

# Harbor Porpoise Mortality in the Monterey Bay Halibut Gillnet Fishery, 1989

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## ABSTRACT

Harbor porpoises (*Phocoena phocoena*) have been killed in gillnets set for halibut in central California since at least 1969. In the Monterey Bay area (Pigeon Pt. to Pt. Sur), past estimates of mortality have ranged from 25–55/yr. In the spring of 1989, many dead harbor porpoises began washing ashore with evidence of gillnet entanglement. Observer records from the California Department of Fish and Game and stranding data indicated that a minimum of 53 harbor porpoises were killed in Monterey Bay gillnets in 1989, and it is likely that the total number killed in this area was several hundred. Two-thirds of the specimens were immature. If Monterey Bay harbor porpoises form a resident population, such high takes in the future threaten to decimate the population. We recommend closing the fishery or setting quotas and monitoring the kill with approximation of 100% observer coverage.

KEYWORDS: INCIDENTAL CAPTURE; MANAGEMENT; FISHERIES; HARBOUR PORPOISE; NORTH PACIFIC

## INTRODUCTION

Harbor porpoises (*Phocoena phocoena*) are killed in entangling nets<sup>2</sup> throughout their range in the temperate waters of the Northern Hemisphere (IWC, 1994). In central California, such mortality occurs as a result of fishing for halibut with bottom-set gillnets and trammel nets (descriptions in Scofield, 1951; Ueber, 1988), and has occurred since at least 1969 (Barlow, 1987). Until 1980, there was no systematic monitoring of the fishery, but in that year some monitoring was begun by Moss Landing Marine Laboratories (MLML) and California Department of Fish and Game (CDFG) personnel (Miller *et al.*, 1983; Keating, 1986). Since 1983/84, CDFG has been systematically monitoring incidental mortality in this fishery and producing annual estimates of mortality of harbor porpoises and other by-catch species (Diamond and Hanan, 1986; Hanan *et al.*, 1986; 1987; Hanan and Diamond, 1989). These estimates for the 1983/84 to 1986/87 seasons have ranged from approximately 200–300 porpoises per year for the central coast, from Bodega Head to Pt. Conception.

Beginning in mid-February 1989, a much higher than normal number of harbor porpoises started washing up on Monterey Bay beaches, most with evidence of gillnet entanglement. CDFG observer data, which began in mid-March, confirmed that higher than usual levels of porpoise mortality were occurring in the Bay. There was a great deal of pressure put on CDFG to reduce the high kills. Before a ban on gillnet sets in waters shallower than 40 fathoms (73m), covering most of Monterey Bay, was put into effect on 15 April, a total of at least 34 porpoise deaths related to gillnets had been documented in the area.

This paper examines 1989 harbor porpoise gillnet-caused mortality in the Monterey Bay area and presents general information that may help in managing this situation in the future. In addition, it provides recommendations for management.

## MATERIALS AND METHODS

The Monterey Bay study area extends from Pigeon Pt. to Pt. Sur, and was divided into four regions of comparable size for analysis (Fig. 1). Materials were of two types: stranding records and gillnet observer data. Stranded cetaceans in the Monterey Bay area were reported to Moss Landing Marine Laboratories (MLML), and Long Marine Laboratory, University of California, Santa Cruz (LML), both participants in the California Marine Mammal Stranding Network (Seagars and Jozwiak, 1991). Personnel from MLML and LML responded to stranding reports and examined the carcasses. When possible, the carcass was collected for more detailed scientific study. Each porpoise was examined for evidence of gillnet entanglement, such as cuts and depressions along the head, flippers, dorsal fin, or flukes (Hare and Mead, 1987). Standard data, including photos, morphometrics, and tissue samples for analysis of reproduction, feeding habits and pollutant levels, were collected on site or at the lab during necropsies.

Gillnet observation data were kindly provided by C.W. Haugen, CDFG. Information on set location, water depth and by-catch was collected by CDFG observers, either from a shore-based observation platform (uncommon in Monterey Bay), from a research vessel that pulled alongside a gillnetter during net retrieval, or from on-board the fishing vessel. When possible, CDFG observers attempted to secure incidentally-taken porpoises, which were then examined by MLML or LML biologists. Samples and data were then forwarded to the Southwest Fisheries Science Center (SWFSC), National Marine Fisheries Service (NMFS), for life history analysis.

## RESULTS

### Harbor porpoise take in 1989

Table 1 shows the total minimum number of harbor porpoises known to be taken in the Monterey Bay gillnets in 1989. The total of 53 porpoises was computed by adding the number of takes observed by CDFG to the number of strandings with gillnet markings that could be excluded from the observed gillnet takes.

A reliable estimate of take is not possible without knowing the number of gillnet sets (fishing effort) in the

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<sup>2</sup> Entangling nets include setnets, driftnets, and trammel nets. In this paper, the term 'gillnet' is used loosely to refer to any type of entangling gear.

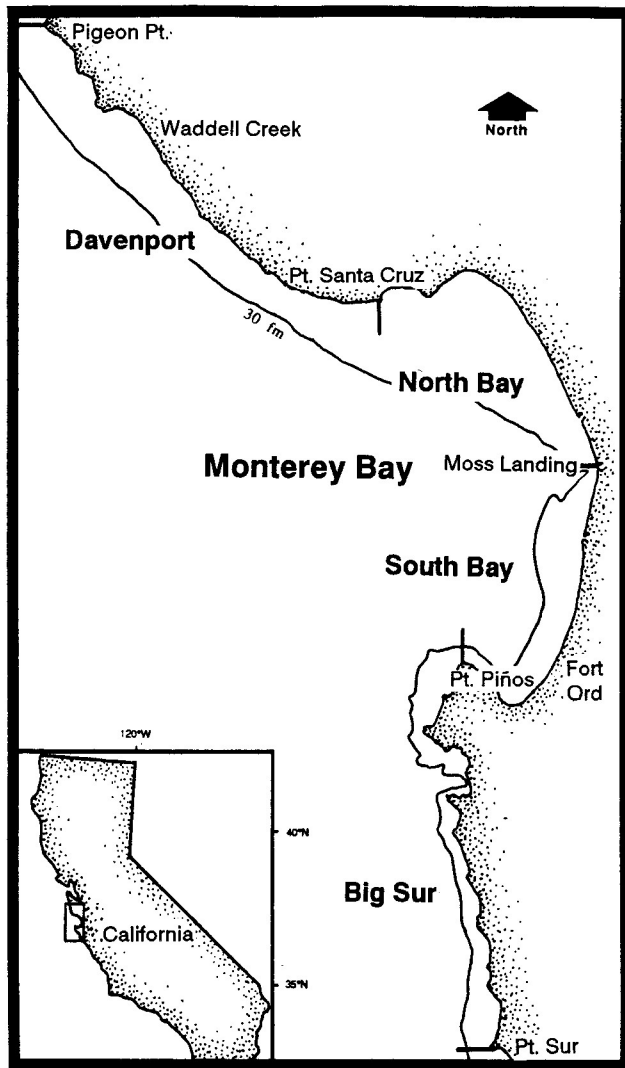


Fig. 1. Map of the study area, showing the four subareas and place names mentioned in the text. Inset shows location of Monterey Bay in central California.

Table 1

Summary of numbers of strandings and observed takes of harbor porpoises in 1989 in Monterey Bay, and an estimate of the minimum number taken in the halibut fishery.

Dates	Gillnet markings on strandings			Observed takes		Minimum taken
	Yes	No	?	Specimen	No	
15 Feb - 15 Apr.	14	1	5	4	16 <sup>1</sup>	34
16 Apr. - 1 Sept.	1	1	3	3	1 <sup>2</sup>	5
2 Sept. - 31 Dec.	0	0	0	5	9	14
	Total					53

<sup>1</sup> Six of these were slashed and sunk and 10 others were taken after the last stranding was recovered, so these 16 animals cannot be duplicates of the 14 stranded with gillnet markings.

<sup>2</sup> This animal cannot be a duplicate of the stranding during this period with gillnet markings, because the stranding, which was freshly dead (< 2 weeks), was found 3½ weeks after the last observed take.

Monterey Bay area in 1989. Fishing effort is estimated by CDFG, by combining data from fishing logs completed by the fishermen, with landing receipts or 'pink tickets', and CDFG observer data (see Diamond and Hanan, 1986). Not all of this information is available, so fishing effort is not known for 1989.

Data are available, however, for four previous years. Assuming that fishing effort in 1989 was within this range, the total number of harbor porpoises killed in the Monterey Bay area alone is possibly several hundred, many times higher than the estimates of 25–55 for previous years (Table 2).

Table 2

Estimated number of sets and estimated harbor porpoise take in Monterey Bay for 1989 and previous years compared.

Year	Est. no. sets (% observed)	Estimated mortality	Take rate	Source
1983/84	517 (4%)	45-47	0.091	Diamond and Hanan, 1986
1984/85	1,606 (7.8%)	25-26	0.016	Hanan <i>et al.</i> , 1986
1985/86	1,255 (3.9%)	55	0.041	Hanan <i>et al.</i> , 1987
1986/87	896 (3.9%)	26	0.029	Hanan and Diamond, 1989
1989	-	180-560 <sup>1</sup>	0.349	CDFG, unpubl. data

<sup>1</sup> Based on range of estimated number of sets for 1983/84 to 1986/87.

#### Take rate in 1989

In 1989, CDFG observers saw 38 harbor porpoises taken in 109 observed sets, for a take rate of  $0.35 \pm \text{SD } 0.738$  porpoises/set. This is much higher than the take rate of 0.02–0.10 observed in past years in the same area (Table 2).

Take rate between the four regions, and take rate between four depth categories (15–18, 19–22, 23–26 and 27–30 fathoms), were examined and no significant differences were found ( $\text{Chi}^2=4.346$ ,  $\text{df}=3$ ,  $p>0.05$ ;  $\text{Chi}^2=1.706$ ,  $\text{df}=3$ ,  $p>0.05$ ; respectively). There were no observed sets in water depths greater than 30 fathoms (55m).

A closure of waters shallower than 40 fathoms (73m), between Waddell Creek and Fort Ord, was in effect from 15 April to 1 September. During the closure, most of the fishing was still in less than 40 fathoms, south of Fort Ord. There was a significantly lower take rate during the closure (Fig. 2;  $\text{Chi}^2=9.296$ ,  $\text{df}=1$ ,  $p<0.01$ ).

#### Biological observations

Of the 28 gillnet-caught porpoises examined by MLML or LML biologists, 16 (57.1%) were females (Table 3). This difference from parity was not statistically significant ( $\text{Chi}^2=0.571$ ,  $\text{df}=1$ ,  $p>0.05$ ).

There was a preponderance of immature animals among the incidentally-taken porpoises. Based on Hohn and Brownell's (1990) information on lengths at sexual maturity for central California harbor porpoises ('best' averages: 140cm for males and 152cm for females<sup>3</sup>), 4 of 12

<sup>3</sup> Hohn and Brownell computed 152cm as the most representative length at sexual maturity for females in their sample (excluding one outlier). Male sexual maturity could not be determined with certainty until testes were examined histologically, but testis weight increased rapidly at 140cm, and this currently represents the 'best' length at sexual maturity.

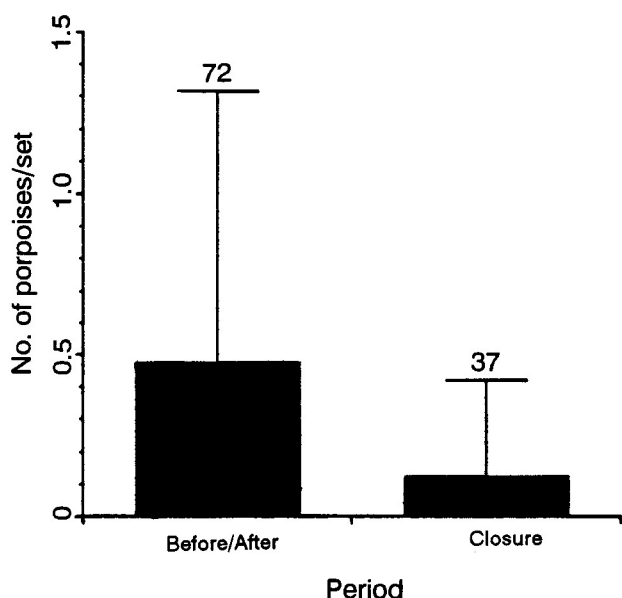


Fig. 2. Mean number of porpoises taken per set by period. The closure was in effect from 15 April to 1 September 1989, and prohibited sets in waters shallower than 40 fathoms north of Fort Ord. Bars are standard deviations and numbers are sample sizes (no. of sets).

(33.3%) males and 5 of 16 (31.1%) females were sexually mature. There were no newborn calves, but at least three of the females were pregnant.

**DISCUSSION**

**Status of population and effect of take**

The population structure of Monterey Bay harbor porpoises is not known (see review of status of central California harbor porpoises by Barlow, 1987; Barlow and

Forney, 1993; Barlow and Hanan, 1994). The only evidence directly relating to population structure is from the work of Calambokidis and Barlow (1991), who compared PCB/DDE pollutant ratios from animals along the west coast of the United States. The variances and ranges of 13 Monterey Bay animals differed from those of animals from adjacent waters (two from Morro Bay to the south, and eight from around San Francisco Bay to the north). So, despite uncertainty resulting from very small sample sizes, the evidence indicates that Monterey Bay may contain a resident population of harbor porpoises, or at least that there is little movement of porpoises to the surrounding coastal areas.

Since 1984, NMFS and CDFG have conducted aerial and ship surveys for the purpose of estimating harbor porpoise abundance in California (Barlow, 1988; Barlow *et al.*, 1988; Forney *et al.*, 1991). Ship survey estimates are currently considered more accurate (see Kraus *et al.*, 1983), however aerial surveys have generally produced estimates similar to those from ship surveys. 'Best estimates' from these surveys are approximately 14,300 harbor porpoises for central and northern California and 1,460 (CV=0.61) for the Monterey Bay area (Barlow, 1988). If the Monterey Bay abundance estimate is correct, then our 1989 minimum take (53 porpoises) represents 3.6% of the population. This is probably unsustainable, and the estimated take of several hundred porpoises would be certainly unsustainable (see Woodley and Read, 1991). However, a more recent abundance estimate, based on aerial surveys, is somewhat higher, 1,948 (CV=0.28) (Barlow and Forney, 1993).

The 1989 fishing year was unusual because of the temporal and spatial distribution of fishing effort. This may be the reason for the high take in that year. However, such unusual years could quickly damage a small resident

Table 3

Harbor porpoise specimens obtained and examined that were either observed taken in gillnets or stranded with gillnet markings, Monterey Bay, 1989. <sup>1</sup> Stranding or capture. <sup>2</sup> NB = North Bay; SB = South Bay and D = Davenport.

Date	Specimen #	S or C <sup>1</sup>	Length (cm)	Sex	Location <sup>2</sup>	Date	Specimen #	S or C <sup>1</sup>	Length (cm)	Sex	Location <sup>2</sup>
15 Feb.	TAJ 181	S	134	F	NB (Pajaro Dunes)	04 Apr.	NAB 011	C	158	F	NB (Santa Cruz)
18 Feb.	EJD 007	S	155	F	NB (ML Beach)	05 Apr.	NAB 012	S	132	F	SB (Marina)
22 Feb.	BEC 89-1	S	129	F	NB (Seascape)	13 Apr.	TAJ 1283	C	131	M	SB (Marina)
28 Feb.	EJD 008	S	135	M	SB (Marina)	13 Apr.	TAJ 184	C	178	F	SB (Marina)
05 Mar.	EJD 009	S	147	F	NB (Seacliff)	10 May	GAW 89-8	S	128	M	NB (Rio del Mar)
16 Mar.	NAB 005	S	139	F	SB (Marina)	10 Aug.	TRK 109	C	129	M	SB (Seaside)
16 Mar.	TRK 108	S	138	F	SB (Marina)	12 Aug.	EJD 020	C	125	M	SB (Seaside)
16 Mar.	EJD 010	S	150	M	SB (Marina)	18 Aug.	EJD 021	C	130	M	SB (South Fort Ord)
25 Mar.	EJD 011	S	151	F	SB (Salinas River)	22 Sept.	EJD 022	C	127	M	NB (Soquel Point)
29 Mar.	NAB 007	S	145	F	NB (Sunset Beach)	07 Oct.	EJD 024	C	138	F	SB (North Fort Ord)
29 Mar.	NAB 008	S	136	F	NB (Sunset Beach)	07 Oct.	EJD 025	C	120	M	SB (North Fort Ord)
29 Mar.	NAB 009	S	156	F	NB (Sunset Beach)	15 Oct.	NAB 013	C	150	F	D (Davenport)
03 Apr.	EJD 012	S	147	M	SB (Marina)	15 Oct.	NAB 014	C	122	F	D (Davenport)
04 Apr.	NAB 010	C	170	F	NB (Santa Cruz)						

population, such as that presumed to exist in Monterey Bay. Due to funding limitations, CDFG's observer effort has been extremely low in the past (see Table 2). In 1989, eight harbor porpoises with gillnet marks were recovered from Monterey Bay beaches before CDFG was able to begin net retrieval observations.

Barlow (1987) and Barlow and Hanan (1994) suggested that past levels of harbor porpoise setnet mortality have resulted in reduction of central California stock(s), possibly to levels below Optimum Sustainable Population (OSP). They further suggested use of the '2 percent rule' for maximum allowable take in this case. The high level of take in 1989 (>3.6% of the best population estimate) warrants serious concern for the future of harbor porpoises in Monterey Bay (and possibly the rest of the central California coast). Despite a great deal of uncertainty, the best available information suggests that the 1989 levels of take are too high for assured survival of the population.

### RECOMMENDATIONS

Considering the current problems involved in management of harbor porpoise populations, we recommended one of the following two options:

- (1) eliminating mortality by closing the Monterey Bay halibut setnet fishery until such time that effective methods of reducing or eliminating porpoise take in gillnets are discovered and implemented [the passage of proposition 132 (SB 2,563 1990, Chapter 884) effectively did so – see Wild, 1990 – but there is a move to overturn this legislation]; or
- (2) if accurate estimates of abundance are available, monitoring the fishery with a goal of 100% observer coverage to eliminate uncertainty in estimating take (minimum acceptable coverage should be 35%, see Barlow, 1989), and observing the '2% rule' for maximum allowable take in any one year (with a quicker response to close the fishery than occurred in 1989, if required).

The main hindrance to sound management of central California harbor porpoise population(s) is the uncertainty involved in determining population status and in estimating incidental take and stock size. If the fishery is to continue, these shortcomings should be addressed immediately.

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### REFERENCES

Barlow, J. 1987. An assessment of the status of harbor porpoise populations in central California. Southwest Fisheries Center Admin. Rep. LJ-87-06 (unpublished). 34pp.

Barlow, J. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon and Washington: I. Ship surveys. *Fish. Bull.*, US 86(3):417-32.

Barlow, J. 1989. Estimating sample size required to monitor marine mammal mortality in California gill-net fisheries. Southwest Fisheries Center Admin. Rep. LJ-89-08 (unpublished). 8pp.

Barlow, J. and Forney, K.A. 1993. An assessment of the status of harbor porpoise in California in 1993. Paper presented to the 1993 Status of Cetacean Stocks Workshop (SOCCS4). 17pp. [Available from the SWFSC, PO Box 271, La Jolla, CA 92038, USA].

Barlow, J. and Hanan, D. 1994. An assessment of the status of harbor porpoise in central California. *Rep. int. Whal. Commn* (special issue 16): In press.

Barlow, J., Oliver, C.W., Jackson, T.D. and Taylor, B.L. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. *Fish. Bull.*, US 86(3):433-44.

Calambokidis, J. and Barlow, J. 1991. Chlorinated hydrocarbon concentrations and their use in describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-10. In: J.E. Reynolds and D.K. Odell (eds.) *NOAA Tech. Rep. NMFS. 98. Marine Mammal Strandings in the United States*. National Marine Fisheries Service, USA. 157pp.

Diamond, S.L. and Hanan, D.A. 1986. An estimate of harbor porpoise mortality in California set-net fisheries April 1, 1983 through March 31, 1984. Southwest Region Admin. Rep. SWR-86-15. [Available from Natl. Mar. Fish. Serv., Southwest Region, 300 S. Ferry Street, Terminal Island, CA 90731]. 40pp.

Forney, K.A., Hanan, D.A. and Barlow, J. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. *Fish. Bull.*, US 89(3):367-77.

Hanan, D.A. and Diamond, S.L. 1989. Estimates of sea lion, harbor seal, and harbor porpoise mortalities in California set net fisheries for the 1986-87 fishing year. Final Rept. to Southwest Region, 300 S. Ferry Street, Terminal Island, CA 90731 (unpublished). 10pp.

Hanan, D.A., Diamond, S.L. and Scholl, J.P. 1986. An estimate of harbor porpoise mortality in California set net fisheries April 1, 1984 through March 31, 1985. Admin. Rep. SWR-86-16. [Available from Natl. Mar. Fish. Serv. Southwest Region, 300 S. Ferry Street, Terminal Island, CA 90731.] 38pp.

Hanan, D.A., Diamond, S.L. and Scholl, J.P. 1987. An estimate of harbor porpoise mortality in California set net fisheries April 1, 1985 through March 31, 1986. Southwest Region Admin. Rep. SWR-87-5. [Available from Natl. Mar. Fish. Serv. Southwest Region, 300 S. Ferry Street, Terminal Island, CA 90731.] 9pp.

Hare, M.P. and Mead, J.G. 1987. Handbook for determination of adverse human-marine mammal interactions from necropsies. Northwest and Alaska Fisheries Center Processed Report 87-06 (unpublished). 35pp.

Hohn, A.A. and Brownell, R.L. 1990. Harbor porpoise in central Californian waters: life history and incidental catches. Paper SC/42/SM47 presented to the IWC Scientific Committee, June 1990 (unpublished). 21pp.

International Whaling Commission. 1994. Report of the Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps. (Published in this volume.)

Keating, T.M. 1986. The catch composition of two monofilament gillnet fisheries in Monterey Bay, California. M.Sc. Thesis, Moss Landing Marine Laboratories/San Francisco State University.

Kraus, S.D., Gilbert, J.R. and Prescott, J.H. 1983. A comparison of aerial, shipboard and land-based survey methodology for the harbor porpoise, *Phocoena phocoena*. *Fish. Bull.*, US 81(4):910-3.

Miller, D.J., Herder, M.J. and Scholl, J.P. 1983. California marine mammal-fishery interaction study, 1979-1981. Southwest Fisheries Center Admin. Rep. LJ-83-13C (unpublished). 233pp.

Scofield, W.L. 1951. An outline of California fishing gear. *Calif. Fish Game* 37:361-70.

Seagars, D.J. and Jozwiak, E.A. 1991. The California Marine Mammal Stranding Network, 1972-1987: implementation, status, recent events and goals. pp. 25-33. In: J.E. Reynolds and D.K. Odell (eds.) *NOAA Tech. Rep. NMFS. 98. Marine Mammal Strandings in the United States*. National Marine Fisheries Service, USA. 157pp.

Ueber, E. 1988. The traditional central California setnet fishery. *Mar. Fish. Rev.* 50:40-8.

Wild, P.W. 1990. The central California experience: a case history of California halibut set net laws and regulations. *California Fish and Game (Fish. Bull.)* 174:321-39.

Woodley, T.H. and Read, A.J. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. *Can. J. Fish. Aquat. Sci.* 48(12):2429-35.