Population abundance of Dall's porpoise (*Phocoenoides dalli*) in the western North Pacific Ocean, 1979-1988

By

B. J. Turnock

National Marine Mammal Laboratory
Alaska Fisheries Science Center
National Marine Fisheries Service, NOAA
7600 Sand Point Way N.E., Bin C15700
Seattle, Washington 98115-0070

November 1989

THIS REPORT MAY BE CITED IN THE FOLLOWING MANNER:

Turnock, B.J. 1989. Population abundance of Dall's porpoise (*Phocoenoides dalli*) in the western North Pacific Ocean, 1979-1988. Document submitted to the Annual Meeting of the International North Pacific Fisheries Commission, November, 1989, Seattle, Wa., U.S.A. 5pp.

ABSTRACT

Sightings data for Dall's porpoise were analyzed using line transect methods to estimate abundance in the western North Pacific Ocean area. Data from 1979 to 1988 were pooled due to the small amount of data in any particular year. Corrections were made for attraction of the animals to the vessel and for missing animals near the transect line. Abundance was 611,235 (95 % CI 360,249 - 1,037,084), which is lower than an estimate of 742,072 (95% C.I. 450,000 - 1,200,000) using similar methods with data from 1980 to 1984 (Turnock 1987).

INTRODUCTION

Sighting surveys for marine mammals have been conducted by U.S. observers on board various research and commercial fishing vessels (Japanese, U.S., Korean, Taiwanese, and Canadian) from 1978 to 1988 to obtain data for estimation of population abundance of marine mammals, specifically Dall's porpoise.

The research vessels followed systematic cruise tracks designed for sampling salmon and squid distribution. Commercial fishing vessels followed no predesigned cruise tracks, resulting in nonsystematic and nonrandom effort. Previous estimates of abundance of Dall's porpoise were for 1980-1984 (Turnock 1987). This paper presents an updated estimate of population abundance of Dall's porpoise incorporating 1979, and 1985-1988 data.

METHODS

Sighting surveys were conducted during periods when sea state and weather conditions were favorable (Beaufort 5 or less and visibility over 500 meters). The area from beam to beam ahead of the vessel was searched by eye and with the aid of binoculars. Distances and angles to sightings were estimated by eye from 1978 to 1986. In 1987 and 1988 observers were trained in the estimation of distances and angles by eye, and most observers used reticle binoculars with compass for estimation of distances and angles.

The sightings data were stratified by visibility codes 1, 2 and 3 (see Turnock 1988 for definition of visibility codes), for estimation of the number of groups sighted and the amount of effort for each visibility code. The sightings were pooled for years 1979 to 1988 due to the small sample sizes when data were stratified by visibility code for individual years. The 1978 data were not used because weather and sea state information were not recorded. In previous abundance estimates the 1978 and 1979 data were not used because of problems with weather and sea state information. However, on examination of the 1979 data, the weather and sea state information was sufficient and so it has been included in the present analysis.

Attraction of Dall's porpoise to vessels causes overestimation of abundance, and missing animals near the transect line causes underestimation of abundance. Corrections for these biases have been estimated by Turnock (1987) and will be used here to correct abundance estimates. The equation for density corrected for missed animals near the transect line and corrected for animal movement is,

$$\hat{D} = \frac{\hat{C}_m \ \hat{f}(0) \ \hat{G} \ \Sigma_{j=1}^{3} n_j \ \hat{C}_{vj}}{2 \ \Sigma_{j=1}^{3} L_j}$$

The variance of the density was estimated by the Taylor series expansion (Seber 1982),

$$\text{var}\ \hat{D} = \hat{D}^2\ [cv(\hat{C}_m)^2 + (cv(\hat{G}))^2 + (cv(\hat{f}(0))^2 + (cv(\Sigma_{j=1}^{3} n_j\ \hat{C}_{vj}))^2]$$

where,

$$\text{var}(\Sigma_{j=1}^{3} n_j\ \hat{C}_{vj}) = \text{var}(n_1) + (n_2\hat{C}_{v2})^2[(cv(n_2))^2 + (cv(\hat{C}_{v2}))^2] + (n_3\hat{C}_{v3})^2[(cv(n_3))^2+(cv(\hat{C}_{v3}))^2)]$$

Where, $\hat{D}$ is density weighted by line length and corrected for missed animals near the transect line and corrected for movement.

$\hat{G}$ is mean group size.

n_j is the number of groups sighted for visibility code j.

$\hat{f}(0)$ is the value at 0 of the probability density function for observed perpendicular distances.

$\hat{C}_{vj}$ is the correction factor for visibility code j

cv is coefficient of variation.

L_j is the line length for visibility code j.

$\hat{C}_m$ is the correction for movement.

Data were pooled from visibility codes 1 through 3 for estimation of f(0) and the mean group size in the western North Pacific Ocean area. Due to the possibility of errors in distance and angle measurements, the data were grouped by 100 meter intervals, and truncated at 500 meters. This resulted in five intervals, which are the least number of intervals desirable for grouped analysis, while maintaining as large an interval width as possible. The Hazard rate model was fit to the data for estimation of f(0) (Buckland 1985). Previous analyses have used the Fourier series estimator due to problems with fitting the hazard rate model. However, recent changes in the computer program have improved the performance of the hazard rate model.

The density in the fishzone area is estimated from visibility code 1 conditions only with no corrections for missed animals. This is because data from visibility codes 1, 2 and 3 from the fishzone area were used to estimate the corrections for missed animals (Turnock 1987).

The estimate of abundance for the total western North Pacific Ocean area is estimated by weighting the density estimates for the fishzone area and the remaining western North Pacific area, the weights being the respective areas in nm^2,

$$\hat{N} = A_f\hat{D}_f + A_n\hat{D} \quad .$$

Where, A_f is the area of the fishzone within the western North Pacific (91,740 nm^2)

A_n is the area of the western North Pacific excluding the fishzone (1,036,354 nm^2)

$\hat{D}_f$ is the density in the fishzone area

$\hat{D}$ is the density in the western North Pacific Ocean area

$\hat{N}$ is the population estimate for the western North Pacific area

The population number is bounded below by the number of distinct animals sighted. If the variance is large compared to the estimate, a zero or negative lower confidence level can be estimated assuming a normally distributed random variable. Here, we assume N is log normal and estimate the confidence interval by (Burnham, et al 1987),

$$95\%\ \text{C.I.} = (\hat{N}/C\ ,\ \hat{N}C)\ ,$$

Where,

$$C = \exp(Z_{\alpha/2} \sqrt{\ } \text{Var}\ (\ln(\hat{N})))$$

and,

$$\text{Var}(\ln(\hat{N})) = \ln(1 + (cv\ \hat{N})^2)$$

Where, $Z_{\alpha/2}$ is 1.96, and α equals 0.05.

RESULTS

A total of 860 Dall's porpoise groups in 18,627 nm of effort were used in the analysis from the 1979 to 1988 data (Table 1). The population estimate for the western North Pacific area including the fishzone is 611,235 (95 % CI 360,249 - 1,037,084).

DISCUSSION

A previous estimate of Dall's porpoise population size using 1980 to 1984 pooled data with similar methods was 742,072 (95% C.I. 450,000 - 1,200,000) (Turnock 1987). The population estimate for the 1979 to 1988 data is lower. In Turnock (1987) data from the fishzone and the western North Pacific Ocean areas were pooled for estimation of f(0), in the present analysis the data were separated. This may have resulted in a lower f(0) value for the western North Pacific Ocean area excluding the fishzone. This stratification of the data separates most of the research vessel and fishing vessel data. The lower population estimate also could be due to the improved estimation of distances and angles using reticle binoculars with compass. The use of the binoculars may have corrected for underestimates of distances to sightings. This would have increased perpendicular distance estimates and decreased the f(0) estimate causing a lower abundance estimate.

Nonrandom distribution of effort by area and year may also bias the population estimates from the pooled data in an unknown direction. Even though research vessels followed systematic cruise tracks, their effort may be more concentrated in certain parts of the area of interest, since they are concerned with sampling squid and salmon distribution. More effort is needed in a single year to estimate abundance and eliminate any biases due to pooling data over many years. To reduce any bias due to nonrandom effort and spatial variability in density, stratification of the data into smaller areas would be desirable. However, more effort in a single year would be needed. This bias may also be reduced by obtaining more effort collected in a systematic design.

REFERENCES

Buckland, S.T. 1985. Perpendicular distance models for line transect sampling. Biometrics 41, 177-195.

Burnham, K. P., D. R. Anderson, G. C. White, C. Brownie, and K. H. Pollock. 1987. Design and analysis methods for fish survival experiments based on release-recapture. American fisheries Society Monograph 5. 437 pp.

Seber, G. A. F. 1982. The Estimation of Animal Abundance. Macmillan Publishing Co., Inc., New York, N.Y., 2nd edition, 654pp.

Turnock, B.J. 1987. Analysis of experiments to assess movement of Dall's porpoise in relation to survey vessels and population estimates corrected for movement and visibility bias for the North Pacific Ocean. Document submitted to the Scientific Subcommittee, Ad Hoc Committee on Marine Mammals, International North Pacific Fisheries Commission, March 11-15, 1987, Tokyo, Japan. 40pp.

Table 1. Population abundance estimate for Dall's porpoise using pooled sighting data from 1979 to 1988 in the Western North Pacific Ocean area.

vis	n(trunc)	L	$\hat{C}_v$	$\hat{G}$	$\hat{f}(0)$	$\hat{C}_m$	$\hat{D}$	$\hat{N}$	95% CI $\hat{N}$
npacnof									
1	101	949	1						
2	311	6136	2.74						
3	297	9910	3.5						
				3.973	8.960	0.2686			
fishzone									
1	151	1632		3.401	10.018	0.2093			
							0.541830	611,235	360,249 - 1,037,084

npacnof is the Western North Pacific Ocean area excluding the fishzone
vis is visibility code
n(trunc) is the number of groups sighted truncated at 500 meters perpendicular distance
L is effort in nautical miles
$\hat{G}$ is mean group size
$\hat{C}_v$ is correction for missed animals near the transect line
$\hat{C}_m$ is the correction for movement