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

Thomas A. Jefferson¹, Barbara E. Curry¹ and Nancy A. Black
Moss Landing Marine Laboratories, PO Box 450, Moss Landing, CA 95039, USA

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 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 Schofield, 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 54 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.

¹ Present address: Marine Mammal Research Program, c/o Department of Wildlife and Fisheries Sciences, 210 Nangle Hall, Texas A&M University, College Station, TX 77843, USA.
² 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.

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 onboard 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
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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Est. no. sets</th>
<th>Estimated</th>
<th>Take</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(% observed)</td>
<td>mortality</td>
<td>rate</td>
</tr>
<tr>
<td>1983/84</td>
<td>517 (4%)</td>
<td>45.47</td>
<td>0.091</td>
</tr>
<tr>
<td>1984/85</td>
<td>1,606 (7.8%)</td>
<td>25.26</td>
<td>0.016</td>
</tr>
<tr>
<td>1985/86</td>
<td>1,255 (3.9%)</td>
<td>55</td>
<td>0.041</td>
</tr>
<tr>
<td>1986/87</td>
<td>896 (3.9%)</td>
<td>26</td>
<td>0.029</td>
</tr>
<tr>
<td>1989</td>
<td>-</td>
<td>180-560$^1$</td>
<td>0.349</td>
</tr>
</tbody>
</table>

$^1$ 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 ± 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 (Chi$^2$=4.346, df=3, p>0.05;
Chi$^2$=1.706, 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; Chi$^2$=9.296, df=1, p<0.01).

Biological observations
Of the 28 gillnet-caught porpoises examined by MML or
LML biologists, 16 (57.1%) were females (Table 3). This
difference from parity was not statistically significant
(Chi$^2$=0.571, 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$^3$), 4 of 12

$^3$ Hohn and Brownell computed 152cm as the most representative
length at sexual maturity for females in their sample (excluding one
oulier). Male sexual maturity could not be determined with certainty
until tests 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

<table>
<thead>
<tr>
<th>Date</th>
<th>Specimen #</th>
<th>S or C1</th>
<th>Length (cm)</th>
<th>Sex</th>
<th>Location²</th>
<th>Date</th>
<th>Specimen #</th>
<th>S or C1</th>
<th>Length (cm)</th>
<th>Sex</th>
<th>Location²</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Feb.</td>
<td>TAJ 181</td>
<td>S</td>
<td>134</td>
<td>F</td>
<td>NB (Pajaro Dunes)</td>
<td>04 Apr.</td>
<td>NAB 011</td>
<td>C</td>
<td>158</td>
<td>F</td>
<td>NB (Santa Cruz)</td>
</tr>
<tr>
<td>18 Feb.</td>
<td>EJD 007</td>
<td>S</td>
<td>155</td>
<td>F</td>
<td>NB (ML Beach)</td>
<td>05 Apr.</td>
<td>NAB 012</td>
<td>S</td>
<td>132</td>
<td>F</td>
<td>SB (Marina)</td>
</tr>
<tr>
<td>22 Feb.</td>
<td>BEC 89-1</td>
<td>S</td>
<td>129</td>
<td>F</td>
<td>NB (Seascape)</td>
<td>13 Apr.</td>
<td>TAJ 1283</td>
<td>C</td>
<td>131</td>
<td>M</td>
<td>SB (Marina)</td>
</tr>
<tr>
<td>28 Feb.</td>
<td>EJD 008</td>
<td>S</td>
<td>135</td>
<td>M</td>
<td>SB (Marina)</td>
<td>13 Apr.</td>
<td>TAJ 184</td>
<td>C</td>
<td>178</td>
<td>F</td>
<td>SB (Marina)</td>
</tr>
<tr>
<td>05 Mar.</td>
<td>EJD 009</td>
<td>S</td>
<td>147</td>
<td>F</td>
<td>SB (Seacliff)</td>
<td>10 May</td>
<td>GAW 89-8</td>
<td>S</td>
<td>128</td>
<td>M</td>
<td>NB (Río del Mar)</td>
</tr>
<tr>
<td>16 Mar.</td>
<td>NAB 005</td>
<td>S</td>
<td>139</td>
<td>F</td>
<td>SB (Marina)</td>
<td>12 Aug.</td>
<td>EJD 020</td>
<td>C</td>
<td>125</td>
<td>M</td>
<td>SB (Seaside)</td>
</tr>
<tr>
<td>16 Mar.</td>
<td>TRK 108</td>
<td>S</td>
<td>138</td>
<td>F</td>
<td>SB (Marina)</td>
<td>18 Aug.</td>
<td>EJD 021</td>
<td>C</td>
<td>130</td>
<td>M</td>
<td>SB (Seaside)</td>
</tr>
<tr>
<td>25 Mar.</td>
<td>EJD 011</td>
<td>S</td>
<td>151</td>
<td>F</td>
<td>SB (Salinas River)</td>
<td>22 Sept.</td>
<td>EJD 022</td>
<td>C</td>
<td>127</td>
<td>M</td>
<td>SB (North Fort Ord)</td>
</tr>
<tr>
<td>29 Mar.</td>
<td>NAB 007</td>
<td>S</td>
<td>145</td>
<td>F</td>
<td>NB (Sunset Beach)</td>
<td>07 Oct.</td>
<td>EJD 024</td>
<td>C</td>
<td>138</td>
<td>F</td>
<td>SB (North Fort Ord)</td>
</tr>
<tr>
<td>29 Mar.</td>
<td>NAB 008</td>
<td>S</td>
<td>136</td>
<td>F</td>
<td>NB (Sunset Beach)</td>
<td>07 Oct.</td>
<td>EJD 025</td>
<td>C</td>
<td>120</td>
<td>M</td>
<td>D (Davenport)</td>
</tr>
<tr>
<td>03 Apr.</td>
<td>EJD 012</td>
<td>S</td>
<td>156</td>
<td>F</td>
<td>NB (San Simeon)</td>
<td>15 Oct.</td>
<td>NAB 013</td>
<td>C</td>
<td>150</td>
<td>F</td>
<td>D (Davenport)</td>
</tr>
<tr>
<td>04 Apr.</td>
<td>NAB 010</td>
<td>C</td>
<td>170</td>
<td>F</td>
<td>NB (Santa Cruz)</td>
<td>15 Oct.</td>
<td>NAB 014</td>
<td>C</td>
<td>122</td>
<td>F</td>
<td>D (Davenport)</td>
</tr>
</tbody>
</table>

1 Harp porpoise specimens obtained and examined that were either observed taken in gillnets or stranded with gillnet markings, Monterey Bay, 1989. 2 Strand or capture. 3 NB = North Bay; SB = South Bay and D = Davenport.
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.

ACKNOWLEDGEMENTS

This paper would not have been possible without the generous assistance of C.W. Haugen of CDFG, in providing the Department's fishery observer data. We sincerely thank E.J. Dorfman, R. Estelle, J.T. Harvey, C.W. Haugen, P. Jeske, T.R. Kiechlefer, P. Leiberg, L. Osborne, G.A.J. Worthy, and several gillnet fishermen for their help in obtaining and/or examining porpoise specimens. Thanks also to J. Barlow, E.J. Dorfman, C.W. Haugen, G.A.J. Worthy, B. Würsig and two anonymous referees for reviewing earlier drafts of the manuscript.

REFERENCES


