Review of California Halibut Trawl Fishery in the California Halibut Trawl Grounds

Report to the

California Fish and Game Commission

California Department of Fish and Game

Marine Region

State Fisheries Evaluation Project

(06/27/2008)

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Background

After March 31, 2008, certain state waters within the California Halibut Trawl Grounds (CHTG) located offshore of Ventura and Santa Barbara Counties are proposed to be closed (Fish and Game Code [FGC] §8495]). The Fish and Game Commission (Commission) may choose to reverse the pending closures if fishery performance criteria listed in FGC §8495 are determined to have been met. The performance criteria require that the use of trawl gear: 1) minimizes bycatch; 2) is likely not damaging seafloor habitat; 3) is not adversely affecting ecosystem health; and 4) is not impeding reasonable restoration of kelp, coral, or other biogenic habitats.

California Halibut Bottom Trawl Fishery

California halibut (*Paralichthys californicus)* is an important flatfish species in the commercial bottom trawl, set gill net, and hook-and-line fisheries off central and southern California. Over the past decade, trawl-caught California halibut have accounted for the majority of California halibut landed statewide generating a seasonal annual average of more than $1.7 million in ex-vessel revenue, with $237,000 of which is attributed to landings from the CHTG. The trawl fishery operating in the CHTG is primarily a low-volume, high-price fishery that supplies local seafood restaurants with a live product that commands a premium price about 1.5 times greater than fish landed in dead condition.

The CHTG fishery is managed with a combination of regulations, including a minimum codend mesh size of 7.5 inches, a closed season of three months, a 500 pound possession limit on the incidental take of fish other than California halibut, and mandated federal observer coverage. In 2006, a California Halibut Bottom Trawl Vessel Permit program was implemented. A total of 62 permits were issued, and 44 of which were active. Only 15 permitted vessels fished within the CHTG.

Fishery Performance Criteria

Bycatch: Trawl vessels targeting California halibut in the CHTG reduce bycatch with the use of a minimum codend mesh size of 7.5 inches. Spawning adults are protected with a closed season from March 15 to June 15, which also serves to reduce bycatch by limiting overall fishing effort. A collaborative bycatch study was conducted by the Southern California Trawlers Association (SCTA), California Sea Grant, and the California Department of Fish and Game (Department) in the CHTG during the summer of 2007. Data from this bycatch study revealed an overall bycatch rate of 56 pounds-per-hour (pounds/hour) with 94 percent of discards returned alive. The bycatch rate (pounds/hour) of federally managed groundfish species was 95 percent lower for vessels targeting California halibut in the CHTG than for limited-entry groundfish trawl vessels targeting California halibut in federal waters off central California. Bycatch relative to retained California halibut for the most commonly caught species was 0.74 pounds of crabs, 0.71 pounds of bat ray, 0.39 pounds of sharks, and 0.16 pounds of skates per-pound of California halibut. Several factors can be attributed to the reduced bycatch for trawling operations within the CHTG, such as the smaller size of trawl nets generally employed within the CHTG, the requirement for larger mesh size in the

codend for vessels fishing within the CHTG, and possible differences in abundance and species composition on the geographically separate fishing grounds. No incidental take of endangered species has been recorded in the California halibut trawl fishery statewide.

Seafloor Habitat: The CHTG is located in the Santa Barbara Channel (SBC) over a shallow, broad shelf with an average depth of 29 fathoms. The seafloor within the CHTG is comprised of approximately 86 percent soft substrate and 14 percent hard substrate. Logbook data indicates that trawlers generally avoid the hard substrate within the CHTG. Few studies on the impacts of bottom trawl gear to the seafloor habitat have been conducted off the west coast of the United States. Information prepared by the National Marine Fisheries Service (NMFS) indicates that habitat impacts by bottom trawl gear in areas where California halibut trawling occurs have the lowest sensitivity classification for impacts to seafloor habitat by bottom trawl gears. Mean recovery time for trawl gear impacts in the CHTG is estimated by NMFS to be less than one year in the absence of continued fishing.

Ecosystem Health: There are no agreed upon quantitative measures of ecosystem health that can be specifically applied to this fishery. Current state and federal California halibut management measures were not implemented to specifically address ecosystem management, although the current management measures may collectively foster a sustainable bottom trawl fishery and indirectly promote a healthy ecosystem by reducing potential fishery impacts on the system. These measures include:

- Limited entry program to control fishing capacity
- Logbook program to monitor catch location and effort information
- Season closure in the CHTG to protect spawning adults
- Minimum size limit of 22 inches total length (TL) to prevent growth overfishing
- Within the CHTG, minimum codend mesh size of 7.5 inches in length and codend not less than 29 meshes long and 47 meshes in circumference to reduce bycatch of immature fish
- Area restrictions (Essential Fish Habitat [EFH] and non-trawl zone)
- Federal at-sea observer coverage to document catch, discards, and bycatch
- Federal and state incidental trip limits for non-target groundfish and fish other than California halibut to minimize mortality of overfished groundfish species and non-target species
- Mandatory vessel monitoring system to monitor compliance with closed areas

Kelp Habitats: Giant kelp (*Macrocystis pyrifera)* is the dominant canopy-forming kelp species in southern California. Aerial surveys of coastal kelp beds since 1989 have not shown kelp growing in the CHTG, although it can be found in adjacent waters. Several kelp restoration projects have been completed in the Santa Barbara/Ventura area. Restoration efforts were reported as successful at all the project sites except for one where failure was attributed primarily to urchin grazing.

*Coral and Other Biogenic Habitats***:** At least four taxa of coral or coral like species occur in waters within and adjacent to the CHTG, and all but sea pens require hard substrate for attachment. Coral habitats are susceptible to damage from bottom trawling, however direct study of the areas impacted by the California halibut trawl fleet in the CHTG has not been done. While trawlers generally avoid hard substrate where corals are found, trawling does occur on the soft substrate where sea pens occur.

INTRODUCTION

In 2004, the Legislature approved Senate Bill (Bill) 1459 which amended FGC §8495 and §8842, and added §8494 and §8841 pertaining to California's bottom trawl fisheries. The Bill granted the Commission authority over all state managed bottom trawl fisheries not managed under a federal or state fishery management plan, created a California halibut bottom trawl permit, established qualifying criteria to obtain permits, and required that every bottom trawl vessel issued a state permit be subject to the requirements and policies of the federal West Coast Groundfish Observer Program (WCGOP). The Bill also prohibited the use of trawl gear in four separate areas within the CHTG that were previously open to California halibut trawling as of 2005 (FGC §8495) (Figure 1). The CHTG is located not less than one nautical mile from mainland shore between Point Arguello (Santa Barbara County) and Point Mugu (Ventura County) (Figure 1). These fishing grounds were established in 1971 and currently encompass a total of 201 square nautical miles of state waters. The 2005 area closures amounted to 13 percent of the previously existing CHTG. After March 31, 2008, four additional closures, comprising 42 percent of the remaining CHTG, will be implemented (Figure 2). The Commission may choose to reverse the pending 2008 area closures if performance criteria listed in FGC §8495 for the fishery are deemed to have been met. The performance criteria require that the use of trawl gear: 1) minimizes bycatch; 2) is likely not damaging seafloor habitat; 3) is not adversely affecting ecosystem health; and 4) is not impeding reasonable restoration of kelp, coral, or other biogenic habitats.

The purpose of this report is to provide the Commission with the best available information about the California halibut bottom trawl fishery operating within the CHTG. Information was obtained from monitoring data (logbook, market receipt, and at-sea observations), relevant scientific literature, and informational documents published by academic institutions, government agencies, and non-government organizations (NGO). Analysis of California halibut catch within the CHTG used data from 1997 to 2006 because earlier data lacked the necessary location specificity.

Fishery Background

California halibut is an important flatfish species in the commercial fisheries of central and southern California. California halibut range from Almejas Bay, Baja California Sur to the Quillayute River, Washington inhabiting nearshore waters less than 50 fathoms deep (Eschmeyer et al. 1983, Oda 1991). Commercial catches of California halibut are taken with bottom trawl nets, set gill and trammel nets, and hook-and-line gear. Set nets produced most of the California halibut catch statewide until 1992 when a series of legislative actions to protect marine life essentially prohibited the use of set gill net gear in state waters. Since then, trawl gear has been the primary producer of the statewide California halibut catch. The annual statewide commercial hook-and-line catch of California halibut is minor when compared to bottom trawl catch, but is similar to the set gill net fishery in recent years. In 2006, trawl gear accounted for 71 percent, set net gear accounted for 15 percent, and hook-and-line gear accounted for 14 percent of the California halibut landings statewide. California halibut caught inside the CHTG accounted for nearly six percent of the total statewide trawl catch in 2006.

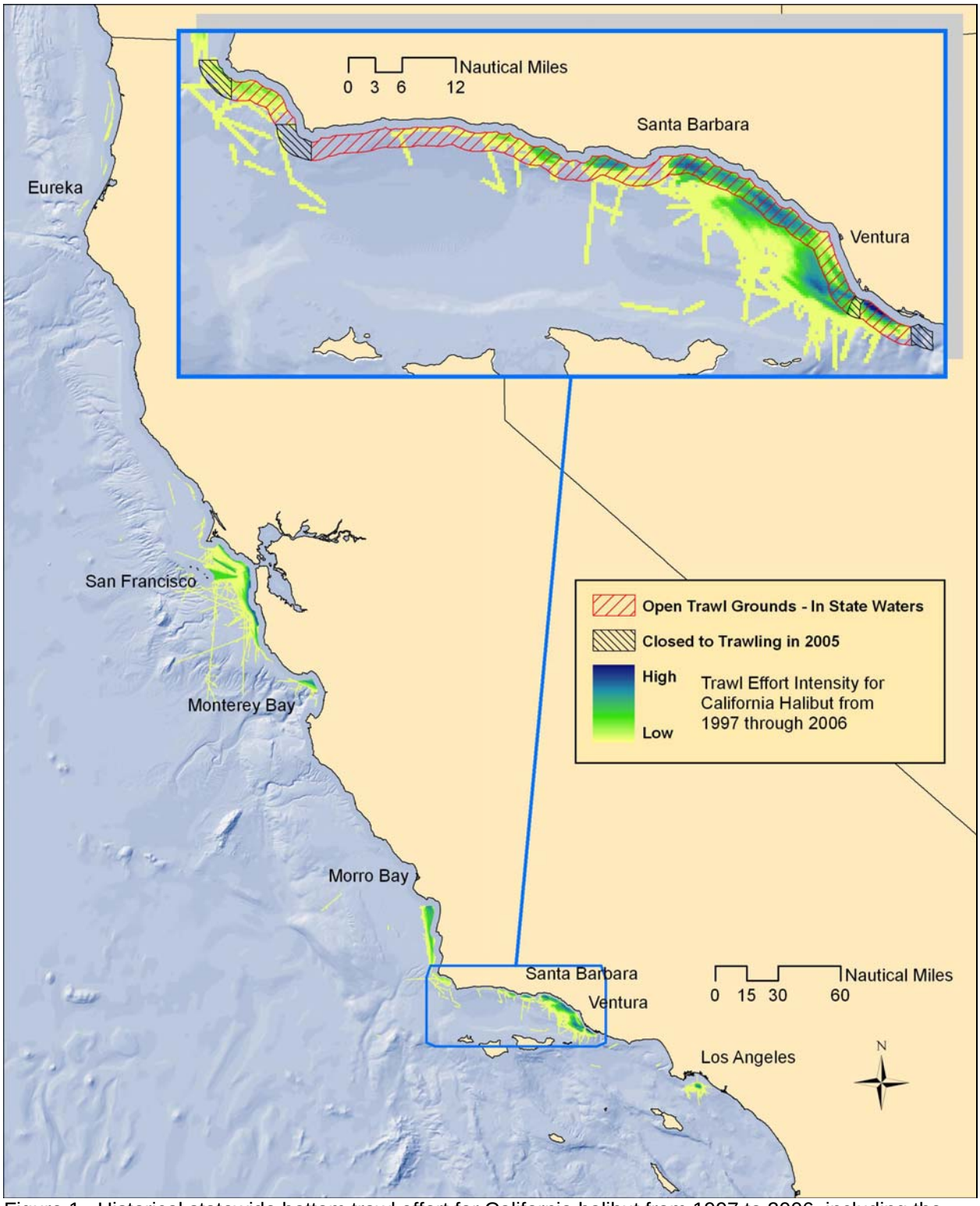

Figure 1. Historical statewide bottom trawl effort for California halibut from 1997 to 2006, including the California halibut trawl grounds which comprise state waters not less than one nm from shore between Point Arguello (Santa Barbara County) and Point Mugu (Ventura County).
Data source: CFIS (2007).

The trawl fishery operating within the CHTG is primarily a low-volume, high-price fishery that supplies local seafood restaurants with a live product that generally commands a premium price about 1.5 times greater than a dead product. This component of the fishery was developed in the early 1990s and is unique because the tow duration for live California halibut is approximately a third of the average tow duration for the dead fish fishery.

Prior to 1876, California halibut were elusive for nearshore commercial fishermen, who used hand lines and beach seines. By the late 1870s, commercial fishermen in the San Francisco Bay area began using paranzella trawl nets to catch bottom dwelling fish, such as California halibut. This gear was towed across the seafloor using two sailboats which sailed parallel to each other to maximize the width of the net opening. The fishery successively transformed from the use of sail-power, to steam-power, to gasoline-power, and finally to diesel-powered engines (Scofield 1948). Historically, the geographic center of the California halibut trawl fishery has oscillated between central and southern California fishing grounds. Since 1980, it has been centered in waters off San Francisco (CFIS 2007).

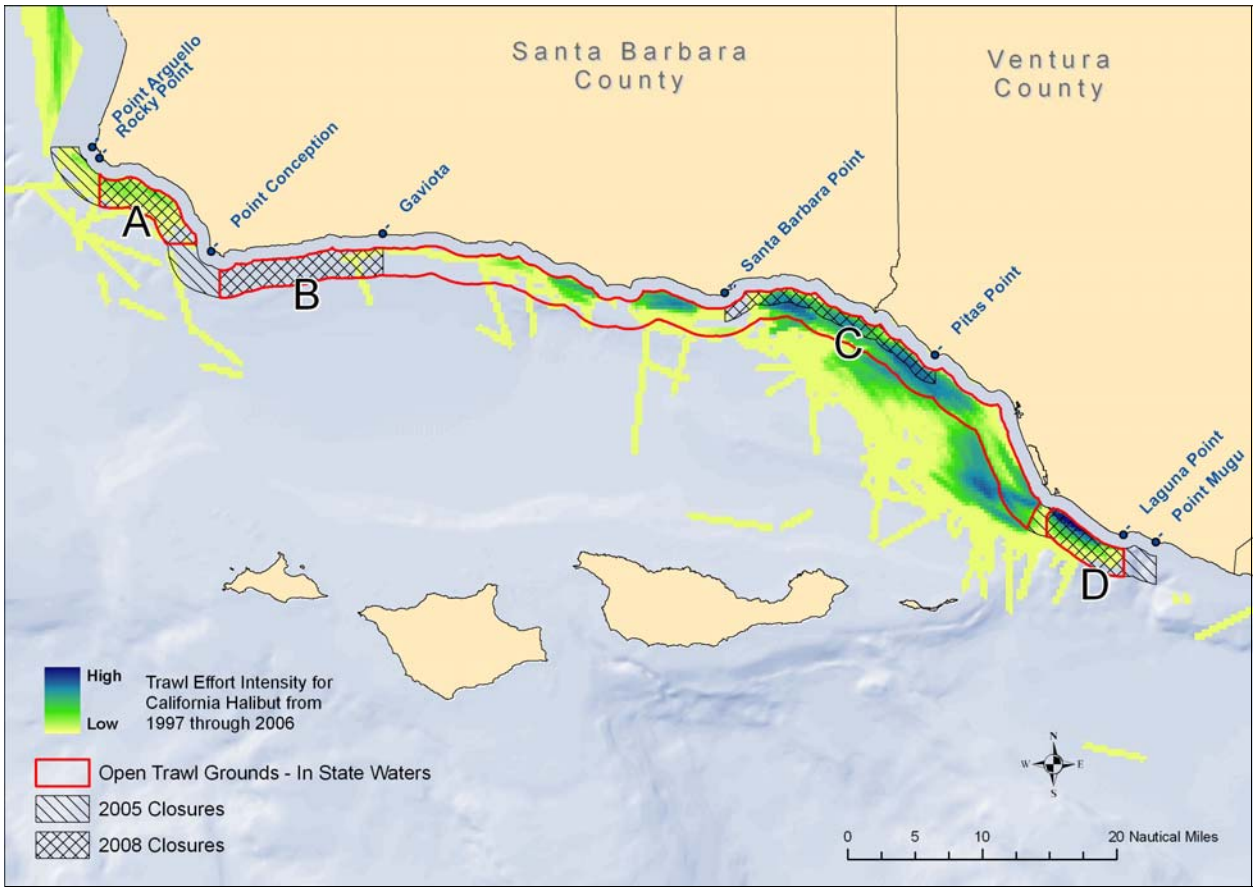

Figure 2. Trawl effort intensity within the entire California halibut trawl grounds and the four individual areas proposed for closure in 2008.
Data source: CFIS (2007).

Regulations for California Halibut Trawl Grounds

In 1971, the Legislature designated the CHTG as state waters adjacent to Santa Barbara and Ventura Counties not more than 25 fathoms deep and not less than one nautical mile from shore. Conservation measures were implemented for sustainable management of the CHTG fishery. These included a minimum codend mesh size of 7.5 inches to reduce bycatch of immature fish and a season closure from February through May to protect spawning adults. The season closure was amended in 1972 to March 15 through June 15.

In 1979, a minimum size limit of 22 inches TL for all commercially landed California halibut became effective. The commercial size limit was amended in 1981 to allow the sale of California halibut if it weighed at least 4 pounds whole, 3.5 pounds dressed with the head on, or 3 pounds dressed with the head off. These minimum weight requirements met the industry needs while insuring the fish were at least 22 inches TL.

The definition of the CHTG was amended to remove the 25 fathom depth restriction in 1988, thus allowing trawling at any depth in waters not less than one nautical mile from mainland shore within the CHTG. Beginning in 2005, the authorized fishing area within the CHTG was reduced by 13 percent (Figure 1, 2), and the provision allowing retention of California halibut based on its weight was removed from FGC (8495, 8392). Other current state bottom trawl regulations in effect include:

- Bottom trawling is prohibited in state waters, except within the CHTG
- Limited entry program to control fishing capacity
- Within the CHTG, minimum codend mesh size of 7.5 inches in length and codend not less than 29 meshes long and 47 meshes in circumference to reduce bycatch of non-target species
- Season closure in CHTG from March 15 through June 15 to protect spawning adults
- Area restrictions (non-trawl zones) to maintain biodiversity
- Mandated WCGOP coverage
- Logbook program to monitor catch location and effort information
- Possession limit of not more than 500 pounds of fish other than California halibut to minimize mortality of non-target species

Trawlers targeting California halibut in federal waters are subject to federal groundfish regulations, including a 4.5 inch minimum net mesh, conservation area restrictions and requirements, daily and monthly incidental trip limits for groundfish species, and a vessel monitoring system for both federal and state waters to monitor compliance with closed areas. Trawling for California halibut can be conducted year round in federal waters but a California Halibut Bottom Trawl Vessel Permit is required to land more than 150 pounds per trip (FGC §8494) (Code of Federal Regulations [CFR] Title 50, §660.301-§660.399).

Gear Description and Vessel Profile

Vessels currently participating in the California halibut trawl fishery use otter trawl gear (Figure 3). Otter trawl gear consists of two doors which are deployed on each side of the net. The net and doors are attached to the vessel with cables. When the gear is towed, water pressure on the doors causes them to spread the mouth of the net open. The mouth of the net is held open vertically with floats attached to the headrope (top of the net) and weights on the footrope (bottom of the net) (Figure 3). The majority of trawlers in southern California use a "dropped-loop" style chain which consists of chain link loops that hang from the footrope approximately three to eight inches, and are set at one foot intervals along the length of the footrope (Figure 4) (Mike McCorkle, SCTA, personal communication). This provides weight to the footrope while decreasing the surface area that comes in contact with the bottom. Historically, trawl nets were made out of nylon. However, most vessels participating in the current southern California halibut trawl fishery use polypropylene nets which are much lighter (Mike McCorkle, SCTA, personal communication). Bridle cables made of nylon or steel connect the doors to the leading edge of the net (Figure 3).

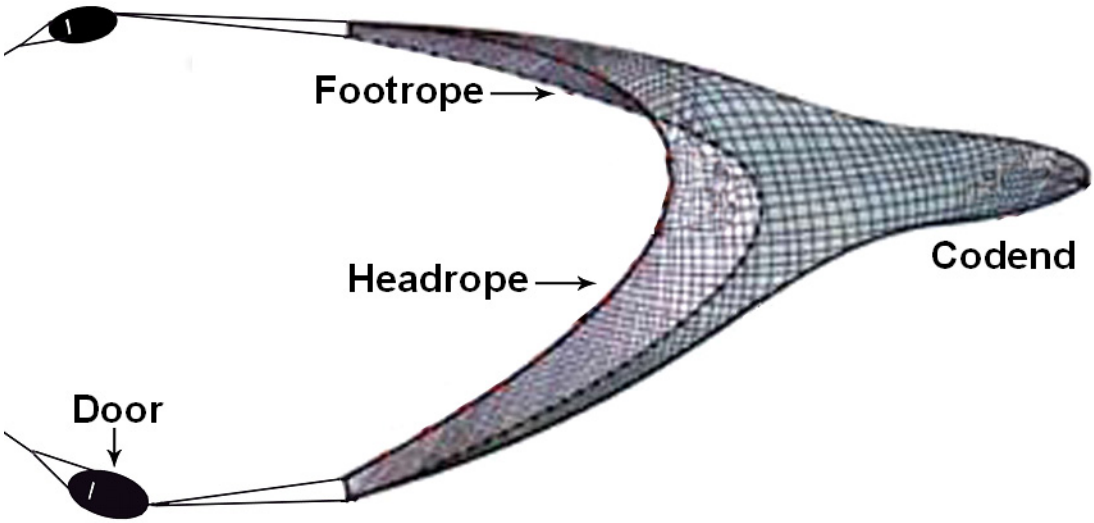

Figure 3. Schematic of an otter trawl net used in the California halibut commercial trawl fishery. Credit: Redesigned by B. Owens from original work by Robin Amoral

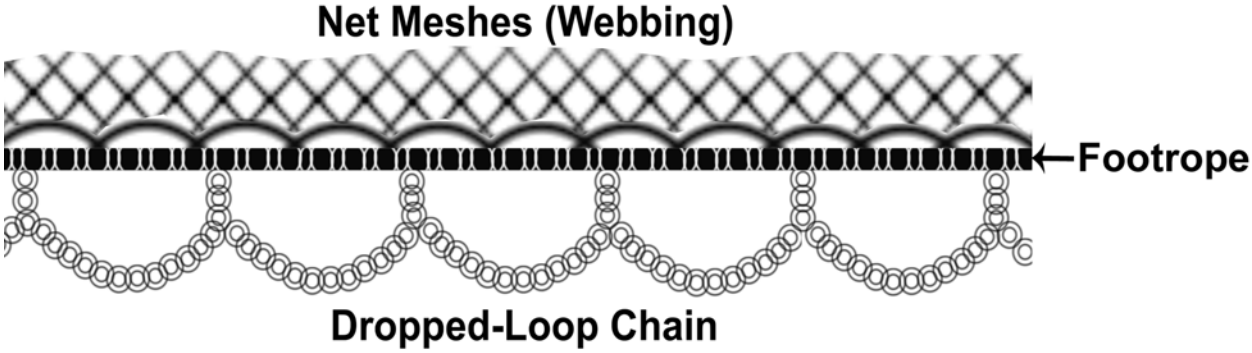

Figure 4. Schematic of a footrope with a "dropped-loop" style hanging chain typically used on boats participating in the California halibut trawl fishery in the California halibut trawl grounds (Mike McCorkle, SCTA, personal communication).

Net configurations must conform to regulatory statutes for trips within the CHTG (FGC §8496, §8843). The criteria for the codend mesh size currently used in the CHTG came from trawl experiments conducted by the Department in 1964 and 1965. These experiments used a 5.5 and 7.5 inch codend mesh to determine which mesh size would provide optimum escapement for sub-legal California halibut and other bycatch while retaining legal California halibut. Results from these experiments revealed that the 7.5 inch mesh codend caught fewer sub-legal California halibut and reduced the amount of bycatch when compared to the 5.5 inch mesh codend.

Trawl vessels fishing in the CHTG are generally smaller and have less horsepower than permitted vessels that made California halibut landings in 2006, operating out of central California (Table 1). A subset (50 percent) of these central California permitted vessels were surveyed by the Department to determine the footrope length used by this portion of the fishery. The footrope length can determine the size of the net entrance. Footrope length for these vessels ranged from 50 to 180 feet with an average of 90 feet.

Table 1. Specifications for bottom trawl vessels operating within the California halibut trawl grounds compared to bottom trawl vessels with halibut permits operating in federal waters off the coast of California.

	Minimum		Maximum		Average	
Vessel	State	Federal	State	Federal	State	Federal
Vessel length (feet)	29	32	63	71	43	47
Horsepower	75	85	250	871	204	304
Tonnage	5	5	52	108	18	27
Year built	1926	1908	1976	1993	1958	1965

Data Source: CFIS (2007).

The Commission has the authority to determine the size, weight, and configuration of all parts of the trawl gear (FGC §8495). To limit bottom trawl gear impacts to the seafloor, the SCTA has recommended that trawl vessels fishing in the CHTG be restricted to gear that is much smaller than gear utilized in other trawl fisheries, such as the selective flatfish trawl fishery and the federal limited-entry groundfish trawl fishery. These recommendations extend beyond current gear restrictions for the CHTG, and include trawl nets with a maximum footrope length, wing panels that do not exceed 100 feet in length, and doors that do not exceed 500 pounds in weight (Mike McCorkle, SCTA, personal communication). The proposed new restrictions generally conform to gear specifications for vessels currently participating in the CHTG fishery.

Fishery Performance

Commercial landings of California halibut have ranged from a historical high of 4.7 million pounds in 1919 to a low of 950,000 pounds in 1932. Since 1932, an average of 766,000 pounds has been landed annually with five notable peaks: 1936 (1.6 million pounds), 1946 (2.5 million pounds), 1964 (1.3 million pounds), 1981 (1.3 million pounds), and 1997 (1.3 million pounds). From 1997 to 2006, annual landings have

averaged 997,000 pounds (Figure 5). During this period, bottom trawlers landed the majority of California halibut statewide, followed by gillnet, and hook-and-line.

Annual statewide California halibut landings from bottom trawlers averaged 565,000 pounds from 1997 through 2006, ranging from a high of 730,000 pounds in 1998 to a low of 340,000 pounds in 2000 (Figure 5). The majority of the landings occurred in the San Francisco port complex (64 percent), followed by 16 percent in Santa Barbara/Ventura port complex, eight percent in the Monterey port complex, five percent in both the Morro Bay and Los Angeles port complexes, and less than one percent in the Eureka, Bodega Bay, Fort Bragg, and San Diego port complexes (Table 2).

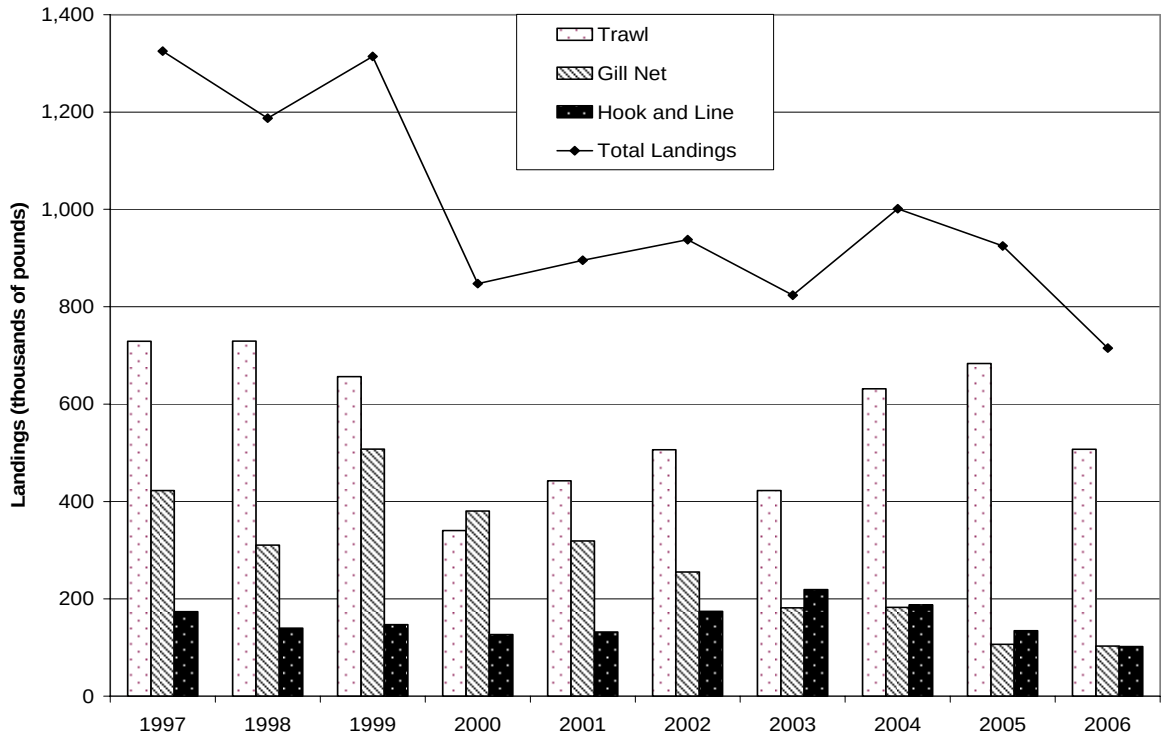

Figure 5. Annual commercial California halibut landings (thousands of pounds) from trawl, gill net, and hook-and-line gears from 1997 through 2006.
Data source: CFIS (2007).

The Trawl Fishery in the Santa Barbara/Ventura Port Complex

The number of trawl vessels landing California halibut in the Santa Barbara/Ventura port complex ranged from a high of 30 vessels in 1997 to a low of 22 vessels in 2006. Activity for vessels having a home port outside of the Santa Barbara/Ventura port complex but made landings in this region remained fairly constant from 1997 to 2000, averaging 52 percent of the total vessel activity for this area. Since 2001, the number of vessels entering the Santa Barbara/Ventura port complex from other ports declined from an average of 14 from 2001 to 2005 to four in 2006. These vessels arrived from ports as far north as Eureka and from ports south of Santa Barbara, such as Los Angeles and San Diego.

Table 2. Annual commercial California halibut trawl landings (pounds) by port complex from 1997 to 2006.

Year	Bodega Bay	Eureka	Fort Bragg	Los Angeles	Monterey	Morro Bay	San Diego	San Francisco	Santa Barbara	Total
1997	24	29,349	0	19,841	93,103	42,318	0	485,353	59,044	729,031
1998	15,764	28,092	0	58,423	23,019	100,954	0	427,457	76,034	729,743
1999	13,011	6,491	0	58,356	57,884	59,854	199	371,134	89,432	656,361
2000	3,366	767	0	18,590	8,560	16,208	30	234,643	57,952	340,114
2001	688	7,326	0	11,516	18,344	37,199	0	212,409	154,845	442,327
2002	0	287	0	18,198	41,221	13,105	0	260,753	172,538	506,102
2003	6,787	38	317	30,539	19,845	4,958	35	272,792	86,903	422,214
2004	697	0	0	24,019	83,664	3,293	0	434,983	84,665	631,322
2005	0	0	0	15,525	59,888	5,071	0	543,606	59,294	683,384
2006	0	0	108	7,437	59,086	15,169	0	356,507	69,086	507,393
Total	40,336	72,350	425	262,444	464,613	298,128	264	3,599,637	909,794	5,647,992
10 year average	4,034	7,235	43	26,244	46,461	29,813	26	359,964	90,979	564,799

Data source: CFIS (2007).

In 2006, the California Halibut Bottom Trawl Vessel Permit was implemented. A total of 62 permits were issued, and 44 of which participated in the fishery statewide. Only 15 permitted vessels fished in the CHTG.

Because the fishing season within the CHTG spans two calendar years, catch and landings data from trawl caught California halibut in the CHTG were analyzed by fishing season instead of annually. This allows for a more accurate assessment of the activity that occurs during the open and closed fishing seasons. Over the past ten seasons, trawl landings of California halibut caught in the CHTG have ranged from a high of 30 percent of the total statewide trawl landings during the 2001/2002 fishing season to a low of four percent during the 2005/2006 fishing season (Table 3, Figure 2). Trawl landings from catch inside the CHTG have averaged 11 percent of the statewide trawl landings during the last ten CHTG fishing seasons Table 3).

Table 3. The statewide[1] percentage of California halibut caught with trawl gear from within the California halibut trawl grounds during the open season (June 16 to March 14).

			2008 closures				
Fishing season	**CHTG[2]**	**2005 closures**	**Area A**	**Area B**	**Area C**	**Area D**	**Total**
97/98	5%	0%	1%	0%	1%	2%	4%
98/99	14%	1%	2%	0%	7%	1%	10%
99/00	14%	0%	1%	0%	6%	1%	8%
00/01	17%	1%	0%	0%	7%	2%	9%
01/02	30%	2%	1%	0%	8%	7%	16%
02/03	23%	1%	2%	0%	9%	4%	15%
03/04	10%	1%	0%	0%	2%	3%	5%
04/05	5%	0%	0%	0%	2%	2%	4%
05/06	4%	0%	0%	0%	2%	0%	2%
06/07*	6%	0%	0%	0%	2%	0%	2%
10 season average[3]	11%	<1%	1%	0%	4%	2%	7%

Data source: CFIS (2007).
[1]Statewide percentage includes all landings by trawl vessels in California.
[2]Includes all open areas, the 2005 closures, and the proposed 2008 closures.
[3]Ten season average is based on the sum of the statewide catch.
*Logbook data not available for 2007.

Regionally, California halibut caught in the CHTG accounted for 75 percent of the landings in the Santa Barbara/Ventura port complex from 1997 to 2006. The four area closures proposed for 2008 accounted for approximately 45 percent of these landings (Table 4, Figure 2). Most of the fishing effort occurred in Area C, averaging 27 percent of the total regional landings, followed by Area D (13 percent), Area A (five percent), and Area B (less than one percent) (Table 4). During the past ten fishing seasons, catch from federal waters accounted for about 25 percent of the regional trawl caught landings during the CHTG open season. Overall California halibut trawl vessel activity

in the Santa Barbara/Ventura region typically drops by 50 percent during the months when fishing in the CHTG is closed.

Table 4. The regional landing percentage[1] of trawl caught California halibut from within the California halibut trawl grounds during the open season (June 16 to March 14).

			2008 closures				
Fishing season	**CHTG[2]**	**2005 closures**	**Area A**	**Area B**	**Area C**	**Area D**	**Total**
97/98	90%	2%	17%	0%	24%	25%	66%
98/99	82%	3%	9%	0%	39%	4%	52%
99/00	76%	2%	8%	0%	31%	5%	44%
00/01	61%	2%	1%	0%	24%	8%	33%
01/02	69%	5%	3%	<1%	18%	16%	37%
02/03	77%	4%	7%	0%	29%	15%	51%
03/04	73%	5%	0%	0%	20%	23%	43%
04/05	81%	2%	0%	0%	28%	28%	56%
05/06	73%	0%	0%	0%	25%	6%	31%
06/07*	62%	0%	0%	0%	22%	3%	25%
10 season average[3]	75%	3%	5%	<1%	27%	13%	45%

Data source: CFIS (2007).
[1]Regional percentage only includes the landings made in the Santa Barbara/Ventura port complex.
[2]Includes all open areas, the 2005 closures, and proposed 2008 closures.
[3]Ten season average is based on the sum of the regional catch.
*2007 logbook data not available

Economic Profile of the California Halibut Trawl Fishery

During the open and closed CHTG fishing seasons from 1997/1998 through 2006/2007, the majority of trawl caught California halibut landings and associated ex-vessel value statewide occurred in the San Francisco and San Mateo counties, constituting 33 percent and 24 percent respectively (Table 5). However, the price-per-pound for California halibut during this same time period has been consistently higher in southern California. The south to north price differential is $4.37 versus $2.83 per pound, and is due in large part to the higher prices paid for live fish in southern California. The Santa Barbara and Ventura counties have seen the greatest increase in California halibut price-per-pound in 2006 as compared to the previous nine year average in each locale, constituting an increase of 29 percent and 27 percent respectively. In terms of contribution to California's economy, the California halibut landings value (1997/1998 through 2006/2007) adjusted for inflation averaged about $1.7 million in ex-vessel landings revenue. Some of this revenue is allocated to purchasing products from other businesses, which in turn use some of the revenue to pay for wages and products from other businesses, creating a ripple effect from re-spending in the economy. Thus, the entire economic contribution of $1.7 million in ex-vessel revenue is as much as $2.7 million in total economic output for the state of

Table 5. Ex-vessel revenue (adjusted to 2006$ prices) of all California halibut trawl landings reported by county from the 1997/1998 through the 2006/2007 open and closed fishing seasons*.

County	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07**
Alameda		$1,177		$1,185	$313	$35				
Contra Costa					$2,596	$769			$1,536	
Del Norte	$39,246	$21,872	$1,594	$736	$1,293	$182	$19			
Humboldt	$9,341	$31,611	$2,787	$1,560	$15,278	$142	$11			
Los Angeles	$156,725	$285,979	$145,524	$80,385	$74,025	$133,376	$170,637	$121,314	$53,923	$11,057
Marin								$2,225	$15,591	
Mendocino									$723	
Monterey	$113,642	$49,379	$64,461	$11,903	$61,857	$41,359	$64,380	$224,998	$174,658	$126,749
Orange	$681		$74		$288	$167	$103			
San Diego		$536	$162	$162		$123				
San Francisco	$991,581	$521,664	$608,883	$360,753	$369,494	$453,087	$428,072	$1,036,972	$636,950	$175,350
San Luis Obispo	$167,798	$301,981	$116,133	$69,061	$96,666	$31,278	$11,027	$8,002	$22,871	$49,752
San Mateo	$551,242	$607,762	$398,343	$228,281	$275,261	$347,987	$423,810	$470,962	$523,998	$168,818
Santa Barbara	$151,311	$155,560	$117,580	$167,249	$279,139	$236,020	$171,175	$133,039	$170,167	$113,659
Santa Cruz	$36,158	$20,448	$43,499	$17,979	$41,859	$27,060	$16,498	$34,805	$26,029	$23,594
Solano								$2,449		
Sonoma	$24,596	$36,867	$25,682	$1,856	$1,046	$14,860	$4,378	$229		$9
Ventura	$103,657	$158,977	$119,878	$197,924	$425,645	$362,394	$177,691	$231,016	$159,667	$91,803
Total	$2,345,978	$2,193,816	$1,644,601	$1,139,033	$1,644,759	$1,648,839	$1,467,802	$2,266,011	$1,786,115	$760,793

Data Source: CFIS (2007).
*Open and closed fishing season is from June 16 through June 15.
* Data not available for landings made in 2007.

California. Wage earnings and employment from a revenue contribution of $1.7 million are estimated to be $1.3 million and 45 jobs, respectively, for California.

Ex-vessel revenue generated from California halibut caught within the CHTG varied from fishing seasons 1997/1998 through 2006/2007, ranging from a high of $427,000 during the 2001/2002 season to a low of $127,000 during the 2006/2007 season (Table 6). The average ex-vessel revenue generated from California halibut caught within the CHTG during this same time period was $237,000 compared to $1.5 million statewide (Table 6).

The direct economic contribution from California halibut taken within the CHTG landings averaged about $237,000 in ex-vessel landings revenue (for 1997 through 2006 seasons). As fishermen purchase products from other businesses, who in turn pay for wages and products from other businesses, the ripple effect results in as much as $538,000 in total economic output for coastal communities near the CHTG. Wage earnings and employment from a landings revenue contribution of $237,000 are estimated to be $256,000 and 11 jobs, respectively, for nearby coastal community economies.

Table 6. Ex-vessel revenue (adjusted to 2006$ prices) generated from California halibut caught with trawl gear inside and outside of the California halibut trawl grounds for fishing seasons 1997/1998 through 2006/2007.

	Ex-vessel Revenue						
			2008 closures				
Fishing season	Statewide[1]	CHTG[2]	Area A	Area B	Area C	Area D	Total
97/98	$2,155,058	$190,920	$36,500	$0	$51,408	$53,008	$140,916
98/99	$1,949,321	$244,494	$26,882	$0	$117,733	$13,341	$157,956
99/00	$1,470,886	$173,715	$17,547	$0	$71,553	$12,571	$101,671
00/01	$976,130	$162,903	$2,454	$0	$64,591	$21,162	$88,207
01/02	$1,218,183	$426,577	$15,721	$183	$109,192	$97,094	$222,190
02/03	$1,256,999	$391,840	$37,735	$0	$148,966	$74,739	$261,440
03/04	$1,275,242	$192,560	$0	$0	$53,860	$61,825	$115,685
04/05	$2,020,109	$245,903	$0	$0	$83,741	$83,855	$167,596
05/06	$1,566,846	$219,268	$0	$0	$76,491	$19,438	$95,929
06/07*	$634,047	$126,746	$0	$0	$45,551	$5,153	$50,704
Ten season average[3]	$1,452,282	$237,493	$13,684	$18	$82,308	$44,219	$140,229

Data source: CFIS (2007).

[1]Statewide ex-vessel revenue excludes CHTG.

[2]Includes all open areas, the 2005 closures, and proposed 2008 closures.

[3]Ten season average is based on the total catch for all ten fishing seasons from 1997/1998 to 2006/2007.

* Partial season; 2007 data not available.

Some economic impacts to the trawl fishermen and coastal communities will occur if the 2008 area closures go into effect, assuming that effort and catch will not fully shift to trawl grounds that remain open. Ex-vessel revenue generated from California halibut caught in the proposed closures averaged $140,000 over the last ten fishing seasons (Figure 6), although the ex-vessel revenue was highly variable from season to season. For example, during the 2002/2003 fishing season, the proposed 2008 area closures were worth $261,000 in ex-vessel revenue, but during the 2006/2007 fishing season, only $51,000 in ex-vessel revenue was generated (Figure 6). Considering the ripple effect in local economies, the $140,000 in ex-vessel revenue represents an estimated $318,000 in total economic output for coastal communities. Wage earnings and employment from a landings revenue contribution of $140,000 are estimated to be $151,000 and six job equivalents, respectively, for nearby coastal community economies. While some effort shift and associated catch could offset potential economic losses due to the proposed closures, it is unlikely that this would make up for the loss of highly productive fishing grounds. Overall fishing effort may be further reduced if fishermen decide against traveling greater distances to fish the less productive fishing grounds that remain open. Another consideration is potentially lower catch rates per vessel in the areas that remain open due to increased crowding on those fishing grounds.

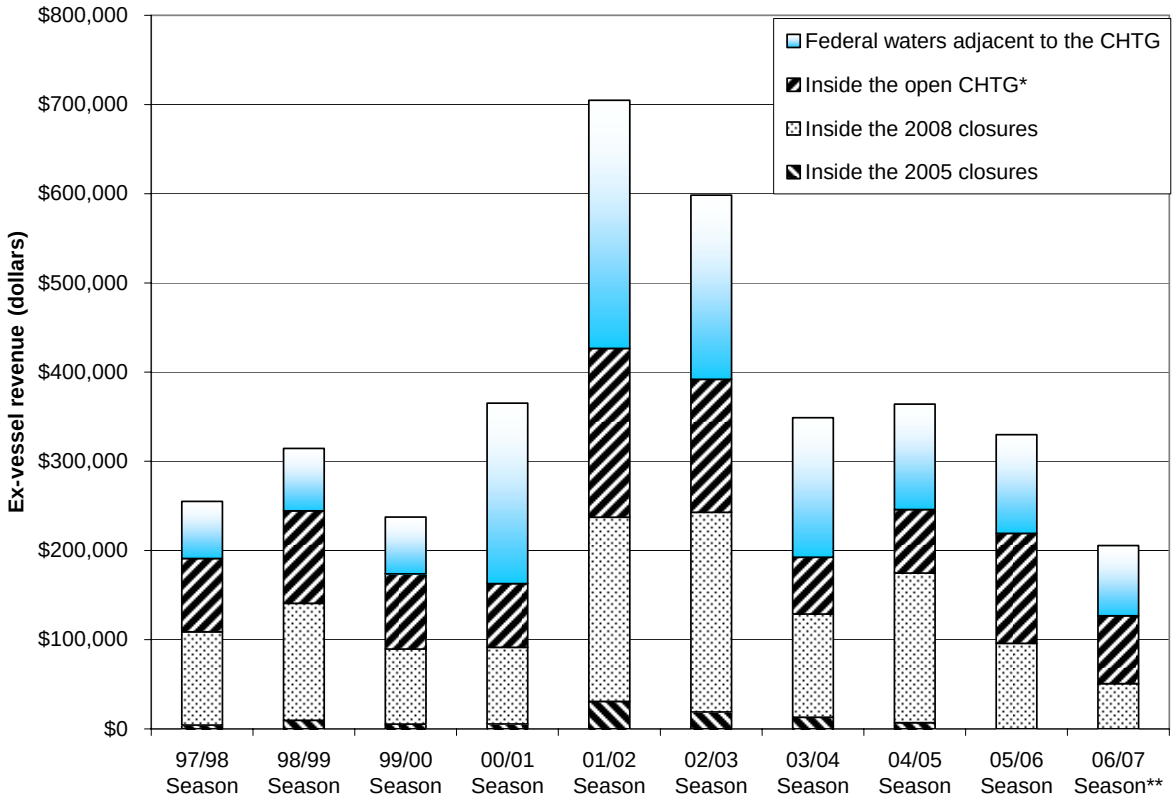

Figure 6. Ex-vessel revenue (adjusted to 2006$) generated for trawl caught California halibut taken in the federal waters adjacent to the Santa Barbara/Ventura counties and within the California halibut trawl grounds, including the 2005 closure areas, and the closures proposed for 2008.
Data source: CFIS (2007).
*The areas not affected by either the 2005 closures or the proposed 2008 closures.
** Partial season. Data not available for landings made in 2007.

Sea Cucumber Trawl Fishery

Nearly 65 percent of the California halibut trawl vessels in the SBC also target sea cucumber. The California sea cucumber (*Parastichopus californicus*) is the primary species but incidental catches of warty sea cucumber (*P. parvimensis*) also occur. The sea cucumber trawl fishery is a limited entry program, and the number of vessels participating in this fishery has declined from 38 permit holders in 1997 to 20 in 2006 (CFIS 2007). Of the total trawl caught sea cucumber landings statewide, 96 percent occurred within the Santa Barbara/Ventura port complex, averaging 183,000 pounds from fishing seasons 1997/1998 through 2006/2007. Landings of sea cucumbers caught within the CHTG comprised 21 percent of the average landings made with the Santa Barbara/Ventura port complex during the same period. Less than one percent of the seasonal average catch within the CHTG comes from the proposed 2008 closure areas.

The total average ex-vessel value for trawl caught sea cucumber landed within the Santa Barbara/Ventura port complex was $160,000 from fishing seasons 1997/1998 through 2006/2007. During the same period, sea cucumbers caught within the CHTG comprised 21 percent of the total average. In recent years there has been an increase in demand for this product, primarily by China and Malaysia, which import the dried product for local use.

FISHERY PERFORMANCE CRITERIA

In accordance with FGC §8495, information about the California halibut bottom trawl fishery operating within the CHTG was obtained from monitoring data (logbook, market receipt, and at-sea observer data) and relevant scientific literature and informational documents published by academic, government agency, and non-government organizations. Based on these sources and the criteria delineated in FGC §8495, the Department reports the following:

Bycatch

Bycatch is defined as any fish or other marine life that are taken in a fishery but which are not the target of the fishery (FGC §90.5). This includes discards (alive and dead) and incidentally caught marketable species that are kept and sold. A collaborative bycatch study involving the SCTA, California Sea Grant, and the Department was conducted in the CHTG during the summer of 2007. Vessels participating in the bycatch study used trawl gear that is typical of the CHTG fishery. Tows were only conducted inside the proposed 2008 closure areas to provide the Commission with detailed bycatch data for these areas. It was determined through preliminary study tows that 30 minute tows would efficiently and effectively provide accurate and unbiased bycatch data, while providing a sufficient sample size of tows so that bycatch rates were available for each of the four separate areas that are proposed for 2008 closure (see: Summary by Individual Closure Area, below). Preliminary test tows showed that the total catch by weight was proportionally higher for one-hour tows compared to 30 minute tows, but the species composition of the catch was similar. All catch data from the 30 minute tows were multiplied by two to reflect one hour tows.

The CHTG bycatch study provides current data on the species composition and catch by weight in the proposed 2008 closure (Appendix B, C). A total of 32 tows (30 minutes/tow) were sampled inside the CHTG and all fish and invertebrate species were identified, counted, and weighed. Total catch for the 32 tows was 1,229 pounds and the species composition consisted of 27 species of finfish and 32 invertebrate species (Appendix B, C). A total of 328 pounds of legal size California halibut were caught (Table 7). The remaining 901 pounds of the total catch consisted of 751 pounds of discards (94 percent returned alive) and 150 pounds of marketable catch that was sold (Table 7). No rocky reef associated hard corals, sponges, or live kelp were caught during the bycatch study. Due to the relatively short tow durations used in this study, the 94 percent discard of live fish may not accurately represent the discard survival rate of the fishery. Vessels targeting California halibut in the CHTG typically have tow durations of 1 to 1.5 hours, which is two to three times longer than the bycatch study tows.

The Department was unable to obtain raw data from the WCGOP for limited-entry trawl vessels targeting California halibut in federal waters. However, summarized bycatch data collected on groundfish limited-entry trawl vessels targeting California halibut in federal waters from Morro Bay to San Francisco were available for 2001 to 2004 (Hastie 2005). These data were collected aboard vessels using 4.5 inch codend mesh that fished in deeper waters north of the CHTG. Despite these geographic differences, Hastie (2005) provides the best available bycatch data for comparisons with

bycatch data collected from trawl vessels using 7.5 inch codend mesh targeting California halibut in the CHTG. Hastie (2005) did not include catch data for invertebrates and some non-federally managed fish species. Therefore, to make the CHTG bycatch study data comparable to Hastie (2005), all invertebrates and non-federally managed fish species were excluded from the comparison and species were grouped into the four categories (California halibut, all federal groundfish, flatfish, and rockfish) reported in Hastie (2005). In addition, due to differences in tow duration, the bycatch rate was standardized to pounds-per-hour. Average tow duration for limited-entry vessels targeting California halibut (2001 to 2004) in federal waters was 3.7 hours, which was longer than the 30 minute tows used in the CHTG study.

A total of 528 tows resulting in 163,422 pounds of California halibut were observed by the WCGOP aboard groundfish limited-entry vessels targeting California halibut in federal waters from 2001 to 2004 (Table 8). The groundfish limited-entry trawl vessels had a higher California halibut catch rate (83 pounds/hour) than that of trawl vessels in the CHTG (23 pounds/hour). The bycatch rates of federally managed groundfish were also higher for the groundfish limited-entry trawl vessels (123 pounds/hour) when compared to the CHTG vessels (6 pounds/hour). A similar trend occurred across all bycatch categories with limited-entry vessels having higher catch rates (Table 8). Limited-entry vessels had a combined bycatch rate of federally managed groundfish and short California halibut that was 94 percent greater (133 pounds/hour) than trawl vessels in the CHTG (8 pounds/hour). Although the groundfish limited-entry vessels demonstrated higher catch rates than the CHTG study for both the targeted California halibut and the associated bycatch, the increase in bycatch was significantly greater than the increase in California halibut. Groundfish limited-entry trawl vessels caught 1.7 pounds of federally managed groundfish for every pound of retained California halibut, while CHTG vessels caught 0.28 pounds-per-pound of retained California halibut.

Table 7. Summarized catch data from the California halibut trawl ground bycatch study. Catch data were from 32 tows conducted from June to September 2007 off the Ventura and Santa Barbara counties within the 2008 proposed closure areas.

	Catch (pounds)	Retained (pounds)	Discarded (pounds)	Percent discarded alive (number)	Percent discarded alive (weight)	Percent of total catch (weight)
Legal California halibut	328	328	0	0	0	27%
Sub-legal California halibut	47	0	47	87%	86%	4%
All other fish	45	8	37	63%	71%	4%
Sharks and skates	483	92	391	100%	100%	39%
Invertebrates	326	50	276	67%	89%	26%
Total bycatch	901	150	751	68%	94%	73%
Total catch	1,229	478	751	n/a	n/a	100%

Table 8. Catch comparisons between groundfish limited-entry trawl vessels targeting California halibut in federal waters north of Point Conception (2001 to 2004) to that of trawl vessels targeting California halibut in the California halibut trawl grounds (CHTG). To make the CHTG bycatch data comparable to Hastie (2005) all invertebrates and some non-federally managed fish species were excluded from the CHTG bycatch data reported below.

	Federal data[1]	CHTG data[2]
Number of observed tows	528	32
California halibut		
Total catch (pounds)	163,422	372
Retained catch (pounds)	142,146	328
Percent discarded	13%	12%
Catch rate (pounds/hour)	83	23
Retained (pounds/hour)	73	21
All federal groundfish		
Total catch (pounds)	240,768	91
Retained catch (pounds)	95,876	24
Percent discarded	60%	74%
Catch rate (pounds/hour)	123	6
Pounds/pound retained halibut	1.7	0.3
All rockfish species		
Total catch (pounds)	24,635	0.1
Retained catch (pounds)	7,797	0
Percent discarded	68%	100%
Catch rate (pounds/hour)	13	0
Pounds/pound retained halibut	0.2	0
All flatfish species (except California halibut)		
Total catch (pounds)	126,664	28
Retained catch (pounds)	85,238	8.0
Percent discarded	33%	71%
Catch rate (pounds/hour)	65	1.8
Pounds/pound retained halibut	0.9	< 0.1

[1] Hastie (2005).
[2] CHTG bycatch study (2007).

The higher bycatch rate by the limited-entry vessels targeting California halibut could be due to regional differences in fishing behavior, fish densities, species composition on the fishing grounds, or other factors. Limited-entry vessels targeting California halibut fished in waters deeper and north (north of Point Conception) of the CHTG. However, the higher bycatch rates are also attributable to the compounding effect of generally larger nets and smaller codend mesh size used by these vessels.

Research has shown that the use of larger codend mesh sizes results in a reduction of bycatch (Schott 1975). Limited-entry vessels use a 4.5 inch mesh codend while vessels trawling inside the CHTG are required to use a 7.5 inch mesh codend.

Seafloor Habitat

The CHTG is located in a relatively wide portion of the continental shelf within the northern part of the Southern California Bight, known as the SBC (Figure 1). Much of the CHTG, particularly the eastern portion, occurs over a shallow, broad shelf; however, two deep submarine canyons, Hueneme Canyon and Mugu Canyon also transect the CHTG (Figure 7). The average depth of the CHTG is 29 fathoms, ranging from 6 fathoms to 212 fathoms. The most intensively fished area in the CHTG is Area C, which has an average depth of 18 fathoms (Figure 2). Generally, effort is concentrated in the shallowest areas of the CHTG (Figure 2). The seafloor environment in the continental shelf portion of the SBC may be described as primarily a soft bottom habitat that is relatively flat and featureless, however vertical relief occurs in some areas in the form of sand ripples and burrows made by infaunal or epifaunal invertebrates and bedrock which is found mostly on the continental shelf south of Goleta (Figure 2) (Allen 2006). Patches of hard or mixed substrate also occur throughout the CHTG (Figure 7), although California halibut trawlers generally avoid these areas (Figure 2). Approximately 14 percent of the CHTG consists of hard substrate and 86 percent

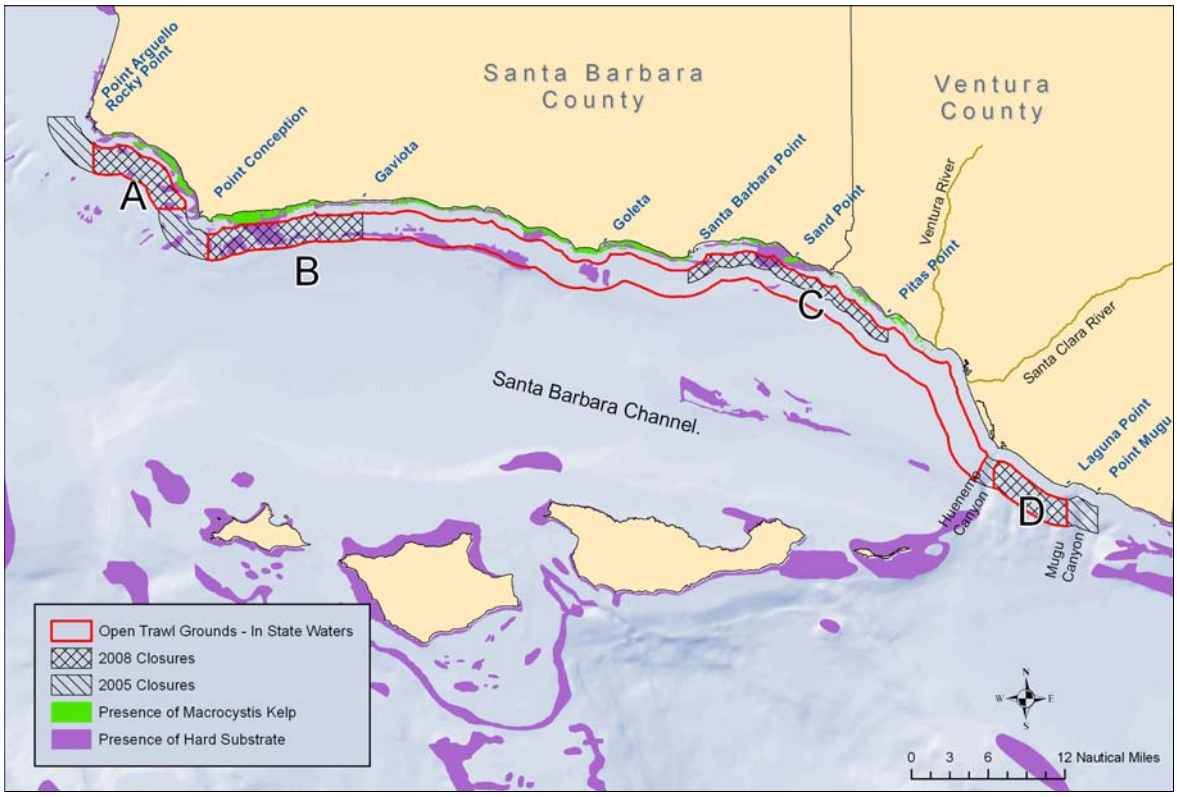

Figure 7. Map of the California halibut trawl grounds showing the location of patches of hard or mixed substrate, kelp habitat, as well as the two submarine canyons in these grounds (Hueneme Canyon and Mugu Canyon).
Data source: CDFG aerial flight surveys and CINMS substrate data.

consists of soft substrate. Natural debris (i.e., marine and terrestrial vegetation) is common in the SBC region compared to waters south of the SBC where anthropogenic debris (i.e., plastic and fishing gear) is more widespread (Allen et al. 1998, Moore and Allen 2000). Natural debris, especially marine vegetation, can be a valuable microhabitat for juvenile fishes associated with the seafloor (Allen and Herbinson 1991). Fishermen in the CHTG have reported the widespread occurrence of natural debris on the seafloor from the introduced giant cane, *Arundo donax*, which grows in riparian habitat associated with local streams and rivers.

The effects of trawling on seafloor habitat can vary, depending on the size and type of trawl gear, level of fishing effort, and the type of habitat. The extent of these effects and rate of recovery also depend on habitat stability. Relatively stable habitats, such as hard bottom and dense mud, experience the greatest changes and have the slowest recovery rates compared to less consolidated coarse sediments in areas of high natural disturbance (NRC 2002).

Few studies on impacts of bottom trawl gear off the west coast of the United States have been undertaken, and currently no studies have been conducted on the impacts of California halibut trawl gear to the seafloor habitat in the CHTG. Two studies on the effects of trawling on soft substrates have been conducted in United States west coast waters; one off Point Sur, California (Engel and Kvitek 1998) and the other near Cape Blanco, Oregon (Hixon and Tissot 2007). Both studies used observations from the two person Delta submersible to characterize and compare effects in trawled and untrawled areas. Hixon and Tissot (2007) studied areas of mud bottom adjacent to Coquile Bank that is fished by the Oregon pink shrimp and groundfish fleet. They found extensive trawl door tracks in the trawled area and found lower abundances of fishes and macroinvertebrates. Species diversity was lower for fish in trawled areas but higher for invertebrates. Engel and Kvitek (1998) studied two areas of sand mud habitats; one heavily trawled by the groundfish fleet primarily targeting flatfish species and the other located inside of state waters where trawling effort was light. They used video from the Delta submersible, sediment grab samples, and experimental trawling to compare differences in habitat structure and invertebrate densities. Results from this study show higher invertebrate densities in the lightly trawled area, but some species of polychaete worms and brittle stars had higher densities in the heavily trawled area. Habitat complexity was found to be lower in the heavily trawled area. Both of these studies concluded that trawling alters the soft bottom habitat resulting in physical and biological changes.

General gear impacts on estuarine, shelf, and slope habitats have been described and analyzed for the Pacific Fishery Management Council and NMFS as part of the Environmental Impact Statement (EIS) for designating EFH for the Pacific Coast Groundfish Fishery (NMFS 2005). The NMFS study consisted of a GIS-based analysis of habitat types, review of gear types off the west coast of the United States, and literature reviews on the impacts of fishing gear on bottom habitats. This information was used to categorize and rate impacts by gear type, habitat, substrate, and depth range. The EIS indicates that the habitat impacts by bottom trawl gear in areas where California halibut trawling occurs is rated between 0.5 and 1 which is the lowest sensitivity classification for impacts to seafloor habitat by bottom trawl gears. The rating

scale for the NMFS report is shown in Table 9.

Although soft bottom seafloor habitats on the continental shelf where California halibut trawl fishing occurs are considered to have a low sensitivity to trawl gear, their recovery times from gear impacts may be longer compared to other substrate types. Several studies examining gear effects on soft bottom indicate that mud substrates are more stable and have longer recovery times than sand substrates (NRC 2002). A mean recovery time for trawl gear impacts in CHTG is estimated to be less than one year in the absence of bottom trawl fishing (NMFS 2005). Trawling is prohibited in the CHTG from March 15 to June 15, allowing a minimum recovery period of three months for seafloor habitats affected by California halibut trawl effort.

Table 9. Rating scale for classifying trawl impacts to bottom habitat.

Sensitivity level	Sensitivity description
0	No detectable adverse impacts on seabed; i.e. no significant differences between impact and control areas in any metrics.
1	Minor impacts such as shallow furrows on bottom; small differences between impact and control sites, <25 percent in most measured metrics.
2	Substantial changes such as deep furrows on bottom; differences between impact and control sites 25 to 50 percent in most metrics measured.
3	Major changes in bottom structure such as re-arranged boulders; large losses of many organisms with differences between impact and control sites >50 percent in most measured metrics.

Data Source: NMFS (2005).

River discharge is the foremost source of sediment input to the oceans worldwide (Milliman and Meade 1983). In California, large river plumes resulting from river floods (Mertes and Warrick 2001) have been reported to influence coastal processes, such as continental shelf currents (Geyer et al. 2000), nearshore phytoplankton blooms (Kudela and Cochlan 2000), offshore sedimentary additions (Wheatcroft et al. 1997), and pollution rates (Bay et al. 1999). River drainage basins in the SBC region range in size from small basins draining directly into the SBC with total drainage areas of less than four square miles to the Santa Clara River drainage basin with a drainage area of approximately 1,583 square miles (Mertes et al. 1998). Sediment transport in the SBC generally occurs in a southeastern direction, primarily influenced by the California Current (Inman and Jenkins 1999), although surface water and water in the eastern SBC typically move in a northwestern direction influenced by the Southern California Counter Current and the Anacapa Current (Warrick et al. 2005). Much of the nearshore sand transported south of Ventura is routed offshore by Hueneme Canyon (Drake et al. 1972). Sediment transport occurs sporadically after large storms typically from December to February of each year (Figure 8), and large variation exists between years

(Drake et al. 1972, Mertes et al. 1998, Inman and Jenkins 1999). For example, the collective flux of sediment load entering the SBC in the flood year of 1969 was at least 100 million tons (Inman and Jenkins 1999). The amount of sediment transported to the SBC by the Santa Clara and Ventura Rivers during that same year exceeded the total amount of sediment transported from these two rivers during the subsequent 25 year period (Inman and Jenkins 1999).

Figure 8. Image of river and terrestrial run-off following a storm in January, 2005, off Santa Barbara County and Ventura County.
Data source: Space Science and Engineering Center, University of Wisconsin-Madison.

Ecosystem Health

An ecosystem is generally defined as a functional system consisting of living organisms in a given area, and all the non-living physical and chemical factors of the associated environment, linked together through nutrient cycling and energy flow. An ecological system is considered healthy if it is stable and sustainable; i.e., a system that maintains its organization and autonomy over time and is resilient to stress (Costanza and Mageau 1999).

Our ability to predict ecosystem dynamics is limited due to their complex nature. Properties characterizing an ecosystem can vary within large boundaries and time

scales (NMFS 2005). According to Field et al. (2006), an ecosystem approach to fisheries management in the California Current must take into consideration the constantly changing climate-driven physical and biological interactions in the ecosystem, the trophic relationships between fished and unfished elements of the food web, the adaptation potential of life history diversity, and the role of humans as predators and competitors. Current state and federal California halibut management measures were not implemented to specifically address ecosystem management. However, the current management measures in place may collectively foster a sustainable bottom trawl fishery inside and outside of the CHTG and indirectly promote a healthy ecosystem by reducing potential fishery impacts on the system. These measures include:

- Limited entry program to control fishing capacity
- Logbook program to monitor catch location and effort information
- Season closure in the CHTG to protect spawning adults
- Minimum size limit of 22 inches TL to prevent growth overfishing
- Minimum 7.5 inch codend mesh-size to allow for escapement of juvenile fish
- Area restrictions (EFH and non-trawl zones) to maintain biodiversity
- Federal at-sea observer coverage to document discards and bycatch
- Federal and state incidental trip limits for non-target groundfish and fish other than California halibut to minimize mortality of overfished species and non-target species
- Mandatory vessel monitoring system to monitor compliance with closed areas

Kelp and Coral Habitats

Biogenic habitat has been defined as any habitat created by plants or animals which provide space for attachment, hiding places from predators, and refuge from harsh environmental conditions (Tyrell 2005). In addition to coral and kelp species, the most common types of biogenic habitats off southern California include species of seagrasses and other structure-forming invertebrates (NMFS 2005). Seagrasses are restricted to shallow depths in nearshore waters (Dennison and Alberte 1985), and not directly influenced by trawling activity in the CHTG. However, a variety of kelp, coral, and other biogenic habitats do occur in waters within or adjacent to the CHTG.

Kelp Habitats

Giant kelp is the dominant canopy forming species in the kelp community occurring near the CHTG (North 1971). Its geographic distribution is primarily controlled by oceanographic conditions such as wave exposure, bottom light intensity, shifting sediments, water temperature, nutrients, salinity, as well as animal grazing, parasites, and diseases (Dayton 1985). The offshore distribution of giant kelp beds in turbid coastal waters usually occurs at depths of 50 to 60 feet, while in clear water around the channel islands of southern California, the offshore edge of the kelp bed may extend to more than 100 feet (North 1971).

Giant kelp occurs on bedrocks, boulders, and reefs (North 1971). While a large majority of giant kelp requires a hard or rocky substrate for their holdfast (root-like structure) to attach, there have been documented cases of kelp utilizing polychaete worm tubes as substrate in the soft sediment (Neushal 1971). Once the alga die, the holdfast remains attached to the worm tubes, providing a substrate for kelp recruitment and growth (Neushal 1971). Historically, these giant kelp beds were growing in the nearshore waters off of Santa Barbara County, and existed there until the early 1980s. After the large storm events from the 1982/1983 El Niño, most of these beds were ripped out of this area and this unique soft sediment kelp community was virtually lost (McPeak and Barilotti 1993).

The inshore boundary of the CHTG occurs at a depth of at least 36 feet. Aerial surveys conducted by the Department did not show any canopy forming kelp growing in the CHTG. There are areas near Gaviota where kelp beds can be found as close as 0.1 nautical mile outside of the CHTG in some years, but the size and shape of the kelp beds adjacent to the CHTG fluctuate on an annual basis (Table 10), which is consistent with other kelp beds statewide. These annual fluctuations are most likely attributed to changing oceanographic conditions (Schiel et al. 2004, Tegner and Dayton 1991).

Table 10. Estimated annual giant kelp canopy (square nautical miles) from Point Mugu to Point Arguello in waters adjacent to the California halibut trawl grounds.

Year	Kelp area (square nautical miles)
1989	2.4
1999	0.4
2002	1.3
2003	2.9
2004	2.0
2005	1.8

Data source: CDFG aerial flight surveys.

Trawling in the CHTG has occurred for over 36 years. During this time, there have been several kelp restoration projects conducted by the Department and NGOs. Several techniques have been used to develop or restore kelp beds and to create artificial reefs. Some of the techniques used in projects near the CHTG include kelp transplanting, addition of suitable substrate, and securing plants into the sediment. Restoration efforts were reported as successful at all the project sites except for one site that failed to sustain kelp after the project was finished. This failure was primarily attributed to sea urchin grazing and not related to bottom trawling activity (D. Craig Barilotti, Sea Foam Enterprises, personal communication).

Coral Habitats

Structure-forming invertebrates, such as corals and coral like species, can support complex ecological communities and increased biodiversity compared to areas without these species (Roberts and Hirshfield 2004). Bottom trawling may cause substantial damage to coral habitats (Auster and Langton 1999, Koslow et al. 2001, Fosså et al. 2002, Roberts et al. 2006). Observations of coral taxa from the WCGOP, research trawls, and in-situ observations (SCUBA, Remote Operated Vehicles, and submersibles) were summarized and compiled to assist in the creation of federal EFH closure areas (NMFS 2005). In waters within and adjacent to the CHTG, these data indicate the presence of four major taxa of coral or coral like species: sea pens (order Pennatulacea), sea fans (order Gorgonacea), black corals (order Antipatharia), and stony corals (order Scleractinia) (Figure 9). The NMFS report is not a spatially

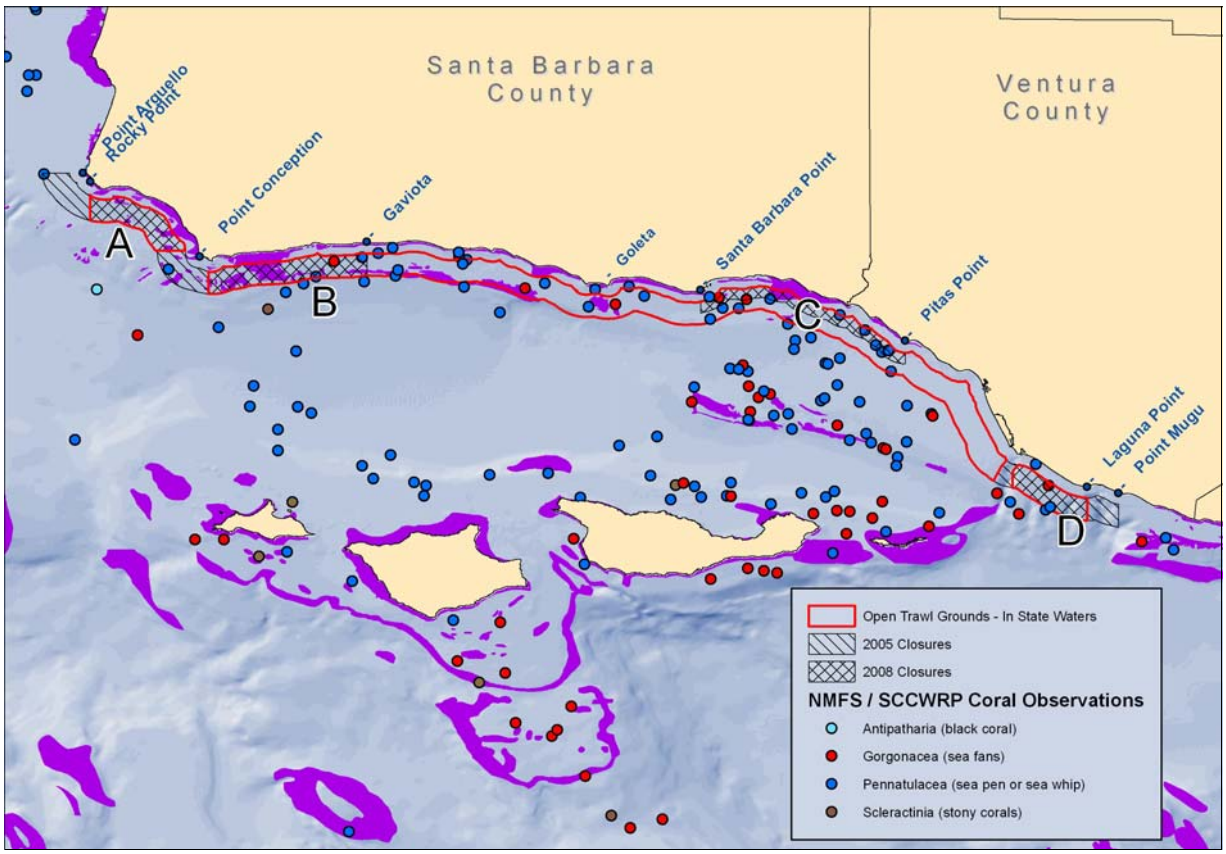

Figure 9. Map of California halibut trawl grounds showing known locations of coral habitat.
Data source: NMFS 2005 and Southern California Coastal Water Resources Project (SCCWRP) 1977, 1990, 1994, and 2003.

comprehensive description of the occurrence of coral or coral like species, although it provides information about what taxa might be found within the CHTG. All of these taxa, except sea pens, require hard substrate for attachment. Several other studies also report the occurrence of coral species in waters near the CHTG. Yoklavich and Love (2005) reported colonies of Christmas tree coral (order Antipatharia) west of Point Mugu, Ventura County between depths of 295 feet and 984 feet and primarily occurring on rocky or hard substrate. Morgan et al. (2005) and Tissot et al. (2006) reported hydrocorals (order Stylasterina), sponges, black corals, and gorgonians as being

common to rocky reefs and banks off southern California, although neither of these studies provide spatially detailed information about corals within the CHTG. Hixon and Tissot (2007) documented a virtual absence of sea pens in trawled areas compared to untrawled areas. However, they did not detect any correlation of fish density to the presence of sea pens. Similarly, in an observational study, Tissot et al. (2006) found that less than two percent of over 9,000 observations of larger structure-forming invertebrates on rocky banks off southern California had other organisms lying on or attached to them, and less than one percent of the observations involved fishes. The effect of trawling on invertebrate species inhabiting sandy and muddy substrates targeted by the California halibut trawl fleet is likely similar to that demonstrated by Hixon and Tissot (2007), however direct study of the areas impacted by the California halibut trawl fleet has not been done.

In 2006, a collaborative effort to map the nearshore seafloor from Goleta to Point Mugu was undertaken by the California Coastal Conservancy. Partners performing the mapping were California State University, Monterey Bay (CSUMB), the United States Geological Survey (USGS), the United States Minerals Management Service, the Beach Erosion Authority for Clean Oceans and Nourishment, and the City of Carpinteria. Using multi-beam and side-scan sonar techniques, the mapping provides high resolution (6.5 feet) information for depth and substrate type. These new surveys combined with previous completed seafloor maps has allowed the identification of areas of hard substrate that could provide habitat for coral and coral like species within all four of the proposed closures (Figures 10 -13). Comparison of the footprint of trawl effort to the location of hard substrate indicates that the trawling fleet has avoided hard substrate in their targeting of California halibut (Figures 2, and 10 through 13).

SUMMARY FOR PROPOSED CLOSURE AREAS

Key attributes and information are summarized for each individual 2008 closure area in Table 9. Each of these areas has different physical characteristics and each has not been utilized equally by the California halibut trawl fleet. The factors regarding performance criteria for the implementation of the Bill differ significantly in each of the proposed closures. The economic impact of the closures on the fishing fleet also differs by each area. A comparison of these factors is provided in Table 9. The individual proposed closure areas have been labeled A through D and are shown on maps in Figures 10, 11, 12, and 13, respectively.

Table 9. Descriptive attributes of the California Halibut Trawl Grounds with individual summaries for each of the four proposed 2008 area closures.

	2008 area closures				
Descriptive attributes	**A**	**B**	**C**	**D**	**Total**
Area (square nautical miles)	17	25	18	13	73
Percent area of CHTG (open in 2007)	10%	14%	10%	8%	42%
Percent soft bottom	90%	72%	97%	100%	86%
Percent area trawled within the CHTG	9%	< 1%	17%	9%	35%
Average discarded (pounds-per-tow)	54	12	13	33	24
Percent discarded dead	2%	38%	1%	8%	6%
Average annual ex-vessel revenue for California halibut landings[1,2]	$13,684	$18	$82,308	$44,219	$140,229

Data source: CFIS (2008)
[1]Ex-vessel revenue was generated from fishing seasons 1997/98 through 2006/2007.
[2]Ex-vessel revenue was adjusted for inflation to year 2006$ prices.

The area trawled within the four proposed closure areas was compared to both the total area trawled inside the CHTG and the area trawled statewide, by plotting all trawl log effort from 1997 to 2006 using GIS software. This information indicates that the actual area trawled for California halibut within the four proposed closure areas was 35 percent of the CHTG and five percent of the total area of bottom habitat trawled statewide. The actual area trawled was highest in Area C of the four areas, comprising 17 percent of the CHTG and three percent of the total area of bottom habitat trawled statewide (Table 9). The actual bottom habitat trawled in Areas A and D each comprised nine percent of the CHTG and one percent of the overall area of bottom habitat trawled statewide. Fishing activity is negligible in Area B.

Bycatch discard rates from the collaborative bycatch study were lowest in Area B at 11.5 pounds-per-tow (38.2 percent discarded dead), and highest in Area A at 53.6 pounds-per-tow (2.3 percent discarded dead) with an overall average of 23.5 pounds-per-tow (Table 9). No rocky reef associated hard corals, sponges, or live kelp were caught during the bycatch study. Bycatch data were collected using the same methods in each of the areas and are comparable across the four areas, however, the 30 minute

sample tows used in the bycatch study were shorter than the 1 to 1.5 hour tows typical of the fishery.

The greatest ex-vessel revenue was generated in Area C, which is also where the highest concentration of trawl effort occurred (Table 9). For the Santa Barbara and Ventura Counties region, the total contribution to local economic output is about 2.3 times the direct ex-vessel revenue. This total output contribution is derived from input-output multipliers which capture how direct output contributes to local economic activity; in terms of total direct, indirect, and induced output, total wages, and employment (Appendix A).

Summary for Closure Area A

General Physical Description

Area A is located in the northwestern portion of the SBC (Figure 2, 7, 9). It encompasses an area of 17 square nautical miles between one nautical mile and three nautical miles from mainland shore from Rocky Point to Point Conception (Figure 10), and represents approximately 10 percent of the open CHTG, with an average bottom depth of 30 fathoms (Table 9). The seafloor of Area A has been surveyed using side-scan sonar. Four areas of rocky reef are inside the closure boundaries making up approximately 10 percent of its area. *Macrocystis* kelp grows about 0.5 nautical mile inshore of this closure (Figure 10).

Discard Information

The four study tows conducted inside Area A had a bycatch discard rate of 53.6 pounds-per-tow, of which 2.3 percent was discarded dead. Discards in this area consisted of both fish and invertebrates, with California bat rays and sheep crabs accounting for 80 percent (by weight) of the discarded catch.

Revenue and Economic Impact

Trawl harvests taken from Area A represent about four percent of the regional revenue (region includes Santa Barbara and Ventura Counties) derived from the harvest of California halibut (Table 9). In terms of dollar value generated, Area A has a relatively small revenue generating potential compared to Areas C and D, averaging about $14,000 annually in ex-vessel revenue, with a range of zero (most recently) to $38,000 (five to ten years ago). The direct ex-vessel revenue from Area A represents a total economic output contribution of about $31,000 on average, and a potential economic output contribution of as much as $86,000 annually.

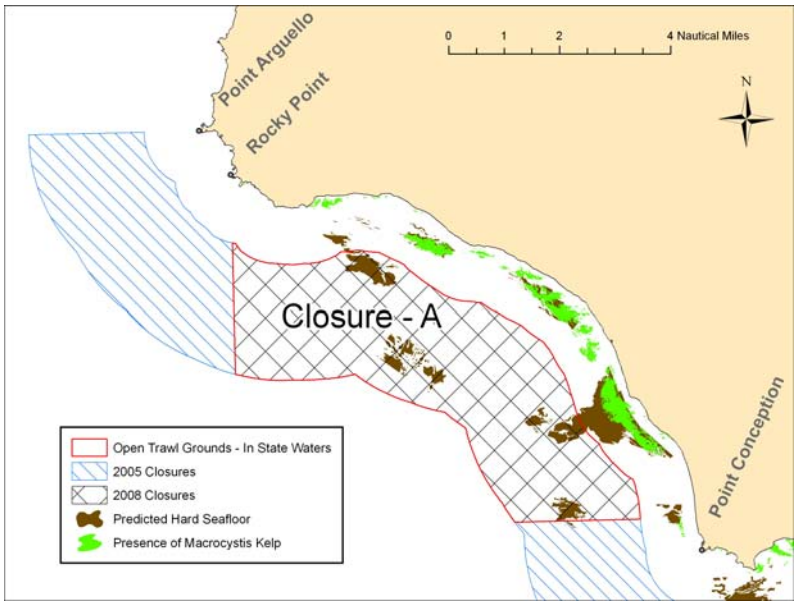

Figure 10. Map of closure Area A located between Rocky Point and Point Conception.

Summary for Closure Area B

General Physical Description

Area B is located in the western portion of the SBC (Figure 2, 7, 9). It is the largest of the four areas, encompassing an area of 25 square nautical miles between one nautical mile and three nautical miles from mainland shore from Point Conception to Gaviota (Table 9). Area B represents approximately 14 percent of the open CHTG, with an average bottom depth of 39 fathoms (Table 9). Side-scan sonar surveys have mapped the seafloor within this closure. This closure contains two areas of rocky reef that make up 28 percent of its area (Figure 11). Most of the rocky reef encompasses one large area that extends from shore to near the outer boundary of the closure. *Macrocystis* kelp beds are found within 0.1 nautical mile of the nearshore boundary (Figure 11).

Discard Information

The four study tows conducted inside Area B had a bycatch discard rate of 11.5 pounds-per-tow, of which 38.2 percent was discarded dead. Discards in Area B consisted mostly (by number) of brittle stars, crab species, and sea pens. Sea pens, which are considered "soft corals", are not reef forming corals and were only encountered in Area B during the bycatch study.

Revenue and Economic Impact

Trawl harvests taken from Area B represent less than one percent of the regional revenue derived from the harvest of California halibut (Table 9). Area B is not a significant revenue producing area for California halibut trawl fishermen in the region of Santa Barbara and Ventura Counties. Likewise, the contributions of Area B to California halibut trawl fishermen and total regional economic output is not significant.

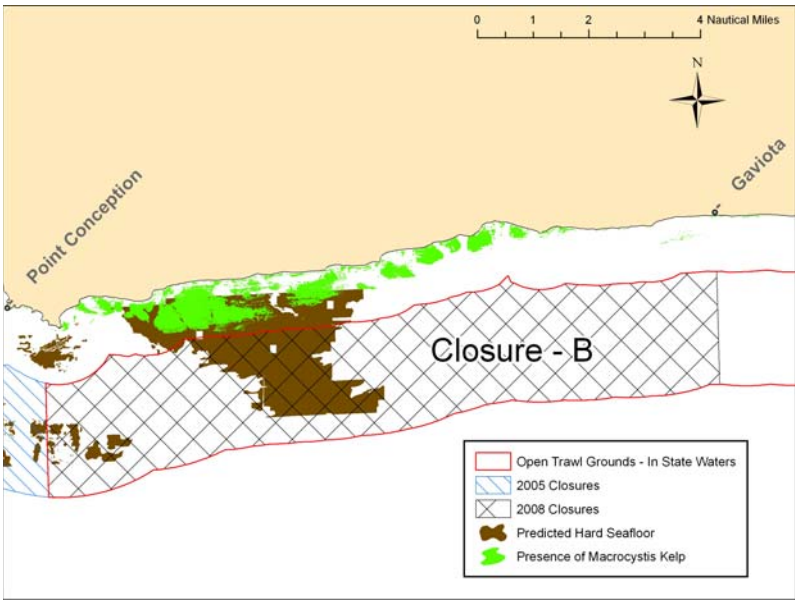

Figure 11. Map of closure Area B located between Point Conception and Rocky Point.

Summary for Closure Area C

General Physical Description

Area C is located in the eastern portion of the SBC (Figures 2, 7, 9). It encompasses an area of 18 square nautical miles between one nautical mile and two nautical miles from mainland shore from Santa Barbara Point to Pitas Point, and represents approximately 10 percent of the open CHTG, with an average bottom depth of 17 fathoms (Table 9). High resolution multi-beam and side-scan sonar bathymetry mapping has recently been completed in this area by CSUMB and the USGS. Previous course scale mapping of rocky seafloor indicated that 9 percent of the seafloor was rocky reef. The new high resolution mapping and observations by the Department's Remote Operated Vehicle (ROV) indicate that the actual percentage of rocky seafloor in closure Area C is between three percent and five percent (Figure 12). *Macrocystis* kelp grows within 0.1 nautical mile of the nearshore boundary of the closure.

Discard Information

The sixteen study tows conducted inside Area C had a bycatch discard rate of 12.9 pounds-per-tow, of which one percent was discarded dead. Discards in this area consisted of both fish and invertebrates with shark and ray species accounting for 60 percent (by weight) of the discarded catch in this area.

Revenue and Economic Impact

Trawl harvests taken from Area C represent over 22 percent of the regional ex-vessel revenue derived from the harvest of California halibut (Table 9). In terms of dollar value generated, Area C has the highest revenue generating potential of all the sub-areas, averaging about $82,000 annually in ex-vessel revenue, with a range of $46,000 to $149,000. The direct ex-vessel revenue from Area C represents a total output contribution of about $187,000 on average, and a potential regional economic output contribution of as much as $338,000 annually to Santa Barbara and Ventura Counties.

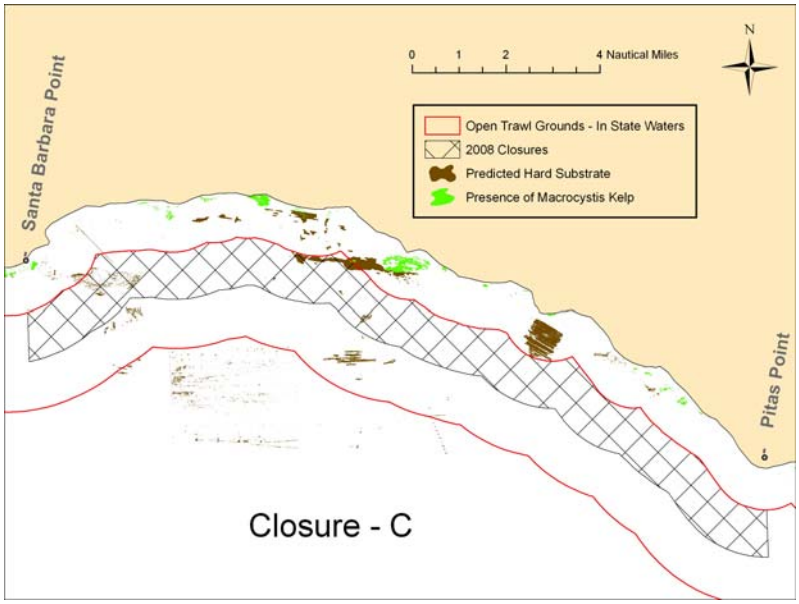

Figure 12. Map of closure Area C located between Rocky Point and Point Conception.

Summary for Closure Area D

General Physical Description

Area D is located in the southeastern portion of the SBC (Figure 2, 7, 9). It is the smallest of the four areas, encompassing an area of 13 nautical miles between one nautical mile and three nautical miles from mainland shore from Hueneme Canyon to Laguna Point (Figure 13). Area D represents approximately eight percent of the open CHTG, with an average bottom depth of 34 fathoms (Table 9). Area D was also mapped in high resolution using multi-beam sonar by CSUMB (Figure 13). This mapping has clearly identified the extensive submarine canyon system within and near the area. Several patches of hard substrate have been mapped in Area D, although they are negligible, combining to represent less than one percent of the area (Table 9) (Figure 13). Determination of rocky seafloor within the canyon areas of this closure has not been completed. The canyon areas within the closure cover 2.5 square nautical miles and make up approximately 19 percent of the closure area. No canopy forming *Macrocystis* kelp grows in or near this closure (Figure 5).

Discard Information

The eight study tows conducted inside Area D had a bycatch discard rate of 32.6 pounds-per-tow, of which 8.3 percent was discarded dead. Discards in Area D consisted of both fish and invertebrates with shark and ray species accounting for 60 percent of the discards by weight and gray sand stars 68 percent by count.

Revenue and Economic Impact

Trawl harvests taken from Area D represent about 12 percent of the regional revenue derived from the harvest of California halibut (See Table 9). In terms of dollar value generated, Area D is second only to the revenue generated in Area C, averaging about $44,000 annually in ex-vessel revenue, with a range of $5,100 to $97,000. The direct ex-vessel revenue from Area D represents a total economic output contribution of about $100,000 on average, with a potential contribution of as much as $220,000 annually to the regional economies of Santa Barbara and Ventura Counties.

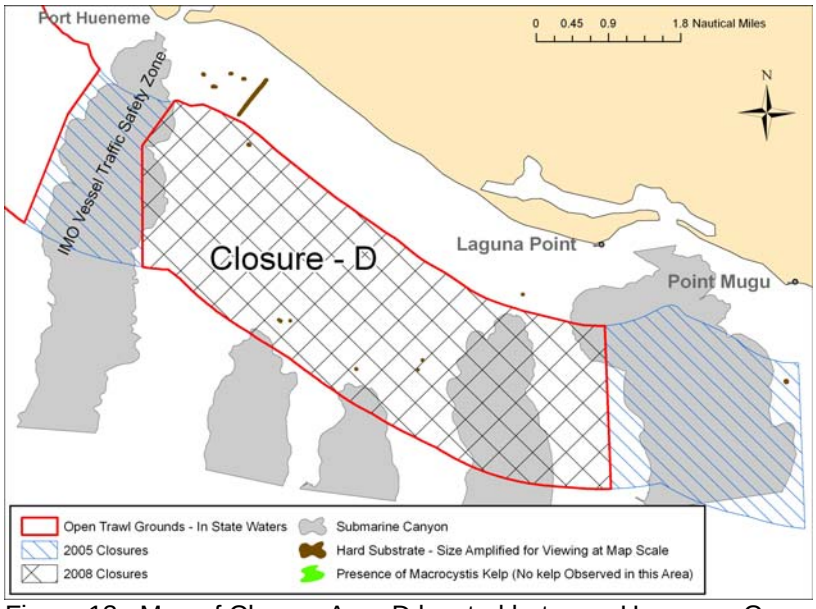

Figure 13. Map of Closure Area D located between Hueneme Canyon and Point Laguna.

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APPENDICES

Appendix A. Selected county characteristics and measures, as collected by United States Census Bureau (2000).

	Land Area (square miles)	Total population	Employed workers (>16 years old)	Workers with jobs in County	Workers with jobs outside County	Total families	Median family income	Per capita income	Percent of population with income below poverty threshold	Economic leakage coefficient*
Alameda	738	1,443,741	678,910	67%	33%	342,048	$65,857	$26,680	11%	86%
Contra Costa	720	948,816	442,008	58%	42%	243,971	$73,039	$30,615	8%	86%
Del Norte	1008	27,507	8,844	94%	2%	6,314	$36,056	$14,573	20%	262%
Humboldt	3573	126,518	54,034	98%	2%	30,894	$39,370	$17,203	20%	131%
Los Angeles	4061	9,519,338	3,858,750	93%	7%	2,154,311	$46,452	$20,683	18%	76%
Marin	520	247,289	126,646	62%	37%	61,329	$88,934	$44,962	7%	78%
Mendocino	3509	86,265	37,663	94%	6%	22,066	$42,168	$19,443	16%	122%
Monterey	3322	401,762	164,517	89%	11%	88,539	$51,169	$20,165	14%	89%
Orange	789	2,846,289	1,313,987	83%	17%	673,912	$64,611	$25,826	10%	64%
San Diego	4200	2,813,833	1,299,503	97%	3%	669,102	$53,438	$22,926	12%	96%
San Francisco	47	776,733	418,553	77%	23%	147,186	$63,545	$34,556	11%	52%
San Luis Obispo	3304	246,681	107,807	90%	10%	58,954	$52,447	$21,864	13%	118%
San Mateo	449	707,161	354,096	58%	42%	172,557	$80,737	$36,045	6%	70%
Santa Barbara	2737	399,347	179,445	94%	6%	90,314	$54,042	$23,059	14%	106%
Santa Cruz	445	255,602	126,106	74%	26%	57,858	$61,941	$26,396	12%	91%
Solano	829	394,542	174,571	57%	43%	98,163	$60,597	$21,731	8%	118%
Sonoma	1576	458,614	224,947	82%	18%	113,645	$61,921	$25,724	8%	96%
Ventura	1845	753,197	345,658	76%	24%	184,378	$65,285	$24,600	9%	78%

* Economic leakage. One way to gauge the significance of an economic activity, to the local economy, is to determine whether it produces exports and brings in new dollars from outside areas. Exports from the local economy stimulate local economic activity (Radtke 1987). In other words, does the basic industry activity bring money into the local economy from outside areas, thus generating new dollars for the local economy? Much like a personal checking account, local economies must balance expenditures on imports purchased outside the area, with an inflow of new dollars for exports sold outside the area. This is because money brought into a local economy does not all stay there, many goods and services used locally must be brought in from outside the area, or imported. The money that flows out of the local economy for these imports is called leakage. We look at this balance between leakage and new dollars moving into the economy to calculate an economic leakage coefficient. This coefficient is the ratio of local economy payments for foreign and domestic trade (leakages) relative to local economy receipts for trade (new dollars). Specifically, we look at the ratio of regional Household and Industry payments (leakages) relative to regional receipts (new dollars), to infer the degree and direction of money flow for the economy. Leakage coefficients higher than 100 percent means the local economy is spending more for imports than it is receiving in new dollars from its local export production.

Appendix B. Species composition (number and pounds) of finfish caught in the 32 tows observed during the California halibut trawl ground bycatch study. Species in each category are ranked in descending order according to pounds caught.

Common name	Number	Weight
Fish		
California halibut	39	372.1
Fantail sole	7	10.3
Hornyhead turbot	15	7.4
Barred sand bass	2	5.7
Starry flounder	1	5.5
Longspine combfish	31	4.8
Spotted ratfish	2	4.4
Bigmouth sole	3	1.6
English sole	5	1.4
Pacific sanddab	6	1.3
Pink seaperch	9	0.8
California scorpionfish	3	0.8
Plainfin midshipman	1	0.2
California tonguefish	1	0.1
Pacific sardine	1	0.1
Stripetail rockfish	1	0.1
Yellowchin sculpin	1	0.1
Sharks and skates		
Bat ray	13	271.5
Swell shark	4	40.2
Pacific angel shark	4	40.1
Pacific electric ray	2	29.3
California skate	28	29.1
Brown smoothhound	11	25.1
Big skate	1	25.0
Spiny dogfish shark	3	22.8

Appendix C. Species composition (number and pounds) of invertebrates caught in the 32 tows observed during the California halibut trawl ground bycatch study. Species are ranked in descending order according to pounds caught.

Common name	Number	Weight
Sheep crab	47	140.5
Armed box crab	91	30.8
Yellow rock crab	30	29.1
Short spined sea star	27	28.4
Slender crab	79	25.3
Sea cucumber, spp.	12	14.7
Red rock crab	18	14.1
Gumboot chiton	5	8.2
Sea jelly, spp	2	5.4
Hydroid (Genus *Bugula*)	6	4.8
Gray sand star	439	4.5
Warty sea cucumber	6	4.4
Brown rock crab	5	3.1
Sea pen, spp	184	2.0
Bryozoan (Genus *Thalamoporella*)	6	1.8
Hydroid (Genus *Aglaophenia*)	6	1.6
Hydroid, spp.	3	1.5
Mantis shrimp	4	1.4
Kellet's whelk	3	0.8
Salp, spp.	7	0.7
Octopus, spp.	12	0.7
California sea slug	6	0.5
Striped sea slug	5	0.3
Brittle sea star	219	0.3
Bryozoan, spp	1	0.3
Market squid	4	0.3
Decorator crab	1	0.1
Hermit crab	1	0.1
Bat sea star	1	0.1
Sand star	2	0.1
Ridgeback prawn	1	0.1
Spanish shawl (nudibranch)	8	0.0