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The relationship between body weight and morphological measurements in Harbour porpoises (*Phocoena phocoena*) from the North Sea

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Summary

From length and girth measurements of live stranded animals, treated at the Harderwijk Marine Mammal Park, a formula has been developed to calculate the body weight of Harbour porpoises from the North Sea. This formula will enable researchers and fishermen to estimate the body weight under conditions in which weighing machines are not available or usable.

Key words: *Phocoena phocoena,* weight estimate, body size.

Introduction

The number of Harbour porpoises (*Phocoena phocoena*) in the North Sea seems to have declined during the last few decades. Some parameters that may have caused this decline are: changes in the Harbour porpoises' distribution area due to physical changes in the environment; over-fishing of the prey species; increased water pollution (Andersen & Rebsdorff, 1976; Gaskin *et al.*, 1979); increased boat traffic; and drowning of Harbour porpoises in fishing nets (also called incidental or indirect catches) (Andersen, 1974; Gaskin, 1984; Read & Gaskin, 1988; Kastelein *et al.*, 1990). For the protection and management of this species in the wild, more knowledge of its biology is needed, as indicated by Gaskin *et al.* (1984). One of the basic parameters is body weight. Because weighing on board a fishing or research vessel can be impossible if there is no weighing machine or if the sea is rough, a method of calculating the body weight from morphological measurements is needed.

The Harderwijk Marine Mammal Park is the rehabilitation centre for cetaceans stranded on the Dutch coast, and has the possibility of weighing and measuring Harbour porpoises when they are treated. The purpose of this study is to establish a relationship between three morphological measurements and the body weight. The formula presented in this study includes girth measurements, and thus takes the physical condition of the animal into account.

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Materials and Methods

Harbour porpoises that had stranded on the Dutch coast were weighed (Fig. 1) and measured during

Table 1. The weight and body measurements of the Harbour porpoises used in the present study. Girth 1 = girth rostral of pectoral fins; Girth 2 = girth caudal of pectoral fins; M = male; F = female

Date/ animal	Sex	Length (cm)	Girth 1 (cm)	Girth 2 (cm)	Weight (kg)
PpSH011	M				
11–07–67		103	48.7	59.4	18.0
PpSH012	F				
10–03–88		107	—	—	18.0
06–07–88		117	66	76	24.5
11–08–88		118	70	77	29.6
25–08–88		122	69	78	29.8
21–09–88		118	67	78	26.0
24–10–88		126	69	78	30.0
13–11–88		126	70	78	31.0
PpSH013	M				
22–03–88		144	—	—	35.0
06–07–88		145	69	75	36.0
11–08–88		146	69	79	38.2
25–08–88		146	67	76	38.6
21–09–88		144	70	77	39.0
24–10–88		145	68	74	37.0
13–11–88		148	70	77	37.0
PpSH014	M				
28–03–88		138	—	—	29.0
07–05–88		139	—	—	32.0
06–07–88		139	69	76	34.0
11–08–88		139	73	76	37.0
25–08–88		139	68	78	37.6
21–09–88		138	71	82	38.0
PpSH015	M				
29–06–88		78	37.0	47.5	7.5
PpSH018	M				
21–02–89		108	62	68	19.4
01–03–89		110	59	66	19.0
PpSH019	M				
05–07–88		111	56.5	64.5	18.0

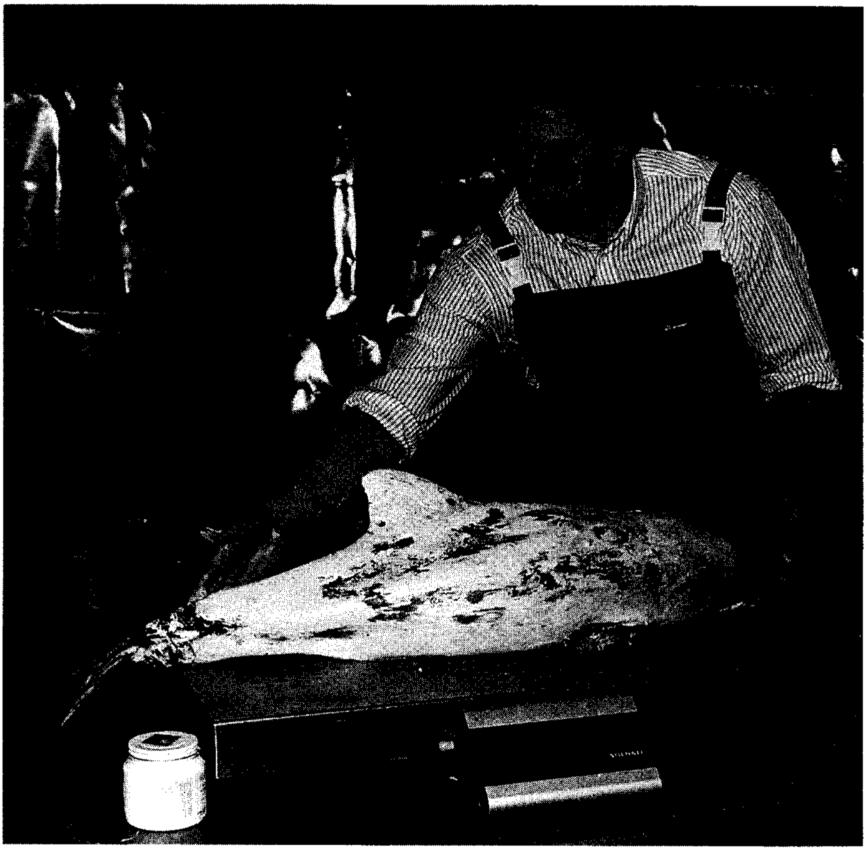

Figure 1. The weighing of a Harbour porpoise on a digital scale. The white cream on the skin is zinc-oxide ointment to prevent dehydration.

their treatment or within one hour after death. Girth measurements were taken rostral (G_1) and caudal (G_2) of the pectoral fins (Fig. 2). The standard body length (L) was measured from the dorsal side of the body as a straight line from the deepest part of the notch in the tail fluke to the tip of the rostrum (Fig. 2). A 2 cm accuracy margin seems feasible for the length measurement, and a 1 cm accuracy margin for each of the two girth measurements.

Results

The weight and the three body measurements of seven Harbour porpoises were taken on 21 occasions (Table 1).

A step-wise multiple linear regression analysis of the length and girth data for these Harbour porpoises yielded the following relationship:

$$W = 4.74 \times 10^{-5} L^{1.68}(G_1 + G_2)^{1.05}$$

In which W is the weight in kg, L is the body length in cm, G_1 is the girth rostral of the pectoral fins in cm, and G_2 the girth caudal of the pectoral fins in cm.

Other relationships were found, but this formula was found to be the best compromise to achieve a maximum correlation coefficient and user friendliness with a minimal relative standard deviation. This formula has a correlation coefficient of 0.9900 and a relative standard deviation of 5.75%.

Discussion and Conclusions

The relationship between the body mass and one body measurement has already been established for Harbour porpoises from the Baltic by Bryden (1986) using data collected by Møhl-Hansen (1954) from 208 males and 164 females:

males: $\log L = 1.552 + 0.357 \log W$
females: $\log L = 1.606 + 0.329 \log W$
(L = length in cm; W = weight in kg).

Van Utrecht (1978) did a similar study using data from 41 males and 58 females from the North Sea:

males: $\log L = 1.607 + 0.346 \log W$
females: $\log L = 1.609 + 0.347 \log W$

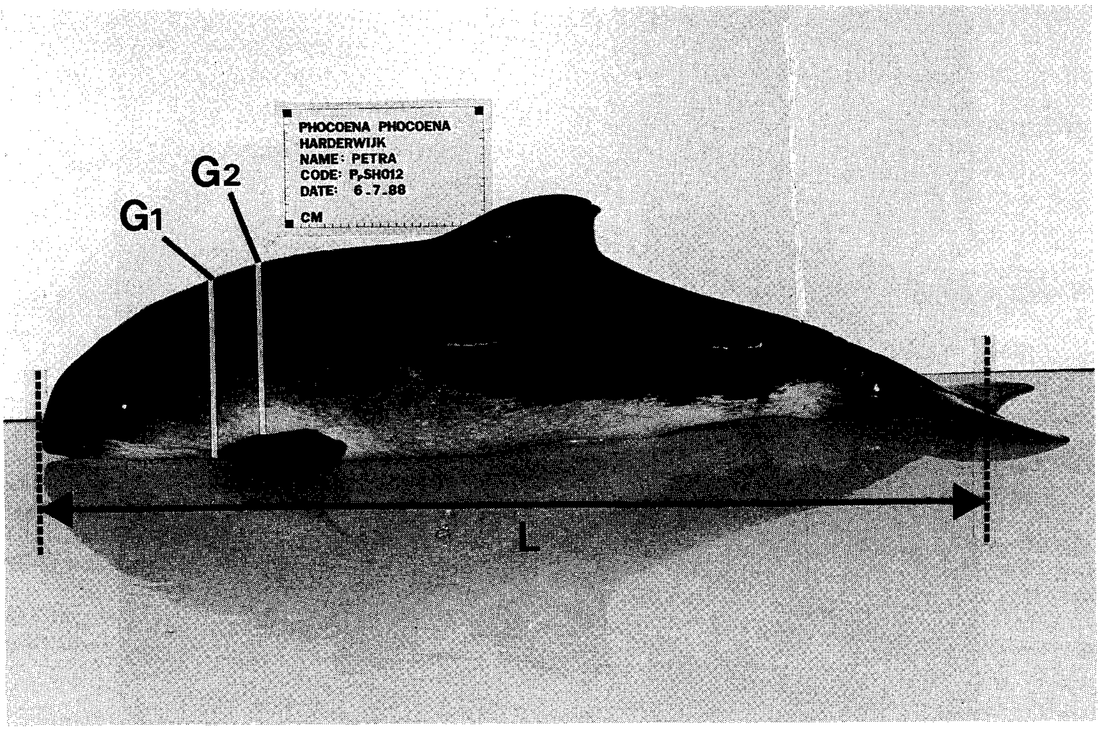

Figure 2. Lateral view of a Harbour porpoise from the North Sea showing where the body measurements were taken. G_1 = girth rostral of pectoral fins; G_2 = girth caudal of pectoral fins; L = standard length.

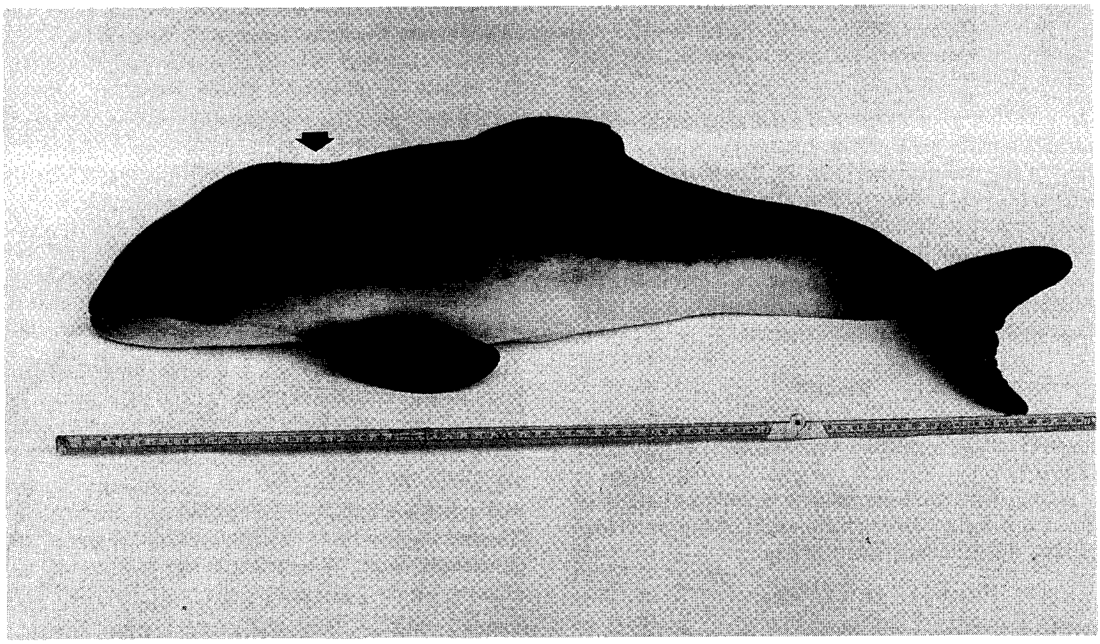

Figure 3. Lateral view of an emaciated young Harbour porpoise from the North Sea. The arrow indicates the 'neck', the result of a loss of body fat.

These formulae to estimate body weight only take the body length into account, and disregard the thickness of the fat deposit on the animal. A report by Spotte *et al.* (1978) on the rehabilitation of a live stranded Harbour porpoise shows that body length is not enough to accurately calculate the body mass. During recovery the body weight increased from 27 kg to 42 kg while the body length remained 148 cm. Kastelein *et al.* (1990) observed large body weight fluctuations in rehabilitating adult Harbour porpoises from the North Sea that were treated at the park. Their study and a study by Andersen (1965) show that because of the high metabolism of this small cetacean (Kanwisher & Sundnes, 1965), the Harbour porpoise can gain and lose weight quickly. It has a very unfavourable body weight to body surface ratio (Andersen, 1981). According to Møhl-Hansen (1954), adult animals of the same length can differ in weight by as much as 25 kg. He found a thick blubber layer in Harbour porpoises from the Baltic (adult females: 25 to 35 mm; young animals: 40 to 60 mm). According to Slijper (1958), the hypodermal blubber layer of Harbour porpoises from the Baltic population can account for about 40% of the total body weight. Van Utrecht (1960) reports on a thinner blubber layer of 9 to 23 mm for animals from the North Sea.

The formula presented in this study is based on the measurements of only seven animals. Many of the measurements are not independent (they are from one animal and connected by time), and are clustered around certain weights. However, the use of girth measurements makes the formula more accurate and compensates for the lower sample number. Girth measurements are good indicators of the physical condition of cetaceans. When toothed whales lose weight, it is usually first seen in depressions in the areas lateral of the dorsal fin. When a cetacean becomes more emaciated it starts to show a pronounced 'neck' region. This is clear when the healthy animal in Figure 2 is compared with the emaciated animal in Figure 3. Boolootian (1956) also showed a live, but very emaciated Harbour porpoise with marked indentation in the neck region.

In the present study the girths immediately rostral and caudal of the pectral fins were chosen because they are easy to find, and therefore easy to explain to other measurers. Another formula derived from the data used in the present study shows that the information obtained from the G_1 measurement to estimate the body weight is relatively small compared to G_2 ($W = 5.11 \times 10^{-5} L^{1.71} \times G_1^{-0.05} \times G_2^{1.20}$). This could be expected, since G_1 is merely a measurement of the caudal part of the skull. G_2 is more indicative for the physical condition of the animal (Figs 2 & 3). The length measurements were taken from the dorsal side. More accurate length measurements can be taken when measuring from the ventral side of a cetacean, but this is often impractical because of the weight of the animals, and the amount of handling that is involved. It is very difficult to measure live animals, since they continue to breathe, and sometimes resist being handled. Therefore the accuracy of the measurements varies from one occasion to another.

The animals used in the present study may not be a representative sample of the wild population in the North Sea. Usually only sick and weak animals are stranded. However, at least two of the seven animals showed signs of entanglement in fishing nets (Kastelein *et al.*, 1990) and so were probably not selected by nature but by human activities. Therefore they may be considered as representatives of the healthy population. Because the formula includes girth measurements and because only a very small sexual dimorphism except in size (females are larger than males) is noted in Harbour porpoises (van Utrecht, 1978), it is probably unnecessary to develop separate formulae for the different sexes.

In the present study only animals from the North Sea population were used. Whether the formula could also be used for other populations remains to be seen when more measurements, including girth measurements, become available. Animals of the East Canadian population are larger than animals of the same age from the North Sea population (Gaskin *et al.*, 1984), while animals of the Baltic population are more slender, but have more body fat than those from the North Sea (van Utrecht, 1960). Kinze (1985) found skull differences between the Baltic and the Dutch North Sea populations.

Hopefully this study will motivate other people to take the same body measurements. The authors of the present study invite measurements to be sent to the Harderwijk Park so that the present formula can be evaluated and possibly improved.

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