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MARINE MAMMAL BYCATCH IN THE CALIFORNIA/OREGON SWORDFISH AND THRESHER SHARK DRIFT GILLNET FISHERY IN 2008

by

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Marine mammal bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2008.

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ABSTRACT

Marine mammal bycatch is reported for the California/Oregon large mesh drift gillnet fishery, based on fishery observer data collected in 2008. Estimates of bycatch are generated using ratio estimation methods. [Other fisheries observed in 2008 include a deep-set longline fishery (at 100% observer coverage), but data confidentiality regulations prevent the reporting of observer information from this fishery because only one vessel was active. Observations in coastal purse seine fisheries for squid, mackerel, anchovy, and sardine were also made in 2008 (63 observed sets) and no marine mammal injuries or deaths occurred.]

In the California/Oregon large mesh drift gillnet fishery for thresher sharks and swordfish, 149 sets were observed out of an estimated 1,103 sets fished by all vessels (13.5% observer coverage). Observed bycatch totals were eight short-beaked common dolphins (*Delphinus delphis*), five Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), one northern right whale dolphin (*Lissodelphis borealis*), one Risso's dolphin (*Grampus griseus*), one long-beaked common dolphin (*Delphinus capensis*) and seven California sea lions (*Zalophus californianus*). All marine mammals were dead upon retrieval. Estimated bycatch is 59 (CV=0.43) short-beaked common dolphins; 37 (CV=0.70) Pacific white-sided dolphins; 7 (CV= 0.99) northern right whale dolphins; 7 (CV=0.99) Risso's dolphins; 7 (CV=1.08) long-beaked common dolphins and 51 (CV=0.52) California sea lions.

INTRODUCTION

Fishery Classification Criteria

The National Marine Fisheries Service (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' in the Federal Register 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 the level of incidental takes relative to the Potential Biological Removal (PBR) for each marine mammal stock. The PBR level is defined in the MMPA 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. Category I fisheries are defined as those for which the annual level of incidental take 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 takes of one or more stocks are greater than 1% but less than 50% of PBR. Category III fisheries include those where the overall serious injury and incidental take 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 takes 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.

The Fishery

The ***California/Oregon large mesh drift gillnet fishery for broadbill swordfish (Xiphias gladias) and thresher shark (Alopias vulpinus)*** is a Category I fishery with approximately 40 vessels participating. This fishery has been observed by NMFS annually since 1990. Observer coverage ranged between 4% and 18% (mean = 13%) of all sets from 1990 to 1996, averaged 20% between 1997 and 2006, and has dropped below 20% in 2007 and 2008. A wide variety of cetacean, pinniped, sea turtle, and seabird species have been incidentally caught in this fishery (Julian and Beeson, 1998; Carretta *et al*., 2004). 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, Carretta *et al*. 2008), 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 protect loggerhead turtles. Basic fishery descriptions can be found in marine mammal stock assessments published annually by NMFS (Carretta *et al*. 2009) and in the NMFS 2009 List of Fisheries (Federal Register, 73 FR 73032, December 1, 2008)

METHODS

Estimation of Fishing Effort and Observer Coverage

The number of sets fished in the California/Oregon drift gillnet fishery is estimated from vessel operators' reports to the NMFS observer contractor and California Department of Fish and Game logbook data. Annual effort estimates from each source are usually similar, but the larger value is used for the purpose of bycatch estimation. In the 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.

Bycatch/Mortality Estimation

Bycatch and mortality is estimated with a ratio estimator (Julian and Beeson 1998, Carretta *et al*. 2004). No geographic or seasonal strata are used in estimating bycatch rates, because previous studies showed no improvement in bycatch point estimates or their precision with stratification (Carretta 2001). The bycatch rate for each species is calculated as

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

where b_s is the observed bycatch (in individuals) of species *s* during a fishing trip and *d* is the number of days (= sets) observed during the trip. The variance of the bycatch rate ($\sigma^2_{\hat{r}_s}$), is estimated using 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 level. 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 $\sigma^2_{\hat{r}_s}$, is calculated.

Annual bycatch estimates ($\hat{m}_s$) for species *s* and the variance of the bycatch estimate (σ^2_m) are estimated for each species using the following formulae:

$$\hat{m}_s = \hat{D}\,\hat{r}_{s,} \qquad (2)$$

$$\sigma^2_m = \hat{D}^2\,\sigma^2_r \qquad (3)$$

where

$\hat{D}$ is the estimated maximum number of days (= sets) fished,
$\hat{r}_s$ is the kill rate per set for species *s* and
σ^2_r is the bootstrap estimate of the kill rate variance.

RESULTS

Swordfish/thresher shark drift gillnet

In 2008, an estimated 1,103 sets were fished and 149 sets were observed from 26 vessel trips, resulting in an observer coverage rate of 13.5% (Table 1, Figure 1). Fishing effort in 2008 was determined exclusively through vessel activity reports submitted to the observer contractor, because complete logbook data were unavailable at the time this report was prepared. In 2008, 38 vessels made at least one set, though only 20 were observed. Eighteen vessels were deemed ‘unobservable’ and reported fishing 413 sets (approximately 37% of total estimated fishing effort). ‘Unobservable’ vessels are typically smaller vessels that lack berthing space for an observer. Fishing effort has declined from over 5,500 sets in 1993 to 1,103 sets in 2008 (Figure 2). Observed bycatch totals were eight short-beaked common dolphins (*Delphinus delphis*), five Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), one northern right whale dolphin (*Lissodelphis borealis*), one Risso’s dolphin (*Grampus griseus*), one long-beaked common dolphin (*Delphinus capensis*), and seven California sea lions (*Zalophus californianus*). All marine mammals were dead upon retrieval. Estimated bycatch is 59 (CV=0.43) short-beaked common dolphins; 37 (CV= 0.70) Pacific white-sided dolphins; 7 (CV=0.99) northern right whale dolphins; 7 (CV=0.99) Rissos dolphin (*Grampus griseus*); 7 (CV=1.08) long-beaked common dolphins, and 51 (CV=0.52) California sea lions (Table 2). The bycatch rate for cetaceans (10.7 individuals per 100 sets) was higher in 2008 than in any year since pinger use (Figure 3). The percentage of observed sets with multiple cetacean entanglements (3 sets/149 observed sets = 2%) was also the highest observed since 1990 (Figure 4). Multiple cetacean entanglements included individual sets with 3 short-beaked common dolphins, one set with 3 Pacific white-sided dolphins, and another set with two Pacific white-sided dolphins.

DISCUSSION

Cetacean bycatch rates were higher in 2008 than in any year since pinger use began, but the number of sets observed (n=149) was the lowest since inception of the observer program in 1990. The fraction of sets with multiple entanglements was also the highest observed in any year, but may also reflect small sample size. Short-beaked common dolphins continue to be the most commonly entangled species in the drift gillnet fishery. However, entanglement rates are much lower since the introduction of acoustic pingers (Figure 5), despite the fact that the fishery today operates almost exclusively south of Point Conception, where common dolphin abundance is highest (Barlow and Forney 2007). South of Point Conception, common dolphin entanglement rates in sets without pingers (122 entanglements/1,848 sets = 6.6 per 100 sets from 1990 to 1997) are approximately 50% higher than in sets with 20 or more pingers (137 entanglements/3,104 sets = 4.4 per 100 sets from 1997 to 2008). Entanglement rates of California sea lions have been higher in the years following the use of pingers (Figure 6). Barlow and Cameron (2003) reported a statistically significant *decline* in sea lion entanglement rates in nets with pingers during a 1996-1997 experiment, though this decline was somewhat unexpected, because some thought that pinnipeds might be attracted to pingered nets to feed on the captured fish (the "dinner bell" effect). Since 1998, sea lion entanglement rates (99 entangled in 3,621 sets = 2.7 per 100 sets) have nearly tripled, compared with entanglement rates observed prior to pinger use (35 entangled in 3,303 sets = 1.0 per 100 sets). A number of factors may be responsible for the increase in sea lion entanglements, including habituation and attraction to pingers, an increasing sea lion population, shifts in the distribution of prey into areas where gillnet activity is greater, and a 2001 area closure that shifted fishing effort into southern California waters, where sea lions are more abundant. In contrast, since pingers were introduced, overall cetacean entanglement rates have declined by approximately 50% and observations of beaked whale bycatch have been nonexistent (Carretta *et al.* 2008). The fraction of estimated sets fished in 2008 that were 'unobservable' (see Results) was 37%, which raises concerns about the randomness of the observer sample. An underlying assumption in the estimation of bycatch is that unobserved fishing effort is 'equivalent' to observed effort. This assumption requires that unobserved vessels are compliant with pinger, extender length, and other gear regulations, and that bycatch rates are no different for these vessels. If bycatch rates on unobserved vessels are significantly different, this would bias the resulting bycatch estimates. A video experiment was utilized in this 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 power drain issues for the vessels. The 2007 Pacific Offshore Take Reduction Team recommended 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

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Table 1. Fishery observer and fishing effort summaries for calendar year 2008 for the swordfish drift gillnet fishery.

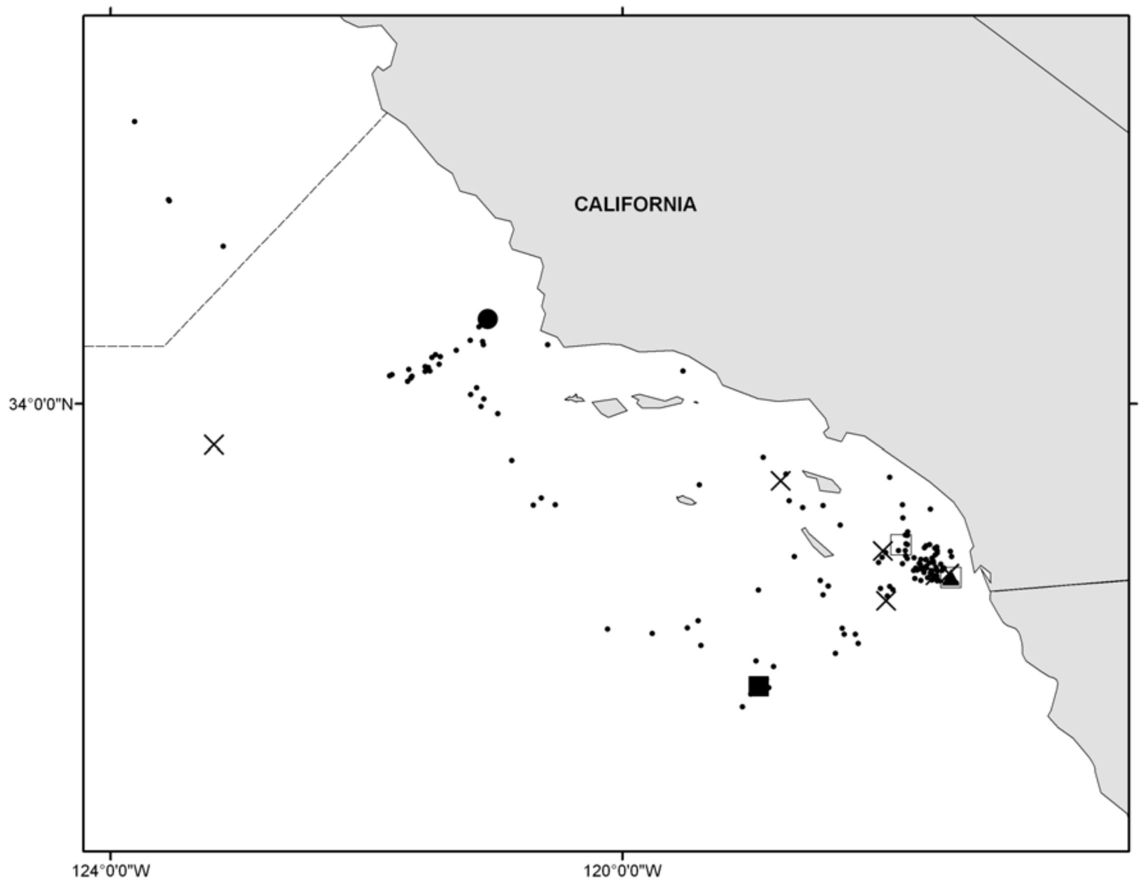
Fishery	MMAP Category	Number of active vessels	Estimated Sets Fished	Observed Sets	Observer Coverage	Observed Species Interactions (number killed or injured)
CA/OR swordfish and thresher shark large-mesh drift gillnet	Category I	40 (22 observed)	1,103 sets[1]	149 sets	13.5% (sets)	Common dolphin, short-beaked (8) Pacific white-sided dolphin (5) Northern right whale dolphin (1) Risso's dolphin (1) Common dolphin, long-beaked (1) CA sea lion (7)

Table 2. Summary of observed bycatch, rates, estimates and statistical precision for the California swordfish drift gillnet fishery in 2008.

Fishery and Species	Observed Bycatch	Bycatch per Set	Bycatch per Set Variance	Bycatch Estimate	Bycatch Estimate CV
CA/OR swordfish/thresher shark drift gillnet					
Short-beaked common dolphin	8	0.053	5.3×10^{-4}	59	0.43
Pacific white-sided dolphin	5	0.033	5.7×10^{-4}	37	0.70
Northern right whale dolphin	1	0.007	3.9×10^{-5}	7	0.99
Risso's dolphin	1	0.007	4.0×10^{-5}	7	0.99
Long-beaked common dolphin	1	0.007	4.0×10^{-5}	7	1.08
California sea lion	7	0.046	6.0×10^{-4}	51	0.52

1 Estimated fishing effort data provided by Scott Casey of Frank Orth & Associates.

Figure 1. Locations of observed fishing sets and cetacean entanglements in the swordfish and thresher shark drift gillnet fishery in 2008. The number of entanglement locations shown are less than those reported in the text due to multi-animal entanglements of common dolphins and Pacific white-sided dolphins in single sets. Key: ● = Risso's dolphin; ■ = northern right whale dolphin; ▲=long-beaked common dolphin; X = short-beaked common dolphin; □=Pacific white-sided dolphin. The dashed region indicates a seasonal area closure where drift gillnet fishing is prohibited between 15 August – 15 November annually.



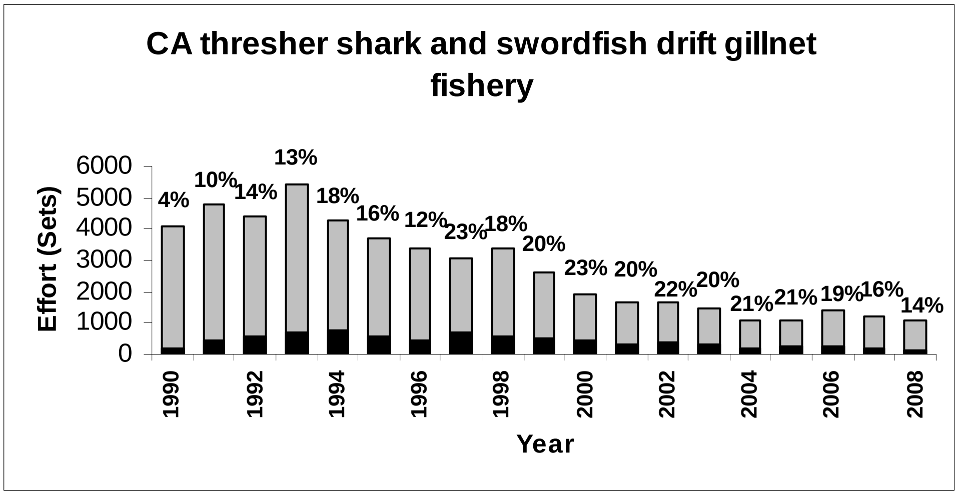


Figure 2. Estimated (gray) and observed (black) days of effort in the California swordfish and thresher shark drift gillnet fishery for 1990-2008. Percent values above bars represent the fraction of observer coverage in the fishery for a given year.

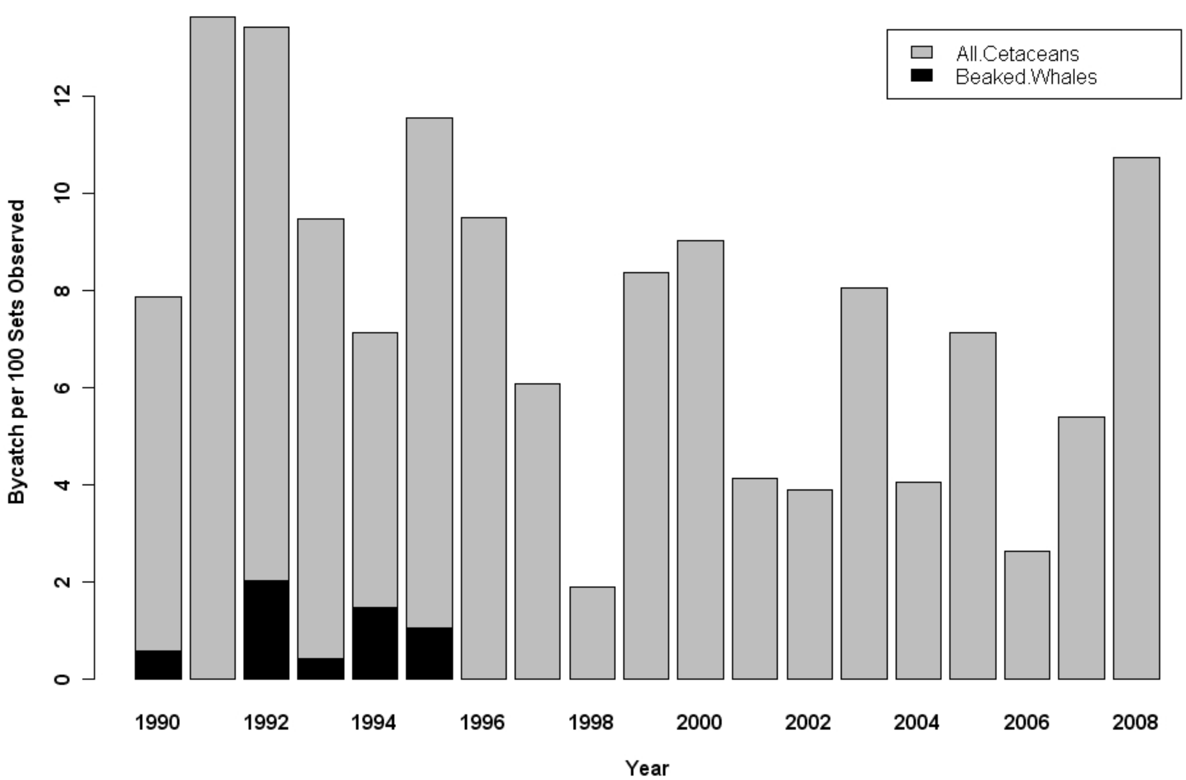


Figure 3. Bycatch rates (individuals per 100 sets) of cetaceans in the California swordfish and thresher shark drift gillnet fishery, 1990–2008.

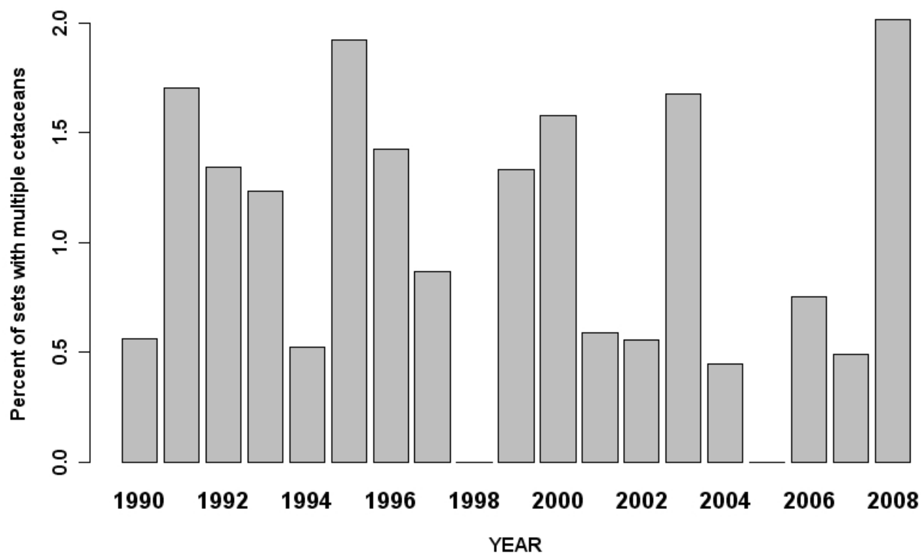


Figure 4. Percentage of observed sets containing multiple cetacean (>1) entanglements, 1990-2008.

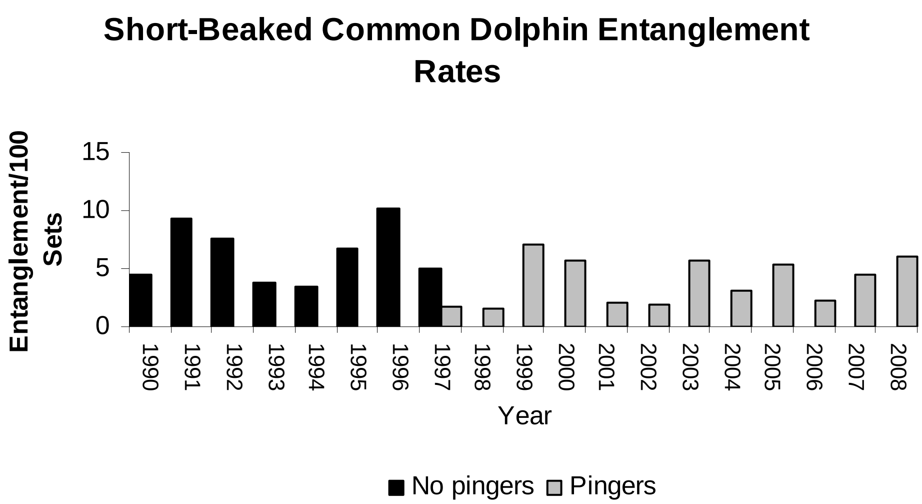


Figure 5. Entanglement rates of short-beaked common dolphin per 100 sets fished in the California swordfish drift gillnet fishery, 1990-2008. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. In 1996, no short-beaked common dolphins were observed killed in 146 pingered sets. For the period 1998-2008, over 99% of all observed sets utilized pingers.

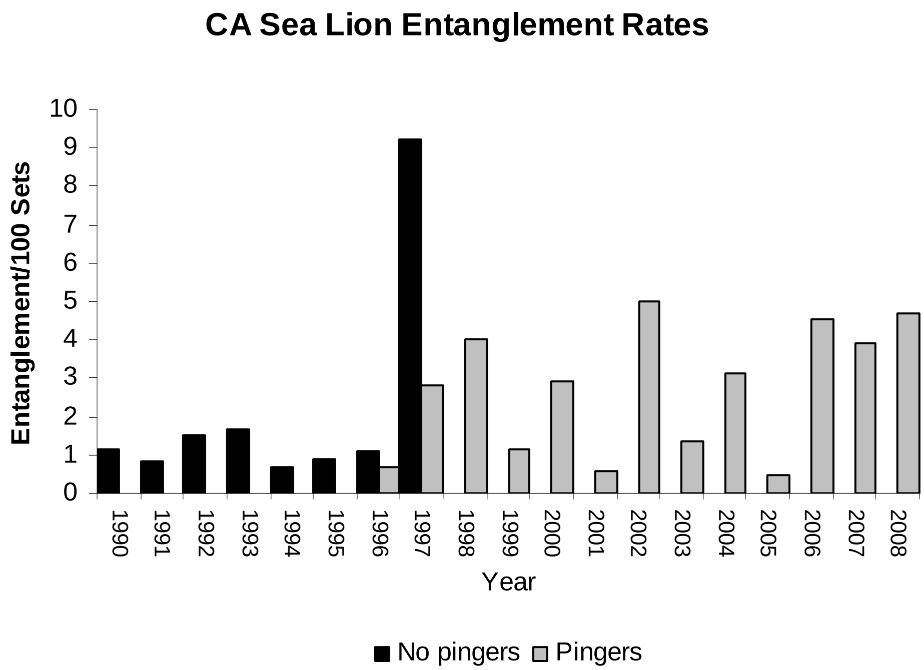


Figure 6. Entanglement rates of California sea lions per 100 sets fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2008. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. For the period 1998-2008, over 99% of all observed sets utilized pingers.