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Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000.

James V. Carretta
Southwest Fisheries Science Center
NOAA, U.S. National Marine Fisheries Service
P.O. Box 271, La Jolla, CA 92038 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 2000. Observed bycatch in each fishery is documented by NMFS biological technicians that accompany ~20-25% of all fishing trips. The set gillnet fishery was observed only in Monterey Bay in 2000 and has not been observed in other geographic strata (Morro Bay, Ventura, Channel Islands, Southern California) since 1994; therefore estimates of kill rates from other geographic strata are estimated from 1991-94 observer data and mortalities are estimated using 2000 fishing effort estimates. Estimated set gillnet mortality in the Monterey stratum is based on 27% observer coverage (67 days observed/249 estimated days fished). Estimated mortality and observed mortality (in parentheses) in the Monterey stratum included 26 (7) cetaceans, 214 (57) pinnipeds, and 3,149 (712) seabirds. In the unobserved portion of the set gillnet fishery, estimated mortality (based on 1991-94 kill rates) included 3 cetaceans, 1,628 pinnipeds, 9 sea turtles, and 110 seabirds. Estimated set gillnet mortality by species (CVs in parentheses) for all geographic strata combined was: 26 (0.51) harbor porpoise (*Phocoena phocoena*), 3 (0.71) unidentified common dolphin (*Delphinus* sp.), 1,346 (0.07) California sea lion (*Zalophus californianus*), 415 (0.08) harbor seal (*Phoca vitulina*), 48 (0.23) northern elephant seal (*Mirounga angustirostris*), 33 (0.34) unidentified pinnipeds, 2 (0.96) loggerhead turtles (*Caretta caretta*), 3 (0.71) green/black turtles (*Chelonia mydas/agassizi*), 2 (0.96) leatherback turtles (*Dermochelys coriacea*), 2 (0.96) unidentified sea turtles, 3,143 (0.11) common murre (*Uria aalge*), and 116 (0.22) Brandt's cormorant (*Phalacrocorax penicillatus*). In the drift gillnet fishery, observer coverage was 25% (444 days observed/1,766 estimated days fished). Estimated mortality and observed mortality (in parentheses) in the drift gillnet fishery included 143 (40) cetaceans, 79 (19) pinnipeds, and 13 (3) seabirds. Estimated drift gillnet mortality by species (CVs in parentheses) was: 75 (0.32) short-beaked common dolphin (*Delphinus delphis*), 9 (0.76) long-beaked common dolphin (*Delphinus capensis*), 7 (0.58) Risso's dolphin (*Grampus griseus*), 47 (0.51) northern right whale dolphin (*Lissodelphis borealis*), 5 (1.02) Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), 24 (0.41) northern elephant seal (*Mirounga angustirostris*), 50 (0.43) California sea lion (*Zalophus californianus*), and 13 (0.89) northern fulmar (*Fulmaris glacialis*).

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 dolphin (*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*). In April 2001, permanent regulations were proposed by the CDFG which would eliminate set gillnetting inshore of 110 m (60 fm) throughout central California.

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 1,766 days in 2000 (Forney et al. 2000; Read 2000a, 2000b, 2000c, 2001). 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.

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 2000 were 3,736 days, of which 195 days were estimated in the Monterey Bay stratum, the only area where the fishery was observed (Read 2000a, 2000b, 2000c, 2001). The remaining 3,541 days of effort were distributed as follows: Channel Islands (54 days), Southern California (1,969), Ventura (1,240) and Morro Bay (278). The NMFS observer program provided an independent effort estimate of 249 fishing days in the Monterey stratum, which was 28% higher than that provided by the CDFG (195 days). The NMFS effort estimate was therefore used in calculating kill rates for the Monterey stratum. Geographic strata for the set gillnet fishery are shown in Figure 1. Estimated 2000 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 2000 was 1,766 days, representing 85 fishing trips ranging from 1 to 12 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 2000, the set gillnet fishery was observed only in Monterey Bay and mortality estimates for this stratum are based on estimates of fishing effort and observer data in 2000. In the remaining 4 geographic strata (Morro Bay, Ventura, Channel Islands, and Southern California), 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 2000.

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

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

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

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*,

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

$\hat{\sigma}^2_{r,s}$ 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 (1-12 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, $\sigma^2_{m,q}$, for each species were calculated as

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

$$\sigma^2_{m,q} = D^2_q \sigma^2_{r,q} \qquad (6)$$

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

$\sigma^2_{r,q}$ 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 the first three calendar quarters, after which the CDFG issued emergency regulations that prohibited fishing in waters shallower than 110 m (60 fm). This area closure effectively eliminated set gillnets in Monterey Bay for the remainder of 2000. Observer coverage in the Monterey stratum was 27%, with 67 days (100 sets) observed out of 249 estimated days fished. The locations of all observed sets are shown in Figure 1. Observed cetacean mortalities in the Monterey stratum were limited to 7 harbor porpoise, which resulted in a mortality estimate of 26 (CV = 0.51) porpoise for this stratum. Of the seven porpoise mortalities observed, entanglements consisted of two pairs of animals and three individuals. Life history information for these specimens is presented in Chivers and Robertson (2001). Locations of the 7 harbor porpoise mortalities are shown in Figure 5. The observed kill rate of harbor porpoise in 2000 (0.104/day) was approximately 40% lower than the kill rate observed in 1999 (0.170 porpoise/day) (Cameron and Forney 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 25% for calendar year 2000, with 444 days (sets) observed out of an estimated 1,766 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 and Robertson (2001). As in previous years, the short-beaked common dolphin (*Delphinus delphis*) was the most frequently entangled species in the drift gillnet fishery, with 23 observed mortalities and a resulting mortality estimate of 75 animals (CV = 0.32). Multiple entanglements (2-4 animals in a set) accounted for 15 of the 23 short-beaked common dolphin mortalities. The second-most frequently entangled cetacean in the drift gillnet fishery was the northern right whale dolphin (*Lissodelphis borealis*), with 11 observed mortalities and a resulting mortality estimate of 47 animals (CV = 0.51). Multiple entanglements (2-4 animals in a set) accounted for 9 of the 11 observed northern right whale dolphin mortalities. One multi-species cetacean entanglement occurred during the first set of a five-set trip (DN-SD-0980) when a Risso's dolphin (*G. griseus*) became entangled in the same net as two northern right whale dolphin (*L. borealis*) off central California. This set carried a full complement of acoustic pingers (n = 40) and none of the remaining four sets on the trip resulted in marine mammal entanglements. A summary of observed and estimated mortalities for all marine mammal and seabird species observed taken in the drift gillnet fishery appears in Table 4. A comparison of drift gillnet mortality estimates from 1999 and 2000 is shown in Table 5.

DISCUSSION

Fishing effort in both the set and drift gillnet fisheries continues to decline in California. The set gillnet fishery in Monterey has been effectively shut down since September 2000 due to depth restrictions imposed by the CDFG. A proposed year-round ban on set gillnets inshore of 110 m (60 fms) from Pt. Reyes to Point Arguello, California will probably result in a significant decline in the incidental mortality of harbor porpoise in this region. 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 2000 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. 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 2000, 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 that it is the most abundant cetacean in California waters (Barlow 1995; Forney *et al*. 1995). The kill rate for 2000 (0.052/day) was comparable to rates observed in years before acoustic pingers became mandatory in the fishery (Figure 6a). Kill rates of short-beaked common dolphin were considerably higher during the first and fourth calendar quarters (20/23 mortalities occurred from November-January). Most kills occurred off southern California, where common dolphin may be more abundant in winter (Forney and Barlow 1998). Kill rates of northern right whale dolphin were at an all-time high in the drift gillnet fishery in 2000 (0.025/day, Figure 6b), although the estimated mortality (47) was lower than that estimated in 1991 (71), 1993 (52) and 1995 (58) when fishing effort was considerably higher (Julian and Beeson 1998). The high kill rate of northern right whale dolphin in 2000 may be due to an elevated local abundance of this species in response to prevailing cold La Niña oceanographic conditions.

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Table 1. Summary of 2000 fishing effort, observer coverage, and estimated mortality for the halibut/angel shark set gillnet fishery in Monterey Bay. Mortality estimates reflect quarterly stratification of data.

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
Est. Effort (NMFS)	110	54	85	0	249
Est. Effort (CDFG)	80	56	59	0	195
Days Observed	23	18	26	0	67
Fraction Coverage	0.21	0.33	0.31	0	0.27

	Obs Mort	Kill/Day	SE Kill/Day	Mort (M)	var M	CV Mort
California sea lion	28	0.41791	0.1881	109	1,173	0.31
Harbor seal	24	0.358209	0.1742	81	886	0.37
Elephant seal	4	0.059701	0.0597	19	78	0.46
Unid. pinniped	1	0.014925	0.015	5	23	0.96
Harbor Porpoise	7	0.104478	0.0807	26	167	0.50
Common Murre	711	10.61194	1.8674	3,141	117,934	0.11
Brandt's Cormorant	2	0.029851	0.0286	8	30	0.68

Table 2. Mortality estimates for the unobserved portion of the set gillnet fishery (non-Monterey strata: Southern California, Ventura, Channel Is., and Morro Bay). Kill rates are based on 1991-94 observer data from these strata and 2000 effort levels.

Species	Kill/Day	Var Kill Rate	Mortality	Var Mort	SE Mort	CV Mort
unidentified common dolphin	0.0009	3.8938E-07	3	50	2	0.71
California sea lion	0.3492	0.000624	1,237	7,821	88	0.07
Harbor seal	0.0944	0.000075	334	935	31	0.09
Northern elephant seal	0.0081	0.000003	29	42	7	0.23
Unidentified pinniped	0.008	0.000008	28	105	10	0.36
Loggerhead Turtle	0.0004	1.7472E-07	2	2	1	0.96
Green/Black Turtle	0.0009	3.8938E-07	3	5	2	0.71
Leatherback Turtle	0.0004	1.7472E-07	2	2	1	0.96
Unidentified Turtle	0.0004	1.7472E-07	2	2	1	0.96
Common Murre	0.0004	1.7472E-07	2	20	1	0.96
Brandt's Cormorant	0.0306	4.772E-05	108	598	24	0.23

Table 3. Total 2000 mortality estimates for the halibut/angel shark set gillnet fishery (all strata combined). 1999 mortality estimates from Cameron and Forney (2000) are shown for comparison. 2000 estimates are shown in bold.

Species	1999 Mort	**2000 Mort**	**Var Mort**	**SE Mort**	**CV Mort**
Harbor porpoise	133	**26**	**167**	**13**	**0.50**
Unid. Common dolphin*	NR	**3**	**5**	**2.21**	**0.71**
California sea lion	1,360	**1,346**	**8,993**	**95**	**0.07**
Harbor seal	662	**415**	**1,015**	**32**	**0.08**
N. elephant seal	76	**48**	**120**	**11**	**0.23**
Unid. pinniped	38	**33**	**128**	**11**	**0.34**
Loggerhead Turtle*	NR	**2**	**2**	**1.48**	**0.96**
Green/Black Turtle*	NR	**3**	**5**	**2.21**	**0.71**
Leatherback Turtle*	NR	**2**	**2**	**1.48**	**0.96**
Unidentified Turtle*	NR	**2**	**2**	**1.48**	**0.96**
Common Murre	2,359	**3,143**	**117,937**	**343**	**0.11**
Brandt's Cormorant	101	**116**	**628**	**25**	**0.22**

NR = not reported

* Species denoted with an asterisk were not observed taken in the set gillnet fishery in 2000. Current estimates of mortality are based on observed bycatch/kill rates from 1991-94 and 2000 fishing effort estimates.

Table 4. Estimates of 2000 fishing effort and mortality in the swordfish/thresher shark drift gillnet fishery. Standard errors (SE), variances (Var), and coefficients of variation (CV) were estimated from bootstrap methods. A Poisson CV is also calculated for comparison, based on the number of observed mortalities.

	1ST QTR	2ND QTR	3RD QTR	4TH QTR	TOTAL
Est. Days Fished (CDFG)	109	41	257	1,359	1,766
Days Observed	51	15	64	314	444
Trips Observed	10	3	13	59	85
Fraction Observer Coverage	0.47	0.37	0.25	0.23	0.25
Observed Mortality					
Short-beaked common dolphin	11	0	0	12	23
Long-beaked common dolphin	0	0	0	2	2
Risso's dolphin	0	1	1	0	2
Northern right whale dolphin	0	0	2	9	11
Pacific white-sided dolphin	1	1	0	0	2
California sea lion	2	1	1	9	13
Northern elephant seal	1	0	0	5	6
Northern fulmar	0	0	0	3	3
All Cetaceans	12	2	3	23	40
All Pinnipeds	3	1	1	14	19
All Seabirds	0	0	0	3	3

			Bootstrap			Bootstrap			
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	11	0.2157	0.084522	0.007144	24	312	18	0.751	0.302
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	12	0.0382	0.012037	0.000145	52	268	16	0.315	0.289
Year (unstratified)	23	0.0518	0.014060	0.000198	91	617	25	0.271	0.209
Year (stratified by quarter)	23	0.0518	0.018221	0.000332	75	580	24	0.319	0.209

			Bootstrap			Bootstrap			
Long-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	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	0.0064	0.004861	0.000024	9	44	7	0.763	0.707
Year (unstratified)	2	0.0045	0.002827	0.000008	8	25	5	0.628	0.707
Year (stratified by quarter)	2	0.0045	0.003438	0.000012	9	44	7	0.763	0.707

			Bootstrap			Bootstrap			
Risso's 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	0.000	0.000
Apr - Jun	1	0.0667	0.042481	0.001805	3	3	2	0.637	1.000
Jul - Sep	1	0.0156	0.013735	0.000189	4	12	4	0.879	1.000
Oct - Dec	0	0.0000	0.000000	0.000000	0	0	0	0.000	0.000
Year (unstratified)	2	0.0045	0.002970	0.000009	8	28	5	0.659	0.707
Year (stratified by quarter)	2	0.0045	0.003415	0.000012	7	15	4	0.583	0.707

Table 4. (continued).

Northern right whale dolphin	Obs. Mort.	Kill Rate/Day	Bootstrap SE Kill Rate	Bootstrap Var Kill Rate	Est. Mort.	Bootstrap Var Mort	Bootstrap SE Mort	Bootstrap 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	2	0.0313	0.031156	0.000971	8	64	8	0.997	0.707
Oct - Dec	9	0.0287	0.016634	0.000277	39	511	23	0.580	0.333
Year (unstratified)	11	0.0248	0.011425	0.000131	44	407	20	0.461	0.302
Year (stratified by quarter)	11	0.0248	0.016255	0.000264	47	575	24	0.510	0.302

Pacific white-sided dolphin	Obs. Mort.	Kill Rate/Day	Bootstrap SE Kill Rate	Bootstrap Var Kill Rate	Est. Mort.	Bootstrap Var Mort	Bootstrap SE Mort	Bootstrap CV Mort	Poisson CV
Jan - Mar	1	0.0196	0.021963	0.000482	2	21	5	2.148	1.000
Apr - Jun	1	0.0667	0.047347	0.002242	3	4	2	0.710	1.000
Jul - Sep	0	0.0000	0.000000	0.000000	0	0	0	-	-
Oct - Dec	0	0.0000	0.000000	0.000000	0	0	0	-	-
Year (unstratified)	2	0.0045	0.003075	0.000009	8	29	5	0.683	0.707
Year (stratified by quarter)	2	0.0045	0.004122	0.000017	5	25	5	1.023	0.707

Northern elephant seal	Obs. Mort.	Kill Rate/Day	Bootstrap SE Kill Rate	Bootstrap Var Kill Rate	Est. Mort.	Bootstrap Var Mort	Bootstrap SE Mort	Bootstrap CV Mort	Poisson CV
Jan - Mar	1	0.0196	0.016970	0.000288	2	13	4	1.659	1.000
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	0.0159	0.006642	0.000044	22	81	9	0.417	0.447
Year (unstratified)	6	0.0135	0.005204	0.000027	24	84	9	0.385	0.408
Year (stratified by quarter)	6	0.0135	0.006647	0.000044	24	94	10	0.408	0.408

California sea lion	Obs. Mort.	Kill Rate/Day	Bootstrap SE Kill Rate	Bootstrap Var Kill Rate	Est. Mort.	Bootstrap Var Mort	Bootstrap SE Mort	Bootstrap CV Mort	Poisson CV
Jan - Mar	2	0.0392	0.025683	0.000660	4	29	5	1.256	0.707
Apr - Jun	1	0.0667	0.045237	0.002046	3	3	2	0.679	1.000
Jul - Sep	1	0.0156	0.013560	0.000184	4	12	3	0.868	1.000
Oct - Dec	9	0.0287	0.015046	0.000226	39	418	20	0.525	0.333
Year (unstratified)	13	0.0293	0.011109	0.000123	52	385	20	0.379	0.277
Year (stratified by quarter)	13	0.0293	0.017074	0.000292	50	462	22	0.430	0.277

Northern fulmar	Obs. Mort.	Kill Rate/Day	Bootstrap SE Kill Rate	Bootstrap Var Kill Rate	Est. Mort.	Bootstrap Var Mort	Bootstrap SE Mort	Bootstrap CV Mort	Poisson CV
Jan - Mar	0	0.0000	0.025683	0.000660	0	29	5	-	-
Apr - Jun	0	0.0000	0.045237	0.002046	0	3	2	-	-
Jul - Sep	0	0.0000	0.013560	0.000184	0	12	3	-	-
Oct - Dec	3	0.0096	0.006932	0.000048	13	89	9	0.726	0.577
Year (unstratified)	3	0.0068	0.004767	0.000023	12	71	8	0.706	0.577
Year (stratified by quarter)	3	0.0068	0.011335	0.000128	13	133	12	0.889	0.577

Table 5. Summary of estimated mortality in the drift gillnet fishery by species for 1999 and 2000. 1999 mortality estimates are from Cameron and Forney (2000). 2000 estimates are shown in bold.

Swordfish/shark drift gillnet fishery	1999	**2000**
CDFG Est. Days Fished	2,634	**1,766**
NMFS Days Observed	526	**444**
Fraction Observer Coverage	0.20	**0.25**
	1999 Mort. (CV)	**2000 Mort. (CV)**
Short-beaked common dolphin	191 (0.28)	**75 (0.32)**
Long-beaked common dolphin	8 (0.93)	**9 (0.76)**
Unidentified common dolphin	2 (-)	**0**
Risso's dolphin	0	**7 (0.58)**
Northern right whale dolphin	17 (0.66)	**47 (0.51)**
Pacific white-sided dolphin	0	**5 (1.02)**
Gray Whale	5 (0.90)	**0**
Fin Whale	5 (0.90)	**0**
Northern elephant seal	10 (0.61)	**26 (0.41)**
California sea lion	30 (0.36)	**54 (0.43)**
Green/Black Turtle	5 (0.90)	**0**
Northern Fulmar	0	**13 (0.89)**

Figure 1. Geographic strata used in the analysis of the halibut/angel shark set gillnet fishery. Also shown are the locations of 100 observed set gillnet sets in the Monterey Bay stratum in 2000.

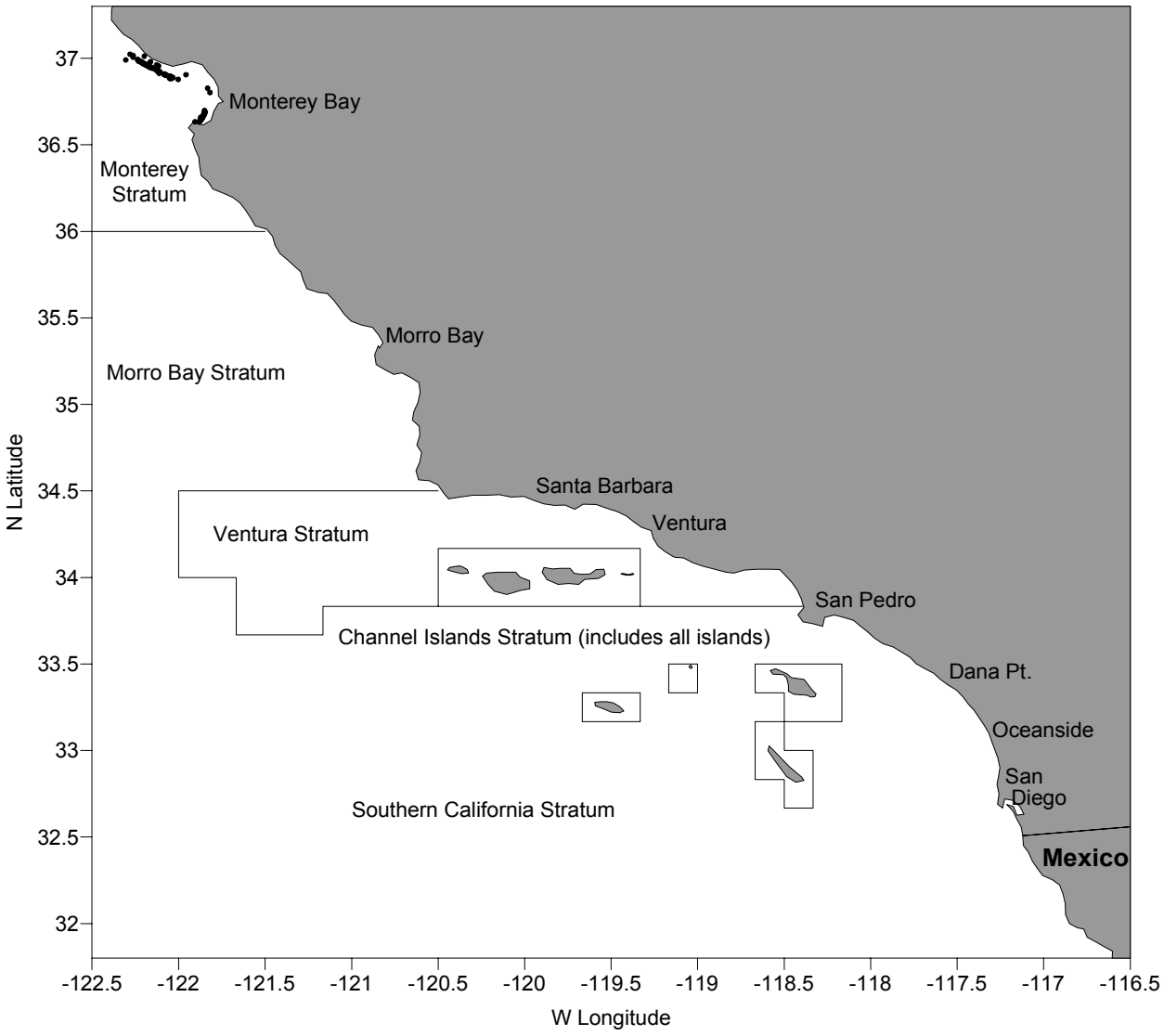

Figure 2. Estimated number of days of set gillnet fishing effort by CDFG block in southern California for calendar year 2000.

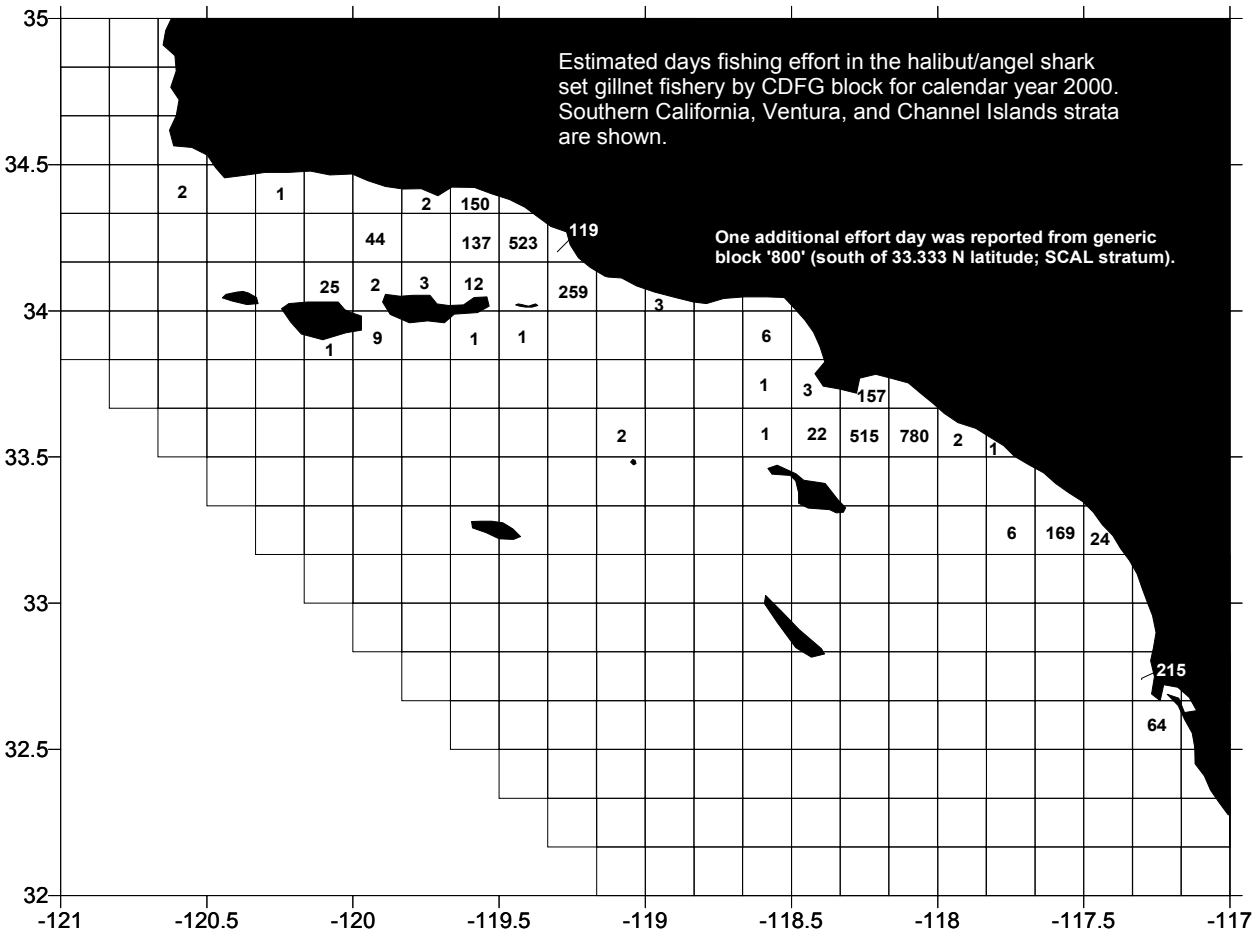

Figure 3. Estimated number of days of set gillnet fishing effort by CDFG block in central California for calendar year 2000. Monterey and Morro Bay strata are shown.

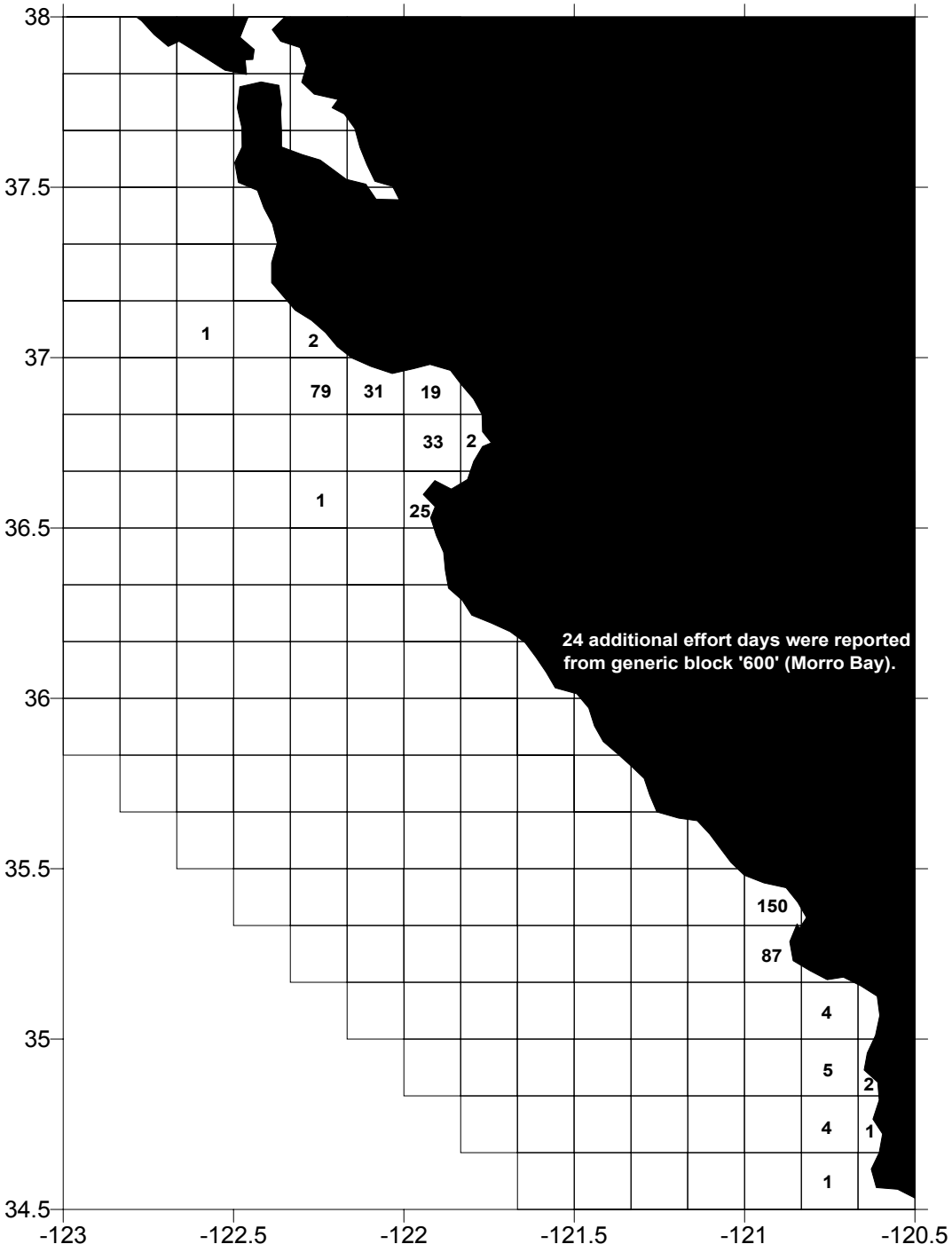

Figure 4. Calendar year 2000 locations of observed drift gillnet sets. A total of 442 sets out of an estimated 1,766 sets are shown (2 additional sets were reported without location).

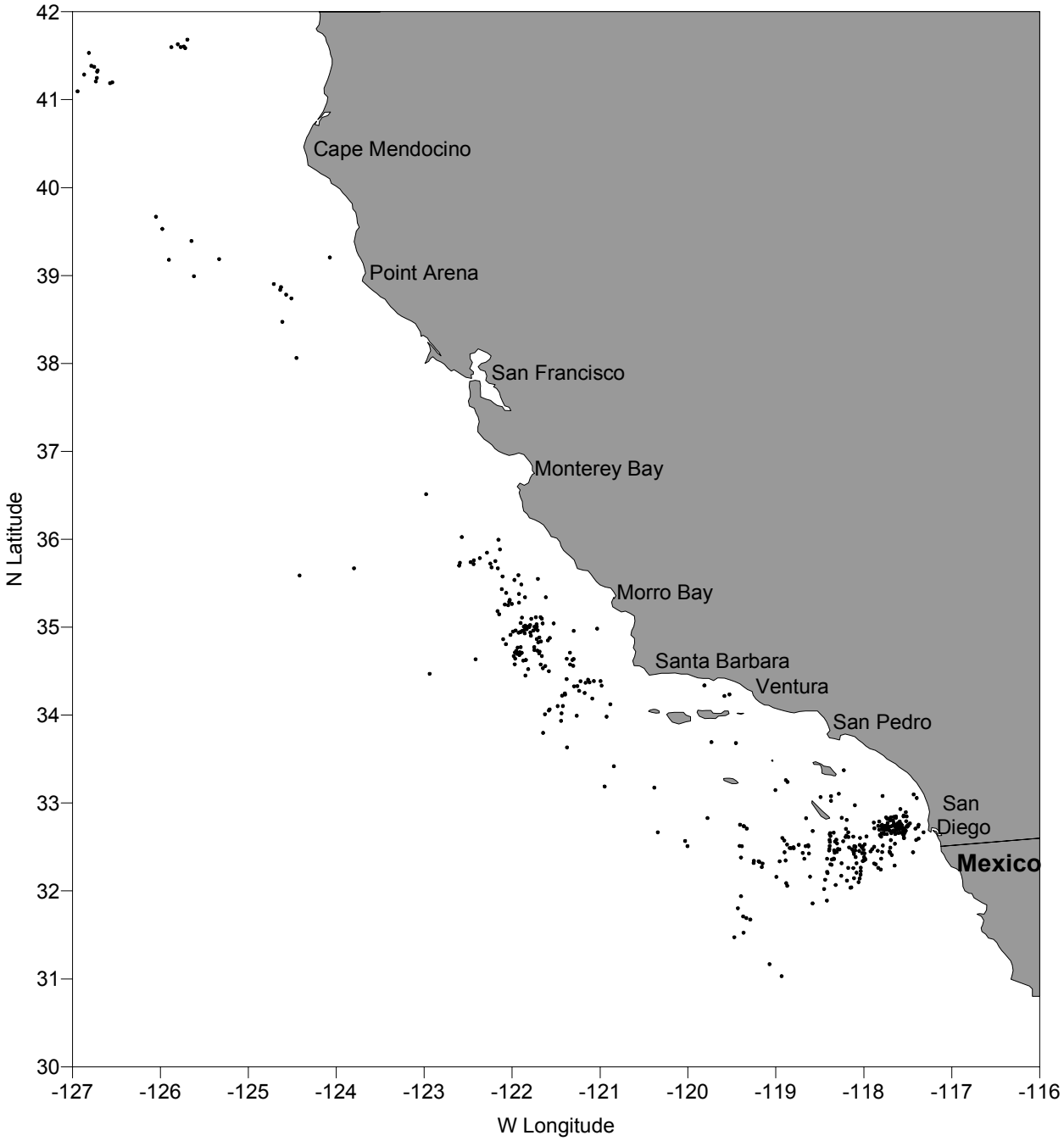

Figure 5. Locations of observed cetacean mortalities in the set gillnet and drift gillnet fisheries, 2000. Key: □ = *Delphinus capensis*; + = *D. delphis*; ▽ = *Grampus griseus*; △ = *Lagenorhynchus obliquidens*; ○ = *Lissodelphis borealis*; ◇ = *Phocoena phocoena*. Harbor porpoise (*P. phocoena*) were only observed entangled in the Monterey Bay set gillnet fishery, all other species were observed in the drift gillnet fishery. The northernmost (~35.8N) entanglement of Risso's dolphin (*G. griseus*) occurred in a driftnet set where 2 northern right whale dolphin (*L. borealis*) were also entangled.

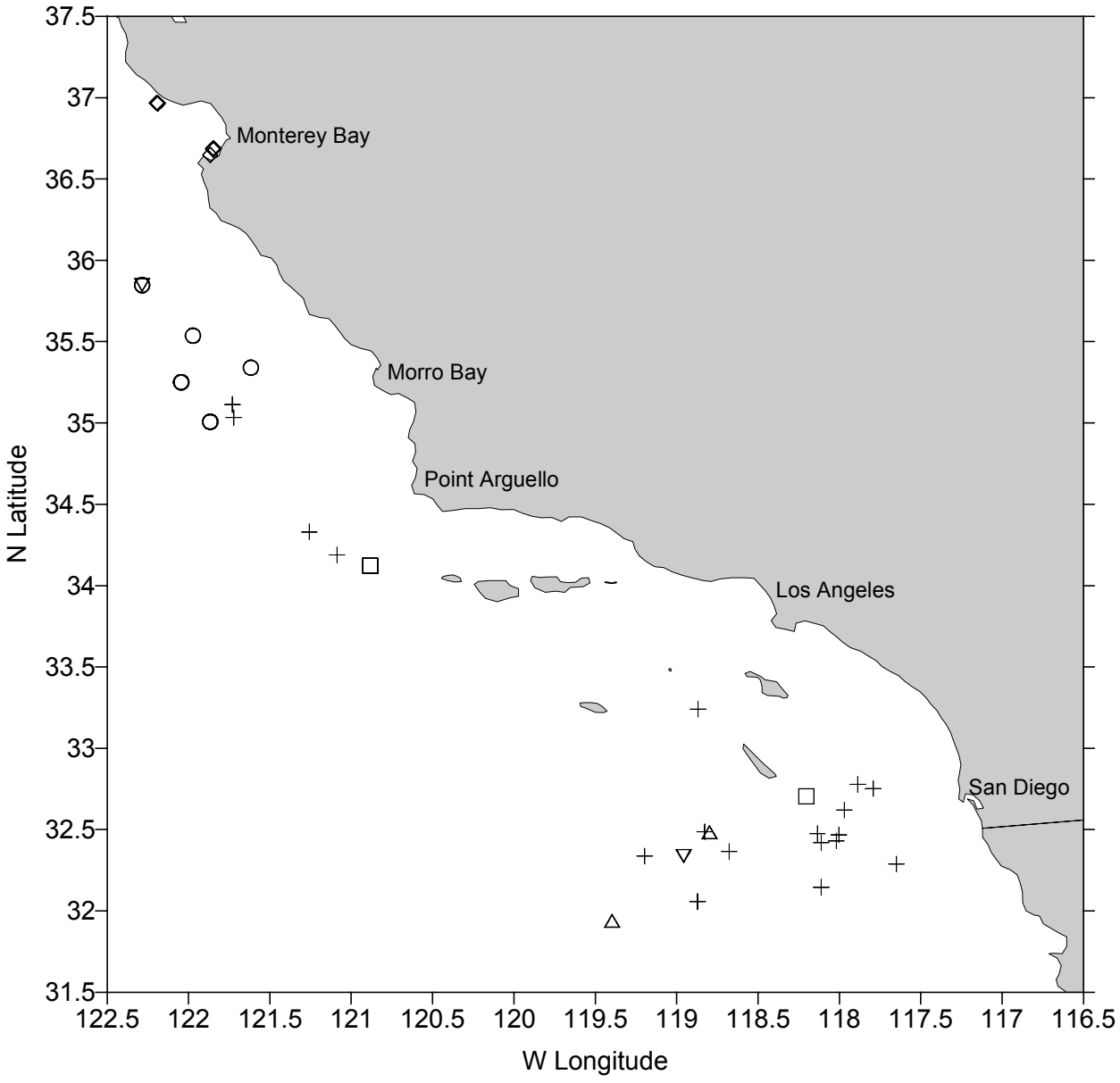

Figure 6a. Observed kill rates of short-beaked common dolphin (*Delphinus delphis*) and observer effort in the drift gillnet fishery, 1990-2000.

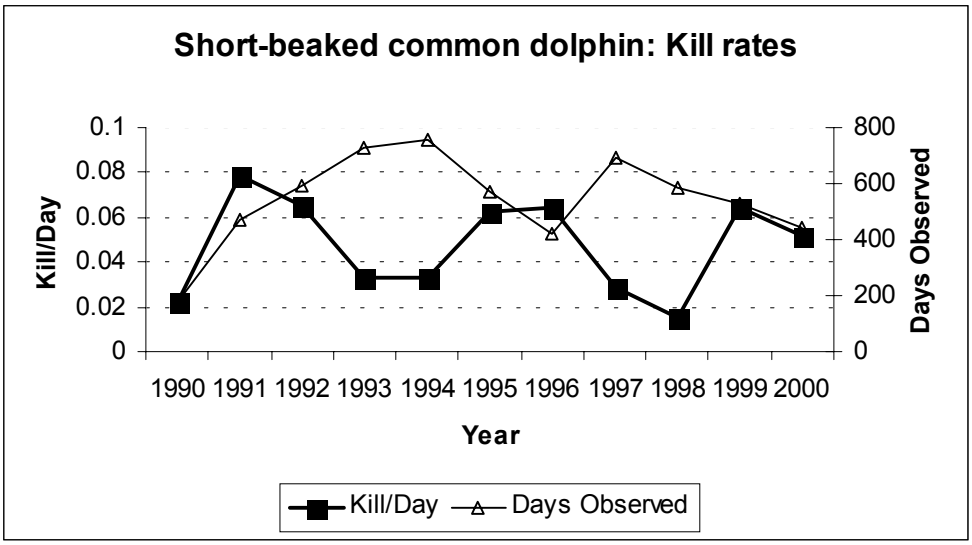

Figure 6b. Observed kill rates of northern right whale dolphin (*Lissodelphis borealis*) and observer effort in the drift gillnet fishery, 1990-2000.