

## Calculation of the yield of meat and other products from fin and minke whales taken in Greenland

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### ABSTRACT

In response to a request from the Commission last year, we use length data from the Greenland native hunt and from the IWC catch database to estimate average body weights of fin and minke whales, and the yield of edible products (meat and blubber) from these species.

Although there was some variation (and questions regarding reliability for some of the reported lengths), overall the results exhibited a notable consistency across all data sets examined. The average lengths of minke whales in three data sets (Greenland hunt, IWC entire North Atlantic, and IWC West Greenland) were in a small range of from 6.9 to 7.2 m. Mean estimated body weight (calculated using Lockyer's (1976) formula) ranged from 4.4 to 5.0 tonnes. Meat (muscle) made up from 2.7 to 3.1 tonnes of body weight, and the yield of blubber was estimated at an average of 0.7 tonnes.

The average lengths of fin whales were also quite consistent across four examined datasets (Greenland hunt, IWC Davis Strait/Baffin Basin, IWC entire North Atlantic, and IWC West Greenland), ranging from 17.8 to 18.6 m. Mean estimated body weight ranged from 34.2 to 39.1 tonnes. Meat (muscle) made up from 15.4 to 17.6 tonnes of body weight, and blubber from 8.2 to 9.4 tonnes.

Overall, these figures are considerably higher than the factors of 2 tonnes (minke whales) and 8 tonnes (fin whales) currently in use by Greenland, whose calculations involve the yield of only meat but not blubber or other edible products (or products from small cetaceans). Logistical considerations may well affect actual yield in the hunt, but we are unable to assess the extent to which this may be the case.

The hunting of whales and other marine mammals for subsistence purposes has a long history in Greenland, and is a central part of the native culture. Fin (*Balaenoptera physalus*) and common minke whales (*B. acutorostrata*) have been regularly taken as part of this subsistence fishery off both the eastern and western coasts of Greenland throughout the twentieth century. As with other aboriginal hunts, the IWC issues a quota for Greenland based upon a "needs statement" submitted to the Commission.

Unlike other native fisheries, Greenland calculates its subsistence need in terms of tonnes of whale meat rather than numbers of whales.<sup>1</sup> For the purpose of calculating this need, Greenland has used an average value of two tonnes of meat per minke whale, and eight tonnes per fin whale (Greenland Home Rule Government 1991). Details of how these figures were apparently derived are given below.

Last year in Santiago, Commission members asked for clarification of these conversion factors and, noting that products other than meat were derived from whales in the Greenland hunt but were not accounted for in the needs statement, asked if the SC could provide advice on what the yields of these products would be. The Chair asked the SC to take note of this request (IWC 2009); in response, in this paper we examine the likely yield of meat and other products from fin and minke whales. We use a conversion based upon lengths reported from both commercial catches as well as the Greenland hunt itself to assess the likely yield, and compare that to results using the current conversion factor.

Our primary aim here is to raise some questions with regard to the present values employed for calculating quota requirements from a needs statement, and to suggest alternatives.

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<sup>1</sup>Various questions have been raised within the Commission regarding this unique method of calculating need, notably as it relates to a potentially interchangeable multi-species quota, but these exceed the scope of the present paper.

## METHODS

### The existing conversion method

Details of how the existing conversion factors (representing 2 tonnes of meat per minke whale, and 8 tonnes per fin whale) are given in a paper by the Greenland Home Rule Government (1991).<sup>2</sup> This paper provides details of body lengths as well as quantities of meat derived from minke, humpback and fin whales from various fishery data, including from Lockyer (1976) as well as from local hunts. It is worth quoting the text of this directly to try to follow the logic involved. For minke whales, the paper states:

*Processing of meat from 26 minke whales... in 1977 yielded an average of 1110 kg of meat per whale (max: 1732 kg, min: 270 kg). An unknown amount from each whale was not processed, but shared/sold locally.*

*Norwegian vessels operating at east Greenland in 1978 produced on average 1750 kg of meat per whale (131 whales; max: 2700 kg, min: 800 kg)... The mean length of minke whales caught by Norwegian vessels at west Greenland was between 7.5 m and 8.0 m (Larsen and Kapel 1982)<sup>3</sup>... According to Lockyer (1976), a minke whale of 7.6 m has a total body weight of around 5.3 tonnes, of which 3.3 tonnes is meat.*

The paper then concludes that:

*Based on this information, it is estimated that two tonnes of meat is produced from a minke whale in Greenland.*

The reasoning behind this conclusion is not clear, since the average value for meat yield (as calculated from Lockyer 1976) that the paper itself quotes is notably larger than two tonnes. No weight data are given in the two main source documents quoted (Kapel 1979, Larsen & Kapel 1982), just average lengths for various time periods and fisheries. Translation of these lengths into body weights (and yield of meat and blubber) requires a formula such as that of Lockyer (1976).

The same difficulty is evident with the analyses for both humpback and fin whales, for which the estimated meat yields of “at least eight tonnes” and “at least ten tonnes” (respectively) are well below the figures that the paper gives for other fishery data. Specifically, for fin whales the paper gives mean lengths from Greenland of 17.7-19.2 m (citing Kapel 1979), and notes that Lockyer (1976) gives a figure of about 17 tonnes of meat for a fin whale with a body length of 18.5 m. However, Kapel (1979) notes the unreliability of at least some of these measurements. For humpbacks, mean lengths of 12.8-14.0 m are given (Kapel 1979), and Lockyer (1976) is cited as saying that a humpback whale of 13.5 m would yield about 14 tonnes of meat.

### Calculating meat and blubber yield from fin and minke whales

To examine the question of weight and yield, we used length data reported by the Greenland hunt itself, as well as from the IWC catch database. From these, we calculated estimates of body weight, and thereby of meat (and blubber) yields

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<sup>2</sup>This information was presented to the IWC’s Technical Committee; it does not appear that the Scientific Committee has ever reviewed the basis for the conversion factor.

<sup>3</sup>Use of an average length of “between 7.5 m and 8.0 m” from Larsen and Kapel (1982) is questionable since it includes animals whose length was estimated rather than measured; Larsen and Kapel themselves note that the mean length of minke whales measured by them, in 1979 and 1980, was 755 cm (range 560-840 cm) for males, and 764 cm (range 560-870 cm) for females.

for minke and fin whales. We did this using the formula given by Lockyer (1976) in her review of weights of baleen whales, and products derived from them.

Details of the data from the two sources above are as follows.

#### *Greenland hunt*

The position, species, sex, and length data used in this study were reported by the fishery for most minke whales landed in 2005 and most fin whales landed between 1986 and 2006. There is a reference in the conversion paper (Greenland Home Rule Government 1991) that lengths recorded in the hunt are unreliable, and certainly there are some outlying implausible length values in the data set; because of this, we discarded a few fin whale lengths greater than 23 m before analyzing the data. With the exception of a single somewhat implausible length of 10.48 m, the lengths given for minke whales taken in the 2005 hunt seem reasonable. However, given the possibility that the lengths recorded by the hunt are fundamentally unreliable (something which we are unable to judge, and which may have changed since the conversion paper was written in 1991), we also examined commercial catch data, below.

#### *IWC catch database*

The IWC catch database (February 2008 version) was queried for minke and fin whales for whom length had been reported. Data for average length of minke whales and fin whales were calculated for (a) the entire North Atlantic; (b) Davis Strait and Baffin Basin (defined as the waters between latitude 60 and 80 degrees N, and between longitudes 45 and 60 degrees W); and c) West Greenland (a subset of (b)). To decrease the likelihood that length measurements were unreliable, only data after 1945 were used. Obviously, the most appropriate of these data sets for the purpose of this paper is the third (West Greenland), or arguably the second (the waters between Greenland and eastern Canada); the entire North Atlantic is given solely for comparison.

Lockyer's (1976) formula for estimating body weight is:

$$W = \alpha L^b$$

where  $W$  is the body weight in tons,  $L$  is the body length in meters, and  $\alpha$  and  $b$  are constants derived for each species (see Lockyer 1976, Table 1). The formula accounts for fluid loss during processing. Lockyer states that the results are likely to be within 1.5% of true measured weight, with the formula tending to be conservative.

The weight of products (meat and blubber) was calculated using Lockyer's (1976) proportions of overall body weight, as follows: minke whales - muscle (meat) 62%, blubber 15%; fin whales - muscle (meat) 45%, blubber 24%.

## RESULTS

Mean lengths, mean estimated body weights, and mean values for yield of meat and blubber are given for the various datasets used in Table 1 (minke whales) and Table 2 (fin whales). Although there is some variation among the data sets queried, overall the results are quite consistent. It is possible that the Greenland hunt data are, as suggested by the Greenland Home Rule Government (1991), unreliable; but this is not apparent from our analysis, which shows the reported lengths (notably for minke whales) to be quite consistent with those from the other data sources.

### **Minke whales**

The average lengths of minke whales in all three datasets (Greenland hunt, entire North Atlantic, and West Greenland) were in a small range of from 6.9 to 7.2 m (Table 1). Mean body weight ranged from 4.4 to 5.0 tonnes. Meat (muscle)

made up from 2.7 to 3.1 tonnes of body weight. Blubber was estimated at an average of 0.7 tonnes across the board, with only one minor exception (0.8 tonnes for North Atlantic males).

### Fin whales

As with minke whales, the average length of fin whales was quite consistent in all four datasets (Greenland hunt, Davis Strait/Baffin Basin, entire North Atlantic, and West Greenland), ranging from 17.8 to 18.6 m (Table 2). Mean body weight ranged from 34.2 to 39.1 tonnes. Meat (muscle) made up from 15.4 to 17.6 tonnes of body weight, and blubber from 8.2 to 9.4 tonnes.

## DISCUSSION

### Conversion factors

Stated simply, the analyses presented here shows that average fin whale yields rather more than 16 tonnes of meat and between 8 and 9 tonnes of blubber. For minkes, the averages are about 3 tonnes of meat and 0.7 tonnes (700 kg) of blubber. There exists some variation in these calculated values among datasets, and certainly there are questions regarding the reliability of some of the length data involved; overall, however, the calculated values are very consistent and all are well above the values of 2 tonnes (minkes) and 8 tonnes (fin whales) currently in use.

The conversion paper (Greenland Home Rule Government 1991) gives a caveat for both fin and humpback whales that “the utilization of [these] whales is probably not as efficient as for minke whales.” We are not in a position to assess the extent to which logistical factors in the Greenland hunt - such as landing a carcass on a steep or rocky beach, with a large tidal range - play into these calculations; ultimately that is not a scientific issue. All we can say here is that the calculated yields are higher than those currently used.

If Greenland continues to present its needs statement in terms of tonnes of meat rather than number of whales, the most logical method of translating this into a future quota requirement would be to train the hunters to take accurate length measurements and require the recording of such data from all hunted whales. Calculating body and product weights from such on-site length data would inevitably provide a more reliable indication of yield than the average values (calculated from historical catch data) given here, or than the conversion factors of 2 and 8 tonnes currently in use. This method could - in theory - also be used to assess when the “yield” quota had been met, although we recognize that real-time coordination of data from the many hunters involved would likely be very challenging, and thus perhaps not practicable.

### Other issues

As noted in the Commission last year, the current needs statement does not take into account products other than meat that are utilized from the killed whales. The conversion factor paper itself (Greenland Home Rule Government 1991) notes this three times (once each for the sections on minke, fin and humpback whales):

*...To this [the estimated quantity of meat derived from the average whale] should be added an unknown, and probably variable, amount of other edible products to arrive at the conversion factor for total edible products.*

As noted above, estimates of the yield of blubber (the only other product that we considered) from minke and fin whales are given in Tables 1 and 2.

A final note is that the needs statement does not take into account products from the large number of small cetaceans killed in Greenland every year. These include harbor porpoise (*Phocoena phocoena*), pilot whales (*Globicephala melaena*), killer whales (*Orcinus orca*), belugas (*Delphinapterus leucas*) and narwhals (*Monodon monoceros*). According to reports submitted by Denmark, the takes of these (and other) species collectively number several thousand animals per annum.

## References

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Table 1. Mean lengths of, and estimated weights of the body and of meat and blubber from, minke whales killed in the Greenland hunt, as well as in the entire North Atlantic and off the coast of West Greenland (both from the IWC database). To exclude records involving unreliable length measurements, only IWC catch data from after 1945 were used. Body weight is the mean of all individual weights calculated on length values, using the formula from Lockyer (1976).

Area and sex	n	Length (m)		Body Weight (t)		Meat (t)		Blubber (t)	
		$\bar{x}$	st dev	$\bar{x}$	st dev	$\bar{x}$	st dev	$\bar{x}$	st dev
<b>Greenland hunt data</b>									
All animals	157	6.9	1.03	4.4	1.45	2.7	0.90	0.7	0.22
Females	124	6.9	0.99	4.4	1.37	2.7	0.85	0.7	0.21
Males	32	6.9	1.18	4.5	1.74	2.8	1.08	0.7	0.26
<b>IWC catch database</b>									
<i>Entire North Atlantic</i>									
All animals	1139	7.2	1.19	4.9	1.80	3.0	1.11	0.7	0.27
Females	690	7.1	1.22	4.8	1.84	3.0	1.14	0.7	0.28
Males	449	7.2	1.14	5.0	1.72	3.1	1.06	0.8	0.26
<i>West Greenland</i>									
All animals	222	7.1	1.55	4.9	2.25	3.0	1.40	0.7	0.34
Females	160	7.1	1.54	5.0	2.26	3.1	1.40	0.7	0.34
Males	62	7.0	1.59	4.8	2.24	3.0	1.39	0.7	0.34

Table 2. Mean lengths of, and estimated weights of the body and of meat and blubber from, fin whales killed in the Greenland hunt, as well as in the entire North Atlantic and off the coast of West Greenland (both from the IWC database). To exclude records involving unreliable length measurements, only IWC catch data from after 1945 were used. The data from the second category (Davis Strait and Baffin Basin) include all records from third (West Greenland) as well as animals taken elsewhere in the region between West Greenland and the Canadian coast. The third category involves only records labeled as "West Greenland" in the IWC database. Body weight is the mean of all individual weights calculated on length values, using the formula from Lockyer (1976).

Area and sex	<i>n</i>	Length (m)		Body Weight (t)		Meat (t)		Blubber (t)	
		$\bar{x}$	st dev	$\bar{x}$	st dev	$\bar{x}$	st dev	$\bar{x}$	st dev
<b>Greenland hunt data</b>									
All animals	181	18.0	1.91	35.7	10.33	16.1	4.65	8.6	2.48
Females	102	18.1	1.88	36.7	10.49	16.5	4.72	8.8	2.52
Males	79	17.7	1.93	34.5	9.96	15.5	4.48	8.3	2.39
<b>IWC catch database</b>									
<i>Entire North Atlantic</i>									
All animals	26,529	18.2	1.58	36.8	9.02	16.5	4.06	8.8	2.16
Females	13,414	18.6	1.71	39.1	10.02	17.6	4.51	9.4	2.40
Males	13,115	17.8	1.32	34.3	7.10	15.5	3.20	8.2	1.70
<i>Davis Strait &amp; Baffin Basin</i>									
All animals	344	18.3	1.41	37.0	8.12	16.6	3.65	8.9	1.95
Females	167	18.6	1.60	38.9	9.38	17.5	4.22	9.3	2.25
Males	177	18.0	1.14	35.1	6.17	15.8	2.78	8.4	1.48
<i>West Greenland</i>									
All animals	228	18.0	1.47	35.8	8.20	16.1	3.69	8.6	1.97
Females	118	18.3	1.61	37.3	9.10	16.8	4.10	9.0	2.18
Males	110	17.8	1.26	34.2	6.72	15.4	3.02	8.2	1.61