Market Squid (*Loligo (Doryteuthis) opalescens*)

Certification Units Considered Under this Species:

- California round haul fishery (purse and drum seine)
- California brail fishery

Summary

In terms of volume and revenue, market squid (*Loligo (Doryteuthis) opalescens*) represents one of the most important commercial fisheries in California, generating millions of dollars of income annually from domestic and foreign sales. Market squid is managed by the state, consistent with federal fishery management guidelines. Because squid live less than a year and die after spawning, there is difficulty in assessing annual recruitment or estimating stock biomass. Bycatch rates are low, and the majority of incidental catch is other coastal pelagic species (CPS).

Strengths:

- Low incidental catch and bycatch
- Managed under a state FMP and monitored under a federal FMP
- New analytical approach to estimate abundance of the spawning population (Dorval et al. 2013)

Weaknesses:

- Catch limits are fixed
- Biomass is largely influenced by environmental factors
- Market squid are an important forage species - more information is needed to determine how current harvest levels impact the ecosystem

History of the Fishery in California

Biology of the Species

Squid belong to the class Cephalopoda of the phylum Mollusca (CDFG 2005). There are approximately 750 recognized species of squid alive today and more than 10,000 fossil forms of cephalopods. Squid have large, well-developed eyes and strong parrot-like beaks. They use their fins for swimming in much the same way fish do and their funnel for extremely rapid "jet" propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances as well as to move vertically through hundreds of meters of water during daily foraging (feeding) bouts.

Market squid, *Loligo (Doryteuthis) opalescens*, range from the southern tip of Baja California, Mexico (23° N latitude) to southeastern Alaska (55° N latitude) (CDFG 2005). Juveniles and adults range throughout the California and Alaska Current systems (Roper and Sweeney 1984). Paralarvae, the life stage of market squid at the time of hatching, are often collected closer to shore (Zeidberg and Hamner 2002). Their distribution is patchy, yet if squid are found at one site, it is likely that additional squid will be found in close proximity (known as contagious distribution).

Market squid generally have a mixed, iridescent (opalescent) coloration of milky white and purple; however, color changes occur rapidly in response to environmental conditions (CDFG 2005). Similar to most squid species, market squid possess an ink sac, which serves as a defense mechanism by expelling ink to confound predators. Market squid are less than 3 mm (0.1 in) at hatching and grow to an average mantle length of 152 mm (6 in) at the time of spawning. Squid have eight arms and two longer feeding tentacles. Males are larger and more robust than females. Squid predominantly recruit in spring–summer in northern California (Monterey) and in autumn–winter in southern California, along the Channel Islands (Reiss et al. 2004; Foote et al. 2006). Following recruitment, mature squid aggregate in shallow coastal waters, where females lay egg cases in clutches for approximately 2–3 days and die soon after spawning (Jackson 1998; Macewicz et al. 2003). A female squid off California can produce approximately 20 egg capsules each containing around 200 eggs and are attached individually to the sea floor. The sustainability of the California market squid population is highly dependent on seasonal recruitments. In California, commercial fisheries target adults during spawning events.

Squid feed on copepods as juveniles gradually changing to euphausiids, other small crustaceans, small fish and other squid as they grow (Karpov and Cailliet 1987). They are also an important part of the food web and are food for many species including pinnipeds, cetaceans, sea birds, and fish (Morejohn et al. 1978).

Commercial Fishery

The California fishery for market squid was established over 130 years ago in Monterey Bay, central California (Vojkovich 1998). The fishery expanded into southern California after the 1950s, but remained relatively minor until the late 1980s, when worldwide demand for all squid species increased. Landings in California prior to 1987 rarely exceeded 20,000 metric tons (mt) (22,046 short tons (st)). Since then, landings have increased fourfold, and squid is now one of the state's largest fisheries in both tons landed and market value (Vojkovich 1998; CDFG 2012b).

There are two major fishery areas in California. The northern fishery consists of Monterey Bay and areas near Half Moon Bay with most squid landed at Monterey and Moss Landing. The southern fishery covers multiple port regions including Channel Islands and coastal areas from Point Conception to La Jolla. The major southern ports include Santa Barbara area (Ventura and Port Hueneme) and the Los Angeles area (San Pedro and Terminal Island). Since the 1993-94 season, much of the revenue has come from the Santa Barbara and Los Angeles port complexes, with the highest revenue from San Pedro, Port Hueneme and Ventura (PFMC 2011a). In the Monterey area, the fishery is most active during the summer months; whereas in southern California, the majority of market squid landings take place during winter months (CDFG 2012b). Landings in the southern region typically exceed the north (CDFG 2005; CDFG 2008). In 2011, the market squid fishery was the largest in California, both in terms of volume and value (CDFW 2012b). In 2012, over 97,076 mt (107,007 st) of market squid were landed in the calendar year, with an ex-vessel value of $68.3 million (Figure 1) (personal communication). In 2012-13 season, the commercial fishery was closed mid-season for the third season in a row.

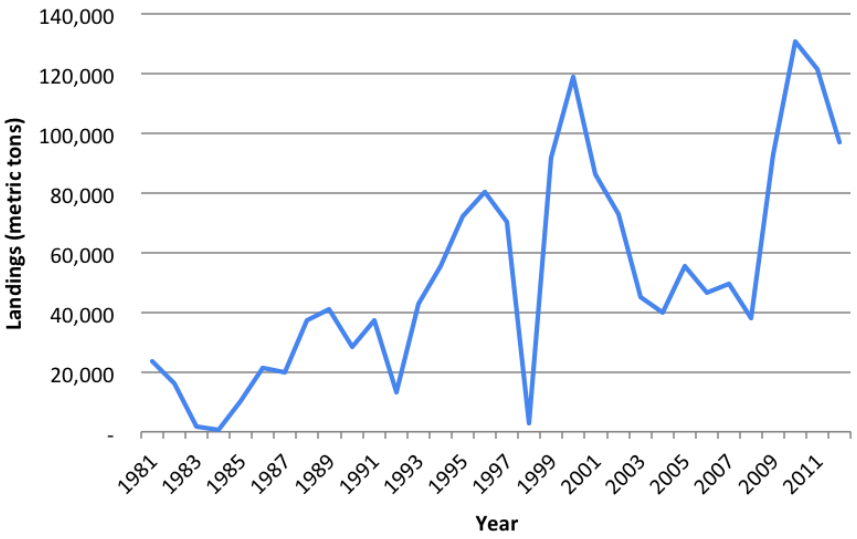

Figure 1. Market squid landings (northern and southern fisheries combined) by fishing season (1 April-31 March) from 1980-81 to 2011-12 seasons (personal communication).

The presence of market squid is strongly correlated with environmental factors, such as water temperature and nutrient availability (CDFG 2011a). In warm water years and during El Niño conditions, squid become scarce and landings decline. However, when water temperatures cool, even after severe warm water events, market squid numbers can rebound quickly and dramatically.

Fishing for market squid typically occurs on shallow-water spawning aggregations. Gear used in the fishery includes purse and drum seines, and less frequently brail gear, including dip and scoop nets (Table 1; CDFG 2005). Lampara gear has been used historically in the fishery but became obsolete once the use of purse and drum seines was legalized, thus it is not being considered in the rapid assessment (CDFG 2005). Light boats are used in tandem with the seiners to attract and aggregate spawning squid to surface waters (CDFG 2005). A light boat is typically a smaller vessel with several high-powered lights located at various levels around the vessel. In 2012, 42 brail permits, 36 light boat permits, 77 vessel permits and zero experimental permits were issued (CDFW 2013b).

Table 1. Market squid gear type description. (CDFG 2005)

Gear type	Description
Purse seine	A round haul net with a "purse" line to close the bottom of the net. One end is attached to a skiff and the deploying vessel encircles the squid. The other end of the net is brought to the deploying vessel and the purse line is drawn, closing the bottom of the net to prevent escaping squid.
Drum seine	Like a purse seine, but a large drum stores, deploys and retrieves the net.
Lampara	A round haul net with the sections of netting made and joined to create bagging. The net is pushed beneath squid to encircle it from each side. The "wings" of the net are pulled back to the boat and the squid end up in the bag portion of the net. This gear has no arrangement for pursing.
Brail	A large dip net sometimes used with the assistance of the vessel's hydraulics.

Market squid are also taken by the commercial live bait industry to supply the California recreational fishing industry, primarily in southern California (CDFG 2005). Live bait catch is largely dependent on local availability, and is sold by vessels either at sea or at live bait dealerships in several harbors statewide. Since the sale of live bait in California is not documented in a manner similar to that used for the commercial sale of squid, estimates of tonnage and value are only available via voluntary live bait logs. Present market squid regulations do not require a squid permit when fishing for live bait. It is assumed the take of live bait is minor, but the actual amount of squid taken as live bait is unknown.

Recreational Fishery

Market squid may be taken recreationally with hand-held dip nets (CDFW 2013a). There is no limit, closed seasons, closed hours or minimum size limits. Sport fishing vessels and privately owned skiffs catch squid for bait by using attracting lights and brail nets and/or rod and reel. Recreational landings records are not kept.

MSC Principle 1: Resource Sustainability

*Sustainability of Target Stock

The status of the population is not fully understood (CDFG 2008). Market squid live on average only 6–9 months (Butler et al. 1999), and the population fluctuates markedly from year to year, largely in apparent response to environmental factors. During El Niño events, the fishery has declined precipitously by an order of magnitude and more. However, it recovers typically within a few years, particularly in response to La Niña events (Zeidberg et al. 2006). Because market squid are a short-lived and highly fecund species, it seems to be able to recover from dramatic decreases in the population in a short period of time. The preponderance of evidence indicates that these dramatic fluctuations are more likely due to changes in abundance than mere shifts in availability to the fishery (Reiss et al. 2004). Evidence from studies on paralarvae, egg beds, behavior, genetics, and catch data suggest biomass is large, and at times, may constitute the largest population of any single marketable species in California's coastal environment. Genetic analyses have indicated no significant differences between the southern California and Monterey populations, suggesting that there are not two distinct stocks between the two fisheries (CDFG 2008).

*For California's Sustainable Seafood Program, this category must score an 80 or higher during an MSC assessment.

The Egg Escapement Method has been used as an assessment tool, to evaluate population dynamics and biological reference points for market squid (Dorval et al. 2008). The estimates of egg escapement are evaluated in the context of a “threshold” that is believed to represent a minimum level that is considered necessary to allow the population to maintain its level of abundance into the future (i.e., allow for “sustainable” reproduction year after year). In practical terms, the Egg Escapement approach can be used to evaluate the effects of fishing mortality (F) on the spawning potential of the stock, and in particular, to examine the relation between the stock’s reproductive output and candidate proxies for the fishing mortality that results in maximum sustainable yield (FMSY). ‘Escapement’ in this sense is defined as the proportion of a female squid’s lifetime fecundity that is spawned, on average, before the female is captured in the fishery (PFMC 2011a). Recent research efforts have developed an analytical approach for computing estimates of absolute abundance of the spawning population using relatively limited information, i.e. catch and biological time series data, and fishing mortality estimates inferred from the eggs-per-recruit methods (Dorval et al. 2013). Although time demanding, this per-recruit analysis represents a potentially effective approach for monitoring reproductive outputs and for aiding stock status determinations of harvested market squid (Dorval et al. 2013). At maximum peaks of abundance, the total spawning stock, including both female and male market squid, may range between 215,000 and 254,000 mt (236,996 and 279,987 st) in a single quarter in southern regions (Santa Barbara and San Diego). In some cases, stock biomass varied by region from one to two orders of magnitude. The current state-imposed catch limit of 107,048 mt (118,000 st) represents an annual quota for the entire California fishery in a fishing season (CDFG 2005).

There are concerns about overexploitation during the periodic downturns of the population (Zeidberg et al. 2006). Catch per unit effort (CPUE), a relative measure of abundance, has been relatively steady, but CPUE is generally unreliable as a proxy for stock biomass, particularly for a fishery with evolving gear technology (greater efficiency over time) and that targets spawning aggregations (Hilborn and Walters 2001). The impact of the fishery on the population has been recently modeled (Dorval et al. 2013). Increasing fishing mortality (F) was estimated to decreases in proportional egg escapement. In cases when F was kept constant, an increase in natural mortality (M) resulted in an increase in catch fecundity and proportional egg escapement. Studies indicate that market squid endure very high natural mortality rates, and the adult population is composed almost entirely of new recruits made up of multiple cohorts. Even in the absence of fishing, the entire stock replaces itself semi-annually, so the stock is entirely dependent on successful spawning from each generation coupled with good survival of recruits to adulthood.

Evaluation against MSC Component 1.1: Sustainability of Target Stock

MSC Performance Indicators	Rating	Justification
1.1.1 Stock Status		Biomass has been recently estimated for some seasons (Dorval et al. 2013), however populations fluctuate markedly from year to year due to environmental variables making it difficult to determine the status of the stock
1.1.2 Reference Points		Proxies for a limit reference point* and a target reference point*.
1.1.3 Stock rebuilding		Did not assess

*MSC evaluations define a Limit Reference Point (LRP) and a Target Reference Point (TRP). These represent the minimum biomass of a stock, below which might endanger self-renewal, and the maintenance of the stock at levels consistent with BMSY, respectively. For market squid, a proxy for the LRP could be the maximum fishing mortality threshold (MFMT), set at: FMSY resulting in egg escapement ≤ 30%; a proxy for TRP is the MSY, set at: FMSY resulting in egg escapement ≥ 30% (PFMC 2011b).

Harvest Strategy (Management)

Market squid is managed by the state, consistent with federal fishery management guidelines (Coastal Pelagic Species Fishery Management Plan (CPS FMP)). In 2005, the Fish and Game Commission (FGC) adopted the Market Squid Fishery Management Plan (MS FMP), which implemented a series of fishery control rules and a restricted access program that limits the number of fishing permits. The fishery control rules currently in place under the California MS FMP are thought to preclude the need for active management under the CPS FMP (PFMC 2011a).

The goals of the MS FMP are to provide a framework that will be responsive to environmental and socioeconomic changes and to ensure long-term resource conservation and sustainability (CDFG 2005). The tools implemented to accomplish these goals include:

1. setting a fixed seasonal catch limit of 107,048 mt (118,000 st) to prevent the fishery from over-expanding (based on an average catch over a 3 year period from 1999-00 to 2001-02 seasons) (Restrepo et al. 1998; CDFG 2005),

2. maintaining monitoring programs designed to evaluate the impact of the fishery on the resource,

3. continuing weekend closures that provide for periods of uninterrupted spawning,

4. continuing gear regulations regarding light shields and wattage used to attract squid,

5. establishing a restricted access program that includes provisions for initial entry into the fleet, permit types, permit fees, and permit transferability that produces a moderately productive and specialized fleet, and

6. creating a seabird closure restricting the use of attracting lights for commercial purposes in any waters of the Gulf of the Farallones National Marine Sanctuary. Under this framework, the MS FMP provides the Commission with specific guidelines for making management decisions.

The following are the harvest control rules for market squid (CDFG 2005; PFMC 2011b):

MFMT	F_{MSY} Resulting in Egg Escapement ≤ 30%
MSY	F_{MSY} Resulting in Egg Escapement ≥ 30%
ABC	F_{MSY} Resulting in Egg Escapement ≥ 30%
California State Seasonal Catch Limit	118,000 st (107,047 mt)

MFMT: Maximum Fishing Mortality Threshold; the level of fishing mortality (F), on an annual basis, above which overfishing is occurring.
MSY: Maximum Sustained Yield; the largest long-term average catch that can be taken from a stock under prevailing ecological, environmental and fishing conditions.
ABC: Acceptable Biological Catch; the range of allowable catch for a species
ACL: Annual Catch Limit

Regulations state that commercial fishing for market squid is not allowed between noon on Friday and noon on Sunday of each week; however, vessels taking squid for live bait purposes are exempt. Vessels using light to attract squid can use a maximum of 30,000 watts and must use shields that cast light directly downward. Use of lights is prohibited for all vessels taking squid in the Gulf of the Farallones National Marine Sanctuary. The Commission has established a statewide seasonal catch limitation based on a multi-year recent average catch. The California Department of Fish and Wildlife (CDFW) will estimate, given current landing trends, when the catch limit will be reached and will publicly announce a date of fishery closure.

The Commission has decided to continue the existing squid monitoring programs, including fishery-dependent sampling efforts and ongoing monitoring of catch information, especially those focused on developing management models. The adopted project also maintains CDFW logbook system for squid vessels and light boats. These records provide valuable catch information other than landing data. These monitoring programs (port sampling and logbooks) are designed to enable learning more about the fishery and resource and are intended to aid in the development of population models to sustain harvests (CDFG 2005).

Evaluation against MSC Component 1.2: Harvest Strategy

MSC Performance Indicators	Rating	Justification
1.2.1 Harvest Strategy		Fixed seasonal catch limit - fishery is shut down once limit is projected to be reached; Management structure and strategy is robust
1.2.2 Harvest Control Rules and Tools		Egg escapement threshold used as a proxy for F_{MSY}; Restricted access, seasonal catch limit, weekend closures, area closures, gear restrictions
1.2.3 Information/Monitoring		Fishery dependent and independent sampling, ongoing catch monitoring data available (logbooks, observers, port sampling); Data collected to aid stock status determinations
1.2.4 Assessment of Stock Status		No stock assessment (inherent difficulties in assessing a stock that is short-lived); Recent research has developed an approach for computing estimates of the spawning population, though approach is not fully utilized to date

MSC Principle 2: Impact on Ecosystem

Retained Species

Purse and Drum Seines

Roundhaul gear consists of encircling type nets, which are deployed around a school of fish or part of a school (PFMC 2011a). When the school is surrounded, the bottom of the net may be closed, then the net drawn next to the boat. The area including the free-swimming fish is diminished by bringing one end of the net aboard the vessel. When the fish are crowded near the fishing vessel, pumps are lowered into the water to pump fish and water into the ship's hold.

Roundhaul fishing results in small quantities of unintentionally caught fish, primarily because the fishermen target specific schools, which usually consists of one species. The load is pumped out of the hold at the dock, where the catch is weighed and incidentally-caught fish can be observed and sorted. Because pumping at sea is so common, any incidental catch of small fish would not be sorted at sea. The presence or absence of incidental catch has been documented through CDFW's port sampling program (all gear types combined) but actual amounts of incidental catch are not quantified with this monitoring (PFMC 2011c). Market squid typically school with similarly sized fish, and the most common incidental catch in the coastal pelagic species (CPS) fishery is another CPS (e.g., Pacific mackerel, Pacific sardine fishery, northern anchovy and jack mackerel). None of these species, including Pacific sardine, Pacific mackerel, are considered overfished or otherwise jeopardized by the market squid fishery (PFMC 2011a).

During a pilot observer program conducted by National Marine Fisheries Service Southwest Region (NMFS-SWR) on seine vessels from 2004-08, the most incidentally caught species, Pacific mackerel, was less than 2% of total squid landings during that time (Table 3). In 2010, less than 1% of roundhaul market squid landings (by tonnage) included reported incidental catch of CPS (PFMC 2011c). Similar to previous years, most of this catch was other pelagic species, including Pacific sardine and mackerel, and kelp was also observed frequently.

While not specifically impacting the ecosystem, a concern in the market squid fishery is incidental catch of market squid egg capsules, which may affect the stock itself. In 2011, approximately 8.4% of sampled landings contained squid egg cases (PFMC 2011d). Under the proposed management strategy, the fishery is monitored by evaluating escapement of squid eggs from the fishery. If the fishery damages squid spawning beds, and this damage is a significant source of egg mortality, the monitoring program will be biased unless this additional source of mortality is accounted for.

Evaluation against MSC Component 2.1: Retained Species

MSC Performance Indicators	Rating	Justification
2.1.1 Outcome		Retained species catch is low and primarily consists of other CPS
2.1.2 Management		Coastal pelagic species (see 2.1.1 Outcome) are managed or monitored under the PFMC's CPS FMP
2.1.3 Information		CDFW port sampling, logbooks, landing receipts; NMFS-SWR CPS pilot observer data (2004-08)

Brail

The brail fleet produces only a small fraction of the overall take of market squid. The hydraulic brail (scoop) net is used onboard vessels that are usually smaller than seiners. Because brail vessels are compact and more maneuverable, they are used in shallower depths that are closer to shore and in areas where seiners are prohibited (e.g., Santa Monica Bay and the mainland side of Catalina Island) (Brady 2008).

CDFW's port sampling program documents the presence of incidental catch. As stated above, the majority of incidental catch in the squid fishery are other coastal pelagic species (e.g., Pacific mackerel, Pacific sardine, northern anchovy and jack mackerel) (PFMC 2011d). None of these species, including Pacific sardine or Pacific mackerel, are considered overfished or otherwise jeopardized by the market squid fishery (PFMC 2011c). Since the brail fleet is responsible for a small portion of total market squid landings in California, along with data to suggest most incidental catch consists of other CPS (managed under the CPS FMP), it is unlikely that the brail fishery poses a risk of serious or irreversible harm to retained species.

Evaluation against MSC Component 2.1: Retained Species

MSC Performance Indicators	Rating	Justification
2.1.1 Outcome		Retained species catch is low and primarily consists of other coastal pelagic species
2.1.2 Management		Coastal pelagic species (see 2.1.1 Outcome) are managed or monitored under the PFMC's CPS FMP
2.1.3 Information		CDFW port sampling, logbooks, landing receipts, NMFS-SWR CPS pilot observer data (2004-08)

Bycatch Species

Purse and Drum Seine

During a CPS pilot observer program conducted by NMFS-SWR on seine vessels from 2004-2008, the majority of non-target species consisted of other CPS (anchovy, jack and Pacific mackerel, sardine), but also infrequently included benthic (bottom-dwelling) species such as stingrays, bat rays, brittle stars, and croaker (Table 2; PFMC 2011c; PFMC 2011d). If larger fish are in the net, they can be released alive before pumping by lowering a section of the cork-line or by using a dip-net. Grates can be used to sort larger non-CPS from the catch.

Since many bycatch species can be discarded live at sea, along with some observed data to suggest bycatch is low, it is unlikely that the seine fishery poses a risk of serious or irreversible harm to bycatch species.

Evaluation against MSC Component 2.2: Bycatch

MSC Performance Indicators	Rating	Justification
2.2.1 Outcome		Bycatch is low, can be discarded live
2.2.2 Management		Bycatch is low, many species covered under the groundfish FMP
2.2.3 Information		Logbooks, NMFS SAFE reports, NMFS-SWR CPS pilot observer data (2004-08)

Brail

NMFS-SWR pilot observer data from seine vessels suggests the majority of non-target species consisted of other CPS, but also infrequently included benthic species (PFMC 2011c). Because brail vessels often fish in areas closer to shore, the pilot observer data may not be representative of the brail fleet. However since the brail fleet produces only a small fraction of the overall take of market squid, it is unlikely that the brail fishery poses a risk of serious or irreversible harm to bycatch species though more data may be necessary if the fishery were to pursue MSC certification.

Evaluation against MSC Component 2.2: Bycatch

MSC Performance Indicators	Rating	Justification
2.2.1 Outcome		Bycatch is likely low, species can be discarded live, but more data is necessary for the brail fleet
2.2.2 Management		Bycatch is likely low, many bottom-dwelling species are covered under the groundfish FMP
2.2.3 Information		Logbooks

Table 2. Catch summary for seine vessels targeting market squid from NMFS-SWR coastal pelagic species pilot observer program, 2004-2008. (NMFS 2011d)

Target species - Squid					
Species	Target Catch	Incidental Catch	Bycatch Returned		
			Alive	Dead	Unknown
Squid	1274 mt		28 mt	350 lbs	2 mt
Anchovy		100 lbs	120 lbs		
Jack Mackerel		2 mt	18 lbs	2 lbs	
Pacific Mackerel		20 mt	20 mt	180 lbs	1 lb
Sardine		12 mt	13 mt	1077 lbs	3 lbs
Spanish Mackerel		20 lbs			
Bat Ray			53		1
Bat Star			1		
Blue Shark			2		
Common Mola			1		
Pelagic Stingray			60		
Pacific Butterfish		19			1
Sunstar		30	4		
Squid Eggs					505 lbs
Lobster			3		
Brittle Star				3000	
Unid. Batfish				2 lbs	
Unid. Crab		1	1		93
Unid. Croaker		3	2	16 lbs	
Unid. Flatfish		1	1	6	2
Unid. Jellyfish		4			
Unid. Mackerel		2 lbs	102 lbs		
Unid. Octopus		1			
Unid. Rockfish		1	1	4	
Unid. Ray			4		1
Unid. Sanddab		4	3		4
Unid. Seastar		1			
Unid. Seaslug					21
Unid. Scorpionfish		1			
Unid. Surfperch				3	
Unid. Skate		3		1	
Unid. Smelt		49			
Unid. Stingray		9	17		
Unid. Shark					1
Thresher Shark		1			
CA Sea Lion			98		
Harbor Seal			3		
Common Dolphin				1	
Unid. Gull			16	1	

*Endangered, Threatened, and Protected Species

Purse and Drum Seine

NOAA National Marine Fisheries Service (NMFS) classifies all U.S. commercial fisheries into one of three categories (I, II, III) based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery (NMFS 2012). The California squid purse seine fishery has occasional interactions with endangered, threatened and protected species, including long-beaked common dolphin, California short-beaked common dolphin, California sea lions, and harbor seals (Table 2; NMFS 2012); however, it is listed as a category III fishery (remote likelihood of/no known incidental mortality or serious injury of marine mammals). Given the NMFS's 2012 LOF classification it is unlikely that the California seine fishery poses a risk of serious or irreversible harm to endangered, threatened and protected species.

Evaluation against MSC Component 2.3: Endangered, Threatened & Protected Species

MSC Performance Indicators	Rating	Justification
2.3.1 Outcome		NMFS category III fishery, ETP species impacts are low, though occasional interactions with dolphins, sea lions and seals
2.3.2 Management		Measures exist, including Magnuson-Stevens Act, CEQA, Migratory Bird Act, Marine Mammal Protection Act, to protect ETP species
2.3.3 Information		Observer data from 2004-2008; logbooks; NMFS SAFE reports; NMFS LOF

Brail

NOAA National Marine Fisheries Service (NMFS) classified the California market squid brail (dip net) fishery as category III, indicting no documented interactions with marine mammal species (NMFS 2012). Given the NMFS's 2012 LOF classification, it is unlikely that the California brail (dip net) fishery poses a risk of serious or irreversible harm to endangered, threatened and protected species.

*For California's Sustainable Seafood Program, this category must score an 80 or higher during an MSC assessment.

Evaluation against MSC Component 2.3: Endangered, Threatened & Protected Species

MSC Performance Indicators	Rating	Justification
2.3.1 Outcome		NMFS category III fishery, ETP species impacts are low, no documented interactions with marine mammals
2.3.2 Management		Measures exist, including Magnuson-Stevens Act, CEQA, Migratory Bird Act, Marine Mammal Protection Act, to protect ETP species
2.3.3 Information		NMFS SAFE reports; NMFS LOF

Habitats

Purse and Drum Seine

The east-west geographic boundary of essential fish habitat (EFH) for market squid is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone (EEZ) and above the thermocline where sea surface temperatures range between 10˚ C to 26˚ C (50˚ to 79˚ F) (CPSMT 2010). The southern boundary of the geographic range of all CPS is consistently south of the US-Mexico border, indicating a consistency in sea surface temperatures (SSTs) below 26˚ C (79˚ F), the upper thermal tolerance of CPS. Therefore, the southern extent of EFH for CPS is the US-Mexico maritime boundary. The northern boundary of the range of CPS is more dynamic and variable due to the seasonal cooling of the SST. The northern EFH boundary is, therefore, the position of the 10˚ C (50˚ f) isotherm, which varies both seasonally and annually.

Appendix D of the CPS FMP (PFMC 1998) notes that contact between roundhaul gear (purse seines) and substrate is rare in fishing for CPS finfish and market squid, because fishing usually occurs in water deeper than the height of the net. Thus, the only opportunity for damage to benthos or essential fish habitat for any species in fishing for CPS finfish is from lost gear. There is potential for fishing to impact squid spawning grounds because market squid attach their egg cases to the bottom substrate at spawning sites that include shallow, nearshore areas. Such damage is not believed to be extensive and is transitory with regard to the habitat.

Evaluation against MSC Component 2.4: Habitat

MSC Performance Indicators	Rating	Justification
2.4.1 Outcome		Habitat damage from roundhaul gear is not believed to be extensive
2.4.2 Management		Temporal and spatial area closures, gear restrictions
2.4.3 Information		Logbooks, observer information

Brail

Unable to assess habitat impacts from brail gear – lack of data.

Evaluation against MSC Component 2.4: Habitat

MSC Performance Indicators	Rating	Justification
2.4.1 Outcome		No data, however likely green since brail gear only scoops from the surface of the water
2.4.2 Management		Temporal and spatial area closures, gear restrictions
2.4.3 Information		Logbooks

Ecosystem

Market squid are an integral part of the food web to many marine vertebrates (Figure 2). Fish, seabirds, and marine mammals all utilize squid as a prey item. Squid has been documented as an important dietary component of the northern elephant seal, northern fur seal, California sea lion (Lowry and Carretta 1999), Dall's porpoise, Pacific striped dolphin, Risso's dolphin, toothed whales such as the short-finned pilot whale (Hacker 1992), the sperm whale, and the bottlenose whale (Fields 1965). In addition, seabirds such as the common murre, ashy storm-petrel, black storm-petrel, fork-tailed storm-petrel, and rhinoceros auklets feed on market squid (Morejohn et al. 1978). In Monterey Bay, 19 species of fish were found to feed upon market squid, including many commercially important species such as Pacific bonito, salmon, halibut, and tuna (Fields 1965, Morejohn et al. 1978). These fishes include all depleted, threatened, and endangered salmon stocks along the coast. In fact predators from many trophic levels utilize both small pelagic fishes, such as northern anchovy and sardine, and squid as either a primary or supplementary food source (CDFG 2005).

Market squid feed on a variety of prey during their life cycle (CDFG 2005). As larvae and juveniles, squid consume copepods and euphasiids. These fast-moving prey items are a challenge to young squid; they enhance the development of prey-capture and escape skills (Preuss and Gilly 2000). As adults, market squid feed on fish, polychaete worms, squid (cannibalism), and crustaceans such as shrimp and pelagic red crab. Also, squid are found in commercial catches of anchovies, sardines, herring, mackerel, and sauries where they feed with and most likely upon these fish (Fields 1965).

Under the Marine Life Management Act (MLMA), CDFW must consider ecosystem impacts of a fishery, namely the conservation of not only the exploited species, but the other species that depend on that resource. At present, the dynamics of many of these trophic relationships for squid are not well understood. In addition, the FGC has a Forage Fish Policy that envisions management of forage species that (1) optimizes their ecological, economic and social values, (2) accounts for the benefits rendered by forage species to other species, fisheries, wildlife, and the overall ecosystem, and (3) considers recreational and commercial fishing interests and other economic sectors. The Commission intends to provide adequate protection for forage species through management goals. At this stage however, more information is needed to understand how or if the current management measures protect the ecosystem structure and function.

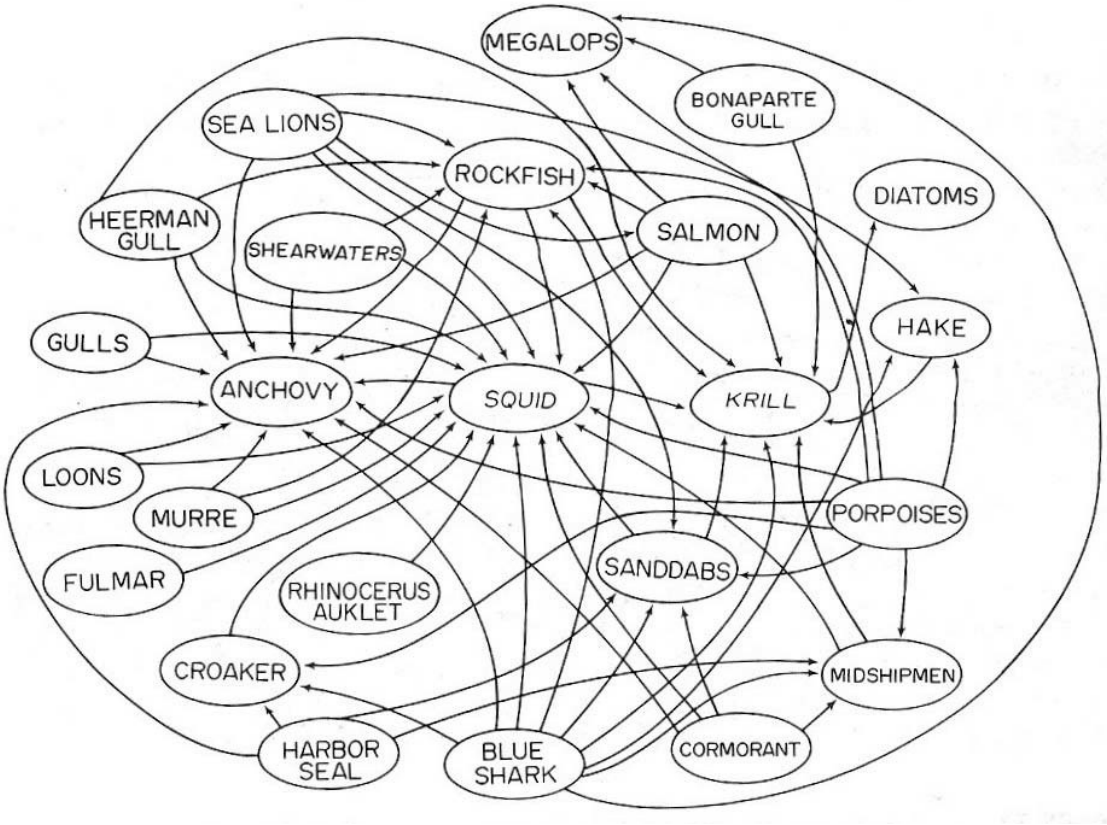

Figure 2. Food web for market squid, *Loligo (Doryteuthis) opalescens*, involving commercially important or abundant fish, birds, and marine mammals (Morejohn et al. 1978).

Evaluation against MSC Component 2.5: Ecosystem

MSC Performance Indicators	Rating	Justification
2.5.1 Outcome		Squid are an important forage species, more information is needed to determine how current harvest levels impact the ecosystem; annual catch limit is currently fixed based on a 3 year average catch
2.5.2 Management		MLMA; The FGC has a Forage Species policy
2.5.3 Information		Trophic interactions are not fully understood

MSC Principle 3: Management System

Governance and Policy

In state waters (0-3 miles offshore), the FGC manages various fisheries through measures that include but are not limited to determining seasons, catch limits, and methods of take. In each case, the FGC holds regular open public meetings throughout the state to receive and consider individual and group input prior to adoption of new or changed regulations. Recommendations also come from CDFW. Once the FGC votes to adopt a regulation, CDFW is responsible for enforcing it. CDFW implements management plans, provides technical expertise, manages fishery regulations and coordinates the implementation of policy state-wide. CDFW is responsible for providing recommendations to the FGC and carrying out research that informs these recommendations or other management decisions by the Legislature. CDFW is also responsible for enforcing the fish and game regulations mandated by the FGC, the Legislature, and the federal government. The Legislature can increase the FGC's powers by delegating further regulatory and management authority. The MLMA governs the way the majority of FGC fisheries are managed.

Market squid is included in the Federal CPS FMP as a monitored species. The Pacific Fishery Management Council is one of eight regional fishery management councils established by the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA). The Guidelines for Fishery Management Plans (FMPs) published by the National Marine Fisheries Service (NMFS) require that a stock assessment and fishery evaluation (SAFE) report be prepared and reviewed annually for each FMP (PFMC 2011c). SAFE reports are intended to summarize the best available scientific information concerning the past, present, and possible future condition of the stocks, marine ecosystems, and fisheries being managed under federal regulation. Regional Fishery Management Councils use this information to determine annual harvest levels for each stock, document significant trends or changes in the resources, marine ecosystems, and fishery over time, and assess the relative success of existing state and federal fishery management programs.

Evaluation against MSC Component 3.1: Governance and Policy

MSC Performance Indicators	Rating	Justification
3.1.1 Legal and/or Customary Framework		The FGC must operate under the MLMA; PFMC and NMFS must operate under Magnuson-Stevens Act
3.1.2 Consultation, Roles and responsibilities		The FGC holds public meetings prior to adoption of new regulations; CDFW responsible for implementing and enforcing both state and federal regulations
3.1.3 Long-term Objectives		Goals and objectives detailed in MLMA, Magnuson-Stevens Act and FMPs
3.1.4 Incentives for Sustainable Fishing		Sustainability is an underlying goal of the MLMA, MSA

Fishery Specific Management System

In 2001, legislation transferred the authority for management of the market squid fishery to the FGC. Legislation required that the FGC adopt a market squid fishery management plan and regulations to protect and manage the resource. In August and December of 2004, the FGC adopted the MSFMP, consistent with the federal management by the Pacific Fishery Management Council. The goals of the MSFMP are to provide a framework that will be responsive to environmental and socioeconomic changes and to ensure long-term resource conservation and sustainability.

Under this framework, the MSFMP provides the FGC with specific guidelines for making management decisions. The FGC has the ability to react quickly to changes in the market squid population off California and implement management strategies without the need for a full plan amendment. The MSFMP framework was also designed to achieve the goals and objectives of the MLMA. The MLMA of 1998 created policies, goals, and objectives to govern the conservation, sustainable use and restoration of California's living marine resources. The MLMA gave the FGC and CDFW specific authorities, goals, objectives, and mandates for managing marine resources (CDFG 2005). The MSFMP must also be consistent with the management outlined in CPS FMP Amendment 10.

The FGC established that the Director of CDFW may create an advisory committee when necessary to assist CDFW with development and review of fishery assessments, management options and proposals, and Plan amendments (CDFG 2005). This squid fishery advisory committee must include representatives from industry, science, and the environmental community. The committee can assist CDFW by providing recommendations regarding the effectiveness of adopted squid management.

The MLMA requires periodic review of management measures because environmental, social, and economic changes may lead to consideration of regulatory changes under the framework described above (CDFG 2005). If CDFW determines that current management of the market squid fishery is not meeting the goals of the MSFMP, CDFW will present the results of this review to the advisory committee(s) established under the MSFMP to seek their views and recommendations. CDFW will then present its recommendations and views of the advisory committee(s) to the FGC regarding the need for changes in management of the market squid fishery. CDFW needs to present the rationale, data and analyses in support of its recommendations for regulatory changes. The advisory committee(s) may also make management recommendations to CDFW. The FGC will then determine whether to consider an amendment to the MSFMP or a full rulemaking action for the regulations implementing it.

Enforcement of fishing regulations is conducted in state waters by CDFW's Law Enforcement Division and in federal waters by NOAA's Office of Law Enforcement. Additionally tools such as port sampling, logbooks, and observer coverage are used to monitor catch and ensure vessels have the correct permits for the catch they are landing. Violators are prosecuted under the law. There is no evidence of systemic non-compliance.

Evaluation against MSC Component 3.2: Fishery Specific Management System

MSC Performance Indicators	Rating	Justification
3.2.1 Fishery Specific Objectives		Outlined in the CPS FMP and MSFMP
3.2.2 Decision-making Processes		MLMA gave the Commission and CDFW specific authorities, goals, objectives, and mandates for managing marine resources
3.2.3 Compliance & Enforcement		An enforcement system exists and has demonstrated an ability to enforce relevant management measures, strategies and/or rules.
3.2.4 Research Plan		CPS FMP and MSFMP detail monitoring plans, however they have not been fully implemented to date
3.2.5 Management Performance Evaluation		MLMA requires periodic review of management measures; the Commission may create advisory committee to review and develop management options and amendments

California Specific Requirements

The California voluntary sustainable seafood program requires fisheries seeking certification to meet California specific standards in addition to the standards and requirements of the Marine Stewardship Council (MSC) sustainable fisheries certification program. These include:

1. Higher scores (80 instead of 60) for two performance indicators (PI) of the MSC program: "Stock Status" (PI 1.1.1) and "By-catch of Endangered, Threatened, or Protected (ETP) Species" (PI 2.3.1). These two PIs are highlighted in the report.

2. Additional independent scientific review: The OPC Science Advisory Team will be engaged in the certification process through early consultation in reviewing minimum eligibility criteria, and review of the MSC-required pre-assessments and full assessments. The reviews will be conducted in addition to MSC's peer review, thus bringing additional credibility, transparency, and independence to California's certification process.

3. Additional traceability components: The California program will develop a unique barcode for California certified sustainable fish. This barcode can be either scanned by a smart-phone or linked to a website that will reveal additional information about the fishery, and information about toxicity when available.

Recommendations

Because market squid are short lived and highly fecund species it seems to be able to recover from dramatic decreases in the population in a short period of time; however, if harvest was

reduced during such low productivity periods the stock may be able to recover even faster when conditions improved.

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Appendix A

MSC Assessment Tree			Market Squid	
			Round Haul	Brail
Principle	**Component**	**Performance Indicator**	**All**	**All**
Principle 1: Health of Fish Stock	Outcome	1.1.1: Stock status		
		1.1.2: Reference points		
		1.1.3: Stock rebuilding	*Did not assess*	*Did not assess*
	Harvest Strategy (Management)	1.2.1: Harvest strategy		
		1.2.2: Harvest control rules		
		1.2.3: Info/ monitoring		
		1.2.4: Stock assessment		
Principle 2: Impact on Ecosystem	Retained species	2.1.1: Status		
		2.1.2: Mgmt strategy		
		2.1.3: Information		
	By-catch species	2.2.1: Status		
		2.2.2: Mgmt strategy		
		2.2.3: Info		
	ETP species	2.3.1: Status		
		2.3.2: Mgmt strategy		
		2.3.3: Info		
	Habitats	2.4.1: Status		
		2.4.2: Mgmt strategy		
		2.4.3: Info		
	Ecosystem	2.5.1: Status		
		2.5.2: Mgmt strategy		
		2.5.3: Info		
Principle 3: Management System	Governance & Policy	3.1.1: Legal framework		
		3.1.2: Consultation, roles, and responsibilities		
		3.1.3: Long term objectives		
		3.1.4: Incentives for sustainable fishing		
	Fishery Specific Mgmt System	3.2.1: Fishery specific objectives		
		3.2.2: Decision making process		
		3.2.3: Compliance & enforcement		
		3.2.4: Research plan		
		3.2.5: Management performance evaluation		