Revised: 27 March 2002

Preliminary estimates of cetacean mortality in California gillnet fisheries for 2001.

James V. Carretta
Southwest Fisheries Science Center
NOAA, U.S. National Marine Fisheries Service
8604 La Jolla Shores Drive
La Jolla, CA 92037 USA
Jim.Carretta@noaa.gov

ABSTRACT

Cetacean, pinniped, sea turtle, and seabird mortality is estimated for the California halibut/angel shark set gillnet and swordfish/thresher shark drift gillnet fisheries for calendar year 2001. Observed bycatch in the drift gillnet fishery is documented by NMFS biological technicians that accompany ~25% of all fishing trips. The set gillnet fishery was not observed in Monterey Bay in 2001, owing to an area closure that reduced fishing effort to negligible levels (26 fishing days). The remainder of the set gillnet fishery (Morro Bay, Ventura, Channel Islands, and Southern California strata) has not been observed since 1994, and therefore, kill rates from these geographic strata are estimated from 1991-94 observer data and mortalities are estimated using 2001 fishing effort estimates. For all strata combined, estimated set gillnet mortality by species (CVs in parentheses) is: 3 (0.77) harbor porpoise (*Phocoena phocoena*), 3 (0.67) unidentified common dolphins (*Delphinus* sp.), 1,197 (0.07) California sea lions (*Zalophus californianus*), 330 (0.09) harbor seals (*Phoca vitulina*), 29 (0.08) northern elephant seals (*Mirounga angustirostris*), 27 (0.36) unidentified pinnipeds, 1 (0.96) loggerhead turtle (*Caretta caretta*), 3 (0.71) green/black turtles (*Chelonia mydas/agassizi*), 1 (0.96) leatherback turtle (*Dermochelys coriacea*), 1 (0.96) unidentified sea turtle, 277 (0.18) common murres (*Uria aalge*), and 104 (0.23) Brandt's cormorants (*Phalacrocorax penicillatus*). In the drift gillnet fishery, observer coverage was 26% (339 days observed/1,293 estimated days fished). Estimated mortality and observed mortality (in parentheses) in the drift gillnet fishery included 57 (14) cetaceans and 15 (3) pinnipeds. Estimated mortality in the drift gillnet by species (CVs in parentheses) was: 26 (0.41) short-beaked common dolphins (*Delphinus delphis*), 22 (0.54) northern right whale dolphins (*Lissodelphis borealis*), 9 (0.69) Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), 6 (0.80) northern elephant seals (*Mirounga angustirostris*), and 9 (0.69) California sea lions (*Zalophus californianus*).

INTRODUCTION

The California halibut/angel shark set gillnet and swordfish/thresher shark drift gillnet fisheries are both classified as Category I fisheries under the U.S. Marine Mammal Protection Act (MMPA), meaning that 'levels of incidental serious injury and mortality of a given marine mammal stock are greater than or equal to 50% of the Potential Biological Removal (PBR) level for that stock' (NMFS List of Commercial Fisheries 1996). PBR is defined as 'the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population' (Barlow *et al*. 1995). Category I fisheries are subject to monitoring by observer programs, which provide data on incidental marine mammal bycatch. NMFS observer programs for both the halibut/angel shark set gillnet and thresher shark/swordfish drift gillnet fisheries were initiated in 1990. Observers are placed on fishing vessels to record catch, bycatch and other gear and environmental variables.

The halibut/angel shark set gillnet fishery was observed from 1990-1994 throughout its range (southern and central California), with levels of observer coverage ranging from 2-15% (mean = 9.6%)(Forney *et al*. 2000). Historically, incidental takes of cetaceans in the set gillnet fishery have been mostly limited to harbor porpoise (*Phocoena phocoena*) in central California, although two unidentified common dolphins (*Delphinus* sp.) and one unidentified cetacean have also been reported (Julian and Beeson 1998). In 1994, area closures restricted set gillnets to waters greater than 5.5 km (3 nmi) from the southern California mainland and greater than 1.85 km (1 nmi) from the Channel Islands. This closure resulted in a marked decrease in fishing effort in this fishery, from approximately 5,500-7,000 fishing days during 1990-93 to 2,000-4,000 days following the closure (Forney *et al*. 2000; Cameron and Forney 1999; 2000). In the central California portion of the fishery, depth restrictions in place since 1991 have not allowed fishing inshore of 55 m (30 fm). There was no observer coverage throughout this fishery during 1995-98. In 1999, a NMFS observer program was reinstated in the Monterey Bay portion of the set gillnet fishery, in response to renewed concerns over the incidental take of harbor porpoise. In September 2000, the California Department of Fish and Game (CDFG) issued emergency regulations that prohibited set gillnet fishing inshore of 110 m (60 fm) in central California from Point Reyes to Yankee Point in Monterey Bay and from Point Arguello to Point Sal, citing concerns over the incidental take of common murre (*Uria aalge*) and California sea otters (*Enhydra lutris*). Permanent regulations which would eliminate set gillnetting inshore of 110 m (60 fm) throughout central California may take effect in mid-2002. In 2001, limited fishing effort resumed in Monterey Bay after the CDFG emergency regulations lapsed.

The swordfish/thresher shark drift gillnet fishery has been observed by NMFS every year since 1990. Levels of fishing effort in this fishery have decreased from approximately 5,500 days in 1993 to 1,293 days in 2001 (Forney et al. 2000; Read 2001a, 2001b, 2001c, 2002). Observer coverage levels in this fishery ranged from 4-18% (mean = 13%) during 1990-96 and 18-25% (mean = 21.5%) during 1997-2000. Bycatch in the drift gillnet fishery has included a wide variety of cetacean, pinniped, sea turtle, and seabird species (Julian and Beeson 1998; Cameron and Forney 1999; 2000). Initiation of a Take Reduction Plan (TRP) in 1996 followed concerns over incidental take levels that exceeded PBR for some cetacean stocks. The TRP included the use of acoustic pingers all on nets (typically 20 each on the floatline and leadline), net extenders to increase minimum fishing depth to 11 m (6 fm), and mandatory skipper education workshops regarding marine mammals and TRP goals. The TRP initially resulted in a

decline in cetacean entanglement rates (Barlow and Cameron1999), although entanglement rates for some stocks have since returned to pre-TRP levels. In 2001, a seasonal (15 August – 15 November) area closure was implemented in the drift gillnet fishery to protect leatherback turtles which feed in this region and have been entangled in previous fishing seasons (see Figure 7).

METHODS

Estimation of Total Fishing Effort

Estimates of overall fishing effort are provided quarterly by the California Department of Fish and Game (CDFG). Effort estimates are generated from fisher logbooks and landing receipts. Preliminary CDFG estimates of fishing effort in the halibut/angel shark set gillnet fishery for the year 2001 were 3,388 days, of which 26 days were estimated in the Monterey Bay stratum. The remaining 3,362 days of effort were distributed as follows: Channel Islands (122 days), Southern California (1,640), Ventura (1,209) and Morro Bay (391). Geographic strata for the set gillnet fishery are shown in Figure 1. Estimated 2001 fishing effort by CDFG block in the set gillnet fishery for southern and central California is shown in Figures 2-3, respectively. The estimated number of days fished in the swordfish/shark drift gillnet fishery in 2001 was 1,293 days, representing 65 fishing trips ranging from 1 to 9 days in length. The locations of all observed drift gillnet sets are shown in Figure 4. Effort estimates for both fisheries are preliminary and may be revised upwards as additional fishing records are received. For this same reason, mortality estimates are also considered preliminary.

Mortality Estimation in the set gillnet fishery

Mortality in the halibut/angelshark set gillnet fishery was estimated with mean-per-unit (MPU) estimators, using effort days (= trips) as the sampling unit (Julian and Beeson, 1998; Cameron and Forney 1999, 2000). As in previous analyses, kill rates were stratified by geographic area, and by calendar quarter for Southern California and Ventura. There were insufficient data to stratify by calendar quarter for other geographic strata. In 2001, the set gillnet fishery was not observed and mortality estimates are based on the most recent kill rates for each stratum. In this case, Monterey Bay mortality estimates are based on kill rates observed in 2000 and estimates of fishing effort in 2001. For all other strata (Southern California, Ventura, Channel Islands, and Morro Bay), the fishery has not been observed since 1994, therefore, current kill rates and mortalities are based on 1991-94 observer program data (the last period for which year-round observations are available) and estimated fishing effort for 2001.

The kill rate for each stratum ($\hat{r}_s$) was calculated as

$$\hat{r}_s = \frac{\sum_i k_{i,s}}{d_s} \qquad (1)$$

where $k_{i,s}$ is the observed kill for the i^{th} observed day in stratum s and d_s are the number of days observed in stratum s. In lieu of analytical formulae previously used to estimate kill rate variances (Julian and Beeson, 1998; Cameron and Forney, 1999; 2000), I estimated kill rate variances using a bootstrap procedure, where one trip (= day) represented the sampling unit.

Within a stratum, days were resampled with replacement until each bootstrap sample contained the same number of days as the actual observed level of effort. A kill rate was then calculated from each bootstrap sample. This procedure was repeated 1,000 times, from which the bootstrap sample variance (kill rate variance) was calculated. Estimated mortality, $\hat{m}$ and its associated variance, were calculated for each stratum as

$$\hat{m}_s = D_s r_s \qquad (2)$$

$$\hat{s}^2_{m,s} = D_s^2 \hat{s}^2_{r,s} \qquad (3)$$

where

$\hat{m}_s$ is the estimated mortality within stratum *s*,

D_s is the estimated number of days fished in stratum *s*,

$\hat{r}_s$ is the kill rate in stratum *s*,

$\hat{s}^2_{m,s}$ is the variance of the estimated mortality in stratum *s*, and

$\hat{s}^2_{r,s}$ is the bootstrap sample variance of the kill rate in stratum *s*.

Quarterly estimates of mortality within a stratum were added to yield annual mortality estimates for that stratum. Annual kill rates and standard errors within a stratum represent effort-weighted averages of the quarterly kill rates and standard errors (weighted by the number of days observed). Fishery-wide estimates of mortality and associated variances were obtained by adding mortality estimates and variances across all strata. Annual estimates of mortality are considered preliminary because fishing effort estimates will likely be revised upwards as more fishing records are received.

Mortality Estimation in the drift gillnet fishery

Mortality in the swordfish/shark drift gillnet fishery was estimated using ratio estimators, with trips as the sampling unit and the number of days per trip as an auxiliary variable (Julian and Beeson 1998). No geographic strata were used in estimating drift gillnet fishery kill rates, but kill rates were stratified by calendar quarter, owing to seasonal differences in abundance for most species (Forney and Barlow 1998). For each species, the kill rate ($\hat{r}_q$) for a given calendar quarter was estimated as

$$\hat{r}_q = \frac{\sum_i k_i}{\sum_i d_i} \qquad (4)$$

where

k_i is the observed kill for the i^{th} trip and
d_i is the number of days for the i^{th} trip.

As with the set gillnet fishery, I estimated kill rate variances using a bootstrap procedure, where one trip (1-9 days in this fishery) represented the sampling unit. Within a stratum, trips were resampled with replacement until each bootstrap sample contained the same number of trips as the actual observed level of effort. A kill rate was then calculated from each bootstrap sample. This procedure was repeated 1,000 times, from which the bootstrap sample variance (kill rate variance) was calculated. Quarterly estimates of mortality, $\hat{m}_q$, and associated variances, $s^2_{m,q}$, for each species were calculated as

$$\hat{m}_q = D_q \hat{r}_q \qquad (5)$$

$$s^2_{m,q} = D_q^2 s^2_{r,q} \qquad (6)$$

where

D_q is the estimated number of days fished in quarter *q*,

$\hat{r}_q$ is the kill rate estimated in quarter *q*, and

$s^2_{r,q}$ is the bootstrap estimate of kill rate variance in quarter *q*.

The total annual estimated fishery mortality and associated variance for each species was calculated as the sum of quarterly mortalities and variances. This total is considered preliminary because effort estimates will likely be revised upwards as more fishing records are received.

RESULTS

Set gillnet fishery

Estimates of fishing effort and mortality for the Monterey Bay stratum of the set gillnet fishery are presented in Table 1. Fishing effort in the Monterey Bay stratum was limited to 26 days, owing to CDFG regulations that prohibited fishing in waters shallower than 110 m (60 fm). This area closure effectively eliminated set gillnets in Monterey Bay for most of calendar year 2001. There was no observer program in Monterey Bay in 2001 therefore, no mortalities were observed and estimates of mortality are based on kill rates observed in 2000. For geographic strata other than Monterey Bay, the only cetacean species for which current estimates of mortality are available are unidentified common dolphin (*Delphinus sp.*) (Table 2). However, this estimate is based on 1991-94 kill rates (2 killed/2,289 days = 0.0009 killed/day) when the fishery outside of Monterey was still observed. Similarly, kill rates of pinnipeds, sea turtles, and seabirds for non-Monterey geographic strata in the set gillnet fishery are based on 1991-94 kill rates and thus are subject to a great degree of uncertainty. Mortality estimates and kill rates for geographic strata other than Monterey Bay appear in Table 2. Annual mortality estimates in the set gillnet fishery for all geographic strata combined are summarized in Table 3.

Drift gillnet fishery

Drift gillnet fishing effort, observer effort, observed mortalities, and mortality estimates are presented in Tables 4-5. Observer coverage in this fishery was 26% for calendar year 2001, with 339 days (sets) observed out of an estimated 1,293 days (sets) fished. The locations of observed sets in this fishery are shown in Figure 4 and observed cetacean mortalities are shown in Figure 5. Life history information for cetaceans taken in the drift gillnet fishery is presented in Chivers *et al*. (2002). As in previous years, the short-beaked common dolphin (*Delphinus delphis*) was the most frequently entangled species in the drift gillnet fishery, with 7 observed mortalities and a resulting mortality estimate of 26 animals (CV = 0.41). There was one set that entangled 2 common dolphin. The second-most frequently entangled cetacean in the drift gillnet fishery was the northern right whale dolphin (*Lissodelphis borealis*), with 5 observed mortalities and a resulting mortality estimate of 22 animals (CV = 0.54). There was one set that entangled 2 northern right whale dolphin. One loggerhead turtle (*Caretta caretta*) was entangled and released alive in a drift gillnet in southern California (N33 W119) in August of 2001. A summary of observed and estimated mortalities for all marine mammal species observed taken in the drift gillnet fishery appears in Table 4. A comparison of drift gillnet mortality estimates from 2000 and 2001 is shown in Table 5.

DISCUSSION

Fishing effort in both the set and drift gillnet fisheries continues to decline in California. Effort in the set gillnet fishery in Monterey Bay has declined considerably since September 2000 due to depth restrictions imposed by the CDFG. Final regulations on a proposed year-round ban on set gillnets inshore of 110 m (60 fms) from Pt. Reyes to Point Arguello, California may be implemented in 2002. If so, this will probably result in a significant decline in the incidental mortality of harbor porpoise in this region as gillnets will be removed from most harbor porpoise habitat. Considerable uncertainty remains in estimating mortality for the southern California portion of the set gillnet fishery because it has not been observed since 1994 and because 2001 mortality is estimated using 1991-94 kill rates. Only three cetaceans other than harbor porpoise (2 *Delphinus* sp. and 1 unidentified cetacean) have been observed taken in the set gillnet fishery (Julian and Beeson 1998), however kill rates reported by Julian and Beeson (1998) probably do not reflect current conditions in the fishery, owing to geographical changes in set gillnet effort since the 5.5 km (3 nmi) inshore ban was implemented in 1994. For this same reason, considerable uncertainty also exists in estimating mortality levels for pinnipeds, seabirds, and sea turtles in the southern California portion of the set gillnet fishery.

The drift gillnet fishery had the lowest level of fishing effort since observation of this fishery began in 1990 (1,293 days). A proposed closure of the drift gillnet fishery in central California is being examined in response to incidental takes of leatherback sea turtles (*Dermochelys coriacea*) prior to 2000. Currently, the drift gillnet fishery is subject to seasonal time/area closures which are summarized in Forney *et al*. (2000). In 2001, the two most frequently entangled cetacean species in the drift gillnet fishery were short-beaked common dolphin and northern right whale dolphin. The short-beaked common dolphin continues to be the most frequently entangled cetacean in the drift gillnet fishery, which probably reflects it being the most abundant cetacean in California waters (Barlow 1995; Forney *et al*. 1995). The kill rate for 2001 (0.02/day) was the second-lowest observed since the fishery has been observed

(Figure 6a). Kill rates of short-beaked common dolphin were highest during the first calendar quarter (kill rate = 0.05/day). Most kills occurred off southern California, where common dolphin may be more abundant in winter (Forney and Barlow 1998).

ACKNOWLEDGMENTS

Thanks go to Bob Read of the California Department of Fish and Game for providing estimates of fishing effort, Rand Rasmussen of the Southwest Fisheries Science Center, National Marine Fisheries Service (SWFSC/NMFS) for providing the observer database of incidental take and gear data, and Lyle Enriquez for providing independent NMFS estimates of fishing effort. Karin Forney's insight into various aspects of the fisheries helped greatly. Thanks also to Grant Cameron for making the mortality estimation process easier by thoroughly documenting his previous work. This work could not have been done without the diligent work of the NMFS biological observers and the continuing cooperation of the California gillnet fishermen. Jay Barlow kindly reviewed a draft of the manuscript.

LITERATURE CITED

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. U.S. Fishery Bulletin 93:1-14.

Barlow, J., Swartz, S.L., Eagle, T.C., and Wade, P.R. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. Department of Commerce NOAA Technical Memorandum, NMFS-OPR-95-6.

Barlow, J. and Cameron, G.A. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Report SC/51/SM2 to the Scientific Committee of the International Whaling Commission, May 1999 (unpublished). 20p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA].

Cameron, G.A. and Forney, K.A.. 1999. Preliminary estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Report SC/51/O4 presented to the Scientific Committee of the International Whaling Commission, May 1999 (unpublished). 14 p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA].

Cameron, G.A. and Forney, K.A. 2000. Preliminary estimates of cetacean mortality in California/Oregon gillnet fisheries for 1999. Report SC/52/O24 presented to the Scientific Committee of the International Whaling Commission, May 2000 (unpublished). 12 p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA].

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2001. Report SC/53/SM9 presented to the Scientific Committee of the International Whaling Commission, June 2001 (unpublished). 21p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA.

Chivers, S.J., Robertson, K.M., Danil, K. 2002. Life history characteristics of the incidental kill of cetaceans in the California drift and set gillnet fisheries during 2001. Report SC/54/SM13 presented to the Scientific Committee of the International Whaling Commission, April 2002 (unpublished). 10p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92038, USA].

Forney, K.A., Barlow, J. and Carretta, J.V. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. U.S. Fishery Bulletin 93:15-26.

Forney, K.A., and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Marine Mammal Science 14(3):460-489.

Forney, K.A., Barlow, J., Muto, M.M., Lowry, M., Baker, J., Cameron, G., Mobley, J., Stinchcomb, C., and Carretta, J.V. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300. 276p. [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038, USA].

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

National Marine Fisheries Service. 1996. Final List of Fisheries for 1996. Federal Register, Vol. 60, No. 249. December 28, 1995.

Read, R.B. 2001a. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white seabass-Yellowtail Set/Drift Net, for January 1 through March 31, 2001. Report submitted to NOAA Fisheries/National Marine Fisheries Service Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213, June 2001.

Read, R.B. 2001b. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white seabass-Yellowtail Set/Drift Net, for April 1 through June 30, 2001. Report submitted to NOAA Fisheries/National Marine Fisheries Service Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213, September 2001.

Read, R.B. 2001c. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white seabass-Yellowtail Set/Drift Net, for July 1 through

September 30, 2001. Report submitted to NOAA Fisheries/National Marine Fisheries Service Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213, December 2001.

Read, R.B. 2002. Effort estimates of California gill net fisheries: halibut-angel shark set net, shark-swordfish drift net, white seabass-Yellowtail Set/Drift Net, for October 1 through December 31, 2001. Report submitted to NOAA Fisheries/National Marine Fisheries Service Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213, March 2002.

Table 1. Summary of 2001 mortality estimates for the halibut/angel shark set gillnet fishery in Monterey Bay. Estimates are based on kill rates observed in calendar year 2000 and 26 days of fishing effort in 2001.

	Kill/Day	SE Kill/Day	Mort (M)	var M	CV Mort
California sea lion	0.41791	0.1881	11	24	0.45
Harbor seal	0.358209	0.1742	9	21	0.49
Elephant seal	0.059701	0.0597	2	2	1.00
Harbor Porpoise	0.104478	0.0807	3	4	0.77
Common Murre	10.61194	1.8674	276	2,357	0.18
Brandt's Cormorant	0.029851	0.0286	1	1	0.96

Table 2. Mortality estimates for the set gillnet fishery (non-Monterey strata: Southern California, Ventura, Channel Is., and Morro Bay). Kill rates are based on 1991-94 observer data and estimated 2001 fishing effort.

Species	Kill/Day	Var Kill Rate	Mortality	Var Mort	SE Mort	CV Mort
unidentified common dolphin	**0.0009**	**3.8938E-07**	3	**4**	**2**	**0.71**
California sea lion	**0.3492**	**0.000624**	1,183	**7,159**	**85**	**0.07**
Harbor seal	**0.0944**	**0.000075**	320	**856**	**29**	**0.09**
Northern elephant seal	**0.0081**	**0.000003**	28	**39**	**6**	**0.23**
Unidentified pinniped	**0.008**	**0.000008**	27	**97**	**10**	**0.36**
Loggerhead Turtle	**0.0004**	**1.7472E-07**	1	**2**	**1**	**0.96**
Green/Black Turtle	**0.0009**	**3.8938E-07**	3	**4**	**2**	**0.71**
Leatherback Turtle	**0.0004**	**1.7472E-07**	1	**2**	**1**	**0.96**
Unidentified Turtle	**0.0004**	**1.7472E-07**	1	**2**	**1**	**0.96**
Common Murre	**0.0004**	**1.7472E-07**	1	**2**	**1**	**0.96**
Brandt's Cormorant	**0.0306**	**4.772E-05**	104	**548**	**23**	**0.23**

Table 3. Total 2001 mortality estimates for the halibut/angel shark set gillnet fishery (all strata combined). 2000 and 2001 (in bold) estimates are shown for comparison.

Species	2000 Mort	**2001 Mort**	**Var Mort**	**SE Mort**	**CV Mort**
Harbor porpoise	26	**3**	**4**	**2**	**0.77**
Unid. Common dolphin	3	**3**	**4**	**2**	**0.67**
California sea lion	1,346	**1,194**	**7,183**	**85**	**0.07**
Harbor seal	415	**329**	**876**	**30**	**0.09**
N. elephant seal	48	**29**	**6**	**2**	**0.08**
Unid. pinniped	33	**27**	**97**	**10**	**0.36**
Loggerhead Turtle	2	**1**	**2**	**1**	**0.96**
Green/Black Turtle	3	**3**	**4**	**2**	**0.71**
Leatherback Turtle	2	**1**	**2**	**1**	**0.96**
Unidentified Turtle	2	**1**	**2**	**1**	**0.96**
Common Murre	3,143	**277**	**2,359**	**49**	**0.18**
Brandt's Cormorant	116	**104**	**548**	**23**	**0.23**

Table 4. Estimates of 2001 fishing effort and mortality in the swordfish/thresher shark drift gillnet fishery. Standard errors (SE), variances (Var), and coefficients of variation (CV) were estimates using bootstrap methods. A Poisson CV is also calculated for comparison, based on the number of observed mortalities.

DRIFT GILLNET YEAR 2001	1ST QTR	2ND QTR	3RD QTR	4TH QTR	TOTAL
Est. Days Fished (CDFG)	147	50	65	1031	1293
Days Observed	51	5	52	231	339
Trips Observed	9	1	11	44	65
Fraction Observer Coverage	0.35	0.10	0.80	0.22	0.26
Observed Mortality					
Short-beaked common dolphin	3	0	0	4	7
Northern right whale dolphin	0	0	0	5	5
Pacific white-sided dolphin	0	0	0	2	2
California sea lion	0	0	0	2	2
Northern elephant seal	0	0	0	1	1
All Cetaceans	3	0	0	11	14
All Pinnipeds	0	0	0	3	3

Short-beaked common dolphin	Obs. Mort.	Kill Rate/Day	SE Kill Rate	Var Kill Rate	Est. Mort.	Var Mort	SE Mort	CV Mort	Poisson CV
Jan – Mar	3	0.0588	0.046400	0.002153	9	47	7	0.789	0.577
Apr – Jun	0	0.0000	0.000000	0.000000	0	0	0	-	-
Jul – Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct – Dec	4	0.0173	0.008242	0.000068	18	72	8	0.476	0.500
Year (unstratified)	7	0.0206	0.008935	0.000080	27	133	12	0.433	0.378
Year (stratified by quarter)	7	0.0206	0.012597	0.000159	26	119	11	0.411	0.378

Table 4. (continued).

Northern right whale dolphin	Obs. Mort.	Kill Rate/Day	SE Kill Rate	Var Kill Rate	Est. Mort.	Var Mort	SE Mort	CV Mort	Poisson CV
Jan - Mar	0	0.0000	0.000000	0.000000	0	0	0	-	-
Apr - Jun	0	0.0000	0.000000	0.000000	0	0	0	-	-
Jul - Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct - Dec	5	0.0216	0.011777	0.000139	22	147	12	0.544	0.447
Year (unstratified)	5	0.0147	0.008496	0.000072	19	121	11	0.576	0.447
Year (stratified by quarter)	5	0.0147	0.008025	0.000064	22	147	12	0.544	0.447

Pacific white-sided dolphin	Obs. Mort.	Kill Rate/Day	SE Kill Rate	Var Kill Rate	Est. Mort.	Var Mort	SE Mort	CV Mort	Poisson CV
Jan - Mar	0	0.0000	0.000000	0.000000	0	0	0	-	-
Apr - Jun	0	0.0000	0.000000	0.000000	0	0	0	-	-
Jul - Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct - Dec	2	0.0087	0.005964	0.000036	9	38	6	0.689	0.707
Year (unstratified)	2	0.0059	0.004179	0.000017	8	29	5	0.708	0.707
Year (stratified by quarter)	2	0.0059	0.004064	0.000017	9	38	6	0.689	0.707

Northern elephant seal	Obs. Mort.	Kill Rate/Day	SE Kill Rate	Var Kill Rate	Est. Mort.	Var Mort	SE Mort	CV Mort	Poisson CV
Jan - Mar	0	0.0000	0.016970	0.000288	0	0	0	-	-
Apr - Jun	0	0.0000	0.000000	0.000000	0	0	0	-	-
Jul - Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct - Dec	1	0.0043	0.004343	0.000019	6	20	4	0.800	1.000
Year (unstratified)	1	0.0029	0.002880	0.000008	4	14	4	0.976	1.000
Year (stratified by quarter)	1	0.0029	0.005512	0.000030	6	20	4	0.800	1.000

California sea lion	Obs. Mort.	Kill Rate/Day	SE Kill Rate	Var Kill Rate	Est. Mort.	Var Mort	SE Mort	CV Mort	Poisson CV
Jan - Mar	0	0.0000	0.000000	0.000000	0	0	0	-	-
Apr - Jun	0	0.0000	0.000000	0.000000	0	0	0	-	-
Jul - Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct - Dec	2	0.0087	0.005964	0.000036	9	0	0	0.689	0.707
Year (unstratified)	2	0.0059	0.004179	0.000017	8	0	0	0.708	0.707
Year (stratified by quarter)	2	0.0059	0.004064	0.000017	9	0	0	0.689	0.707

Table 5. Summary of estimated mortality in the drift gillnet fishery by species for 2000 and 2001. 2000 mortality estimates are from Carretta (2001).

Swordfish/shark drift gillnet fishery	2000	2001
CDFG Est. Days Fished	1,766	1,293
NMFS Days Observed	444	339
Fraction Observer Coverage	0.25	0.26
	2000 Mort. (CV)	2001 Mort. (CV)
Short-beaked common dolphin	75 (0.32)	26 (0.41)
Long-beaked common dolphin	9 (0.76)	0
Risso's dolphin	7 (0.58)	0
Northern right whale dolphin	47 (0.51)	22 (0.54)
Pacific white-sided dolphin	5 (1.02)	9 (0.69)
Northern elephant seal	26 (0.41)	6 (0.80)
California sea lion	54 (0.43)	9 (0.69)

Figure 1. Geographic strata used in the analysis of the halibut/angel shark set gillnet fishery.

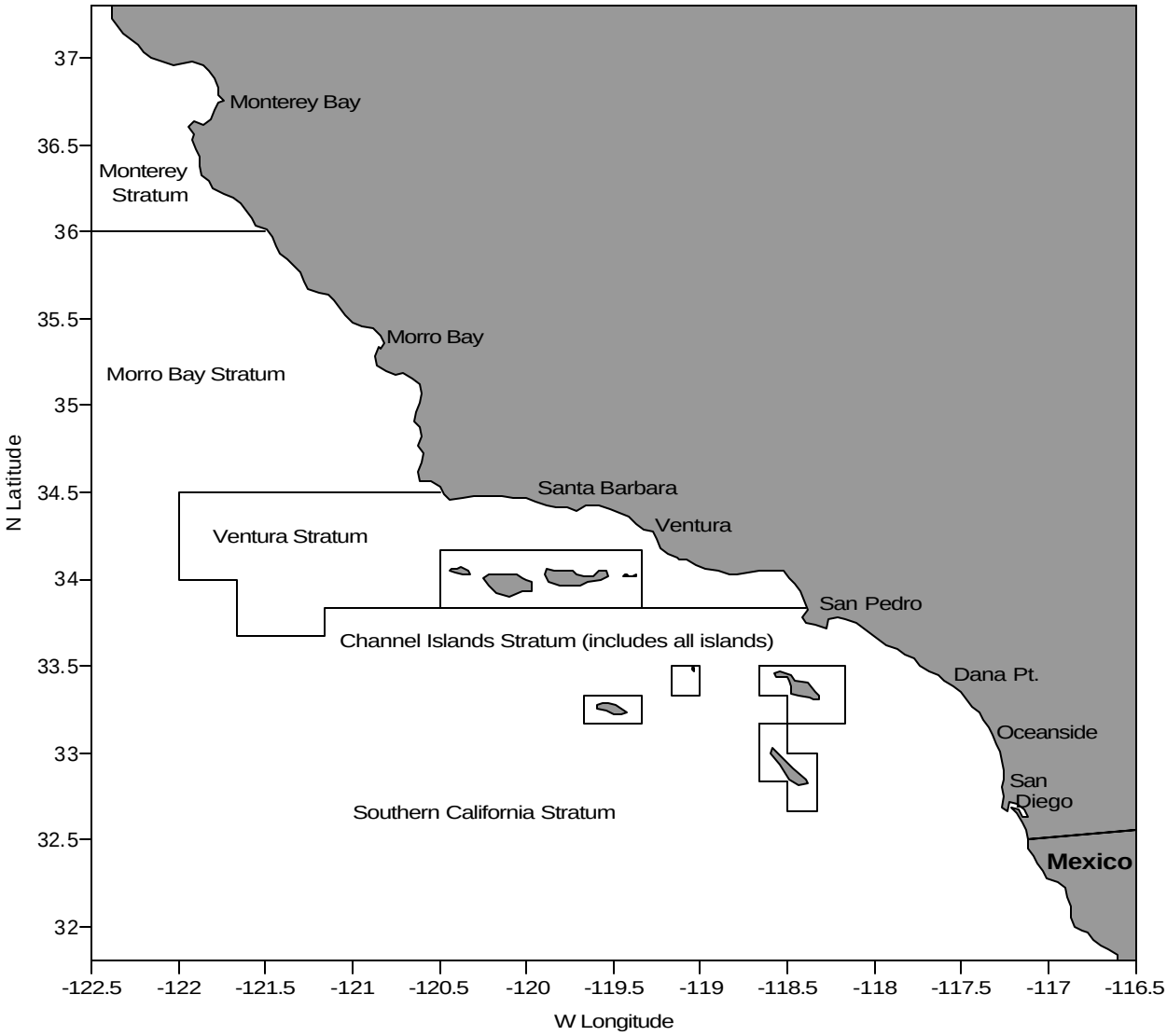

Figure 2. Estimated number of days of set gillnet fishing effort by CDFG block in southern California for calendar year 2001.

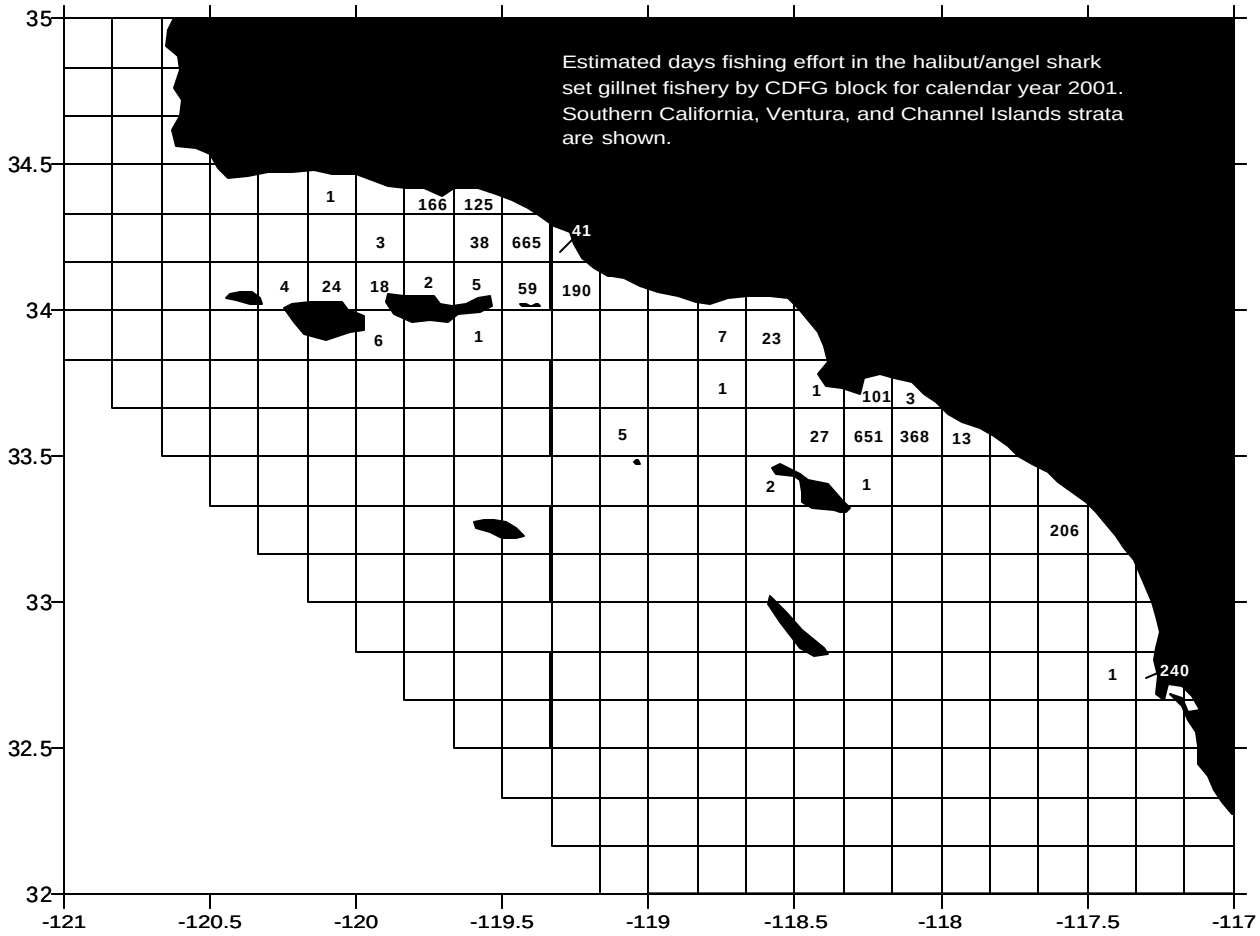

Figure 3. Estimated number of days of set gillnet fishing effort by CDFG block in central California for calendar year 2001. Monterey and Morro Bay strata are shown.

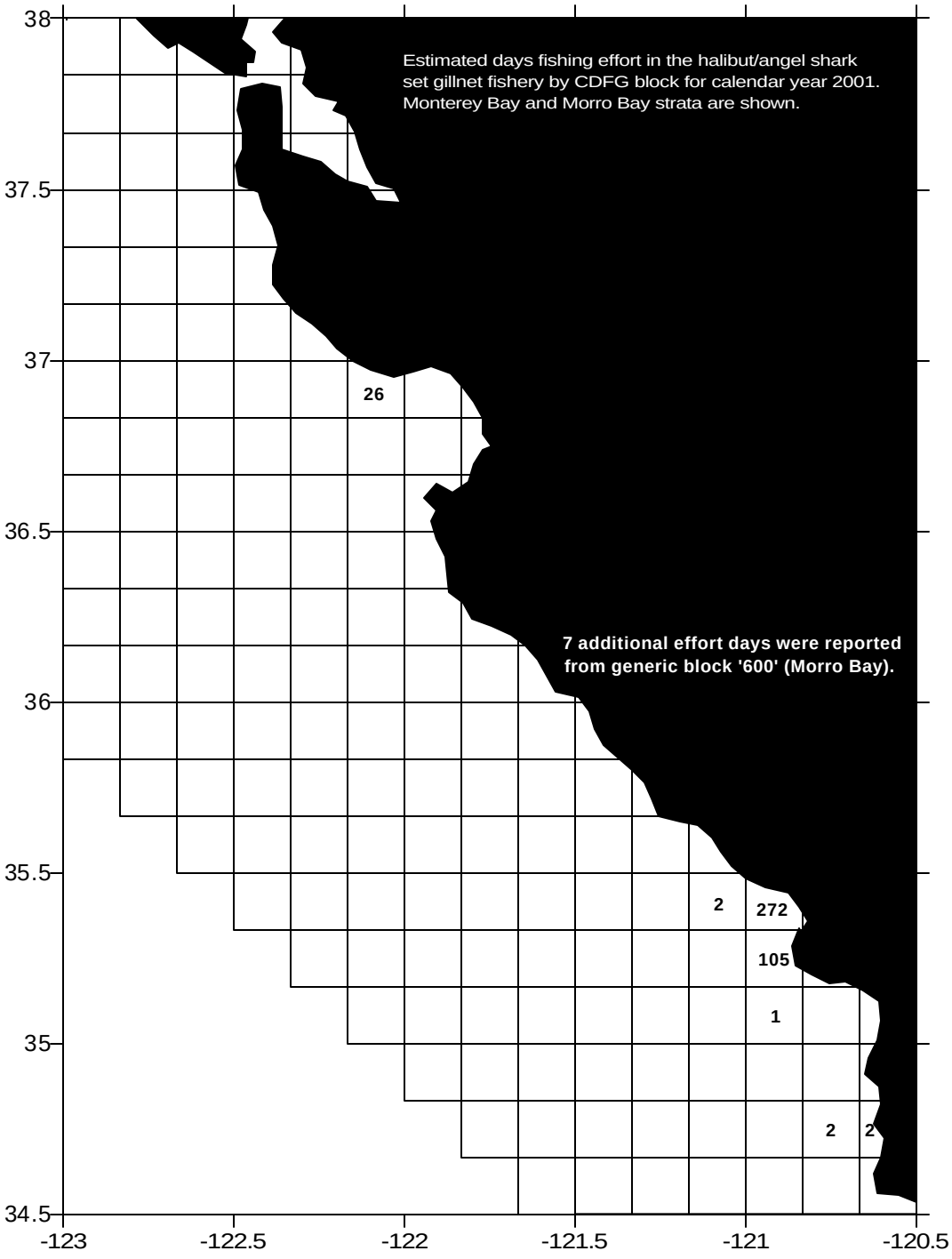

Figure 4. Calendar year 2001 locations of observed drift gillnet sets. A total of 339 sets out of an estimated 1,239 sets are shown (1 set was reported without a location).

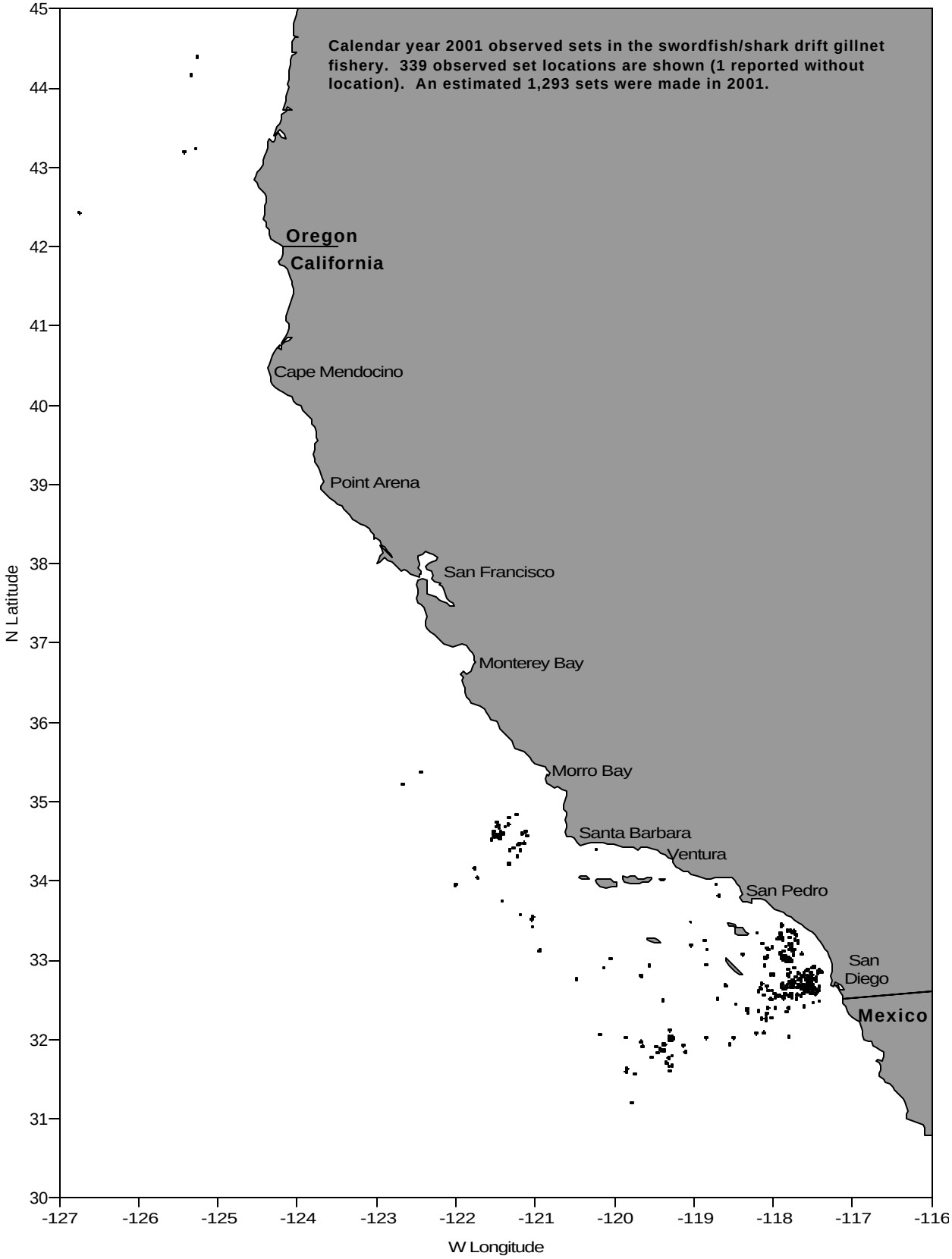

Figure 5. Locations of observed marine mammal mortalities in the drift gillnet fishery, 2001. Key: □ = *Delphinus delphis*; + = *Lissodelphis borealis*; ▽ = *Lagenorhynchus obliquidens*; ○ = *Zalophus californianus*; △ = *Mirounga angustirostris*.

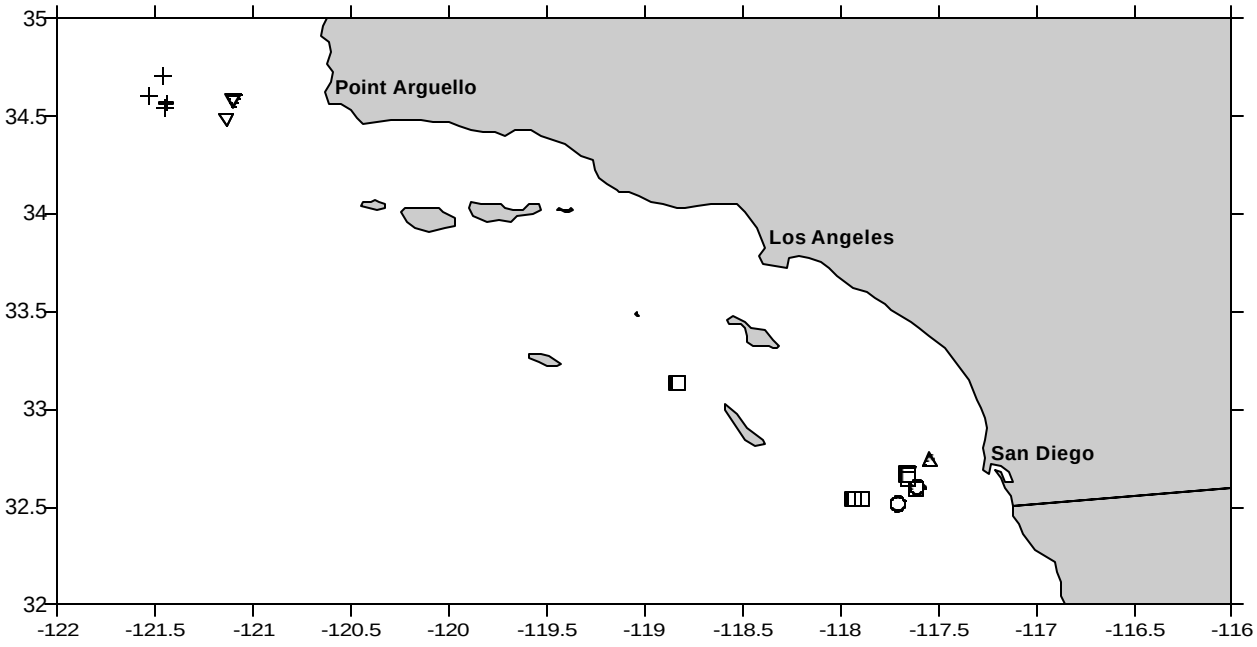

Figure 6a. Observed kill rates of short-beaked common dolphin (*Delphinus delphis*) and observer effort in the drift gillnet fishery, 1990-2001.

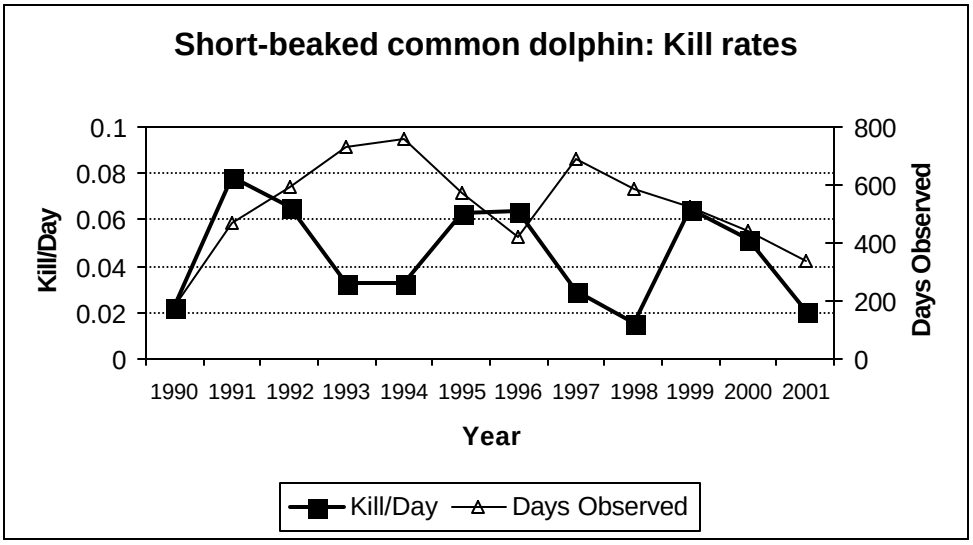

Figure 6b. Observed kill rates of northern right whale dolphin (*Lissodelphis borealis*) and observer effort in the drift gillnet fishery, 1990-2001.

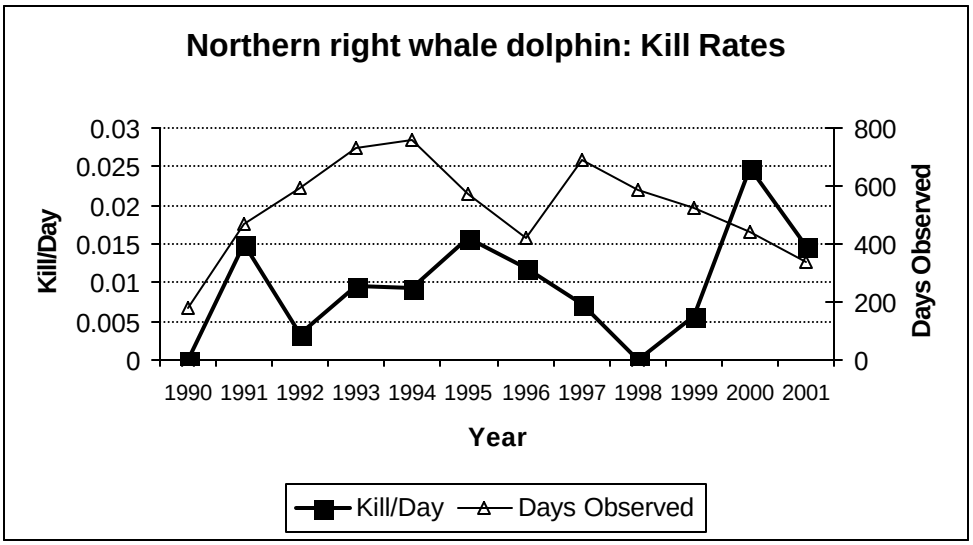

Figure 7. Area closure implemented in the drift gillnet fishery in 2001.