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REPORT ON PINNIPED AND CETACEAN MORTALITY IN CALIFORNIA GILLNET FISHERIES: 1988-1990

By

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ADMINISTRATIVE REPORT LJ-94-11

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Abstract.

The number of marine mammals that were killed in California gillnet fisheries is estimated for the time period April 1988 to December 1990. During most of this period, there was no on-board observation of marine mammal mortality for any of three major gillnet fisheries in California (set-net fisheries for halibut and angel shark and a drift-net fishery for shark and swordfish). Mortality rates are assumed to be the same as those estimated from the July 1990-June 1991 observation program. These rates are not statistically different from rates estimated from the April 1987-March 1988 observation program that preceded the period covered by this report. Total mortality of all species was estimated by multiplying the estimated mortality rate per fishing day by the estimated number of days of fishing effort. Standard errors in estimates of total mortality are based on the estimated variance in kill rates only and, thus, assume that fishing effort is known without error. The total number of pinnipeds estimated to have been killed during this time period is 12,473 (s.e. = 959). The estimate of the total number of cetaceans killed is 2,706 (s.e. = 377).

1. Introduction.

During the late 1970's and early 1980's, there was a rapid expansion in the use of entangling nets (drift gillnet, set gillnet, multi-panel and trammel nets) in coastal California waters (Herrick and Hanan, 1988). The incidental kill of many non-target species, including marine mammals, with these nets in some fisheries has become a focus of concern for state, national, and international environmental and legislative bodies.

This report examines pinniped and cetacean mortality during the period April 1988 to December 1990 for three fisheries: set-net fisheries for California halibut and Pacific angel shark, and a shark/swordfish drift-net fishery. Specifically, we estimate the total pinniped and cetacean mortality due to the combined set-net fisheries and to the drift-net fishery from April 1988 to December 1990. Because there was no consistent gillnet observer

program for these fisheries during most of that period, mortality is estimated using kill rate estimates for the same fisheries from a later time period (see Perkins, Barlow, and Beeson, 1992). For a detailed description of the fisheries and a discussion of their relation to the Marine Mammal Protection Act (MMPA), see Barlow et. al. (In Press), Lennert, Kruse, and Beeson (1991), and Herrick and Hanan (1988).

2. Kill Rates.

Data.

This report covers the period April 1988 to December 1990. The California Department of Fish and Game (CDFG) operated a gillnet observer program up until the end of the 1987-1988 fishing year (March 1988), when cooperation from fishers had decreased to the point where observers were denied permission to board vessels and the on-board observer program was terminated. The CDFG continued to make observations from CDFG vessels and from land using telescopes, but these data are too limited geographically and too few in number to be used for estimating mortality rates. In 1988, collection of statistically reliable data on the status of marine mammal stocks and total incidental mortality was congressionally mandated (U.S. Federal Register, 1989). Beginning in 1990, operators in fisheries associated with frequent take of marine mammals were required to take National Marine Fisheries Service (NMFS) observers on board and allow them to collect information on the number and species of marine mammals taken.

Two previous reports, Konno (1990) and Perkins et al. (1992), examined pinniped and cetacean mortality for the fisheries covered by this report. Konno analyzed CDFG observer data collected just prior to the time period covered by this report, whereas Perkins et al. analyzed NMFS data collected towards the end of, and immediately following, the period covered by this report. In the absence of any observer data for most of the interim period, we assume the kill rates estimated by Perkins et al. to be representative for the entire period covered by this report. As a partial check on this assumption, we compare kill rates from Perkins et al. to kill rates from Konno. We did not pool the two sets of kill rate estimates for reasons explained in the discussion.

Konno (1990) examined mortality for California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), and harbor porpoise (*Phocoena phocoena*) during the 1987-1988 fishing year (April 1987 to March 1988). The data were collected by CDFG observers either aboard fishing vessels, along side in research vessels, or on shore using telescopes. After an analysis of contagion factors, i.e. mortality rate differences between skippers (Diamond and Hanan, 1986), and because few complete days of fishing effort could be observed for any one boat, the sampling unit was taken to be a net pull, and the kill rates were estimated as kill per net pull. The total fishing effort was estimated in boat-days, then converted to total net pulls using a conversion factor estimated from CDFG log book data, as well as observer logs and reports. As discussed by Konno, the 1987-1988 estimates include kill rates only for sea lion, harbor seal, and harbor porpoise, and the estimated kill rates for the drift-net fishery were actually based on observations made during the 1986-1987 fishing year.

Perkins et al. (1992) examined mortality for a number of pinniped and cetacean species during the period July 1990 to June 1991. The species actually observed included those considered by Konno as well as northern elephant seal (*Mirounga angustirostris*) and seven cetaceans observed in the drift-net fishery: mesoplodont beaked whale (*Mesoplodon* spp.), common dolphin (*Delphinus delphus*), northern right whale dolphin (*Lissodelphis borealis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Risso's dolphin (*Grampus griseus*), Dall's porpoise (*Phocoenoides dalli*), and short-finned pilot whale (*Globicephala macrorhynchus*). The data were collected primarily by NMFS observers aboard commercial gillnet fishing boats. The observers recorded data on position, environment, gear, catch, and bycatch (including marine mammal entanglements) for each net pull observed. For a detailed description of the sampling methods used, see Lennert et al. (1991). The kill rates estimated by Perkins et al. were in units of kill per day, and so no conversion was needed for total effort. As discussed in that report, the 1990-1991 observations included mortalities for several unidentified sea lions and unidentified pinnipeds, as well as several pinnipeds released alive. For the purposes of comparing kill rates, we assumed all sea lions are California sea lions, and did not include in the kill rates any unidentified individuals or individuals released alive. However, both the unidentified mortalities and the individuals released alive were used to calculate a worst-case estimate for total mortality (see Table 6).

Methods.

As in Perkins et al. (1992), based on marine mammal distributions and the fisheries themselves, we used 3 area strata for the set-net fisheries: southern California mainland, Channel Islands, and central California. Central California includes all effort north of Point Conception and south of Pt. Reyes (CDFG blocks 100-650). No coastal set-net fishing is allowed north of Pt. Reyes in California. Channel Islands include all effort within CDFG blocks containing any part of the Channel Islands (CDFG blocks 684-690, 707-713, 760-762, 765, 806-807, 813-814, 829, 849-850, and 867). Southern California includes all effort south of Point Conception (blocks 651 and higher), excluding the Channel Islands. We did not stratify by area for the drift-net fishery.

Because Konno (1990) estimated kill rates in units of kill per net pull, and Perkins et al. (1992) estimated them in kill per day, the two sets of estimates are not directly comparable for the set-net fisheries. Rather than converting one or the other using an estimate of net pulls per day, we used the raw NMFS observer data to estimate kill per net pull directly for the 1990-1991 period. For the drift-net fishery, there is exactly one net pull per fishing day, so the two sets of kill rate estimates are comparable.

Several other points should be made about differences between the two sets of kill rates and their variances. First, the species considered by Konno (1990) were California sea lion, harbor seal and harbor porpoise. Perkins et al. (1992) included estimates for those species as well as northern elephant seal and seven cetacean species observed in the drift-net fishery. Second, the variances computed by Konno were bootstrap estimates, and the exact procedure used to generate them was not detailed. Perkins et al. computed analytic variance estimates, although they note that bootstrapping produced similar results. Third, in some cases, Konno used smaller area strata than those considered in this paper, as well

as stratifying by variables such as soak time or month. The strata used in this paper, and in Perkins et al., correspond in those cases to the "pooled" strata defined in Konno's analysis. However, there are kill rate estimates but no variance estimates given for those pooled strata, e.g. variances are given for each of the six southern California soak time/month strata, but not for the area as a whole. To obtain variance estimates for the strata used in this paper, we took a weighted average of the substratum variances, weighting by the square of the observed effort in each substratum.

To estimate kill per net pull for the set-net fisheries from the 1990-1991 NMFS observer data, we used a ratio estimator rather than a mean per unit estimator (MPUE). In these fisheries, boats make trips of one to several days each, and make up to several net pulls per day. Sampling consisted of first selecting a boat, then observing all net pulls made during a single trip. Thus, the observed net pulls are clustered by trips, rather than being a random sample, and a MPUE estimator based on net pulls is not appropriate. All but two of the observed trips were a single day, and so we treated days as a random sample and estimated the mortality rate using a ratio estimator, with days as the sampling unit, and net pulls per day as the auxiliary variable. In each area stratum, the ratio estimate of kill per net pull, $\hat{r}$, and its variance, are (see Cochran, 1977):

$$\hat{r} = (\Sigma k_i) / (\Sigma n_i)$$

$$\hat{\sigma}_r^2 = \frac{D-d}{dD} (\hat{r}^2 \hat{\sigma}_n^2 + \hat{\sigma}_k^2 - 2\hat{\sigma}_{nk}^2) / n_{avg}^2$$

where, for each area, k_i and n_i are the observed kill and number of net pulls for the i^{th} day, n_{avg} is the mean number of net pulls per day, $\hat{\sigma}_n^2$, $\hat{\sigma}_k^2$, and $\hat{\sigma}_{nk}^2$ are the sampling variances and covariance of n_i and k_i, n and d are the observed number of net pulls and days, and D is the total number of days of effort.

The kill rate estimates are asymptotically normal, and so to compare the 1990-1991 estimates to those for 1987-1988, we used a test for the difference of normal means with unequal variances. Because the degrees of freedom in estimating the variances is large in both the 1990-1991 and the 1987-1988 data, we used a normal test rather than the standard t-test:

$$p = 2\left[1 - \Phi\left(\frac{|\hat{r}_{90-91} - \hat{r}_{87-88}|}{\sqrt{\hat{\sigma}_{90-91}^2 + \hat{\sigma}_{88-89}^2}}\right)\right]$$

where p is the significance (p-value) of the z-test, and $\Phi(\cdot)$ is the normal cumulative probability function.

Results.

Tables 1 and 2 summarize the estimates of kill rates and variances from both the 1987-1988 and the 1990-1991 data, for both the set-net fisheries (by area) and the drift-net fishery. Table 3 lists the p-values for the comparison of means tests. Because the 1987-

1988 report only considered three species, a limited number of tests were possible. Both reports assumed no harbor porpoise mortality outside of the central California area.

Of the nine possible difference of means tests, only the test for harbor seal in the southern California area was significant at the 5% level. There is no particular a priori reason why the kill rate would change over time for this species in this area (and not for the other areas/species). This significance result may be simply be due to random chance, i.e. type II error. The comparison for California sea lion in the Channel Islands had a small p-value of .082, however, it should be noted that the 1990-1991 kill rates for the Channel Islands are based on a total of only 24 observed net pulls (corresponding to 10 days observed out of an estimated total of 487 days of effort).

3. Total Fishing Effort.

Data and Methods.

In order to extrapolate from observed marine mammal kill to total kill, the total fishing effort must be estimated. The California Department of Fish and Game (CDFG) provides NMFS with quarterly and yearly (1 April through 31 March) estimates of fishing effort for both the halibut and angel shark set-net fisheries and the shark/swordfish drift-net fishery. The unit of effort reported is one day of fishing for a single boat for a single target fishery. For the drift-net fishery, one day of effort is equivalent to a single net pull, in contrast to the set-net fisheries, where one day of effort may represent several net pulls. The primary source of data for the effort estimates are daily fishing logs of commercial gillnet fishers. In addition, landing receipts of fish sales are used to account for unlogged effort. NMFS observer data are also used to verify logbook entries and landing receipts when possible. For a detailed description of the methods used to estimate total effort, see Beeson and Hanan (1991).

For the purposes of estimating total marine mammal kill, we treated the total effort estimates as known, even though they include at least three sources of uncertainty. First, much of the logbook data are reported by the fishers well after the fact, and it is not clear how accurate they are, both in terms of number of days and location. Second, a single landing receipt may represent more than the assumed one day of effort. Because all but 2 observed set-net trips were a single day (due to observer safety considerations), we have no way of estimating the average set-net trip length and therefore cannot check the assumption of one day per landing receipt. Finally, the location for a significant portion (40% for 1988-1989, 11% for 1989-1990, and 20% for 1990-1991) of the estimated set-net effort was specified only very grossly (i.e., assigned to a large group of blocks, but not to any one specific block) or not at all. Although this lack of positional information does not affect the total effort estimate, it introduces uncertainty for the purposes of stratification by area. We did stratify by area for the set-net fisheries mortality estimate, and so the poorly- or unspecified days of effort were apportioned to the 3 area strata considered, according to the reported percentages of the fully specified effort.

This report covers a total of 33 months. Previous reports have been organized by fishing permit year (April to March), and future NMFS reports will be organized by calendar year. However, to match available CDFG yearly effort estimates as closely as possible, this report estimates mortality for three periods: April 1988-March 1989 (CDFG fishing permit year 1988/89), April-December 1989, and calendar year 1990. We used the CDFG January-March quarterly effort estimates for both 1990 and 1991 along with the 1990/1991 yearly estimates to estimate total effort for the 1990 calendar year. Because the quarterly estimates are preliminary data only (and no final quarterly estimates were available), this may have introduced more inaccuracy into the effort estimates.

Results.

We estimated the total days of effort for the combined set-net fisheries at 7849, 5044, and 7123 days for the 1988-1989, 1989, and 1990 periods, respectively. We estimated the total days of effort for the drift-net fishery at 6139, 5904, and 5189 days for the same three periods. Table 4 summarizes the total effort estimates for these fisheries, as well as the effort estimate in each area for the combined set-net fisheries.

4. Total Mortality Estimates.

Data and Methods.

To estimate total mortality, we used the effort estimates from the previous section, and the kill per day estimates from Perkins et al. (1992). Table 5 summarizes these estimated kill rates for the drift-net fishery and for each area in the set-net fisheries.

This report includes estimates of mortality due to the set-net fisheries for four species: California sea lion, harbor seal, northern elephant seal, and harbor porpoise. For each species, we estimated the total set-net mortality, $\hat{m}$, and its variance as:

$$\hat{m} = \Sigma D_a \hat{r}_a$$

$$\hat{\sigma}^2_m = \Sigma D_a^2 \hat{\sigma}^2_{r,a}$$

where, for each area stratum, $\hat{r}_a$ and $\hat{\sigma}^2_{r,a}$ are the estimated set-net kill per day and its variance (from Perkins et al., 1992), and D_a is the total number of days of effort.

For mortality due to the drift-net fishery, we provide estimates for all the species (three pinniped and seven cetacean) for which kill was actually observed in the 1990-1991 observer data. For each species, we estimated the total drift-net mortality, $\hat{m}$, and its variance as:

$$\hat{m} = D\hat{r}$$

$$\hat{\sigma}^2_m = D^2\hat{\sigma}^2$$

where $\hat{r}$ and $\hat{\sigma}_r^2$ are the estimated drift-net kill per day and its variance (from Perkins et al., 1992), and D is the total number of days of effort.

Results.

Tables 6, 7, and 8 summarize the estimated total kill due to the set-net and drift-net fisheries, as well as the estimated set-net kill in each area, for each of the three periods covered by this report. For the drift-net fishery, we include all the species (three pinniped and seven cetacean) for which kill was actually observed in the 1990-1991 observer data. However, as discussed in Perkins et al. (1992), kill for other species present in the fishing areas may have occurred without being observed, due to random chance or to a sampling bias in observations. In particular, total kill for those species should not necessarily be assumed to be zero.

5. Discussion.

This report is based on kill rates estimated by Perkins et al. (1992), and any biases present in those kill rates will also be present in these mortality estimates. Because of low sampling levels, possible nonrandom sampling, and possible incorrect stratification, the kill rates used probably do include unknown biases. For a detailed discussion of these problems, see Lennert et al. (1991) and Perkins et al (1992). Because all of the mortality estimates in Tables 6, 7, and 8 are based on the same mortality rates, they are correlated from year to year.

In addition, the kill rates used are based on 1990-1991 observations, and so may not be representative of the period covered by this report. Although kill rates were also estimated by Konno (1990), based on CDFG observations from 1987-1988, we did not pool the two sets of estimates because Konno's estimates were in units of kill per net pull. To be used in estimating total mortality, they would have to be converted to kill per day, for which we did not have an acceptable conversion factor. We did compare the two sets of kill rates (in terms of kill per net pull), however, the estimated variances for the earlier estimates are quite high, with coefficients of variation ranging from 30% to 100%. The fact that most of the kill rates were not significantly different during the two periods may just reflect the small sample sizes available to Konno. It may have been possible to increase the power of the tests by pooling Konno's 1987-1988 kill rate estimates with similar estimates from previous years (Diamond and Hanan, 1986, Hanan et al., 1986, 1987, 1988, and Hanan and Diamond, 1989), but we did not pursue this.

Finally, we have assumed that the total effort used to estimate total mortality is known exactly. This is clearly not the case, and the estimated variances for total mortality are almost certainly underestimated due to the uncertainty in the total effort. More analysis needs to be done to estimate the variances and examine the biases of the effort estimates.

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TABLE 1. Estimated kill rates for California gillnet fisheries during the 1987-1988 fishing year (April '87 through March '88), stratified by fishery, area, and species. Estimates are in units of kill per net pull (KPNP), with estimated standard errors included in parentheses. These rates are based on Konno (1990). Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. No other species were considered by Konno. Both kill rates and standard errors are reported to three decimal places, as in Konno.

	Drift-Net Fishery	Set-Net Fishery		
		Southern CA	Channel Is.	Central CA
California Sea Lion	.018 (.013)	.070 (.068)	.177 (.074)	.248 (.147)
Harbor Seal	.009 (.009)	.006 (.006)	.061 (.023)	.229 (.080)
Harbor Porpoise	-	-	-	.024 (.006)

TABLE 2. Estimated kill rates for California gillnet fisheries from July 1990 through June 1991, stratified by fishery, area, and species. Estimates here are in units of kill per net pull (KPNP), with estimated standard errors included in parentheses. These rates are based on Perkins et al. (1992). They estimated kill rates both including and excluding observations of animals released alive from the nets and pinnipeds that were not identified. Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. Kill for all other cetaceans was assumed zero in the set-net fisheries. Both kill rates and standard errors are reported to three significant digits, as in Perkins et al.

	Drift-Net Fishery	Set-Net Fishery		
		Southern CA	Channel Is.	Central CA
California Sea Lion[1][2][3]	.0195 (.0135)	.0634 (.00917)	.583 (.221)	.328 (.0540)
Harbor Seal[4]	.00488 (.00468)	.0234 (.00496)	.125 (.0580)	.125 (.0325)
Northern Elephant Seal[5]	.0195 (.00949)	.00151 (.00103)	0 (0)	.0677 (.0269)
Harbor Porpoise	-	-	-	.0365 (.0162)
Common Dolphin	.0829 (.0327)	-	-	-
N. Right Whale Dolphin	.0146 (.0108)	-	-	-
Pac. Whited-Sided Dolphin	.0146 (.00821)	-	-	-
Risso's Dolphin	.00976 (.00662)	-	-	-
Dall's Porpoise	.00976 (.00638)	-	-	-
Mesoplodont Beaked Whale	.00488 (.00475)	-	-	-
Short-Finned Pilot Whale	.00488 (.00468)	-	-	-

1. also includes unidentified sea lions.
2. including the 1 animal released alive in the drift-net fishery increases the drift-net kill rate estimate to .0244 (.0140).
3. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .0657 (.00920), .625 (.231), and .333 (.0540).
4. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .0257 (.00508), .167 (.0640), and .130 (.0328).
5. including the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .00302 (.00145), .0417 (.0423), and .0729 (.0272).

TABLE 3. Significance levels of the z-test comparing kill rates estimated by Konno (1990) and Perkins et al. (1992). No tests were possible for northern elephant seal, because no kill rates were estimated by Konno.

	Drift-Net Fishery	Set-Net Fishery		
		Southern CA	Channel Is.	Central CA
California Sea Lion	.94	.92	.082	.61
Harbor Seal	.68	.025	.31	.23
Harbor Porpoise	-	-	-	.47

TABLE 4. Total estimated fishing effort for California gillnet fisheries, in days fished, stratified by fishery and area for April 1988 to December 1990. The three time periods were chosen to correspond most closely with the available California Dept. of Fish and Game data. Note that the second period covers only nine months, and that the first and last are twelve months long.

	Drift-Net Fishery	Set-Net Fishery			
		Southern CA	Channel Is.	Central CA	Total Set-Net
Apr 1988 - Mar 1989	6139	5600	1224	1025	7849
Apr 1989 - Dec 1989	5904	3518	483	1043	5044
Jan 1990 - Dec 1990	5189	5610	568	945	7123

TABLE 5. Estimated kill rates for California gillnet fisheries during July 1990 through June 1991, stratified by fishery, area, and species. Estimates here are in units of kill per day (KPD), with estimated standard errors included in parentheses. These rates are from Perkins et al. (1992). They estimated kill rates both including and excluding observations of animals released alive from the nets and pinnipeds that were not identified. Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. Kill for all other cetaceans was assumed zero in the set-net fisheries.

	Drift-Net Fishery	Set-Net Fishery		
		Southern CA	Channel Is.	Central CA
California Sea Lion[1,2,3]	.0195 (.0135)	.197 (.0288)	1.40 (.575)	.797 (.127)
Harbor Seal[4]	.00488 (.00468)	.0726 (.0155)	.300 (.151)	.304 (.0784)
Northern Elephant Seal[5]	.0195 (.00949)	.00468 (.00319)	0 (0)	.165 (.0667)
Harbor Porpoise	-	-	-	.0886 (.0387)
Common Dolphin	.0829 (.0327)	-	-	-
N. Right Whale Dolphin	.0146 (.0108)	-	-	-
Pac. Whited-Sided Dolphin	.0146 (.00821)	-	-	-
Risso's Dolphin	.00976 (.00662)	-	-	-
Dall's Porpoise	.00976 (.00638)	-	-	-
Mesoplodont Beaked Whale	.00488 (.00475)	-	-	-
Short-Finned Pilot Whale	.00488 (.00468)	-	-	-

1. also includes unidentified sea lions.
2. including the 1 animal released alive in the drift-net fishery increases the drift-net kill rate estimate to .0244 (.0140).
3. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .204 (.0289), 1.50 (.595), and .810 (.127).
4. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .0796 (.0159), .400 (.162), and .316 (.0788).
5. including the 4 unidentified pinnipeds in the set-net fishery increases the set-net estimates to .00937 (.00451), .100 (.0990), and .177 (.0674).

TABLE 6. Estimated total pinniped and cetacean kill for California gillnet fisheries from April 1988 through March 1989, stratified by fishery, area, and species. Worst-case totals are also included in footnotes, computed from kill rates based on observations that included animals released alive from the nets and pinnipeds that were not identified. These kill estimates are reported to the nearest animal. Estimated standard errors are included in parentheses. Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. Kill for all other cetaceans was assumed zero in the set-net fisheries.

	Drift-Net Fishery	Set-Net Fishery				Total Both Fisheries
		Southern CA	Channel Is.	Central CA	Total Set-Net	
California Sea Lion[123]	120 (82.6)	1102 (161)	1714 (704)	817 (131)	3633 (734)	3753 (739)
Harbor Seal[4]	30 (28.7)	407 (86.7)	367 (185)	311 (80.4)	1085 (220)	1115 (222)
Northern Elephant Seal[5]	120 (58.3)	26 (17.9)	0 (0)	169 (68.3)	195 (70.6)	315 (91.6)
Harbor Porpoise	-	-	-	91 (39.6)	91 (39.6)	91 (39.6)
Common Dolphin	509 (201)	-	-	-	-	509 (201)
N. Right Whale Dolphin	90 (66.2)	-	-	-	-	90 (66.2)
Pac. Whited-Sided Dolphin	90 (50.4)	-	-	-	-	90 (50.4)
Risso's Dolphin	60 (40.7)	-	-	-	-	60 (40.7)
Dall's Porpoise	60 (39.2)	-	-	-	-	60 (39.2)
Mesoplodont Beaked Whale	30 (29.1)	-	-	-	-	30 (29.1)
Short-Finned Pilot Whale	30 (28.7)	-	-	-	-	30 (28.7)

1. also includes unidentified sea lions.
2. including the 1 animal released alive in the drift-net fishery increases the drift-net kill estimate to 150 (86.1).
3. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 3807 (757).
4. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 1260 (231).
5. including the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 357 (142).

TABLE 7. Estimated total pinniped and cetacean kill for California gillnet fisheries from April through December 1989, stratified by fishery, area, and species. Worst-case totals are also included in footnotes, computed from kill rates based on observations that included animals released alive from the nets and pinnipeds that were not identified. These kill estimates are reported to the nearest animal. Estimated standard errors are included in parentheses. Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. Kill for all other cetaceans was assumed zero in the set-net fisheries.

	Drift-Net Fishery	Set-Net Fishery				Total Both Fisheries
		Southern CA	Channel Is.	Central CA	Total Set-Net	
California Sea Lion[1,2,3]	115 (79.4)	692 (101)	676 (278)	832 (133)	2200 (324)	2315 (334)
Harbor Seal[4]	29 (27.6)	255 (54.5)	145 (73.0)	317 (81.8)	717 (122)	746 (125)
Northern Elephant Seal[5]	115 (56.0)	16 (11.2)	0 (0)	172 (69.6)	188 (70.5)	303 (90.0)
Harbor Porpoise	-	-	-	92 (40.3)	92 (40.3)	92 (40.3)
Common Dolphin	490 (193)	-	-	-	-	490 (193)
N. Right Whale Dolphin	86 (63.7)	-	-	-	-	86 (67.3)
Pac. Whited-Sided Dolphin	86 (48.5)	-	-	-	-	86 (48.5)
Risso's Dolphin	58 (39.1)	-	-	-	-	58 (39.1)
Dall's Porpoise	58 (37.7)	-	-	-	-	58 (37.7)
Mesoplodont Beaked Whale	29 (28.0)	-	-	-	-	29 (28.0)
Short-Finned Pilot Whale	29 (27.6)	-	-	-	-	29 (27.6)

1. also includes unidentified sea lions.
2. including the 1 animal released alive in the drift-net fishery increases the drift-net kill estimate to 144 (82.8).
3. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 2286 (332).
4. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 803 (126).
5. including the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 266 (86.5).

TABLE 8. Estimated total pinniped and cetacean kill for California gillnet fisheries from January through December 1990, stratified by fishery, area, and species. Worst-case totals are also included in footnotes, computed from kill rates based on observations that included animals released alive from the nets and pinnipeds that were not identified. These kill estimates are reported to the nearest animal. Estimated standard errors are included in parentheses. Kill for harbor porpoise was assumed zero except for the set-net fishery in central California. Kill for all other cetaceans was assumed zero in the set-net fisheries.

	Drift-Net Fishery	Set-Net Fishery				Total Both Fisheries
		Southern CA	Channel Is.	Central CA	Total Set-Net	
California Sea Lion[1,2,3]	101 (69.8)	1104 (161)	795 (327)	754 (120)	2652 (384)	2753 (390)
Harbor Seal[4]	25 (24.3)	407 (86.8)	170 (85.9)	287 (74.1)	865 (143)	890 (145)
Northern Elephant Seal[5]	101 (49.3)	26 (17.9)	0 (0)	156 (63.0)	182 (65.5)	283 (82.0)
Harbor Porpoise	-	-	-	84 (36.5)	84 (36.5)	84 (36.5)
Common Dolphin	430 (170)	-	-	-	-	430 (170)
N. Right Whale Dolphin	76 (56.0)	-	-	-	-	76 (56.0)
Pac. Whited-Sided Dolphin	76 (42.6)	-	-	-	-	76 (42.6)
Risso's Dolphin	51 (34.4)	-	-	-	-	51 (34.4)
Dall's Porpoise	51 (33.1)	-	-	-	-	51 (33.1)
Mesoplodont Beaked Whale	25 (24.6)	-	-	-	-	25 (24.6)
Short-Finned Pilot Whale	25 (24.3)	-	-	-	-	25 (24.3)

1. also includes unidentified sea lions.
2. including the 1 animal released alive in the drift-net fishery increases the drift-net kill estimate to 127 (72.7).
3. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 2761 (394).
4. including the 1 animal released alive and the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 973 (148).
5. including the 4 unidentified pinnipeds in the set-net fishery increases the total set-net estimate to 277 (88.6).