally, much of the readily available science analyzing abundance, population trends, and impacts of fishing activity on these species has been developed within the MMPA context (i.e., at the stock level rather than the DPS level). Furthermore, since issuance of an ITP requires meeting both ESA jeopardy standard and the MMPA negligible impact standard, utilizing the NIT calculation in determining impacts from the requested level of take confers the benefit of streamlining ESA permitting requirements with MMPA authorizations.

NMFS Procedure 02-204-02 (NMFS 2020c) defines NIT with the following formula:

$$NIT_i = N_{min} * 0.5R_{max} * NIF_i$$

where N_{min} represents the minimum abundance estimate for a species/stock, and R_{max} represents the maximum net productivity rate for that species/stock. NIF_i represents a "negligible impact factor," which represents the delay in recovery due to anthropogenic mortality. The value of i for NIT_i and NIF_i can be set to either t (the total impact across all sources) or s (the impact of a specific source, such as a single fishery). If total removals (i.e., cumulative mortality and serious injury) across all anthropogenic sources are less than NIT_t, then all fisheries which interact with that stock are considered to have negligible impacts under MMPA. If total removals exceed NIT_t, then NMFS evaluates the effect of an individual fishery as NIT_s.

The NMFS Procedure states that N_{min} and R_{max} values should be those used to calculate PBR in the most recent stock assessment, and sets NIF_s for commercial fisheries as 0.013. CDFW has used the R_{max} value from Carretta et al. (2020). However, the N_{min} values in Carretta et al.

(2020) rely on estimates based on mark-recapture data collected between 2011 and 2014 (for humpback whales) and line transect surveys conducted in 2014 (for blue whales), and CDFW does not consider these to be reliable estimates of current abundance.

Pursuant to NMFS Instruction 02-204-01, abundance estimates based on data collected several years prior no longer "provide reasonable assurance that the stock size is presently greater than or equal to that estimate", and N_{min} should be considered unknown if eight or more years have transpired since the last abundance survey (NMFS 2016). The abundance surveys used in Carretta et al. (2020) are only marginally below this eight-year threshold. Furthermore, while not determinative, a recent Biological Opinion prepared for the West Coast groundfish fishery (NMFS 2020d) as well as updated guidance from NMFS WCR Protected Resources Division (Yates 2021) rely on updated abundance estimates from Calambokidis and Barlow (2020) rather than the values from Carretta et al. (2020) when calculating N_{min}.

After considering all the above, CDFW considers the Calambokidis and Barlow (2020) estimates to constitute the best available information regarding current abundance of blue and humpback whales. CDFW has therefore chosen to use N_{min} values from Calambokidis and Barlow (2020), which is consistent with the approach taken in NMFS (2020b) and Yates (2021). Given the three-year cycle for issuance of the necessary MMPA take authorizations and the corresponding three-year requested take allowance, CDFW has converted the annual NIT_s into a three-year total, as shown in Table 4-5.

Table 4-5. Preliminary NIT calculation for humpback and blue whales.

Species	N_{min}	R_{max}	NIF_s	Annual NIT_s	Three-Year Total NIT_s
Blue Whale	1,767	0.04	0.013	0.46	1.38
Humpback Whale	4,776	0.08	0.013	2.48	7.44

For blue whales, the MMPA stock designation matches the listed DPS under ESA; therefore, the three-year total NIT_s value in Table 4-6 directly translates to the maximum removals which would be considered negligible for the purposes of MMPA. CDFW's requested take level of one blue whale every three years is below the three-year total NIT_s value of 1.38 blue whales every three years and can therefore be considered negligible. Furthermore, NMFS 2020e calculates an average M&SI rate of 0.92 for blue whales entangled in Dungeness crab gear, suggesting that the take of one blue whale over a three-year period will only result in the removal of 0.92 blue whales.

NMFS 2020e calculates an average M&SI rate of 0.75 for humpback whales entangled in California commercial Dungeness crab gear where gear was not removed through human intervention. Applying this proportion to the requested take level of nine humpback whales every three years equates to removal of 6.75 individuals every three years, which is below the three-year total NIT_s value of 7.44 humpback whales every three years. However, as described in Section 3.2.1, humpback whales off California originate from multiple DPS, and Yates (2021) highlights the importance of accounting for impacts of requested take on each DPS.

Yates (2021) identifies Wade (2021) as the best available information regarding the proportion of humpback whales present off California and Oregon from the Mexico (0.58) and Central America (0.42) DPS' and combines these proportions with the Calambokidis and Barlow (2020) abundance estimates to calculate N_{min} values of 2,006 for the Central America DPS and 2,770 for the DIP of the Mexico DPS which forages off California, Oregon and Washington. While

Yates (2021) estimates a much higher total abundance for the Mexico DPS (6,981), the guidance dictates jeopardy analyses should be conducted on the relevant DIP. Therefore, CDFW calculated NIT_s equivalents for the two covered DPS units (Table 4-6) using N_{min} values from Yates (2021), the R_{max} value from Carretta et al. (2020), and NIF_s of 0.013 as defined in the NMFS Procedure.

Table 4-6. Preliminary NIT_s equivalent calculations for the Mexico DPS (California/Oregon/Washington DIP) and Central America DPS of humpback whales.

Distinct Population Segment	N_{min}	R_{max}	NIF_s	Annual NIT_s	Three-year Total NIT_s
Mexico – CA/OR/WA DIP	2,770	0.08	0.013	1.44	4.32
Central America	2,006	0.08	0.013	1.04	3.12

CDFW considered two methods for evaluating the DPS-specific impact of the requested take level (nine humpback whales per three-year period). The first method assumes that all entangled humpback whales off California belong to the most endangered DPS, i.e., all entangled whales are from the Central America DPS. However, given the best available science regarding the distribution of both DPS (including the known presence of Mexico DPS humpback whales off California), CDFW considers this to be an unreasonable assumption that would excessively constrain Covered Activities. Therefore, CDFW uses a second method as follows:

three-year requested take amount * average mortality and serious injury * proportion of humpbacks off CA = DPS-specific 3-year total removals

CDFW estimates that the requested take of nine humpback whales over a three-year period will result in the removal of 3.92 humpback whales from the Mexico DPS (CA/OR/WA DIP) and 2.84 humpback whales from the Central America DPS (Table 4-7).

Table 4-7. Total estimated removals per three-year period for the Mexico DPS (California/Oregon/Washington DIP) and Central America DPS of humpback whales.

Distinct Population Segment	Requested Take (Stock Level)	Average M&SI	Proportion of humpback whales off CA	Three-year total removals
Mexico – CA/OR/WA DIP	9	0.75	0.58	3.92
Central America	9	0.75	0.43	2.84

For both DPS, the three-year total estimated removals are below the three-year total NIT_s calculated above. Furthermore, total estimated removals constitute a nominal percentage of the minimum abundance of each DPS (Table 4-8).

Table 4-8. Proportional impact of total estimated removals on the Mexico DPS (California/Oregon/Washington DIP) and Central America DPS of humpback whales per three-year period.

Distinct Population Segment	Three-year total removals	N_{min}	Impact as a proportion of DIP/DPS
Mexico – CA/OR/WA DIP	3.92	2,770	0.14%
Central America	2.84	2,006	0.14%

4.3.2 Anticipated Impacts of Taking Leatherback Sea Turtles

While PBR is only calculated for marine mammals, Curtis et al. (2015) adapted the PBR concept to leatherback sea turtles by calculating Local Limit Reference Points (LLRPs). The LLRP approach estimates the maximum amount of anthropogenic mortality along the West Coast which would still allow for recovery of this species. LLRPs were calculated for three distinct conservation outcomes: (1) allowing the population to rebuild to the maximum net productivity level, (2) limiting delay of, or expediting population rebuilding, and (3) preventing further population decline. At that time, Curtis et al. (2015) noted estimated abundance was approximately 10% the size prior to anthropogenic impact. While more recent publications do not provide a directly comparable value, there is evidence of continued decline in nesting females (NMFS and USFWS 2020) as well as animals foraging off California (Benson et al. 2020).

While Curtis et al. (2015) provides specific thresholds against which CDFW could evaluate requested take, NMFS has not yet adopted any of these values or provided guidance on their applicability to analyzing impacts under ESA. The Curtis et al. (2015) LLRPs apply to take from all sources (similar to PBR) rather than to take from a given activity (as seen with the MMPA NIT standard). Furthermore, both Curtis et al. (2015) and more recent USFWS and NMFS documents acknowledge the outsized influence of anthropogenic pressures occurring outside of the Plan Area (particularly those affecting nesting beaches) on the continued decline of this species (NMFS and USFWS 2020; NMFS 2021a). Even if all take within the EEZ were kept below these LLRP values, without substantive actions at the international level to promote recovery, Benson et al. (2020) and the recent ESA status review (NMFS and USFWS 2020) forecast declines in this population. CDFW has therefore decided against directly evaluating requested take of leatherback sea turtles against the Curtis et al. (2015) LLRP values when considering potential impacts.

CDFW anticipates that each leatherback sea turtle interaction will result in removal from the population. This is a conservative assumption, given that the single known instance of a leatherback sea turtle entangled in Dungeness crab trap gear was released alive; however, given the extremely poor stock status for this species CDFW is taking a conservative approach. Therefore, the take level requested in Section 4.2 equates to the removal of one leatherback sea turtle during each 10-year period. Given the current status of the species and the cumulative impacts described in Section 4.5.2, CDFW anticipates the requested take of one animal over a ten-year period will not significantly alter the recovery or survival of the species.

4.4 Effects on Critical Habitat

4.4.1 Blue Whales

NMFS has neither proposed nor adopted critical habitat designations for blue whales, and CDFW is unable to assess the impact of the Covered Activities on blue whale critical habitat. However, the current draft recovery plan (NMFS 2020f) highlights the importance of additional research to document important habitat through satellite tagging, surveys, and environmental modeling.

4.4.2 Humpback Whales – Central America DPS and Mexico DPS

NMFS designated critical habitat for three DPS of humpback whales (Western North Pacific, Mexico, Central America) on April 21, 2021 (86 FR 21082). Critical habitat for the Mexico and

Central America DPS includes most waters off California, with nearshore boundaries defined by the 15, 30 or 50-meter isobath and the offshore boundaries defined by the 2,000, 3,000 or 3,700-meter isobath (Figure 4-4). Presence of key prey species within known humpback whale feeding areas of sufficient quality, abundance, and accessibility to support feeding and population growth was the primary driver of these designations. CDFW is unaware of any direct evidence that the Covered Activities will affect the quality, density, or accessibility of humpback whale prey. Therefore, CDFW concludes the Dungeness crab fishery is unlikely to negatively impact critical habitat for humpback whales.

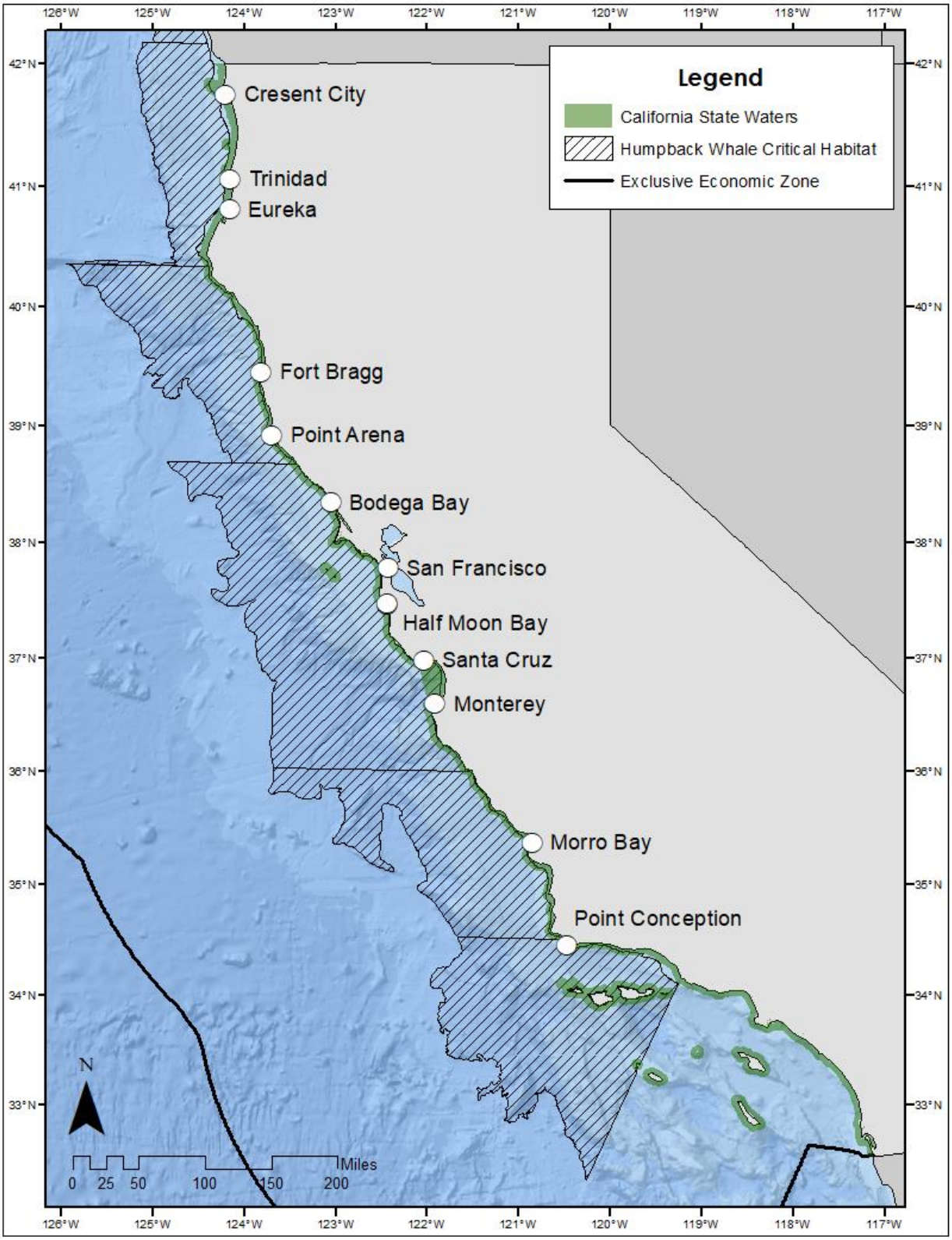

Figure 4-4. Designated critical habitat for the Mexico DPS and Central America DPS of humpback whales off California.

4.4.3 Leatherback Sea Turtles

Leatherback sea turtle critical habitat (Figure 4-5) was most recently revised on January 26, 2012 (77 FR 4169). The portion off California includes ocean waters east of the 3,000-meter depth contour from Point Arena to Point Arguello. Critical habitat has also been designated off Oregon and Washington. Oceanographic features which provide consistent foraging areas with sufficient density of preferred prey (brown sea nettles) were the primary driver of this designation. CDFW is unaware of any direct evidence that the Covered Activities will affect the quality or density of leatherback sea turtle prey. Therefore, CDFW concludes the Dungeness crab fishery is unlikely to negatively impact critical habitat for leatherback sea turtles.

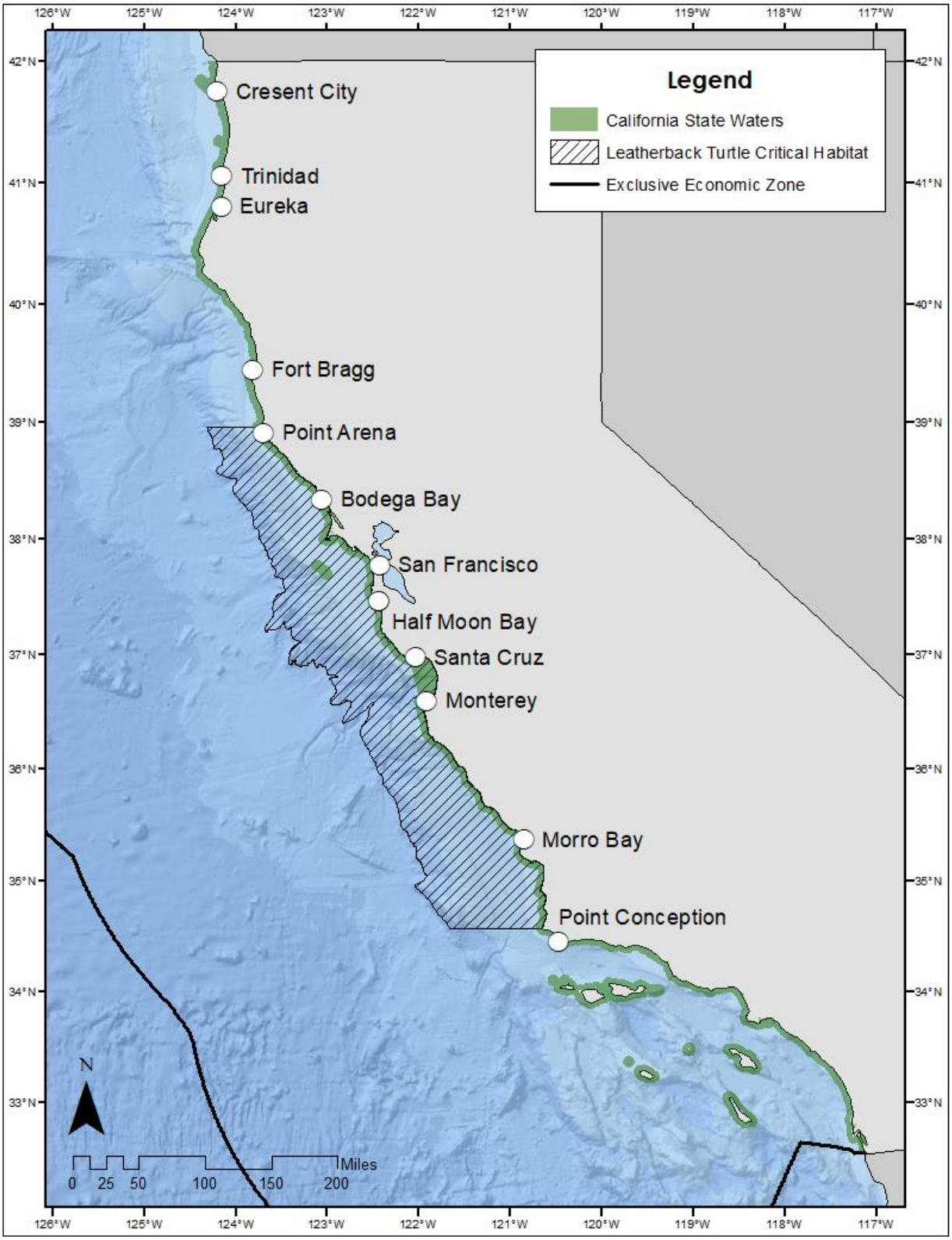

Figure 4-5. Designated critical habitat for leatherback sea turtles off California.

4.5 Cumulative Effects and Impacts

Under Section 7 of ESA, NMFS is required to consider cumulative effects of future, non-federal activities which are reasonably certain to occur within the action area of the Federal action (i.e., issuance of the requested permit) subject to consultation (50 CFR 402.02 and 402.17 subd. (a)). This is distinct from the NEPA requirement to consider cumulative impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future federal and non-federal actions (40 CFR 1508.7). Analyses of cumulative impacts (under ESA) and cumulative effects (under NEPA) fall within the purview of NMFS and are not required elements of a CP developed pursuant to Section 10(a)(1)(B) of ESA. Here, CDFW briefly reviews anticipated future activities within the Plan Area which NMFS may incorporate into their analyses of cumulative impacts and/or cumulative effects.

CDFW anticipates both new and ongoing activities will contribute to climate change effects within the Plan Area. However, differentiating between impacts caused by baseline global climate change and those which result from specific future actions is not feasible. Therefore, CDFW has included an overview of potential climate change impacts on Covered Species within the Plan Area in Chapter 3.

4.5.1 Cumulative Effects and Impacts on Blue and Humpback Whales

Pursuant to MMPA, NMFS routinely prepares stock assessment reports for marine mammals under their jurisdiction, including large whales. These reports reflect the best available information regarding past and present anthropogenic impacts within U.S. waters that are known to cause mortality and serious injury to members of a given stock. Caretta et al. (2020) identifies vessel strikes and entanglements in fishing gear as sources of M&SI for blue and humpback whales (Table 4-9). Mean annual M&SI is estimated as 1.84 for blue whales and 22.28 for humpback whales.

Table 4-9. Known sources of anthropogenic mortality for covered cetacean species between 2013 and 2017, adapted from the 2019 U.S. Pacific Marine Mammal Stock Assessments (Carretta et al. 2020). Commercial and tribal pot/trap fisheries includes Dungeness crab, sablefish, and spot prawn. Gillnet fisheries includes unidentified gillnet and Drift Gillnet. Mean annual M&SI numbers may differ slightly from those presented in Carretta et al. (2020) due to rounding.

Sector	Total (Mean Annual) M&SI: Blue Whales	Total (Mean Annual) M&SI: Humpback Whales
Ship Strikes	2 (0.4)	10.8 (2.16)
Commercial and Tribal Pot/Trap Fisheries	3.75 (0.75)	43.25 (8.65)
Recreational Crab Pot	0 (0)	1.75 (0.35)
Gillnet Fisheries	0 (0)	1.05 (0.21)
Unidentified fisheries	3 (0.6)	43.25 (8.65)
Non-Fishery Entanglement	0 (0)	1 (0.2)
Unidentified whales, pro-rated	0.46 (0.09)	10.3 (2.06)
Total	9.21 (1.84)	111.4 (22.28)

Carretta et al. (2020) notes that the M&SI values above likely underestimate total impacts from both ship strikes and fishery interactions due to incomplete detection. Rockwood et al. (2017) used an encounter theory model to estimate annual ship strike mortality as 18 blue whales and 22 humpbacks, far higher than the estimates in Table 4-9. Although standardized observer

programs allow for more precise estimates in certain fisheries (e.g., sablefish pot, drift gillnet), in general estimates of M&SI from fishery interactions rely upon opportunistic reports. There is no method currently available to correct for this negative bias (Carretta et al. 2020). Therefore, the totals in Table 4-9 should be considered minimum values.

Unidentified whales represent approximately 15% of West Coast entanglement cases. If excluded from further consideration, this can also negatively bias estimates of species-specific entanglement rates and associated M&SI. Carretta et al. (2020) therefore uses a cross-validated species identification model to estimate an additional 2.1 humpback whale M&SI and 0.9 blue whale M&SI per year. CDFW has included these values in Table 4-9.

Furthermore, Carretta et al. (2020) notes increasing levels of anthropogenic sound as an additional impact to blue and humpback whales. Low- and mid-frequency sounds, including those produced by shipping traffic and used in active sonar military exercises, can cause harm by impacting communication between individuals and can cause lethal or sublethal injuries to individuals. Noise-related injuries are not included in injury determinations due to the challenges of detecting them in live animals (NMFS 2012).

Additional activities which may occur within the Plan Area and result in cumulative effects to blue and humpback whales include aquaculture projects, offshore energy development (e.g., wind farms), changes to vessel traffic separation schemes, and modifications of National Marine Sanctuary or state Marine Protected Area boundaries. These types of changes in ocean use policies are highly uncertain and subject to change as available resources and state and federal priorities shift. Given the federal nexus of these activities, while they could be considered under NEPA as contributing to cumulative impacts they would not be considered under ESA as a component of cumulative effects, which are limited to non-federal actions.

4.5.2 Cumulative Effects and Impacts on Leatherback Sea Turtles

While anthropogenic impacts on leatherback sea turtles are not quantified in the same way as for marine mammals (i.e., through Stock Assessment Reports), there are multiple known threats to this species, including bycatch in fisheries, direct harvest of eggs and adults, coastal development adjacent to nesting beaches, pollution, marine debris, disease, and climate change (NMFS and USWFS 2020; NMFS 2021a). The majority of these threats, particularly those affecting nesting beaches in the Western Pacific, occur in areas outside of U.S. jurisdiction. Within U.S. waters, incidental take in fisheries, particularly those using longline and gillnet, remains a threat to the West Pacific Leatherback population.

Longline fishing is prohibited within the Plan Area, and not considered further. The best available bycatch rates for the California drift gillnet (DGN) fishery are computed by the SWFSC using Bayesian regression trees (PFMC 2017). Estimates are produced with a two-year lag; the most recent estimates available when this CP was prepared were through 2019. Leatherback sea turtle bycatch rates dropped significantly after 2001 upon implementation of the Pacific Leatherback Conservation Area (Eguchi et al. 2016). Estimated annual M&SI rates from 2014 to 2019 ranged from 0.1 to 0.5, with a total of 1.3 over this period or 0.65 every three years (Carretta 2020, Highly Migratory Species Management Team 2021). Neither observer data nor logbook data for state-managed gillnet fisheries indicates historical take of leatherback sea turtles.

CDFW also considered potential impacts from the Deep-Set Buoy Gear (which, like DGN, targets swordfish) and West Coast groundfish fisheries. There have been no reported interactions with leatherback sea turtles during the experimental phase of the Deep-Set Buoy Gear Fishery (2015-2020; NMFS 2021b). Between 2002 and 2019 there was a single observed leatherback sea turtle mortality in the groundfish fishery, however no take has been observed since 2008 (PFMC 2021).

An additional source of information regarding anthropogenic take of leatherback sea turtles is the SWFSC stranding database. Of the eight leatherback sea turtle takes documented between 2014 and 2020, four were associated with human interactions and four were of unknown origin. Of the four takes associated with human interactions, three involved fishing gear (one in rock crab gear, one in California commercial Dungeness crab gear, one in unspecified fishing gear) and one involved ingested plastic.

Based on available information, there appears to be limited anthropogenic take of leatherback sea turtles within the Plan Area and waters off the West Coast. Additional activities which may occur within the Plan Area and result in cumulative effects to leatherback sea turtles include aquaculture projects, offshore energy development (e.g., wind farms), changes to vessel traffic separation schemes, and modifications of National Marine Sanctuary or state Marine Protected Area boundaries. These types of changes in ocean use policies are highly uncertain and subject to change as available resources and state and federal priorities shift. Given the federal nexus of these activities, while they could be considered under NEPA as contributing to cumulative impacts they would not be considered under ESA as a component of cumulative effects, which are limited to non-federal actions.

CHAPTER 5. CONSERVATION PROGRAM

This chapter describes the biological goals and objectives for the Covered Species (Section 5.1) and the Conservation Program CDFW will implement to achieve those goals and objectives. The Conservation Program is comprised of the following Conservation Measures – the Risk Assessment and Mitigation Program (Section 5.2), promotion of best practices (Section 5.3), retrieval of lost or abandoned commercial Dungeness crab gear (Section 5.4), and outreach efforts (Section 5.5). Section 5.6 describes outcomes from the 2020-21 fishing season, during which several components of the Conservation Measures were implemented, and Section 5.7 describes CDFW's collaboration with key partners for full CP implementation over the permit term. Chapter 6 describes the process for evaluating and implementing future changes to this Conservation Program.

In developing this CP, CDFW was guided by the dual goals of minimizing take of Covered Species to the maximum extent practicable and maintaining an economically viable commercial Dungeness crab fishery. As described in Chapter 2, the commercial Dungeness crab fishery is one of the most valuable fisheries in California and constitutes one of the most important economic sectors for coastal communities in central and northern California. Economic viability can be assessed by looking at the long-term, statewide stability of the fishery with regard to landings, value, and participation level. An economically viable fishery should include diverse business plans and operations to adapt to market fluctuations, season modifications, product availability and climate uncertainty. CDFW will continue to work with stakeholders to identify additional methods for evaluating economic viability and to reduce economic impacts on affected individuals, communities, and industries from implementation of the Conservation Program described in this Chapter, primarily through the adaptive management process described in Chapter 6.

5.1 Biological Goals and Objectives

Biological goals and objectives are the broad, guiding principles for this CP. Collectively, they describe a desired future condition for the Covered Species and specific actions CDFW will undertake to achieve it. These actions are more fully described in the remainder of this Chapter.

The California Legislature has charged OPC with coordinating agency activities related to the protection and conservation of coastal and ocean ecosystems, including those of CDFW (Public Resources Code § 35615). As such, OPC's policies and their corresponding strategic plan serve to inform the broader context of this CP. That vision, in turn, is to ultimately move towards zero annual M&SI from entanglement by all state managed fisheries, as described in Target 3.3.5 in OPC's 2020-2025 Strategic Plan (OPC 2020). While meeting this target is not an explicit goal of this CP, it underpins many of the precautionary elements detailed in this Chapter. Minimizing bycatch (entanglements) is also consistent with the Marine Life Management Act (Fish & G. Code § 7050 et seq.), which guides management of California fisheries.

To reduce take, including removals, of Covered Species, CDFW must first understand the processes by which a given animal becomes entangled in a manner that causes M&SI. Entanglements are rarely observed in real time, leading to a number of uncertainties around the circumstances which result in severe entanglements. CDFW has constructed a conceptual model (Figure 5-1) to illustrate the process by which entanglements occur and highlight key uncertainties.

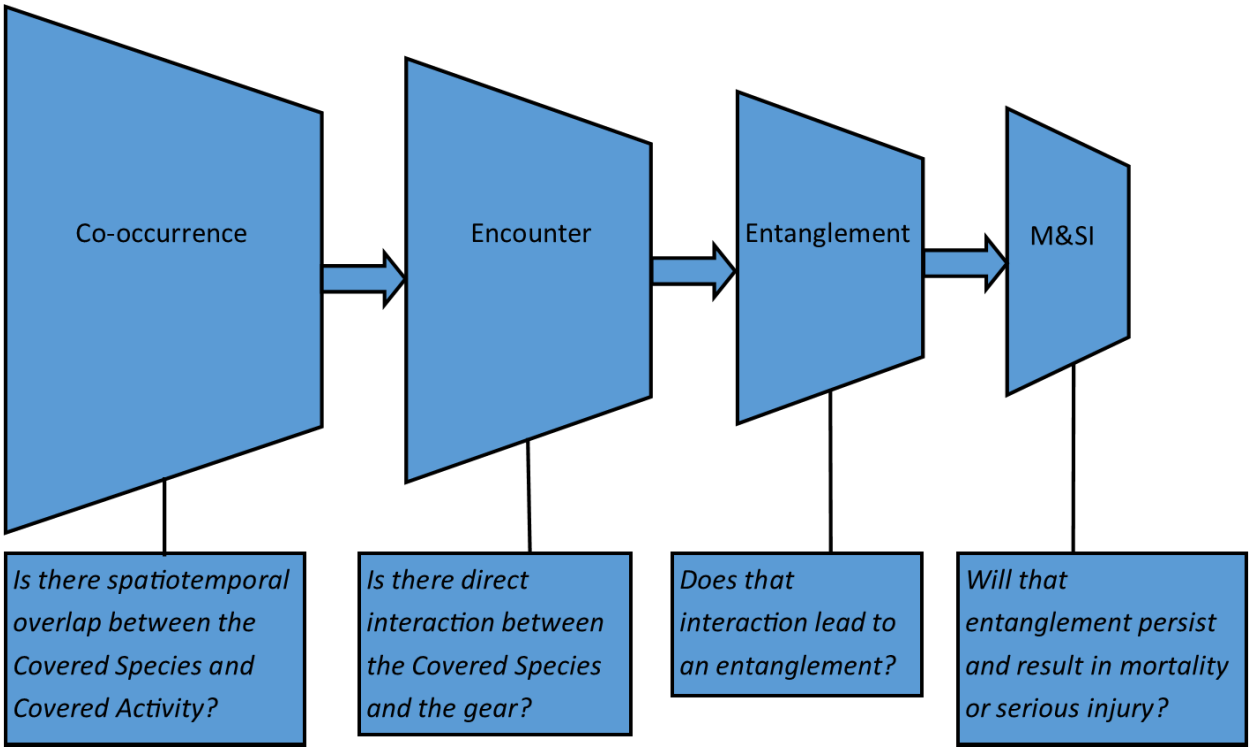

Figure 5-1. Conceptual model illustrating the stepwise process for understanding the circumstances leading to severe entanglements.

The first step involves co-occurrence, or whether there is spatiotemporal overlap between the Covered Species and Covered Activity (i.e., trap gear). Without co-occurrence, an entanglement cannot occur. In some proportion of the instances where there is co-occurrence, an encounter will occur where the Covered Species directly interacts with the trap gear. An unknown proportion of those encounters will result in an entanglement, and a subset of those will persist and cause M&SI.

Given the substantial uncertainties involved with each transitional step in this conceptual model, CDFW has primarily focused the Conservation Program described in this Chapter on reducing take by minimizing co-occurrence (Goal 1). While this will provide protection for Covered Species, CDFW also anticipates this approach may have substantial economic impacts on the fishery. Therefore, CDFW will also evaluate and refine management approaches that reduce the opportunity for co-occurrence to translate into encounters, encounters into entanglements, and entanglements into M&SI (Goal 2). CDFW will also focus on improving available information regarding the amount of take attributable to the Covered Activities through an enhanced detection network (Goal 3) and improved gear marking for all state managed fisheries (Goal 4). As described further in Chapter 6, over time CDFW expects additional information and evaluation of management actions will allow relaxation of restrictions on Covered Activities without increasing take, thereby reducing impacts on the fishery while remaining in compliance with the provisions of an issued ITP.

CDFW's goals and associated objectives for the Covered Species are as follows:

Goal 1: Reduce take of Covered Species by the commercial Dungeness crab fishery to the maximum extent practicable by minimizing co-occurrence between Covered Species and commercial Dungeness crab trap gear across the Plan Area.

- Objective 1a: CDFW will conduct assessments of marine life entanglement risk across all Fishing Zones at least monthly from November to June each year (or until the season closes) and implement management measures based on the best-available science to reduce co-occurrence between commercial Dungeness crab trap gear and Covered Species, as described in Cal. Code Regs., Tit. 14 §132.8, throughout the permit term.
- Objective 1b: CDFW will improve available information regarding presence, distribution, and abundance of Covered Species within the Plan Area to inform evaluation of co-occurrence and identify areas of elevated entanglement risk. This will be achieved by collaborating with industry and non-governmental organization partners to develop scientifically rigorous protocols for surveys of Covered Species. By the fifth year following permit issuance and for the remainder of the permit term, these surveys will be conducted in each RAMP Fishing Zone on a monthly basis by CDFW and its partners between October – December and March – June (or until the season closes).
- Objective 1c: CDFW will improve the quality and timeliness of available information regarding Covered Activities within the Plan Area to inform evaluation of co-occurrence and identify areas of elevated marine life entanglement risk. This will be achieved by implementing a comprehensive electronic vessel location monitoring program for the commercial Dungeness crab fishery by the 2024-25 fishing season. *Note: the RAMP regulations will be revised for consistency with this new timeline prior to the 2023-24 fishing season*
- Objective 1d: CDFW will incorporate the best available science that supports quantification of species distribution and abundance to inform co-occurrence. Specifically, models which quantify and/or predict distribution and abundance of Covered Species, distribution and intensity of Covered Activities, and their co-occurrence are under development. Once these models have been deemed best available science by CDFW and/or NMFS, CDFW will incorporate model outputs into future assessments of marine life entanglement risk under Cal. Code Regs., Tit. 14 § 132.8 subd. (c) and (d).
- Objective 1e: Throughout the permit term, CDFW will minimize co-occurrence between Covered Species and lost or abandoned Dungeness crab trap gear through the lost and abandoned trap gear program described in Cal. Code Regs., Tit. 14 §132.7, voluntary actions by the Dungeness crab fishery under Cal. Code Regs., Tit. 14 §132.2, and salvage operations. By the fifth year following permit issuance, CDFW will establish an annual minimum recovery target for lost or abandoned commercial Dungeness crab gear.

Goal 2: Reduce the frequency and severity of interactions between Covered Species and commercial Dungeness crab trap gear through development and implementation of best practices, development and adoption of Alternative Gear, and support of entanglement response efforts. CDFW will evaluate severity based on a five-year average of the final M&SI scores presented in the most recent supporting materials developed through the stock

assessment report process. By the end of the permit term, average M&SI scores for confirmed humpback and blue whale entanglements in California commercial Dungeness crab trap gear will be less than 0.25.

- Objective 2a: CDFW will improve available information regarding M&SI associated with various entanglement types by collaborating with NMFS, PSMFC and other interested parties to convene an in-depth forensic review workshop every three years during the permit term. CDFW will advise the California Legislature regarding, and implement regulatory changes to require use of, gear modifications which demonstrate ability to reduce M&SI. In the interim, CDFW will update the Best Practices Guide to reflect the proposed changes to baseline fishing practices.
- Objective 2b: On a biennial basis during the permit term, CDFW will host a workshop with gear developers, fishery participants, and other interested parties to foster communication, improve progress and address remaining barriers to development and adoption of gear innovations which meet CDFW's requirements for certification as Alternative Gear under Cal. Code Regs., Tit. 14 §132.8.
- Objective 2c: CDFW will directly support entanglement response efforts within the Plan Area by providing timely information and available aerial or vessel assets.

Goal 3: To produce an annual statewide estimate of Covered Species entanglements which occur in California commercial Dungeness crab gear by implementing a robust entanglement detection network.

- Objective 3a: CDFW will improve available information regarding Covered Species entanglements by establishing a network of partners to conduct on-the-water survey efforts no later than 2024. Throughout the term of the permit, CDFW will oversee and provide strategic support for the network, including convening a biennial meeting to conduct training, set expectations, provide data collection protocols, and work to improve the program. Partners will conduct one survey per month in each Fishing Zone for the duration of the permit, and at least one person who has taken the Level 1 West Coast Large Whale Entanglement Response Program training will be present on each survey to ensure the report includes appropriate details and documentation.

Goal 4: To reduce instances of unidentified gear entanglements of Covered Species reported off California through improved standardized gear marking for all trap gear fisheries. By the end of the permit term, the proportion of confirmed entanglements reported off California which NMFS categorizes as occurring in unidentified fishing gear will be no more than 25% of the total number of confirmed Covered Species entanglements reported off California.

- Objective 4a: Prior to permit issuance, all gear deployed in state-managed commercial trap fisheries will be marked in a standardized format which enables identification of the associated fishery.

5.1.1 Climate Change Impacts on Biological Goals and Objectives

While the specific future effects of climate change on the CCS are highly uncertain, climate change will impact several of the goals and objectives outlined above. It has been suggested

the CCS may experience a net increase of available nutrients (Rykaczewski and Dunne 2010). However, the potential nutrient increase may be tempered by the onset of stronger ocean acidification (Bednaršek et al. 2014) and a trend of increasingly prevalent hypoxia (Bograd et al. 2008). In addition, it is possible that LMH events may become more frequent as the changing climate leads to the formation of more high-pressure systems in the Northeast Pacific (Di Lorenzo and Mantua 2016).

While the specific timing, location, and magnitude of impacts are impossible to predict, climate change will likely result in physical changes to foraging grounds within the CCS as well as other ocean habitats where Covered Species transit, forage, and breed. These changes, which may include increased water temperatures and changes in upwelling patterns, may in turn affect ocean productivity, timing and biomass of spring phytoplankton blooms, and the abundance and distribution of forage species such as anchovy, krill, and brown sea nettles. Both physical and biological phenological cues are likely to affect the timing of spring and fall Covered Species migrations, and their movement patterns when present within the CCS.

The same physical and biological signals described above may also alter the timing of Dungeness crab molting and reproduction, affecting crab meat quality. Fish & G. Code § 8276.2 specifies the NMA opening cannot be delayed beyond January 15 due to low crab quality. However, if low crab quality conditions routinely persist beyond this date in the future, that requirement may change. Domoic acid events that delay the season opening, as was seen during the 2014-16 LMH event (see Section 3.1), could have similar impacts (McCabe et al. 2016; McKibben et al. 2017). However, delays due to domoic acid may be diminished following the passage of SB80 (McGuire, 2021), which authorized a process for allowing the fishery to open under an evisceration order when only the viscera (and not the meat) have domoic acid concentrations exceeding federal alert levels. In these instances, processors would be required to remove the contaminated intestinal tract section before cooking and ultimate sale to the consumer, allowing the fishery to safely open. Climate change may also affect crab distribution, as warmer nearshore ocean temperatures may drive adult Dungeness crabs to seek deeper-water habitats. These changes would incentivize fishermen to move their gear into deeper water, which may alter the degree of co-occurrence between Covered Species and Covered Activities. Lastly, new research (Bednaršek et al. 2020) suggests ocean acidification is already having measurable impacts on crab larval survival and shell formation, which may reduce crab availability and have a profound effect on the future viability of the fishery.

Together, these changes will have a direct impact on co-occurrence of Covered Species with actively fished Dungeness crab gear. The Goal 1 objectives were designed to provide flexibility in the face of changing environmental conditions due to climate change. Given the uncertainty regarding future co-occurrence dynamics, CDFW will conduct routine assessments of marine life entanglement risk based on robust, real-time information (Objectives 1a-1d) rather than relying on static closures based on historical patterns. Specifically, scientifically rigorous surveys of Covered Species presence (Objective 1b) and electronic vessel location monitoring (Objective 1c) will allow CDFW to evaluate changes in fishing activity and Covered Species presence that may occur with changing environmental conditions. Recovery of lost or abandoned gear will further limit co-occurrence (Objective 1e), even if increased frequency or severity of storms increases the overall amount of lost or abandoned gear.

5.2 Risk Assessment and Mitigation Program

As described in Section 4.1, the Working Group first piloted a version of the RAMP during the 2017-18 fishing season. Initially, any changes in fishery operations due to elevated entanglement risk were made voluntarily by the fishing fleet, with no metrics for CDFW to directly assess industry adherence to Working Group guidance. On January 1, 2019, Fish & G. Code § 8276.1 granted the Director authority to implement mandatory in-season management measures for the commercial Dungeness crab fishery to mitigate entanglement risk. Also, in early 2019, CDFW, the Center for Biological Diversity, and the Pacific Coast Federation of Fisherman's Association reached a settlement agreement (*Center for Biological Diversity v. Bonham*, Settlement Agreement, Case No. 3: l 7-cv-05685-MMC (Mar. 26, 2019)) that included multiple provisions to minimize risk of entanglement to whales and sea turtles until an ITP is issued. That agreement requires implementation of specific actions when certain thresholds are reached.

Fish & G. Code § 8276.1 also directed CDFW, in consultation with the Working Group, to adopt regulations formalizing the RAMP. CDFW released proposed regulations (Cal. Code Regs., Tit. 14 § 132.8) for public comment on May 15, 2020, and subsequently adopted the final language on October 19, 2020 with an effective date of November 1, 2020. These regulations began governing fishing operations with the 2020-21 fishing season, and form the regulatory foundation of this CP.

As defined in regulation and further described in this Chapter, the RAMP is a dynamic management framework that: establishes quantitative thresholds for determining if entanglement risk is elevated; specifies potential management actions; and requires outreach to stakeholders and consideration of the best available science when determining appropriate management actions. Under the 2018 Marine Life Management Act Master Plan, CDFW has defined the best available science as that which is relevant, inclusive, objective, open, and timely. CDFW will use these standards when determining whether information should be considered as best available science. The Working Group plays a key role in RAMP implementation by independently evaluating available data and recommending appropriate management actions to the CDFW Director based on the Working Group members' relevant expertise. Under the RAMP, the Director will conduct a risk assessment at least monthly between November and the end of the fishing season, and consider Working Group recommendations regarding appropriate management measures prior to implementation (Objective 1a).

Specifically, subsections (a) – (f) of the RAMP regulations define key terms, specify the frequency and process for conducting risk assessments and receiving input from the Working Group, specify triggers for management actions (see Section 5.2.1), specify management considerations which will inform selection of an appropriate management action (see Section 5.2.2), specify potential management actions (see Section 5.2.3), and describe the process by which CDFW will notify fishery participants of management actions taken pursuant to these regulations. This portion of the RAMP regulations also establishes seven Fishing Zones (Figure 5-2) which together comprise the Plan Area for this CP with the following latitudinal boundaries:

- Zone 1: From the California/Oregon border (42° N. latitude) to Cape Mendocino (40° 10' N. latitude).

- Zone 2: From Cape Mendocino to the Sonoma-Mendocino county line (38° 46.125' N. latitude).
- Zone 3: From Sonoma-Mendocino county line to Pigeon Point (37° 11' N. latitude)
- Zone 4: From Pigeon Point to Lopez Point (36° N. latitude)
- Zone 5: From Lopez Point to Point Conception (34° 27' N. latitude)
- Zone 6: From Point Conception to the U.S./Mexico border
- Zone 7: “Pacific leatherback sea turtle Foraging Area” from Point Arena (38° 57.5' N. latitude) to Point Piños (36° 38.314' N. latitude).

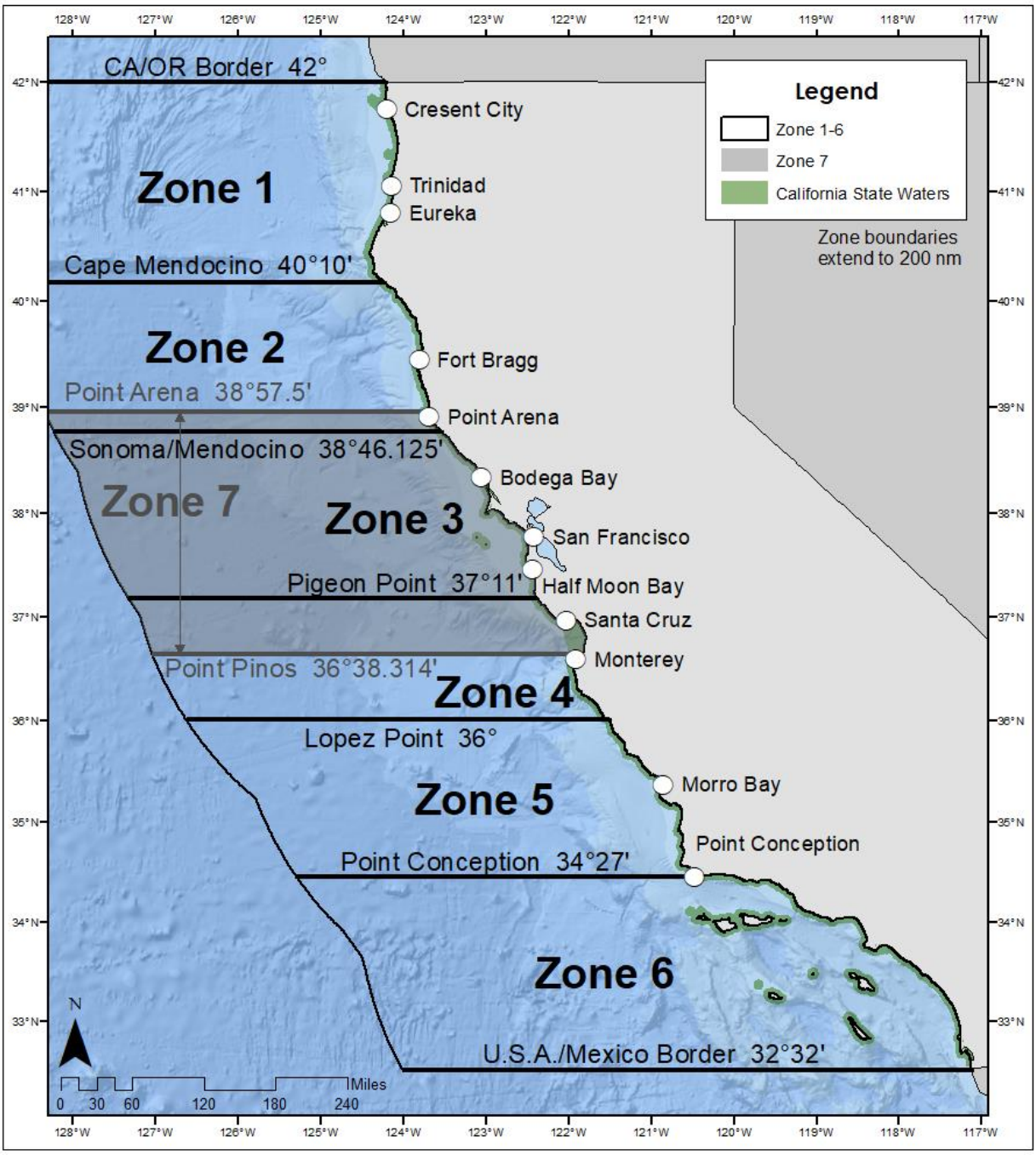

Figure 5-2. The RAMP Fishing Zones and California State Waters boundary. Created by CDFW Marine Region.

In addition to the risk assessment and management action elements of the RAMP (Objective 1a), Cal. Code Regs., Tit. 14 §132.8 also contains provisions that relate to available data under subsection (d) and management actions under subsection (e). Subsection (g) specifies additional reporting requirements for all fishery participants, including bi-weekly fishing activity reports and electronic monitoring (see Section 5.2.2.7). Subsection (h) establishes a process for

CDFW certification of gear innovations as Alternative Gear (see Section 5.2.3.5). Collectively, the requirements and processes of each subsection in Cal. Code Regs., Tit. 14 § 132.8 constitute the RAMP.

Enforcement of the RAMP falls primarily under the responsibility of LED. Fish and Wildlife Officers are responsible for ensuring compliance with various management measures implemented under the RAMP, including time/area closures, vertical line reductions, and gear modifications. Both traditional tools (e.g., at-sea vessel and fishing gear checks) and novel data streams (e.g., electronic vessel location monitoring) will be essential to evaluating fleet compliance with CDFW directives. CDFW also receives law enforcement support from the U.S. Coast Guard (USCG) and National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement.

5.2.1 Risk Factors

5.2.1.1 Entanglements

5.2.1.1.1 Entanglement Detection

Due to the nature of how the Dungeness crab fishery is prosecuted (i.e., fishermen set and periodically return to check gear), entanglement events are presumed to occur while gear is unattended. Unattended gear is of particular concern for cetaceans because the entangled animal is likely to swim away with the gear. This is a key distinction between the Dungeness crab fishery and other fisheries where gear is more actively tended (e.g., North Carolina gillnet fishery, and Hawaii shallow set longline fishery) and take of protected species can be documented in real time, or when gear is retrieved, by fishermen or independent observers.

Historically, NMFS has relied on opportunistic reporting of entanglements to assess the prevalence of fishery interactions. A portion of these reports are confirmed by NMFS staff and affiliates and represent the best source of information regarding entanglements. Only confirmed entanglement reports are considered because unconfirmed reports may lead to double counting (i.e., multiple reports of the same whale) or may not in fact be entanglements (e.g., kelp or other debris on a whale, that may resemble fishing gear). CDFW will continue to rely on NMFS to provide information regarding confirmed entanglements during the duration of the permit. CDFW anticipates updates will be provided throughout the year, similar to the approach taken during the 2018-19, 2019-20, and 2020-21 fishing seasons.

CDFW will not duplicate NMFS's entanglement confirmation process, but will augment the existing system for detecting marine life entanglements (Objective 3a). By 2024, CDFW will facilitate the establishment of a statewide entanglement detection program through a network of partners. CDFW intends to collaborate with the Oregon and Washington Departments of Fish and Wildlife on design and implementation of the program, which will allow CDFW to produce an annual statewide estimate of Covered Species entanglements in California commercial Dungeness crab gear (Goal 3). This timeframe will allow sufficient time for CDFW to coordinate with NMFS, the other states, and potential partners on program design, while also ensuring it is in place prior to permit issuance. In many cases, entanglement detection surveys will also serve to inform the evaluation of marine life concentrations (see Section 5.2.1.2). CDFW and partner commitments will be as follows:

- CDFW will convene, and partners will participate in, an annual meeting to review program expectations, data collection protocols, and other relevant items.
- Partners will ensure at least one individual on each survey platform has taken the Level 1 West Coast Large Whale Entanglement Response Program training. This training is freely available online, and qualifies an individual to assess, document, and report entanglement information prior to the launch of a response effort by Level 4 and 5 responders.
- Partners will strive to conduct one survey per month (weather and safety permitting) for their respective Fishing Zone(s). Partners will record their survey tracklines and associated effort (i.e., total time spent surveying and distance traveled), number of detected entanglements during the survey, and any weather or visibility conditions which may have affected detections. All information will be provided in electronic format to CDFW within seven days of survey completion.
- Partners will immediately report any detected entanglements via the entanglement reporting hotline or to the USCG on VHF Channel 16, and (when feasible) standby until a response team arrives.
- CDFW will routinely review the efforts of each partner to ensure the network is collectively monitoring each Fishing Zone or Fishing Zones likely to have whales present. If meaningful gaps are detected, CDFW will work to increase coverage through increased activity of existing partners, deployment of CDFW assets, or recruitment of additional partners.
- CDFW will routinely validate partner compliance with established protocols.

CDFW will look to leverage existing research efforts and partnerships. CDFW will add or remove partners as appropriate to meet program requirements. CDFW will recruit partners from a broad range of agency, academic, fishing industry, and environmental organizations, including but not limited to the following:

- Whale watch vessels
- Dungeness crab fishing vessels
- Commercial Passenger Fishing Vessels
- Other fishery participants, including those who are operating under an Experimental Fishing Permit issued by the Fish and Game Commission
- Research institutions, including those who are conducting work under a Scientific Collecting Permit issued by CDFW
- Trap Gear Retrieval Program participants
- USCG
- NOAA research vessels and aircraft

CDFW will also leverage existing survey efforts across CDFW and utilize available resources (e.g., patrol vessels, research vessels, and aircraft) to conduct dedicated surveys for entanglements.

5.2.1.1.2 Entanglement Response

NMFS WCRO Protected Resources Division oversees the Large Whale Entanglement Response Network. In California, entanglement reports are directed to one of eight member organizations, depending on the report location: Northcoast Marine Mammal Center (Del Norte and Humboldt County); The Marine Mammal Center (Mendocino to San Luis Obispo County); Channel Islands Marine Wildlife Institute (Santa Barbara and Ventura County); California Wildlife Center, Marine Animal Rescue, and Marine Mammal Care Center at Fort MacArthur (Los Angeles County); Pacific Marine Mammal Center (Orange County); and Sea World of California (San Diego County).

If the report documentation is sufficient, assets are available, and conditions allow, an entanglement response effort is launched. Of the 235 confirmed large whale entanglements off the West Coast between 2014 and 2020 in which the whales were alive at the time of reporting, response efforts were initiated for 107 (46%; data from Saez et al. 2021). Of these 107 responses, in 46 (43%) cases some or all of the gear was removed either by the response team or through self-release. Depending on the extent of the injuries at the time the response is initiated, timeliness of the response effort, and how much of the gear is removed, a response effort can meaningfully reduce severity of the entanglement. Continued operations of the Large Whale Entanglement Response Network are therefore an important strategy for reducing M&SI for Covered Species entangled in California commercial Dungeness crab gear (Goal 2). CDFW will directly support those efforts by providing timely information and available aerial or vessel assets (Objective 2c).

The documentation provided in the initial report, which is often supplemented during a response effort, informs efforts by NMFS WCRO to understand the circumstances under which an entanglement occurred (termed “forensic reviews”). Throughout the term of the permit, CDFW will collaborate with NMFS and entanglement response network partners to develop and distribute outreach materials which highlight key information to include in entanglement reports, including photographs of the surface gear and identifying marks on the animal, to bolster the information available to NMFS. CDFW will also search license and permitting records for vessel, permit, or fishermen identification numbers documented on entangling gear. If this search indicates California-permitted gear was responsible for the entanglement, CDFW will conduct a follow up interview with the permitted individual to learn about gear set location, gear configuration, last known servicing and any other relevant information that will support entanglement response and/or forensic review.

5.2.1.1.3 Fishery Attribution

Historically, CDFW has relied on NMFS to attribute confirmed entanglements to specific fisheries (e.g., California commercial Dungeness crab) or gear types (e.g., other trap gear). While the availability and quality of documentation has increased since 2013 (Saez et al. 2021), NMFS is unable to identify a responsible fishery or gear type for approximately 50% of confirmed entanglements reported off the West Coast. The trap limit program implemented in 2013 has made California commercial Dungeness crab gear more readily identifiable by requiring the use of buoy tags (see Chapter 2 and Figure 4-1). CDFW also implemented expanded gear marking requirements for commercial trap fisheries, with a compliance date of May 1, 2020, and the recreational crab fishery, with a compliance date of November 1, 2021. The Washington and Oregon Departments’ of Fish and Wildlife are also pursuing additional

marking requirements for their trap fisheries. Over time, CDFW anticipates these expanded marking requirements will increase the proportion of confirmed entanglements which can be attributed to a given fishery. Reducing the proportion of entanglements which NMFS categorizes as occurring in "unidentified fishing gear" is a priority for CDFW (Goal 4), as it will improve CDFW's ability to accurately assess the impact of Covered Activities on Covered Species and identify other state-managed fisheries where entanglement risk reduction measures are needed.

CDFW will review the proportion of confirmed entanglements reported off California which NMFS classifies as occurring in unidentified fishing gear on an annual basis, and has established a target proportion of 25% by the end of the permit term (Objective 4a). CDFW will review progress towards this target through the adaptive management process described in Section 6.2. Should available information indicate expanded gear marking requirements are needed, CDFW will work with the Fish and Game Commission, California Legislature, and fishery participants to design and implement appropriate changes.

Even with these efforts, and the support described in Section 5.2.1.1.2, CDFW expects that NMFS will continue to classify some proportion of confirmed entanglements reported in the Plan Area as unidentified gear entanglements. For each entanglement which NMFS categorizes as unidentified fishing gear, CDFW will review available information with NMFS and the Working Group. In some cases, specific characteristics (e.g., buoy and line type) may provide sufficient rationale for CDFW to eliminate the California commercial Dungeness crab fishery as a potential source. For confirmed entanglements reported within the Action Area (i.e., waters off California), if the commercial Dungeness crab fishery cannot be eliminated as the contributing fishery the entanglement will be considered a confirmed entanglement in Unknown Fishing Gear and included when evaluating take from the Covered Activities, as described in Sections 4.2 and 5.2.1.1.4.

5.2.1.1.4 Entanglement Triggers

The RAMP regulations define triggers related to the cumulative number of confirmed entanglements of each Covered Species which would require management action: *Note: the RAMP regulations will be revised for consistency with the values below prior to permit issuance*

- Humpback whales
    - Each confirmed entanglement in California commercial Dungeness crab gear or Unknown Fishing Gear
    - During a given fishing season, a total of three or more confirmed entanglements in California commercial Dungeness crab gear or equivalent combination of confirmed entanglements in California commercial crab gear and Unknown Fishing Gear
- Blue whales
    - Each confirmed entanglement in California commercial Dungeness crab gear or Unknown Fishing Gear
- Leatherback sea turtles
    - Each confirmed entanglement in California commercial Dungeness crab gear or Unknown Fishing Gear

Entanglements which can be attributed to other fisheries or are known to not be commercial Dungeness crab gear will not lead to a restriction for the commercial Dungeness crab fishery. However, CDFW will weigh entanglements in Unknown Fishing Gear (as defined in Section 5.2.1.1.3) at 50% of an entanglement confirmed in California commercial Dungeness crab gear. As described in Section 5.2.1.1.3, CDFW expects the enhanced gear marking requirements described elsewhere in this CP, as well as those implemented in Oregon and Washington, will reduce the proportion of entanglements classified as occurring in Unknown Fishing Gear, minimizing the potential for commercial Dungeness crab fishery operations to be impacted by entanglements from other fisheries. However, as described in Chapter 4, given the number of vertical lines deployed within the commercial Dungeness crab fishery relative to other fisheries operating off California, CDFW expects that up to 50% of unidentified gear entanglements are likely to be from California commercial Dungeness crab gear. Furthermore, when the gear set region is known (n = 94), 74% (n = 70) of the entanglements between 1982 and 2017 were reported within the same region as where the gear was set (Saez et al. 2021). Given that the overwhelming majority of confirmed entanglements are reported off California (85%), CDFW has determined that taking action for confirmed entanglements reported off California is warranted even when a specific fishery cannot be identified.

Under the RAMP regulations, CDFW must take a management action informed by the best available science following each confirmed entanglement of a Covered Species in either California commercial Dungeness crab gear or Unknown Fishing Gear. The Conservation Program described in this Chapter, and specifically the RAMP, is intended to limit co-occurrence between Covered Species and the Covered Activities which could lead to entanglements (Goal 1). Therefore, when an entanglement does occur, CDFW will implement a management action designed to further limit co-occurrence and prevent additional entanglements. The default management action is a Fishing Zone closure. The specific Fishing Zone(s) closed will depend on whether available information is limited to the reporting location, or also includes the location where the entanglement occurred. Regardless, the Director retains discretion to select an alternative management action after review of the most current information related to the management considerations identified in Section 5.2.2. CDFW discretion is needed due to the potential for distinct risk profiles for each Covered Species and the dynamic nature of both the Covered Species and Covered Activities. For example, even when entanglements are ultimately traced to the point of origin, this may occur weeks or months later, at which point a predetermined management response may be ineffective. Following entanglements of a blue whale or leatherback sea turtle, CDFW might consider implementing closures based on known habitat or depth preferences. However, if those closures would further concentrate gear in the remaining open areas, and those areas have high suitability for humpback whales, that action could have the unintended consequence of further increasing risk for humpback whales. Furthermore, while Saez et al. 2021 suggests nearly three-quarters of entanglements occur within the same region as the original reporting location, NMFS analysis includes three zones within California (Northern California, Central California, and Southern California) rather than the six primary Fishing Zones defined in the RAMP regulations. When only the entanglement reporting location is known, there is a reasonable probability that closing the Fishing Zone where the report originated may not meaningfully address entanglement risk in the Fishing Zone where that entanglement occurred. By working through the RAMP process, CDFW can consider the full suite of available information and select an action which is appropriately informed by these complexities.

In specifying that actions will be taken following each entanglement event, CDFW considered that management actions may be implemented differently depending on when the entanglement is confirmed (i.e., during the open fishing season or during the offseason). If an entanglement is confirmed during the open fishing season, direct actions to limit further co-occurrence can be employed. Entanglements which are reported during the offseason might have occurred during the prior fishing season with a lag between entanglement occurrence and reporting/confirmation or in lost or abandoned gear during the offseason. For offseason entanglements, CDFW would determine whether ocean conditions, available forage, or other management considerations indicate elevated risk levels will persist going into the next fishing season, suggesting a more precautionary approach is appropriate. Alternatively, if conditions over the summer and during the early fall indicate decreasing entanglement risk, management actions at the start of the next season may be limited to issuance of a Fleet Advisory.

CDFW has requested take of up to one blue whale every three years and up to one leatherback sea turtle every 10 years. Based on the analysis of existing take in Section 4.1, CDFW expects entanglements of these species to be rare events. When taking action following each confirmed entanglement of these species in either California commercial Dungeness crab gear or Unknown Fishing Gear, CDFW would evaluate the management considerations and implement a management action designed to prevent additional take (see Section 5.2.2.11).

CDFW has requested take of no more than nine humpback whales during any three consecutive years. In addition to taking action following each confirmed entanglement, CDFW has established a precautionary trigger related to the cumulative number of entanglements during a given fishing season. If the cumulative number of confirmed entanglements during the fishing season reaches three (i.e., three confirmed entanglements in California commercial Dungeness crab gear, six confirmed entanglements in Unknown Fishing Gear, or an equivalent combination thereof), the fishery will close statewide for the remainder of the season. Reaching this amount of take provides an early warning sign that the dynamic management approach established by the RAMP is not working as intended, and additional measures are needed to prevent exceeding the permitted take levels. In this instance, the early closure would not directly impact operations during the next season. However, CDFW will consider the cumulative number of confirmed entanglements for the current three-year period and other management considerations when determining appropriate actions during subsequent seasons (see Section 5.2.2.11).

5.2.1.1.5 Entanglements Which Do Not Trigger Action Under The RAMP

There are several categories of entanglements for which this CP does not establish management triggers, including unconfirmed entanglements, confirmed entanglements of unidentified species, confirmed entanglements in gear known not to be California commercial Dungeness crab gear, confirmed entanglements in unidentified fishing gear reported outside the Plan Area, and unreported entanglements. Unconfirmed entanglements are not considered for reasons described in Section 5.2.1.1.1.

Confirmed entanglements with unidentified species are relatively rare occurrences, representing just 4% (n = 19) of the 501 total confirmed entanglements between 1982 and 2020 (data from Saez et al. 2021). Only two of those entanglements were confirmed in commercial Dungeness crab gear, one in 2007 and one in 2008. At this time, CDFW considers these available data too speculative to include confirmed entanglements of unidentified species as a management

trigger under the RAMP. However, as with other changes to the RAMP, should improved information indicate such triggers are warranted, CDFW will consider updating this element of the CP through the adaptive management process described in Chapter 6.

As mentioned in Sections 5.2.1.1.3 and 5.2.1.1.4, confirmed entanglements in gear which are known to not be commercial Dungeness crab gear will not trigger action under the RAMP because they do not reflect take from the Covered Activities. Furthermore, as described in Section 5.2.1.1.4, nearly three quarters of the confirmed entanglements where the gear set region is known are reported from that same region. CDFW therefore considers confirmed entanglements in unidentified fishing gear reported outside of the Plan Area as unlikely to reflect take from the Covered Activities. Additionally, CDFW lacks authority to implement management actions outside of the Plan Area.

Regarding unreported entanglements, the entanglement reports received by NMFS represent an unknown subset of the total number of entanglements which occur. While the expanded entanglement detection program described in Section 5.2.1.1.1 will standardize entanglement reporting across fishing seasons and lead to an overall increase in the proportion of detected entanglements, it will not be able to provide a full census of all Covered Species entanglements which occur off California or in California commercial Dungeness crab gear. On the East Coast, routine photo ID efforts allow for assessment of total entanglement frequency at the individual and population level. Implementation of a similar program off the West Coast would allow estimation of the frequency of unreported entanglements. However, such a program does not exist at this time, and even if funding and coordination among the three states were to occur, there are several limitations to incorporating estimated numbers of unreported entanglements into the management approach described in this CP. These estimations would only be valid at a coast-wide scale and across all fisheries, making it difficult to apportion entanglements among the three states and impossible to attribute entanglements to specific fisheries. Furthermore, these estimates would likely be produced on an annual timescale, and would not be well suited to the real-time assessment and response approach which is the primary method by which CDFW is seeking to limit take of Covered Species.

5.2.1.2 Marine Life Concentrations

Unlike confirmed entanglements, which have both reactionary (action in response to each confirmed entanglement) and precautionary (action to prevent cumulative entanglements from exceeding allowable take levels) components, the marine life concentration risk factor is solely precautionary. The Director will implement management actions when counts of Covered Species in California waters exceed the specified thresholds. Thresholds are defined for each Covered Species and for two time periods, fall (November 1 – December 31) and spring (March 1 – July 15 or fishery closure). Two distinct time periods are identified because information on marine life concentrations collected during these periods has different implications for management based on anticipated presence of Covered Species and their respective historical migration patterns. Covered Species migration status, or whether they are anticipated to be moving into or out of the Fishing Grounds, in conjunction with the status of the fishing season (open or closed) and associated overlap between Covered Species and Covered Activities warrants identification of distinct triggers and management actions for each time period due to differences in potential co-occurrence.

In the absence of current marine life concentration survey data during the fall or spring periods, CDFW would take a precautionary approach and either delay the fishery opening (during the fall) or implement a management action based on all relevant data (in the spring) to avoid entanglement risk from the co-occurrence of Covered Species and Covered Activities. The absence of current information on marine life concentrations does not mean there is no entanglement risk.

If data are unavailable by November 1, the fishery will be delayed in 15-day increments until the end of December. These incremental delays provide sufficient time for CDFW and other partners to collect and analyze additional information changes in Covered Species presence. This is also a reasonable period for CDFW staff to analyze data, provide information to the Director, prepare the necessary management documents, and provide sufficient notice for the orderly and safe implementation of a fishery opening. The 15-day increment also allows alignment with the structure for delays due to low crab meat quality.

If data are available, and counts of humpback whales are greater than or equal to 20 or there is a running average of five or more animals over a one-week period within a single Fishing Zone (excluding Zone 7), the Director shall implement a Fishing Zone delay or other management action based on the best available science. The same applies when counts of blue whales are greater than or equal to three or there is a running average of three or more blue whales over a one-week period within a single Fishing Zone (again excluding Zone 7). For leatherback sea turtles, rather than using counts from any given survey or a one-week running average, a more restrictive method is proposed. Any Fishing Zone found with an animal in it would be closed unless the best available science indicates an alternative management action will protect the species. Based on historical tagging and sightings data, CDFW anticipates leatherback sea turtles are most likely to be observed between Point Arena and Point Pinos. CDFW therefore established this area as Fishing Zone 7, which encompasses all of Fishing Zone 3 and portions of Fishing Zones 2 and 4, to allow for strategic management actions which protect leatherback sea turtles without unduly constraining Covered Activities outside of Fishing Zone 7.

After the fishing season opens, marine life concentrations are again evaluated in the spring. If data are unavailable by March 15, the Director must implement a management action. In the absence of current information on marine life concentrations, CDFW must consider the likelihood Covered Species are present within one or more Fishing Zones when determining the appropriate management action. If data are available, and the number of humpback whales is greater than or equal to 10 or there is a running average of five or more animals over a one-week period within a single Fishing Zone (excluding Fishing Zone 7), the Director shall implement a Fishing Zone closure or other management action based on the best available science. The same applies when there are three or more blue whales or a running average of three or more blue whales over a one-week period within a single Fishing Zone (again excluding Fishing Zone 7). For leatherback sea turtles, any Fishing Zone found with an animal in it would be closed unless the best available science indicates an alternative management action will protect the species.

The marine life concentration threshold values established in regulation for humpback and blue whales were first developed by the Working Group with the assistance of NMFS and independent scientists with expertise in whale migration and movement patterns off the California coast. Based on historical migration patterns, high average daily sightings within a Fishing Zone are an indication of risk that may require a management action. The results were

incorporated in the Risk Assessment Framework that the Working Group first used during the pilot phase of the RAMP. While these threshold values are approximations developed based on the best available information and expertise, CDFW is committed to refining the marine life concentration triggers as co-occurrence data is developed and longer-term results from RAMP implementation become available.

The presence of Covered Species can be assessed through multiple data sources. At the time this CP was prepared, CDFW identified aerial surveys, vessel surveys, and satellite tagging data as the primary sources of information; summaries of those sources are provided below. Recognizing available funding may limit future surveys by other agencies or independent research organizations, CDFW will work closely with scientists who possess relevant expertise to develop protocols that would allow CDFW, contingent upon available resources, to conduct comparably rigorous surveys aboard CDFW research and patrol platforms. CDFW will also continue developing external partnerships with other agencies, research affiliates, and fishing associations who are able to conduct aerial or vessel-based research surveys employing reliable, standardized methods (Objective 1b). By the fifth year following permit issuance, surveys will be conducted in each RAMP Fishing Zone on a monthly basis between October – December and March – June (or until the season closes). CDFW has selected this timeline to ensure sufficient time for developing protocols and recruiting participants.

In addition, both NMFS scientists and external scientific partners are actively engaged in work to improve the available data for this factor, and CDFW is committed to relying upon the best available science to inform the RAMP. Specifically, species distribution models currently under development by the NMFS Southwest and Northwest Fisheries Science Centers will predict either relative abundance or absolute density values for humpback and blue whales. While CDFW is unlikely to rely solely on these predictions to assess risk, using model outputs within the risk assessment process offers several benefits. Once developed, timely information could be accessed even when weather or funding constraints prevent collection of additional data. Continued collection of distribution information from on-the-water surveys and satellite tagging data would provide not only real-time snapshots of current conditions, but also build confidence in (or highlight areas for improvement of) the models. Nowcast or (at a later stage) forecasted predictions would allow greater emphasis on precautionary rather than reactive management. Lastly, the expanded coverage would facilitate direct comparisons with fishing effort, allowing for an explicit calculation of co-occurrence and associated entanglement risk. While these are not directly included in the current iteration of the RAMP, CDFW will consider emerging data sources as they become available and integrate them into the RAMP as appropriate (Objective 1d).

5.2.1.2.1 Aerial Surveys

Aerial surveys provide high-resolution information regarding distribution of Covered Species, forage (e.g., bait balls, *Chrysaora* patches), and observed trap gear. Historically, systematic surveys designed to provide quantitative estimates of the abundance and density of marine life and trap gear have been conducted three to four times per year by NMFS SWFSC scientists, contingent upon available funding and suitable weather windows. Reconnaissance surveys are intended to provide a qualitative assessment of marine life and trap gear co-occurrence and have been conducted opportunistically by Working Group members and the non-profit group Lighthawk prior to fishing season openings and during periods of elevated risk in spring months. Beginning with the 2019-20 season, CDFW has placed an increased emphasis on conducting

reconnaissance flights. Beginning with the 2020-21 fishing season, the USCG has also conducted focused surveys in support of their Living Marine Resources mandates and opportunistically recorded information during other types of flight operations. CDFW will continue taking advantage of all reconnaissance flight data, as well as that from any systematic surveys conducted by NMFS. Additionally, CDFW intends to continue working closely with NMFS SWFSC scientists to develop data collection tools which would allow CDFW flights to transition from reconnaissance to systematic surveys, contingent upon available resources.

5.2.1.2.2 Vessel Surveys

Vessel-based surveys are another option for collecting fine-scale information on the presence, abundance, and distribution of Covered Species. Unlike aerial surveys, vessel-based surveys cover far less area per unit time, and an individual survey is unable to provide a snapshot of conditions over a large area. However, vessel-based surveys place observers in closer proximity to observed individuals, enabling collection of genetic samples and high-resolution photographs (enabling assignment of individuals to specific DPS, see Section 3.3), attachment of satellite tags (see Section 5.2.1.2.3), or other supplemental research activities.

Notwithstanding routine vessel-based enforcement patrols (during which LED personnel can document sightings of both gear and Covered Species), CDFW has historically relied upon external partners to conduct these surveys. NMFS has several ongoing vessel-based research and monitoring efforts that collect information on the distribution and abundance of marine life off California either as their primary mission or as ancillary data. Examples include the Rockfish Recruitment and Ecosystem Assessment Survey, Applied California Current Ecosystem Studies, and Coastal Pelagic Species surveys. Location and timing vary between surveys and years, however data are often collected during the spring and summer months when Covered Species are abundant off California.

Beginning in summer 2019, Cascadia Research Collective has conducted vessel surveys to support the assessment of real-time large whale distributions. In June 2020 and June 2021, OPC awarded funding to continue this work through the 2022-23 season. Transects typically follow both a shallower (e.g., 70m) and deeper (e.g., 200m) depth contour to assess the spatial distribution of large whales across multiple depths. All sightings of humpback whales and blue whales are recorded, as well as sightings of unidentified whales and other species of interest. In addition to sightings information, researchers document prey species when animals are observed foraging at the surface. Photographs are taken to allow for identification of individual humpback whales and assignment to a specific DPS. Satellite telemetry tags are opportunistically deployed, allowing tracking of individual animal movements and inference of foraging behavior.

CDFW will continue to explore other potential vessel-based surveys to collect information as funding and additional resources become available. Of particular interest at the time this CP was prepared was a pilot effort by the California Coast Crab Association and The Nature Conservancy. This industry-led vessel survey utilized commercial fishing vessels and crew to document whale presence. Sections of the coast were systematically surveyed to document the presence and location of large whales. Working closely with Working Group Advisors, surveys were conducted during Fall 2020 and Spring 2021 to evaluate the feasibility of , and protocols for, fishing vessel-based surveys for Covered Species. CDFW believes the fleet can make significant contributions to surveys at the beginning of the season during crab quality and

domoic acid testing, which requires fishing vessels to collect samples from the fishing grounds. Conducting standardized surveys during these sampling efforts will provide valuable information regarding Covered Species concentrations.

5.2.1.2.3 Tagging

Ongoing satellite tagging programs targeting blue whales and leatherback sea turtles provide information regarding their presence and distribution. Unlike aerial or vessel surveys, which quantify presence within a given area and time, tagging data provide long-term tracks of individual animal movements. For species with known migratory patterns, these index individuals provide a general understanding of when populations begin to arrive or depart from the Plan Area. Deployment of satellite tags requires scientists to locate and then closely approach an individual animal; for cryptic species which spend limited time at the surface (e.g., blue whales) and are difficult to observe even when on the surface (e.g., leatherback sea turtles), this often results in small sample sizes. Additionally, due to limited battery life, tag loss, or individual mortality, satellite tags generally report for weeks to months after deployment. Therefore, understanding multi-year trends requires routine tagging operations.

At this time, CDFW does not plan to undertake tagging operations. CDFW will consider any tagging information provided by NMFS staff, and explore collaborative funding opportunities with NMFS researchers. Additionally, CDFW will explore partnership opportunities with research organizations and institutions that conduct tagging operations on Covered Species, which could allow CDFW access to real-time tagging information.

5.2.1.3 Fishing Season Dynamics, Ocean Conditions and Available Forage

Pilot versions of the RAMP included two additional factors: fishing season dynamics and ocean conditions/available forage. Fishing season dynamics are intended to detect patterns in fishing activity that might lead to higher overlaps between Covered Species and Dungeness crab trap gear. Ocean conditions and anticipated forage availability are of particular value when attempting to forecast distributions of Covered Species and co-occurrence with Dungeness crab trap gear. However, at the time the RAMP regulations were developed, CDFW could not identify routinely produced, real-time data streams with objective thresholds for management action. Therefore, the RAMP regulations do not require management action based on either fishing season dynamics or ocean conditions and available forage. However, the RAMP does include a requirement for bi-monthly reporting of fishing locations and gear deployment, along with electronic vessel location monitoring by fall 2024. As these data become available, CDFW will consider establishing additional triggers related to fishing season dynamics through the adaptive management process described in Chapter 6. CDFW will also evaluate new research regarding the nexus between ocean conditions, available forage, and Covered Species behavior and movement patterns for incorporation into the RAMP.

In the interim, fishing season dynamics and ocean conditions are considered on a case-by-case basis to inform appropriate action when management responses are triggered by confirmed entanglements or marine life concentrations, as described in Sections 5.2.2.7-5.2.2.9.

5.2.2 Other Available Data and Management Considerations

After one of the specified thresholds (i.e., confirmed entanglements or marine life concentrations) is reached, the Director will implement a management response based on the

best available science and will, to the maximum extent possible, rely on relevant and publicly available information. The types of information that can be considered include a Working Group recommendation, information from NMFS, management measure effectiveness, economic impacts, data availability, historical migration patterns, fishing season dynamics, forage, ocean conditions, marine life concentrations, and cumulative confirmed entanglements. These management considerations are further described in the following sections.

5.2.2.1 Working Group Recommendation

The Working Group and its Advisors are comprised of individuals who have expertise regarding the Covered Activities, oceanography, climate, and Covered Species. As such, their input is critical to informing the Director when selecting and implementing appropriate management actions. Once CDFW determines a trigger has been met, notice will be provided to the Working Group and public. CDFW will then convene the Working Group to discuss available data and solicit its management recommendation(s). The specific process by which the Working Group will arrive at its recommendation(s) is specified in its most recent charter, available on the Working Group webpage, and not described in detail here. However, the Working Group generally strives to make recommendations by consensus that reflect expert input from its external Advisors as well as the full range of stakeholders represented on the Working Group. All Working Group recommendations will be carefully evaluated by the Director, particularly those which are made by consensus and firmly grounded in the best available science related to the other management considerations described below.

5.2.2.2 Information from NOAA

There may be instances when CDFW consults with NOAA to determine the need for or appropriateness of a specific management action, given their subject matter expertise regarding Covered Species and management authority under ESA and MMPA. Those recommendations will be considered when selecting a management action.

5.2.2.3 Management Measure Effectiveness

The RAMP regulations require CDFW to consider the effectiveness of a given management measure and, when multiple management measures would provide equivalent reductions in entanglement risk, economic impact to the fleet. However, the regulations do not specify a particular method which will be used to evaluate effectiveness of a given management measure. This will allow CDFW to continually review and incorporate the best available science related to this aspect of the RAMP, and allow for adaptive management as described in Chapter 6.

A basic premise of the biological goals and objectives and the measures comprising the Conservation Program, including actions taken under the RAMP, is that co-occurrence is an appropriate measure of and proportional to entanglement risk. Given this assumption, when evaluating management measure effectiveness, the fundamental question is whether it will meaningfully reduce co-occurrence. This is expected to vary based on the time of year, progression of the fishing season, and ocean conditions. For example, a depth restriction may be more effective if the distribution of Covered Species and available forage is constrained to a certain depth range. If the distribution of Covered Species or available forage is more widespread across a range of depths within a particular Fishing Zone, a season delay/closure or vertical line reduction may be more effective. This consideration will be evaluated based on

expert input from the Working Group and its Advisors, as well as any other information made available to CDFW through the RAMP process. Once the necessary inputs are available, CDFW will actively seek collaborators to develop a spatially-explicit model which produces a quantitative assessment of co-occurrence based on the overlap between trap gear (as determined through electronic vessel location monitoring) and distribution of Covered Species (as predicted by dynamic species distribution models). This model could also incorporate findings from forensic reviews and related research which modulates risk from co-occurrence based on other factors (e.g., gear configuration, domoic acid, etc).

Another aspect of effectiveness is the degree to which this type of management measure has been successfully implemented during prior periods. Was there high compliance by the fleet the last time this management measure was implemented? Are there known enforcement issues that would require dedicated resources to effectively implement this management measure? This will be evaluated based on routine compliance checks by CDFW and, beginning with the 2024-25 fishing season, review of electronic vessel location monitoring information.

While quantifying co-occurrence is relatively straightforward, evaluating how reduced co-occurrence translates into reduced take and M&SI of Covered Species is more complex. Even with robust methods for detecting entanglements, there remains uncertainty regarding cause and effect relationships between a given management action and an observed decline in confirmed entanglements in California commercial Dungeness crab gear. As described in Section 6.2, CDFW will use an adaptive management approach to resolve uncertainties and better quantify management measure effectiveness.

5.2.2.4 Economic Impact

When selecting between management measures that equivalently reduce entanglement risk, CDFW must consider total economic impact on the fleet and fishing communities. The regulations do not specify a particular method for determining the relative amount of economic impact for a given management measure, although they do reflect the fact that for the fleet as a whole the number of vessels impacted is higher for delays in the fall than for early closures in the spring (CDFW 2020b). Historical landings data also indicate that total landings and economic value are similar for seasons with and without fall delays. However, an early closure during the spring will have different impacts on sectors of the fleet depending on their reliance on the fishery throughout the season and on the higher market price that is typically paid for late season crab. Operators who have completed Dungeness crab fishing activities for the season and transitioned to other fisheries may experience less of an impact.

The RAMP incorporates an entire suite of management actions that can protect Covered Species, which are further described in Section 5.2.3. Generating additional information regarding economic impacts from management actions implemented under the RAMP is a priority for CDFW. CDFW will strive to improve the ability to conduct these assessments through: implementing other types of management actions, as appropriate; establishing and monitoring metrics which more fully characterize economic viability of the fleet and relevant sectors; and evaluating the development and implementation of decision-support tools such as trade-off analyses and management strategy evaluations that can explicitly quantify entanglement risk reduction and economic impact from a given management measure (see Section 6.2.3).

The selected management actions will be based on a holistic evaluation of the management considerations specified in Cal. Code Regs., Tit. 14 § 132.8 subd. (d). However, CDFW anticipates that the suite of management actions identified in Cal. Code Regs., Tit. 14 § 132.8 subd. (e) will generate specific learning opportunities during the permit term. CDFW will work closely with the Working Group and its Advisors, industry organizations, social scientists, and other individuals with relevant expertise to identify additional metrics. These metrics should enhance CDFW's ability to assess impacts on the fleet as a whole, as well as on different sectors within the fishery.

5.2.2.5 Data Availability

The availability of data within and across Fishing Zones will be considered when implementing a management action. If data are unavailable for an individual Fishing Zone, CDFW may rely on historical patterns or data from an adjacent Fishing Zone. Availability of data within a Fishing Zone may influence the Director's selection of a management measure. For example, a more restrictive management measure may be implemented for a Fishing Zone with no data to add a level of precaution. In contrast, available data from adjacent Fishing Zones may increase confidence that a less restrictive measure is appropriate.

5.2.2.6 Historical Migration Pattern

Historical migration patterns will be an important consideration, especially when determining whether Covered Species are leaving the fishing grounds in the fall or returning in the spring and summer. Since risk changes throughout the year, the Director may choose to implement a less restrictive measure in the fall because entanglement risk is decreasing as Covered Species migrate out of the fishing grounds. Whereas in the spring, a more conservative management action may be implemented because it provides greater protections for Covered Species when entanglement risk is anticipated to be increasing as Covered Species migrate into the fishing grounds.

5.2.2.7 Fishing Season Dynamics

As noted above, understanding the distribution of Dungeness crab trap gear is an essential element of evaluating co-occurrence between the fishery and Covered Species. Prior to implementation of the RAMP regulations, the best available information regarding fishing effort was based on landing receipts, and CDFW analyses of fishing season dynamics assumed that a given vessel utilized their full trap allocation (see Section 2.2.4). This allowed CDFW to estimate a maximum number of deployed traps by adding up the trap allotments for each permitted vessel. These estimates could be further refined by only including vessels that made landings in a given season, port complex, or other spatiotemporal unit. However, this approach created the opportunity for both overestimation (since not every vessel consistently utilizes their full trap allotment) and underestimation (since vessels may have gear deployed without making a landing during a given period). While this is less of a concern for analyses at the fishing season level, it was a limiting factor when conducting analyses at the weekly or monthly level to support in-season assessment of risk. CDFW has therefore incorporated mandatory reporting requirements into the RAMP.

As part of the RAMP regulations, all fishery participants are required to submit bi-weekly reports to CDFW. These reports include vessel permit number, Fishing Zone (see Figure 5-2) where

gear is currently deployed, and the number and depth range of currently deployed traps. This formalizes and expands on a previous voluntary effort by fishery participants to provide estimates of current fishing effort for risk assessments during the 2019-20 fishing season. Submitting these reports every two weeks allows CDFW and the Working Group to consider recent information during the routine risk assessment process. While data are still self-reported, and are likely to contain errors, these reports will nevertheless greatly improve CDFW's ability to quantify near real-time fishing effort and gear deployment.

Starting with the 2020-21 fishing season, the RAMP regulations also require electronic vessel location monitoring for all Dungeness crab vessels using Alternative Gear (see Section 5.2.3.5) or when operating under a depth restriction (see Section 5.2.3.2). While CDFW does not specify the type of vessel monitoring systems that must be used, systems must meet the specified minimum ping rate of once per minute and data must be available to CDFW upon request for up to 60 days. This information can be compared with the bi-weekly reports mentioned above to verify accuracy, and will allow for closer monitoring (i.e., higher spatial resolution information) for compliance with depth restrictions, fishery closures, and tracking of Alternative Gear deployment. This requirement will be extended to all vessels starting with the 2024-25 fishing season (Objective 1c), which will greatly enhance available information regarding fleet-wide fishing activity and likely gear hotspots. CDFW has chosen to use a phased approach, rather than requiring 100% coverage during the 2020-21 season, to allow the fleet sufficient time to acquire the necessary equipment and comply with the program requirements. CDFW anticipates this timeline will ensure full implementation prior to the first full season following ITP issuance. When paired with Species Distribution Models (see Section 5.2.1.2), information gathered from electronic vessel location monitoring will also inform explicit calculations of co-occurrence and associated entanglement risk, which will be integrated into the RAMP once it is deemed the best available science (Objective 1d).

The Working Group conducted preliminary testing of three electronic monitoring systems and a paper logbook during the 2016-17 commercial fishing season. One specific model of solar-powered vessel tracking systems (solar loggers) tested by Working Group members showed the most promise due to its automated operations, easy installation, and ability to report vessel location every few seconds, providing tracking data with a high degree of spatial resolution (Figure 5-3) that would meet CDFW's minimum ping rate requirement. Additional testing during subsequent fishing seasons has highlighted the potential for solar loggers to provide high-quality, real-time information on vessel activity. To date, equipment, data storage, and processing have been paid for by grants from OPC, and participation in the pilot projects has been voluntary. Participation is expected to increase given new electronic vessel location monitoring requirements.

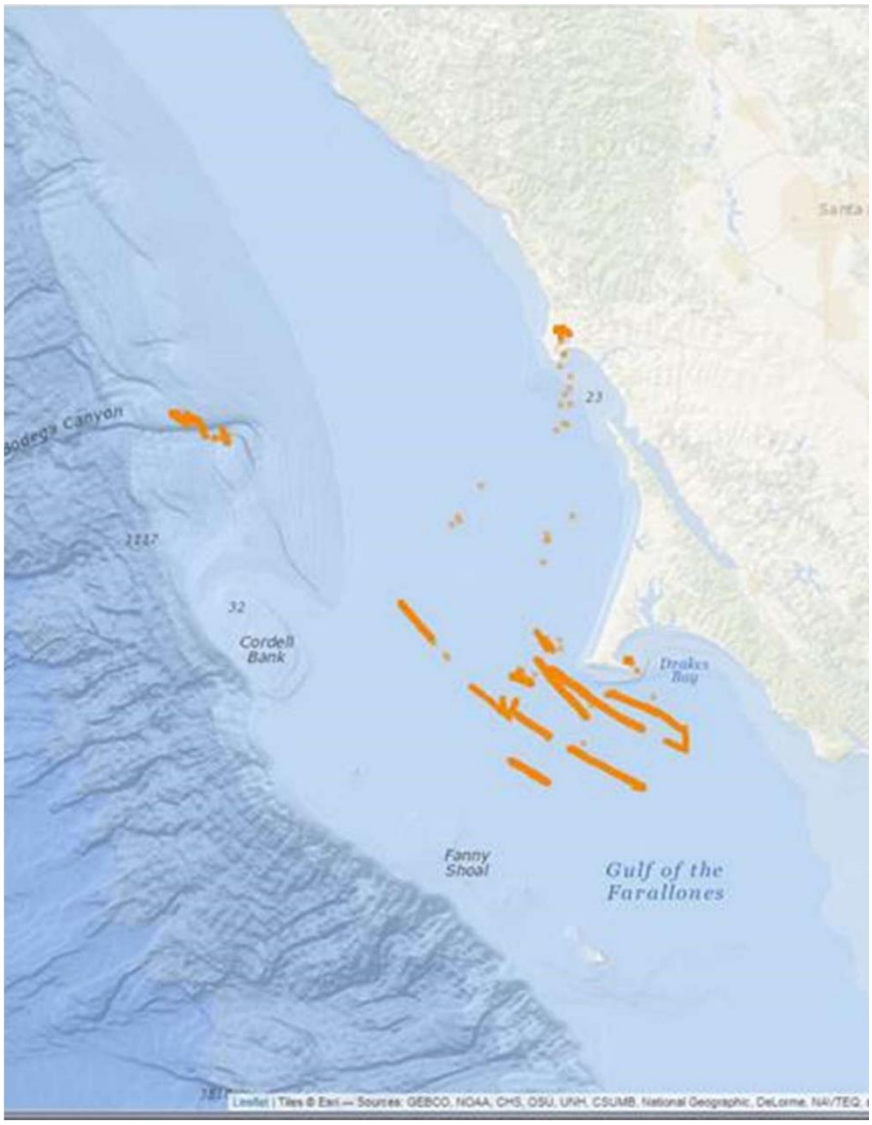

Figure 5-3. Solar logger vessel tracks example, courtesy of Aileen Smith (PSMFC).

Another form of electronic vessel location monitoring currently required for participation in certain federally managed fisheries is a Vessel Monitoring System (VMS; see 50 CFR § 660.14 for requirements applicable to West Coast groundfish fisheries). A mobile transceiver unit detects the vessel's location and transmits it via satellite to a communication service provider, which then provides the information to the NOAA Office of Law Enforcement. Both the transceiver unit and the service provider must be approved by NMFS. The unit must be operational 24/7 and transmit location information at least four times per hour. While Dungeness crab is a state managed fishery, some Dungeness crab vessels participate in federally managed fisheries where VMS is required. Around 35% of total annual Dungeness crab landings are made from vessels with VMS, and about 30% of vessels that participate in the fishery have VMS (Feist et al. 2021). When combined with landings data, VMS tracks can indicate where Dungeness crab fishing activity occurred. While VMS data are only available for a portion of the Dungeness crab fleet and have lower resolution than the CDFW-required systems, this information provides a valuable resource for hindcast analyses. VMS data are available to

select NMFS staff in near-real time, however CDFW's inability to access and utilize these data for state managed fisheries prevents their use for in-season management at this time.

Aerial and vessel surveys (see Sections 5.2.1.2.1 and 5.2.1.2.2) can provide fine-scale information on trap gear distribution, and potentially be used to validate self-reported information on landing receipts and through the bi-weekly reports. However, particularly for aerial surveys, while the number and color of buoys attached to the trap gear may be recorded, observers generally cannot attribute gear to a particular fishery or distinguish between actively fished and lost or abandoned gear.

When combined, available data described above (landing receipts, bi-weekly reports, electronic vessel location monitoring, and aerial/vessel surveys) allow the Working Group and CDFW to consider the concentration and geographic location of fishing effort, amount of gear deployed, and progression of the fishing season when determining appropriate management actions. Fishing pressure (number of vessels and amount of gear deployed) is greatest in fall when the fishery opens and declines substantially during the spring months (see Section 2.2.5). Historical migration patterns indicate fewer Covered Species are in the fishing grounds in late fall/early winter as opposed to spring. Therefore, an on-time (November 15 or December 1, depending on location) or slightly delayed fishery opening is associated with lower entanglement risk as compared to an opening late in the fishing season (February-April). Historical landings data suggests that more than 80% of commercial Dungeness crab landings occur within the first eight weeks of the season (Figure 2-8). The scheduled season openings mean this high level of effort, and large amount of deployed gear, occur when marine life concentrations are decreasing in the fishing grounds, and entanglement risk is therefore declining.

In contrast, if the fishery does not open until late winter or spring, the high effort period is more likely to overlap with a period of increasing marine life presence as whales and turtles return to the fishing grounds. Additionally, during a compressed fishing season, fishing effort would likely be higher than normal during the latter part of the season as individuals try to make up for lost fishing opportunities. This would increase the likelihood of co-occurrence between gear and Covered Species, resulting in an increased risk of entanglement.

The location of the fleet in relation to marine life presence (i.e., co-occurrence) will therefore be an important consideration when assessing appropriate management responses. If Covered Species are observed towards the end of a fishing season in locations where fishing activity is decreasing due to progression of the fishing season (late spring/early summer), the Director may choose to implement a less restrictive management action. Conversely, if there is a risk of substantial overlap of fishing activity and Covered Species the Director may choose a more restrictive measure to enhance protections.

5.2.2.8 Available Forage

Distribution and abundance of forage can have a profound impact on movement patterns and concentrations of Covered Species (Santora et al. 2020). While specific thresholds have not yet been defined, CDFW will consider available information regarding forage species presence in the Plan Area when assessing relative risk of marine life entanglement. Relative abundance of krill and anchovy are assessed during the annual NMFS SWFSC Rockfish Recruitment and Ecosystem Assessment Surveys. Midwater trawls are deployed during the spring and early summer at defined sampling stations which cover both coastal and offshore waters. Data for

central California are available from 1990 on, allowing for comparison of current values with historical conditions and trends.

Higher coastal abundance of forage species increases entanglement risk by increasing the probability that large whales will congregate in nearshore areas and overlap with fishing activity. Conversely, abundant offshore or widespread foraging opportunities are associated with reduced entanglement risk.

5.2.2.9 Ocean Conditions

A variety of oceanographic conditions influence the distribution of key prey species (see Chapter 3), with direct consequences for co-occurrence between Covered Species and fishing gear. During the 2019-20 and 2020-21 fishing seasons, CDFW considered available information regarding habitat compression, coastal upwelling, NPH, ONI, and LMH events to predict distributions of Covered Species. While specific thresholds indicating elevated risk have not yet been incorporated into regulation, ongoing research efforts by NMFS SWFSC scientists may allow CDFW to establish precautionary triggers in the future. Until that time, CDFW will consider historical trends when forecasting entanglement risk. Additionally, ocean conditions such as high winds or strong currents strongly influence fishing behavior and responsiveness of the fleet. High winds and strong swell events can affect the fleet's ability to detect and retrieve gear or be responsive to a management directive.

5.2.2.10 Marine Life Concentrations

Marine life concentrations and their spatial distribution will be an important consideration when choosing a management response, particularly in determining the area over which that response will apply. More concentrated presence of Covered Species could indicate management action for a single Fishing Zone is appropriate, while a more dispersed presence might indicate that management over a larger area is necessary.

In addition to data streams identified in Section 5.2.1.2 (aerial surveys, vessel surveys, and satellite tagging), CDFW and the Working Group may consider other observations or modeled distributions of Covered Species. During the 2020-21 fishing season, CDFW considered reports from trained naturalists at the Farallon Islands and Channel Islands as well as species distribution models for blue whales. During preparation of this CP, CDFW received briefings from NMFS SWFSC staff regarding similar predictive models under development for humpback whales. When complete, and with concurrence from NMFS WCRO that they are sufficiently robust for use in decision making, CDFW will work with scientific advisors and members of the Working Group to develop objective thresholds for management action based on the blue and humpback whale distribution models and subsequently incorporate them into regulation (Objective 1d). In the interim, CDFW will consider model outputs under this subsection.

5.2.2.11 Confirmed Entanglements and Cumulative Take

Along with the other Conservation Measures described in this Chapter, the fundamental goal of the RAMP is to limit take of the Covered Species to levels at or below those permitted under an issued ITP. As the number of confirmed entanglements approaches the permitted take limits, CDFW will implement increasingly precautionary management actions. The higher take limit for humpback whales provides CDFW the opportunity to transition from less restrictive to more restrictive actions with each additional confirmed entanglement. For example, if the

management considerations identified above suggest a gear reduction is the best approach to reduce entanglement risk and the cumulative total number of entanglements during the current three-year period is five, CDFW might implement a 25% gear reduction. Should additional entanglements occur during that same season, CDFW might implement a 50% or 75% gear reduction, and ultimately consider closure of one or more Fishing Zones.

Given the low take limits for blue whales and leatherback sea turtles, CDFW would likely implement a restrictive management action following a single confirmed entanglement of these species. For example, if the entanglement is confirmed during the open fishing season, CDFW might close one or more Fishing Zones for the remainder of the season to prevent continued co-occurrence. As another example, if the entanglement is confirmed during the offseason, CDFW might elect to restrict operations for the subsequent fishing season to low-risk areas or time periods to reduce the risk of additional entanglements that could exceed permitted take thresholds.

If the permitted take thresholds are exceeded, CDFW will initiate consultation with NMFS and implement measures as dictated by the issued permit.

5.2.3 Management Responses

The most protective management response CDFW can implement to prevent entanglements is to close part or all of the Plan Area to commercial Dungeness crab gear. Therefore, the default action when a trigger is reached is closure of one or more Fishing Zones to traditional Dungeness crab gear. In most cases, however, the Director may select from several alternatives based on the best available science related to the management considerations described in Section 5.2.2.

Management responses are limited to a Fleet Advisory, depth constraint, vertical line/gear reduction, Fishing Zone closure, and authorizing deployment of Alternative Gear (Cal. Code Regs., Tit. 14 § 132.8 subd. (e)). Having a bounded range of options allows management responses to be both flexible and predictable. Should the best available science be insufficient to support alternative management responses, the default of a partial or statewide closure of the fishing grounds provides a protective threshold to minimize entanglement risk.

5.2.3.1 Fleet Advisory

The Director may issue an advisory to the fleet to encourage voluntary efforts if risk is elevated or expected to increase but a more restrictive management response is not necessary. Voluntary actions encouraged by the Working Group during prior seasons have included implementation of Best Practices, as detailed in their Best Practices Guide, regarding gear configuration (e.g., reducing slack line and minimizing surface gear) and placement (e.g., avoiding areas with high concentrations of forage or where Covered Species have been sighted). In some instances, a trigger may be reached but management action to reduce entanglement risk is not warranted. For example, the season opening may be delayed due to domoic acid or low crab meat quality, so there would not be a need to implement a management action. Alternatively, if a trigger is hit late in the spring when fishing effort is decreasing rapidly and expected to be at negligible levels prior to Covered Species entering the fishing grounds in large numbers, additional mandates to remove gear may not be needed.

5.2.3.2 Depth Constraint

A depth constraint may be implemented to avoid co-occurrence of Covered Species and fishery operations. Depth constraints will be based on waypoints as defined in federal regulation (50 CFR §§ 660.71-660.72). The use of waypoints to define depth contours is routine in the groundfish fishery and is familiar to Dungeness crab fishermen because many individuals participate in both fisheries. As discussed in Chapter 3, available forage for Covered Species is in part tied to the depth contour off the coast. If the best available scientific information indicates that certain depths carry a higher risk of entanglement, the Director could implement a depth closure over the fishing grounds or within specific Fishing Zones. An example could be prohibiting take of Dungeness crab seaward (deeper) of the 30 or 40-fathom line to protect leatherback sea turtles by excluding gear from their primary foraging area. Prohibiting take of Dungeness crab seaward of the 50-fathom line could reduce interactions with blue whales, which are primarily found in deeper depths over the continental shelf. CDFW will consider the best available science when determining appropriate depth-based closures.

5.2.3.3 Vertical Line/Gear Reduction

If entanglement risk is elevated, but not yet at a level which would prompt closures, reducing the number of vertical lines in the water can reduce risk. Based on the availability of marine life concentration data, CDFW could implement a vertical line reduction to lower the overall risk of entanglement within a given Fishing Zone. For example, if data collected prior to the season opening indicated the southward migration of Covered Species had begun but was not yet complete, a vertical line reduction during the early weeks of the fishing season would allow the fishery to commence while reducing entanglement risk for the Covered Species.

In the near term, CDFW anticipates implementing vertical line reductions by reducing the number of traps individual fishermen can deploy, which could be accomplished in a variety of ways:

- Excess tags on vessel. Require a percentage of issued buoy tags to be onboard the vessel, rather than affixed to traps. Any deployed gear without the required buoy tags would be non-compliant.
- Issuance of required buoy tags in multiple colors. During periods of reduced trap use, only specified colors could be used.
- Gear check in. During periods of reduced trap use, fishermen would be required to bring the specified amount of gear ashore, where it is checked-in by CDFW.

The current RAMP regulations specify trap reductions would be effectuated through requiring excess tags to be present onboard the vessel. However, CDFW will evaluate the need for and benefits of alternate approaches under the adaptive management process described in Chapter 6.

Two other methods for reducing vertical lines involve replacing the traditional vertical line and surface gear with a “pop-up” system and transitioning from traditional single-trap configurations to multi-trap trawls (where multiple pots are connected by a common ground line and only a subset of those traps have a vertical line attached; see Figure 2-3). At this time, CDFW anticipates these methods would be authorized under the Alternative Gear framework, as

further described in Section 5.2.3.5. However, CDFW will evaluate and consider statutory and regulatory changes allowing additional methods for achieving specified vertical line reductions.

5.2.3.4 Closures

Spatiotemporal closures are a key management measure in the spring months when historical migration patterns, surveys, and/or models indicate that Covered Species have begun to arrive in California waters, or during the fall when Covered Species have not yet left California waters. In these instances, the scheduled season opening can be delayed, or the scheduled season closure advanced. When real-time information on marine life concentrations, trap gear, and co-occurrence is available, spatiotemporal closures can also be used to selectively close hotspots with elevated entanglement risk. Cal. Code Regs., Tit. 14 § 132.8 specifies that closures can occur by Fishing Zone (Figure 5-2) or statewide. Once a closure is in effect, LED can take appropriate enforcement action against owners of Dungeness crab traps found inside closed Fishing Zones.

The current Fishing Zones were selected based on a combination of ecological and fishery characteristics and the anticipated scale of available information. As additional sources of information regarding fishing activity and distribution of Covered Species become available, CDFW may determine closures providing equivalent protections for Covered Species could be implemented on smaller spatial scales, reducing economic impacts on fishery participants.

5.2.3.5 Alternative Gear

Several types of gear modifications and innovations are currently being explored by gear developers, fishermen, and members of the Working Group. These include, but are not limited to, “pop-up” gear (commonly called “ropeless gear”). In general, pop-up gear involves a coil of rope, acoustic receiver, and buoy attached to the trap. An acoustic signal is sent from the fishing vessel to the receiver, triggering the release of the rope and buoys. Once the buoy “pops up” to the surface of the water, the fisherman can retrieve the gear using the same methods as they would for traditional gear. Some configurations rely on a timed release rather than an acoustic signal, where either a chemical reaction (for galvanic releases) or elapsed time (for electronic releases) results in release of the rope and buoys. Other companies have entirely replaced the rope and buoys, and the acoustic release instead triggers compressed gas canisters to fill large lift bags which bring the entire trap to the surface for retrieval. All of these approaches share the common element of minimizing the amount of time vertical lines are present in the water column and gear is at the surface. This decreases the opportunity for an adverse encounter between Covered Species and commercial Dungeness crab trap gear.

Allowing use of pop-up gear during periods of elevated entanglement risk in areas otherwise closed to commercial Dungeness crab fishing could reduce prevalence of vertical lines while limiting negative impacts on the fishery. However, preliminary testing of pop-up gear off California has highlighted economic and reliability concerns from fishery participants and CDFW concerns regarding gear conflict, gear loss, and enforceability of trap limits, gear configuration, Marine Protected Areas, and other regulations. Pop-up gear is expected to reduce entanglements, but these benefits are challenging to quantify without observational data or experimental studies. Recognizing ongoing development efforts in this area, the limitations of currently available options, and the potential for non-pop-up gear innovations that would similarly decrease entanglement risk to arise at a later time, the RAMP establishes a process for

CDFW certification of Alternative Gear, which includes but is not limited to pop-up technologies. This process includes performance standards such as detectability by CDFW, reliable means of retrieval, easily identifiable, and providing a tangible benefit by reducing risk or severity of entanglement with marine life.

In 2019, CDFW began actively engaging with gear manufacturers and other stakeholders to better understand the current limitations of, and potential solutions for, pop-up gear design and adoption by the Dungeness crab fishery. CDFW sees value in continuing these types of direct conversations, and as part of this CP is committed to hosting a biennial workshop with gear developers, fishery participants, and other interested parties to discuss progress and remaining barriers to the development and adoption of gear innovations that meet CDFW's requirements for certification as Alternative Gear under Cal. Code Regs., Tit. 14 § 132.8 (Objective 2b). The biennial frequency will allow for additional testing to occur and inform the next workshop. This certification process is distinct from, and serves a different role than, potential issuance of Experimental Fishing Permits (EFPs) by the Fish and Game Commission. EFPs would be issued to specified individuals for a set period of time and allow for fishing activity which is not otherwise authorized under existing regulations. EFPs are a mechanism by which testing of innovative gear could occur, thereby generating the information required to request CDFW certification as Alternative Gear. However, upon certification, Alternative Gear would become legal commercial fishing gear and could be used by all participants (not just those who received an EFP).

While pop-up gear has generated a lot of interest from certain constituents, there are other types of gear that may also reduce either the risk or severity of entanglement with marine life that could be considered for certification as Alternative Gear. These include configurations that incorporate reduced breaking strength line (making it more likely an entangled whale can self-release), eliminate splices (reducing the potential for developing into a complex entanglement), or use types of line that cause less damage when wrapped around the whale. Some of these modifications are currently being evaluated or even actively recommended as best practices (see Section 5.3). So long as the modified gear meets existing requirements for traditional Dungeness crab gear (e.g., presence of a persistent surface buoy), it does not require specific authorization as Alternative Gear to be used during the open season. However, certification as Alternative Gear would allow those configurations to be fished in times and areas closed to traditional gear. Incorporating these types of gear modifications is anticipated to be substantially lower in cost than transitioning to pop up gear, increasing the pool of Dungeness crab vessels who could adopt Alternative Gear and continue fishing with limited impacts on Covered Species during periods of elevated entanglement risk.

Stakeholders have expressed interest in allowing use of multi-trap trawls during periods of high risk as an additional method for reducing vertical lines. Fish & G. Code § 9012 specifically prohibits the use of multi-trap trawls in the NMA. Legislative bill analysis of AB 3337 from 1994 indicates there were concerns about overcapitalization and excessive early-season fishing effort. More recently, Working Group members and other fishery participants have described gear conflict and human safety as additional reasons for prohibiting the use of multi-trap trawls in certain areas. Even though connecting multiple traps to a single buoy leads to fewer vertical lines in the ocean, any entanglements which then occur may be more severe than an entanglement with a single trap. Findings from testing under an EFP would inform future actions that might be appropriate related to multi-trap trawls.

5.3 Best Practices

As described in Section 5.2.3.5, some gear modifications that are likely to reduce entanglement severity are currently being evaluated or recommended for widespread use as best practices. The first Best Practices Guide was developed in fall 2015 by the Working Group, with input and support from OPC, NMFS, and CDFW. The Best Practices Guide was updated on an annual basis prior to the start of the 2016-17, 2017-18, 2018-19, 2019-20, and 2020-21 seasons. Starting with the 2021-22 fishing season, the Best Practices Guide will be updated on an as-needed basis to incorporate new recommendations from the Working Group, Working Group Advisors, and agencies. Copies are given to Working Group members for distribution, posted online, and shared through various listservs. The Best Practices Guide is available at CDFW license counters that fall within the range of the Dungeness crab fishery and is also distributed by CDFW staff during recreational fishery sampling and at outreach events.

CDFW anticipates additional modifications to fishing gear components and configurations may be deemed best practices during the permit term. One example is the use of "South Shore sleeves" and other methods to reduce vertical line breaking strength, which have been tested in New England trap fisheries in an attempt to decrease anthropogenic mortality of the endangered North Atlantic right whale. Unlike pop-up gear, these methods could be used without any additional authorization by CDFW. However, while early evidence on these methods shows some promise, there has been limited testing in West Coast fisheries and there are no known studies documenting the potential benefits the methods provide in reducing M&SI for the Covered Species.

The "South Shore sleeve" is a method of splicing rope together where the two butt ends of the rope meet in the middle of the sleeve (Figure 5-4). This sleeve then acts as a weak link. The sleeves were designed by the South Shore Lobster Fishermen's Association and further developed and manufactured by Novabraid. On the East Coast, these sleeves are manufactured with a 1,700-pound breaking strength, the minimum breaking strength of ropes which have persisted on entangled North Atlantic right whales. The average breaking strength of ropes which have persisted on adult and juvenile humpback whales is significantly lower (Knowlton et al. 2016), indicating even weaker ropes might be needed for the California commercial Dungeness crab fishery so that whales are able to self-release by breaking the rope. Similar research has not yet been conducted for blue whales, although Arthur et al. (2015) estimated the force output for large individuals as approximately 60 kN (13.5k pounds of force). In addition to serving as weak links, connecting gear with South Shore sleeves instead of knots or splices means the rope lacks binding points which can get caught up in baleen (PSMFC 2018), increasing the likelihood an entangled whale can self-release. Due to their smaller size, the benefits for leatherback sea turtles are unknown but self-release is unlikely.

Figure 5-4. Novabraid South Shore sleeve, courtesy of Fran Recht (PSMFC).

While additional gear trials can help address questions of reliability and the degree to which these types of gear modifications can be implemented in the fishery, it is more challenging to directly assess the benefits they may provide to Covered Species. Much of our understanding of the specific gear configurations that are more likely to result in entanglements, and increase entanglement severity, comes from forensic review of available documentation following a given entanglement. In 2018, PSMFC and NMFS hosted a focused workshop with fishermen, Large Whale Entanglement Response Network members, scientists, managers, and gear experts to review available forensic data and improve understanding of how a given entanglement occurs. While CDFW staff were unable to participate, both the report generated after the workshop and reflections shared by the Working Group members in attendance have provided valuable insights. CDFW is committed to working in partnership with PSMFC and NMFS to convene a similar workshop on a triennial basis (Objective 2a). A key outcome of the workshop will be specific gear configuration recommendations that would reduce M&SI from entanglements. CDFW will implement regulatory changes to require the use of those modifications as part of baseline fishing practices and will advise the California Legislature regarding any needed statutory adjustments. In the interim, CDFW will work with the Working Group, NMFS, OPC, and fishery participants to incorporate the proposed changes into an updated version of the Best Practices Guide. The triennial frequency creates an opportunity for these changes to be reflected in forensic documentation from subsequent confirmed entanglements, while also ensuring CDFW and other partners are routinely considering additional improvements.

5.4 Lost or Abandoned Gear Recovery

As part of the regulations implementing the trap limit program (Cal. Code Regs., Tit. 14 § 132.2), CDFW specified that no more than six traps could be on a vessel without a buoy tag assigned to that vessel, although an unlimited number are allowed from July 16 - October 31 (during the closed season). This allowance was intended to facilitate good-faith efforts by

Dungeness crab vessel permitholders to retrieve lost or abandoned trap gear, while ensuring CDFW would still be able to enforce the trap limit program.

Fishery participants have commonly estimated annual gear loss of 5-10%. Assuming 140,000 traps are deployed, this would mean between 7,000 and 14,000 traps are lost each season. Prior to implementation of Cal. Code Regs., Tit. 14 § 132.8, CDFW had no specific mechanism to assess gear loss, however requests for replacement buoy tags (which can be submitted both in-season and between the two seasons of each biennial period) could be used to roughly estimate gear loss. If the number of lost traps is assumed to be equal to the number of replacement tag requests, then 10,442 traps were lost during the 2013-14 season, 5,432 traps were lost during the 2015-16 season, and 8,176 traps were lost during the 2017-18 season. While there are a variety of limitations with this approach (e.g., lost tags do not necessarily equate to lost traps at sea), it is a particularly inadequate mechanism for assessing lost gear during the second season of each biennial period, since each permitholder will receive a complete set of tags prior to the next season and therefore will not submit a between season replacement request. Beginning with the 2020-21 fishing season, the bi-weekly Fishing Activity Reports required by Cal. Code Regs., Tit. 14 § 132.8 subd. (g)(1) required fishery participants to annually report the number of lost traps. During the 2020-21 season, 297 fishery participants reported a total of 1,438 lost traps. These same bi-weekly reports indicated 95,267 traps were deployed during the season, resulting in a reported gear loss rate of 1.5%. This is far lower than the common estimate of 5-10%, as well as substantially less traps than suggested by replacement tag requests. As discussed in Section 2.2.4.1, due to compliance issues with this new reporting requirement, CDFW considers estimates from the bi-weekly reports to be a lower bound, and the actual number of lost traps, deployed traps, and/or gear loss percentage may differ from the values presented here. With continued implementation of the RAMP, CDFW will be able to more accurately quantify annual gear loss.

In several ports, local non-profit organizations and fishing organizations have worked with commercial Dungeness crab fishermen to conduct coordinated gear retrieval operations after the close of the fishing season. Between 2014 and 2019, these operations have removed over 2,000 traps (personal communications: Jennifer Renzullo, Sea Doc Society, 8/10/2015; Oliviya Wyse, Monterey Bay Fisheries Trust, 11/26/2019; Jenn Humberstone, The Nature Conservancy, 3/6/2020).

CDFW adopted regulations (Cal. Code Regs., Tit. 14 § 132.7) in September 2019 implementing a lost or abandoned commercial Dungeness crab trap gear retrieval program. Under the terms of the program, qualified entities (sport or commercial fishing associations with a board and/or charter, non-profits, and local government agencies or harbor districts) work with commercial trap fishermen to conduct on-the-water retrieval operations from two weeks after the scheduled season closure (Fish & G. Code § 8276) to September 30. The Director can authorize retrieval to begin sooner as part of a closure under the RAMP. All retrieved traps are documented in a logbook, which is submitted to CDFW each year. Compensation for retrieval activities is provided either by the Dungeness crab vessel permitholder, in exchange for the retrieved trap, or by CDFW. The guaranteed compensation is one key difference between the formal program and the informal retrieval activities conducted under Cal. Code Regs., Tit. 14 § 132.2. CDFW has conducted extensive outreach to potential Retrieval Permittees to encourage their participation, as well as notifying commercial fishery participants of the program's implications.

Based on the bi-weekly fishing activity reports, logbooks submitted under the Trap Gear Retrieval Program, voluntary submission of documentation regarding retrieval under Cal. Code Regs., Tit. 14 § 132.2, and any provided documentation regarding retrieval activities conducted under other authorities (e.g., salvage permits issued by the NOAA Office of National Marine Sanctuaries), CDFW will conduct an annual assessment of the total amount of lost gear, recovered gear, and unrecovered gear. By the fifth year following permit issuance, CDFW will establish an annual minimum recovery percentage for lost or abandoned commercial Dungeness crab gear (Objective 1e), which is intended to further reduce co-occurrence between the Covered Species and Covered Activities. Any lost or abandoned gear retrieval reported to CDFW will be included when determining whether the annual recovery percentage has been met. Establishing a deadline of 5 years after permit issuance will give CDFW sufficient time to generate robust estimates of gear loss and evaluate the efficacy of the Trap Gear Retrieval Program and other methods of recovering gear, allowing CDFW to set a meaningful and realistic recovery target.

5.5 Outreach

Outreach to fishery participants is a crucial component of this CP. CDFW will continue routinely engaging key stakeholders on the Working Group and DCTF, as well as encouraging them to share information with the constituents they represent.

CDFW will annually distribute a pre-season newsletter which includes updates regarding implementation of this CP and any new regulatory requirements for the commercial fishery. The most recent Best Practices Guide will also be included. The newsletter will be mailed to all Dungeness crab vessel permitholders. The newsletter will also be distributed electronically through CDFW's Marine Management News blog and posted on CDFW's Whale Safe Fisheries webpage.

CDFW will hold at least one public meeting prior to the start of each fishing season. The goal of these meetings is to increase awareness of marine life entanglement issues and management actions by the fleet and broader public. CDFW will provide updates regarding implementation of the Conservation Program and identify areas where industry collaboration and involvement is needed to increase effectiveness.

CDFW will also generate press releases, send updates via a dedicated listserv, and regularly update the Whale Safe Fisheries webpage with new developments related to implementation of the CP.

5.6 Conservation Program in Action During the 2020-2021 Season

As highlighted in Section 4.1.2 and throughout this Chapter, CDFW has already implemented several elements of the Conservation Program described above. The 2020-21 season can therefore be treated as a case study for how the Conservation Program will function during the permit term.

The 2020 Trap Gear Retrieval Program began on May 22 in the CMA (Fishing Zones 3-6) and began on July 30 in the NMA (Fishing Zones 1-2). CDFW issued permits to qualified entities based in seven ports: Crescent City, Eureka, Trinidad, Bodega Bay, San Francisco, Half Moon Bay, and Monterey Bay. Gear was recovered under six of these permits (all but Bodega Bay), with a total of 13 active Designated Retrievers conducting 47 retrieval trips and collecting 521 Dungeness crab traps. Recovered gear was traced to 130 unique Dungeness crab vessels, with

an average of four traps per vessel. In addition to gear recovered under CDFW-issued Retrieval Permits, CDFW received reports of an additional 112 Dungeness crab traps recovered near Trinidad, for a total of 633 traps recovered during 2020.

During September and October 2020, CDFW collaborated with NMFS, OPC, and Working Group members to develop an updated Best Practices Guide for the 2020-21 season. In October 2020, CDFW mailed a pre-season newsletter and copies of the Best Practices Guide to all commercial Dungeness crab vessel permitholders.

CDFW conducted the first pre-season risk assessment on November 4, 2020. Marine life concentrations in Fishing Zones 3 and 4 required implementation of a management action, and the Director delayed the scheduled November 15, 2020 season opening in Fishing Zones 3-6. During the second risk assessment on November 24, 2020, marine life concentrations in Fishing Zones 3 and 4 again exceeded the threshold for management action, and the Director further delayed the season opening in Fishing Zones 3-6. Additionally, the scheduled December 1, 2020 opening in Fishing Zones 1 and 2 was delayed due to low crab quality. On December 7, 2020 Tri-State fishery managers determined further crab quality delays of Fishing Zones 1 and 2 were not required. A third risk assessment on December 11, 2020 indicated marine life concentrations in Fishing Zone 4 still exceeded the threshold for management action. The Director delayed the season opening in Fishing Zones 1-6 until December 23, 2020 and issued a Fleet Advisory requesting fishery participants to avoid setting gear at the edges of the Monterey Canyon (where krill and blue whales were sighted), as well as near Point Reyes and around the Farallon Islands (known hotspots for humpback and blue whales). The Fleet Advisory also requested fishery participants to employ the best practices in all waters.

During the January 14, 2021 and February 11, 2021 risk assessments, no triggers were reached and management action was not required. During the March 12, 2021 risk assessment, marine life concentrations in Fishing Zone 4 and a lack of CDFW-approved survey data in Fishing Zones 1, 5 and 6 required implementation of a management action. The Director issued a Fleet Advisory for Fishing Zones 1-6 which requested fishery participants to employ the best practices and immediately remove all gear once the operator was done fishing for the season. The Fleet Advisory specifically encouraged vessels in Fishing Zone 4 to pay attention to the location of set gear and foraging whales. During the April 1, 2021 risk assessment, a lack of CDFW-approved survey data for Fishing Zones 5 and 6 required implementation of a management action. The Director issued a second Fleet Advisory for Fishing Zones 1-6 which requested fishery participants to employ the best practices and immediately remove all gear once the operator was done fishing for the season. The Fleet Advisory specifically encouraged vessels in Fishing Zones 3 and 4 to pay attention to the location of set gear and foraging whales. During the April 14, 2021 risk assessment, a lack of CDFW-approved survey data for Fishing Zones 1, 2, 5 and 6 required implementation of a management action, and the Director issued a third Fleet Advisory.

During the May 3, 2021 risk assessment, a lack of CDFW-approved survey data for Fishing Zones 1, 2, 5 and 6 required implementation of a management action. The Director issued a fourth Fleet Advisory. In addition, in response to large aggregations of humpback whales observed between 30 and 45 fathoms in Fishing Zones 1 and 2, the Director implemented a depth restriction constraining the fishery to waters shallower than 30 fathoms in these zones. During the May 18, 2021 risk assessment, marine life concentrations information in Fishing Zones 1 and 4, and a lack of CDFW-approved survey data in Fishing Zones 2, 3, 5 and 6

required implementation of a management action. The Director closed the fishery statewide (all Fishing Zones) beginning at noon on June 1, 2021 and authorized operations under the Trap Gear Retrieval Program beginning at 6am on June 7, 2021.

As part of each risk assessment, CDFW convened the Working Group and solicited their recommendation(s) regarding appropriate management actions. The Working Group provided formal recommendations for the November 4, November 24, December 11, May 3, and May 18 risk assessments. All documents related to the risk assessments, including available data compilations, Marine Region staff recommendations, Working Group recommendations, and declarations by the Director are available on CDFW's Whale Safe Fisheries webpage.

NMFS WCRO did not confirm any entanglements of either blue whales or leatherback sea turtles between August 2020 and July 2021. During this period, NMFS identified two humpback whale entanglements which met CDFW's criteria for triggering a management action. One humpback whale entanglement was reported on April 3, 2021 in Fishing Zone 6. Based on the available documentation (photos showing a dark line, with no visible surface gear), NMFS was unable to attribute the entanglement to a gear type or specific fishery and classified the entanglement as occurring in unidentified fishing gear. CDFW solicited input from the Working Group and Working Group Advisors during multiple meetings. Despite robust discussion, CDFW was unable to rule out California commercial Dungeness crab as a potential gear type, and therefore classified the entanglement as occurring in Unknown Fishing Gear. Given it's potential to have originated from the commercial Dungeness crab fishery, the entanglement was considered during subsequent risk assessments as an indicator of elevated entanglement risk. The second humpback whale entanglement was reported on June 9, 2021 off Los Cabos, Mexico and confirmed by NMFS as occurring in California commercial Dungeness crab gear. As the fishery had already closed, CDFW did not implement any additional management actions.

In September 2021, NMFS WCRO notified CDFW and the Working Group of two additional confirmed entanglements in unidentified fishing gear reported off California. Both were reported in Fishing Zone 6, one on July 13, 2021 and the other on August 28, 2021. *Note: CDFW will include additional information regarding these entanglements prior to submittal.*

The low number of confirmed Covered Species entanglements in either California commercial Dungeness crab gear or Unknown Fishing Gear during this period provides strong evidence that even partial implementation of the Conservation Program described in this Chapter will be effective at keeping take of Covered Species below the take limits described in Section 4.2. In addition, entanglement response reports received during this period indicate CDFW's standardized marking program appears to be effective; two entanglements identified during May and June 2021 were attributed to other California fixed gear fisheries due to enhanced marking requirements.

5.7 Coordination and Key Partners

5.7.1 NMFS

Successful implementation of this CP will require continued coordination and collaboration between CDFW and NMFS staff within the WCRO, Protected Resources Division and the Fisheries Science Centers. As described in Sections 5.2.1.1.1 and 5.2.1.1.3, CDFW will continue relying on NMFS to review and confirm reported entanglements and to provide any available information regarding the appropriate attribution of those entanglements (i.e., which

gear type was involved). CDFW will consider any information provided to support the in-season risk assessment and management action selection process under the RAMP, including real-time marine life concentrations information from surveys or satellite tagging operations (see Section 5.2.1.2), analysis of historical patterns (see Section 5.2.2.6), and insights regarding ocean conditions and forage availability (see Sections 5.2.2.8 and 5.2.2.9).

CDFW will also engage NMFS when conducting triennial reviews of the Conservation Plan, and when considering potential amendments to this CP and associated regulations, as described in Sections 6.2 and 6.3.

5.7.2 Tribal Governments

CDFW is committed to consulting with tribes about the potential impact of activities on tribal interests and providing meaningful opportunities to participate in decision-making processes regarding those activities. Throughout the term of the permit, CDFW will conduct consultation with tribal governments in accordance with the CDFW Tribal Communication and Consultation Policy.

5.7.3 California Ocean Protection Council

OPC was established in 2004 to coordinate the scientific and management activities between California state agencies related to ocean conservation (Public Resources Code §§ 35600 *et seq.*). As California's lead agency for marine policy issues, OPC strategic plans and policies provide crucial guidance for the ocean conservation activities of state agencies. Of particular relevance to this CP are elements of the current OPC Strategic Plan (OPC 2020) which discuss sustainable fisheries and anthropogenic impacts on marine life, including entanglements. As discussed in Section 5.1, the OPC's goal of zero annual M&SI provides overarching context for the design and implementation of this CP. OPC also provides financial resources (from bond funds and legislative appropriations) to state agencies and external parties that enhance the quality and quantity of scientific information upon which state management decisions are made. In November 2019, OPC approved an investment strategy to guide the allocation of approximately $5.3 million in general funds for projects reducing marine life entanglements (OPC 2019).

Along with CDFW and NMFS, OPC was instrumental in organizing the initial public meeting on marine life entanglements in August 2015 and convening the Working Group in September 2015. Since the Working Group's inception, OPC has provided financial support for Working Group operations, strategic guidance regarding Working Group activities, and staff resources to organize meetings and document outcomes of Working Group discussions. CDFW intends to continue this collaborative relationship with OPC when implementing this CP.

5.7.4 Tri-State

Washington and Oregon have indicated that they plan to submit applications for ITPs providing coverage for their commercial Dungeness crab fisheries. While differences in each state's regulatory environment and fishery operations will be reflected in their respective CPs, California will continue routine data-sharing with the other two states, particularly with regard to forensic review of entanglements, gear marking and innovations, and emerging science. California will also continue participating in the Tri-State Agreement overseen by PSMFC, through which the three states routinely discuss and coordinate management actions regarding

domoic acid and Dungeness crab quality as well as marine life entanglement efforts undertaken by each state's Working Group, industry, and management agency.

5.7.5 State Advisory Bodies

The expertise of Working Group members and Advisors is crucial to gathering and reviewing available information and making management recommendations to the Director under RAMP (Section 5.2). The Working Group also provides a forum for conducting and evaluating trials of innovative gear that may reduce entanglement risk, which may be authorized as Alternative Gear (Section 5.2.3.5) or adopted by the fleet as best practices (Section 5.3). A substantial amount of the Working Group's value is vested in its composition. At the time this CP was prepared, Working Group members included commercial and recreational fishermen and industry representatives, environmental organization representatives, members of the Large Whale Entanglement Response Network, and agency staff. Working Group members are appointed by the Marine Region manager, and CDFW will undertake reasonable efforts to ensure continued representation across a diverse range of interests throughout the permit term.

While not exclusively focused on entanglement issues, the DCTF is charged with making recommendations to the California Legislature, Fish and Game Commission, CDFW, and other state institutions regarding the need for changes in management of the Dungeness crab fishery. As such, CDFW will keep the DCTF informed regarding implementation of this CP and may request DCTF review of adaptive management measures under consideration.

5.7.6 Fishing and Port Associations

As described in Section 5.1, CDFW recognizes implementation of the Conservation Measures described in this Chapter will have short-term economic impacts on the commercial Dungeness crab fishery, related industries, and coastal communities throughout central and northern California. Feedback from fishing and port associations on proposed regulations, the draft CP, and the in-season RAMP process has provided crucial insights into industry perspectives. CDFW will continue collaborating with fishing and port associations through, and in parallel to, the cross-interest Working Group process. In particular, CDFW will work with fishing and port associations to develop more detailed metrics and approaches for assessing economic impact of management actions implemented under the RAMP (Section 5.2.2.4); design and implementation of industry-led surveys for detecting entanglements and documenting presence, abundance, and distribution of Covered Species (Section 5.2.1.2.2); testing gear innovations and evaluating best practices (Sections 5.2.3.5 and 5.3); and promoting recovery and reporting of lost or abandoned gear through the Trap Gear Retrieval Program and other regulatory provisions (Section 5.4).

Additionally, CDFW will welcome continued strategic investments and other support fishing and port associations are able to provide to bolster implementation of the various Conservation Measures described in this Chapter, as well as broader updates to the Conservation Program as a whole through the triennial review process described in Section 6.2.

5.7.7 Environmental Organizations

During the early years of the Working Group and initial development of the various Conservation Measures described in this Chapter, conservation-oriented environmental organizations have provided valuable input. CDFW will continue collaborating with environmental organizations through, and in parallel to, the cross-interest Working Group process. In particular, CDFW

anticipates environmental organizations will continue to support the development and testing of gear innovations (Section 5.2.3.5); evaluating best practices (Section 5.3); highlighting advances in the best available science to inform the RAMP (Section 5.2); and promoting recovery and reporting of lost or abandoned gear through the Trap Gear Retrieval Program and other regulatory provisions (Section 5.4).

Additionally, CDFW will welcome continued strategic investments and other support environmental organizations are able to provide to bolster implementation of the various Conservation Measures described in this Chapter, as well as broader updates to the Conservation Program as a whole through the triennial review process described in Section 6.2.

5.7.8 External Researchers

As highlighted throughout this CP, and particularly in this Chapter, CDFW is committed to relying upon the best available science when implementing and evaluating the Conservation Measures which comprise this Conservation Program. CDFW will undertake targeted research efforts as resources allow, but to a large extent will rely on findings from studies conducted and funded by other parties. CDFW will encourage interested researchers to focus their efforts on resolving key uncertainties highlighted by the conceptual model in Figure 5-1, and identifying enhancements to the RAMP that will allow for proactive and targeted management responses which limit impact to industry.

CDFW has established robust working relationships with researchers at the NMFS Fisheries Science Centers and outside organizations such as Point Blue Conservation Science and Cascadia Research Collective, who serve as Working Group members and Advisors. Throughout the permit term, CDFW will build on these existing relationships and explore opportunities to establish new relationships with other individual, institutional, and agency researchers focused on marine life entanglement issues in both East and West Coast contexts.

CHAPTER 6. FUTURE ADAPTATION OF THE CONSERVATION PLAN

The Conservation Program described in Chapter 5 establishes a multifaceted approach to reduce marine life entanglements and achieve the biological goals and objectives identified in Section 5.1. However, as illustrated in Figure 5-1 substantial uncertainties persist regarding co-occurrence of Covered Species and Covered Activities, the degree to which co-occurrence translates into encounters, how encounters develop into an entanglement, and the relative impact of a given entanglement on an individual animal. The degree to which certain management actions can prevent or mitigate these events is also highly uncertain.

Given these uncertainties, CDFW anticipates ongoing improvements to the structure and function of the Conservation Program over the term of the ITP. In particular, CDFW anticipates that modifications may be needed to the RAMP regulatory structure, including integration of new data streams, establishment of new or amended triggers for management action, modifications to the list of management actions, and expanded fishery reporting requirements. While several reasonably foreseeable modifications are described in Chapter 5 (e.g., establishing management action triggers related to species distribution models), this Chapter will describe how the Conservation Program as a whole will be periodically assessed, how the assessments will drive improvements via an adaptive management framework, and how these improvements will be implemented.

6.1 Annual Assessment: Compliance Monitoring

CDFW will prepare and submit an annual report to NMFS by October 1 of each year beginning the first year after permit issuance. Each report will capture the period immediately preceding, during, and immediately following each fishing season by tracking an August-July reporting period (i.e., a report submitted in 2023 would cover activities between August 1, 2022 and July 31, 2023). The primary purpose of these reports is to serve as a recording tool to document CDFW's implementation of the Conservation Program and to meet CDFW's obligations under 50 CFR 222.301 subd. (h); i.e., to support compliance monitoring. Each report will include monitoring components of the Conservation Program described in Chapter 5. Specifically, each report will include the following:

Reducing Take By Minimizing Co-occurrence (Goal 1)

- Summary of risk assessments completed during the season; data relied upon (including new best available science regarding species distribution and co-occurrence); and any management measures implemented to reduce entanglement risk and associated rationale (Objectives 1a, 1d)
- Summary of CDFW and partner (industry and non-governmental) surveys for Covered Species, including the number of surveys conducted in each Fishing Zone (Objective 1b)
- Summary of the electronic vessel location monitoring program, including the percentage of the fleet with active monitoring equipment (Objective 1c)
- During the first five years of the permit term, progress towards developing an annual minimum recovery target for lost or abandoned Dungeness crab gear (Objective 1e)
- Summary of lost or abandoned Dungeness crab gear retrieval efforts during the prior calendar year from the Trap Gear Retrieval Program, voluntary efforts under Cal. Code Regs., Tit. 14 §132.2, and salvage efforts; beginning with the sixth year of the permit

term, the total amount of gear removed relative to the minimum recovery target (Objective 1e)

Reducing Entanglement Severity from Commercial Dungeness Crab Gear (Goal 2)

- Dates of, and any outcomes from, West Coast or California-focused entanglement forensic review workshop(s), including any updated Best Practices Guide informed by the workshop(s) and any regulatory or statutory efforts underway to incorporate the best practices into baseline fishing practices (Objective 2a)
- Summary of and meeting materials for any CDFW-hosted or co-hosted workshops regarding development and adoption of gear innovations as well as a list of Alternative Gear certifications approved by CDFW (Objective 2b)
- Summary of CDFW's support of entanglement response activities (Objective 2c)

Improving Entanglement Detection and Reducing the Instances of Unidentified Gear Entanglements (Goals 3 and 4)

- Prior to 2024, progress towards developing the entanglement detection network (Objective 3a)
- Beginning in 2024, summary of and meeting materials from biennial meetings with network partners, including any updated data protocols (Objective 3a)
- Beginning in 2024, summary of entanglement detection network surveys and partnerships developed during the season; estimated number of transect miles and their distribution within the Plan Area (if applicable); and the associated timing, staffing, and survey platform(s) (Objective 3a)
- Current marking requirements in place for state-managed trap fisheries (Objective 4a)

CDFW will make these reports available to the public on CDFW's Whale Safe Fisheries webpage for a period of five years and provide access to archived documents for the duration of the permit. The same public accessibility measures will be applied to any information on entanglements, marine life abundance, and any other non-confidential information relied upon by the Working Group or Director during decision-making; risk assessment and management recommendation memos produced by the Working Group; and CDFW staff recommendations transmitted to the Director. All information will be provided and archived in accordance with CDFW's Scientific Integrity Policy (CDFW 2017).

6.2 Triennial Review: Improving Effectiveness through Adaptive Management

While CDFW's compliance with the terms of an issued permit will be demonstrated through the annual report described above, the overall effectiveness of the Conservation Program is ultimately measured by whether implementation of the objectives specified in Section 5.1 are sufficient to attain the associated goals. To that end, CDFW will undertake targeted effectiveness monitoring efforts.

For Goal 1, CDFW will evaluate effectiveness by assessing the number of confirmed entanglements for each Covered Species that occur in California commercial Dungeness crab gear as well as confirmed entanglements for each Covered Species reported off California that occur in Unknown Fishing Gear. CDFW will consider whether the number of confirmed Covered

Species entanglements are below the permitted take levels, and whether there are trends indicating stable, declining, or increasing numbers of confirmed entanglements attributable to the California commercial Dungeness crab fishery. The entanglement detection network described in Section 5.2.1.1.1 will be the primary source of this information, although CDFW will also include any confirmed entanglements resulting from other types of reports provided directly to NMFS.

For Goal 2, CDFW will evaluate effectiveness by reviewing M&SI scores for each confirmed entanglement in California Dungeness crab gear, as documented in NMFS injury determination reports prepared through the Stock Assessment Report process. By the end of the permit term, CDFW's goal is for average M&SI scores for blue and humpback whales from the most recent 5-year period to be less than 0.25. As described in Section 4.3.1, between 2013 and 2018 average M&SI scores were 0.92 for blue whale entanglements and 0.75 for humpback whale entanglements. The target M&SI value of 0.25 would represent a substantial reduction in severity for entanglements resulting from the Covered Activities. While CDFW does not anticipate a linear reduction in M&SI scores, and there is generally a two-year lag between when an entanglement occurs and when M&SI scores are available, CDFW will evaluate each new set of M&SI scores to determine whether the average scores indicate stable, declining, or increasing severity. Should this trend indicate M&SI will not reach the target value by the end of the permit term, CDFW would consider whether additional or updated objectives are needed.

For Goal 3, effectiveness will be determined by whether CDFW is able to produce an annual statewide estimate of Covered Species entanglements resulting from the Covered Activities. The broad spatiotemporal coverage and direct quantification of effort associated with activities of the entanglement detection network described in Section 5.2.1.1.1 is intended to provide the necessary information to achieve this goal. If production of this estimate is not possible with the existing data and survey design, CDFW would implement the necessary modifications.

For Goal 4, effectiveness will be determined by calculating the number of unidentified gear entanglements as a proportion of all known entanglements reported off California. As with Goal 2, CDFW's intention is to achieve the target value (25%) by the end of the permit term. On an annual basis, CDFW will review the proportion of confirmed entanglements in unidentified fishing gear and evaluate whether the proportion is stable, declining, or increasing. Should this trend indicate the proportion of unidentified gear entanglements will not reach the target value by the end of the permit term, CDFW will work with the Fish and Game Commission and California Legislature to implement additional changes as appropriate.

In addition to evaluating effectiveness of the Conservation Program at achieving the goals described above, CDFW will also consider program implementation efficiencies that could reduce costs to the state or further minimize economic impacts on the fishing industry. To that end, CDFW has developed an adaptive management framework centered around a triennial review cycle. The three-year timeframe is designed to give CDFW sufficient opportunity to assess program effectiveness prior to making management or regulatory changes, while also ensuring routine review of the conservation program. While some changes could be administrative in nature, many will likely involve formal rulemaking action by CDFW and/or formal amendment of the Conservation Plan. As this will require a substantial investment of staff resources, conducting a focused effort once every three years will reduce workload for CDFW and NMFS staff. In addition, a shorter timeframe is unlikely to provide enough feedback for meaningful analyses due to the relative rarity of entanglements. The three-year timeframe also

provides some certainty for industry, whose livelihoods will be directly impacted by any substantive changes to the Conservation Program.

6.2.1 Resolving Uncertainty

CDFW anticipates adaptation of the Conservation Program will be based on an improved understanding of the various causes of marine life entanglement. Entanglements are statistically rare events and rarely observed in real-time. As described in Section 5.1, CDFW has developed a four-part conceptual model which illustrates these uncertainties. As discussed elsewhere in this CP, uncertainties regarding when and how entanglements occur are further compounded by an increasingly dynamic ocean environment as the planet's climate changes. There are also substantial uncertainties regarding the efficacy of potential management tools.

Meeting the conservation-oriented biological goals and objectives in Section 5.1 and avoiding exceedance of the requested take limits in Section 4.2 is paramount. CDFW is therefore constrained in its ability to implement management actions that may resolve uncertainty but whose effectiveness at preventing take is unclear. However, CDFW will leverage lessons learned from each management action outcome and undertake a suite of monitoring activities to resolve uncertainties related to each part of the conceptual model illustrated in Figure 5-1. During each triennial review CDFW staff will work with NMFS, the Working Group, and other partners and stakeholders to review findings from these monitoring activities as well as other best available science.

Specific types of information that could address uncertainties and allow CDFW to shift from a management approach focused on reducing co-occurrence to one focused on reducing encounters, entanglements, and M&SI are highlighted in Figure 6-1. Many of these elements have been described to some degree in Chapter 5, but some are new and briefly described below.

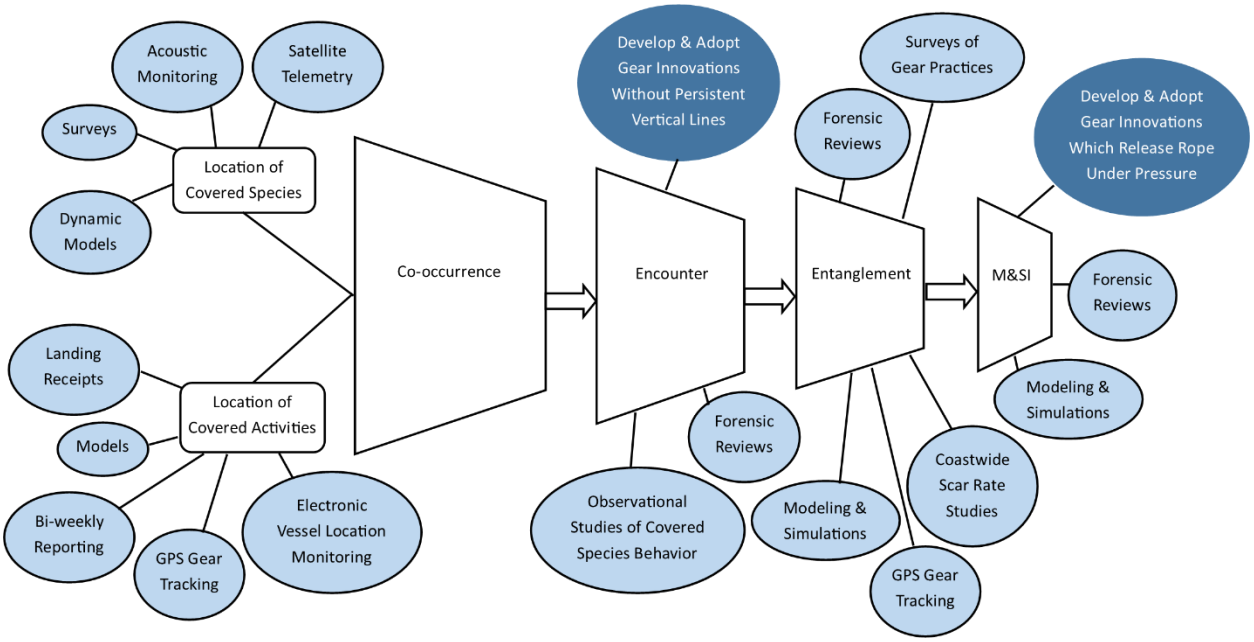

Figure 6-1. Forecasting improvements in the best available science. Key sources of information that will enable CDFW to resolve uncertainties around each step in the conceptual model from Chapter 5 are shown in light blue. Potential modifications to Covered Activities which could enable CDFW to shift away from a focus on reduced co-occurrence are shown in dark blue.

6.2.1.1 Co-Occurrence: Acoustic Monitoring

Reliable, cost-effective, and routinely deployable methods for detecting Covered Species presence are essential to a management approach grounded in assessing and limiting co-occurrence between Covered Species and Covered Activities. Unlike the methods described in Section 5.2.1.2 that are either currently available or will soon be available for real-time decision-making, acoustic monitoring would require substantial investment of additional resources. In the Northeastern U.S. and Southeastern Canada, a combination of stationary and mobile (i.e., glider-mounted) acoustic detectors are used in parallel with aerial and vessel-based surveys to monitor for the presence of North Atlantic right whales, and acoustic detections trigger vessel slow zones (in the U.S. and Canada) and fishery closures (in Canada). Deployment of acoustic detectors to monitor for large whales off California would have greater value if done at a coast-wide scale in partnership with Oregon and Washington.

A key limitation of acoustic detectors is that while they can indicate presence of a given species within a certain radius, they cannot be used to quantify abundance or to definitively determine absence (known as the “silent whale challenge”). However, a network of strategically deployed detectors would provide an early indication of when Covered Species have begun to enter the fishing grounds, allowing for a more targeted deployment of aerial and vessel resources to monitor changes in their distribution during the summer foraging season. Preliminary conversations with partners at California’s National Marine Sanctuaries during preparation of this CP have indicated there are some acoustic detectors present within Monterey Bay, although real time access to synthesized data is not yet available. CDFW will continue to explore the possibility of using acoustic data within the RAMP framework.

6.2.1.2 Co-Occurrence: GPS Gear Tracking

While electronic vessel location monitoring (see Section 5.2.2.7) will provide CDFW with much finer-scale information regarding vessel activity, which can be used to infer where gear is deployed, GPS gear tracking devices would provide specific, real-time information on trap location. Encouraging (or requiring) use of GPS gear tracking devices on actively fished traps would enhance CDFW's ability to explicitly quantify the Covered Activity aspect of co-occurrence. However, outfitting each trap with a GPS gear tracker would entail substantial costs for the fleet; as of May 2021, cost estimates for one model were approximately $635 per buoy, although over time and with sufficient demand this cost will likely decline (personal communication, Kortney Opshaug, 5/20/2021). Additionally, ongoing monitoring of gear locations would be needed, likely through a combination of machine-learning algorithms and manual (human) review. Over the permit term, CDFW will consider the benefit of GPS gear tracking for informing assessment of co-occurrence relative to the associated costs. The same gear may also support entanglement response efforts, as described in Section 6.2.1.5.

6.2.1.3 Encounter: Observational Studies of Covered Species Behavior

Observational studies that document Covered Species behavior when amongst trap gear could provide key insights regarding this element of the conceptual model. If particular environmental conditions, tactile aspects of the gear, visibility of the gear (e.g., rope color, presence of lights) or other factors would reduce the probability of an encounter, CDFW could work with researchers and industry to develop updated best practices that would allow for low-risk fishing despite the presence of Covered Species.

During the preparation of this CP and design of the RAMP regulations, Working Group members and fishing industry members routinely shared that they are able to fish in areas where large whales are present around actively fished trap gear, without an entanglement event occurring. Given the large number of vertical lines used in this fishery and in other trap fisheries off California, CDFW acknowledges this is frequently the case. However, without a clear understanding of whale behavior and the circumstances that lead to an entanglement, CDFW's initial focus is on reducing co-occurrence. CDFW is committed to continuing to improve understanding of circumstances leading to an entanglement and making associated changes to gear configuration requirements.

6.2.1.4 Entanglement: Modeling and Simulations

The lack of observations of Covered Species encounters with trap gear also limits our understanding of entanglement event dynamics. Knowlton et al. (2018) describes two efforts to illuminate these dynamics, applying *OrcaFlex* software used in the oil and gas industry to dynamically model endline tension in a variety of contexts (e.g., haul speed, seafloor drag, line thickness, etc), and developing a computer model to simulate encounters between North Atlantic right whales and fishing gear as further detailed in Howle et al. (2019). The Virtual Whale Entanglement Scenario program developed by Howle et al. (2019) was able to identify particular whale behaviors that are most likely to influence whether a particular encounter will result in an entanglement, as well as reconstruct specific sequences of events that produce a given entanglement configuration. While both efforts were targeted towards North Atlantic right whales, similar technical applications could be developed for other large whale species, including humpback and blue whales. This would allow CDFW and other researchers to conduct

structured evaluations of a given gear configuration (e.g., transitioning from single-trap to multi-trap fishing) or modification (e.g., placement of weak links at designated intervals within a fishing line) and their effects on entanglement rates and severity. Paired with real-world testing to ensure on-the-water feasibility, these simulations could inform updated best practices.

6.2.1.5 Entanglement: GPS Gear Tracking

Each large whale entanglement response effort is dictated by environmental conditions, available equipment and personnel, behavior of the entangled whale, and nature of the entanglement (personal communication, Justin Greenman, August 2, 2021). One common element of successful responses is the response team's ability to locate and track the whale's movements. This can be done either through ongoing monitoring of the entangled whale from vessel or aerial platforms, or through deployment of a GPS tracker on the entangling gear. Continuous observation from vessel or aerial platforms is resource intensive, can be hindered by weather and sea conditions, and is very difficult at night. Deployment of a GPS tracker is often a preferrable method, however this is a delicate operation that can only be done by trained members of the Large Whale Entanglement Response Network. In some cases, by the time the response team arrives on site, the whale is no longer visible, precluding any further actions. In other instances, the response team may lose sight of the animal due to weather or sea conditions, or the specific gear configuration or behavior of the whale may preclude attachment of a telemetry buoy. Of the 252 confirmed large whale entanglements off the West Coast, between 2014 and 2020, 203 (81%) either had no response or a response that resulted in only partial removal of the gear. In these instances, if the entangling gear already had a GPS tracker, response teams would be far more likely to locate the whale and mount a successful response.

In order to reliably monitor for potential entanglements, each individual trap would need to be outfitted with a GPS gear tracker. Acquisition of this technology would require substantial investment by the fleet, and review of the location data would require additional CDFW resources (see Section 6.2.1.2 for further details). As the technology matures, widescale deployment of GPS gear trackers could improve both assessments of true entanglement rates (Goal 3), and the proportion of entanglements with successful human interventions (Goal 2).

6.2.1.6 Entanglement: Surveys of Gear Practices

When gear involved in an entanglement is identified to a specific fisherman (see Section 5.2.1.1.3), follow up interviews can provide additional information regarding gear location, likely date of the entanglement, and details regarding the gear's configuration (e.g., type(s) of line, use of knots or splices, etc). While learning the details for a specific set of gear involved in an entanglement is beneficial, it would provide greater value within a comprehensive understanding of gear practices for the fishery as a whole. To date, CDFW has not conducted a systematic survey, or a set of field inspections to characterize fleet-wide trends. Such efforts would require a high level of cooperation from fishery participants (to generate a sufficient survey response rate) or substantial investment of CDFW vessel and personnel resources (to conduct widespread field inspections).

In addition to providing greater context when a specific entanglement occurs, if this type of fleet-wide gear characterization was conducted routinely (e.g., every three to five years), CDFW could also monitor the degree to which certain best practices are employed by the fleet and the efficacy of outreach efforts such as the Best Practices Guide.

6.2.2 Implementing Improvements

As described in Chapter 5, CDFW is guided by the dual goals of minimizing take of Covered Species, and maintaining an economically viable commercial Dungeness crab fishery. If available information shows that the Conservation Program as implemented is not adequately meeting the biological goals of this CP, CDFW must implement changes. If the biological goals and objectives are being met, then CDFW will evaluate whether there are improvements that could reduce economic impacts on the fishery and resources needed to implement the program, without compromising the protection of Covered Species. CDFW will determine the appropriate course of action based on the best available science and in consultation with stakeholders.

Following the triennial review, necessary changes can be implemented by amending existing components of the Conservation Program, creating new components, or establishing new methods for Conservation Program implementation. For example, CDFW may identify a promising new management tool or action that can be built into the RAMP regulations, an optimal management action for a specific set of circumstances under the RAMP, or a new regulatory program independent from RAMP. Regulatory changes and CP amendments will follow the processes described in Section 6.3.

6.2.3 Decision Support Tools

Adopting a decision support tool could provide greater consistency, structure, and analytical sophistication for the triennial review process described above. During preparation of this CP, CDFW consulted with the developers for two specific decision support tools. One of the tools takes a hindcasting approach to anticipate tradeoffs (Jameal Samhouri, personal communication), while the other uses a management strategy evaluation to explicitly predict future conditions (Chris Free, personal communication). Both tools rely on a similar conceptual model that evaluates Covered Species and Covered Activities co-occurrence by relating habitat suitability models developed for large whales (e.g., Abrahms et al. 2019b) and fishery-dependent data from landing receipts and VMS. However, the tools then use different methodologies to translate this co-occurrence into entanglement risk. CDFW will continue to engage with decision support tool developers to assess utility within the adaptive management framework of this CP and to support evaluations of economic impact from a given RAMP management action (see Section 5.2.2.4).

6.3 Amendments

The following sections describe the process by which CDFW will amend the CP and promulgate new or amended state regulations, should the triennial review process described above identify needed changes to the Conservation Program.

6.3.1 Minor Amendments to the CP/ITP

Minor amendments may be made by mutual agreement between CDFW and NMFS without any prior public notice or comment period, provided NMFS determines that they otherwise satisfy the requirements of applicable federal statutes and regulations, do not result in an increase in levels of incidental take, and the activity does not change in ways that were not analyzed in applicable analyses under NEPA and ESA Section 7. The following changes are considered minor amendments, unless they change the intended purpose of the amended text:

- Correction of typographical, grammatical, and similar editing errors

- Correction of maps, numbers, and similar substantive errors that deviate from the references they are pulled from
- Minor changes to survey, monitoring, reporting, or analytical protocols

For every minor amendment, the proposing agency shall provide a written statement describing its effect on Covered Species, rationale for the amendment, and its effect on CP implementation. Amendments must be approved in writing by both parties, and both parties will endeavor to reach agreement within 45 days of the proposed amendment's initial transmittal. Following this agreement, the amended document(s) will be posted on CDFW's Whale Safe Fisheries webpage.

6.3.2 Major Amendments to the CP/ITP

An amendment is considered a major amendment if it is not a minor amendment. In general, any amendment which affects the take level of a Covered Species, modifies the scope of this CP, or otherwise changes the Conservation Program in a way not analyzed by this CP or associated environmental review documents (e.g., NEPA) will be considered a major amendment. These amendments must also satisfy federal statutory and regulatory requirements.

As with minor amendments, either CDFW or NMFS may initiate a major amendment to the CP or the ITP. The proposing agency will provide a written statement describing the amendment's effect on Covered Species, the rationale for the amendment, and its effect on CP implementation. CDFW shall provide notice of any major amendment under consideration on its Whale Safe Fisheries webpage with a 45-day public comment period. Both CDFW and NMFS shall review and consider all public comments prior to taking final action on the proposed amendment. The proposed amendment will be adopted following written approval from both CDFW and NMFS, after which CDFW will post the amended document(s) on the Whale Safe Fisheries webpage.

6.3.3 Amendments to State Regulations

Fish & G. Code § 8276.1 provides CDFW with the authority to develop and amend regulations implementing the RAMP and other necessary measures to reduce marine life entanglement risk. The amendment process for any of the regulations underlying the Conservation Program described in Chapter 5 will adhere to the California APA (see Section 1.3.6). At a minimum, this requires CDFW to provide a notice to the public through the California Notice Register that includes the amended text of the regulations and a statement of reasons providing rationale for the proposed changes. The public must be afforded at least 45 calendar days to provide comments before the amendment can be adopted.

Given public interest in marine life entanglement issues, CDFW has historically conducted additional outreach with key stakeholders prior to commencing the formal rulemaking process, including adoption of regulations establishing the Trap Gear Retrieval Program, RAMP, and standardized gear marking requirements. CDFW will continue to proactively engage with stakeholders throughout the term of the ITP when contemplating changes to these and other regulations relevant to this CP.

6.4 Renewal, Suspension/Revocation, and Cancellation

As noted in Section 2.3, CDFW requests NMFS issue a renewable ITP. CDFW will submit its renewal request at least 30 days before the permit's expiration. ITP renewal shall follow the terms of federal regulation (50 CFR 222.304).

NMFS may suspend or revoke the permit if CDFW fails to implement the CP in accordance with the terms and conditions of the permit or if suspension or revocation is otherwise required by federal law. Suspension or revocation of a Section 10(a)(1)(B) permit, in whole or in part, must be in accordance with the process provided in federal statutes and regulations.

If the conservation measures prescribed by this CP are no longer required due to improved stock status or decreased risk of entanglement from Covered Activities, CDFW will request a cancellation of the ITP. Cancellation will follow the terms of federal regulation (50 CFR 222.306).

6.5 Changed Circumstances

As part of this CP, CDFW must contemplate changed circumstances affecting the Covered Species that may necessitate additional conservation and mitigation measures and can be reasonably anticipated (50 CFR 222.307 subd. (g)). Changed circumstances include relatively predictable, but unplanned, events. NMFS will not require CDFW to implement conservation or mitigation measures beyond the Conservation Program described in Chapter 5 unless the changed circumstance is provided for in the following sections.

6.5.1 Covered Activity Take of Newly Listed Species

In the event a new species that may be affected by Covered Activities is listed under ESA during the permit term, NMFS will determine whether current conservation measures in the CP are sufficient to avoid take of the newly listed species. If not, NMFS will work with CDFW to identify appropriate measures.

6.5.2 De-listing of Covered Species

In the event a Covered Species is delisted during the permit term, CDFW will continue to include assessments of take and removals in the annual report to NMFS for the duration of the permit. CDFW will also evaluate whether changes to the Conservation Program are appropriate and consider initiating a major amendment process and associated updates to state regulations.

6.5.3 Change in Covered Species Status Under ESA

In the event ESA classification of a Covered Species (i.e., endangered vs threatened) changes during the permit term, during the next triennial review CDFW will consider whether changes to the Conservation Program are appropriate.

6.5.4 Designation or Revision of Critical Habitat; Changes to Stock Abundance, Distribution, or DPS structure

As described in Section 4.4, CDFW does not anticipate trap gear will significantly impact currently designated critical habitat for humpback whales or leatherback sea turtles. Should additional or revised critical habitat be designated for Covered Species, CDFW will evaluate

whether a major or minor amendment and associated changes to state regulations are warranted.

CDFW anticipates changes in the abundance, distribution, and DPS/stock structure of Covered Species over the term of the permit. As part of the triennial review process, and more often as warranted, CDFW will consider the best available science and determine whether amendments to the CP and associated state regulations are warranted.

6.6 Unforeseen Circumstances

Unforeseen circumstances are changes in circumstances affecting the Covered Species that could not reasonably have been anticipated by CDFW and NMFS at the time of the CP's development, and that result in a substantial and adverse change in the status of the Covered Species (50 CFR 222.102). Such events by their very nature cannot be reasonably predicted and mitigated. Under terms of federal regulation (50 CFR 222.307 subd. (g)(3)), NMFS may require additional management measures from CDFW, provided that they are within the current scope of this CP. NMFS bears the burden of demonstrating that unforeseen circumstances exist, and it will not require additional measures and resource commitment from CDFW without CDFW's consent. Should unforeseen circumstances arise, CDFW will work with NMFS to redirect existing resources and evaluate additional actions as appropriate.

CHAPTER 7. FUNDING ASSURANCES

CDFW is responsible for implementation of this CP and ongoing management and monitoring during the permit term. Section 10(a)(2)(A)(ii) of the ESA and NMFS implementing regulations at 50 CFR § 222.307 subd. (b)(5) require ITP applicants to demonstrate sufficient funding is available to implement the measures described in their CP, including changed circumstances and any future CP amendments. CDFW acknowledges that failing to implement the Conservation Program as described in Chapters 5 and 6 may be cause for suspension or revocation of an issued ITP as described in Section 6.4.

This following chapter describes the state resources that will support implementation of the CP (Section 7.1), anticipated participation from various non-state entities (Section 7.2), and the role of grant funding (Section 7.3).

7.1 State Funding

CDFW is primarily funded through an annual budget cycle (July 1 – June 30) and is subject to state agency funding rules and processes. Funding sources include general funds from California income taxes, permit and licensing fees, dedicated accounts funded by other assessments, and federal grants. The California Legislature appropriates and allocates funding to all state agencies, including CDFW. Typically, CDFW receives funding to cover staffing and operating expenses for existing programs. In addition, either the Executive Branch or the Legislature can propose budget changes to cover costs for new or expanded programs. During the 2020-21 fiscal year, CDFW had nearly 2,300 full-time employees and a total budget of nearly $580 million (Table 7-1).

Table 7-1. CDFW budget for the 2011-12 through 2020-21 fiscal years in millions of dollars.

Fiscal Year	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
CDFW	$392	$390	$398	$437	$397	$495	$459	$537	$553	$579

CDFW cannot guarantee the amount of funding that will be available over the permit term because of the annual budgeting process and the prioritization that occurs based on available state revenue. However, CDFW will work to ensure staffing and operating resources are sufficient to fully implement the CP. Budget allocations over the last 10 years (Table 7-1), policy statements by the California Legislature (e.g., AB 1241, Keeley, 1998; SB 1309, McGuire, 2018), OPC (e.g., OPC 2020), and other potential funding partners indicate reducing marine life entanglements is a priority for the State of California. Given this, CDFW does not expect any reduction in funding that would materially impact its ability to fulfill obligations under an issued permit. If such circumstances arise, CDFW will notify NMFS and work with NMFS to prioritize CP obligations to maximize benefits to Covered Species during any period of reduced resources. Such changes to CP operations may be considered a major amendment and would then follow the process described in Section 6.3.3.

Both CDFW and OPC began allocating staff time to marine life entanglement issues in fall 2015. Initially, these efforts were considered to be a part of general management for the commercial Dungeness crab fishery. Recognizing the importance of, and increased workload associated with, addressing marine life entanglements the Budget Act of 2018 included dedicated staffing and funding. OPC received a one-time general fund allocation of $7.5 million to address marine

life entanglement risk. Of this, $1 million was directed to support sea lion stranding response and $1 million was directed to the Drift Gillnet Transition Program mandated by Fish & G. Code § 8583. At the November 13, 2019 meeting, OPC approved an investment strategy to guide investment of the remaining funds over the next five years (funds must be spent by July 1, 2024). This funding is available to support a variety of projects, including development of predictive models to inform real-time assessment of entanglement risk and testing of gear innovations. As of June 2021, OPC has provided a total of $3.5 million to fund projects consistent with the investment strategy that advance entanglement science and reduce the risk of whale and sea turtle entanglement in fishing gear. Of these, the largest allocation was $2 million to PSMFC to fund and administer projects that develop, align, or improve information to reduce entanglement risk and minimize impacts on the fishing industry. In total, OPC has approved 11 projects that support the strategy's goals of advancing collaborative partnerships, improving the best available science, promoting gear innovation, and improving response and outreach.

As described in Section 1.2, primary responsibility for implementation of the CP falls within the Marine Region, whose budget has steadily increased since the 2013-14 fiscal year (Table 7-2). The Budget Act of 2018 included funding for two full time Marine Region (MR) staff within the Invertebrate Management Program dedicated to marine life entanglement issues. Upon issuance of the ITP, their primary duties will include implementation of the CP, including the underlying RAMP regulations. Within the Invertebrate Management Program, additional staff who actively manage the Dungeness crab fishery will support CP implementation. Outreach and education staff, administrative staff, and managers within MR will also provide support.

Table 7-2. Marine Region budget for the 2011-12 through 2020-21 fiscal years in millions of dollars.

Fiscal Year	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Marine Region	$22.6	$23.4	$18.9	$19.0	$19.8	$20.7	$20.5	$25.3	$26.2	$25.7

Specifically, MR staff duties will include:

- Participation in, and oversight of, constituent groups (e.g., Working Group, DCTF)
- Routine monitoring of available data streams
- Research and development to improve RAMP performance
- Providing aggregated data to the Working Group during the RAMP risk assessments
- Administering the Trap Gear Retrieval Program
- Supporting entanglement response activities
- Supporting NMFS forensic reviews, including conducting interviews with California fishermen whose gear was involved in an entanglement
- Coordination with Oregon and Washington regarding entanglement mitigation efforts
- Oversight and coordination of Alternative Gear development and testing
- Outreach to Dungeness crab fishery participants and other trap fisheries

CDFW has numerous staff and operational resources from several other functions, including LED, OGC, DTD, OCEO, the RU, LRB, and Executive (Exec) who will assist with CP

implementation. Table 7-3 provides an overview of which function areas will be involved in each of the CP commitments.

Table 7-3. Summary of CDFW commitments and involved function areas.

CDFW Commitment	Function Area
Conduct monthly RAMP risk assessment and implement management measures	MR, LED, OGC, OCEO, Exec
CDFW data gathering and review to support risk assessments	MR, LED, OGC
Management measure compliance	MR, LED
Electronic vessel location monitoring	MR, LED, DTD, LRB
Forensic reviews	MR, LED
RAMP improvements	MR, LED, OGC, RU, Exec
Development and promotion of best practices	MR, LED, DTD, LRB
Outreach to fleet	MR, OCEO, LRB
Lost or abandoned gear retrieval	MR, LED, LRB
Triennial review of Conservation Program	MR, LED, OGC, Exec
Implementation of needed regulatory changes, preparing minor or major CP amendments	MR, LED, OGC, RU, Exec

LED staff and equipment (e.g., vessels, aircraft) will support the RAMP surveys for entanglement detection and Covered Species presence. If available information triggers management action under the RAMP, LED will help select appropriate management measures and inform implementation timelines. LED will also evaluate fleet compliance with implemented management measures as well as reporting requirements and take appropriate enforcement actions when violations occur. LED will provide input regarding the design and function of electronic vessel location monitoring systems, as well as review available information from those systems. LED will work with MR staff to review available documentation from reported entanglements and classify confirmed entanglements as occurring in California commercial Dungeness crab gear, Unknown Fishing Gear, or unidentified non-California commercial Dungeness crab gear, as described in Section 5.2.1.1.3. LED will also work with MR staff to review requests for authorization of innovative gear types as Alternative Gear. LED will conduct on-the-water and dockside inspections of gear retrieval operations, including those of the Trap Gear Retrieval Program. LED will also participate in research and development to improve RAMP performance, triennial reviews of the Conservation Program, and developing new or amended state regulations and preparing CP amendments.

OGC will be instrumental in reviewing available information to ensure CDFW selects management actions which align with the RAMP regulations, and in preparing management action declarations. OGC will also participate in research and development to improve RAMP performance, triennial reviews of the Conservation Program, and developing new or amended state regulations and preparing CP amendments.

DTD maintains CDFW webpages and electronic databases, as well as biogeographic data resources and software applications. DTD will provide technical support to LED and MR staff for technological aspects of authorized Alternative Gear. DTD will also support the collection, storage, and review of electronic vessel location monitoring data. OCEO will develop press releases and other external communications regarding the RAMP risk assessments and

management measures. The RU will oversee internal and public-facing processes for promulgation of new or amended state regulations, as required throughout the term of the permit. LRB will issue Trap Gear Retrieval Permits and collect associated fees. LRB is also responsible for issuing commercial fishing licenses, commercial Dungeness crab permits, and vessel registrations, and therefore routinely engages with fishery participants. LRB will work with MR to identify and distribute appropriate outreach materials to fishery participants.

Exec staff, specifically the Director, holds the ultimate decision-making authority regarding implementation of Conservation Measures, including actions taken under the RAMP. As such, Exec staff will provide high-level policy guidance regarding CDFW actions and priorities throughout the term of the permit. Exec staff will also develop requests for any needed budget and staffing augmentations and redirect existing staff to support CP implementation, as appropriate.

Taken together, direct allocations to both OPC and CDFW's MR, as well as dedicated staffing within the MR Invertebrate Management Program reflect a portion of the state funding available to support CP implementation over the requested permit term (Table 7-4). However, these values substantially underestimate CDFW's anticipated investment, as they do not reflect all operating expenses or CDFW staff time that are directly tasked with supporting CP implementation, specifically the activities of other CDFW functions discussed above. Existing funding for other functions mentioned above is expected to continue throughout the permit term and adequately support CDFW's obligations under the CP. Furthermore, additional budget augmentations for CDFW and/or OPC are likely to occur over the permit term, including a substantial additional allocation of funds to OPC in the FY 2021-22 budget which may be available to support CP implementation.

Table 7-4. Minimum amount of state funding available to support CP implementation. MR staff costs include salary, benefits, and operating expenses for 1 Range C Environmental Scientist and 1 Range A Senior Environmental Scientist Specialist. Amounts are as currently allocated, and not adjusted for inflation. Table does not include additional OPC funding in the FY 2021-22 budget.

Category	Annual Cost	Over 21-Year Permit Term
OPC General Fund Allocation	NA	$5,400,000
Dedicated MR Staff	$290,500	$6,100,500
Dedicated MR Funding	$500,000	$10,500,000
Total	$790,500	$22,000,500

In addition, enabling legislation for the Trap Gear Retrieval Program described in Section 5.4 (Fish & G. Code § 9002.5) includes a requirement for CDFW to fully recover reasonable costs of administering and implementing the program. As other methods of gear recovery will be conducted entirely by external parties, CDFW anticipates this Conservation Measure will be cost-neutral over the term of the permit.

7.2 Anticipated Non-State CP Implementation Partners

While CDFW anticipates the available state funding discussed above will be sufficient to fulfill state obligations under the CP, CDFW also recognizes the importance of working with outside entities in CP implementation. There are several non-state entities which have been involved in

funding recent projects or activities related to reducing the risk of marine life entanglements, and who may be reasonably expected to continue doing so throughout the permit term.

As highlighted in Sections 1.6.1 and 5.7.5, the Working Group has been an essential partner in developing key elements of this CP. Between September 2015 and August 2021, the Working Group held over 75 meetings. While many of these meetings were virtual, others were held in-person in Santa Rosa, and required travel from as far away as San Luis Obispo and Crescent City. Going forward, CDFW anticipates the Working Group will participate in at least 12 meetings a year throughout the term of the permit. CDFW anticipates the Working Group will remain engaged throughout the permit term and considers their time and travel expenses to be an in-kind contribution towards CP implementation.

The California commercial Dungeness crab fishing industry will likely need to allocate funding to cover program costs, especially with regards to regulatory requirements placed on the fishery as a part of implementation of this CP. As mentioned in Section 7.1, while costs of mandatory electronic vessel location monitoring are currently being covered by grant funding, CDFW anticipates transitioning to an industry-funded model. Implementation of aerial and vessel-based surveys for the entanglement detection network (see Section 5.2.1.1.1) and evaluating marine life concentrations (see Section 5.2.1.2) are particularly costly, yet also critical to implementation of the CP. While CDFW anticipates state resources will support some level of survey activity, it will also facilitate participation of commercial fishing vessels. During the 2019-20 and 2020-21 seasons, commercial vessel participation in surveys provided data to inform the RAMP process. Given past participation and the importance to the fleet of maximizing fishing opportunity, CDFW anticipates continued industry involvement in these surveys.

PSMFC is an interstate compact agency that promotes and supports policies and actions to conserve, develop, and manage fishery resources in a five-state member region (California, Oregon, Washington, Idaho and Alaska). Through this forum, CDFW works with other resource agencies and the fishing industry to determine how both federal and non-federal funds can be directed to address regional needs, including marine life entanglements in the commercial Dungeness crab fishery. Since 2017, PSMFC has helped convene three regional workshops to facilitate information sharing, improve collective knowledge about whale entanglements, review forensic data provided by gear removed from entangled whales, and develop recommendations for gear innovations and other options to reduce entanglement risk. PSMFC staff are also active participants in the Working Group. Furthermore, PSMFC has a stated policy resolution to continue to work on marine life entanglements issues (PSMFC 2019). Based on these commitments and examples of past funding and participation on this issue, CDFW reasonably expects to continue to work with and/or pursue funding from PSMFC to support activities related to CP implementation over the term of the permit.

7.3 Grants

As a state wildlife management agency, CDFW is eligible to apply for federal, state, and NGO funds to support CP tasks. CDFW will evaluate future grant opportunities and consider applying for funding, however implementation of this CP is not dependent upon external grant funds. This, however, does not preclude future grant applications if the situation warrants it.

CHAPTER 8. ALTERNATIVES

Issuance of an ITP requires the applicant to avoid, minimize, and/or mitigate take of Covered Species to the maximum extent practicable. In the course of developing this CP, CDFW considered a variety of Conservation Measures, the degree to which they would reduce take of Covered Species, and the feasibility of implementation. CDFW ultimately selected the Conservation Program described in Chapter 5. CDFW did not select the alternatives described in this Chapter due to limited information regarding their effectiveness in reducing take of Covered Species; anticipated economic impacts on the Covered Activity, rendering their adoption impracticable; and/or the lack of necessary management authority.

8.1 Permanently Shortened Season

The management program described in Chapter 5 creates uncertainty for fishery participants due to potential delays and early closures. Restricting fishery operations to periods of extremely low entanglement risk, as defined by historical patterns, would require significantly fewer resources for CDFW to implement and enforce, reduce CDFW's reliance on data collection efforts by outside partners, and may provide greater market stability. CDFW considered modifying the season to a historically low-risk period (e.g., late December through March). However, given the dynamic nature of the CCS and potential for climate change impacts on spatiotemporal dynamics of co-occurrence (see Sections 3.1 and 5.1.1), this static approach may not provide the necessary protections to Covered Species over the full permit term. Furthermore, the potential socioeconomic costs of this alternative to the fleet and fishing communities render this alternative impracticable.

California fishery operations would no longer be aligned with Oregon and Washington, as required under the Tri-State Agreement. Additionally, while season delays and early closures under the RAMP may shorten some fishing seasons, permanently shortened seasons would greatly reduce fishing opportunity during otherwise low risk years. A delayed start to the season would mean fishery participants would no longer provide crab for the Thanksgiving and Christmas holidays, eliminating key markets that support economic viability of the fishery. An early end to the season would disproportionately impact vessels that traditionally harvest through the spring and early summer months (see Section 5.2.2.4). While an economic analysis prepared during the RAMP rulemaking process (CDFW 2020b) indicates the fishery as a whole could achieve similar levels of harvest and Ex-Vessel Value despite a fishing season delay or early closure, the impacts for specific sectors of the fleet may be far greater. Furthermore, permanently restricting the fishery to a shorter period would likely have more dramatic effects on the economic viability and composition of the fleet than those contemplated during the RAMP rulemaking. Restricting operations to a two or three-month period could compound any negative impacts resulting from adverse climate change effects, harmful algal blooms, trade disputes, or other external pressures. CDFW's interest in maintaining an economically viable fishery includes maintaining a diversity of business plans and avoiding disproportionate impacts on certain sectors of the fleet. While larger vessels which generally transition to other fisheries after the initial six to eight weeks of the season might not be affected, CDFW anticipates this alternative would be detrimental for smaller, artisanal operators who rely on being able to fish for a greater proportion of the season.

Given the uncertainty regarding the degree of protection offered to Covered Species, as well as the potential for substantial economic impacts on certain sectors of the fishery, CDFW decided against implementing a permanently shortened season at this time.

8.2 Required Use of Multi-Trap Trawls

Under the Conservation Program detailed in Chapter 5, a transition from single traps to multi-trap trawls is one potential method of achieving vertical line reductions (see Section 5.2.3.3) and could be authorized as Alternative Gear (see Section 5.2.3.5). However, as noted in Section 5.2.3.3, there is potential for gear conflict and safety issues, as well as uncertainty relative to the benefit to Covered Species from reduced encounter rates but the potential for heavier gear if an entanglement occurs. Fishing with multi-trap trawls poses substantial safety concerns for smaller vessels, which have less available deck space and capacity to handle the gear. Only requiring vertical lines on a subset of fished traps also poses concerns similar to those highlighted in Section 5.2.3.5 regarding CDFW's ability to enforce trap limits and closed areas. At the time this CP was prepared, CDFW determined there was insufficient evidence to appropriately weigh the relative costs and benefits of widespread use of multi-trap trawls and instead identified it as one potential management response in the instance of elevated entanglement risk. For similar reasons, CDFW ultimately decided against requiring the use of multi-trap trawls as a baseline fishing practice.

8.3 Require Use of Pop-Up ("Ropeless") Gear

As described in Section 5.2.3.5, there is increasing interest in replacing standard trap configurations (which include persistent vertical lines) with pop-up gear. CDFW received numerous public comments regarding use of pop-up gear during the rulemaking process to adopt Cal. Code Regs., Tit. 14 § 132.8. In February 2021, a bill (AB 534, Bonta) was introduced that would have required all commercial and recreational trap fisheries to use "ropeless" fishing gear within National Marine Sanctuary waters by 2025. CDFW considered requiring the use of pop-up gear throughout the fishing season, rather than classifying it as one of many potential types of Alternative Gear whose use is limited to certain closures after April 1. Ultimately, CDFW decided against this alternative due to concerns about gear conflict, enforceability, implementation costs, and compatibility with fishery operations.

As described in Appendix 1 of the Final Statement of Reasons (CDFW 2020c) and Section 5.2.3.5, CDFW chose to prohibit the use of pop-up gear in an open Fishing Zone due to concerns about gear conflicts with traditional Dungeness crab trap gear, other trap fisheries, and commercial trawl fisheries. Furthermore, the greatest need for pop-up and other types of Alternative Gear is during spring closures, when entanglement risk is expected to continue increasing through the end of the fishing season as Covered Species return to the fishing grounds. Allowing the use of pop-up gear in these situations allows for continued harvest of Dungeness crab in a manner that poses a lower risk of entanglement, mitigating economic impacts of such closures. Since traditional commercial Dungeness crab gear will not be deployed in those areas for the remainder of the fishing season, the potential for within-fishery gear conflict is reduced. During the fall and winter months, when Covered Species are either absent from or present in low numbers within the fishing grounds, the additional protective benefit from the use of pop-up gear is outweighed by concerns regarding gear conflict.

One method for reducing gear conflict would be to create a single platform capable of displaying real-time locations of any pop-up gear deployed at sea. While certain gear manufacturers have developed proprietary mobile applications or webpages that display locations for their specific gear type, at the time this CP was prepared CDFW was not aware of a product that performs this function across all manufacturers. Furthermore, existing applications display the location where the gear was deployed, and do not necessarily reflect the current location at any given time. Real-time gear location information is necessary to account for instances where gear is moved by strong currents, storm activity, or another vessel.

Should CDFW require the entire fishery to transition to pop-up gear, each vertical line would need to be replaced with a pop-up unit and (for acoustically-triggered releases) each vessel would also need an on-deck or hull-mounted unit to locate the gear and transmit the release signal. Calculating the cost for each participant to purchase, install, and operate the required gear is difficult, as it depends on whether a single pop-up unit would be attached to each trap or whether they could be deployed onto multi-trap trawls (see Figure 2-3). Additionally, given the number of traps used in the fishery, this sort of fleet-wide transition to pop-up gear could drive down production costs. However, equipment acquisition costs for a National Marine Sanctuary Foundation's gear innovations testing project, funded by OPC and carried out in partnership with CDFW, provide some insight into potential costs. Galvanic timed-release devices were by far the lowest cost option ($225/unit), although one component would need to be replaced at a cost of $1 each time the trap was re-deployed. Electronic timed-release devices were slightly more expensive ($300/unit). Of the four acoustic-triggered release devices, per-unit costs ranged from $1,700 - $11,000. In contrast, a traditional Dungeness crab trap, rope, and buoys typically costs $275. It is unclear at this time how the additional costs of transitioning to pop-up gear would impact economic viability of the fishery.

After consideration of the potential harm from gear conflicts and the anticipated economic impacts on the fishery, CDFW found this to be an impracticable alternative.

8.4 Permanent Capacity Reduction

As described in Section 5.1, the Conservation Program in this CP is primarily focused on reducing co-occurrence between Covered Species and Covered Activities. As a result, CDFW considered multiple methods for implementing permanent reductions in fishery capacity (i.e., amount of fished gear) in order to limit baseline entanglement risk due to co-occurrence. Capacity reductions can be targeted at decreasing the number of participating vessels in the fishery, the amount of gear being fished by those vessels, or both. In order to be meaningful, the reduction must apply to active rather than latent effort. Three common methods of achieving capacity reductions within a limited entry fishery are a permit buy-back, permit stacking, and reduced gear allotments.

Based on the considerations detailed below for each of these methods, CDFW did not seek a permanent capacity reduction for the fishery. However, acknowledging the importance of reduced capacity as a tool to manage entanglement risk, CDFW has included temporary vertical line reductions as a potential management action under the RAMP (see Section 5.2.3.3), which can achieve a similar result on an as-needed basis when implemented by the Director.

8.4.1 Permit Buy-Back

Implementing a successful permit buy-back program can be costly, must remove a meaningful portion of active effort from the fishery, and is ultimately driven by the interest of fishery participants. CDFW recently implemented a buy-back program for the DGN fishery pursuant to SB 1017 (Allen, 2018), which offered active permitholders $110,000 and inactive permitholders $10,000 for surrendering their permit and nets. So far, a total of $3.3 million has been invested in the buy-back program, of which $2.3 million is from state sources, and CDFW anticipates buying back 44 permits. During 2018, the last year before the buyout program began, there were 69 total DGN permits of which 28 (41%) were active. In contrast, as described in Chapter 2, the California commercial Dungeness crab fishery has approximately 550 permitted vessels; on average, 80% were active during the 2017-18 through 2019-20 seasons. Additionally, mean Ex-Vessel Value during the 2017-18 through 2019-20 seasons for a given Dungeness crab permit ($120,000) was substantially higher than that for a DGN permit ($34,357) during calendar year 2018. Both the percentage of active vessels and mean per-permit Ex-Vessel Value make it likely that substantially greater resources would be needed to implement a similar degree of capacity reduction in the commercial Dungeness crab fishery. Without a direct appropriation from the California Legislature, or commitments from outside entities, CDFW lacks both the necessary funding and statutory authority to implement a permit buy-back program.

CDFW would also need to develop meaningful targets for the buy-back program that correspond to a sufficient decrease in entanglement risk, to avoid exceeding the requested take levels in Section 4.2. Furthermore, given the derby nature of this fishery, any reduction in the amount of gear may alter typical fishing season dynamics. If it takes longer for the fleet to harvest the same amount of crab, remaining vessels may fish their full trap allocation for a longer period of time. This could have the unintended effect of increasing the amount of gear present during the spring or summer months, when Covered Species are likely to be returning to the fishing grounds. Recent discussions by the DCTF highlighted a variety of industry concerns around cost, equity, harm to local communities, and other unintended side effects of a permit buy-back program (DCTF 2020). At this time, CDFW does not anticipate gaining authority to establish a buy-back program without broad support from the DCTF and other partners.

8.4.2 Permit Stacking

Dungeness crab permits are assigned to specific vessels, and each vessel may only fish a single permit (Fish & G. Code 8280.2 subds. (b) and (d)). Permit stacking would allow multiple Dungeness crab permits, and therefore more gear, to be fished by a given vessel. If paired with a stacked permit trap reduction, whereby the vessel could fish the full trap tier for the first permit but only a portion of the trap tier (e.g., 50%) for subsequent permits, permit stacking would reduce the maximum amount of gear that could be deployed in the fishery. However, as highlighted in Section 2.2.4.1, the maximum amount of gear that could be fished doesn't necessarily reflect the amount of gear that is actually deployed at any given time. Furthermore, if permits that are not currently being fished are stacked onto a vessel that does participate in the fishery, permit stacking could actually result in re-activation of latent effort and increase the amount of gear being fished, contrary to the intent. CDFW anticipates permit stacking would differentially impact the diverse business models currently employed by fishery participants, and could fundamentally change the nature of the Covered Activities by pushing the fishery towards consolidation. Finally, authorization for permit stacking would require a legislative change. Due

to the lack of appropriate targets, the potential for increased rather than decreased fishing effort, potential impacts on the economic viability of the fishery, and lack of authority, CDFW did not select this alternative for inclusion in the CP.

8.4.3 Reduced Gear Allotments

As described in Section 2.2.3, the number of traps a given vessel can deploy is specified by the tier level of the Dungeness crab vessel permit. The existing tiers were established following extensive negotiation with the fleet. Modifying the trap tiers could reduce the maximum amount of gear that could be deployed in the fishery. While some of the limitations from Section 8.4.2 apply, the conservation benefit would be more predictable as this method would implement a reduction across the entire fleet, rather than phasing in reductions through permit stacking as individual operators decide to purchase additional permits. This could be done by a proportional reduction across all tiers, or by some differential reduction. For example, all tiers could be limited to 75% of their current trap allotment, or a set number of traps (e.g., 25) could be subtracted from each tier's current allotment.

As described in Chapter 5, prior to implementation of the RAMP regulations, CDFW had limited available information regarding the number of deployed traps on either a fishery-wide or per-permit basis. Without this information, it is not possible to calculate the appropriate reduction in the number of permitted traps that would translate to a reduction from baseline levels of fishing activity. It is also unclear what impact adjusting the permit tiers would have on the economic viability of the fishery. Furthermore, Fish & G. Code § 8276.5 subd. (d) requires that any changes to the existing permit tiers be approved by the DCTF, so CDFW cannot unilaterally implement modifications.

Given the potential for adverse economic impacts on the fishery, CDFW decided against implementing this alternative.

8.5 Alternative Thresholds for Determining Elevated Entanglement Risk

As described in Chapter 5, the RAMP program relies on routine evaluation of information regarding the distribution and abundance of Covered Species and tracking confirmed entanglements in California commercial Dungeness crab and Unknown Fishing Gear. For both of these risk factors, CDFW has established specific thresholds that when attained, require implementation of a management action. Section 5.2.1.1.4 describes the rationale for the selection of thresholds related to confirmed entanglements.

CDFW relied upon the best available science, including the expert opinion of Working Group Advisors, when developing the marine life concentration thresholds. CDFW determined that lower thresholds would excessively limit fishing activity, while higher thresholds would be insufficiently protective of Covered Species. However, as described in Section 5.2.1.2, CDFW anticipates additional advances in available information during the permit term related to this risk factor. Should the best available science indicate revised values are warranted, CDFW will undertake the CP and state regulatory amendment processes described in Section 6.3.

References

Abrahms B, Hazen EL, Aikens EO, Savoca MS, Goldbogen JA, Bograd SJ, Jacox MG, Irvine LM, Palacios DM, Mate BR. 2019a. Memory and resource tracking drive blue whale migrations. Proceedings of the National Academy of Sciences 116(12): 5582-5587.

Abrahms B, Welch H, Brodie S, Jacox MG, Becker EA, Bograd SJ, Irvine LM, Palacios DM, Mate BR, Hazen EL. 2019b. Dynamic ensemble models to predict distributions and anthropogenic risk exposure for highly mobile species. Diversity and Distributions 25(8): 1182-1193.

Arthur LH, Mclellan WA, Piscitelli MA, Rommel SA, Woodward BL, Winn JP, Potter CW, Pabst DA. 2015. Estimating maximal force output of cetaceans using axial locomotor muscle morphology. Marine Mammal Science 31(4): 1401-1426.

Bailey H, Mate BR, Palacios DM, Irvine L, Bograd SJ, Costa DP. 2009. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. Endangered Species Research 10:93-106.

Becker EA, Forney KA, Thayre BJ, Debich AJ, Campbell GS, Whitaker K, Douglas AB, Gilles A, Hoopes R, Hildebrand JA. 2017. Habitat-based density models for three cetacean species off Southern California illustrate pronounced seasonal differences. Frontiers in Marine Science 4(121): 1–14. https://doi.org/10.3389/fmars.2017.00121

Bednaršek N, Feely RA, Reum JCP, Peterson B, Menkel J, Alin SR, Hales B. 2014. *Limacina helicina* shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem. Proceedings of the Royal Society B: Biological Sciences 281:1-8.

Bednaršek N, Feely RA, Beck MW, Alin SR, Siedlecki SA, Calosi P, Norton EL, Saenger C, Štrus J, Greeley D, Nezlin NP, Roethler M, Spicer JI. 2020. Exoskeleton dissolution with mechanoreceptor damage in larval Dungeness Crab related to severity of present-day ocean acidification vertical gradients. Science of the Total Environment 716:1-8.

Benoit-Bird KJ, Waluk CM, Ryan JP. 2019. Forage Species Swarm in Response to Coastal Upwelling. Geophysical Research Letters 46: 1537–1546.

Benson SR, Forney KA, Harvey JT, Carretta JV, Dutton PH. 2007. Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990 –2003. Fishery Bulletin 105: 337–347.

Benson SR, Eguchi T, Foley DG, Forney KA, Bailey H, Hitipeuw C, Samber BP, Tapilatu RF, Rei V, Ramohi P, Pita J, Dutton PH. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere 2(7): 1-27.

Benson SR, Forney KA, Moore JE, LaCasella EL, Harvey JT, Carretta JV. 2020. A long-term decline in the abundance of endangered leatherback turtles, Dermochelys coriacea, at a foraging ground in the California Current Ecosystem. Global Ecology and Conservation 24:1-13.

Bettridge S, Baker CS, Barlow J, Clapham PJ, Ford M, Gouveia D, Mattila DK, Pace RM III, Rosel PE, Silber GK, Wade PR. 2015. Status Review of the Humpback Whale

(Megapters novaengliae) under the Endangered Species Act. NOAA Technical Memorandum NMFS-SWFSC-540. 263 p.

Bograd SJ, Castro CG, Di Lorenzo E, Palacios DM, Bailey H, Gilly W, Chavez FP. 2008. Oxygen declines and the shoaling of the hypoxic boundary in the California Current. Geophysical Research Letters 35:1-6.

Bograd SJ, Schroeder I, Sarkar N, Qiu X, Sydeman WJ, Schwing FB. 2009. Phenology of coastal upwelling in the California Current. Geophysical Research Letters 36:1-5.

Bond NA, Cronin MF, Freeland H, Mantua N. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophysical Research Letters 42:3414–3420.

Brady RX, Alexander MA, Lovenduski NS, Rykaczewski RR. 2017. Emergent anthropogenic trends in California Current upwelling. Geophysical Research Letters 44: 5044–5052.

Calambokidis J, Schorr GS, Steiger GH, Francis J, Bakhtiari M, Marshal M, Oleson EM, Gendron D, Robertson K. 2007. Insights into the underwater diving, feeding, and calling behavior of blue whales from a suction-cup-attached video-imaging tag (CRITTERCAM). Marine Technology Society Journal 41(4):19-29.

Calambokidis J, Steiger GH, Curtice C, Harrison J, Ferguson MC, Becker E, DeAngelis M, Van Parijs SM. 2015. 4. Biologically important areas for selected cetaceans within U.S. waters – West Coast region. Aquatic Mammals 41(1):39-53.

Calambokidis J, Barlow J. 2020. Updated abundance estimates for blue and humpback whales along the U.S. West Coast using data through 2018. NOAA Technical Memorandum NMFS-SWFSC-634. 17 p.

California Department of Fish and Wildlife (CDFW). 2017. Department of Fish and Wildlife Scientific Integrity Policy. Department of Fish and Wildlife Departmental Bulletin 2017-02. 5 p.

California Department of Fish and Wildlife (CDFW). 2020a. Dungeness Crab, *Metacarcinus magister*, Enhanced Status Report.

California Department of Fish and Wildlife (CDFW). 2020b. Standardized Regulatory Impact Assessment, Proposed Addition of Section 132.8, Title 14, California Code of Regulations for the Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery. 41 p.

California Department of Fish and Wildlife (CDFW). 2020c. Final Statement of Reasons for Regulatory Action, Proposed Addition of Section 132.8, Title 14, California Code of Regulations for the Risk Assessment Mitigation Program: Commercial Dungeness Crab Fishery. Appendix 1: Summary of Comments Received and General Responses to Comments. 26 p.

Carr ME, Kearns EJ. 2003. Production regimes in four Eastern Boundary Current systems. Deep Sea Research Part II: Topical Studies in Oceanography 50: 3199-3221.

Carretta JV. 2020. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery: 1990-2018. NOAA Technical Memorandum NMFS-SWFSC-632. 80 p.

Carretta JV, Forney KA, Oleson EM, Weller DW, Lang AR, Baker JB, Muto MM, Hanson B, Orr AJ, Hubert H, Lowry MS, Barlow J, Moore JE, Lynch D, Carswell L, Brownell Jr. RL. 2020. U.S. Pacific Marine Mammal Stock Assessments: 2019. NOAA Technical Memorandum NMFS-SWFSC-629. 380 p.

Carretta JV, Oleson EM, Forney KA, Muto MM, Weller DW, Lang AR, Baker JB, Hanson B, Orr AJ, Barlow J, Moore JE, Brownell Jr. RL. 2021. U.S. Pacific Marine Mammal Stock Assessments: 2020. NOAA Technical Memorandum NMFS-SWFSC-646. 389 p.

Cavole LM, Demko AM, Diner RE, Giddings A, Koester I, Pagniello CM, Paulsen ML, Ramirez-Valdez A, Schwenck SM, Yen NK, Zill ME. 2016. Biological impacts of the 2013–2015 warm-water anomaly in the Northeast Pacific: Winners, losers, and the future. Oceanography 29(2): 273-285.

Chavez FP, Ryan J, Lluch-Cota SE, Ñiquen MC. 2003. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. Science 299:217-221.

Checkley DM, Barth JA. 2009. Patterns and processes in the California Current System. Progress in Oceanography 83: 49–64.

Clapham PJ, Leatherwood S, Szczepaniak I, Brownell Jr. RL. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919–1926. Marine Mammal Science 13(3): 368-394.

Croll DA, Acevedo-Gutiérrez A, Tershy BR, Urbán-Ramírez J. 2001. The diving behavior of blue and fin whales: is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology Part A 129:797-809.

Croll DA, Marinovic B, Benson S, Chavez FP, Black N, Ternullo R, Tershy BR. 2005. From wind to whales: trophic links in a coastal upwelling system. Marine Ecology Progress Series 289:117-130.

Curtis KA, Moore JE, Benson SR. 2015. Estimating Limit Reference Points for Western Pacific Leatherback Turtles (*Dermochelys coriacea*) in the U.S. West Coast EEZ. PLoS ONE 10(9):1–24.

Di Lorenzo E, Mantua N. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nature Climate Change 6:1042-1047.

Dungeness Crab Task Force (DCTF). April 14, 2020 Executive Committee Meeting Summary. Accessed April 22, 2021. https://opc.ca.gov/webmaster/_media_library/2009/04/DCTF_EC_SummaryApr2020.pdf

Eguchi T, Benson SR, Foley DG, Forney KA. 2016. Predicting overlap between drift gillnet fishing and leatherback turtle habitat in the California Current Ecosystem. Fisheries Oceanography 26(1):17-33.

Feist BE, Samhouri JF, Forney KA, Saez LE. 2021. Footprints of fixed-gear fisheries in relation to rising whale entanglements on the U.S. West Coast. Fisheries Management and Ecology 00:1–12.

Fiedler PC, Reilly SB, Hewitt RP, Demer D, Philbrick VA, Smith S, Armstrong W, Croll DA, Tershy BR, Mate BR. 1998. Blue whale habitat and prey in the California Channel Islands. Deep Sea Research Part II 45:1781-1801.

Field JC, Francis RC, Aydin K. 2006. Top-down modeling and bottom-up dynamics: Linking a fisheries-based ecosystem model with climate hypotheses in the Northern California Current. Progress in Oceanography 68:238–270.

Fleming AH, Clark CT, Calambokidis J, Barlow J. 2016. Humpback whale diets respond to variance in ocean climate and ecosystem conditions in the California Current. Global Change Biology 22:1214-1224.

Forney KA, Barlow J. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991–1992. Marine Mammal Science 14(3):460-489.

Friedlaender AS, Hazen EL, Nowacek DP, Halpin PN, Ware C, Weinrich MT, Hurst T, Wiley D. 2009. Diel changes in humpback whale *Megaptera novaeangliae* feeding behavior in response to sand lance *Ammodytes* spp. behavior and distribution. Marine Ecology Progress Series 395:91–100.

Goldbogen JA, Calambokidis J, Croll DA, Harvey JT, Newton KM, Oleson EM, Schorr G, Shadwick RE. 2008. Foraging behavior of humpback whales: kinematic and respiratory patterns suggest a high cost for a lunge. Journal of Experimental Biology 211:3712–3719.

Graham WM, Pagès F, Hamner WM. 2001. A physical context for gelatinous zooplankton aggregations: a review. Hydrobiologia 451:199-212.

Harvey C, Garfield T, Williams G, Tolimieri N. 2021. California Current Integrated Ecosystem Assessment (CCIEA) California Current Ecosystem Status Report, 2021. Pacific Fishery Management Council March 2021 Meeting, Agenda Item I.1.a., IEA Team Report 1.

Hatfield BB, Ames JA, Estes JA, Tinker MT, Johnson AB, Staedler MM, Harris MD. 2011. Sea otter mortality in fish and shellfish traps: estimating potential impacts and exploring possible solutions. Endangered Species Research 13:219–229.

Hazen EL, Friedlaender AS, Thompson MA, Ware CR, Weinrich MT, Halpin PN, Wiley DN. 2009. Fine-scale prey aggregations and foraging ecology of humpback whales *Megaptera novaeangliae*. Marine Ecology Progress Series 395:75–89.

Hazen EL, Palacios DM, Forney KA, Howell EA, Becker E, Hoover AL, Irvine L, DeAngelis M, Bograd SJ, Mate BR, Bailey H. 2016. WhaleWatch: a dynamic management tool for predicting blue whale density in the California Current. Journal of Applied Ecology 54(5):1415-1428.

Heaslip SG, Iverson SJ, Bowen WD, James MC. 2012. Jellyfish support high energy intake of leatherback sea turtles (*Dermochelys coriacea*): Video evidence from animal-borne cameras. PLoS ONE 7(3):1–7.

Hickey BM. 1979. The California current system - hypotheses and facts. Progress in Oceanography 8(4):191–279.

Highly Migratory Species Management Team. 20201. Highly Migratory Species Management Team Report on Drift Gillnet Bycatch Performance Metrics. Pacific Fishery Management Council June 2021 Meeting, Agenda Item F.4.a., HMSMT Report 1.

Howle LE, Kraus SD, Werner TB, Nowacek DP. 2019. Simulation of the entanglement of a North Atlantic right whale (*Eubalaena glacialis*) with fixed fishing gear. Marine Mammal Science 35(3):760–778.

Huyer, A. (1983). Coastal Upwelling in the California Current System. Progress in Oceanography, 12, 259–284.

Ingman K, Hines E, Mazzini PLF, Rockwood RC, Nur N, Jahncke J. 2021. Modeling changes in baleen whale seasonal abundance, timing of migration, and environmental variables to explain the sudden rise in entanglements in California. PLoS ONE 16(4):1-19.

Jackson JA, Steel DJ, Beerli P, Congdon BC, Olavarría C, Leslie MS, Pomilla C, Rosenbaum H, Baker C. 2014. Global diversity and oceanic divergence of humpback whales (*Megaptera novaeangliae*). Proceedings of the Royal Society B 281(1786): 1-10.

Jacox MG, Alexander MA, Stock CA, Hervieux G. 2019. On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability. Climate Dynamics 53:7519–7533.

Jones TT, Bostrom BL, Hastings MD, van Houtan KS, Pauly D, Jones DR. 2012. Resource Requirements of the Pacific Leatherback Turtle Population. PLoS ONE 7(10):1-10.

Kieckhefer TR. 1992. Feeding ecology of humpback whales in continental shelf waters near Cordell Bank, California [MS Thesis]. Moss Landing, California: San Jose State University. 86 p.

Knowlton AR, Robbins J, Landry S, McKenna HA, Kraus SD, Werner TB. 2016. Effects of fishing rope strength on the severity of large whale entanglements. Conservation Biology 30(2): 318-328.

Knowlton AR, Malloy Jr. R, Kraus SD, Werner TB. 2018. Final Report: Development and Evaluation of Reduced Breaking Strength Rope to Reduce Large Whale Entanglement Severity. Anderson Cabot Center for Ocean Life, New England Aquarium. MMARS #: CT EVN 0607160000 000 000 3938. 66 p.

Lenarz WH, VenTresca DA, Graham WM, Schwing FB, Chavez F. 1995. Explorations of El Niño Events and Associated Biological Population Dynamics off Central California. California Cooperative Oceanic Fisheries Investigations Report 36:106–119.

Lynn RJ, Simpson JJ. 1987. The California Current System: The seasonal Variability of its Physical Characteristics. Journal of Geophysical Research 92(C12):12947–12966.

Magel CL, Lee EMJ, Strawn AM, Swieca K, Jensen AD. 2020. Connecting crabs, currents, and coastal communities: examining the impacts of changing ocean conditions on the distribution of U.S. west coast Dungeness Crab commercial catch. Frontiers in Marine Science 7:1-16.

Marchesiello P, McWilliams JC, Shchepetkin A. 2003. Equilibrium Structure and Dynamics of the California Current System. Journal of Physical Oceanography 33:753-783.

Mate BR, Lagerquist BA, Calambokidis J. 1999. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Marine Mammal Science 15(4):1246-1257.

McCabe RM, Hickey BM, Kudela RM, Lefebvre KA, Adams NG, Bill BD, Gulland FMD, Thomson RE, Cochlan WP, Trainer VL. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. Geophysical Research Letters 43:10366-10376.

McKibben SM, Peterson W, Wood AM, Trainer VL, Hunter M, White AE. 2017. Climatic regulation of the neurotoxin domoic acid. Proceedings of the National Academy of Sciences, 114(2):239-244.

National Marine Fisheries Service (NMFS). 2012. Process for Distinguishing Serious from Non-Serious Injury of Marine Mammals - Process for Injury Determinations. NMFS Instruction 02-038-01, January 27, 2012. 42 p.

National Marine Fisheries Service (NMFS). 2016. Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the MMPA. NMFS Instruction 02-204-01, February 22, 2016. 33 p.

National Marine Fisheries Service (NMFS). 2018a. Fisheries Economics of the United States, 2016: Economics and Sociocultural Status and Trends Series. NOAA Technical Memorandum NMFS-F/SPO-187, 251 p.

National Marine Fisheries Service (NMFS). 2020a. Blue Whale (Balaenoptera musculus) 5-Year Review: Summary and Evaluation. NMFS Office of Protected Resources, Silver Spring, MD. 15 p.

National Marine Fisheries Service (NMFS). 2020b. Biological Report for the Designation of Critical Habitat for the Central America, Mexico, and Western North Pacific DPS of Humpback Whales (Megaptera novaeangliae). 162 p.

National Marine Fisheries Service (NMFS). 2020c. Criteria for Determining Negligible Impact under MMPA Section 101(a)(5)(E). NMFS Procedure 02-204-02, June 17, 2020. 20 p.

National Marine Fisheries Service (NMFS). 2020d. Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion - Continuing Operation of the Pacific Coast Groundfish Fishery (Reinitiation of consultation #NWR-2012-876) – Humpback whale (*Megaptera novaeangliae*). NMFS West Coast Region. WCRO-2018-01378. 83 p.

National Marine Fisheries Service (NMFS). 2020e. Draft Analysis of U.S. West Coast Large Whale Entanglement Serious Injury and Mortality Assessments for Use in Conservation Planning by States. NMFS West Coast Region Protected Resources Division. 25 p.

National Marine Fisheries Service (NMFS). 2020f. Recovery Plan for the Blue Whale (*Balaenoptera musculus*): First Revision to the July 1998 Recovery Plan for the Blue Whale. NMFS Office of Protected Resources. 118 p.

National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS). 2020. Endangered Species Act Status Review of the Leatherback Turtle (*Dermochelys coriacea*) 2020. Report to the National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service. 387 p.

National Marine Fisheries Service (NMFS). 2021a. Species in the Spotlight Priority Actions 2021-2025: Pacific Leatherback Turtles (*Dermochelys coriacea*). National Marine Fisheries Service. 20 p.

National Marine Fisheries Service (NMFS). 2021b. Amendment 6 to the Fishery Management Plan for West Coast Highly Migratory Species Fisheries: Authorization of Deep-set Buoy Gear; Draft Environmental Impact Statement. National Marine Fisheries Service. 175 p.

California Ocean Protection Council (OPC). 2019. Strategy for Protecting Whales and Sea Turtles & Ensuring Thriving Fisheries: Reducing the Risk of Entanglement in California Fishing Gear. California Ocean Protection Council. 23 p.

California Ocean Protection Council (OPC). 2020. Strategic Plan to Protect California's Coast and Ocean 2020-2025. California Ocean Protection Council. 64 p.

Pacific Fishery Management Council (PFMC). 2017. National Marine Fisheries Service (NMFS) Report on Highly Migratory Species (HMS) Activities. Pacific Fishery Management Council March 2017 Meeting, Agenda Item J.1.b., NMFS Report 1.

Pacific Fishery Management Council (PFMC). 2021. Leatherback Sea Turtle Bycatch in U.S. West Coast Groundfish Fisheries 2002-2019. Pacific Fishery Management Council June 2021 Meeting, Agenda Item G.4.a, NMFS Report 5.

Pacific States Marine Fisheries Commission (PSMFC). 2018. Forensic Review Workshop Report Reviewing the Gear Involved in West Coast Entanglements. Pacific States Marine Fisheries Commission and NOAA. 49 p.

Pacific States Marine Fisheries Commission (PSMFC). 2019. 72nd annual report of the Pacific States Marine Fisheries Commission. Pacific States Marine Fisheries Commission. 91 pp.

Palacios DM, Bailey H, Becker EA, Bograd SJ, Deangelis ML, Forney KA, Hazen EL, Irvine L M, Mate BR. 2019. Ecological correlates of blue whale movement behavior and its predictability in the California Current Ecosystem during the summer-fall feeding season. Movement Ecology 7:1–21.

Peterson W, Robert M, Bond N. 2015. The warm blob- Conditions in the northeastern Pacific Ocean. PICES Press 23(1):36-38.

Reilly SB, Thayer VG. 1990. Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific. Marine Mammal Science 6(4):265-277.

Reiss CS, Checkley DM, Bograd SJ. 2008. Remotely sensed spawning habitat of Pacific sardine (*Sardinops sagax*) and Northern anchovy (*Engraulis mordax*) within the California Current. Fisheries Oceanography 17(2):126–136.

Rice DW. 1998. Marine mammals of the world: systematics and distribution. Lawrence, KS: The Society for Marine Mammalogy and Allen Press, Inc. 231 p.

Rykaczewski RR, Dunne JP. 2010. Enhanced nutrient supply to the California Current Ecosystem with global warming and increased stratification in an earth system model. Geophysical Research Letters 37:1-5.

Saez L, Lawson D, DeAngelis M. 2021. Large whale entanglements off the U.S. West Coast, from 1982-2017. NOAA Technical Memorandum NMFS-OPR-63A. 50 p.

Santora JA, Sydeman WJ, Schroeder ID, Wells BK, Field JC. 2011. Mesoscale structure and oceanographic determinants of krill hotspots in the California Current: Implications for trophic transfer and conservation. Progress in Oceanography 91:397-409.

Santora JA, Mantua NJ, Schroeder ID, Field JC, Hazen EL, Bograd SJ, Snydeman WJ, Wells BK, Calambokidis J, Saez L, Lawson D, Forney KA. 2020. Habitat compression and ecosystem shifts as potential links between marine heatwave and record whale entanglements. Nature Communications 11:1–12.

Skogsberg T. 1936. Hydrography of Monterey Bay, California. Thermal Conditions, 1929-1933. Transactions of the American Philosophical Society, 29(1):1–152.

Schroeder ID, Black BA, Sydeman WJ, Bograd SJ, Hazen EL, Santora JA, Wells BK. 2013. The North Pacific High and wintertime pre-conditioning of California current productivity. Geophysical Research Letters 40:541–546.

Starbird CH, Baldridge A, Harvey JT. 1993. Seasonal occurrence of leatherback sea turtles (*Dermochelys coriacea*) in the Monterey Bay region, with notes on other sea turtles, 1986-1991. California Fish and Game 79(2):54-62.

Stewart JD, Weller DW. 2021. Abundance of Eastern North Pacific Gray Whales 2019/2020. NOAA Technical Memorandum NMFS-SWFSC-639. 5 p.

Stinson ML. 1984. Biology of sea turtles in San Diego Bay, California, and in the northeastern Pacific Ocean [MS thesis]. San Diego, California: San Diego State University. 575 p.

Swimmer Y, Gutierrez A, Bigelow K, Barceló C, Schroeder B, Keene K, Shattenkirk K, Foster DG. 2017. Sea Turtle Bycatch Mitigation in U.S. Longline Fisheries. Frontiers in Marine Science, 4:1-19.

Szesciorka AR, Ballance LT, Širović A, Rice A, Ohman MD, Hildebrand JA, Franks PJ. 2020. Timing is everything: Drivers of interannual variability in blue whale migration. Scientific Reports 10:1-9.

Talley LD, George LP, Emery WJ, Swift, JH. 2011. Descriptive physical oceanography: an introduction, 6th edition. San Diego, California: Academic Press. 555 p.

Tapilatu RF, Dutton PH, Tiwari M, Wibbels T, Ferdinandus HV, Iwanggin WG, Nugroho BH. 2013. Long-term decline of the western Pacific leatherback, *Dermochelys coriacea*: a globally important sea turtle population. Ecosphere 4(2):1–15.

Thomas A, Strub PT. 2001. Cross-shelf phytoplankton pigment variability in the California Current. Continental Shelf Research 21:1157-1190.

United States Fish and Wildlife Service (USFWS). 2021. Marine Mammal Stock Assessment Report: Southern Sea Otter (*Enhydra lutris nereis*). United States Fish and Wildlife Service, Ventura, California. 20 p.

Wade PR. 2017. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas revision of estimates in SC/66b/IA21. International Whaling Commission Report SC/A17/NP/11. 9 p.

Wild PW, Tasto RN. 1983. Life History, Environment, and Mariculture Studies of the Dungeness Crab, Cancer magister, With Emphasis on The Central California Fishery Resource. California Department of Fish and Game. Fish Bulletin 172. 352 p.

Yates C. 2021. West Coast Region's revised Endangered Species Act implementation and considerations about "take" given the September 2016 humpback whale DPS status review, species-wide revision of listings, and updates to best available scientific information. NMFS West Coast Region Protected Resources Division Memorandum, July 15, 2021. 18 p.

Zwolinski JP, Demer DA, Byers KA, Cutter GR, Renfree JS, Sessions TS, Macewicz BJ. 2012. Distributions and abundances of Pacific sardine (*Sardinops sagax*) and other pelagic fishes in the California Current Ecosystem during spring 2006, 2008, and 2010, estimated from acoustic-trawl surveys. Fishery Bulletin 110:110–122.

Zwolinski JP, Demer D, Macewicz BJ, Cutter GR, Elliot BE, Mau SA, Murfin DW, Renfree JS, Sessions TS, Stierhoff K. 2016. Acoustic-trawl estimates of northern-stock Pacific sardine biomass during 2015. NOAA Technical Memorandum NMFS-SWFSC-559. 15 p.

Zwolinski JP, Demer D, Macewicz BJ, Mau SA, Murfin DW, Palance D, Renfree JS, Sessions TS, Stierhoff K. 2017. Distribution, biomass and demography of the central-stock of Northern anchovy during summer 2016, estimated from acoustic-trawl sampling. NOAA Technical Memorandum NMFS-SWDSC-572. 18 p.