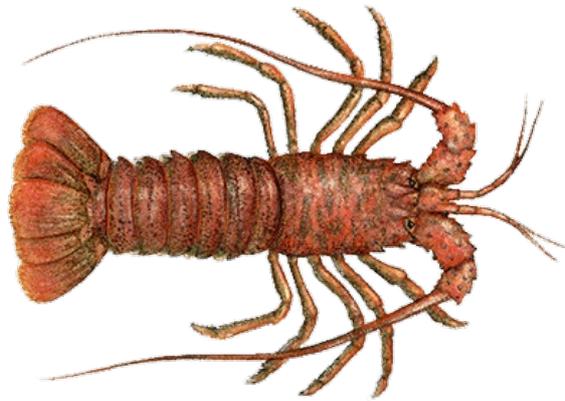


Monterey Bay Aquarium Seafood Watch®

California spiny lobster

Panulirus interruptus



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California

Pots

October 2, 2019

Seafood Watch Consulting Researcher

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or its recommendations on the part of the reviewing scientists. Seafood Watch is solely responsible for the conclusions reached in this report.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological 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. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. 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.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ 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, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

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

Avoid/Red Take a pass on these for now. These items are overfished or caught 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 they are fished are Point Conception, Santa Barbara County to Magdalena Bay, and Baja, CA. This report will provide information and recommendations for the California spiny lobster (*Panulirus interruptus*) commercially fished with traps in the waters of California. There is a large recreational fishery for spiny lobster, but this report focuses on the commercial fishery only.

The California spiny lobster is moderately vulnerable to fishing pressure. They mature fairly quickly, between 5 years (Chávez-Hidalgo and Chávez 2016) and 7 years (K. A. Hovel, personal communication 2017), compared to their life span of approximately 15 years (Fishwatch 2017). Mature spiny lobsters spawn once a year and females produce around 2,000,000 eggs (Flores et al. 2016). The produced larvae disperse widely during their 7 to 11 month planktonic stage.

Infrequent stock assessments for spiny lobster are conducted in the California fishery with the last assessment completed in 2011.

The California spiny lobster fishery has experienced steady landings; the most recent assessment suggests the California spiny lobster population is stable. Landings during the 2014 to 2015 fishing season were the third highest on record and fishing mortality is suggested to be close to Maximum Sustainable Yield (MSY) (Hovel et al. 2015). Fishing mortality is estimated based on commercial landing receipts and logbook data.

A recent 2013 study that included some bycatch information found that bycatch from the California lobster fishery is comprised mainly of sublegal-sized lobsters and Kellet's whelk, *Kelletia kelletii* (at 5.98% of the bycatch). The study shares similar results with the bycatch studies in the Mexican spiny lobster fishery. Sublegal-sized lobsters will be discussed in Criteria 1 since they are part of the target species. Due to the effect of ghost fishing by lost traps, the incidence of capture of other species is likely to be higher than known bycatch rates. However, because there are little species-specific data on the impacts of ghost fishing in this region, and many species have been observed entering and leaving traps freely, it is not believed that any species are being impacted significantly. 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 capture of undersized lobsters, and destruct devices that enable traps to open up after a certain amount of time—provide additional protection to the population. Enforcement of existing regulations is carried out by the Law Enforcement Division (LED) of the California Department of Fish and Wildlife (CDFW). 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. Overall, the management of the spiny lobster fishery is ranked yellow.

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 in the impact of the CA fishery on habitat; however, studies conducted in neighboring fisheries have suggested that spiny lobster fisheries present a non-significant impact on habitats. Additionally, MPAs 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. CDFW has started to implement measures (such as Marine Protected Areas) to protect the ecosystem.

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	CRITERION 1: Impacts on the Species	CRITERION 2: Impacts on Other Species	CRITERION 3: Management Effectiveness	CRITERION 4: Habitat and Ecosystem	OVERALL RECOMMENDATION
California spiny lobster California/Eastern Central Pacific Pots United States of America	Yellow (2.644)	Red (1.677)	Yellow (3.000)	Yellow (3.000)	Good Alternative (2.513)

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. The California spiny lobster, *Panulirus interruptus*, is found along the western coast of North America from Monterey, CA to Manzanillo, Mexico though a small population exists in the Gulf of California; see Figure 1-1 (CDFW 2016). In the US it is fished from Point Conception, Santa Barbara County, south to the Mexican border. This report provides information and recommendations for the California spiny lobster that is commercially fished with traps in the waters of Southern California.

Species Overview

The spiny lobster, of the genus *Panulirus*, contains approximately 20 different species occurring worldwide in tropical and sub-tropical waters (Pollack 1995). The 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 m (meters), depending upon the species (Holthuis 1991). Little is known about the recruitment habitats of California spiny lobsters (K. A. Hovel, personal communication 2017). Previous studies suggest that juvenile California spiny lobsters spend their first few years in nearshore surf grass beds (CDFG 2001), although some live in non-surfgrass habitats such as algal habitat (K. A. Hovel, personal communication 2017). Adults are often found on rocky substrates, reefs, and within surfgrass beds (CDFG 2001). Generally, spiny lobsters tend to be nocturnal, foraging at night and sheltering during the day (K. A. Hovel, personal communication 2017). Lobster migration processes attract debate: some studies suggest that they migrate among depths depending upon the season, generally moving deeper in winter months (CDFG 2001); others hypothesize that lobsters generally have high site fidelity, remaining in the same area for years (Hovel and Lowe 2007) (Withy-Allen and Hovel 2013) (Hovel et al. 2015) as cited in (Yaeger et al. 2017), or migrate seasonally to suitable spawning habitats (Kelly 2001) (Withy-Allen and Hovel 2013).

Several different species of spiny lobster support commercial fisheries worldwide. As previously 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 (SFW 2012).

The CDFW regulates the fishery through several means:

- A harvest control rule to prevent, detect and recover the spiny lobster population from overfishing, which is underpinned by the Marine Life Management Act (MLMA)

- Minimum landing size (MLS) of 82.5 mm (3.25 in) carapace length

- Permit restrictions: limited entry program (capping permit numbers at 141 transferable and 53 non-transferable permit holders), permit transfer restrictions, permit limit of up to 2 per commercial fishers

- Gear restrictions: trap servicing requirements, lost trap requirements, trap limits of 300 per permit, buoy marking, a tag per trap

- Logbook requirements

- 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. Additionally, recent studies suggest that sexual maturity may occur at a smaller size than original studies estimate (Kay 2011) (Hovel et al. 2015) or differs depending on location (Yaeger et al. 2017) (Culver et al. 2016). Because of this, recent research

suggests that area-based management would be more suited to the stock to account for differences in size distributions, sex ratios, number of recruits, and CPUE among CA 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 15 March (CA Government 2016a §8251) to protect egg-carrying (or berried) females (CA Government 2016b) and to minimize handling of molting (soft) animals. Females have been found carrying anywhere from 5,000 to 500,000 eggs (Johnson 1956).

CDFW requires lobster traps to have a destruct device to prevent ghost fishing in the event of trap loss, and escape ports to minimize the capture of undersize lobsters (Barsky 2001). 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 non-transferable 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 in areas where lobster were 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 1 January 2012, creating a network of MPAs. Southern California, from Point Conception south to the US-Mexico border contains 50 marine protected areas (MPAs) including 19 no-take state marine reserves, 10 state marine conservation no-take areas, 21 state marine conservation areas, plus an additional two special closures (CDFW 2016b).

Mexico sits in the center of the spiny lobster range (Figure 1) and the species has a very long larval duration; therefore, the Mexican fishery could potentially impact the US component of the spiny lobster population. Due to the potential strong connectivity between Mexico and California spiny lobster stocks, a greater understanding is needed in the larval dispersal and recruitment processes in the spiny lobster fishery to ensure effective management. A better understanding of larval sinks and sources will enable increased understanding of how it effects differences in size structure between areas within the fishery (Yaeger et al. 2017).

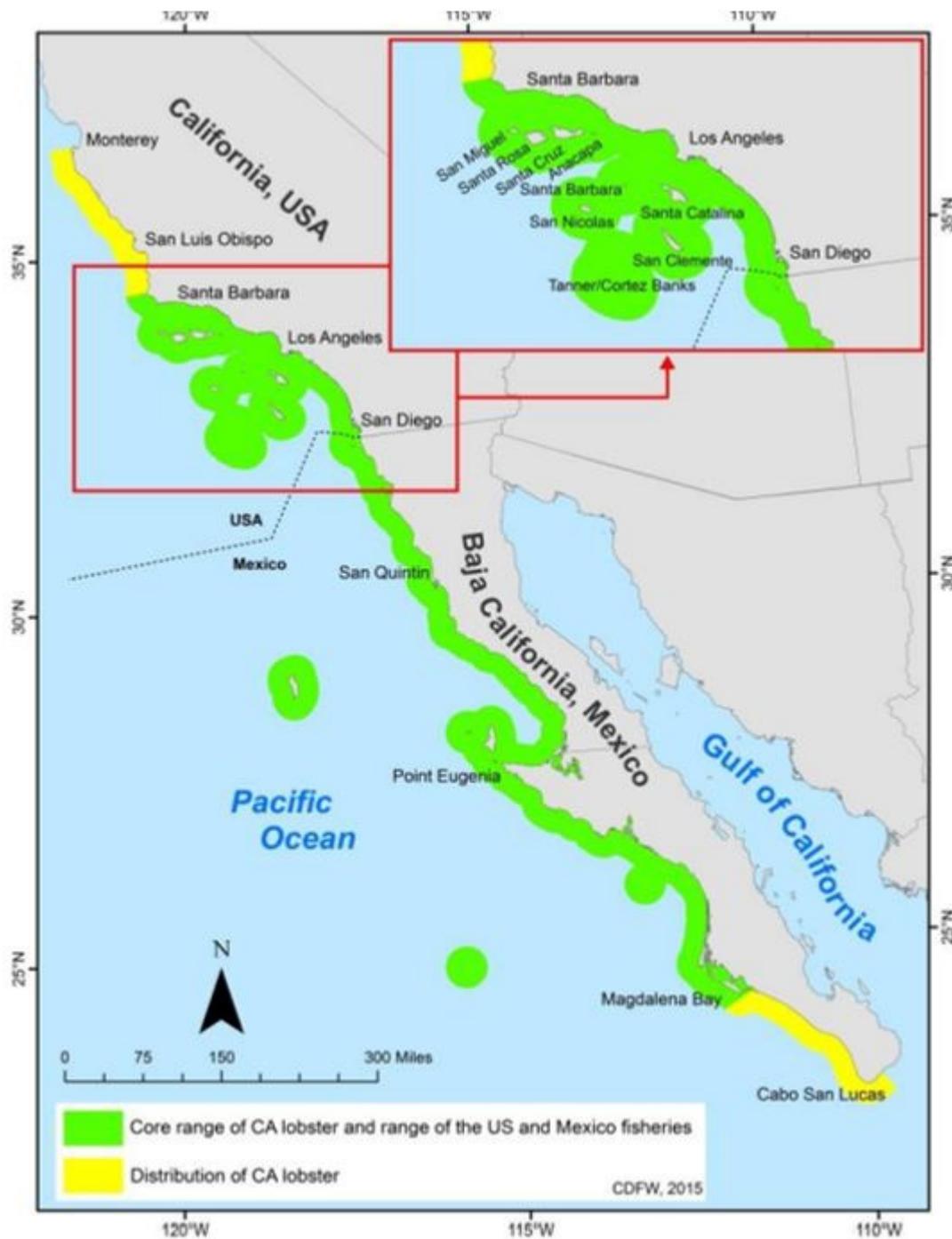


Figure 1 Primary distribution range of the California spiny lobster. *A 20mi buffer from the coast was used to indicate the approximate range of the species, and does not represent fine-scale distribution. Figure from CDFW 2016c.

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Production Statistics

Landings from the California lobster fishery have remained fairly steady over the last 10 years, with 431 MT (metric tons) (950,000 lb) landed during the 2014 to 2015 season (CDFW 2016c). The fishery is thought to be operating close to maximum sustainable yield (MSY) (Hovel et al. 2015). All US landings of the California spiny lobster occur in the state of California (NOAA, 2012). The US also imports spiny lobster from Mexico, which may include the California spiny lobster and the Caribbean spiny lobster (*Panulirus argus*).



Figure 2 US Landings of California lobster from the 1936-1937 to the 2014-2015 fishing season in lbs.

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 doesn't depict the species. Ex-vessel value reached a record high of \$18.12 million during the 2014 to 2015 season, which is 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 (since they cannot be tailed for market) to Asian countries, particularly China, and to a lesser extent within the US in the last several years (C. LaMell, personal communication 2016).

Common and market names.

Spiny lobsters, in general, are also known as:

- Rock lobsters
- California lobster and red lobster
- Crawfish, Bug (FishWatch 2017).

Primary product forms

The spiny lobster is marketed whole because it is illegal to tail them, and they are 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
California/Eastern Central Pacific Pots United States of America	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

The most recent stock assessment for the 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 to be at a sustainable level based on individual size, catch size, and fishing effort {Nielson 2011}. There is much uncertainty around mortality estimates, particularly in the recreational sector. Both the Marine Life Management Act (MLMA) and the fishery management plan (FMP) agree that it is one of the highest data priorities in the fishery {CDFW 2016c}.

Criterion 1 Assessment

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

Factor 1.1 - Abundance

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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], catch and spawning potential ratio [SPR]) to determine abundance (CDFW 2016c). CPUE has overall declined since 2004, but has been increasing since 2011. CPUE_{CURRENT} values have been below CPUE_{THRESHOLD} values for the past four fishing seasons, which suggests negative trends. Conversely, the Cable-CDFW models suggest that SPR values have increased in recent years: the 2014 to 2015 season are some of the highest values in the time series (CDFW 2016c). The SPR_{CURRENT} for 2014 to 2015 was estimated at 32%, which is above SPR_{THRESHOLD} (25%) (CDFW 2016e), which suggests positive trends (CDFW 2016c). Modeled and observed results indicate that the population is stable (CDFW 2016c).

The stock assessment in 2011 suggested that the fishery has potentially reached MSY (Nielson 2011). However, this assessment is over five years old. Further research is required to better understand diverging trends among data-limited indicators.

Since 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 as 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), suggests 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). $CPUE_{THRESHOLD}$ values have been breached seven times during the $CPUE_{CURRENT}$ time-series data, with four of those occurring over the last four fishing seasons (from 2010 to 2014). 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 (Figure 2) while CPUE decreased (Figure 3). CPUE generally increased from 2010 to 2016, but is still lower than most annual CPUE results throughout the time-series (CDFW 2016c). The final FMP HCRs require that an investigation is initiated if $CPUE_{CURRENT}$ drops below the $CPUE_{THRESHOLD}$, or if $CPUE_{CURRENT}$ decreases for six consecutive years.

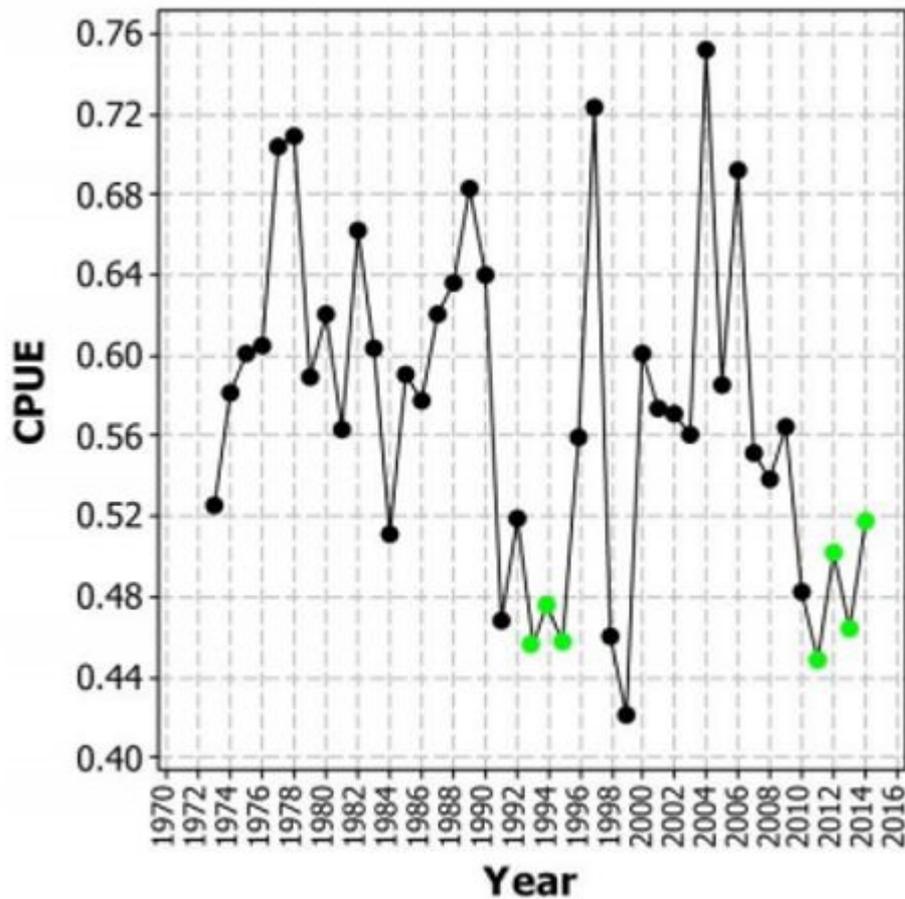


Figure 3 Catch Per Unit Effort (CPUE) in the California spiny lobster fishery (CDFW 2016c).

Yaeger et al. (2017) showed that 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 have increased in recent years due to an increasing trend in average weight of spiny lobster. The 2014 to 2015 fishing season had its highest average weight since observations began (year 2000) (CDFW 2016c).

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.

Reasons for this 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 northwest islands, since the sublegal lobster population contributed substantially to egg production (Culver et al 2016).

Abundance varies significantly with climate patterns: during El Niño and 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 = 1.83

Susceptibility (S) Score = $[(3 \times 3 \times 2 \times 3) - 1] / 40 + 1 = 2.325$

Vulnerability (V) Score = $\sqrt{P^2 + S^2} = 2.961$

This equates to a medium vulnerability score.

Figure 4 Productivity and susceptibility of California spiny lobster.

Factor 1.2 - Fishing Mortality

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 regards 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 have been increasing in recent years (CDFW 2016c).

Due to the high level of uncertainty and low level of data availability associated with fishing mortality, Seafood Watch considers fishing mortality to be 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 to 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). Following this, landings began to decline for the next 25 years, reaching a low in 1974 to 1975 (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 estimated F_{MSY} levels in the Fisheries Simulation Model (Nielson 2011). However, 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 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 since 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 CA lobsters reach the legal size faster, and therefore are caught more quickly than in other regions, or there is a higher abundance of sublegal CA 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 Pacific Decadal Oscillation (PDO) and La Niña/El Niño

systems (Nielson 2011), but this isn't 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 sub-legal lobsters (CDFW 2016c). Due to the high level of uncertainty in fishing mortality, its relevance in modelling and 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" (K. A. Hovel, personal communication 2017). In similar spiny lobster fisheries, when lobsters were handled for short handling times, survival rates were estimated at 88% (DiNardo and DeMartini 2002). However, studies in spiny lobster fisheries in Florida have shown that mortality rates can increase due to injury during or after handling (Parsons and Eggleston, 2005). Spiny lobsters are susceptible to handling stress or unintentional damage to their antennae or legs, demonstrated in Australian western rock lobster, *Panulirus cygnus*, studies, thereby decreasing fecundity and increasing uncertainty in their mortality rates (Melville-Smith and de Lestang 2007). This is particularly important since 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 Critical

Guiding Principles

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

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

CALIFORNIA SPINY LOBSTER					
California/Eastern Central Pacific Pots United States Of America					
Subscore:	2.236	Discard Rate:	0.75	C2 Rate:	1.677
Species Stock	Abundance	Fishing Mortality	Subscore		
Bottlenose dolphin	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Humpback whale	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
Kellet's whelk	1.00:High Concern	5.00:Low Concern	Yellow (2.236)		
gray whale	3.67:Low Concern	5.00: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 the species that represented >5% of the catch. Species were considered as ETP species if they were listed under the Endangered Species Act or were considered as ETP species on the IUCN website. Other data sources 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 was mainly formed of sublegal-

sized California spiny lobster (83.29%), followed by Kellet's whelk (*Kelletia kelletii*) (5.98%) (Culver et al. unpublished data). 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 support their own commercial fishery (CDFW 2016c).

Otters have been considered as part of bycatch under SFW criteria; however, it is not likely that current fishing patterns pose a risk to otter populations in the California spiny lobster fishery, so they are not discussed further. Likewise there are three species of cormorant: the Brandt's, pelagic, and double-crested (double-crested cormorants are protected by the Migratory Bird Act (US Fish and Wildlife service 2015)), which occur in the region particularly around the Channel Islands and have the potential to interact in the California lobster fishery (Cornell University 2017). But the FMP suggests that there are no known interactions between the lobster fishery and cormorants (CDFW 2016c) and therefore, are not considered further.

Traps are known to interact with finfish. Moray eels have been observed to be captured in traps in research studies, albeit infrequently (K. A. Hovel, personal communication 2017). Since traps present minimal impacts on non-invertebrate species, only selected and managed species may be taken by vessels with lobster permits (CDFW 2017c) (§8250.5) (CA Government 2016a). Traps have escape panels (§122.2[d]) (CDFW 2017b) and have to be checked regularly (§122.2[d]) (CDFW 2017b), the impact 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 US west coast. Reported whale entanglements have peaked at 35 in 2014, totaling 231 between 2000 and 2015 (Lawson 2015). Most entanglements occur in the Dungeness crab fishery (Lawson 2015) and entanglement is rare in the CA lobster fishery. However, entanglements have been reported in lobster gear: since the year 2000, there have been four reported incidents of Gray whales (one received serious injuries), two humpback whales (one died), and one unidentified whale (which died) (Carretta et al. 2015b) (National Marine Fisheries Service stranding database) and one incidence of bottlenose dolphin entanglement in 2008 (Carretta et al. 2015b).

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 (E. Hogan, personal communication 2016). 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 CA spiny lobster trap fishery in California, the humpback whale limits the score for Criterion 2 due to their 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)

BOTTLENOSE DOLPHIN

Factor 2.1 - Abundance

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

High Concern

The California/Oregon/Washington (CA/OR/WA) offshore bottlenose dolphin stock abundance was estimated using 2008 and 2014 summer/autumn vessel-based line-transect surveys from California, Oregon, and Washington waters at 1,924 animals (Barlow 2016). The status of the stock in California relative to OSP is unknown, and there are insufficient data to determine population trends. Bottlenose dolphins are not listed as "Threatened" or "Endangered" under the Endangered Species Act, nor as "depleted" under the MMPA (Carretta et al. 2017b).

Since population size is unknown relative to a sustainable level and marine mammals are considered highly vulnerable to fishing activities, Seafood Watch deems abundance as a "high" conservation concern.

Factor 2.2 - Fishing Mortality

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Low Concern

The potential biological removal (PBR) for CA/OR/WA offshore bottlenose dolphin stock is estimated as 11 offshore bottlenose dolphins per year (Carretta et al. 2017b). The estimated mean annual take of this stock per year in the CA spiny lobster trap/pot fishery is estimated at 0.2 dolphins per year (Carretta et al. 2016a) (Carretta et al. 2017a) (Jannot et al. 2011).

Therefore, the percentage of PBR taken by fishery is $0.2/11 = 1.8\%$. The cumulative fishing mortality is estimated as at least 1.6 per year, which is less than the PBR. Therefore, Seafood Watch deems fishing mortality as a "low" concern.

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

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

≥ 100%

Neither discard, discard mortality rates nor bait use is recorded in the fishery. However, it is assumed that discards are around 15% (Shester and Micheli 2011) and bait use is assumed to be over 100% of lobster

landing weight. Therefore, the modifying factor receives a score of 0.75.

Justification:

Discards

There are no finalised discard rates available for the California spiny lobster fishery that account for handling mortality or post-release mortality. However, Nielson (2011) stated that retained lobster account for 23 to 30% of total lobster caught. Fishery-dependant data showed that around 70% of the catch is short (Nielson 2011).

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

Bait

The bait use in the California 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 volumes of bait used regularly exceed the volume of the target species landed (Harnish and Willison 2009) (Waddington and Meeuwig 2009) (SCS 2011). For one season in the Punta Abreojos and Bahia Tortugas cooperatives in Mexico, bait use was equal to approximately 4,500 to 5,000 t (or 2.3 to 3.5 kg of bait per kg of landed lobster (SCS 2011)).

In the California spiny lobster fishery, many fishers have arrangements with local fish processors and use the scraps and carcasses provided post-processing. They have also been known to use a wide variety of fish, including mackerel, since it is readily available (K. Barsky, personal communication 2012). 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); (§8250.5) (CA Government 2016a).

With no accurate information available from the California lobster fishery, bait use is considered to be greater than 100% of the volume landed.

HUMPBACK WHALE

Factor 2.1 - Abundance

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

High Concern

Humpback whales in the California/Oregon/Washington stock feed along the US West Coast, but are attributed to three Distinct Population Segments (DPS) (81 Federal Register 62259). The stock includes whales from the Central American DPS, which are ESA listed as "Endangered" (411 individuals), whales from the threatened Mexico DPS (3,264 individuals), and some from the non-listed Hawaii DPS (11,398 individuals). Those in the Hawaii DPS comprise a smaller proportion of the total stock and feed in waters of northern Washington and

southern British Columbia. The minimum population estimate for the California/Oregon/Washington stock is 2,784 with the population growing over the long term but with trends that have varied in recent years (Carretta et al. 2019). Population trends are uncertain as humpback whales from three DPS are currently being managed as one stock. As the stock includes endangered and threatened whales, abundance is considered a "high" concern.

Factor 2.2 - Fishing Mortality

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Low Concern

The PBR allocation for US waters is 16.7 whales per year (Carretta et al. 2019). Between 2012 and 2016, there were 123 documented human interactions with humpback whales along the west coast of the US (Carretta et al. 2019). The minimum level of annual mortality and serious injury across all pot/trap fisheries has been calculated at 15.7 whales annually (Carretta et al 2019). However, it is unclear how much the CA spiny lobster contributes to the fishing mortality of humpback whales. The only interaction recorded between humpback whales and the spiny lobster fishery was between 2007 and 2011, which resulted in serious injuries (Carretta et al. 2015b). Unidentified pot and trap fisheries were responsible for 1.55 serious injuries or mortalities between 2012 and 2016, which is approximately 9% of the PBR allocation.

Since the percentage of PBR taken by CA lobster fishery is <10%, the total mean annual take from commercial fisheries is less than the PBR, and the spiny lobster is listed as a Category II fishery, Seafood Watch deems fishing mortality as a "low" concern for this fishery.

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

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

≥ 100%

Neither discard, discard mortality rates nor bait use is recorded in the fishery. However, it is assumed that discards are around 15% (Shester and Micheli 2011) and bait use is assumed to be over 100% of lobster landing weight. Therefore, the modifying factor receives a score of 0.75.

Justification:

Discards

There are no finalised discard rates available for the California spiny lobster fishery that account for handling mortality or post-release mortality. However, Nielson (2011) stated that retained lobster account for 23 to 30% of total lobster caught. Fishery-dependant data showed that around 70% of the catch is short (Nielson 2011).

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

Bait

The bait use in the California 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 volumes of bait used regularly exceed the volume of the target species landed (Harnish and Willison 2009) (Waddington and Meeuwig 2009) (SCS 2011). For one season in the Punta Abreojos and Bahia Tortugas cooperatives in Mexico, bait use was equal to approximately 4,500 to 5,000 t (or 2.3 to 3.5 kg of bait per kg of landed lobster (SCS 2011)).

In the California spiny lobster fishery, many fishers have arrangements with local fish processors and use the scraps and carcasses provided post-processing. They have also been known to use a wide variety of fish, including mackerel, since it is readily available (K. Barsky, personal communication 2012). 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); (§8250.5) (CA Government 2016a).

With no accurate information available from the California lobster fishery, bait use is considered to be greater than 100% of the volume landed.

KELLET'S WHELK

Factor 2.1 - Abundance

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 PSA has been used to assess the vulnerability of the species.

Since the PSA deems Kellet's whelk to be of "high" vulnerability, Seafood Watch deems abundance as a "high" concern.

Justification:

There are ongoing studies to determine the abundance of Kellet's whelk (C. White, personal communication 2018). 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 their recruitment in the expanded range (on the California coast). This information has not been used to denote trends in the populations since the time-series is too short and the results have not been compared to previous years to determine whether populations are at healthy levels (Palmer et al 2017).

Productivity-Susceptibility Analysis

Kellett’s whelk are deemed to have "medium" vulnerability, scored 3.066859:

Productivity

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 Kellett’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 Kellett’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 = $(((3 \times 3 \times 2 \times 3) - 1) / 40) + 1 = 2.325$
Vulnerability (V) Score = $VP^2 + S^2 = 3.235$
This equates to a high vulnerability score.

Figure 5

The supplemental data collected in 2013 indicated that only one species other than lobster comprised more than 5% of bycatch: Kellet's whelk, at 5.98% (Culver et al. unpublished data (CDFW 2016c)). The species is not one of concern (IUCN 2016); however 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 (CDFG 2010). However, studies determining abundance and connectivity are ongoing (C. White, personal communication 2018). Kellet's whelk are normally found between central Baja California and Point Conception, California (CDFG 2010). Kellet's whelk abundance generally decreases towards its northerly range; it is up to 10 times greater among their historic southern populations as compared to their newer northern populations (CDFG 2010). The Kellet's whelk fishery has been considered an emerging fishery since 2011 (CDFG 2011b) (C. White, personal communication 2018). 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

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Low Concern

Most of the harvested Kellet's whelks (89%) have been caught incidentally in crustacean traps since 1979 (CDFG 2010). Fishers can retain Kellet's whelk; however, landings are limited by total allowable catch (TAC) (§8250) (CA Government 2016a). Landings are required to be reported for California state waters. Landings were recorded around 42,000 lb in 2000, and 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 80,000 to 90,000 lb (CDFW 2016d). The TAC is 100,000 lb (CDFW 2017c).

Fishing mortality receives a default score of "low" concern in accordance with the Unknown Bycatch Matrix.

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

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

≥ 100%

Neither discard, discard mortality rates nor bait use is recorded in the fishery. However, it is assumed that discards are around 15% (Shester and Micheli 2011) and bait use is assumed to be over 100% of lobster landing weight. Therefore, the modifying factor receives a score of 0.75.

Justification:

Discards

There are no finalised discard rates available for the California spiny lobster fishery that account for handling mortality or post-release mortality. However, Nielson (2011) stated that retained lobster account for 23 to 30% of total lobster caught. Fishery-dependant data showed that around 70% of the catch is short (Nielson 2011).

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

Bait

The bait use in the California 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 volumes of bait used regularly exceed the volume of the target species landed (Harnish and Willison 2009) (Waddington and Meeuwig 2009) (SCS 2011). For one season in the Punta Abreojos and Bahia Tortugas cooperatives in Mexico, bait use was equal to approximately 4,500 to 5,000 t (or 2.3 to 3.5 kg of bait per kg of landed lobster (SCS 2011)).

In the California spiny lobster fishery, many fishers have arrangements with local fish processors and use the scraps and carcasses provided post-processing. They have also been known to use a wide variety of fish, including mackerel, since it is readily available (K. Barsky, personal communication 2012). 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); (§8250.5) (CA Government 2016a).

With no accurate information available from the California lobster fishery, bait use is considered to be greater 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.

Criterion 3 Summary

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: California/Eastern Central Pacific Pots United States of America	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Yellow (3.000)

Management of the California spiny lobster fishery has been "moderately effective" at maintaining a relatively stable population over time. Lobster populations are protected commercially, through biological regulations (size limits, specific seasons to protect breeding females), effort based regulations (permit limits), and trap design (§8250–8259) {CA Government 2016a}; (§9000–9024) {CA Government 2016b}. The numerous area closures associated with marine reserves may also be providing additional measures of protection for this fishery.

Criterion 3 Assessment

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 managers 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.

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 have been implemented in the 2017/2018 season (CDFW 2017c). There are no catch limits, such as TACS, in place. The recent (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. The current abundance indices include CPUE and catch data; although there are a lot of data available, they are 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). However, it is unclear how management accounts for uncertainty from poaching or uncertainty in unreturned report cards (CDFW 2016c).

Since a suite of new measures has been implemented in the fishery, but their effectiveness is not yet known, 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:

"Continuous replacement of resources, taking into account fluctuations in abundance and environmental variability.

"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" (§99.5) (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 section 1.2). Landings have generally fluctuated at ~350 MT (700,000 lb) since the turn of the century, but have increased since 2010: 2014 to 2015 landings were the third highest in the time-series, associated with high ex-vessel prices (Figure 2). 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 15 March (§8251) (California Government 2016a) 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 x 29.21 cm (2.38 x 11.5 in), to minimize the capture of undersize lobsters (CDFG 2003). Traps are required to have a destruct device to ensure 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, 2015b). 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):

- Change in commercial trap limit
- Change in recreational bag limit
- TAC
- District closures
- Change in season length
- Change minimum size limit
- Impose a maximum size limit
- 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 has a history of modifying the regulations in response to declines in landings and 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:

- A suitable precautionary approach to models (CDFW 2016c)
- Adapting models to include MPA effects only when MPAs reach full maturity so that SPR modelling is more accurate (CDFW 2016c); discussion of the uncertainty around recreational catch rates to calculate cumulative fishing mortality appropriately (CDFW 2016c)
- Set TACs (this could be done using historical high catch rates opposed to biomass levels, which are not available in the current stock assessments). However, this must be done with careful consideration and effort, keeping in mind markets and environmental conditions (CDFW 2016c)
- Implement area-based management utilizing area-based essential fisheries information, e.g., SAM and interactions with other regional stocks, e.g. (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 to 2015 season). This value may be even higher, since there is a lack of data regarding poaching and unreported report cards (only 54% of report cards were returned during the 2014 to 2015 season) (CDFW 2015). 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), Kelleys whelk, and octopus (§8250.5) (CA Government 2016a), provided they are landed under valid permits (CDFW 2017b).

Kelleys whelk represent 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 (1 July through the first Wednesday after 15 March) (14 CCR §127; FGC §8250) (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 2016d), 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) (C. White, personal communication 2018); 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

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.

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 apart from a few exceptions (CDFW 2016c) (discussed in Criteria 3.1.). Any person who is taking finfish, mollusks or crustaceans commercially must have a valid trap permit (§9001) (CA Government, 2016b).

Due to the increased recordings of marine mammal mortality in trap and pot fisheries on the west coast of the United States over recent years (National Marine Fisheries Service stranding database) (CDFW 2016c), the CA spiny lobster fishery has been amended from a Category III to Category II fishery (NOAA 2017) 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 are listed as "depleted" or "strategic" stock under the Marine Mammal Protection Act (Carretta et al. 2017b). Therefore, these are not species of concern. However, 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. 2017b). 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 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). However, fishery managers have had a very short time to adjust to the new categorization of the CA spiny lobster fishery and fully investigate and mitigate the impacts on the marine mammals. Recorded interactions in the spiny lobster fishery are low compared to the PBR and other fishing mortality sources such as the Dungeness crab fishery. Measures have recently been adopted in the fishery that will likely further reduce the risk of interaction such as trap limits (CDFW 2017c).

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 (§122.2 [d]) (CDFW 2017b); however, destruct devices can take a substantial time to destruct (Kushner, personal communication 2012). New measures to further reduce the risk to bycatch include requirements for checking traps every seven days (weather permitting) (§122.2[d]) (CDFW 2017b) 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 they would react to scientific advice.

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 as "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). However, as the season progresses towards 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 (E. Hogan, personal communication 2016). The fishery from which these traps originate is unknown. However, since these traps may originate in the lobster fishery, 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)):

California lobster fishers are now required to not leave traps unattended for more than seven 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).

Every trap is required to have a trap tag (§ 122.1[c]).

A trap limit of 300 traps for each permit (a commercial fishermen is permitted to have up to two permits, one of which may be transferable).

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.

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]).

At the end of each season permit holders are required to report all trap loss (§705[c][7]).

CDFW permit SCUBA gear to locate and secure lost traps (§ 122[h]).

Any lobster fishing permit holder is allowed to retrieve up to 6 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

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.

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Moderately Effective

Research about the stock has been fairly limited, but recent studies have been conducted to collect essential

fishery information (size structure, sex ratios, number of recruits, trap vulnerability) and incidental catch (bycatch), MPA effects, and tag recapture studies (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 not ongoing, recent studies are researching the Kellet's whelk fishery (C. White, personal communication 2018), which is the only main bycatch species in the California spiny lobster fishery.

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

Justification:

The CDFW has relied upon a commercial logbook system since 1973 (CDFG 2001) (Nielson 2011) (CDFW 2016c) to monitor details about the 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 sale date, species landed, landing ports, fisherman ID, vessel ID, CDFW fishing block, catch origin, price/sale (\$) and weight landed (CDFW 2016c). Tag-recapture studies have collected data on movement of lobsters over long periods of time, growth estimates, and population sizes (K. A. Hovel, personal communication 2017), but these data were not used in the SPR model (California Ocean Science Trust, 2015b). A collaborative at-sea sampling program (CASP) has recently collected data on 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 mean weight of lobster estimated by CDFW data. However, CASP and other studies did not agree with CDFW's estimates on 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 as one of the highest priorities of data gaps to be addressed). Lobster mortality is thought to be "very low" (K. A. Hovel, personal communication 2017). California Government (2016a) §8252 requests that all undersize lobster "shall be returned to the water immediately" (CA Government 2016a).

The level of uncertainty regarding the recreational catch is also of concern: recent estimates suggest harvest rates from the recreational fishery represented 26% of the total catch (commercial and recreational combined) in the 2014 to 2015 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 (C. White, personal communication 2018). 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 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. However, 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).

While 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 (information below is from (CDFW 2016c) unless otherwise stated):

- Stock's sublegal sized lobster abundance (since they form the majority of non-retained catch and the discard mortality rate is unknown (California Ocean Science Trust 2015)).
- Obtaining abundance indices including CPUE and catch
- Fishing mortality
- Stock size structure
- Lobster growth rates
- Selectivity of length frequency sampling gear
- Mean size of lobster catch
- Effects of MPAs on size and abundance
- Percentage of a habitat type covered by MPAs.

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.

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Highly Effective

Enforcement duties are conducted by CDFW wardens. CDFW wardens 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).

Since a variety of enforcement and surveillance methods are used to monitor the fishery, enforcement is scored as "highly effective."

Justification:

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

- Conducting research and management activities to increase compliance rates in the spiny lobster fishery;
- Patrolling and enforcing current regulations which include illegal possession of various species;

Enforcing logbook completion and landings receipts; environmental scientists calculate average weights of lobsters and the number of lobsters landed to help produce CPUE estimates;
Inspecting the following facilities to ensure compliance through education and enforcement:
wholesalers, retailers, restaurants, fish transportation vehicles.

The FMP states that poaching still continues, but this occurs in the recreational fishery (CDFW 2016c).

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.

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 their 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).

Since management is transparent, involves and encourages interaction from all major stakeholders, and addresses conflicts in the fishery, stakeholder inclusion is scored as "highly effective."

Justification:

Stakeholders were key during the process of establishing marine reserves under the Marine Life Protection Act (CDFW 2017a), and the Lobster Advisory Committee 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), formed in 2011; it 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' 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

Region Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
California/ Eastern Central Pacific Pots United States of America	3	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 - Physical Impact of Fishing Gear on the Habitat/Substrate

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Pots | United States Of America

3

The 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 non-significant impacts (Shester 2008). Since the fishery is not likely to cause significant impacts, Seafood Watch awards a score of "3" for 4.1a.

Justification:

There is no study investigating the physical impacts of trap fishing on substrate in the California lobster fishery. However, a study in the Baja, Mexico fishery found that traps present minimal impacts to the most vulnerable biogenic habitats, yielding non-significant impacts for the Baja, California fishery (Shester and Micheli 2011) (SCS 2004). Shester (2008) showed that the lobster fishery in Baja, Mexico 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

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Pots | United States Of America

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 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 section 4.1b, though it should be noted that there have been improvements to habitat protection including that 14.6% of lobster habitat are 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 seven days which may reduce the risk of ghost fishing (§122.2[d]) (CDFW 2017b). There has not been sufficient time to measure the effectiveness of these measures.

Factor 4.3 - Ecosystem-Based Fisheries Management

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

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 limit the abundance of red and purple sea urchin populations (CDFW 2016c). When spiny lobster populations decline, sea urchin abundance is able to increase. Since 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).

Though 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 4.2 scores a "moderate" concern, since key evidence about the fishery is lacking, but management measures have been implemented to protect the ecosystem.

Justification:

Lobsters are 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 lobsters have a high connectivity between interactions in the food web (Barrett et al. 2009) (Ling et al. 2009) (Shears and 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 lobster-size dependant (Hamilton and 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 lobsters 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 lobsters 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. In the California spiny lobster fishery, however, it is debated whether upwelling will strengthen or weaken with climate change (Bakun et al. 2010) (Ryckaczewski and Dunne 2010), and how lobster larvae will in turn react to upwelling strength (Roemmich and McGowan 1995) (Gaylord and Gaines, 2000) (Connolly et al. 2001) (Harley et al. 2006).

Kellet's whelk

Kellet's whelk (the second largest bycatch component) catch rates are closely monitored by the CDFW; measures to protect the stock include a fishing season and a TAC (14 CCR § 127; FGC § 8250) (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 (C. White, personal communication 2018). Kellet's whelk populations vary with El Niño (Palmer et al. 2017). 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 review does 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: Extra By Catch Species

GRAY WHALE

Factor 2.1 - Abundance

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Low Concern

The minimum population size for the eastern North Pacific stock of gray whales is 25,849 individuals (Carretta et al. 2019). The population was removed from ESA listing in 1994 and has been considered stable over the past few decades. 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 summer and fall. The status of this group as a distinct population stock is uncertain as genetic studies indicate matrilineal fidelity (significant differences in mtDNA haplotype frequencies between groups) but with suggestion of interbreeding with individuals from other feeding grounds (no significant nuclear differences between groups) (Carretta et al. 2019) (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, since 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 recent years (2011 to 2015) but population status relative to reference points is unknown. Due to a recent stock assessment with indications that the stock is within range of its optimal sustainable population size, but with some uncertainty regarding the health of the PCFG sub-population, stock status is considered a "low" concern.

Factor 2.2 - Fishing Mortality

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

Low Concern

There were no known interactions between gray whales and the California spiny lobster fishery between 2012 and 2016 (Caretta et al 2019); however there are known interactions with other trap and pot fisheries in the region, particularly the Dungeness crab fishery, and a number of interactions are attributed to unidentified pot and trap fisheries, which could be the result of the lobster fishery. Within the eastern North Pacific (ENP) gray whale population, unidentified fisheries are responsible for 1.9 serious injuries or mortalities (SIMs) per year (on average between 2012 and 2016), with commercial fisheries being responsible for 8.7 such interactions per year (Caretta et al 2019). For the Pacific Coast Feeding Group (PCFG), unidentified fisheries are responsible for 0.3 SIMs per year, with commercial fisheries being responsible for 0.85 interactions per year (Caretta et al 2019). In all instances, the interactions are lower than the potential biological removals for ENP (801) and PCFG (3.5) (Caretta et al 2019); therefore, Seafood Watch considers the impact of the spiny lobster fishery to be a "low" conservation concern.

Factor 2.3 - Discard Rate

CALIFORNIA / EASTERN CENTRAL PACIFIC

Pots | United States Of America

≥ 100%

Neither discard, discard mortality rates nor bait use is recorded in the fishery. However, it is assumed that discards are around 15% (Shester and Micheli 2011) and bait use is assumed to be over 100% of lobster landing weight. Therefore, the modifying factor receives a score of 0.75.

Justification:

Discards

There are no finalised discard rates available for the California spiny lobster fishery that account for handling mortality or post-release mortality. However, Nielson (2011) stated that retained lobster account for 23 to 30% of total lobster caught. Fishery-dependant data showed that around 70% of the catch is short (Nielson 2011).

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

Bait

The bait use in the California 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 volumes of bait used regularly exceed the volume of the target species landed (Harnish and Willison 2009) (Waddington and Meeuwig 2009) (SCS 2011). For one season in the Punta Abreojos and Bahia Tortugas cooperatives in Mexico, bait use was equal to approximately 4,500 to 5,000 t (or 2.3 to 3.5 kg of bait per kg of landed lobster (SCS 2011)).

In the California spiny lobster fishery, many fishers have arrangements with local fish processors and use the scraps and carcasses provided post-processing. They have also been known to use a wide variety of fish, including mackerel, since it is readily available (K. Barsky, personal communication 2012). 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); (§8250.5) (CA Government 2016a).

With no accurate information available from the California lobster fishery, bait use is considered to be greater than 100% of the volume landed.

Appendix B: 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 and susceptibility analysis (PSA) to determine vulnerability to fishing pressure. However, the following information was available and was used to estimate values for the characteristics required for a PSA.

Characteristic	Value	Reference
Maximum Length	175mm	Sanctuary Integrated Monitoring Network 2016
Length at Maturity	66-71mm	Troyano et al.
Growth Rate	Juvenile: 7-10mm per year Adult: 20 years to reach 90mm	CDFG 2010

Figure 6

Based on the information in Table A1, one can estimate the age at maturity using size at maturity and juvenile growth rate (assuming constant growth rate), as follows:

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

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

Figure 7

If we consider that it takes 20 years to reach a size of 90 mm, but that as a juvenile it takes 8 years to reach 68.5 mm, we can estimate the adult growth rate and thus a maximum age based on the maximum size.

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

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

Figure 8

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 over estimate of maximum age as 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.