NOAA Technical Memorandum NMFS

FEBRUARY 2014

MARINE MAMMAL, SEA TURTLE AND SEABIRD BYCATCH IN CALIFORNIA GILLNET FISHERIES IN 2012

James V. Carretta[1]
Lyle Enriquez[2]
Charles Villafana[2]

[1]National Marine Fisheries Service
Southwest Fisheries Science Center
Marine Mammal and Turtle Program
La Jolla, CA 92037-1509

[2]West Coast Region
National Marine Fisheries Service
501 W. Ocean Blvd.
Long Beach, CA 90802

NOAA-TM-NMFS-SWFSC-526

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency that establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries, is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, the NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and may be referenced in the formal scientific and technical literature.

NOAA Technical Memorandum NMFS
This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing.

FEBRUARY 2014

MARINE MAMMAL, SEA TURTLE AND SEABIRD BYCATCH IN CALIFORNIA GILLNET FISHERIES IN 2012

James V. Carretta[1]
Lyle Enriquez[2]
Charles Villafana[2]

[1]National Marine Fisheries Service
Southwest Fisheries Science Center
Marine Mammal and Turtle Program
La Jolla, CA 92037-1509

[2]West Coast Region
National Marine Fisheries Service
501 W. Ocean Blvd.
Long Beach, CA 90802

NOAA-TM-NMFS-SWFSC-526

U. S. DEPARTMENT OF COMMERCE
Penny S. Pritzker, Secretary of Commerce
National Oceanic and Atmospheric Administration
Dr. Kathryn D. Sullivan, Acting Administrator
National Marine Fisheries Service
Eileen Sobeck, Assistant Administrator for Fisheries

Marine mammal, sea turtle, and seabird bycatch in California gillnet fisheries in 2012.

James V. Carretta[1], Lyle Enriquez[2] and Charles Villafana[2]

[1] Marine Mammal and Sea Turtle Division
Southwest Fisheries Science Center
National Marine Fisheries Service, NOAA
8901 La Jolla Shores Drive
La Jolla, CA 92037 USA
Jim.Carretta@noaa.gov

[2] West Coast Region
National Marine Fisheries Service, NOAA
501 West Ocean Boulevard
Long Beach, CA 90802 USA
Lyle.Enriquez@noaa.gov

ABSTRACT

Bycatch of marine mammals, sea turtles, and seabirds is reported for two gillnet fisheries in 2012: 1) the **California (CA) swordfish and thresher shark drift gillnet fishery**, and 2) the **CA halibut and white seabass set gillnet fishery**, based on fishery observer data collected in 2012. Bycatch estimates are generated using ratio estimation methods.

Observations in the **CA swordfish and thresher shark drift gillnet fishery** included 83 sets during 15 fishing trips, from an estimated 445 sets fished by all vessels (18.7% observer coverage). Observed bycatch included 5 short-beaked common dolphins (*Delphinus delphis*), one northern right whale dolphin (*Lissodelphis borealis*), and six California sea lions (*Zalophus californianus*). Additionally, one leatherback sea turtle (*Dermochelys coriacea*) was reported released alive and we provide an estimate of entanglements of this species in 2012. Estimated bycatch is 26 (CV=0.78) short-beaked common dolphins, five (CV=1.01) northern right whale dolphins, and 32 (CV=0.60) California sea lions. The estimated number of leatherback turtle entanglements in 2012 is five (CV=1.09), based on the observation of one entangled turtle and 18.7% observer coverage.

Observations in the **CA halibut and white seabass set gillnet fishery** included 75 days of fishing, from an estimated 1,360 days fished by all vessels (5.5% observer coverage). Observed bycatch included 18 California sea lions, one pelagic cormorant (*Phalacrocorax pelagicus*), and three unidentified cormorants (*Phalacrocorax* sp). Estimated bycatch is 326 (CV=0.33) California sea lions, 18 (CV=0.98) pelagic cormorants and 54 (CV=0.72) unidentified cormorants.

Two additional fisheries observed in 2012 did not have any recorded bycatch of marine mammals, seabirds, or sea turtles. The **CA yellowtail, barracuda, and white seabass drift gillnet fishery** had very low observer coverage, with three observed sets during one fishing trip, from an estimated 141 trips fished (0.7% observer coverage). The **CA pelagic longline fishery,** which operates outside of the U.S. Exclusive Economic Zone, was also observed in 2012, with 100% observer coverage and no observed bycatch.

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 2012. Estimates of shark, finfish, and invertebrate bycatch in California commercial fisheries has been reported elsewhere (Larese and Coan 2008).

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 > 1% but < 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, only those fisheries with annual takes less than 1% of PBR are considered Category III.

Fishery Descriptions

The **California (CA) swordfish and thresher shark large-mesh drift gillnet fishery** is a Category I fishery (Federal Register 78 FR 53336, 29 August 2013) with 16 vessels participating in 2012. 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 Team (TRT) was convened in 1996 because bycatch levels exceeded PBR for beaked whales, short-finned pilot whales, and sperm whales (Federal Register 61:5385, 12 February 1996). The TRT developed a Take Reduction Plan (TRP), which 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 (Federal Register 62:51805, 3 October 1997). 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 (Federal Register 66:44549, 24 August 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 **CA halibut and white sea bass set gillnet fishery** is a Category II fishery with approximately 50 vessels participating in 2012. 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 **CA yellowtail, barracuda, and white seabass drift gillnet fishery** is a Category II fishery with approximately 30 vessels participating in 2012. 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 5%.

The **CA pelagic longline fishery** is a Category III fishery with fewer than three vessels participating. This fishery operates outside of the U.S. EEZ and has 100% observer coverage.

Further descriptions of these fisheries can be found in marine mammal stock assessments published annually by NMFS (Carretta et al. 2013a) 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 **CA swordfish and thresher shark large-mesh drift gillnet fishery** is estimated from vessel activity reports submitted by captains to the contracting agency that places observers on vessels (Frank Orth and Associates, http://www.frank-orth.com/). 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 as determined from 2012 vessel activity reports.

Effort in the **CA halibut and white sea bass set gillnet fishery** and **CA yellowtail, barracuda, and white seabass drift gillnet fishery** is estimated solely from state logbook data due to different reporting requirements from the federally-managed swordfish drift gillnet fishery. Multiple sets per day (typically 2 or 3) are fished in these two fisheries and one fishing trip is equivalent to one day. Observer coverage is calculated as the number of observed fishing trips, divided by the estimated number of trips fished from logbook data. The most recent year for which complete logbook data are available (2011), is used to estimate fishing effort in the halibut set gillnet fishery and the white seabass drift gillnet fishery for calendar year 2012. Estimated fishing effort in this fishery has been relatively stable for the last several years at approximately 1,300 trips annually (Figure 2).

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

$$\hat{r}_s = \frac{\sum_{i}^{n} b_s}{\sum_{i}^{n} d} \qquad (1)$$

where b_s is the observed bycatch expressed as the number of individuals of species *s* during fishing trip *i* and *d* is the number of days (or sets in the swordfish drift gillnet fishery) observed during fishing trip *i*. The variance of the bycatch rate ($\sigma^2_{\hat{r}_s}$), 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 $\sigma^2_{\hat{r}_s}$, is calculated.

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

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

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

$$CV = \sqrt{\sigma^2_m} \Big/ \hat{m}_s \qquad (4)$$

where

$\hat{D}$ is the estimated number of sets/days fished,
$\hat{r}_s$ is the kill rate per set/day for species *s* and
σ^2_r is the bootstrap estimate of the bycatch rate variance and
CV is the coefficient of variation of the bycatch estimate.

RESULTS

CA swordfish and thresher shark drift gillnet

In 2012, 83 sets were observed during 15 vessel trips, from an estimated 445 sets fished, resulting in an observer coverage rate of 18.7% (Table 1, Figure 3). In 2012, 16 vessels made at least one set, though only nine were observed. Four vessels were considered ‘unobservable’, because they are smaller vessels that lack berthing space for observers, while three other vessels were unobserved

due to limited fishing activity. Observer program tracking of sea days indicates that the four unobservable vessels fished 137 sets, or approximately 31% of the total fishing effort in 2012[1], while the three unobserved vessels fished approximately 26 sets, or 6% of the total fishing effort in 2012[1]. Estimated fishing effort has declined from over 5,500 sets in 1993 to 445 sets in 2012 (Figure 1). In 2012, observed bycatch totals included 5 short-beaked common dolphins (*Delphinus delphis*), one northern right whale dolphin (*Lissodelphis borealis*), and six California sea lions (*Zalophus californianus*) (Table 2, Figure 4). Additionally, one leatherback sea turtle (*Dermochelys coriacea*) was released alive without trailing gear. Estimated bycatch is 26 (CV=0.78) short-beaked common dolphins, five (CV=1.01) northern right whale dolphins and 32 (CV=0.60) California sea lions (Table 2). We also estimate that five (CV=1.09) leatherback sea turtles were entangled in this fishery in 2012, based on the observation of a single turtle entanglement and 18.7% observer coverage. Historically, 25 leatherback sea turtles have been observed entangled in this fishery since 1990, from a total of 8,365 observed sets through 2012. Of these, 11 were released alive (44%), 13 were dead (52%), and one (4%) was released in 'unknown' condition. It is expected that unobserved entanglements would reflect the same pattern of outcomes seen from observed cases. Using the historic outcomes of all observed leatherback entanglements in the fishery since 1990 and prorating the estimated number of entanglements in 2012 based on outcome type, would result in 5 x 0.44 = 2.2 turtles released alive, 5 x 0.52 = 2.6 turtles released dead, and 0.2 turtles released in unknown condition.

CA halibut and white seabass set gillnet

In the halibut and white seabass set gillnet fishery, 250 sets during 75 fishing trips were observed from an estimated 1,360 fishing trips by all vessels in 2012. The mean number of sets per fishing trip was approximately three, consistent with the findings of Julian and Beeson (1998). Halibut set gillnet fishing effort for 2012 reflects the number of fishing trips reported fished from 2011 logbook data, the most recent year for which complete logbook data are available. The resulting observer coverage for 2012 is 5.5%. (Figure 5). Observed marine mammal bycatch included 18 California sea lions, one pelagic cormorant, and three unidentified cormorants (Figure 5). Estimated bycatch is 326 (CV=0.33) California sea lions, 18 (CV=0.98) pelagic cormorants, and 54 (CV=0.72) unidentified cormorants (Table 3).

CA yellowtail, barracuda, and white seabass drift gillnet

A total of three sets during one fishing trip were observed in the CA yellowtail, barracuda, and white seabass small mesh drift gillnet fishery in 2012, from a total estimated 141 trips fished (0.7% observer coverage). No marine mammal, seabird, or sea turtle bycatch was observed.

CA pelagic longline fishery

The CA pelagic longline fishery**,** which operates outside of the U.S. Exclusive Economic Zone, was also observed in 2012, with 100% observer coverage and no observed bycatch. Fewer than three vessels participate in this fishery, thus we do not report levels of fishing effort to comply with data confidentiality rules under the Magnuson Act (Federal Register 77 FR 35349, 13 June 2012).

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

DISCUSSION

Since acoustic pingers were introduced into the CA 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. Short-beaked common dolphins continue to be the most commonly entangled cetacean species in the fishery (Barlow and Cameron 2003, Carretta *et al*. 2008, Carretta and Barlow 2011, Figure 6). 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).

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 before pinger use in 1996 (Carretta and Barlow 2011) (Figure 8). 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 one-third of the total estimated fishing effort in the CA swordfish and thresher shark large mesh drift gillnet fishery in 2012 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.

Fisheries such as the CA halibut set gillnet and CA yellowtail small-mesh drift gillnet are observed too infrequently and at coverage levels too low to provide statistically precise bycatch estimates. Fiscal constraints may limit future observer coverage to the CA swordfish drift gillnet fishery, thus, it is anticipated these other fisheries will continue to be observed sporadically. Observer data from the CA halibut set gillnet fishery in the 1990s documented entanglements of common dolphins (of unknown species), California sea lions, and harbor seals (Julian and Beeson 1998). Current stranding evidence includes gillnet-related strandings of harbor seals and long-beaked common dolphins, both of which are infrequently observed entangled in the swordfish drift gillnet fishery (Carretta et al. 2013b). During the 5-year period 2007 to 2011, three long-beaked common dolphin and 23 short-beaked common dolphin were observed entangled in the swordfish drift gillnet fishery (Carretta et al. 2013b). However, stranding data during the same period reveal an opposite pattern, with 33 fishery-related strandings of long-beaked common dolphin (this includes five

2 NMFS Enforcement Division, personal communication.

shooting records assumed to be fishery-related), compared with only three short-beaked common dolphins (Carretta et al. 2013b). The relative abundance of long-beaked common dolphin fishery-related strandings suggests that gillnet fisheries other than the swordfish gillnet fishery are responsible for these entanglements (Danil et al. 2011).

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 Kerri Danil, Susan Chivers, and Jay Barlow for their constructive comments on a draft of this manuscript.

LITERATURE CITED

Barlow, J. and Cameron, G.A. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Mar. Mamm. Sci. 19(2):265-283.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. U.S. Fish. Bull. 105(4):509-526.

Carretta, J.V., T. Price, D. Petersen, and R. Read. 2004. Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996-2002. Mar. Fish. Rev. 66 (2): 21-30.

Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gillnet fishery. Mar. Mamm. Sci. 24(4):956-961.

Carretta, J.V. and J. Barlow. 2011. Long-term effectiveness, failure rates, and "dinner bell" properties of acoustic pingers in a gillnet fishery. Marine Technology Society Journal 45(5):7-19.

Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., D. K. Mattila, and M.C. Hill. 2013a. U.S. Pacific Marine Mammal Stock Assessments: 2012. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-504. 378 p.

Carretta, J. V., S. M. Wilkin, M. M. Muto, and K. Wilkinson. 2013b. Sources of human-related injury and mortality for U.S. Pacific west coast marine mammal stock assessments, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-514, 83 p.

Danil, K., S.J. Chivers, M.D. Henshaw, J.L. Thieleking, R. Daniels, J.A. St. Leger. 2010. Cetacean strandings in San Diego County, California, USA: 1851-2008. Journal of Cetacean Research and Management 11:163-184.

Danil K., Chivers S.J., Carretta J.V. 2011. Human interaction in stranded San Diego County cetaceans between 2001 and 2010. Southern California Marine Mammal Workshop, Newport Beach, CA, January 21-22.

Federal Register. 1996. Pacific Offshore Fisheries Take Reduction Team Meeting. Volume 61, pp. 5385-5386.

Federal Register. 1997. Taking of Marine Mammals Incidental to Commercial Fishing Operations; Pacific Offshore Cetacean Take Reduction Plan Regulations. Volume 62, pp. 51805-51814.

Federal Register. 2001. Endangered and Threatened Wildlife;Sea Turtle Conservation Requirements; Taking of Threatened or Endangered Species Incidental to Commercial Fishing Operations. Volume 66, pp. 44549-44551.

Federal Register. 2012. Confidentiality of Information; Magnuson-Stevens Fishery Conservation and Management Reauthorization Act. Volume 77, pp. 35349 – 35350.

Julian, F. and Beeson, M. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. U.S. Fish. Bull. 96:271-284.

Larese, J.P. and A.L. Coan. 2008. Fish and invertebrate bycatch estimates for the California drift gillnet fishery targeting swordfish and thresher shark, 1990-2006. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-426. 53 p.

Table 1. Fishery observer and fishing effort summaries for calendar year 2012 for California gillnet fisheries. Estimates of fishing effort for the CA halibut and white seabass set gillnet and CA yellowtail, barracuda, and white seabass drift gillnet fisheries are based on logbook data for calendar year 2011, the most recent year for which data are available. Estimated fishing effort for the CA swordfish and thresher shark drift gillnet fishery are based on vessel activity reports submitted by captains to the NMFS observer contractor. All species listed involved entangled animals that died in the net, with the exception of a leatherback sea turtle that was released alive without trailing gear.

Fishery	MMAP Category	Number of active vessels	Mean observed mesh size (inches)	Estimated Sets/Trips/Days Fished	Observed Sets (Trips)	Observer Coverage	Observed Species Interactions (number killed or entangled)
CA swordfish and thresher shark drift gillnet	Category II	16	19.2	445 sets	83 (15)	18.7%	Common dolphin, short-beaked (5) Northern right whale dolphin (1) California sea lion (6) Leatherback sea turtle (1)
CA halibut and white seabass set gillnet	Category II	50	7.3	1,360 trips/days	250 (75)	5.5%	California sea lion (18) Pelagic cormorant (1) Unidentified cormorant (3)
CA yellowtail, barracuda, and white seabass drift gillnet	Category II	30	6.5	141 trips/days	3 (1)	0.7%	No observed bycatch

Table 2. Summary of observed bycatch, rates, estimates and statistical precision for the California swordfish drift gillnet fishery in 2012. Bycatch estimates of leatherback sea turtles represent the number *entangled* in 2012. A total of 83 fishing sets were observed during 15 fishing trips in 2012. Bycatch estimates of leatherback sea turtles represent a prorated mix of dead and live animals (see text and footnote).

Fishery and Species	Observed Bycatch	Bycatch per 100 sets	Bycatch Estimate (CV)
CA drift gillnet for swordfish and thresher shark			
Short-beaked common dolphin	5	6.0	26 (0.78)
Northern right whale dolphin	1	1.2	5 (1.01)
California sea lion	6	7.2	32 (0.60)
Leatherback sea turtle	1	1.2	5 (1.09)[3]

Table 3. Summary of observed bycatch, rates, estimates and statistical precision for the California halibut and white seabass set gillnet fishery in 2012. A total of 250 fishing sets were observed during 75 fishing trips in 2012.

Fishery and Species	Observed Bycatch	Bycatch per 100 days	Bycatch Estimate (CV)
CA set gillnet for halibut and white seabass			
California sea lion	18	24.0	326 (0.33)
Pelagic cormorant	1	1.3	18 (0.98)
unidentified cormorant	3	4.0	54 (0.72)

3 Using the historic outcomes of all observed leatherback entanglements in the fishery since 1990 and prorating the estimated number of entanglements in 2012 based on outcome type, would result in 5 x 0.44 = 2.2 turtles released alive, 5 x 0.52 = 2.6 turtles released dead, and 0.2 turtles released in unknown condition.

Figure 1. Estimated (gray) and observed (black) days of fishing effort in the California thresher shark and swordfish drift gillnet fishery for 1990-2012. Observer coverage (number of observed sets divided by estimated number of sets fished) is shown inside bars and ranged from 4% in 1990 to 22.9% in 2000. Estimated observer coverage in 2012 was 18.7%.

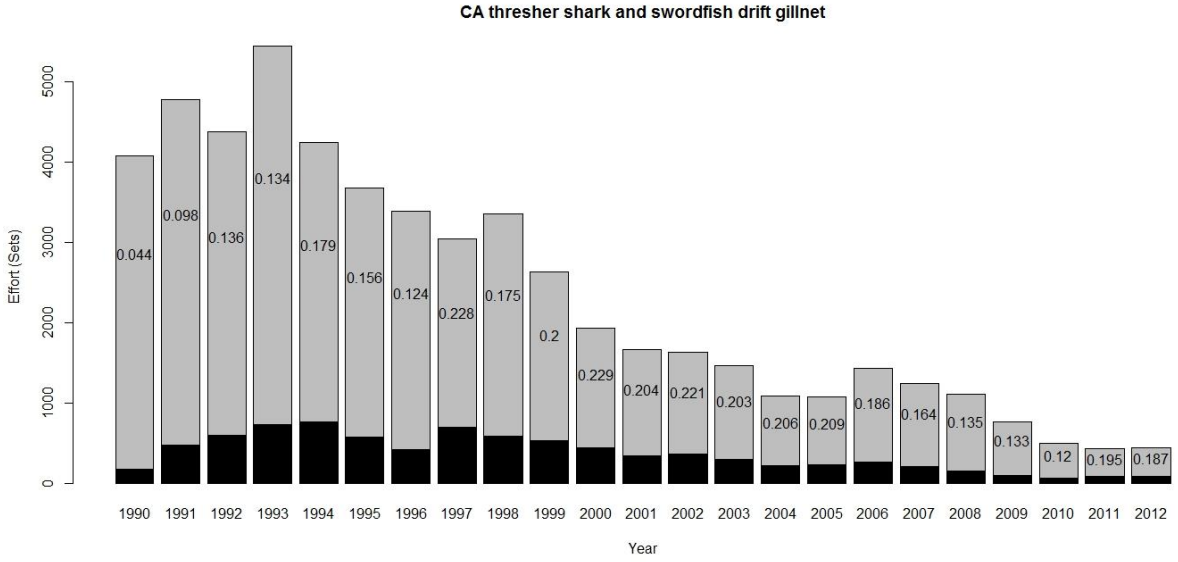


Figure 2. Estimated (gray) and observed (black) fishing trips in the California halibut and white seabass set gillnet fishery for 1990-2012. Observer coverage (number of observed trips divided by estimated number of trips fished) is shown inside bars and ranged from less than 1% in 2006 to a high of 19% in 1993. There was no observer coverage during 1995-1998, 2001-2005, and 2008-2009. Estimated observer coverage in 2012 was 5.5%.

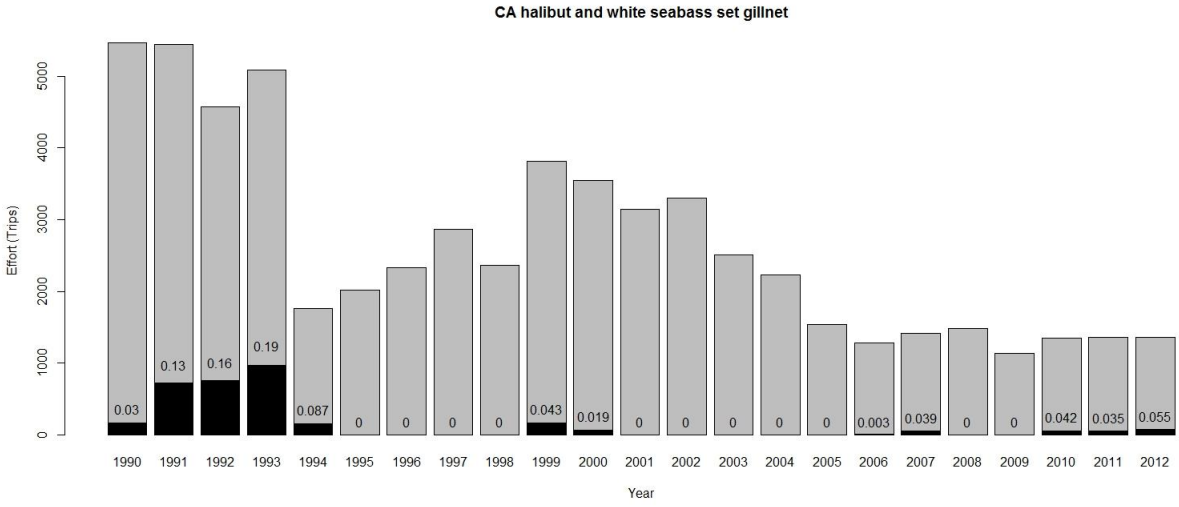


Figure 3. Locations of observed sets (n=83) in the drift gillnet fishery for swordfish and thresher shark in 2012. The shaded region indicates a seasonal area closure where drift gillnet fishing is annually prohibited between 15 August and 15 November. Dashed line delineates the U.S. Exclusive Economic Zone.

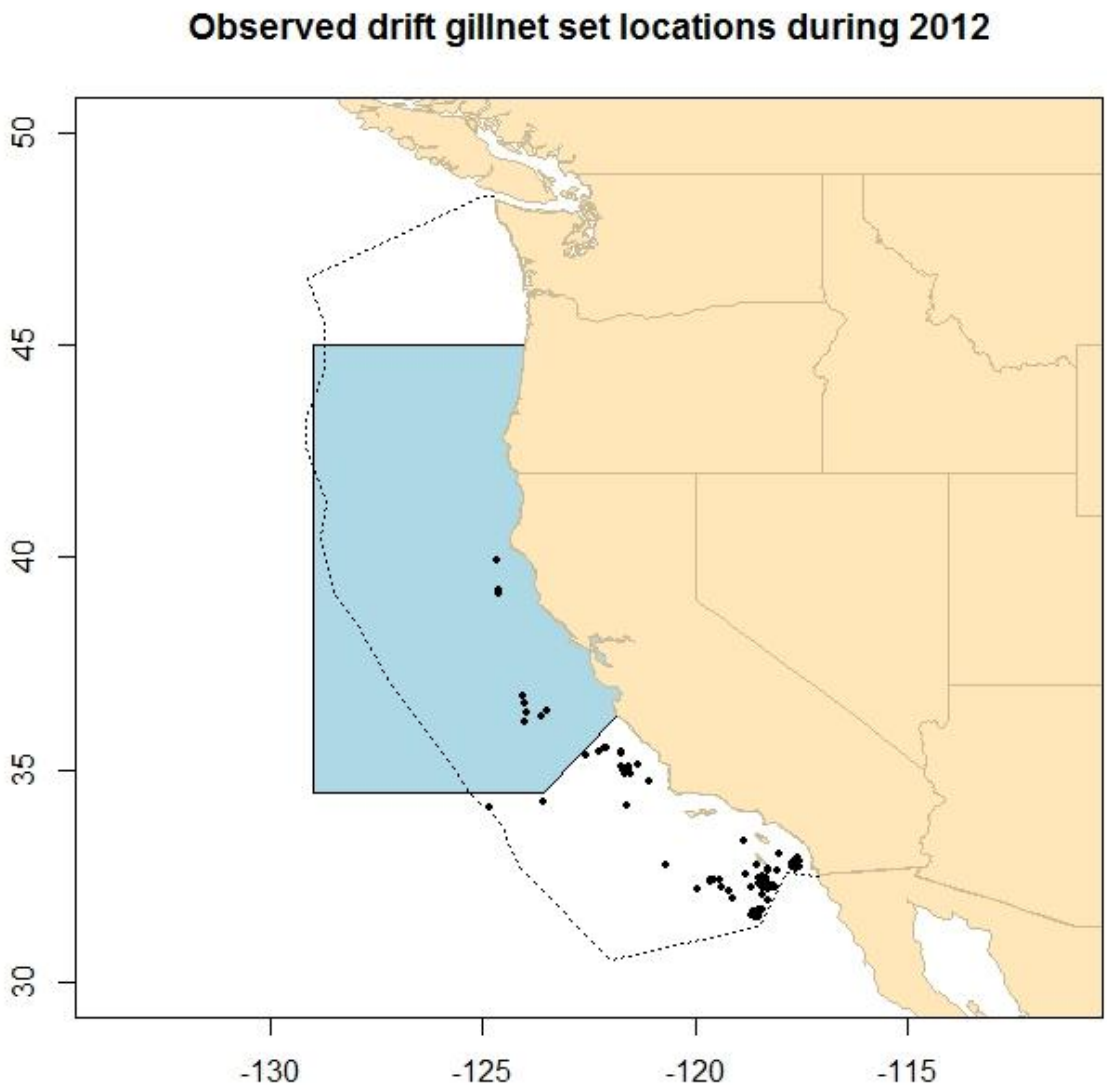


Figure 4. Locations of marine mammal and sea turtle entanglements in the drift gillnet fishery for swordfish and thresher shark in 2012. Key: closed green circles = short-beaked common dolphin (*Delphinus delphis*); □ = northern right whale dolphin (*Lissodelphis borealis*); ○=California sea lion (*Zalophus californianus*); red inverted triangle = Leatherback sea turtle (*Dermochelys coriacea*). The shaded region indicates a seasonal area closure where drift gillnet fishing is annually prohibited between 15 August and 15 November.

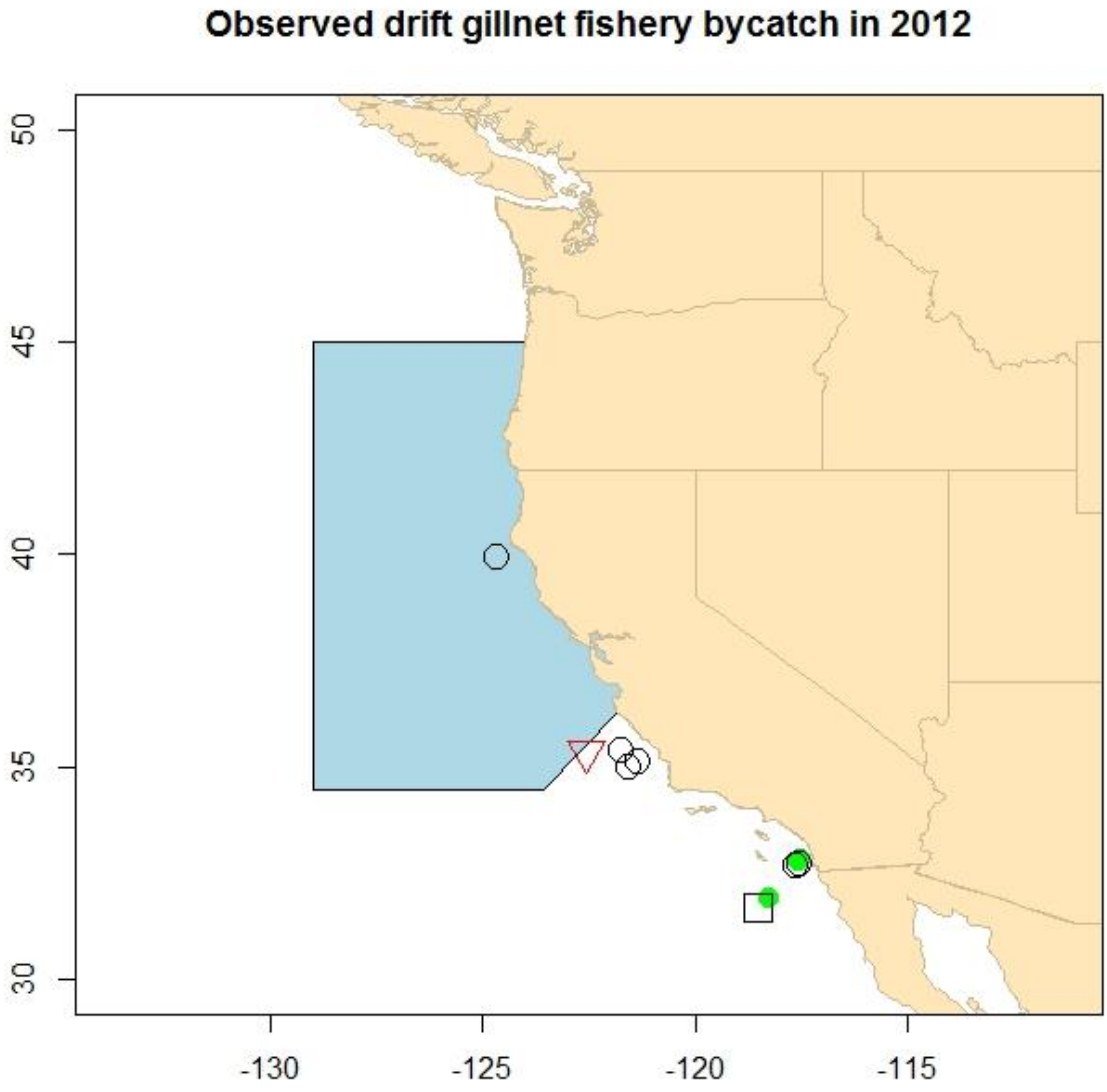


Figure 5. Locations of 250 observed sets (open squares) and bycatch of California sea lions (red circles) in the halibut and white seabass set gillnet fishery in 2012.

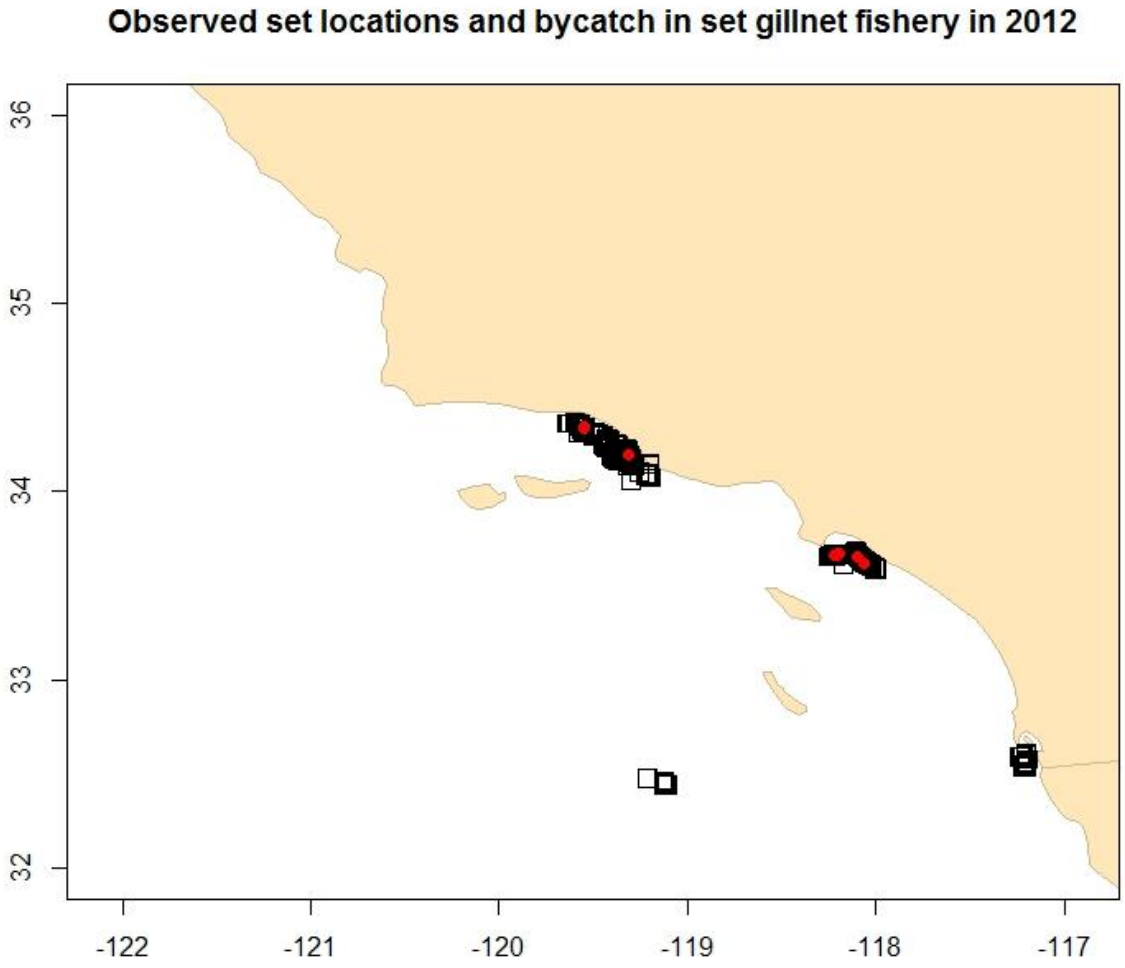


Figure 6. Bycatch rates (individuals per 100 sets) of cetaceans in the California thresher shark and swordfish drift gillnet fishery, 1990–2012.

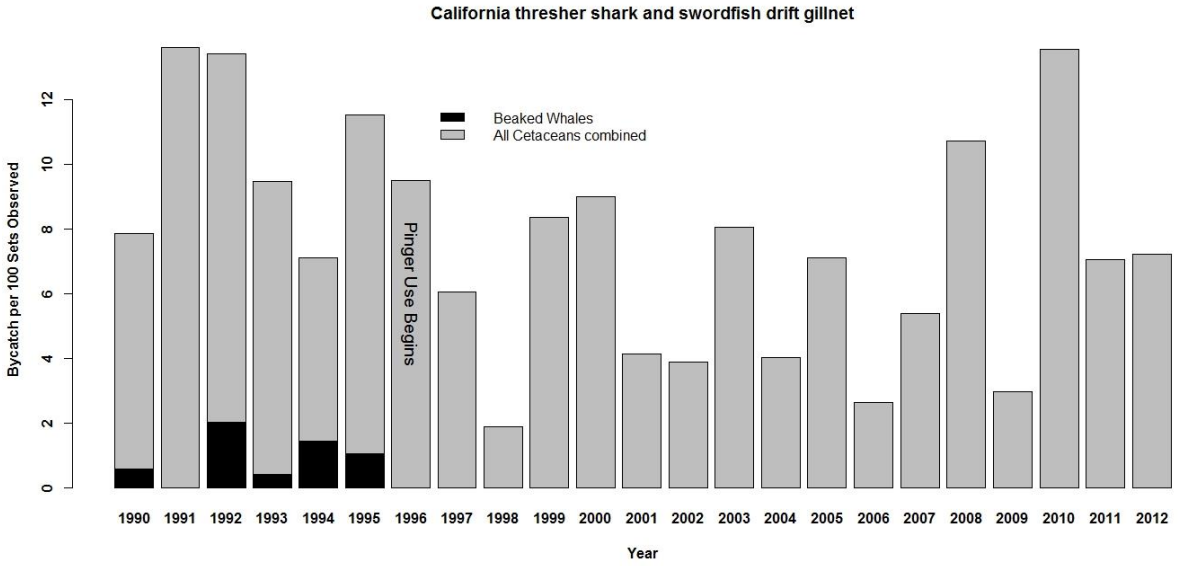


Figure 7. Entanglement rates of short-beaked common dolphin per 100 sets fished in the California swordfish drift gillnet fishery, 1990-2012. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. In 1996, no short-beaked common dolphin were observed killed in 146 pingered sets. For the period 1998-2012, over 99% of all observed sets utilized pingers.

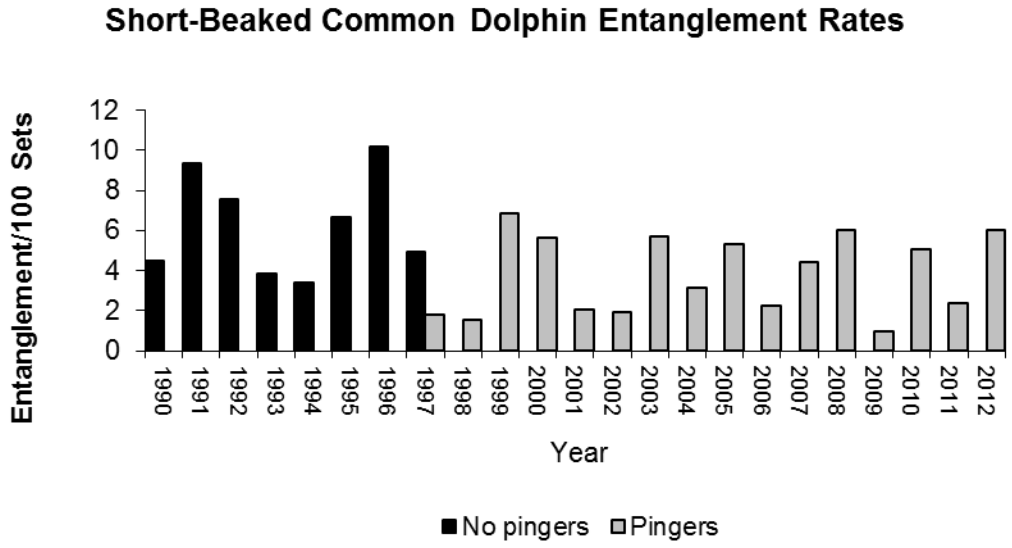
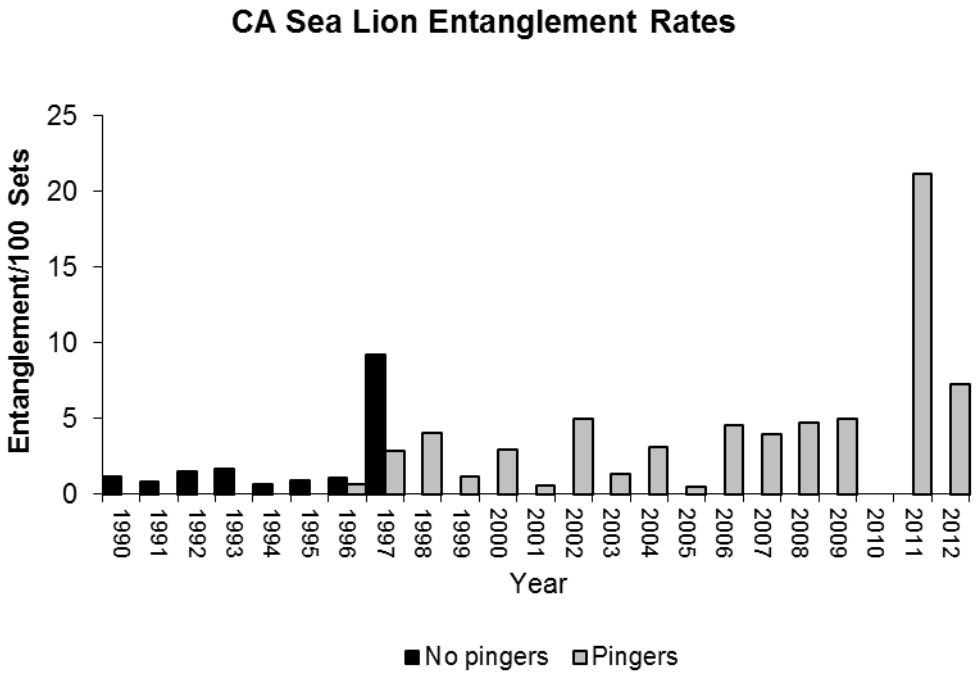


Figure 8. Entanglement rates of California sea lions per 100 sets fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2012. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. For the period 1998-2012, over 99% of all observed sets utilized pingers. In 2010, no sea lions were observed entangled in 59 sets.



RECENT TECHNICAL MEMORANDUMS

SWFSC Technical Memorandums are accessible online at the SWFSC web site (http://swfsc.noaa.gov). Copies are also available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (http://www.ntis.gov). Recent issues of NOAA Technical Memorandums from the NMFS Southwest Fisheries Science Center are listed below:

NOAA-TM-NMFS-SWFSC-516 Form, function and pathology in the pantropical spotted dolphin (*STENELLA ATTENUATA*).
EDWARDS, E. F., N. M. KELLAR, and W. F. PERRIN
(August 2013)

517 Summary of PAMGUARD beaked whale click detectors and classifiers used during the 2012 Southern California behavioral response study.
KEATING, J. L., and J. BARLOW
(September 2013)

518 Seasonal gray whales in the Pacific northwest: an assessment of optimum sustainable population level for the Pacific Coast Feeding Group.
PUNT, A. E., and J. E. MOORE
(September 2013)

519 Documentation of a relational database for the Oregon sport groundfish onboard sampling program.
MONK, M. E., E. J. DICK, T. BUELL, L. ZUMBRUNNEN, A. DAUBLE and D. PEARSON
(September 2013)

520 A fishery-independent survey of cowcod (*SEBASTES LEVIS*) in the Southern CA bight using a remotely operated vehicle (ROV).
STIERHOFF, K. L., S. A. MAU, and D. W. MURFIN
(September 2013)

521 Abundance and biomass estimates of demersal fishes at the footprint and piggy bank from optical surveys using a remotely operated vehicle (ROV).
STIERHOFF, K. L., J. L. BUTLER, S. A. MAU, and D. W. MURFIN
(September 2013)

522 Klamath-Trinity basin fall run chinook salmon scale age analysis evaluation.
SATTERTHWAITE, W. H., M. R. O'FARRELL, and M. S. MOHR
(September 2013)

523 Status review of the Northeastern Pacific population of white sharks *(CARCHARODON CARCHARIAS)* under the endangered species act.
DEWAR, H., T. EGUCHI, J. HYDE, D. KINZEY, S. KOHIN, J. MOORE, B. L. TAYLOR, and R. VETTER
(December 2013)

524 AMLR 2010-2011 field season report.
WALSH, J. G., ed.
(February 2014)

525 The Sacramento harvest model (SHM).
MOHR, M. S., and M. R. O'FARRELL
(February 2014)