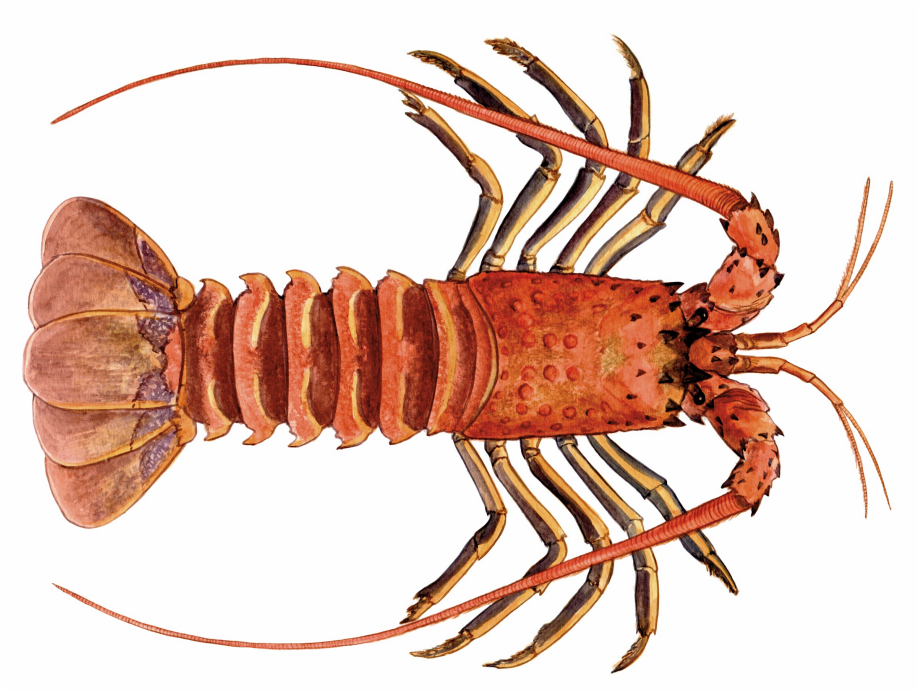
Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught California spiny lobster from California caught using pots



Species:	California spiny lobster (*Panulirus interruptus*)
Location:	California
Gear:	Pots
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

Several species of spiny lobster occur around the world that support commercial and recreational fisheries. The California spiny lobster's range is along the western coast of North America from Monterey, California to Manzanillo, Mexico, though a small population exists in the Gulf of California. The main areas where it is fished are from Point Conception, Santa Barbara County, United States to Magdalena Bay, Baja California, Mexico. This report provides information and recommendations for California spiny lobster (*Panulirus interruptus*) that is commercially fished with traps in the waters of the U.S. state of California. There is a large recreational fishery for spiny lobster, but this report focuses only on the commercial fishery.

The California spiny lobster is moderately vulnerable to fishing pressure. It matures fairly quickly—between 5 years (Chávez-Hidalgo & Chávez 2016) and 7 years of age (Hovel 2017, pers comm)—compared to its life span of approximately 30 to 50 years (CDFW 2019). Mature spiny lobsters spawn once a year, and fecundity increases with size (CDFW 2019). A recent survey of California spiny lobster (2018–20) indicated that fecundity ranges from about 300,000 to 500,000 eggs per reproductive episode for a legal-sized lobster (Hovel 2024, pers comm). The larvae that are produced disperse widely during their 7–11 month planktonic stage.

Stock assessments for spiny lobster are conducted infrequently in the California fishery, with the most recent assessment completed in 2011. The California spiny lobster fishery has experienced steady landings; the most recent assessment suggests that the California spiny lobster population is stable. Landings during the 2014–15 fishing season were the third highest on record, and fishing mortality is suggested to be close to the maximum sustainable yield (MSY) (Hovel et al. 2015). Fishing mortality is estimated based on commercial landing receipts and logbook data.

A 2013 study that included some bycatch information found that bycatch from the California lobster fishery mainly comprises sublegal-sized lobsters and Kellet's whelk (*Kelletia kelletii*) (at 5.98% of the bycatch) (Culver et al. unpublished data, (CDFW 2016c)). The study shares similar results with the bycatch studies in the Mexican spiny lobster fishery (Culver et al. unpublished data, (CDFW 2016c)). Sublegal-sized lobsters will be discussed in Criterion 1 because they are part of the target species. As the result of ghost fishing by lost traps, the incidence of capture of other species is likely to be higher than known bycatch rates; however, there are few species-specific data on the impacts of ghost fishing in this region, so there is uncertainty regarding the impacts on some species. Entanglement of humpback whale is of particular concern in this fishery. Importantly, destruct devices are incorporated into traps to reduce the risk of ghost fishing effects.

Management of the California spiny lobster fishery is considered moderately effective. Lobster populations are protected commercially through biological regulations (size limits, specific seasons to protect breeding females and peak molting periods), effort-based regulations (permits, trap limits per permit) and gear restrictions (including requirements to check traps frequently, and escape ports to allow bycatch to escape traps). In addition, trap design—including escape ports designed to reduce the capture of undersized lobsters, and destruct devices that enable traps to open after a certain period—provide protection to the population. Enforcement of existing regulations is carried out by the Law Enforcement Division of the California Department of Fish and Wildlife. Enforcement includes daily patrols at sea and inspections where lobsters are handled that may result in citations for illegal fishing and poaching; however, an unknown level of poaching is still thought to occur.

The commercial spiny lobster fishery in California is entirely trap-based. Traps result in some damage to the benthic habitat. There is a lack of studies on the impact of the CA fishery on habitat; however, studies conducted in neighboring fisheries have suggested that spiny lobster fisheries present a nonsignificant impact on habitats. In addition, marine protected areas (MPA) have been established to protect 14.6% of lobster habitat and to fulfill other conservation objectives. The ecosystem impacts from the trap fishery are a moderate conservation concern because these impacts are unknown for this fishery. The California Department of Fish and Wildlife has started to implement measures (such as MPAs) to protect the ecosystem.

California spiny lobster caught in California using pots are rated Yellow because of uncertainty surrounding population status, concerns about impacts to other species, moderately effective management, and moderate impacts to the habitat and ecosystem.

List of Abbreviations	
CA	California
CDFW	California Department of Fish and Wildlife
CFR	Collaborative Fisheries Research
CLTFA	California Lobster and Trap Fishermen's Association
CPUE	Catch per unit effort
FMP	Fisheries Management Plan
HCR	Harvest control rule
LAC	Lobster Advisory Council
LEK	Local ecological knowledge
MLMA	Marine Life Management Act
MPA	Marine protected area
MSY	Maximum sustainable yield
PDO	Pacific Decadal Oscillation
SAM	Size at maturity
SCLRG	South Coast Lobster Research Group
SPR	Spawning potential ratio
TAC	Total allowable catch

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
California spiny lobster | Eastern Central Pacific | United States | California | Pots	2.644	1.000	3.000	3.000	**Good Alternative (2.209)**	433 (MT) 2022

Landings from the California spiny lobster fishery have remained fairly steady since the mid-1980s, with 433 MT (955,423 lb) landed during the 2022 season (NOAA 2023).

Summary

California spiny lobster caught in California using pots is rated yellow because of uncertainty surrounding its population status, concerns about impacts to other species, moderately effective management, and moderate impacts to the habitat and ecosystem.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

Spiny lobsters are marine invertebrates that are widely fished around the world. California spiny lobster (*Panulirus interruptus*) is found along the western coast of North America from Monterey, California, United States to Manzanillo, Mexico, although a small population exists in the Gulf of California (Figure 1) (CDFW 2016c). In the U.S., it is fished from Point Conception, Santa Barbara County south to the border with Mexico. This report provides information and recommendations for California spiny lobster that is commercially fished with traps in the waters of Southern California.

Species Overview

Spiny lobster, of the genus *Panulirus*, comprises approximately 20 species occurring worldwide in tropical and subtropical waters (Pollock 1995). Spiny lobster can be easily distinguished by the long, spiny antennae and the lack of claws on the first four pairs of legs (Holthuis 1991). Spiny lobsters are typically found at depths from 0 to 90 meters (m), depending upon the species (Holthuis 1991). Little is known about the recruitment habitats of California spiny lobster (Hovel 2017, pers comm). Previous studies suggest that juvenile California spiny lobsters spend the first few years in nearshore surfgrass beds (CDFG 2001), although some live in nonsurfgrass habitats such as algal habitat (Hovel 2017, pers comm). Adults are often found on rocky substrates, reefs, and within surfgrass beds (CDFG 2001). Spiny lobster tends to be nocturnal—foraging at night and sheltering during the day (Withy-Allen & Hovel 2013). Lobster migration processes attract debate: some studies suggest that they migrate among the depths depending upon the season, generally moving deeper in winter months (CDFG 2001); other studies hypothesize that lobsters generally have high site fidelity, remaining in the same area for years (Hovel and Lowe 2007)(Withy-Allen & Hovel 2013)(Hovel et al. 2015)(Yaeger et al. 2017), or they migrate seasonally to suitable spawning habitats (Kelly 2001)(Withy-Allen & Hovel 2013).

Several different species of spiny lobster support commercial fisheries worldwide. As mentioned, this report covers the spiny lobster commercial fishery in California. The fishery in California is managed by the California Department of Fish and Wildlife (CDFW) and occurs along the Southern California Bight from Point Conception south to the Mexican border (CDFW 2016c).

The CDFW regulates the fishery through several means:

1. A harvest control rule to prevent, detect, and recover the spiny lobster population from overfishing, which is underpinned by the MLMA;
2. Minimum landing size (MLS) of 82.5 mm (3.25 in) carapace length;
3. Permit restrictions: limited entry program (capping permit numbers at 141 transferable and 53 nontransferable permit holders), permit transfer restrictions, permit limit of up to 2 per commercial fisher;
4. Gear restrictions: trap servicing requirements, lost trap requirements, trap limits of 300 per permit, buoy marking, a tag per trap;
5. Logbook requirements;
6. Spatial management: open season (early October through mid-March) and MPAs (14.6% of lobster habitat is calculated to be protected by MPAs) (CDFW 2017b).

The MLS is greater than that at which individuals reach sexual maturity, thereby ensuring the survival of

younger broodstock (Kay 2011). The MLS was first implemented in the fishery in 1901 (CDFW 2016c); however, models evaluating size at maturity (SAM) and growth include uncertainties. Also, recent studies suggest that sexual maturity may occur at a smaller size than original studies estimated (Kay 2011)(Hovel et al. 2015) or differs depending on the region (Yaeger et al. 2017)(Culver et al. 2016). As a result, recent research suggests that region-specific management would be more suited to the stock to account for differences in size distributions, sex ratios, number of recruits, and CPUE among California spiny lobster populations (Yaeger et al. 2017).

The fishery season is regulated to allow fishing from the first Wednesday in October through the first Wednesday after March 15 (CA Government 2016), to protect egg-carrying (or berried) females (CA Government 2016b) and to minimize the handling of molting (soft) animals. A recent survey of California spiny lobster (2018–20) indicated that fecundity ranges from about 300,000 to 500,000 eggs per reproductive episode for a legal-sized lobster (Hovel 2024, pers comm). In California, fecundity is typically higher in northern areas than southern ones; this contrasts with Baja California, Mexico, where southern lobsters tend to have higher fecundity than northern ones (Hovel 2024, pers comm).

CDFW requires lobster traps to have a destruct device to prevent ghost fishing in the event of trap loss, and to have escape ports to minimize the capture of undersize lobsters (Barsky 2001, pers comm). A permit system for entry into the lobster fishery was established in 1961, and a restricted access program was initiated in 1996, limiting the number of permits in the fishery to 141 transferable and 53 nontransferable permit holders (CDFW 2016c). Though not directly considered a regulation in the lobster fishery, it should be noted that several marine reserves have been established where lobster was previously fished. Specifically, in 2003, the Channel Islands National Marine Sanctuary established several no-take marine reserves at the Northern Channel Islands in the Santa Barbara Channel (Kay et al. 2012). Also, in 2010, the California Fish and Game Commission adopted regulations as part of the Marine Life Protection Act, which became effective January 1, 2012, creating a network of MPAs. Southern California, from Point Conception to the U.S.–Mexico border, contains 50 MPAs: 19 no-take state marine reserves, 10 state marine conservation no-take areas, and 21 state marine conservation areas, plus an additional 2 special closures (CDFW 2016b).

Mexico sits in the center of the California spiny lobster range (Figure 1) and the species has a long larval duration; therefore, the Mexican fishery could potentially affect the U.S. component of the California spiny lobster population. Due to the potential strong connectivity between Mexico and U.S. California spiny lobster stocks, a greater understanding is needed in the larval dispersal and recruitment processes in the California spiny lobster fishery to ensure effective management. A better understanding of population connectivity through research approaches, such as genomic analyses, will enable an increased understanding of how connectivity affects differences in size structure between areas within the fishery (Yaeger et al. 2017).

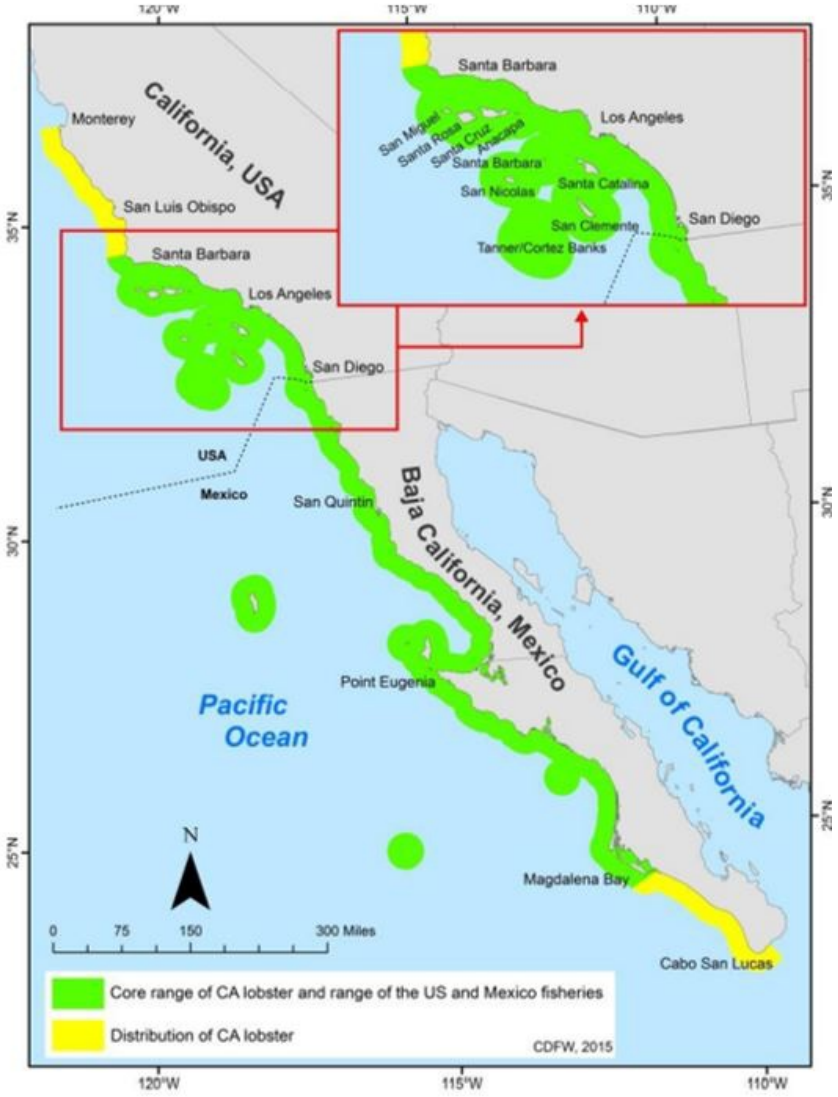

Figure 1: Primary distribution range of California spiny lobster. Note: a 20-mi buffer from the coast was used to indicate the approximate range of the species, and does not represent fine-scale distribution (CDFW 2016c).

Production Statistics

Landings from the California spiny lobster fishery have remained fairly steady since the mid-1980s (see Figure 3), with 433 MT (955,423 lb) landed during the 2022 season (NOAA 2023). The fishery is thought to be operating close to MSY (Hovel et al. 2015). All U.S. landings of California spiny lobster occur in the state of California (see Figure 2) (NOAA 2023). The United States also imports spiny lobster from Mexico, which may include California spiny lobster and Caribbean spiny lobster (*Panulirus argus*).

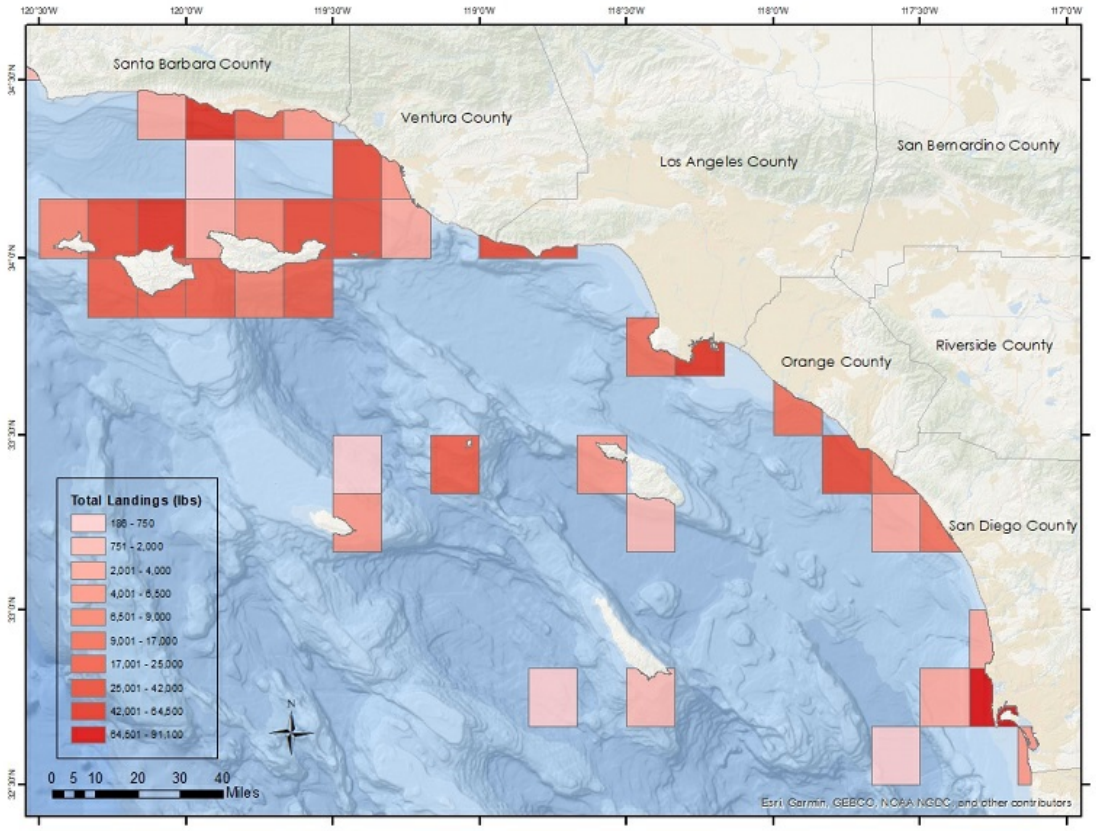

Figure 2: Map of commercial fishery landings (lb) by fishing block for the 2019–20 season (CDFW 2023).

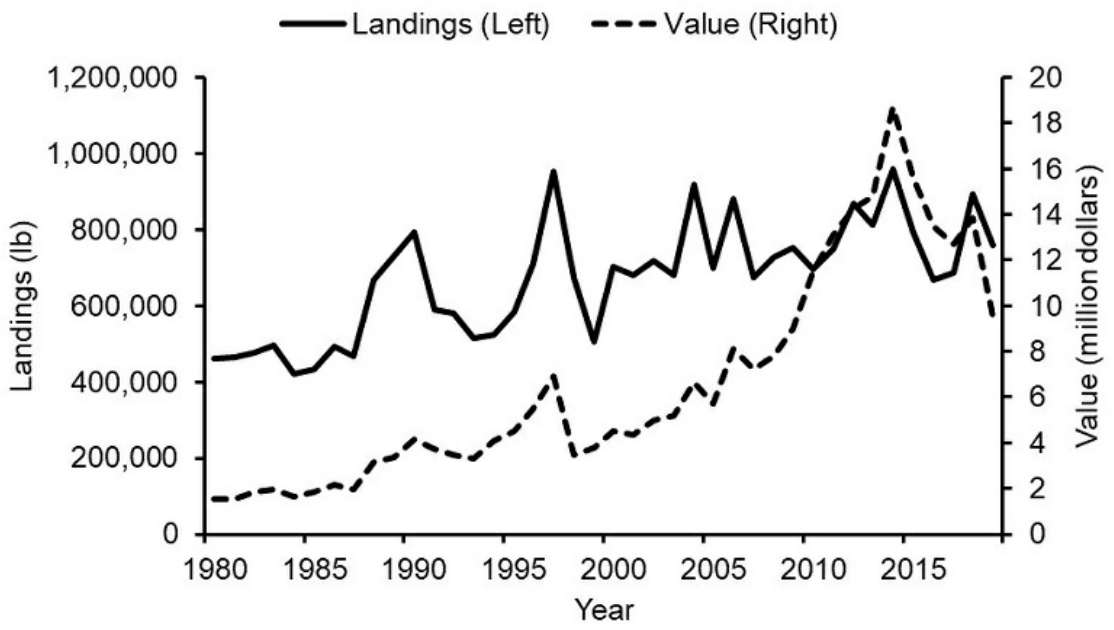

Figure 3: Spiny lobster commercial fishery landings (lb) and value (million dollars), 1980 to 2020 (CDFW 2023).

Importance to the US/North American market.

There is a lack of species-specific reporting for import and export data. For example, import databases sometimes record lobsters using the term “Lobster rock NSPF” (not specifically provided for), which does not depict the species. The ex-vessel value reached a record high of $18.12 million during the 2014–15 season, which was attributable to foreign market expansion and increasing demand (CDFW 2016c). This has increased substantially over time. The majority of the lobsters caught in California are exported and shipped live (because they cannot be tailed for market) to Asian countries, particularly China, and to a lesser extent within the United States in the last several years (LaMell 2016).

Common and market names.

Spiny lobster, in general, is also known as:

- Rock lobster
- California lobster and red lobster
- Crawfish, bug (Fishwatch 2017).

Primary product forms

California spiny lobster is marketed whole because it is illegal to tail it, and it is primarily sold live.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

CALIFORNIA SPINY LOBSTER			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | United States | California | Pots	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

The most recent stock assessment for California spiny lobster was in 2011 (Nielson 2011). The status of the stock is uncertain, though the fishery is expected to be operating close to or at MSY (Nielson 2011). The management agency considers the population at a sustainable level based on individual size, catch size, and fishing effort (Nielson 2011). Both the MLMA and the FMP agree that obtaining mortality estimates, particularly in the recreational sector, is one of the highest data priorities in the fishery because of the uncertainty around them (CDFW 2016c).

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

California spiny lobster (Panulirus interruptus)

Factor 1.1 - Abundance

Eastern Central Pacific | United States | California | Pots

Moderate Concern

The California spiny lobster fishery is considered data-limited (CDFW 2016c); therefore, the 2016 FMP uses data-limited indicators—catch per unit effort (CPUE) and catch and spawning potential ratio (SPR)—to determine abundance (CDFW 2016c). CPUE has overall declined since 2004, but has been increasing since 2011, with a larger increase from 2017 to 2020 (CDFW 2024). $CPUE_{CURRENT}$ values were below $CPUE_{THRESHOLD}$ values in the mid-2010s, which suggested negative trends; however, they increased above the threshold in recent years. Conversely, the Cable-CDFW models suggest that SPR values increased in the early 2010s, with the 2014–15 season having some of the highest values in the time series, and then decreased through 2020 (CDFW 2016c)(CDFW 2024). Despite the recent decrease in SPR, it still remains above the threshold in recent years (CDFW 2024). Modeled and observed results indicate that the population is stable (CDFW 2016c)(CDFW 2024).

The stock assessment in 2011 suggested that the fishery had potentially reached MSY (Nielson 2011); however, this assessment is more than 10 years old. Further research is required to better understand diverging trends among data-limited indicators. Because data-limited indicators show conflicting results for abundance, and the productivity-susceptibility analysis (PSA) deems California spiny lobster to have a medium vulnerability, Seafood Watch deems abundance a moderate concern.

Justification:

The most recent stock assessment (2011) suggested that biomass was relatively stable during the 2000s (Nielson 2011). CPUE increased throughout the 2000s, but was still mostly lower compared to CPUE values from the previous two to three decades (Nielson 2011). This, coupled with the stable landings at the time (Nielson 2011), suggested that overall abundance was stable.

Since the 2011 stock assessment, the 2016 FMP stated that fishers have claimed that they are catching less with more effort (CDFW 2016c). The $CPUE_{THRESHOLD}$ values are calculated as average CPUE levels for the 3 most recent seasons divided by average CPUE for the 10 most recent seasons to create a CPUE-based threshold, to which the annual CPUE reference point is compared. Between 2004 and 2011, landings increased while CPUE decreased. CPUE generally increased from 2010 to 2016 (CDFW 2016c) and then significantly more from 2017 to 2020 (CDFW 2024). The final FMP HCRs require that an investigation be initiated if $CPUE_{CURRENT}$ drops below the $CPUE_{THRESHOLD}$, or if $CPUE_{CURRENT}$ decreases for six consecutive years.

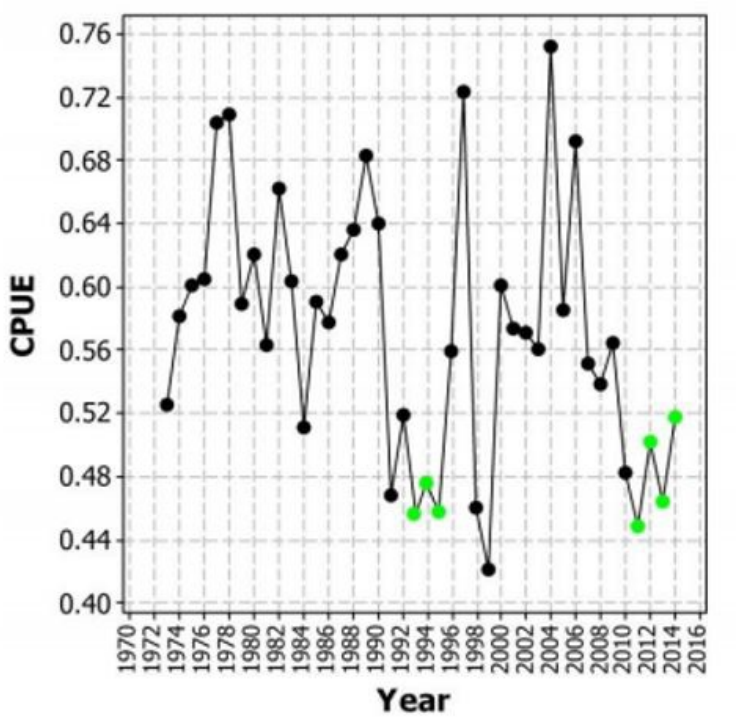

Figure 4: Catch per unit effort (CPUE) in the California spiny lobster fishery (CDFW 2016c).

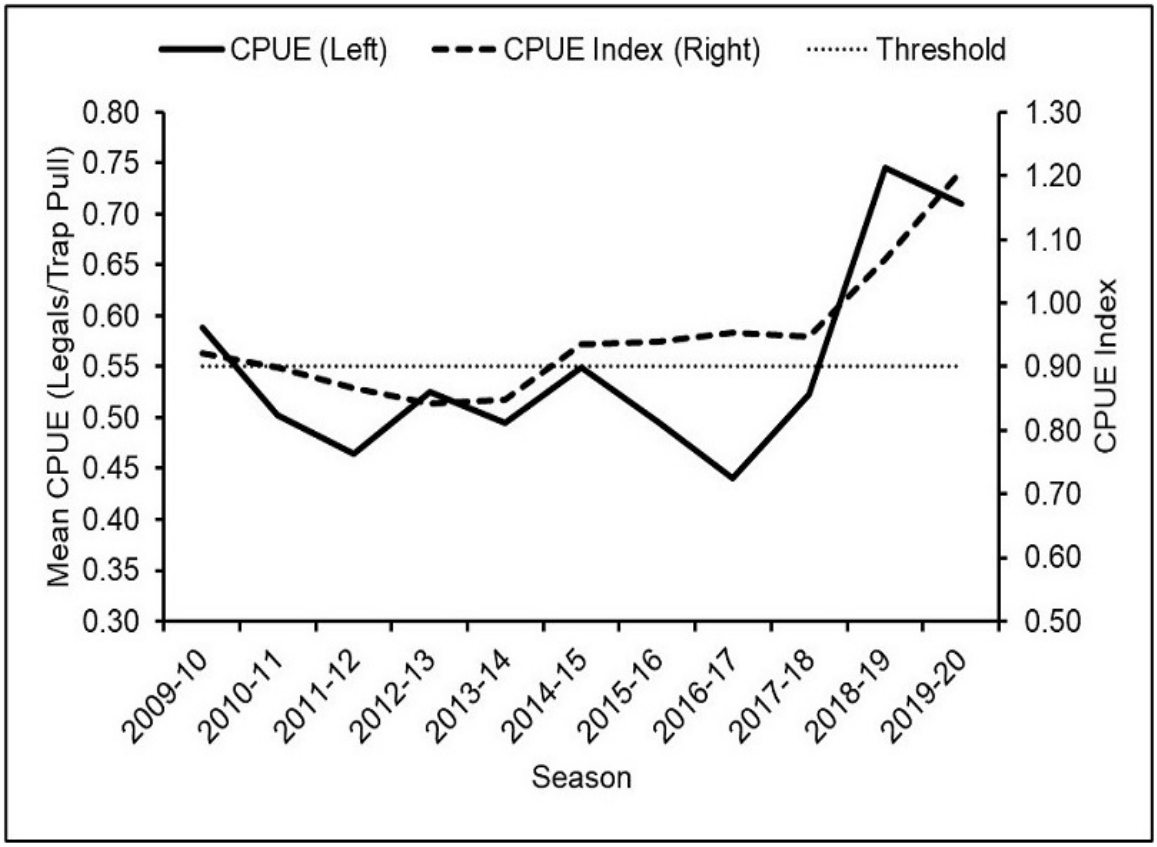

Figure 5: Lobster CPUE and CPUE Index from 2009 to 2020 (CDFW 2024).

Yaeger et al. (2017) showed that the weight of lobster across all regions had remained stable, which denotes a positive data-limited indicator outcome (Yaeger et al. 2017). The Collaborative At-Sea Sampling Program (CASP) showed similar trends to CDFW data among mean legal-sized lobster CPUE and weight datasets (Culver et al. 2016).

The FMP showed that SPR values had increased in the early 2010s because of an increasing trend in average weight of spiny lobster. The 2014–15 fishing season had its highest average weight since observations began (in 2000) (CDFW 2016c). The SPR then began decreasing through 2020, although it has remained above the threshold (CDFW 2024).

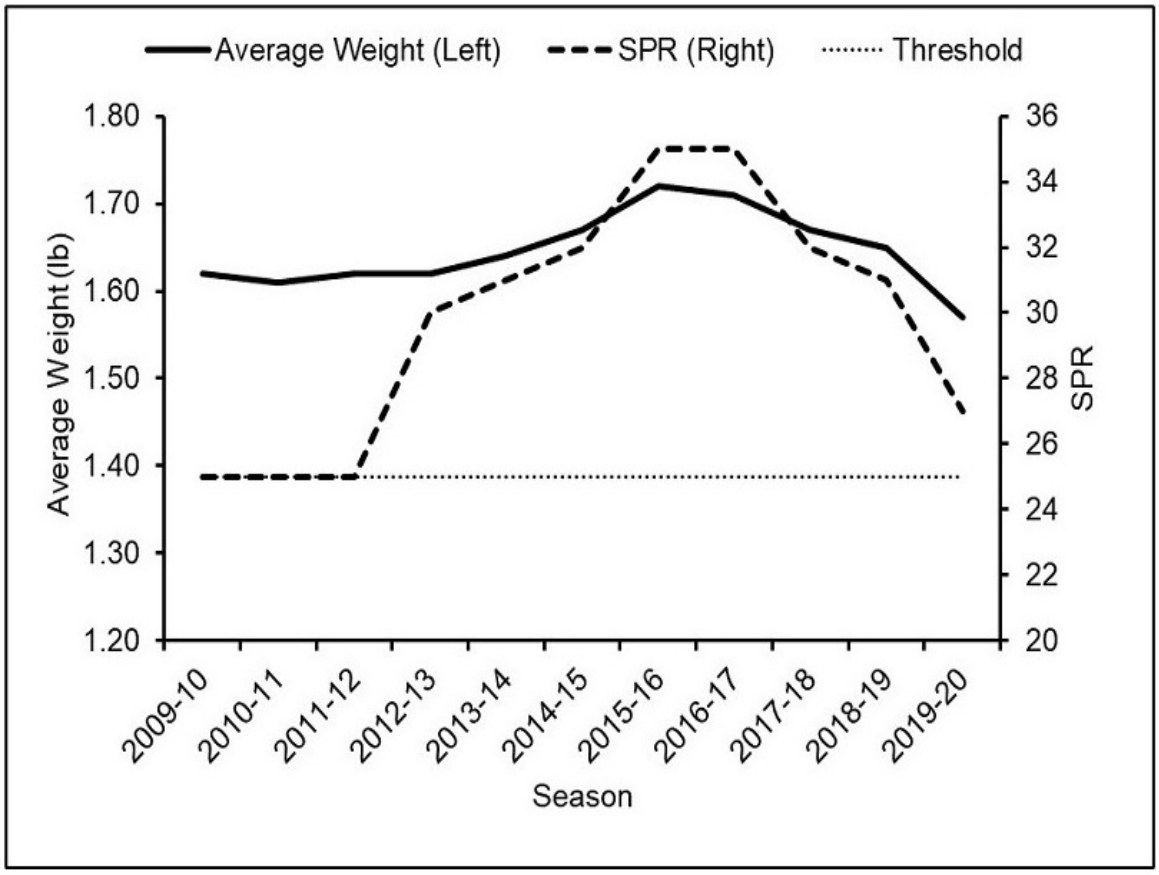

Figure 6: Lobster average weight and SPR index from 2009 to 2020 (CDFW 2024).

The abundance of different cohorts of lobster and reproductive capacity vary regionally. Yaeger et al. (2017) found high levels of recruits in the south of the fishery (between San Diego and Dana Point, including San Clemente and Catalina Islands); this was not observed in the north or northwest islands. The reasons may be environmental: the south has warmer waters, which are more conducive to lobster settlement, thus promoting increased recruitment (Yaeger et al. 2017). The south also has greater egg production than the north or the northwest islands, because the sublegal lobster population contributed substantially to egg production (Culver et al. 2016).

Abundance varies significantly with climate patterns: during El Niño and the Pacific Decadal Oscillation (PDO), when mean SST increases, lobster larval abundance also increases (Koslow et al. 2012). Long-term landing data have agreed with these results, which have positively correlated during El Niño Southern Oscillation Index since the mid-1990s (Nielson 2011).

Productivity

Productivity Attribute		Score	Source
Average age at maturity	5.275	2	Average value from table 3-2 in CDFW 2016c
Average max age	30-50 years.	3	Neilson 2011
Fecundity	5,000 – 500,000	1	Johnson 1956
Reproductive strategy	Brooder	2	CDFG 2001
Trophic Level	~3	2	Behringer and Butler 2006
Density Dependence	Depensatory dependence based on the Allee effect	3	Gascoigne and Lipcius 2004
Total Score		13	
Average		13/6 = 2.17	

Susceptibility

Susceptibility Attribute		Score	Source
Areal overlap	Default scores	3	
Vertical overlap	The spiny lobster fishery normally occurs in less than 100 ft water	3	CDFW 2016c
Selectivity of gear type Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught, b. Individuals < half the size at maturity can escape or avoid gear	2	The bycatch study found that the traps catch a high proportion of individuals < SAM, however, escape ports allow for individuals to leave the traps.
Post-capture mortality (PCM) The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Retained species, however the majority of the catch is undersized and returned with a high likelihood of survival.	2	Nielson 2011

Key relevant information:
Productivity (P) Score = 2.17
Susceptibility (S) Score = [((3x3x2x2)-1)/40]+1 = 1.875

Vulnerability (V) Score = $\sqrt{(P^2 + S^2)}$ = 2.869
This equates to a medium vulnerability score.

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | United States | California | Pots

Moderate Concern

Fishing mortality is uncertain because components of overall mortality, including post-release mortality of sub-legal lobsters and the effects of climatic events such as El Niño and La Niña, are unknown. Data are lacking in regard to the recreational fishing mortality rates (Yaeger et al. 2017).

An age-structured fisheries simulation model (FISMO) suggested that F fluctuates around or above F_{MSY} (Nielson 2011), although at the time of the stock assessment, this model was not considered a reliable proxy for F_{MSY} (CDFG 2011a). The catch-based reference point ($Catch_{THRESHOLD}$) indicates that $Catch_{CURRENT}$ is stable and above the reference point (CDFW 2016c); however, landings generally increased through the early to mid-2010s (CDFW 2016c).

Because of the high level of uncertainty and the low level of data availability associated with fishing mortality, Seafood Watch considers fishing mortality a moderate concern.

Justification:
Since the 1800s, there has been a commercial spiny lobster trap fishery along the southern California coast. Toward the end of the 1880s, landings started to decline until the fishery collapsed, forcing a two-year closure of the fishery in 1909 to 1910 (CDFG 2003). When the fishery reopened (in 1911), the stock once again appeared abundant. From then until World War II, landings remained between 200,000 and 400,000 lb (90,718 to 181,437 kg) (CDFG 2003). During World War II, landings began to rise and peaked after the war at 1.05 million lb (0.48 million kg). Landings began to decline for the next 25 years, reaching a low in 1974–75 (Nielson 2011). In the 2000s, the commercial fishery landed averages of 660,000 lb (299,371 kg) per season (Nielson 2011). More recently, increases in landings have been observed, with a peak at 951,435 lb (431,564 kg) in 2014 (NOAA 2016). The fluctuation of landings is attributable to a number of factors including market demand and price (CDFW 2016c).

The latest stock assessment (2011) revealed that the recent recreational fishing effort is leading to an overall fishing mortality that, at times, exceeded the estimated F_{MSY} levels in the Fisheries Simulation Model (Nielson 2011). But, F_{MSY} has not been defined for the California spiny lobster fishery because there is disagreement and uncertainty in models, creating difficulties when trying to determine the appropriate level for F_{MSY} (CDFW 2016c). Proxy reference points have been used in the absence of F_{MSY} in the 2016 FMP. Catches over the last 3 years are similar to those over the last 10 years. $Catch_{CURRENT}$ (1.1) is above the reference point $Catch_{THRESHOLD}$ (0.9). When $Catch_{CURRENT}$ is around 1, catches are considered stable. When the threshold is breached (defined as when the catches fall below the threshold 0.9), management is triggered. The reference point is dynamic because it is based on the ratio of the average catch rate over 3 years toward the previous 10 years. The dynamic reference point is unable to detect small gradual changes or a reduction caused by environmental variability; therefore, CDFW will observe $Catch_{CURRENT}$ values and implement further management when the catch reference falls below 0.9 (CDFW 2016c).

The Cable-CDFW model suggests that there is a higher F rate in the south of the fishery, associated with lower SPR values. This is either because southern California spiny lobsters reach the legal size faster, and therefore are caught more quickly than in other regions, or there is a higher abundance of sublegal California spiny lobsters in the south due to higher recruitment levels (CDFW 2016c).

Uncertainty in fishing mortality occurs from various sources: the California spiny lobster landings appear to be influenced by temperature changes associated with the PDO and La Niña/El Niño

systems (Nielson 2011), but this is not fully understood and is difficult to predict. The recreational fishing mortality estimates host uncertainty, and there is a lack of data available about post-capture mortality of sublegal lobsters (CDFW 2016c). Because of the high level of uncertainty in fishing mortality, its relevance in modeling, and the limited availability in accurate data, it is outlined as one of the highest research priorities for data collection (CDFW 2016c).

Estimates of post-capture mortality vary: in the California spiny lobster fishery, post-capture mortality is unknown but assumed to be “very low” (Hovel 2017, pers comm). In similar spiny lobster fisheries, when lobsters were handled for short handling times, survival rates were estimated at 88% (DiNardo & DeMartini 2002). But, studies in spiny lobster fisheries in Florida have shown that mortality rates can increase due to injury during or after handling (Parsons & Eggleston 2005). Spiny lobster is susceptible to handling stress or unintentional damage to its antennae or legs—as demonstrated in Australian western rock lobster (*Panulirus cygnus*) studies—thereby decreasing fecundity and increasing uncertainty in mortality rates (Melville-Smith & de Lestang 2006). This is particularly important because sublegal size lobster bycatch has increased (commercial fishing logs CDFW data) and is substantial in the southern part of the fishery (Yaeger et al. 2017).

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

CALIFORNIA SPINY LOBSTER			
REGION / METHOD	SUB SCORE	DISCARD RATE/LANDINGS	SCORE
Eastern Central Pacific | United States | California | Pots	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

EASTERN CENTRAL PACIFIC | UNITED STATES | CALIFORNIA | POTS			
SUB SCORE: 1.000	DISCARD RATE: 1.000	SCORE: 1.000	
SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Humpback whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Kellet's whelk	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Bottlenose dolphin	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
California spiny lobster	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Gray whale	3.670: Low Concern	5.000: Low Concern	Green (4.284)

Species considered in Criterion 2 are those that are either endangered, threatened, or protected (ETP) species, Category II species, and/or the species that represented >5% of the catch. Species were considered ETP species if they were listed under the Endangered Species Act or as ETP species on the International Union for the Conservation of Nature (IUCN) website. Other data sources that were used to inform the bycatch included independent bycatch studies.

Bycatch levels of the commercial and recreational lobster fisheries are not considered to have unacceptable impacts on the population (CDFW 2016c). Supplemental information collected during a collaborative at-sea sampling program (in the commercial fishery in 2013) indicated that bycatch mainly comprised sublegal-sized California spiny lobster (83.29%) and Kellet's whelk (*Kelletia kelletii*) (5.98%) (Culver et al. unpublished data (CDFW 2016c)). Undersized lobsters are considered in Criterion 1 as part of the assessment of the impact of the fishery on the spiny lobster stock. Kellet's whelk can be landed and supports its own commercial fishery (CDFW 2016c).

Southern sea otter and California sea lion have been considered part of the bycatch under SFW criteria because they have been noted as potentially being affected by this fishery on the 2023 MMPA List of Fisheries; however, it is not likely that current fishing patterns pose a risk to either population in the California spiny lobster fishery, so they are not discussed further. Likewise, three species of cormorant—Brandt's,

pelagic, and double-crested (double-crested cormorant is protected by the Migratory Bird Act (US Fish and Wildlife Service 2015))—occur in the region, particularly around the Channel Islands, and have the potential to interact with the California lobster fishery (Cornell University 2023). But the FMP suggests that there are no known interactions between the lobster fishery and cormorants (CDFW 2016c), so these species are not considered further.

Traps are known to interact with finfish. Moray eel has been observed to be captured in traps in research studies, albeit infrequently (Hovel 2017, pers comm). Because traps present minimal impacts to non-invertebrate species, only selected and managed species may be taken by vessels with lobster permits (CDFW 2017c)(CA Government 2016). Traps have escape panels (CDFW 2017b) and must be checked regularly (CDFW 2017b), so the impact on finfish will not be assessed.

The California spiny lobster fishery was recently reclassified as a Category II fishery, based on interactions with the CA/OR/WA offshore population of bottlenose dolphin (NOAA 2017). Interactions between pot fisheries and cetaceans are a growing concern along the U.S. West Coast. Most entanglements occur in the Dungeness crab fishery (Lawson 2015), and entanglement is rare in the California spiny lobster fishery; however, entanglements have been reported in lobster gear and unidentified gear in the region. From 2016 to 2020, there were 65 cases of unidentified fishery interactions (in California, Oregon, and Washington commercial fisheries) leading to mortality or serious injury to whales either identified as humpback or prorated to humpback (Carretta et al. 2023). There were 13 cases attributed to unidentified pot/trap fishery interactions (Carretta et al. 2023).

There is a lack of data regarding ghost fishing impacts in California. SeaDoc divers collected around 82 ghost traps (of unknown fishery origin) around Anacapa Island in 2006, and this has generally decreased over time, with the most recent findings showing 29 traps (of unknown fishery origin) in 2013 (Hogan 2016, pers comm). In the Mexican fishery, Shester (2008) claimed that ghost fishing is not a concern because the traps have destruct devices, which limit the damage to the marine environment (Shester 2008).

For the California spiny lobster trap fishery in California, humpback whale limits the score for Criterion 2 because of its conservation status.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Bottlenose dolphin (Tursiops truncatus)

Factor 2.1 - Abundance

Eastern Central Pacific | United States | California | Pots

High Concern

Two stocks of bottlenose dolphin are found off the coast of California and may potentially interact with this fishery: the California coastal stock and the California-Oregon-Washington Offshore Stock.

The best estimate available for abundance for the California coastal stock is 453 individuals (CV = 0.06) (Carretta et al. 2023). The status of this stock relative to the optimum sustainable population (OSP) is unknown and there is no evidence of a trend in abundance (Carretta et al. 2023). It is not listed as “Threatened” or “Endangered” under the Endangered Species Act nor listed as “Depleted” or classified as a “Strategic” stock under the MMPA (Carretta et al. 2023).

The best estimate available for abundance for the California-Oregon-Washington offshore stock is 3,477 individuals (CV = 0.696) (Carretta et al. 2023). The status of this stock relative to the OSP is unknown, and there is no evidence of a trend in abundance (Carretta et al. 2023). It is not listed as “Threatened” or “Endangered” under the Endangered Species Act nor listed as “Depleted” or classified as a “Strategic” stock under the MMPA (Carretta et al. 2023).

Because the population sizes are unknown relative to a sustainable level and marine mammals are considered highly vulnerable to fishing activities, Seafood Watch deems abundance a high concern.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | United States | California | Pots

Low Concern

Two stock of bottlenose dolphin are found off the coast of California and may potentially interact with this fishery: the California coastal stock and the California-Oregon-Washington Offshore Stock.

The potential biological removal (PBR) for the California coastal stock is estimated as 2.7 dolphins per year (Carretta et al. 2023). Two strandings with evidence of entanglement in rope or braided material from unidentified fisheries were documented between 2010-2014 (Carretta et al. 2023). After including a correction factor for non-detection of most stranded dolphins, the estimated annual bycatch from all commercial fisheries that might interact with this species is at least 1.6 per year (CV=0.46), which is less than PBR (2.7) (Carretta et al. 2023).

The potential biological removal (PBR) for the California-Oregon-Washington offshore stock is estimated as 19.7 dolphins per year (Carretta et al. 2023). The estimated annual bycatch from all commercial fisheries that might interact with this species is at least 0.82 per year (CV=0.52), which is less than PBR (19.7) (Carretta et al. 2023).

The California spiny lobster fishery's contribution to bottlenose dolphin fishing mortality is unknown,

although the estimated mortality and serious injury from commercial fisheries in the region is estimated to be below PBR for both the California coastal and the California-Oregon-Washington offshore stocks. Therefore, Seafood Watch deems fishing mortality as a “low concern."

Gray whale (Eschrichtius robustus)

Factor 2.1 - Abundance

Eastern Central Pacific | United States | California | Pots

Low Concern

The Eastern North Pacific stock of gray whale has a minimum population estimate of 25,849 individuals and is not classified as a strategic stock (Carretta et al. 2023). The population was removed from ESA listing in 1994 and has been considered stable over the past few decades. But, Eastern North Pacific gray whale has been experiencing an unusual mortality event beginning in 2019, likely from nutritional stress, that is proving to be similar to the previous unusual mortality event of 1999–2000, which was an acute, short-term event that the population recovered from (Carretta et al. 2023).

There are a minimum of 227 individuals in the Pacific Coast Feeding Group (PCFG), a distinct feeding aggregation defined as those feeding between northern California and northern British Columbia in the summer and fall. The status of this group as a distinct population stock is uncertain, because genetic studies indicate matrilineal fidelity (significant differences in mtDNA haplotype frequencies between groups) but with a suggestion of interbreeding with individuals from other feeding grounds (no significant nuclear differences between groups) (Carretta et al. 2023)(Lang et al 2017). The National Marine Fisheries Service considers a stock to be demographically distinct if population dynamics are a consequence of internal dynamics (births and deaths) rather than external dynamics (immigration and emigration). Insufficient data are available to determine if the PCFG meets these criteria, because it is plausible that the PCFG is a demographically independent group; however, external immigration into the group may also be taking place. The abundance estimates of the PCFG subpopulation have increased in somewhat recent years (2011 to 2015), but the population status relative to reference points is unknown.

Because of a recent stock assessment with indications that the stock is within range of its OSP, but with some uncertainty regarding the health of the PCFG sub-population, stock status is considered a low concern.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | United States | California | Pots

Low Concern

The PBR for the Eastern Northern Pacific stock of gray whale is calculated to be 801 whales per year (this includes the Pacific Coast Feeding Group individuals). Between 2014 and 2018, no mortality or serious injury to gray whales were attributed directly to the California spiny lobster fishery; however, some instances were documented with unidentified commercial fishing gear (Carretta et al. 2023).

During this 5-year period, there were 4.75 instances of mortality or serious injury attributed to unidentified pot/trap gear, 18.25 instances attributed to unidentified fishery interactions involving gray whale, and 2.9 instances attributed to unidentified fishery interactions involving unidentified whales prorated to gray whale (Carretta et al. 2023). This resulted in 25.9 instances of gray whale mortality or serious injury that could potentially have been due to the California spiny lobster fishery between 2014 and 2018, or 5.18 whales per year. This is substantially lower than the calculated PBR of 801 whales per year, therefore warranting a score of low concern.

Humpback whale (Megaptera novaeangliae)

Factor 2.1 - Abundance

Eastern Central Pacific | United States | California | Pots

High Concern

The Central America/Southern Mexico-CA-OR-WA stock of humpback whale is a Demographically Independent Population (DIP) delineated from the Central America DPS, which is listed as "Endangered" under the ESA and considered "Depleted" and "Strategic" under the MMPA. The stock is estimated to have grown around 1.6% annually since 2004, although there is high uncertainty in this estimate. According to the stock assessment, the best estimate for population size for the Central America/Southern Mexico-CA-OR-WA stock is 1,496 whales (CV = 0.171) (Carretta et al. 2023).

The Mainland Mexico-CA-OR-WA stock of humpback whale is a Demographically Independent Population (DIP) delineated from the Mexico DPS, which is listed as "Threatened" under the ESA and considered "Depleted" and "Strategic" under the MMPA. There is currently no direct estimate of population trend for this stock. The best estimate for population size for the Mexico-CA-OR-WA stock is 3,477 whales (CV = 0.101) (Carretta et al. 2023).

Both stocks of humpback whale in the region of this fishery are of concern and have been determined to be endangered or threatened. Therefore, abundance of humpback whale is considered a high concern.

Justification:

Humpback whale has been listed as "Endangered" under the ESA since 1970 (81 Federal Register 6225). In 2016, NOAA fisheries revised the ESA listing to identify 14 Distinct Population Segments (DPS); the whales in California waters are part of the Mexico DPS and the Central America DPS. At this time, four DPS were determined to be "Endangered" (Cape Verde/Northwest Africa, Western North Pacific, Central America, and Arabian Sea). The Mexico DPS was determined "Threatened," while the remaining nine DPS were determined "Not at Risk" (81 Federal Register 6225). The most recent humpback whale stock assessment report, published in 2023, transitioned the stock delineation to be based on Demographically Independent Populations (DIPs) (Carretta et al. 2023). The evaluations of the four North Pacific DPS resulted in three DIPs and four "units" that may contain multiple DIPs as well as five stocks from these delineations. The Central America-CA-OR-WA DIP, also considered the Central America/Southern Mexico-CA-OR-WA stock, is listed as "Endangered" under the ESA. The Mainland Mexico-CA-OR-WA DIP, or the Mainland Mexico-CA-OR-WA stock, is

listed as “Threatened” under the ESA. Genetics and movement data resulted in the delineation of these two DIPs/stocks. The Mexico-North Pacific unit/stock may also contain other DIPs based on movement data, but data are limited so it is considered a separate stock.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | United States | California | Pots

High Concern

There were 13 cases of humpback whale mortality and serious injury documented in California, Oregon, and Washington commercial fisheries from 2016 to 2020 due to unidentified pot/trap fishery gear entanglement, although this is not attributed directly to this fishery {Caretta et al. 2023}. There were also 58 cases attributed to unidentified fishery interactions with whales identified as humpback and an additional 7 cases of unidentified fishery interactions with unidentified whales prorated to humpback {Caretta et al. 2023}. This totals 78 cases of mortality and serious injury from 2016 to 2020 that were potentially caused by this fishery, or an average of 15.6 whales per year. Although this risk of 15.6 whales per year does not exceed the calculated annual PBR (43) of the Mainland Mexico-CA-OR-WA stock, it greatly exceeds the Central America/Southern Mexico-CA-OR-WA stock’s annual PBR of 3.5.

There is some uncertainty regarding which stock that each case identified here is associated with; however, the 2022 U.S. Pacific Marine Mammal Stock Assessment prorated the impact of fisheries across the different DPIs based on point estimates of summer and winter movements. As a result, the annual estimated mortality and serious injury rate (2016–20) from fisheries to the Central America/Southern Mexico-CA-OR-WA DPI is 8.1 per year—still exceeding PBR for this stock {Caretta et al. 2023}.

Mortalities from 2016 to 2020 increased when compared to the previous 5-year period (2012–16), suggesting that total fishery impacts on humpback whale are increasing (Carretta et al. 2023). Because this fishery’s contribution is unknown and PBR is being exceeded for one of the stocks present in this fishery’s range, fishing mortality is considered a high concern in the California spiny lobster fishery.

Kellet's whelk (Kelletia kelletii)

Factor 2.1 - Abundance

Eastern Central Pacific | United States | California | Pots

High Concern

The abundance of Kellet’s whelk is unknown relative to reference points, and there are no data-limited indicators to determine trends in abundance. In the absence of these data, a productivity-susceptibility analysis (PSA) has been used to assess the vulnerability of the species. Because the PSA deems Kellet’s whelk to be of high vulnerability, abundance warrants a score of high concern.

Justification:

There are ongoing studies to determine the abundance of Kellet's whelk (White 2018, pers comm). Recent studies have collected data on size-frequency and recruitment of Kellet's whelk in areas surrounding the Channel Islands. Results suggest that El Niño drives recruitment in the species' expanded range (on the California coast). This information has not been used to denote trends in the populations because the time series is too short and the results have not been compared to previous years to determine whether populations are at healthy levels (Lippert et al. 2017).

Productivity-Susceptibility Analysis

Kellet's whelk is deemed to have high vulnerability, scored 3.235.

Productivity Attribute		Score	Source
Average age at maturity	8.05	2	Inferred from calculations (see Appendix A)
Average max age	>25	3	Inferred from calculations (see Appendix A)
Fecundity	400 and 1200 eggs	2	CDFG 2010
Reproductive strategy	Demersal egg layer	2	Romero et al. 2012
Trophic Level	Unknown		
Density Dependence	Unknown		
Total Score		9	
Average		2.25	

Susceptibility

Susceptibility Attribute		Score	Source
Areal overlap	Default scores as the current information is unavailable.	3	N/A
Vertical overlap	High degree of overlap as Kellet's Whelk occur between 0-230 ft whilst lobster traps fish in depths of less than 100 ft	3	(SIMoN 2016) (CDFW 2016c)
Selectivity of gear type	Not targeted, bycatch species. There is no minimum landing size (CDFG 2010)(but there are escape ports in the traps that allow Kellet's whelk to escape	2	(14 CCR § 127; FGC § 8250) (CDFW 2016c)
Post-capture mortality (PCM)	Can be retained.	3	(14 CCR § 127; FGC § 8250)

Key relevant information:
Productivity (P) Score = 2.25
Susceptibility (S) Score = [((3 x 3 x 2 x 3) - 1)/ 40] +1 = 2.325

Vulnerability (V) Score = $\sqrt{P^2 + S^2}$ = 3.235
This equates to a high vulnerability score.

The supplemental data collected in 2013 indicated that only one species other than lobster composed more than 5% of bycatch: Kellet's whelk, at 5.98% (Culver et al. unpublished data (CDFW 2016c)). The increased landings of the species, coupled with its low fecundity, slow growth, and

aggregative feeding behavior, have raised concerns in the commercial fishery (SIMoN 2016). There is no recent stock assessment for the species; the most recent stock assessment was in 1995 and found that the stock status was stable, and recent information suggests that the stock has remained stable through the 2010s since the implementation of a total allowable catch (CDFW 2020). But, studies determining abundance and connectivity are ongoing (White 2018, pers comm). Kellet's whelk is normally found between central Baja California, Mexico and Monterey, California (CDFW 2020). The Kellet's whelk fishery has been considered an emerging fishery since 2011, although the commercial fishery is primarily an incidental fishery to spiny lobster and other fisheries in Southern California (CDFW 2020)(White 2018, pers comm). An emerging fishery is defined as one for which "the existing regulations are not sufficient to insure a stable, sustainable fishery" (CDFG 2011b).

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | United States | California | Pots

Moderate Concern

Most of the harvested Kellet's whelk have been caught incidentally in lobster and crab traps (CDFG 2011b). Fishers can retain Kellet's whelk; however, landings are limited by total allowable catch (TAC) (CA Government 2016). Landings are required to be reported for California state waters. Landings were recorded at around 42,000 lb in 2000, had increased to 150,000 lb by 2010, had declined to around 60,000 lb by 2012 (when a commercial TAC was implemented), and have since fluctuated between 60,000 and 96,000 lb (CDFW 2020). The TAC is 100,000 lb (CDFW 2017c); however, the California spiny lobster fishery's contribution to fishing mortality is unknown, therefore warranting a score of moderate concern.

Factor 2.3 - Discard Rate/Landings

Eastern Central Pacific | United States | California | Pots

< 100%

Neither discard, discard mortality rates, nor bait use is recorded in the fishery; however, it is assumed that discards are around 15%, based on a study in a similar fishery (Shester & Micheli 2011). Considering that the majority of discards are undersized lobsters that are returned alive, and that bait is typically in the form of processing scraps or carcasses, bait use and discards are considered less than 100% of the volume landed, so a modifying score of 1 is given.

Justification:
Discards

There are no finalized discard rates available for the California spiny lobster fishery that account for handling mortality or post-release mortality. But, Nielson (2011) stated that retained lobster accounts for 23 to 30% of the total lobster caught. Fishery-dependent data showed that around 70% of the catch is short (Nielson 2011). Sublegal-sized lobsters make up the largest portion of discards by numbers in this fishery (Mason 2024, pers comm).

In the California commercial spiny lobster fishery, traps are serviced immediately, one at a time, so it is assumed that all handling of undersized lobster and other bycatch is significantly less than 1 hour—most likely a small fraction of an hour (Buck 2018, pers comm). Survival is likely to be high when lobster is quickly returned to the water (CDFW 2016c). In similar spiny lobster fisheries with short handling times, survival rates were estimated at 88% (DiNardo & DeMartini 2002). If around 70% of the catch is short and 88% survive, dead discards represent around 8% of the total spiny lobster catch. Shester and Micheli (2011) suggest that total bycatch rates for the Mexico spiny lobster trap fisheries are 15% (Shester & Micheli 2011).

Bait

The bait use in the California spiny lobster fishery has not been quantified; however, bait use is generally quite large in trap fisheries. Studies from other lobster fisheries globally have shown that the volumes of bait used regularly exceed the volume of the target species landed (Harnish & Willison 2009)(Waddington & Meeuwig 2009)(SCS 2011).

But in the California spiny lobster fishery, many fishers have arrangements with local fish processors and often use the scraps and carcasses provided post-processing (Mason 2024, pers comm). In the Mexican Baja spiny lobster fishery, incidental fish caught are often used as bait, including barred sand bass (*Paralabrax nebulifer*) and ocean whitefish (*Caulolatilus princeps*). Such practice is not permitted in California: only crab—other than Dungeness crab (*Metacarcinus magister*), Kellet's whelk, and octopus—may be taken by vessels with lobster permits. All other species must be returned to the water (CDFW 2017c)(CA Government 2016).

Because a large portion of the bait used in this fishery is processing scraps, bait use is likely less than 100% of the volume landed.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Eastern Central Pacific | United States | California | Pots	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

California spiny lobster populations are protected commercially through biological regulations (size limits, specific seasons to protect breeding females), effort-based regulations (permit limits), and gear modifications (CDFW 2017c)(CA Government 2016b). The numerous area closures associated with marine reserves may be providing additional measures of protection for this fishery. Although limited, there have

been recent efforts to collect data on the California spiny lobster population (CDFW 2016c), and there are a variety of enforcement and stakeholder inclusion methods being implemented.

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation
Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy
Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring
Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations
Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion
Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Eastern Central Pacific | United States | California | Pots

Moderately Effective

The fishery is managed as a single-stock fishery and has some effective management in place to protect brood stocks and juveniles. There is a permit limit, and trap limits of 300 traps per permit have been implemented in the 2017–18 season (CDFW 2017c). There are no catch limits, such as TACs, in place. The 2016 FMP has advised that once reference point thresholds are breached, a TAC is one of the eight control-rule toolbox options that can be implemented (CDFW 2016c). The current abundance indices include CPUE and catch data; although a large amount of data are available, it is not an accurate indicator of abundance, creating uncertainty. Therefore, manipulated CPUE indices have been adopted to ensure that models are more sensitive to changes in abundance (CDFW 2016c). The HCR considers the precautionary approach. For example, increased management is executed when the stock breaches pre-selected reference points (CDFW 2016c). Some uncertainty is recognized (for example, environmental variability caused by El Niño and PDO). But, it is unclear how management accounts for uncertainty from poaching or uncertainty in unreturned report cards (CDFW 2016c). It is also estimated that 14.6% of spiny lobster habitat is protected by the network of marine protected areas in state waters (CDFW 2019).

Kellet's whelk is also retained in this fishery, but it is not a species of concern and is managed through a commercial TAC (CDFW 2017c).

Because a suite of management measures that are expected to be effective has been implemented in the fishery for the main targeted and retained species but the effectiveness is unknown, management strategy and implementation gains a moderately effective score.

Justification:

The goal of the FMP is to "formalize a management strategy that can respond effectively to changes in the California lobster fisheries pursuant to the tenets of the MLMA" and the primary goal is sustainability, defined by:

1. "Continuous replacement of resources, taking into account fluctuations in abundance and environmental variability."
2. "Securing the fullest possible range of present and long-term economic, social, and ecological benefits, maintaining biological diversity, and, in the case of fishery management based on maximum sustainable yield, taking in a fishery that does not exceed optimum yield" (CA Government 2016c).

To date, most changes in the management and regulation of the fishery have occurred as a reaction to declines in the landings (see Criterion 1.2). Landings have generally fluctuated at ≈350 MT (700,000 lb) since the turn of the century, but have increased since 2010: landings in 2014–15 were the third highest in the time series, associated with high ex-vessel prices (see Figure 2 in the Introduction). Similarly, commercial fishing effort—based on the number of trap pulls—has been

increasing in recent years (CDFW 2016c), which has been associated with high market prices (Yaeger et al. 2017).

Currently, the CDFW regulates the fishery through a minimum size limit of 82.55 mm (3.25 in) carapace length, a regulated fishing season (from the first Wednesday in October through the first Wednesday on or after March 15 (§8251) (CA Government 2016) to protect egg-carrying (or berried) females and molting individuals, gear restrictions (destruct devices and escape ports), trap limits, and a limited-entry system through lobster operator permits (LOP). Each trap must be tagged, and 300 trap tags can be allocated for each LOP. Commercial fishers may hold up to two LOPs (CDFW 2017c). There are no total catch limits for the fishery. Lobster traps are required to have a minimum of one escape port, measuring 6.05 × 29.21 cm (2.38 × 11.5 in), to minimize the capture of undersize lobsters (CDFG 2003). Traps are required to have a destruct device to ensure that lost and/or abandoned traps do not continue to fish indiscriminately (CDFG 2003).

Significant improvements have been implemented in fishery management through the introduction of the 2016 FMP, particularly through the implementation of a harvest control rule (HCR). The main changes are the introduction of reference points using population indicators (CPUE and catch-based reference points). These reference points are implemented to be more robust and sensitive to reveal population declines more quickly, allowing for reactive management (California Ocean Science Trust 2015). Therefore, the new HCRs use averaged CPUE values and a CPUE threshold, allowing the abundance index to become more sensitive to changes in abundance. The FMP has advised that, in the case where reference point thresholds are breached, a control rule toolbox (consisting of the following measures) should be instigated (CDFW 2016c):

1. Change in commercial trap limit
2. Change in recreational bag limit
3. TAC
4. District closures
5. Change in season length
6. Change the minimum size limit
7. Impose a maximum size limit
8. Sex-selective fishery (male-only fishery or female-specific size restriction).

The FMP has collated scientific evidence to guide management of the lobster fishery, and it has a history of modifying the regulations in response to declines in landings and of improving the management system. There is a need to continue this adaptive management and implement new recommendations.

An external peer review was conducted to improve the robustness of the FMP, its data requirements, and further management. The review resulted in improvements to the FMP including the methods of calculating SPR, changes to catch and CPUE reference points, expansion of discussion and selection on the model used in the FMP, and information regarding regional differences of the stock. Suggestions that were not fully addressed included:

1. A suitable precautionary approach to models (CDFW 2016c).
2. Adapting models to include MPA effects only when MPAs reach full maturity so that SPR

modeling is more accurate (CDFW 2016c); discussion of the uncertainty around recreational catch rates to calculate cumulative fishing mortality appropriately (CDFW 2016c).

3. Set TACs (this could be done using historical high catch rates opposed to biomass levels, which are not available in the current stock assessments). But, this must be done with careful consideration and effort, keeping in mind markets and environmental conditions (CDFW 2016c).
4. Implement area-based management utilizing area-based essential fisheries information; e.g., SAM and interactions with other regional stocks (Yaeger et al. 2017).

The California spiny lobster population is also harvested by the large recreational fishery (representing 26% of the total catch in the 2014–15 season). This value may be even higher because there is a lack of data regarding poaching and unreported report cards (only 54% of report cards were returned during the 2014–15 season) (CDFW 2015). But there have been recent efforts to better estimate unreported recreational lobster catch, including a 2019 survey of lobster cardholders that found significant differences in effort between cardholders that reported and that did not report (previously they were considered to have similar effort in estimates) (CDFW 2020b). The recreational fishery is managed using gear restrictions, bag limits, and seasonal closures; however, the 2011 stock assessment suggested that recreational catches may be pushing overall mortality over F_{MSY} (Nielson 2011).

Retained species

The CDFW requires all incidentally caught species to be released, with a few exceptions: crab (other than Dungeness crab), Kellet's whelk, and octopus (CA Government 2016), provided that they are landed under valid permits (CDFW 2017b).

Kellet's whelk represents nearly 6% of the bycatch in the spiny lobster fishery (Culver et al. unpublished data (CDFW 2016c)). It is managed through a commercial TAC (100,000 lb) and a commercial fishing season (July 1 through the first Wednesday after March 15) (CDFW 2017c). Kellet's whelk is not a species of concern, and reported landings in California waters have remained below the TAC since its introduction (CDFW 2017c), but catch rates have been raised as an issue in the fishery (SIMoN 2016). The lack of studies about the species has prompted concern, and the Kellet's whelk fishery has been characterized as an "emerging fishery" since 2011 (CDFG 2011b)(White 2018, pers comm); this is due to increased concern in the fishery about issues such as increased landings, or effort, or that "the existing regulations are not sufficient to ensure a stable, sustainable fishery" (CDFG 2011b).

Factor 3.2 - Bycatch Strategy

Eastern Central Pacific | United States | California | Pots

Moderately Effective

There are management measures to reduce the catch of bycatch species in traps, including requiring escape ports and destruct devices in traps, and prohibiting landings of incidental species caught, with a few exceptions (CDFW 2016c) (see Criterion 3.1). Any person who is taking finfish, mollusks, or crustaceans commercially must have a valid trap permit (CA Government 2016b).

Because of the increased recordings of marine mammal mortality in trap and pot fisheries on the U.S. West Coast in recent years (National Marine Fisheries Service stranding database) (CDFW 2016c), the California spiny lobster fishery has been amended from a Category lll to Category ll fishery for bottlenose dolphin (CA/OR/WA offshore stock), gray whale (eastern North Pacific stock) and humpback whale (CA/OR/WA stock) (NOAA 2017). Neither the bottlenose dolphin nor the gray whale stock is listed as a “Depleted” or “Strategic” stock under the Marine Mammal Protection Act (Carretta et al. 2023). Therefore, these are not species of concern. But the humpback whale has been considered a species of concern due to its designation as a “Strategic” stock under the MMPA and its “Endangered” and “Depleted" status (Carretta et al. 2023). Seafood Watch requires that best management practices be implemented to minimize mortality of “stocks of concern” and are believed to be effective in order to be scored as moderately effective. There is currently no observer coverage and no applicable take reduction plan to fully investigate the true mortality caused by the California spiny lobster fishery or a plan to mitigate the risk of interaction (NOAA 2017). There is no applicable take reduction plan in the fishery (NOAA 2017). Until recently, the impact of trap fisheries in the region on humpback whale was considered to be below the PBR; however, the July 2023 delineation of the Central America/Southern Mexico-CA-OR-WA DIP identifies that there is a risk that PBR is being exceeded. Actions to adjust to the new categorization of the California spiny lobster fishery and to fully investigate and mitigate the impacts on the marine mammals may take several years. Because the determination that PBR of humpback whale is being exceeded by unidentified fisheries in California is relatively recent, we have not expected management measures to be implemented at this time; however, future assessments will consider whether mitigation measures have been developed and implemented.

To reduce the risk of ghost fishing, traps are required to have destruct devices with mandatory escape ports. Many species have been observed entering and leaving traps freely due to the mandatory escape ports (CDFW 2017b); however, destruct devices can take a substantial time to destruct (Kushner 2012, pers comm). New measures to further reduce the risk to bycatch include requirements for checking traps every 7 days (weather permitting) and tagging traps (CDFW 2017b).

Little research has been conducted regarding the impacts of the fishery on other species, but the history of the CDFW to respond to the information that is available indicates that they would react to scientific advice.

California spiny lobster pots generally incur a relatively low level of bycatch, and there are management measures to further reduce their risk; however, there has been recent concern for the potential interactions of the fishery with marine mammals, and the effectiveness of ghost fishing management is unknown. Therefore, Seafood Watch deems the bycatch strategy moderately effective.

Justification:
Lobster traps are typically deployed in depths of less than 100 ft; therefore, the likelihood of entangling marine mammals is low compared to other fisheries, such as the Dungeness crab fishery, which takes place offshore where large marine mammals typically reside (CDFW 2016c). But as the season progresses toward winter, lobster fisheries move offshore to avoid stormy conditions (NOAA 2017) and deploy pots as deep as ≈300 ft (93 m) (CDFW 2016c).

Very little data are available regarding ghost fishing and its impacts in the California spiny lobster fishery, although SeaDoc data show that ghost traps (of unknown fishery origin) are present in the Anacapa Island area (Hogan 2016, pers comm). The fishery from which these traps originate is unknown. But these traps may originate in the lobster fishery, so management and monitoring must be applied to reduce the risk of ghost fishing from the lobster fishery. The FMP mandates the following measures, which likely reduce the risk of ghost fishing (all information below is found in (CDFW 2017b):

1. California lobster fishers are now required to not leave traps unattended for more than 7 days (weather permitting) to prevent damage to marine environments, and the California government states that “no trap shall be abandoned in the waters of this state” (§9004) (CA Government 2016b).
2. Every trap is required to have a trap tag (§ 122.1[c]).
3. A trap limit of 300 traps for each permit (a commercial fisher is permitted to have up to two permits, one of which may be transferable).
4. In the case of “catastrophic trap tag loss” (where 75 or more trap tags are lost during the season) (§ 122.1[c][2]), the respective permit needs to be submitted and is subject to further requirements.
5. To enable improved data on ghost fishing, CDFW deems any trap left in the fishery 14 days after the end of the commercial lobster fishing season as ghost gear (§ 122.2[e]).
6. At the end of each season, permit holders are required to report all trap loss (§705[c][7]).
7. CDFW permit scuba gear to locate and secure lost traps (§ 122[h]).
8. Any lobster fishing permit holder is allowed to retrieve up to six lobster traps per fishing trip of another lobster operator permit holder if they were lost, damaged, abandoned, or otherwise derelict per fishing trip (§ 122.2[h][1][A]) (CDFW 2017b).

Factor 3.3 - Scientific Research And Monitoring

Eastern Central Pacific | United States | California | Pots

Moderately Effective
Research about the stock has been fairly limited, but recent studies have been conducted to collect essential fishery information such as size structure, sex ratios, number of recruits, trap vulnerability, incidental catch (bycatch), MPA effects, and tag recapture (CDFW 2016c). There have been several local fishery-independent studies based on tag-recapture methodologies, but these are not interrelated nor do they represent the entire lobster fishery (the Southern California Bight) (Nielson 2011). Management is therefore typically based on fishery-dependent data (landings, CPUE, etc.). The latest stock assessment (2011) used the fishery-dependent data in several different models to determine the current status (Nielson 2011). Only one study recorded information on bycatch of the

fishery, and though this is currently not ongoing, studies have been researching the Kellet's whelk fishery (White 2016, pers comm), which is one of the main bycatch species in the California spiny lobster fishery.

Because some data are collected regarding abundance and fishing mortality but the fishery is considered to be data-limited, scientific research and monitoring is scored moderately effective.

Justification:
The CDFW has relied upon a commercial logbook system since 1973 (CDFG 2001)(Nielson 2011)(CDFW 2016c) to monitor details about catch and effort. The logs are required to document the catch (the numbers of legal and short [undersized] lobsters caught) and effort (number of traps pulled and the depths of traps fished) (CDFW 2016c). Landing receipts record the sale date, species landed, landing ports, fisher ID, vessel ID, CDFW fishing block, catch origin, price/sale ($) and weight landed (CDFW 2016c). Tag-recapture studies have collected data on the movement of lobsters over long periods of time, growth estimates, and population sizes (Hovel 2017, pers comm), but these data were not used in the SPR model (California Ocean Science Trust 2015). A collaborative at-sea sampling program (CASP) has collected data on the size frequency, sex ratio, number of recruits, and trap vulnerability information using fishery-dependent data throughout the California lobster fishing area from 2012 to 2015 (Culver et al. 2016). The data will enable modeling of the stock on a more regional scale (Yaeger et al. 2017). CASP study findings agreed with CPUE and the mean weight of lobster estimated by CDFW data. But, CASP and other studies did not agree with CDFW's estimates on the average weight of legal lobster for the northwest islands (where CASP found smaller average weights). This highlights inadequacies with landings receipts and logbooks for the region (Culver et al. 2016).

The FMP review stated that "obtaining better information on the stock's sublegal size abundance is one of the highest priorities for management" and that data are currently poor for this information category (Table 5-1 of (CDFW 2016c)). California Sea Grant's at-sea sampling pilot project and CASP measure sublegal-size lobsters (CDFW 2016c). Yet, these data do not account for discard mortality rates for returned sublegal lobsters (which the FMP considers one of the highest priorities of data gaps to be addressed). Lobster mortality is thought to be "very low" (Hovel 2017, pers comm). The California government (2016a) requests that all undersize lobster "shall be returned to the water immediately" (CA Government 2016).

The level of uncertainty regarding the recreational catch is also of concern: estimates suggest that harvest rates from the recreational fishery represented 26% of the total catch (commercial and recreational combined) in the 2014–15 fishing season (CDFW 2016c); therefore, this data gap warrants further research and monitoring (Yaeger et al. 2017).

There has not been any dedicated bycatch study for the California spiny lobster fishery, but during the CASP study, information on bycatch was reported for a single year (2013). Kellet's whelk was the predominant bycatch species (CDFW 2016c). There are no current abundance estimates for the species and it has been deemed an "emerging fishery" since 2011 (CDFG 2011b); however, this research is ongoing (White 2018, pers comm). There have been recent changes that allow better measurement of interactions of the California spiny lobster fishery with bycatch and marine

mammals. For example, each trap is fished individually with its own marked buoy, depicting the commercial license number and the letter “P” to denote a spiny lobster trap (NOAA 2017).

The South Coast Lobster Research Group (SCLRG) has collected data to elicit how MPAs have affected California spiny lobster abundance, size, and behavior by monitoring through tag recapture, scuba surveys, habitat mapping, CPUE analysis, and fishing effort mapping (Hovel et al. 2015). Different survey methods showed different results about the impact of MPAs; tag recapture studies in trapping studies showed that there was little difference between abundance inside and outside of MPAs. But scuba surveys indicated different trends, with varying patterns depending on the area, prey, and predation (Hovel et al. 2015). Therefore, MPA effectiveness must take into account factors other than the effects of a reduction of fishing (Hovel et al. 2015).

Although data availability has been increasing, the fishery remains data limited. The FMP has recommended that better information is required on stock distribution, ecological roles, and life history, which would enable improved management by the CDFW. Key improvements to address in fishery monitoring have been outlined as follows (this information is from (CDFW 2016c) unless otherwise stated):

1. Stock’s sublegal-sized lobster abundance (because they form the majority of nonretained catch and the discard mortality rate is unknown) (California Ocean Science Trust 2015).
2. Obtaining abundance indices including CPUE and catch
3. Fishing mortality
4. Stock size structure
5. Lobster growth rates
6. Selectivity of length frequency sampling gear
7. Mean size of lobster catch
8. Effects of MPAs on size and abundance
9. Percentage of a habitat type covered by MPAs.

Factor 3.4 - Enforcement Of Management Regulations

Eastern Central Pacific | United States | California | Pots

Highly effective

Enforcement duties are conducted by CDFW wardens, who conduct research on both fishery and management activities, increase compliance through education programs, and conduct patrols and inspections of all facilities from vessels to restaurants (CDFW 2016c). The fishery is limited by permits, and a suite of regulations ensure compliance, such as a trap limit, trap tags, and mandatory logbooks (CDFW 2017c). Enforcement of existing regulations is ongoing, with punishments for illegal fishing (CDFW 2016c). An estimated 14.6% of spiny lobster habitat is also protected by the California network of marine protected areas, enforced by CDFW’s Law Enforcement Division in partnership with other state and federal agencies and local enforcement officers (CDFW 2019). Because a variety of enforcement and surveillance methods are used to monitor the fishery,

enforcement is scored highly effective.

Justification:
The main enforcement duties conducted by CDFW wardens include the following (this information is from (CDFW 2016c)):

1. Conducting research and management activities to increase compliance rates in the spiny lobster fishery;
2. Patroling and enforcing current regulations, which include illegal possession of various species;
3. Enforcing logbook completion and landings receipts; environmental scientists calculate average weights of lobsters and the number of lobsters landed to help produce CPUE estimates;
4. Inspecting the following facilities to ensure compliance through education and enforcement: wholesalers, retailers, restaurants, and fish transportation vehicles.

The FMP states that poaching still continues, but this is thought to occur more often in the recreational fishery (CDFW 2016c).

Factor 3.5 - Stakeholder Inclusion

Eastern Central Pacific | United States | California | Pots

Highly effective
The management process in the fishery is transparent, involves the major user groups in the fishery, and effectively encourages stakeholder participation through research and frequent public meetings. The CDFW and its associated website offer information hubs about research conducted in the fishery and meetings and scientific reviews of the management plan, thereby demonstrating transparency in the decision-making process. Both fishers' local ecological knowledge (LEK) and findings from the Lobster Advisory Committee (LAC) have been used to inform research and have promoted an effective relationship between user groups (CDFW 2016c). Conflicts have been effectively addressed through the LAC; for example, consensus has been reached between user groups regarding the marking of hoop nets (CDFW 2016c). Because management is transparent, involves and encourages interaction from all major stakeholders, and addresses conflicts in the fishery, stakeholder inclusion is scored highly effective.

Justification:
Stakeholders were key during the process of establishing marine reserves under the Marine Life Protection Act (CDFW 2017), and the Lobster Advisory Committee (LAC) participated in the development of the new FMP (CDFW 2016c). The CDFW improves transparency in management by arranging regular meetings, encouraging participation, and updating the website with materials including independent review papers and FMPs (CDFW 2016a). The CDFW also observes recreational and commercial fishing websites to understand fishery culture and issues (CDFW 2016c).

The California Lobster and Trap Fishermen's Association (CLTFA) has been active in various Collaborative Fisheries Research (CFR) projects in conjunction with researchers from the University of California, Santa Barbara, and the CDFW (CAlobster 2008).

The South Coast Lobster Research Group (SCLRG) was formed in 2011 and facilitates collaboration between scientists, managers, fishers, and institutions—such as the San Diego Oceans Foundation (SDOF), San Diego State University (SDSU), Scripps Institution of Oceanography (SIO), the California Department of Fish and Wildlife (CDFW), and the CLTFA—to answer questions about the fishing and MPA effects on the lobster fishery. This promotes constructive and effective relationships between user groups to contribute to essential research.

The LAC facilitates discussion around conflicts in the fishery and in the past has enabled consensus between user groups. Nine different regulations have been described and adopted in the FMP, which were agreed upon through the LAC, including lobster opening times for the recreational fishery and increased soak time for commercial traps (CDFW 2016c).

Fishers' local ecological knowledge (LEK) has been used by research institutes to design surveys (Kay et al. 2012).

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Eastern Central Pacific | United States | California | Pots	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*

- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*

- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

Eastern Central Pacific | United States | California | Pots

Score: 3

California spiny lobster fishing is carried out on rocky reef/boulder habitat (Hovel et al. 2015). Although there are no specific data on the physical impact of fishing on the habitat, neighboring fisheries show nonsignificant impacts (Shester 2008). Because the fishery is not likely to cause significant impacts, Seafood Watch awards a score of 3.

Justification:

There is no study investigating the physical impacts of trap fishing on substrate in the U.S. California spiny lobster fishery. But a study in the Baja California fishery for California spiny lobster found that traps present minimal impacts to the most vulnerable biogenic habitats, yielding nonsignificant impacts for the Baja California fishery for California spiny lobster (Shester & Micheli 2011)(SCS 2011). Shester (2008) showed that the California spiny lobster fishery in Baja California is “highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm” except from some algae removal from the seabed when pulling the trap, which recovered quickly (Shester 2008). The Baja fishery contains some gorgonian corals, and if these are found in the California spiny lobster fishery, they warrant protection.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Eastern Central Pacific | United States | California | Pots

Score: 0

MPAs have been implemented in the area that protect lobster habitat; however, the Seafood Watch methodology does not consider the proportion substantial enough to provide additional scoring. Also, there are no proven developments to the gear to ensure that their impacts to the seabed are mitigated. Therefore, no additional scoring has been added.

Justification:

No additional scoring has been added in Criterion 4.2, though it should be noted that there have been improvements to habitat protection, including that 14.6% of lobster habitat is currently protected by MPAs (CDFW 2016c). This habitat protection is not substantial (which requires at least 20% of habitat is protected). Fishers are required to lift traps every 7 days, which may reduce the risk of ghost fishing (CDFW 2017b). There has not been sufficient time to measure the effectiveness of these measures.

Factor 4.3 - Ecosystem-based Fisheries Management

Eastern Central Pacific | United States | California | Pots

Moderate Concern

The California spiny lobster experiences strong interactions with predators and prey such as urchins (lobster prey) and sheephead, a common juvenile lobster predator (CDFW 2016c). Spiny lobster likely limits the abundance of red and purple sea urchin populations (CDFW 2016c). When spiny lobster populations decline, sea urchin abundance is able to increase. Because urchins are herbivores that consume algae and kelp, their increased populations increase pressure and can decrease resilience on kelp forest, potentially leading to trophic cascades (CDFW 2016c).

Although protective measures exist to mitigate potential cumulative fishing and environmental impacts such as El Niño, the likelihood of trophic cascades is higher in a fishery with such strong predator-prey interactions. This risk is exacerbated by the lack of data regarding essential fishery information (including spiny lobster and Kellet's whelk abundance). A recent study shows that pre-recruit abundance is high; therefore, evidence suggests that the fishery poses no negative impact to recruitment (Yaeger et al. 2017).

Factor 4.3 scores a moderate concern because detrimental food web impacts are possible, based on the California spiny lobster's ecological role, and there are some management measures in place; however, stronger policies may be needed to fully protect the ecological role of the species.

Justification:

Lobster is known to be an important predator in kelp forest and reef ecosystems, controlling herbivore populations. Recent studies in similar fisheries have shown that decreasing lobster abundance and/or size can alter ecosystems and result in cascading effects on marine systems, and that lobster has a high connectivity between interactions in the food web (Barrett et al. 2009)(Ling & Johnson 2009)(Shears & Babcock 2003). In the absence of top-down control of predators such as spiny lobster and sheephead, the resilience of southern California kelp forest decreases, and management measures such as minimum size limits and marine reserves are crucial to maintaining kelp forest resilience. Minimum sizes are particularly important because predator-prey interactions are dependent on lobster size (Hamilton & Caselle 2014), and smaller individuals find it more difficult to break through large urchin shells, which, in turn, allows an increased abundance of urchins (Eurich et al. 2014).

FMPs are generally intended to fully assess the ecological impacts of a fishery and discuss the role of the direct and indirect effects of lobster in the ecosystem. California marine reserves have shown that, where lobster populations have not been fished, previously overgrazed areas by urchins have developed into kelp forest (Lafferty 2004).

MPAs, which protect 14.6% of lobster habitat, are currently the only identifiable protection for California spiny lobster habitat (CDFW 2016c). Escape ports are designed to allow smaller individuals and species to escape from traps; however, further bycatch studies are required to understand how gear can be adapted to be more selective.

To understand the cumulative effects of fishing and other impacts on the fishery, the environmental

variability must be understood. Climate change is expected to create direct and indirect effects on lobster landings: indirect effects on lobster include limited growth and reproductive rates caused by increased energy consumed to compensate for corroding shells of lobster and their calcified prey; e.g., urchins and bivalves (Long et al. 2013). Upwelling underpins transport of lobster larvae food sources and larvae dispersal. But in the California spiny lobster fishery, it is debated whether upwelling will strengthen or weaken with climate change (Bakun et al. 2010)(Rykaczewski & Dunne 2010), and how lobster larvae will in turn react to upwelling strength (Roemmich & McGowan 1995)(Gaylord & Gaines 2000)(Connolly et al. 2001)(Harley et al. 2006).

Kellet's whelk

Catch rates of Kellet's whelk (the second-largest bycatch component) are closely monitored by the CDFW; measures to protect the stock include a fishing season and a TAC (CDFW 2016c). Studies on Kellet's whelk abundance and interactions in the fishery are currently being conducted by the Council on Ocean Affairs, Science and Technology (COAST) research group. Studies determining abundance and connectivity are currently being conducted (White 2016, pers comm). TACs have been implemented in the Kellet's whelk fishery; however, further management measures have been advised to maximize management effectiveness, including size limits, depth restrictions of traps, and seasonal closures of areas to protect spawning stocks (CDFG 2011b).

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Scientific reviewdoes not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Appendix A: Life History Characteristics of Kellet's Whelk

There is limited life history information available for Kellet's whelk, making it difficult to perform a productivity-susceptibility analysis (PSA) to determine vulnerability to fishing pressure. But, the following information was available and was used to estimate values for the characteristics required for a PSA.

Characteristic	Value	Reference
Maximum Length	175 mm	(CDFG 2008)
Length at Maturity	66–71 mm	(CDFG 2008)
Growth Rate	Juvenile: 7–10 mm per year Adult: 20 years to reach 90 mm	(CDFG 2008)

Based on the information in the table, the age at maturity can be estimated using the size at maturity and juvenile growth rate (assuming constant growth rate), as follows:

$$Age\ at\ Maturity = \frac{Length\ at\ Maturity}{Juvenile\ Growth\ Rate}$$

$$Age\ at\ Maturity = \frac{68.5}{8.5} = 8.06$$

If it takes 20 years to reach a size of 90 mm but a juvenile takes 8 years to reach 68.5 mm, then the adult growth rate can be estimated, and thus a maximum age based on the maximum size.

$$Adult\ Growth\ Rate = \frac{90mm - 68.5mm}{20yrs - 8.06yrs}$$

$$Adult\ Growth\ Rate = \frac{21.5mm}{11.94yrs} = 1.8\text{mm/yr}$$

To reach a maximum size of 175 mm once mature (68.5 mm) would take approximately 60 years at a rate of 1.8 mm per year. This is likely an overestimate of the maximum age because many whelk may not reach the maximum size even in optimum conditions; however, it is likely that the maximum age is greater than 25 years and is therefore characteristic of low productivity.

Appendix B: 2024 Update to the California Spiny Lobster Report

This report was reviewed for any significant stock status and management updates in 2024. As a result, some score changes occurred. The Production Statistics section of the Introduction was updated with the most recent landings data (CDFW 2019). Overall, the California spiny lobster rating has remained Yellow.

Criterion 1

No further information was found for abundance or fishing mortality, and Criterion 1 is considered up to date.

Criterion 2

Abundance and fishing mortality for humpback whale were updated with information from the most recent stock assessment (Carretta et al. 2023), resulting in a score change for fishing mortality to high concern. Fishing mortality scores for bottlenose dolphin, gray whale, and Kellet's whelk were updated with recent stock assessment information (Carretta et al. 2023) and landings data (CDFW 2020), but only the fishing mortality score for Kellet's whelk warranted a change from low concern to moderate concern. No further information was found for bottlenose dolphin, so it is considered up to date. California sea lion was also considered (added to the MMPA List of Fisheries entry for this fishery in 2022), although it was not included in the analysis because of the insignificant impacts on its populations. The bait use and discards modifying score was increased from 0.75 to 1.0 because of recent confirmation that a substantial portion of bait used is in the form of post-processing scraps, which suggests that bait, along with discards, is less than 100% of the volume landed (Mason 2024, pers comm).

Criterion 3

Information regarding marine protected areas across California spiny lobster habitat (CDFW 2019) was added to management strategy and enforcement, although no scores have changed. No further information was found for bycatch strategy, research and monitoring, or inclusion, so all are considered up to date.

Criterion 4

No further information was found for impacts on the habitat and ecosystem, and Criterion 4 is considered up to date.