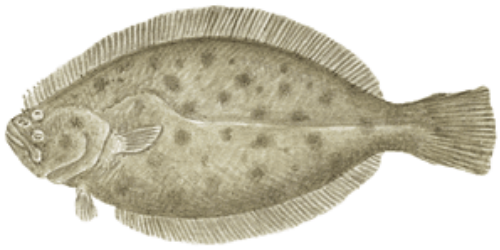
Sustainable Fishery Advocates

Seafood Report

California Halibut

Paralichthys californicus



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Final Report
July 6, 2006

Teresa Ish and Francine Stroman
Director of Science and Science Intern
Sustainable Fishery Advocates

About SFA® and the Seafood Reports

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 the Internet (seafoodwatch.org) or obtained from the Seafood Watch® program by emailing seafoodwatch@mbayaq.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 Report. Each report 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." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, 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® Fisheries 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 Seafood Reports 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 Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

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® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

Executive Summary

California halibut (*Paralichthys californicus*) is a moderately long-lived fish found along the coast of California and Baja California, Mexico. It is caught primarily by bottom trawls, hook-and-line gear, and gillnets. The nursery habitat for this species is degraded, raising concerns about the ability of the population to sustain heavy fishing pressure. However, with no current assessment, the impact of environmental degradation or fishing pressure on abundance is unclear. Fishing methods with high collateral damage such as gillnets are high conservation concerns and are best avoided, while fishing methods with lower impacts rank as a moderate conservation concern and are preferred over more destructive methods.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability		√		
Status of Stocks		√		
Nature of Bycatch	√ Hook and line	√ Bottom trawl		√ Set gillnet
Habitat Effects	√ Hook and line; Set gillnet	√ Bottom trawl		
Management Effectiveness		√		

About the Overall Seafood Recommendation[1]

- A seafood product is ranked "**Unsustainable**" if a total of two or more criteria are indicated as Concern: High (red) OR if one or more criteria are indicated as Concern: Critical (black) in the table above.
- A seafood product is ranked "**Some Concerns**" if a total of three or more criteria are indicated as Concern: Moderate (yellow) OR where the "Status of Stocks" and "Management Effectiveness" criteria are both indicated as Concern: Moderate.
- A seafood product is ranked "**Best Choices**" if a total of three or more criteria are indicated as Concern: Low (green) and no remaining criteria are indicated as Concern: High or Concern: Critical.

Overall Seafood Recommendation

Hook & Line; Bottom Trawl:

Best Choice | **Some Concerns** | Unsustainable

Set Gillnet:

Best Choice | Some Concerns | **Unsustainable**

[1] Sustainable Fishery Advocates uses different language to describe the red, yellow, and green categories in Seafood Watch's ranking methodology. This reflects the different needs of business customers versus general consumers but does not represent differences in evaluation methodologies between SFA and Seafood Watch®.

Introduction

California halibut is a member of the family Paralichthyidae (large tooth flounders and sanddabs). Although it is a member of the left-eyed flounder family, about 40 percent of California halibut have their eyes on the right side (DFG). The body of the California halibut is oblong and compressed with a small head and large mouth (Figure 1), and is dark brown to black on the eyed side and white on the blind side. Their numerous teeth, very large mouth and a high arch in the middle of the "top" side above the pectoral fin make them easily distinguishable from other flatfish. California halibut occur from Magdalena Bay, Baja California, to the Quillayute River, British Columbia. A separate population occurs in the upper Gulf of California (DFG).

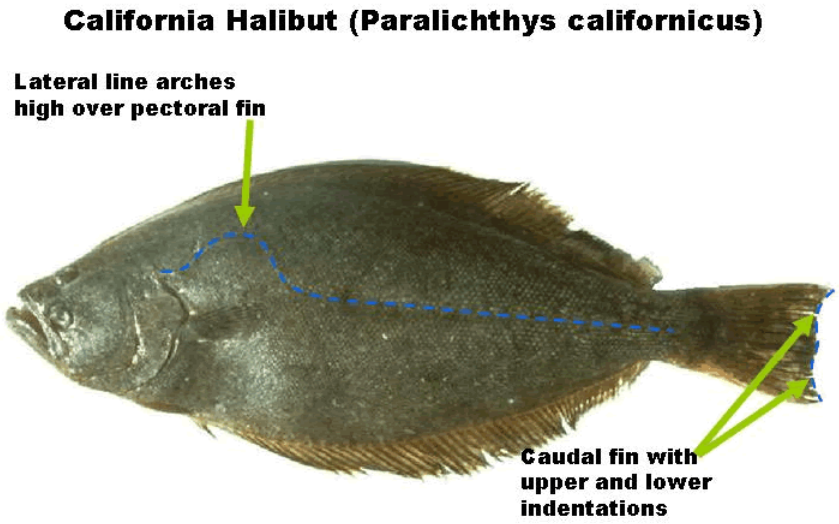


Figure 1. Distinctive characteristics of California halibut. Photo taken from DFG website: http://www.dfg.ca.gov/mrd/mspcont8.html.

California halibut are broadcast spawners with eggs being fertilized externally. The eggs and larvae are pelagic (Allen 1988). Adults move inshore to spawn during the spring and summer and offshore during the winter (Haaker 1975). The spawning season is generally thought to extend from February to August with most spawning occurring in May (Frey 1971). Spawning is thought to occur on sandy bottoms over depths of 6-20 meters (m) along the coast outside embayments (Haaker 1975). After spawning, adults return to water of about 40-100 m in depth (Ginsburg 1952). There is some evidence that suggests that young-of-the-year California halibut occupy embayments in large numbers (Allen 1988; Kramer 1991; Kramer 1991), although they are found all along the coast in low densities (Kramer 1991; Kramer 1991; Forrester and Swearer 2002). Juveniles move from nursery habitats to join with adult populations offshore after about 1 year (Kramer 1991; Forrester and Swearer 2002).

Juveniles and adults are demersal and occur mostly on sandy sediments, although some have been found near rocks, algae, or beds of pacific sand dollars (*Dendraster excentricus*) (Feder et al. 1974). They frequently lie buried or partially buried in the sediment. California halibut are relatively sedentary, remaining in the same area for long periods of time with little movement

(Haaker 1975; Domeier and Chun 1995; Posner and Lavenberg 1999). However, occasionally halibut have been found to move long distances (Domeier and Chun 1995). Smaller halibut (<55 mm) eat small fish and crustaceans, while larger halibut (55-230 mm) eat larger crustaceans and fish (Haaker 1975). The northern anchovy, *Engraulis mordax*, is probably the most important prey of the California halibut (Frey 1971).

Fishery Information

The fishery for California halibut is concentrated from Bodega Bay in northern California to San Diego in southern California (Figure 2) (DFG). While the population extends well into Mexico, the contribution of halibut from Mexican waters imported into the US has generally been trivial since 1967 (Figure 3) (DFG). Substantial genetic variation between two populations of California halibut in the Southern California Bight suggests that the natural population is subdivided (Hedgecock and Bartley 1988). Jow (1990) found that the widespread separation of the two major halibut trawl fishing areas and the ecological differences between them are suggestive of separate populations. However, with the lack of growth recruitment to the population in northern California, the halibut fishery could be supported by northward movement or migration within a common stock.

Figure 2. The four fishing areas for California halibut with gill and entangling nets (set nets). Set nets are illegal in California north of the San Francisco area.

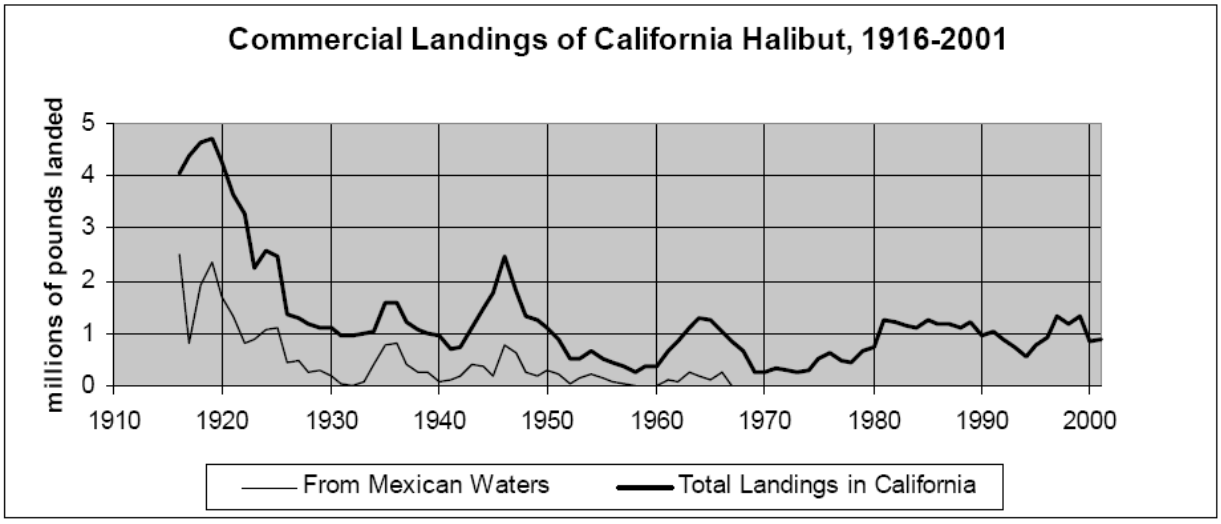


Figure 3. Annual commercial landings (pounds) of California halibut from 1916 to 2001. Data sources are the California Department of Fish and Game (DFG) Catch bulletins (1916-1983) and the DFG commercial landing receipt database (1984-2001). From Wertz et al. (2004).

Effort and Trends

California halibut were first landed by trawl as bycatch in fisheries for English sole (*Parophrys vetulus*), petrale sole (*Eopsetta jordani*), and rockfish (*Sebastes* spp.) off San Francisco (Jow 1990). Landing records were first kept in the mid-1910s. After the initial development of the fishery, landings have been constant, but much lower than the early landings. The record commercial landing of halibut was 4.7 million pounds (lbs) in 1919 (Wertz et al. 2004) and the lowest landing recorded was 256,000 lbs in 1958 (Barsky 1990). From 1981-1991 landings remained relatively constant (Figure 4). A decrease in landings from 1992-1994 may be a result of changes in gill and trammel net regulations during this period (Figure 6). Landings have remained relatively constant since 1995, but they have not reached the 1919 record of 4.7 million pounds. Recently a live-fish fishery has developed for California halibut, which fetches nearly twice the price as the traditional fishery (Love 1996).

The recreational fishery has also been an important component of California halibut fishing mortality (Figure 4). Variation in the recreational fishery has been much higher than in the commercial fishery during the 1980s and 1990s. Since 2000, recreational landings have dropped substantially. It is unclear whether the variations are from actual changes in fishing pressure or from poor data due to the difficulty in sampling this fishery.

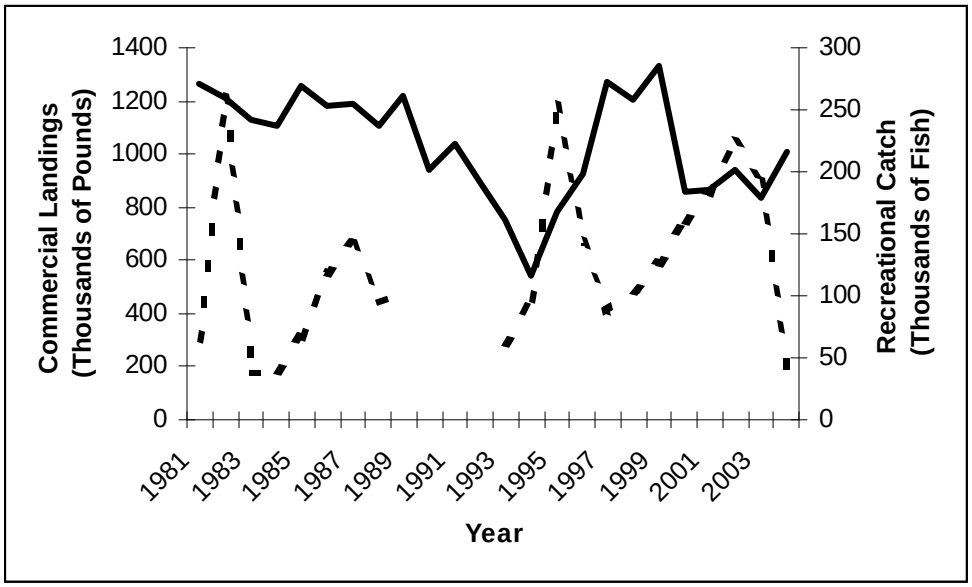


Figure 4. History of California halibut catch from 1981-2004. Commercial landings (solid line) are reported in pounds. Recreational catch (broken line) is reported in number of fish. Data from RecFin and PacFin.

Availability of Science

Life history data for California halibut are readily available. No stock assessment for this species is available, and population biomass data are fisheries-dependent. Data on the Mexico fishery are not readily available.

Market Availability

Common and Market Names

California halibut is also known as bastard halibut, Monterey halibut, flyswatter, barndoor, chicken halibut, and southern halibut (Love 1996). California halibut is sometimes labeled just as halibut (FDA 2005). In markets it is often confused with or marketed as Pacific halibut, a different species sourced primarily for Alaska and British Columbia. When used for sushi or sashimi, halibut is commonly sold as *hirame*.

See http://www.mbayaq.org/cr/SeafoodWatch/web/sfw_factsheet.aspx?gid=9 for a detailed analysis of the sustainability of Pacific halibut.

Seasonal Availability

The California halibut fishery is year-round in southern California, but is most active during the winter and spring (Barsky 1990). In the central California fishery, most of the catch is taken in the summer (Herrick and Hanan 1988).

Product Forms

California halibut are delivered to buyers intact with only the viscera removed, except in Monterey where most are delivered in the round (Barsky 1990). They are sold as fillets, steaks, chunks, or whole (Love 1996; Hastie 2005; PacFIN 2005).

Product Sources
Sources of California halibut for 2004 were dominated by catches in Monterey and Point Conception, whereas all of the Pacific halibut for 2004 were caught in Vancouver, BC, the Columbia River region, Eureka, CA, and Oregon, and north to Alaska (Figure 5).

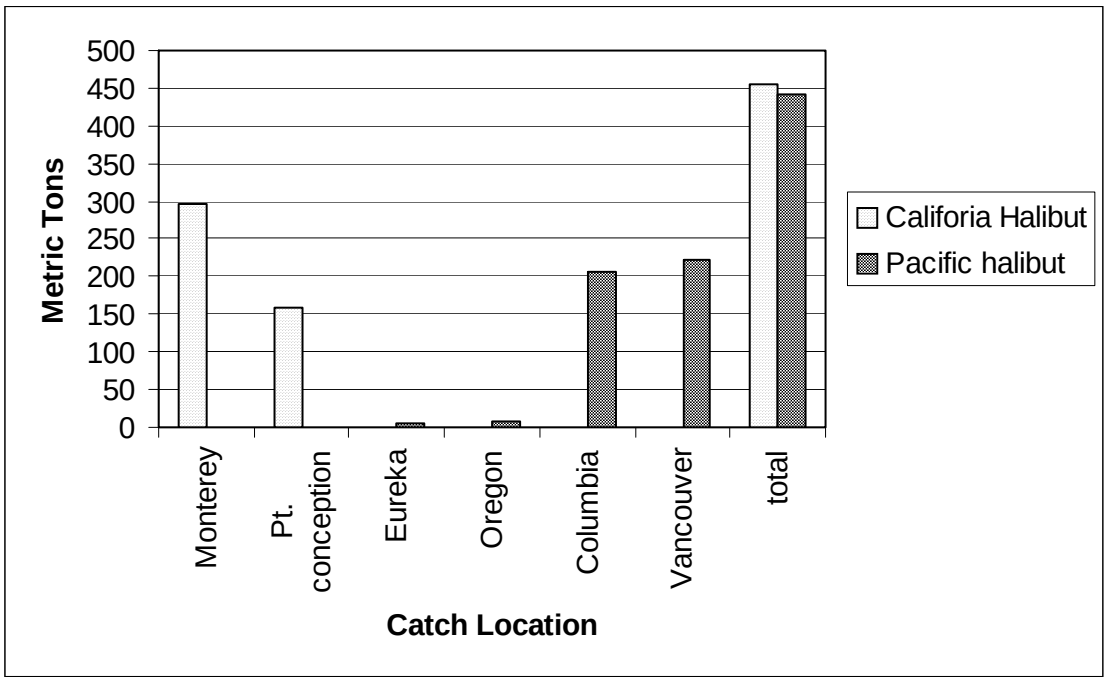


Figure 5. Commercial landings for California and Pacific halibut, exclusive of BC and Alaska, shown by location. Data obtained from PACFIN website.

Analysis of Seafood Watch® Sustainability Criteria for Wild-Caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

California halibut are relatively fast growing fish (Table 1). They can live up to 30 yrs (Frey 1971), but the oldest fish commonly found are 12-13 years of age (MacNair et al. 2001).

Table 1. Life history parameters for California Halibut.

Species	Intrinsic rate of increase (r)	Age at 1st maturity	Von Bertalanffy growth coefficient (k)	Maximum age	Reproductive potential (fecundity)	Species range	Sources
California Halibut	Unknown	Females: 4-5 yrs[1] Males: 2-3 yrs[1]	Southern (k =. 08)[2] Central (k =. 10)[2] (k =. 14)[3]	30 years[4]	1.5-7.6 million eggs per female per spawning season[5]	Magdalena Bay, Baja California, to the Quillayute River, British Columbia[6]	(DFG /6; Frey 1971/4/; Kucas 1986/1 /; Reed and Maccall 1988/3/; Caddell et al. 1990/5/; MacNair et al. 2001/2/)

Natural mortality of California halibut is most likely very low due to the high fishing pressure the population sustains and the short lifespan (Reed and Maccall 1988). MacNair et al. (2001) estimate annual natural mortality in the southern California population to be 0.6 for males and 0.49 for females, which, when lifespan is considered, seems too high. Age at maturity and growth are also divided by sex. Maturity occurs relatively early, with males maturing slightly before females. Age at maturity for males is 2-3 yrs, while females mature at 4-5 yrs (Kucas 1986). Love and Brooks (1990) found that all individuals were mature by 7 years. In addition to differences in growth by sex, there are also regional differences. The central population (k=.10) has a higher growth rate than the southern population (k=.08) (MacNair et al. 2001), while males grow faster than females (Reed & Maccall 1988).

California halibut are batch spawners. Caddell et al (1990) noted between 5 and 12 spawns per season, producing a total of between 1.5 and 7.6 million eggs per female each spawning season. The spawning season is generally thought to extend from February to August with peak spawning in May (Frey 1971).

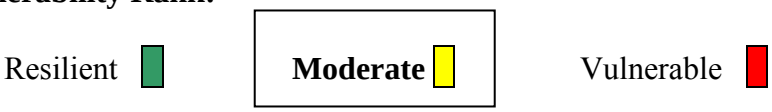
California halibut depend on bays and estuaries for nursery habitat (Allen 1988; Kramer 1991). Throughout coastal California, bays and estuaries are in declining health as they are subject to pollution, runoff, and coastal development (Schiff et al. 2000; Long et al. 2001). The overall decline in halibut landings corresponds to a decline in shallow water habitats in southern California associated with dredging and filling of bays and wetlands (Wertz et al. 2004). Adding to the disruption by the loss of physical habitat is pollution. Schiff et al (2000) show that 89% of the sediments in the Southern California Bight contain evidence of anthropogenic contamination.

Wastewater discharges in the Southern California Bight have been shown to cause shifts in abundance, biomass, diversity, and species composition (Schiff et al. 2000; Long et al. 2001), and have caused the benthic infaunal community to change from crustaceans to polychaetes. As a result, the fish species that prefer crustaceans have also diminished (Schiff et al. 2000; Long et al. 2001). This may also affect California halibut since their diet includes crustaceans as juveniles and as adults, although fish are the preferred prey at all life stages (Kramer 1991).

Synthesis

The basic life history characteristics for California halibut make them inherently resilient to fishing pressure. Although California halibut are moderately long lived, they are fast-growing, mature at an early age, and have high fecundity. However, the greatest concern in the inherent vulnerability of California halibut is the species' limited range and the high levels of habitat degradation in critical nursery habitats. The bulk of the species range is in one of the most densely populated areas of California. The ports and bays in this area are amongst the busiest in the nation, and the water quality and health of the bays and estuaries in this region reflects this. These additional factors result in a rank of moderately vulnerable to fishing pressure.

Inherent Vulnerability Rank:



Criterion 2: Status of Wild Stocks

There has not been a formal assessment of California halibut populations. An assessment completed in 1994 was performed by CDFG, but was never released to the public (Michael Domeier, PIER, pers. comm.). Data from 1988 show the fishery was fully utilized or overfished based on yield per recruit measures (Reed and Maccall 1988). Since the 1980s, landings before and after the gillnet ban in 1994 were relatively stable (Figure 3). There was a dramatic increase in landings after the initial drop that coincided with the ban, and landings are currently trending slightly upwards. A number of other restrictions, such as limited entry permits, bans on gears in certain regions and bycatch reduction measures have coincided with some of the large fluctuations in landings (Figure 6). However, as with most fisheries, current landings are substantially lower than the peak in the 1910s (Caddell et al. 1990).

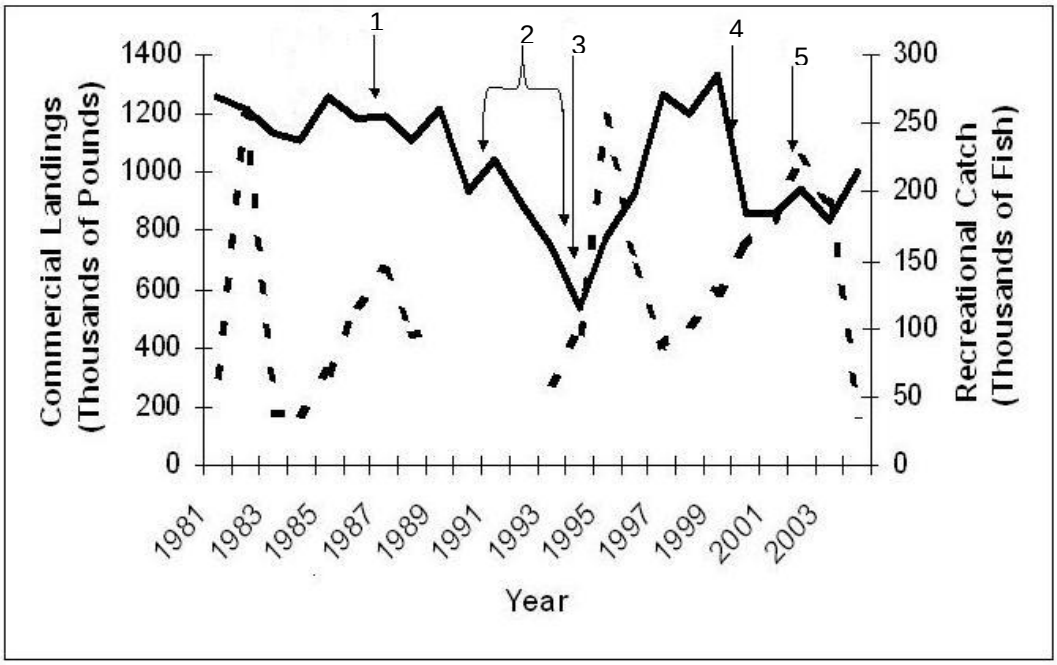


Figure 6. California halibut landings with significant regulations and closures indicated. 1-Ban on gillnets in waters less than 20 fathoms: 1987; 2-Gill & trammel nets were only allowed to be used in the zone pursuant to a nontransferable permit issued by the DFG pursuant to section 5: 1991-December 1993; 3-Gill & trammel nets banned in the "zone": 1994; 4-Beginning September 2000 a series of closures were enacted to protect marine birds & mammals: 2000 (Wertz et al 2004); 5-A 60 fathom depth closure for all gillnet fishing between Pt. Arguello and Pt. Reyes: 2002.

Berkson (1990) provides the most current estimate of population size available (Figure 7); however, Wertz et al. (2004) mentions a trawl survey-based population biomass estimate from the early 1990s of 6.9 million pounds in southern California and 2.3 million pounds in central California. The increasing population size from Berkson (1990) does not correspond with a large increase in landings or with a large increase in catch-per-unit-effort (CPUE) (Figure 3 & 8).

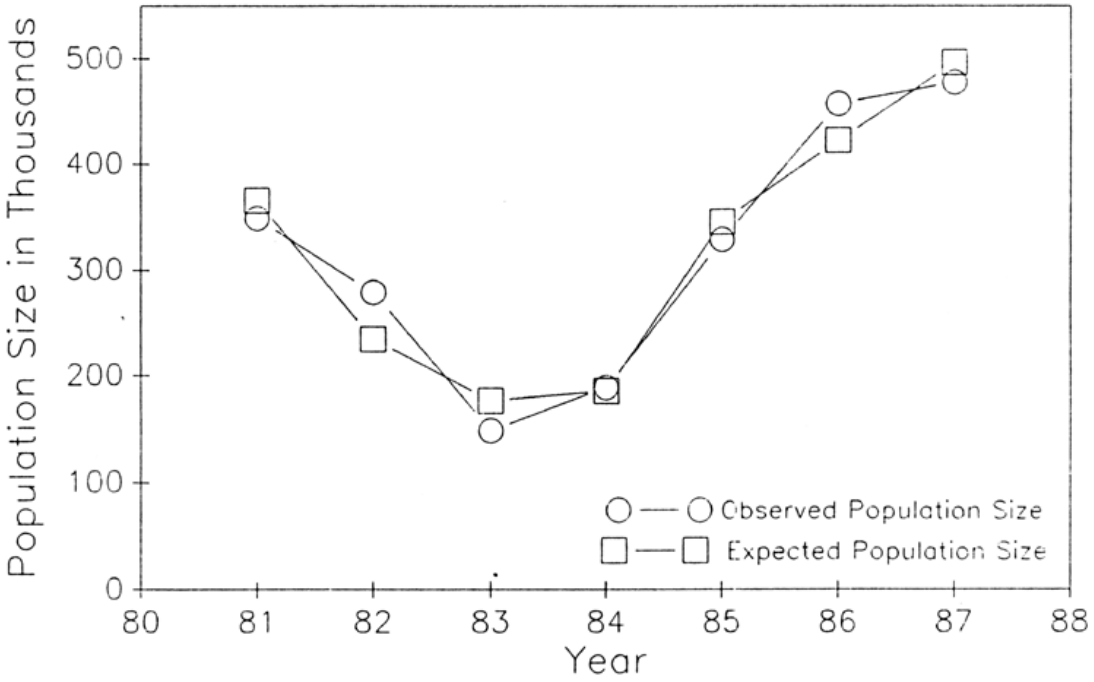


Figure 7. Model fit of California halibut population size with variable recruitment from Berkson (1990).

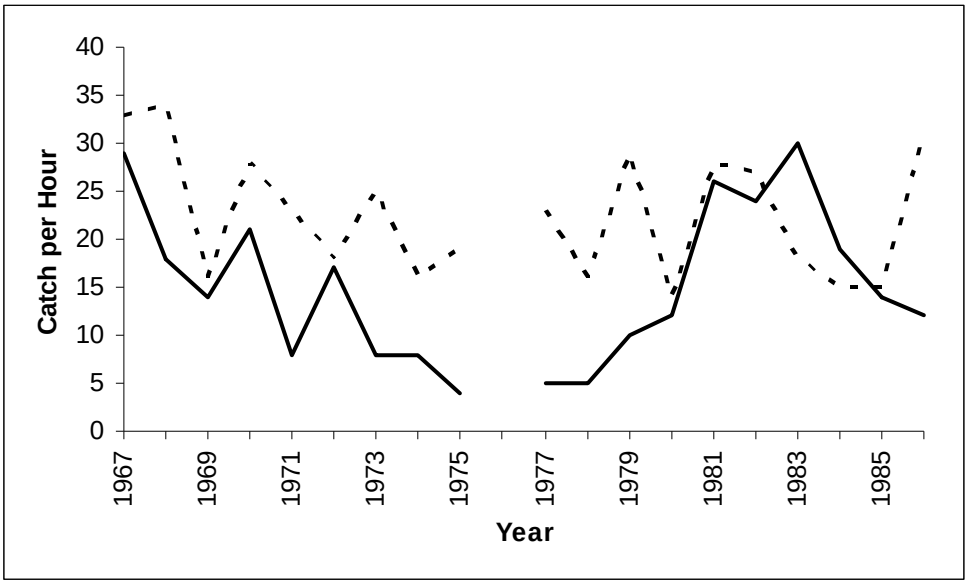


Figure 8. CPUE estimates for northern (solid line) and southern (broken line) California trawl fisheries. From Jow (1990).

This could imply that fluctuations in catch are not dependent primarily on population size, which could mean that fishing mortality during the 1980s was sustainable. Berkson (1990) produced projections for high (1986-1987 levels) and low (1981-1983 levels) recruitment with catch levels from 1988. The projections show that those catch levels are sustainable as long as recruitment is high. Landings are currently at or below 1988 catch levels, which may indicate that recruitment has been stable, or that the catch has adjusted to match recruitment. Landings and population size also tend to fluctuate on approximately 20-year cycles (Wertz et al. 2004).

Commercial landings track larval abundance, and larval abundance varies dramatically with environmental variation (Figure 9) (Moser and Watson 1990), which raises concerns of potential overfishing in poor recruitment years.

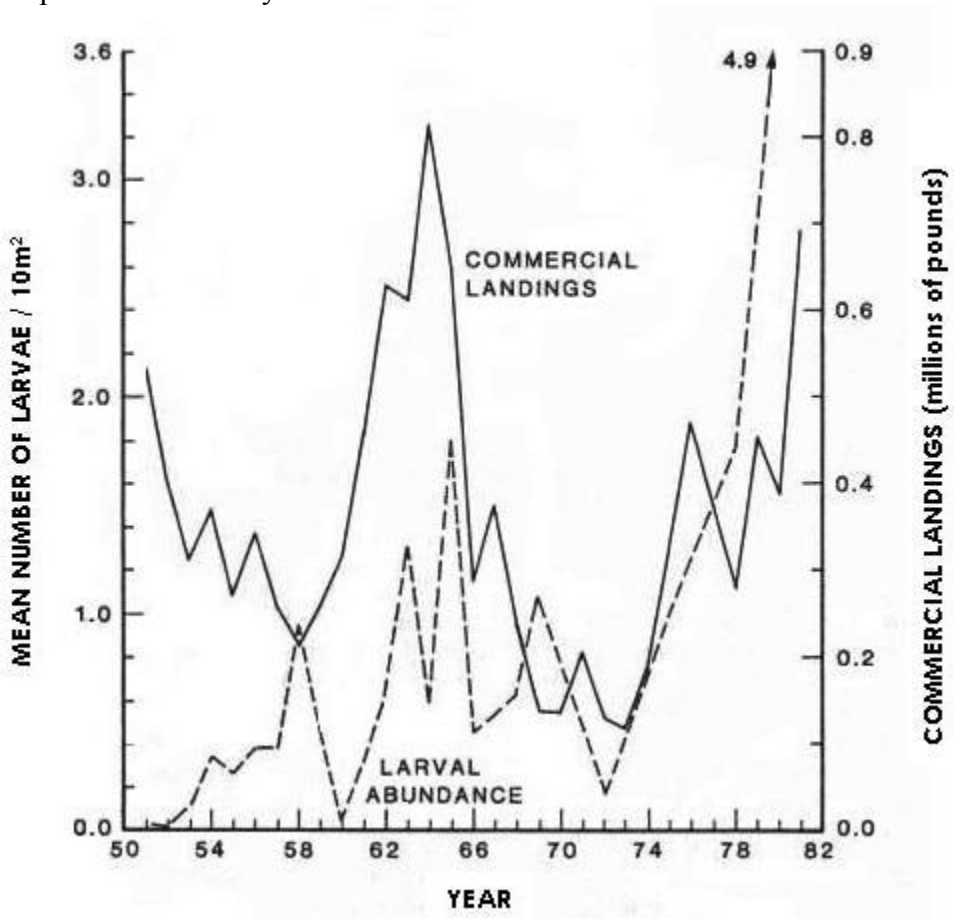


Figure 9. Annual mean abundance of larval California halibut collected at CalCOFI stations off southern California from 1951-1981, and annual southern California commercial landings from 1951-1981.

There have not been any studies of age, size, or sex distribution in California halibut from landings data or fishery-independent sources. Some studies have documented a range of size and sex selection for the trawl fishery by region. Females in southern California were, on average, older than males, while in central California males had a higher proportion of older individuals than females (Figure 10) (MacNair et al. 2001).

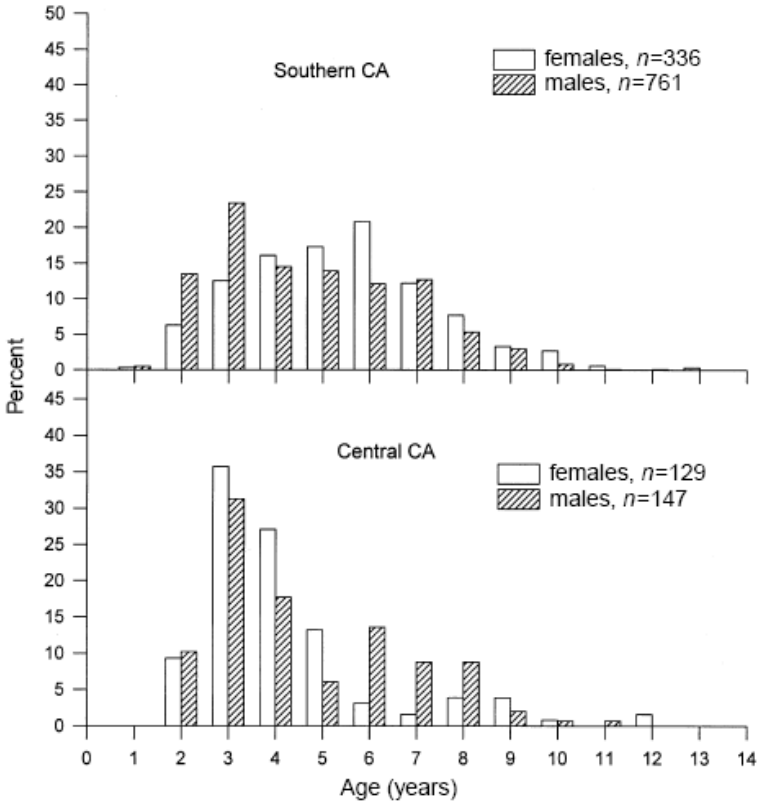


Figure 10. Age frequencies in percent for male and female California halibut sampled off southern and central California. From MacNair et al. (2001).

Females comprise a larger percentage (60-80%) of landings than males (unpublished data in Reed and Maccall 1988). These findings, however, do not necessarily imply a skewed distribution, but are dependent on mesh size and trawling area, amongst other factors. The oldest male found was 13, and the oldest female was 12 (MacNair et al. 2001). It is reflective of heavily exploited populations to have much fewer old fish in the population, so these results are not surprising.

Synthesis

No formal stock assessment has been performed for either the northern or southern population of California halibut. Over the long term, landings have remained fairly consistent, indicating that the population is most likely not severely depleted; however, landings for the last 50 years have not approached the landings early in the fishery (around 1919). The population shows a strong 20 year cycle, with recruitment tied to environmental fluctuations. Landings generally reflect these trends. Gear and fishing area restrictions have affected landings greatly, and following restrictions there has always been a drop in landings. The landings recover quickly from these down turns as fishermen adapt by adopting new gears. Because it is unlikely that the population is overfished, but possible that overfishing is occurring in low recruitment years, the status of the stock is ranked as a 'moderate conservation concern.'

Status of the Stocks Rank:

Healthy | **Moderate** | Poor | Critical

Criterion 3: Nature and Extent of Bycatch

Seafood Watch® defines sustainable wild-caught seafood as marine life captured using fishing techniques that successfully minimize the catch of unwanted and/or unmarketable species (i.e., bycatch). Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for, and/or managed in some way.

California halibut are taken commercially by bottom trawls, hook-and-line gear, gillnets, and to a lesser extent traps. Bottom trawls, which constitute nearly 50% of landings (Figure 11), are restricted to federal waters, 3-200 nautical miles offshore, and California halibut trawling areas that extend between one and three nautical miles from shore south of Point Arguello to Point Mugu (Fish and Game Code 8495) (Wertz et al. 2004). Set gillnets are monofilament gillnets anchored to the sea floor (Morgan and Chuenpagdee 2003). The California halibut/angel shark gillnet fishery is dominated by monofilament nets with a mean length of about 469 m with a 21.2 cm mean mesh size. Trips are typically one day long with two to four net sets per trip (Julian and Beeson 1998). Set gillnets have been restricted north of Pt. Arguello to depths of 60 fathoms, severely reducing the set gillnet fishery for California halibut in central and northern California (Karin Forney, Southwest Fisheries Science Center, NOAA Fisheries, pers. comm.), as well as within 1 nautical mile of the Channel Islands and 3 nautical miles of the southern California coast (Carretta and Chivers 2002). Despite such widespread closure of the set gillnet fishery, it still accounts for nearly 25% of total California halibut landings, and, along with bottom trawls, are the main sources of bycatch in the California halibut fishery. Landings in the gillnet fishery, however, have declined consistently since 1999 (Figure 12).

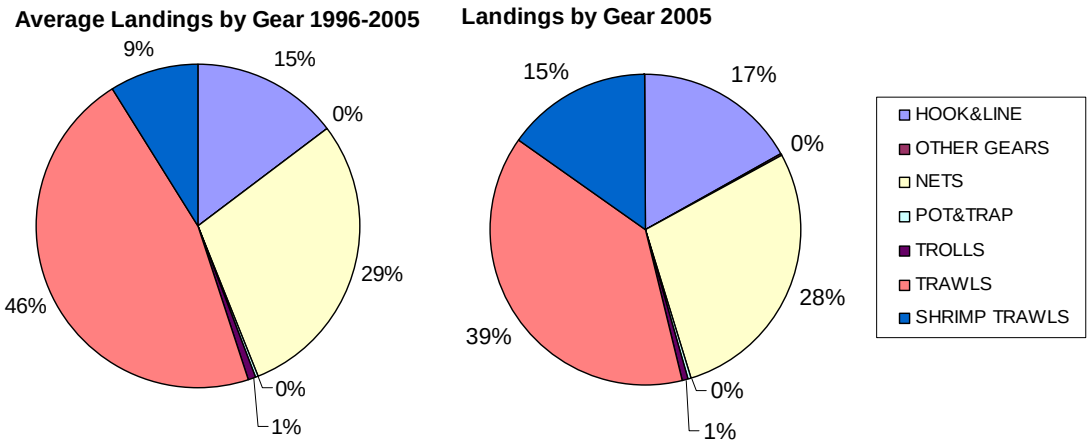


Figure 11. Breakdown of gear types landing California halibut averaged over the last 10 year for which data are available, and for 2005, the most recent year for which data are available. Taken from PacFin (http://www.psmfc.org/pacfin/pfmc.html).

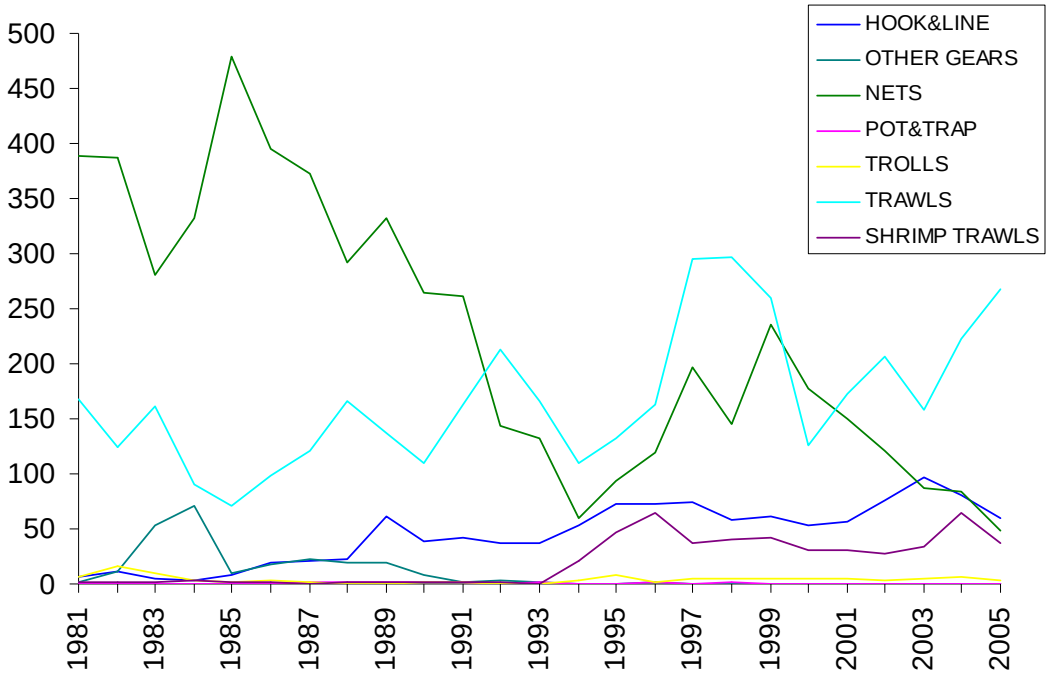


Figure 12. Landings by gear since 1981. From PacFin database (http://www.psmfc.org/pacfin/pfmc.html).

The greatest concern of bycatch in the California halibut fisheries, with respect to protected species, is in the set gillnet fishery. It is a Category I fishery because the average estimated annual mortality and serious injury of the Monterey Bay stock of harbor porpoise in this fishery exceeds 50 percent of the PBR (Potential Biological Removal) level (11 animals per year) for this stock (Dotson and Charter 2003). The set gillnet fisheries in central and northern California have had particularly high impacts on populations of common murre (*Uria aalge*), southern sea otter (*Enhydra lutris*), and harbor porpoise (*Phocoena phocoena*). Since 2002, a 60-fathom depth closure for all gillnet fishing between Pt. Arguello and Pt Reyes has eliminated this fishery in central California. Before the set gillnet ban in 2002, mortality of these three species during the 1980s was at least 70,000 common murres, hundreds of sea otters (Wendell and Hardy 1986), and about 2,000 harbor porpoises (Barlow and Hanan 1995). The ban in waters north of Point Arguello less than 60 fathoms deep ended much of the bycatch in the region because 89% of the halibut catch in northern/central California occurred in depths of 55 m (30 fathoms) or less (Jow 1990). Bycatch in southern California may still be substantial, although the set gillnet fishery has also been closed around the Channel Islands and within 3 nautical miles of the mainland (Carretta and Chivers 2002). Julian and Beeson (1998) estimate that the bycatch of common murres will continue at 1990-1994 levels, that entanglement of California sea lions (*Zalophus californianus*) and harbor seals (*Phoca vitulina richardii*) will decline and then level off, and that sea turtles will continue to be entangled. Currently, none of these estimates can be verified because observer coverage ended in 1994. Without observer coverage, Sustainable Fishery Advocates must conclude that bycatch of protected species is a critical conservation concern in the set gillnet fishery.

There are few studies on bycatch of finfish in bottom gillnet fisheries. We were unable to find any studies in the region where California halibut are fished. Thorpe et al. (2001) reported catch of non-target finfish species in a fishery for a related flounder species (*Paralicthys* spp.) in North

Carolina in which non-flounder landings constituted over 80% of the total catch, including over 300 sharks and rays. Walker et al. (2005) found higher finfish bycatch in the southeastern Australia shark fishery's bottom gillnet fishery than in the longline fishery. Incidental catch of finfish, however, was 20-fold less than landings of Chondrichthryes species.

Bycatch in the trawl fishery was dominated by other commercially important groundfish species, including flatfish, lingcod (*Ophiodon elongates*), and rockfish (*Sebastes* spp.). Species assemblages taken as bycatch in trawls are different in northern and southern California. In northern California the five main species taken were starry flounder (*Platichthys stellatus*), English sole (*Parophrys vetulus*), sand sole (*Psettichthys melanostictus*), and Pacific sanddab (*Citharichthys sordidus*), with California halibut constituting only 10% of the catch. In southern California, California halibut constituted over 50% of the fish taken, followed by skates (*Raja* spp.), starry flounder, English sole, and sand sole (Jow 1990); however, these percentages do not reflect exclusively targeted halibut trawl fishing.

Hastie (2005) found an overall flatfish catch in northern Californian for limited entry, targeted trawls of roughly 50% of the retained California halibut. Discard rates of flatfish ranged from 30-40% which are reasonably consistent with rates of discard for flatfish observed in depths of less than 75 fathoms throughout the area south of Oregon. Skates, which are taken in large numbers, were discarded (Hastie 2005).

In northern California targeted halibut trawl fisheries that fall under the West Coast observer program, landings of rockfish species (*Sebastes* spp.) were about 22% of halibut landings (Table 2). A majority (99%) of the species were discarded. Despite landings of *Sebastes* spp. nearing one quarter of the halibut catch in 2004, catch of overfished rockfish species was very low overall. Hastie (2005) observed a total of 3 lbs of bocaccio and 16 lbs of canary rockfish, and no catch of cowcod or widow, darkblotched, or yelloweye rockfish between 2002 and 2004. Lingcod was taken as bycatch in higher numbers than rockfish, with landings averaging 28 lbs per 1,000 lbs of California halibut. The bycatch numbers given in Hastie (2005), however, do not represent all the unintentionally caught fish, but only commercially important teleosts landed in the fishery. There may be bycatch of infaunal or epibenthic invertebrates as well, as indicated by higher invertebrate density and biodiversity in non-trawled areas (Engel and Kvitek 1998).

Table 2. Bycatch of groundfish in observed trawl tows targeting California halibut by vessels with groundfish limited-entry permits, 2001-2004. Adapted from Hastie (2005).

		2001	2002	2003	2004
California halibut					
	total landings	27,920	12,518	49,512	73,472
	% discarded	29%	25%	15%	3%
	lbs retained	19823	9389	42085	71268
	% bycatch	29%	25%	15%	3%
***Sebastes* spp.**					
	total landings	177	7,228	481	16,749
	% discarded	11%	0%	41%	99%
	% bycatch	0.10%	0.00%	0.47%	23.27%
flatfish spp.					
	total landings	25,118	13,196	51,480	36,870
	% discarded	9%	23%	41%	40%
	% bycatch	11.40%	32.33%	50.15%	20.69%
Lingcod					
	total landings	436	272	1,713	1,092
	% discarded	88%	85%	59%	26%
	% bycatch	1.37%	1.85%	2.04%	0.39%

Recreationally, California halibut are caught mostly using hook-and-line gear on small boats, but may also be caught from shore by surf-casting or spearfishing (Wertz et al. 2004). These methods are more selective and have not been observed obtaining unwanted bycatch. In a survey of impacts of fishing gears, Morgan and Chuenpagdee (2003) found limited published studies on bycatch from hook-and-line fisheries. In surveys of fisheries experts, the consensus was that hook–and-line fisheries are the lowest impact fisheries, and have "moderate" bycatch of sharks (Figure 13).

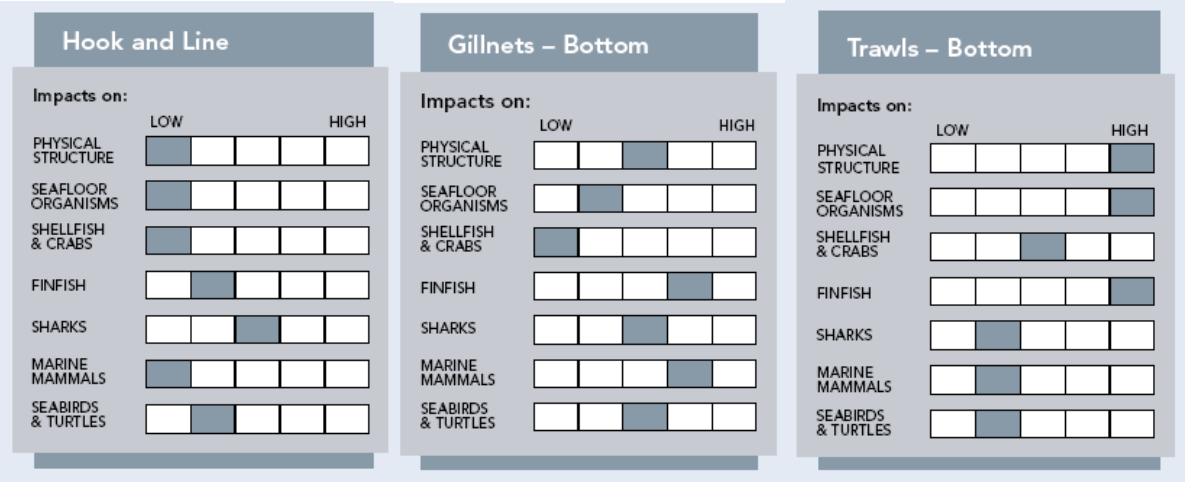


Figure 13. Impact ratings for the three main fishing methods for California halibut. Taken from Morgan and Chuenpagdee (2003).

Synthesis
The three fishing methods that land the most California halibut (trawl, hook-and-line, and set gillnets) have very different risks and levels of bycatch. Hook-and-line operations have very low bycatch, bottom trawls have moderate levels of incidentally-caught finfish, many of which are landed, and gillnets have high levels of bycatch of birds and marine mammals, some of which are protected species. Bycatch in the set gillnet fishery has been controlled by closure of segments of the fishery, but its continued contribution to California halibut landings indicate that it may continue to contribute high levels of bycatch. This bycatch is no longer tracked, however, because of the lack of observer data. Without these data, SFA conservatively concludes bycatch in the set gillnet fishery is a critical conservation concern. Discard rates are increasing in the bottom trawl fishery, and while no restricted species are caught, a total of over 700 pounds of bycatch of commercially-important species is caught for every 1000 lbs of California halibut, of which a large portion is discarded. This results in a rank of moderate conservation concern for bycatch in trawl fisheries. Bycatch in hook-and-line fisheries is considered benign.

Nature of Bycatch Rank:

Hook & line:	**Benign**	Moderate	Severe	Critical
Bottom trawl:	Benign	**Moderate**	Severe	Critical
Set gillnet:	Benign	Moderate	Severe	**Critical**

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

The fishery for California halibut is limited to a small area of the US West Coast. In normal ocean cycles, more than 70% of the catch originates in central and southern California waters (Hastie 2005; California Seafood Council, http://ca-seafood.ucdavis.edu/facts/species.htm #anchor1128809). The majority of California halibut from Sept. 1, 2003, to Aug. 31, 2004, was caught in waters less then 75 fathoms and all were caught south of 40°10′ N. lat. (NOAA 2005).

Historically, California halibut have been commercially harvested by otter trawl, entangling nets (set gill net and set trammel net), and hook-and-line gear. Pacfin data for 2004 shows that trawls catch the largest amount of California halibut (220.8 metric tons-mt) followed by gillnets (84.3 mt), hook-and-line (80 mt), trolls (6 mt) and pots and traps (0.2 mt) (PacFIN 2005).

Habitat Effects
Intense otter trawling may significantly decrease habitat heterogeneity and decrease biodiversity (Engel and Kvitek 1998). Typically, California halibut are found on sand bottoms or any soft substrate (Jow 1990). These habitats are relatively more resilient to trawling that hard substrate, so the habitat impacts may be reduced (Collie et al. 2000).

Trawling is prohibited within California waters (0-3 nautical miles offshore), except in the designated "California halibut trawl grounds," which encompass the area between Point Arguello

(Santa Barbara County) and Point Mugu (Ventura County) in waters 1-3 nautical miles from shore (Wertz et al. 2004). The reduced area within which trawling is allowed also reduces total impact of the trawl fishery.

Both bottom gillnets and pots and traps have some impact on the seafloor, although substantially less than bottom trawling (Morgan and Chuenpagdee 2003). However, there are a number of studies documenting ghost fishing by derelict gillnets. Carr (1988) did not find any fish mortality in derelict nets, but did see a lower density of fish in the study area. Hook-and-line fisheries, however, rarely contact the seafloor, and are not thought to damage habitats.

Ecosystem Effects

California halibut are important predators; however. they compete with a number of other fish for the same prey species (including northern anchovy) (Allen 1990). There are five species of large-mouthed flatfishes with similar foraging behaviors whose geographic range overlap with California halibut (Allen 1990). The number of other species that fill this niche, as well as their limited range, means that their removal would most likely not disrupt the foodweb.

Synthesis

Approximately 50% of the total California halibut landings are taken by trawls. Trawls have been shown to severely impact biodiversity of benthic organisms and decrease habitat heterogeneity. The impacts of trawling are most severe on hard seafloors, with severity decreasing for mud and sand bottoms. So, while impacts in the habitat of California halibut from trawling are probably less severe than other groundfish habitats, there is still moderate concern for the impacts of benthic infauna on halibut trawling grounds. The range of California halibut is relatively small, and there are many other fish inhabiting the same niche, so there is little concern for disruption in the food web from fishing mortality.

Effect of Fishing Practices Rank:

Hook & line; set gillnet:	**Benign**	Moderate	Severe	Critical
Bottom trawl:	Benign	**Moderate**	Severe	Critical

Criterion 5: Effectiveness of the Management Regime

Management of California halibut falls under the jurisdiction of the California Department of Fish and Game (CDFG) (Wertz et al. 2004). While no stock assessment has been performed on California halibut to date, a stock assessment is planned for 2005-2006 (Meisha Key, CDFG, pers. comm.) as required by the Marine Life Management Act (MLMA). A handful of past studies made estimates of stock size and population health (see Reed and Maccall 1988; Berkson 1990), but the most recent of these is 15 years old.

The California Department of Fish and Game has been pro-active in seeking solutions to bycatch of seabirds and mammals in the set gillnet fishery. After a series of restrictions on the set gillnet fishery, beginning in 1987, set gillnets have been banned in nearly all nearshore habitats along the California coast where affected animals are found (Forney et al. 2001; Carretta and Chivers

2002). In July 1990, the Fisheries Observer Branch began placing mandatory observers on the California set gillnet fishery targeting California halibut, angel shark, white seabass, soupfin shark, and yellowtail. The program was discontinued in July 1994 (Forney et al. 2001). The National Marine Fisheries Service (NMFS) also has an observer program that monitors the Monterey Bay portion of the gillnet fishery, for which from 1999-2000 there was 20% observer coverage (Carretta and Chivers 2002). There is still a set gillnet fishery for angel shark/halibut in southern California, which was last observed in 1994, and NMFS hopes to be able to place observers in this fishery again in the coming years (Karin Forney, SWFSC NOAA Fisheries, pers. comm.).

Bycatch of finfish in the trawl fishery exceeds 50% of the landed California halibut (Hastie 2005). The West Coast groundfish observer program (WCGOP) at the Northwest Fisheries Science Center began at-sea observation of vessels with limited-entry trawl permits in September 2001 (Hastie 2005). The loss of observers for the gillnet fishery has meant that data on current bycatch levels in the fishery are difficult to find. Some of the halibut trawl grounds will be closed in 2008 pursuant to CDFG code 8496, "unless the commission finds that a bottom trawl fishery for halibut minimizes bycatch, is likely not damaging seafloor habitat, is not adversely affecting ecosystem health, and is not impeding reasonable restoration of kelp, coral, or other biogenic habitats" (http://www.leginfo.ca.gov/calaw.html).

A number of regulations are also established to protect the California halibut population specifically. Trawling is closed from March 15th to June 15th to protect spawning adults (Wertz et al. 2004). Commercial fishing laws prohibit the sale of California halibut less than 22 inches long, unless the weight is at least 4 lbs whole, 3.5 lbs dressed with the head on, or 3 lbs dressed with the head off (Wertz et al. 2004). Four halibut less than the legal minimum size may be retained for personal use if taken incidentally with a gill, trammel, or trawl net (Wertz et al. 2004). Recreational regulations require a minimum size limit of 22 inches, in addition to a daily bag limit of five California halibut per day when fishing south of Pt. Sur (Monterey County), and three California halibut per day when fishing north of Pt. Sur. South of Pt. Arena (Mendocino County) fillets must be a minimum of 16.75 inches long and bear the entire skin intact (Wertz et al. 2004).

Synthesis

California halibut are managed under the California Department of Fish and Game's Nearshore Fishery Management Plan. No stock assessment has been performed, although one is planned for 2006. Regulations on the fishery are extensive and have been enacted to both reduce fishing mortality and protect bycatch species and habitats. However, few studies exist to measure the effectiveness of these regulations. Lack of a complete and current stock assessment and ongoing concerns over bycatch levels and observer coverage in the set gillnet fishery results in a rank of moderately effective for management of California halibut stocks.

Effectiveness of Management Rank:

Overall Evaluation and Seafood Recommendation

The overall conservation concern for California halibut taken by set gillnet is high and results in a recommendation of "Unsustainable," while the conservation concern for California halibut taken by other methods, such as hook-and-line gear, traps, or trawls is moderate and results in a recommendation of "Some Concerns." Restricted range of the fish and degradation of nursery habitats increased the inherent vulnerability of California halibut to fishing pressure to a moderate concern. Additionally, there is no current stock assessment or population estimate for California halibut. Landings tend to track recruitment and regulations, and do not show boom-bust patterns. Although landings have dropped greatly since the inception of the fishery, they have remained relatively stable. Bycatch of a number of species of concern was high in the set gillnet fishery, and as a result the area the gillnet fishery can operate in has been greatly reduced, and now only constitutes about a quarter of California halibut landings and is restricted to federal waters. However, there is no longer any observer coverage of the set gillnet fishery. Bycatch in the trawl fishery is dominated by commercially-important groundfish and skates. In both northern and southern California, landings of California halibut make up only a fraction of the total landings in the trawl fishery, and bycatch is increasingly discarded. Since California halibut live on sandy bottoms, the impacts of bottom trawling on the habitat is minimized, although still of moderate concern. Furthermore, the limited area in which they are caught reduces ecosystem wide impacts associated with trawling for California halibut. Once the stock assessment is completed in 2006, and observer coverage is re-established in the set gillnet fishery, the management of this fishery will most likely be considered highly effective. If stocks are found to be at or above B_{MSY}, hook-and-line-caught California halibut would be given the seafood recommendation of "Best Choice."

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability		√		
Status of Stocks		√		
Nature of Bycatch	√ Hook and line	√ Bottom trawl		√ Set gillnet
Habitat Effects	√ Hook and line; Set gillnet	√ Bottom trawl		
Management Effectiveness		√		

Overall Seafood Recommendation[2]

Hook & Line; Bottom Trawl:

Best Choice | **Some Concerns** | Unsustainable

Set Gillnet:

Best Choice | Some Concerns | **Unsustainable**

Acknowledgements

SFA would like to thank Michael Domeier, President of PIER (Pfleger Institute of Environmental Research) and Sharon Kramer, Senior Aquatic Ecologist, Stillwater Sciences, for their insightful reviews of this document. SFA would also like to thank George Leonard, Science Manager of the Seafood Watch® program, for additional comments.

Scientific review does not constitute an endorsement of SFA® or Seafood Watch® on the part of the reviewing scientists. SFA® staff is solely responsible for the conclusions reached in this report.

Supplemental Information

Consumption advice on the Seafood Watch© pocket guides is provided by Environmental Defense. Environmental Defense Fund applies the same risk-based methodology as the U.S. Environmental Protection Agency (EPA) to data from government studies and papers published in scientific journals. Environmental Defense Fund has issued a consumption advisory for California halibut due to elevated mercury levels. More detailed information about the Environmental Defense advisory can be found at www.edf.org/seafoodfhealth.

[2] Sustainable Fishery Advocates uses different language to describe the red, yellow, and green categories in Seafood Watch's ranking methodology. This reflects the different needs of business customers versus general consumers but does not represent differences in evaluation methodologies between SFA and Seafood Watch®.

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Appendix 1: Rankings of individual criteria

Factor	Ranking
Intrinsic rate of increase Green: high (>0.16), Yellow: medium (0.05-0.16), Red: low (<0.05)	
Age at 1st maturity Green: low (<5 years), Yellow: medium (5-10 years), Red: high (>10 years)	
Von Bertalanffy growth coefficient ('k') Green: high (>0.16), Yellow: medium (0.05-0.15), Red: low (<0.05)	
Maximum age Green: low (<11 years), Yellow: medium (11-30 years), Red: high (>30 years)	
Reproductive potential (fecundity) Green: high (>100 inds./yr), Yellow: moderate (10-100 inds./yr), Red: low (<10 inds./yr)	
Species Range Green: Multiple ocean basins with intermixing stocks, Yellow: Limited (Single ocean basin), Red: one coastline or numerous ESUs	
Special Behaviors or Requirements Green: No known behaviors or behaviors that decrease vulnerability, Yellow: 1-2 behaviors, Red: Many behaviors	
Quality of Habitat, degradation from non-fishery impacts Green: Habitat is robust, Yellow: moderately altered by non-fishery impacts, Red: substantially compromised from non-fishery impacts and thus reduced capacity to support this species	
Conservation Concern: Inherent Vulnerability	

Factor	Ranking
Management Classification Status Green: underutilized OR close to virgin biomass, Yellow: fully fished OR recovering from overfished OR unknown, Red: recruitment or growth overfished, overexploited, depleted or "threatened"	
Current population abundance relative to B_{msy} Green: well above B_{msy} (>125%), Yellow: close to B_{msy} (75-125%), Red: substantially below B_{msy} (<75%)	
Occurrence of overfishing Green: overfishing not occurring (Fcurr/Fmsy < 1.0), Yellow: overfishing is likely/probable, Red: overfishing occurring	
Overall degree of uncertainty in status of stock Green: low (current stock assessment), Yellow: medium (limited fishery-dependent data), Red: high (little or no current fishery-dependent or independent data)	
Long-term trend, relative to generation time, in population abundance Green: trend is up, Yellow: trend is flat or variable, Red: trend is down	
Short-term trend in population abundance Green: trend is up, Yellow: trend is flat or variable, Red: trend is down	
Current age, size, sex distribution of the stock relative to natural conditions Green: functionally normal, Yellow: unknown, Red: skewed	
Conservation Concern: Status of Wild Stocks	

Factor	Ranking
Quantity of bycatch, including species of "special concern" Green: low (<10% of targeted landings) and does not regularly include species of special concern, Yellow: moderate (10-100% of targeted landings and does not regularly include species of special concern OR unknown, Red: high (>100% of targeted landings) OR bycatch includes species of special concern	Hook & Line Bottom trawls Gillnets
Population consequences of bycatch Green: little or no impact on population levels, Yellow: conflicting evidence of population consequences of bycatch OR unknown, Red: severe	Hook & Line Bottom trawls Gillnet
Trend in bycatch interaction rates as a result of management measures Green: trend in bycatch is down, Yellow: trend in bycatch is flat OR unknown, Red: trend in bycatch is up, Neutral: N/A because bycatch is low	
Evidence that ecosystem has been or likely will be substantially altered in response to continued discard of bycatch species	
Conservation Concern: Nature and Extent of Discarded Bycatch	Hook & Line Bottom trawls Gillnets

Factor	Ranking
Known effect of fishing gear on physical and biogenic habitats Green: minimal damage, Yellow: moderate damage, Red: great damage	Trawl / other
Resilience of physical and biogenic habitats to disturbance by fishing method Green: high (benthic habitats not impacted), Yellow: moderate, Red: low	
Evidence that removal of targeted species or the removal/deployment of baitfish has or will likely disrupt food web Green: studies show no evidence, Yellow: conflicting evidence OR unknown, Red: ecosystem impacts demonstrated	
Evidence that fishing method has caused or is likely to cause substantial ecosystem state changes Green: studies show no evidence of ecosystem impacts, Yellow: conflicting evidence OR unknown, Red: ecosystem impacts from fishing method demonstrated	
Conservation Concern: Effect of fishing practices on habitats and ecosystems	Trawl / other

Factor	Ranking
Stock Status Green: stock assessment complete and robust, Yellow: stock assessment is planned or underway but is incomplete, Red: no stock assessment	
Scientific Monitoring Green: regular collection and assessment of both fishery-dependent and independent data, Yellow: regular collection of fishery-dependent data, Red: no regular collection of data	

Scientific Advice- management has track record of consistently setting quotas beyond those recommended by scientific advisors Green: no, Red: yes	
Bycatch: Management implements an effective bycatch reduction plan Green: bycatch plan in place and reaching goals, Yellow: bycatch plan in place but effectiveness debated or undetermined, Red: no bycatch plan implemented or not meeting goals, N/A: bycatch is low	
Fishing Practices: Management addresses the effect of the fishing methods on habitats and ecosystems Green: mitigative measures in place and deemed effective, Yellow: mitigative measures in place but effectiveness debated or undetermined, Red: no mitigative measures in place, N/A: fishing method is benign	
Enforcement Green: regulations regularly enforced by independent bodies, Yellow: regulations enforced by fishing industry, Red: regulations not enforced	
Management track record Green: management maintained stock productivity and limited ecosystem change, Yellow: management not been in place long enough to evaluate effectiveness, Red: measures not prevented declines	
Conservation Concern: Effectiveness of Management	