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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Marine mammal and seabird bycatch in California gillnet fisheries in 2011.

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ABSTRACT

Bycatch of marine mammals and seabirds is reported for the **California swordfish and thresher shark drift gillnet fishery** and the **California halibut and white seabass set gillnet fishery** from fishery observer data collected in 2011. Bycatch estimates are generated using ratio estimation methods. There was no observed bycatch of sea turtles in California fisheries in 2011. Two additional fisheries (CA pelagic longline and CA small-mesh drift gillnet) were also observed in 2011 with no observed bycatch of marine mammals, sea turtles, or seabirds.

Observations in the **CA swordfish and thresher shark drift gillnet fishery** included 85 sets during 19 fishing trips, from an estimated 435 sets fished by all vessels (19.5% observer coverage). Observed bycatch included two short-beaked common dolphins (*Delphinus delphis*), one long-beaked common dolphin (*Delphinus capensis*), one Risso's dolphin (*Grampus griseus*), one northern right whale dolphin (*Lissodelphis borealis*), and 18 California sea lions (*Zalophus californianus*). In addition, one minke whale (*Balaenoptera acutorostrata*) was reported released alive. Estimated bycatch is 10 (CV=0.69) short-beaked common dolphins, 5 (CV=1.02) long-beaked common dolphins, 5 (CV=1.02) Risso's dolphins, 5 (CV=1.05) northern right whale dolphins and 95 (CV=0.79) California sea lions.

Observations in the **CA halibut and white seabass set gillnet fishery** included 171 sets during 47 fishing trips, from an estimated 2,123 sets fished by all vessels (8% observer coverage). Observed bycatch included six California sea lions, four Brandt's cormorants (*Phalacrocorax penicillatus*), and 16 unidentified cormorants (*Phalacrocorax* sp). Estimated bycatch is 74 (CV=0.39) California sea lions, 49 (CV=0.61) Brandt's cormorants and 198 (CV=1.03) unidentified cormorants.

Observations in the **CA yellowtail, barracuda, and white seabass drift gillnet fishery** included seven sets during two fishing trips, from an estimated 209 sets fished (3.3% observer coverage). No bycatch of marine mammals, sea turtles, or seabirds were observed. Other fisheries observed in 2011 include the **CA pelagic longline fishery** that operates outside of the U.S. Exclusive

Economic Zone. Sixty-eight sets were observed (at 100% observer coverage), with no bycatch of marine mammals, sea turtles, or seabirds.

INTRODUCTION

Background

NOAA's National Marine Fisheries Service (NMFS) is required under Section 118 of the Marine Mammal Protection Act (MMPA) to "*obtain statistically reliable estimates of incidental mortality and serious injury*" of marine mammals in commercial fisheries, also known as 'bycatch'. Estimates of bycatch are used to prepare marine mammal stock assessments as required under Section 117 of the MMPA, with particular emphasis on how human-caused mortality levels compare with potential biological removal (PBR) levels of marine mammal stocks. The PBR level is defined as the maximum number of animals (not including natural mortality) that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. In addition to marine mammals, NMFS also estimates bycatch of other taxa, including sea turtles, fish, sharks, and seabirds. This report includes observed and estimated bycatch of marine mammals and seabirds from fishery observations in California commercial fisheries in calendar year 2011. Estimates of shark, finfish, and invertebrate bycatch in California commercial fisheries has been reported elsewhere (Larese and Coan 2008). No sea turtle bycatch was observed in 2011.

Fishery Classification Criteria

NMFS is required under Section 118 of the Marine Mammal Protection Act (MMPA) to place all U.S. commercial fisheries into one of three categories based on levels of incidental serious injury and mortality of marine mammals in each fishery (16 U.S.C. 1387 (c) (1)). Each year, NMFS publishes a 'List of Fisheries' that determines whether fishery participants are subject to registration, observer coverage, and take reduction plan requirements. Fisheries are classified as Category I, II, or III, depending on levels of human-caused mortality and serious injury relative to the PBR for each marine mammal stock. Category I fisheries are defined as those where the mortality or serious injury of one or more stocks is greater than or equal to 50% of a stock's PBR. Category II fisheries are defined as those for which the annual mortality and serious injury of one or more stocks are greater than 1% but less than 50% of PBR. Category III fisheries include those where mortality and serious injury of all marine mammal stocks, across all fisheries that interact with these stocks, is less than 10% of the stocks' PBR level. In cases where combined mortality and serious injury across all fisheries exceed 10% for one or more stocks, then only those fisheries with annual takes less than 1% of PBR are considered Category III.

Fishery Descriptions

The **California swordfish and thresher shark large-mesh drift gillnet fishery** is a Category II fishery (Federal Register 76 FR 73912 29 November 2011) with approximately 20 vessels participating. This fishery has been observed by NMFS annually since 1990, with annual observer coverage levels ranging between 4% and 20% (Figure 1). Historically, a wide variety of cetacean, pinniped, sea turtle, and seabird species have been incidentally caught in this fishery (Julian and Beeson, 1998; Barlow and Cameron 2003; Carretta *et al.*, 2004, Carretta *et al.* 2008, Carretta and Barlow 2011). A Take Reduction Plan (TRP) was implemented in 1996 because bycatch levels exceeded PBR for some cetacean stocks. The TRP resulted in the mandatory use of

acoustic pingers on all nets, net extenders to increase minimum fishing depth to 11 m (6 fm), and mandatory skipper education workshops. Although marine mammal bycatch was significantly reduced as a result of pinger use in this fishery (Barlow and Cameron 2003), continued bycatch of leatherback turtles resulted in the establishment of a seasonal (15 August – 15 November) area closure in central California and southern Oregon waters in 2001 (Figure 1). An additional season/area closure in southern California is implemented during forecasted or existing El Niño periods to reduce the likelihood of entangling loggerhead turtles.

The **California halibut and white sea bass set gillnet fishery** is a Category II fishery with approximately 50 vessels participating. This fishery currently operates only south of Point Conception, California. The fishery has been observed sporadically in recent years, with observer coverage levels of less than 10% (Figure 2).

The **California yellowtail, barracuda, and white seabass drift gillnet fishery** is a Category II fishery with approximately 30 vessels participating. This fishery operates in southern California offshore waters near the Channel Islands. The fishery has been observed sporadically in recent years, with observer coverage levels of less than 10%.

The **California pelagic longline fishery** is a Category III fishery with one vessel participating. This fishery operates outside of the U.S. EEZ and has 100% observer coverage.

Basic fishery descriptions can be found in marine mammal stock assessments published annually by NMFS (Carretta *et al.* 2012) and in the NMFS 2012 List of Fisheries (Federal Register 76 FR 73912 29 November 2011)

METHODS

Estimation of Fishing Effort and Observer Coverage

Total fishing effort in the **California swordfish and thresher shark large-mesh drift gillnet fishery** is estimated from vessel activity reports submitted by captains to the NMFS observer contractor. In addition, logbook data from the California Department of Fish and Game are utilized to estimate effort. Annual effort estimates from each source are usually similar, but the larger value is used to estimate bycatch. This is done because effort data based on logbook submissions may be negatively-biased if fishermen don't report all of their fishing activity. In the swordfish and thresher shark drift gillnet fishery, one set is equal to one day of fishing effort, as nets are deployed near sunset and retrieved the next morning. Observer coverage is estimated as the number of observed sets, divided by the number of estimated sets fished.

Effort in the **California halibut and white sea bass set gillnet fishery** and **California yellowtail, barracuda, and white seabass drift gillnet fishery** is estimated solely from logbook data due to different reporting requirements from the swordfish drift gillnet fishery. Multiple sets per day (typically 1 to 2) are fished in these two fisheries. Observer coverage is calculated as the number of observed fishing sets, divided by the estimated number of sets fished from logbook data.

Bycatch Estimation

Bycatch is estimated with a ratio estimator following methods used by Julian and Beeson (1998) and Carretta *et al.* (2004). The bycatch rate for each species is calculated as

$$\hat{r}_s = \frac{\sum b_s}{\sum d} \quad (1)$$

where b_s is the observed bycatch (in individuals) of species s during a fishing trip and d is the number of days (or sets) observed during the trip. The variance of the bycatch rate ($\sigma_{\hat{r}_s}^2$), is estimated with a bootstrap procedure, where one trip represents the sampling unit. Trips are resampled with replacement until each bootstrap sample contains the same number of trips as the actual observed effort. This method is preferable to resampling sets, because sets within a trip are more likely to be spatially and temporally correlated. A bycatch rate is then calculated from each bootstrap sample. This procedure is repeated 1,000 times, from which the bootstrap or bycatch rate sample variance $\sigma_{\hat{r}_s}^2$, is calculated.

Annual bycatch estimates (\hat{m}_s) for species s , variance of the bycatch estimate (σ_m^2), and the coefficient of variation (CV) for each bycatch estimate were estimated for each species using the following formulae:

$$\hat{m}_s = \hat{D} \hat{r}_s, \quad (2)$$

$$\sigma_m^2 = \hat{D}^2 \sigma_r^2 \quad (3)$$

$$CV = \sqrt{\frac{\sigma_m^2}{\hat{m}_s}} \quad (4)$$

where

\hat{D} is the estimated number of sets fished,

\hat{r}_s is the kill rate per set for species s and

σ_r^2 is the bootstrap estimate of the kill rate variance and

CV is the coefficient of variation of the bycatch estimate.

RESULTS

Swordfish and thresher shark drift gillnet

In 2011, 85 sets were observed during 19 vessel trips, from an estimated 435 sets fished, resulting in an observer coverage rate of 19.5% (Table 1, Figure 3). In 2011, 19 vessels made at least one set, though only 12 were observed. Six vessels were deemed ‘unobservable’, because they are smaller vessels that lack berthing space for observers, while a seventh vessel made only one trip of four days duration and was not observed. Observer program tracking of sea days indicates that the six unobservable vessels fished 151 sets or approximately 33% of the total fishing effort in 2011¹. Fishing effort has declined from over 5,500 sets in 1993 to 435 sets in 2011 (Figure 1). In 2011, observed bycatch totals included two short-beaked common dolphins (*Delphinus delphis*), one long-beaked common dolphin (*Delphinus capensis*), one northern right whale dolphin (*Lissodelphis borealis*), and one Risso’s dolphin (*Grampus griseus*) (Figure 4). Additionally, one minke whale (*Balaenoptera acutorostrata*) was released alive without trailing gear. Estimated bycatch is 10

¹ Scott Casey, Frank Orth and Associates, personal communication.

(CV=0.69) short-beaked common dolphins, 5 (CV=1.02) long-beaked common dolphins, 5 (CV=1.05) northern right whale dolphins, 5 (CV=1.02) Risso's dolphins, and 95 (CV=0.79) California sea lions (Table 2).

Halibut and white seabass set gillnet

In the halibut and white seabass set gillnet fishery, 171 sets during 47 fishing trips were observed from an estimated 2,123 sets fished by all vessels in 2011 (8% observer coverage) (Figure 5A). Observed bycatch included six California sea lions (*Zalophus californianus*), four Brandt's cormorant (*Phalacrocorax penicillatus*), and sixteen unidentified cormorants (Figure 5B). Estimated bycatch is 74 (CV=0.39) California sea lions, 49 (CV=0.61) Brandt's cormorants, and 198 (CV=1.03) unidentified cormorants (Table 3).

DISCUSSION

Since acoustic pingers were introduced into the swordfish and thresher shark drift gillnet fishery in 1996, overall cetacean entanglement rates have declined by approximately 50% and there have been no observations of beaked whale bycatch during this time (Barlow and Cameron 2003, Carretta *et al.* 2008, Carretta and Barlow 2011, Figure 6). Short-beaked common dolphins continue to be the most commonly entangled cetacean species in this fishery. However, entanglement rates of common dolphins are approximately 50% lower since the introduction of acoustic pingers (Figure 7), despite the fact that the fishery today operates almost exclusively south of Point Conception, where common dolphin abundance is highest (Barlow and Forney 2007).

The high rate of California sea lion bycatch in 2011 (Figure 8) is the result of three sets within the same fishing trip, where three, four, and eight sea lions were entangled, respectively. This trip accounted for 15 of the 18 sea lion entanglements observed in 2011 and occurred in a region of relatively high sea lion densities west of Point Conception, California. Although rates of California sea lion entanglements in this fishery have increased in recent years, the extremely high rate of entanglement seen in 2011 is based on a small number of observed sets.

Although Barlow and Cameron (2003) reported a statistically significant *decline* in sea lion entanglement rates in drift gillnets with acoustic pingers during a 1996-1997 experiment, sea lion entanglement rates have increased since that time and at elevated levels compared with entanglement rates prior to initial pinger use in 1996 (Carretta and Barlow 2011). Sea lions depredate swordfish catch in drift gillnets, but acoustic pingers do not appear to be responsible for attracting sea lions to drift nets (Carretta and Barlow 2011). Other factors, such as total swordfish catch, month and area fished, and nocturnal use of vessel deck lights were found to be more important predictors of sea lion depredation. Some of the increase in sea lion entanglement rates likely reflects the continuing increase in sea lion numbers in the area where the fishery occurs (Carretta and Barlow 2011).

Approximately 33% of the total estimated fishing effort in the swordfish and thresher shark large mesh drift gillnet fishery in 2011 involved 'unobservable' vessels. This highlights concerns about the randomness of the observer sample. In our analysis, an underlying assumption is that unobserved and observed fishing effort is 'equivalent'. This assumption requires that unobserved vessels are compliant with pinger, extender length, closure area, and other gear regulations, and that bycatch rates are no different from observed vessels. If bycatch rates on unobserved vessels are significantly different, this could bias resulting bycatch estimates. Vessels in this fishery are periodically boarded and inspected for gear compliance, and recorded violations have been rare

(NMFS Enforcement, personal communication)². A video experiment was utilized in the drift gillnet fishery recently to see if video monitoring of bycatch would be feasible on unobservable vessels. Some shortcomings of that methodology were identified, such as the inability to identify bycatch to species, high cost, and battery power drain issues for the fishing vessels. The Pacific Offshore Take Reduction Team recommended in 2007 that NMFS continue to pursue other technologies to address this gap in observer coverage, while continuing to refine the video technology for potential future use on unobservable vessels.

ACKNOWLEDGMENTS

Thanks to Suzy Kohin for maintaining the fishery observer database. Amy Betcher, Scott Casey, and John Childers provided logbook and observer data used to estimate fishing effort. Kerri Danil and Kelly Robertson provided photographic and genetic information, respectively, on the bycatch specimens. This work could not have been done without the diligent work of NMFS fishery observers and the cooperation of the California commercial fishermen. We thank Jay Barlow, Susan Chivers, and Kerri Danil for their constructive comments on an early draft of this manuscript.

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² NMFS Enforcement Division, personal communication.

Table 1. Fishery observer and fishing effort summaries for calendar year 2011 for California gillnet fisheries.

Fishery	MMAP Category	Number of active vessels	Mean observed mesh size (inches)	Estimated Sets Fished	Observed Sets	Observer Coverage	Observed Species Interactions (number killed)
CA swordfish and thresher shark drift gillnet	Category II	19	19.4	435	85	19.5%	Common dolphin, short-beaked (2) Common dolphin, long-beaked (1) Risso's dolphin (1) Northern right whale dolphin (1) California sea lion (18)
CA halibut and white seabass set gillnet	Category II	50	7.4	2,123	171	8%	California sea lion (6) Brandt's cormorant (4) Unidentified cormorant (16)
CA yellowtail, barracuda, and white seabass drift gillnet	Category II	30	6.5	209	7	3.3%	None observed

Table 2. Summary of observed bycatch, rates, estimates and statistical precision for the California swordfish drift gillnet fishery in 2011.

Fishery and Species	Observed Bycatch	Bycatch per 100 sets	Bycatch Estimate	Bycatch Estimate CV
CA drift gillnet for swordfish and thresher shark				
Short-beaked common dolphin	2	2.3	10	0.69
Long-beaked common dolphin	1	1.1	5	1.02
Northern right whale dolphin	1	1.1	5	1.05
Risso's dolphin	1	1.1	5	1.02
California sea lion	18	21.1	95	0.79

Table 3. Summary of observed bycatch, rates, estimates and statistical precision for the California halibut and white seabass set gillnet fishery in 2011. A total of 171 fishing sets were observed in 2011.

Fishery and Species	Observed Bycatch	Bycatch per 100 sets	Bycatch Estimate	Bycatch Estimate CV
CA set gillnet for halibut and white seabass				
California sea lion	6	3.5	74	0.39
Brandt's cormorant	4	2.3	49	0.61
unidentified cormorant	16	9.3	198	1.03

Figure 1. Estimated (gray) and observed (black) days of fishing effort in the California thresher shark and swordfish drift gillnet fishery for 1990-2011. Observer coverage (number of observed sets divided by estimated number of sets fished) ranged from a low of 4% in 1990 to 22.9% in 2000. Estimated observer coverage in 2011 was 19.5%.

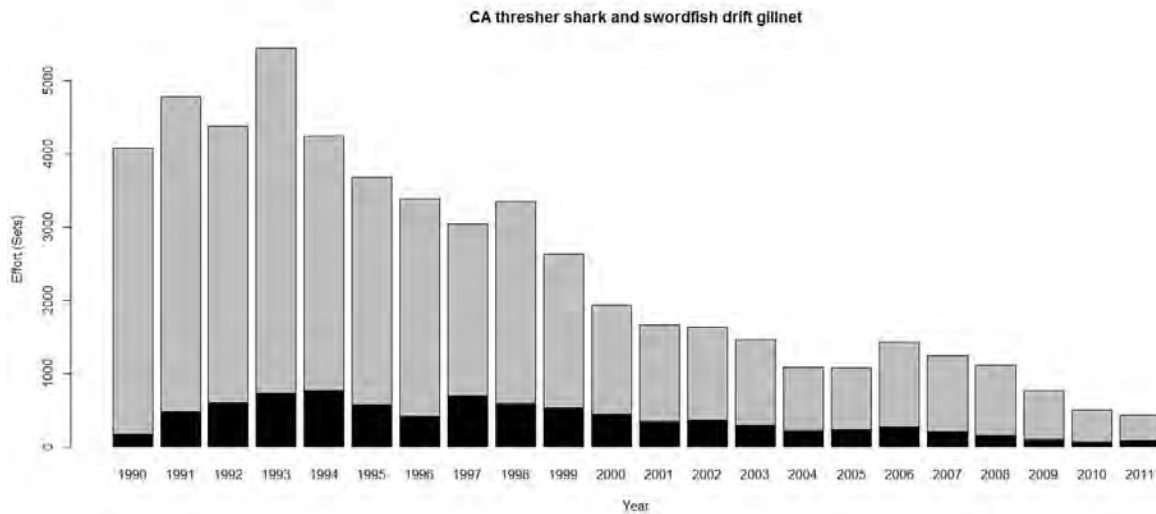


Figure 2. Estimated (gray) and observed (black) days of fishing effort in the California halibut and white seabass set gillnet fishery for 1990-2011. Observer coverage (number of observed sets divided by estimated number of sets fished) has been sporadic, with 11 out of 22 years lacking any observer coverage.

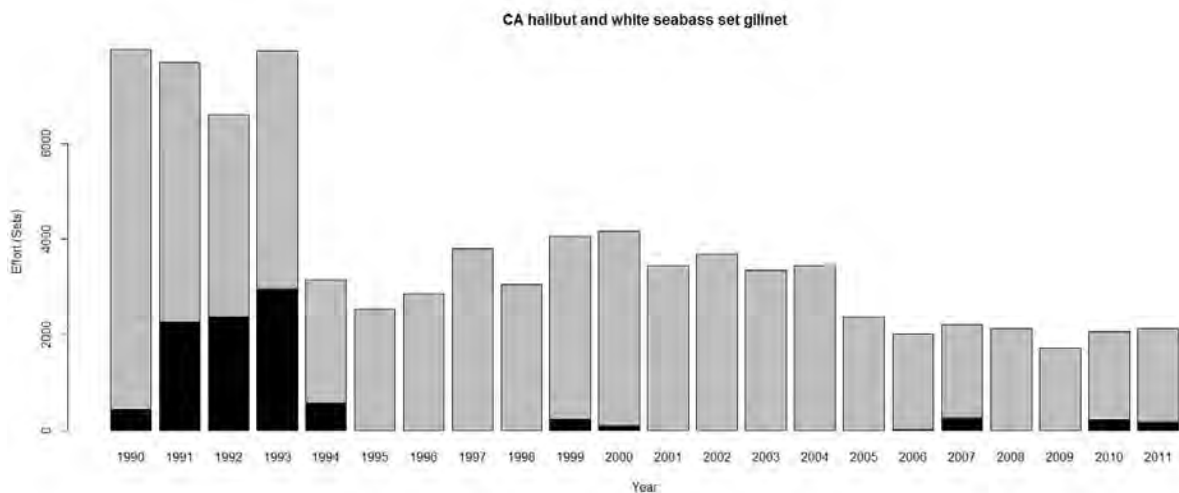


Figure 3. Locations of observed sets (n=85) in the drift gillnet fishery for swordfish and thresher shark in 2011. The shaded region indicates a seasonal area closure where drift gillnet fishing is annually prohibited between 15 August and 15 November. Dashed line delineates the U.S. Exclusive Economic Zone.

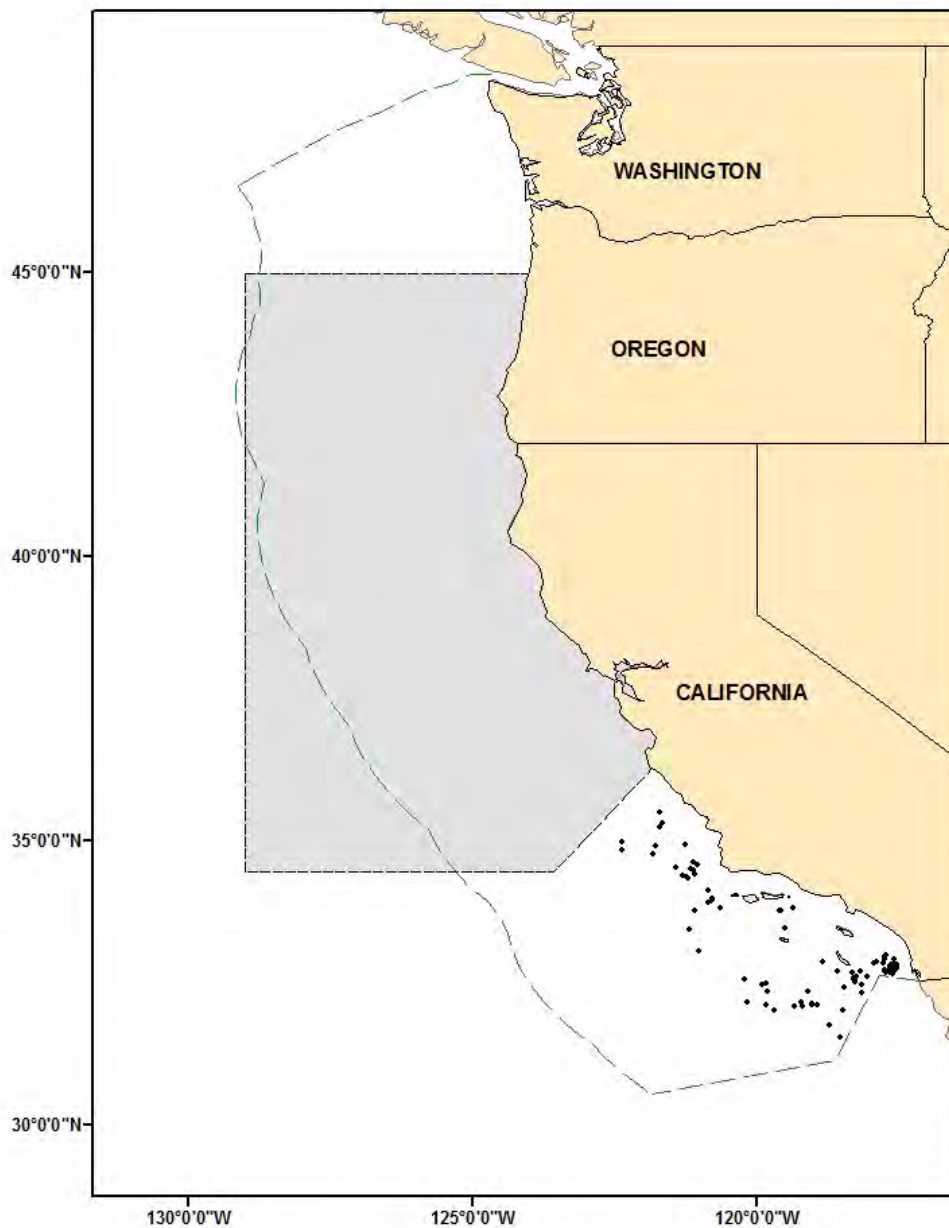


Figure 4. Locations of marine mammal entanglements in the drift gillnet fishery for swordfish and thresher shark in 2011. Key: ▲= long-beaked common dolphin (*Delphinus capensis*); ●=short-beaked common dolphin (*Delphinus delphis*); □=California sea lion (*Zalophus californianus*); Δ=northern right whale dolphin (*Lissodelphis borealis*); + = Risso's dolphin (*Grampus griseus*); X = minke whale (*Balaenoptera acutorostrata*). The shaded region indicates a seasonal area closure where drift gillnet fishing is annually prohibited between 15 August and 15 November. Dashed line delineates the U.S. Exclusive Economic Zone.

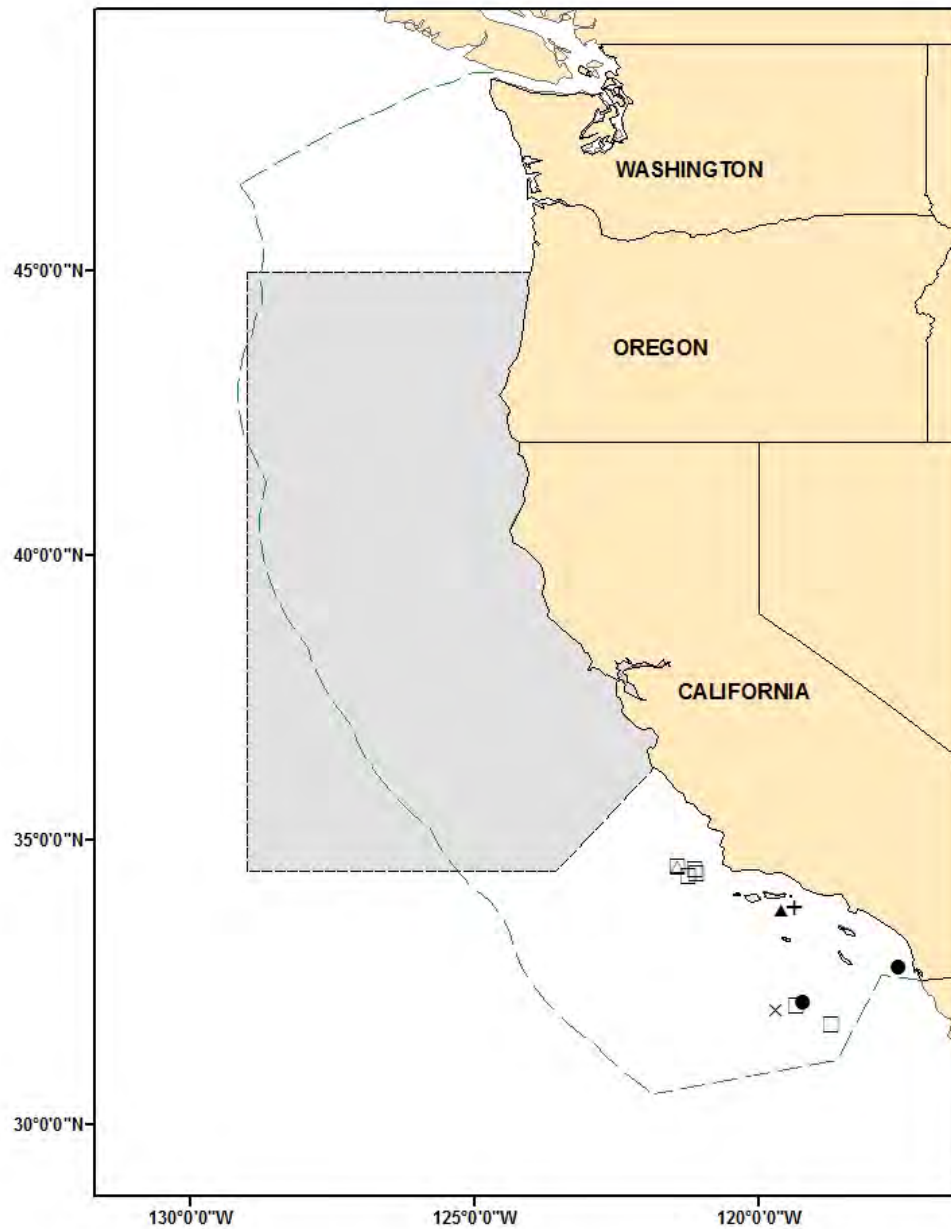


Figure 5. Locations of 171 observed sets (A) and bycatch of California sea lions (▲) and cormorants (□) in the halibut and white seabass set gillnet fishery in 2011 (B).

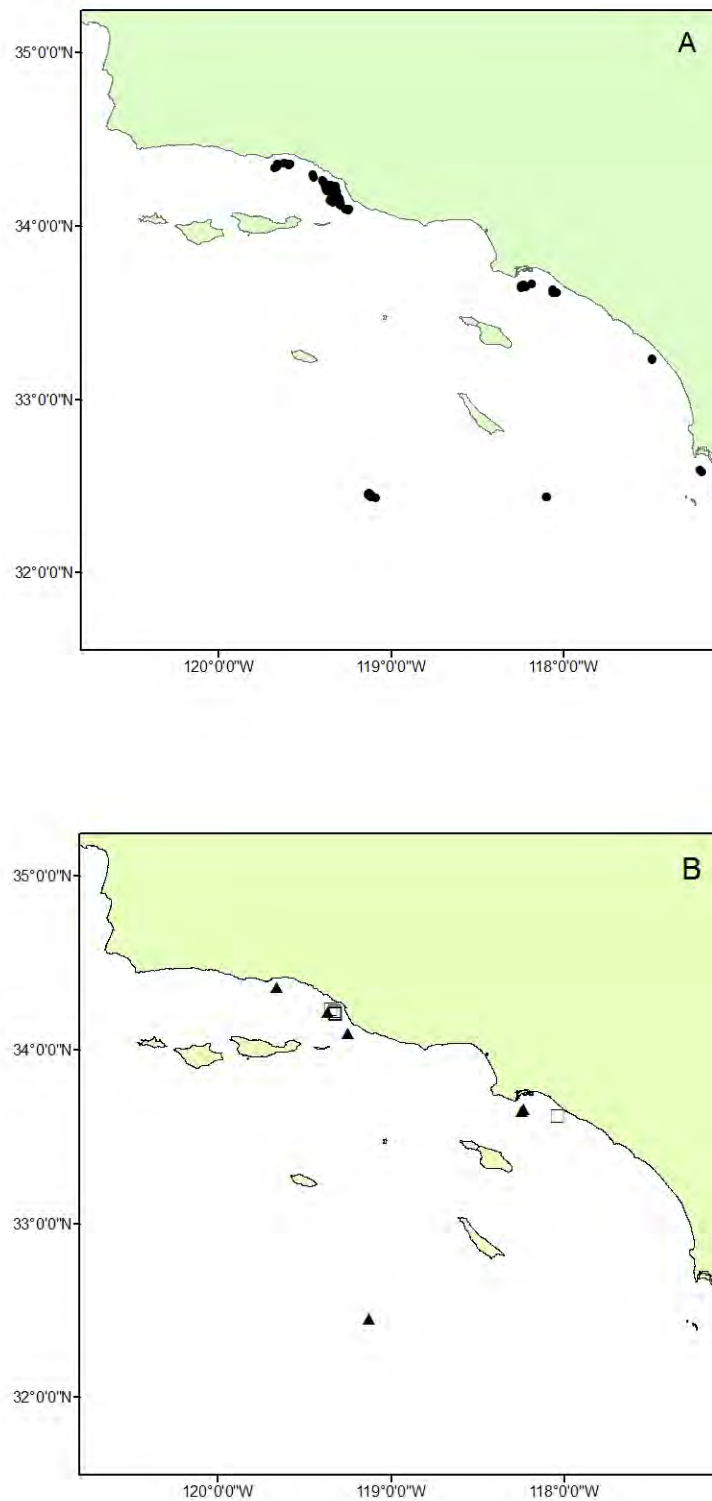


Figure 6. Bycatch rates (individuals per 100 sets) of cetaceans in the California thresher shark and swordfish drift gillnet fishery, 1990–2011.

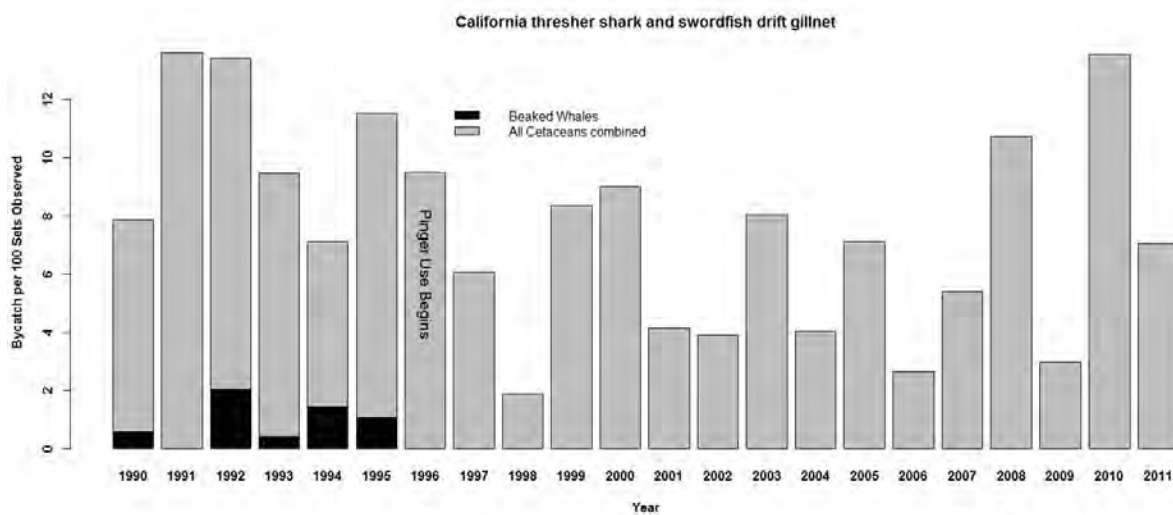


Figure 7. Entanglement rates of short-beaked common dolphin per 100 sets fished in the California swordfish drift gillnet fishery, 1990-2011. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. In 1996, no short-beaked common dolphin were observed killed in 146 pingered sets. For the period 1998-2011, over 99% of all observed sets utilized pingers.

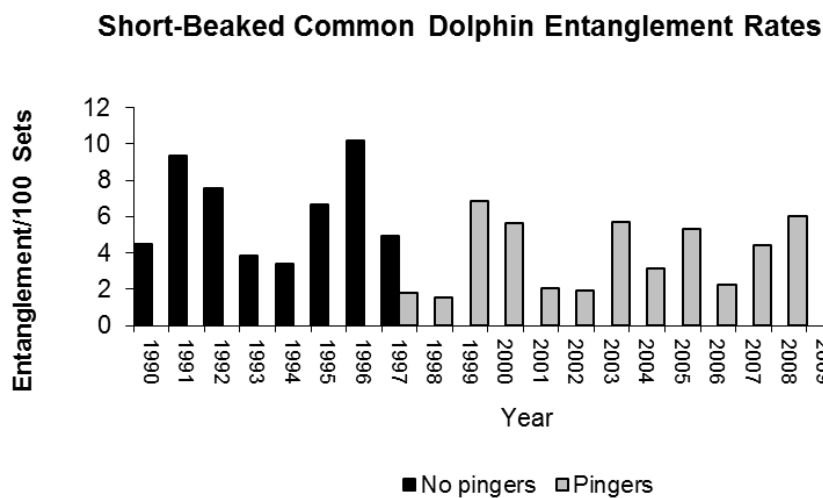
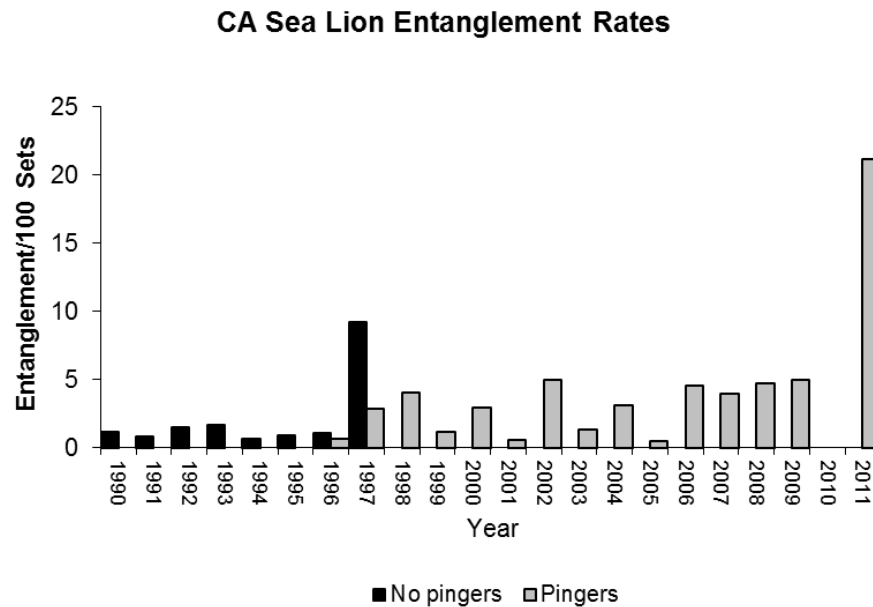


Figure 8. Entanglement rates of California sea lions per 100 sets fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2011. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. For the period 1998-2011, over 99% of all observed sets utilized pingers. In 2010, no sea lions were observed entangled in 59 sets.



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