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Market surveys of whale meat in Japan 2008/2009: How many fin whales are for sale?

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ABSTRACT

We report on species identification of whale-meat products purchased directly and via the Internet from commercial markets of Japan from early July 2008 to early April 2009. The total of 59 products included six species of baleen whales, humpback (n=1), fin (n=27), Bryde's (n=1), sei (n=3), North Pacific minke (n=18) and Antarctic minke whales (n=6), and one species of beaked whale, Baird's (n=1). The individual identity of market fin whales was considered by comparison to products purchased since scientific hunting of fin whales in the Antarctic was initiated in the austral season of 2005/06 as part of the JARPA II programme. Although only 13 fin whales have been reported in the JARPA II program with a further 2 reported as coastal bycatch, a minimum of 20 individual fin whales were represented by products on the market during this time. Only one of these individuals matched to the mtDNA sequence of a product that was purchased before 2005/06. The import of fin whales from Iceland, released from Japan customs October 2008, was excluded as a likely source of products in the survey based on date of purchase and sequence identity. To improve control of commercial whale-meat markets and estimation of illegal, unreported or undocumented (IUU) takes, we **recommend** that information from the Japanese and Icelandic DNA register be made available through the data availability procedure of the IWC Scientific Committee.

INTRODUCTION

A diverse range of products originating from protected whales and unprotected dolphins continues to be widely available on commercial markets throughout Japan and some coastal cities of the Republic of (South) Korea more than 20 years after the 1986 international moratorium on commercial whaling. In 2000, Japan increased the species diversity of its legal market in whale products by expanding its scientific whaling programme in the North Pacific (JARPN II) and the Antarctic (JARPA II). In addition, Japanese regulations were changed from July 2001 to permit the killing and selling of whales that had been accidentally caught in coastal fishing set nets (Anon. 2001). Products from reported stockpiles of frozen products from species killed before the 1986 moratorium, or taken in subsequent scientific hunting by Iceland until 1989, are now presumably well past their reported 10-year 'use by' date. However the renewal of whale-meat trade between Iceland and Japan, starting in 2008, is a complicating factor in identifying the source of commercial products.

Here we report on the species identification of market products purchased in Japan between July 2008 and April 2009. The results of these recent surveys highlight persistent uncertainties regarding stock definitions for some protected species and stocks, and possible infractions of international agreements with regard to the likely origins of some products. Previously (Baker et al. 2007 & 2008), we presented evidence from products purchased in 2006 (referred to as the '2006 market survey') suggesting that some fin whale products sold in Japan prior to the start of the scientific hunt of this species in the Antarctic in 2005/06 did not originate from the Icelandic scientific hunt in the North Atlantic, the last legal source of fin whale. Additionally (Baker et al. 2008), we presented evidence from a combined analysis of products purchased during the '2006 market survey' and during 2007

(referred to as the '2007 market survey') suggesting under-reporting of the total numbers of fin whales taken in the scientific hunt and/or as coastal bycatch. Here we present results of market surveys during 2008 and early 2009 (referred to as the '2008/09 market survey'). Again, of particular interest was the minimum number of individual fin whales available on the market, relative to the expected number from the reported scientific hunt and coastal bycatch.

MATERIALS AND METHODS

Market product surveys

For the 2008/09 survey of Japan, products were purchased via the Internet from shops located in six prefectures on the islands of Honshu (Aichi, Tokyo, Osaka, and Wakayama,), Shikoku (Kochi) and Kyushu (Nagasaki) from July 2008 to March 2009. Shops were searched by key words, "whale meat" and "whale" in Japanese, and one to five products were purchased from those shops that specified whale species. Additionally, six prefectures (Iwate, Miyagi, Toyama, Ishikawa, Osaka, and Wakayama) were visited in March and April 2009. In an effort to evaluate changes to species availability resulting from the JARPA II hunt, fin whale products were purchased from all shops listing this species by name.

Field Amplification and Isolation of DNA

As in all previous surveys of commercials markets, DNA extractions from cetacean tissue and subsequent amplification via the Polymerase Chain Reaction (PCR) were conducted on site. The field analyses in the current surveys were performed using a Biometra thermocycler. Tissue from each product was prepared for amplification using Chelex resin (BioRad Laboratories) using the methods of Walsh et al. (1991), as described in Baker et al. (1996b). By using biotin-labelled primers and streptavidin-coated plates (see below), all amplified (synthetic) products were isolated and washed free of the original DNA template before transport to our home laboratory for direct DNA sequence analysis. This is in accordance with the regulations of the Convention on International Trade in Endangered Species (CITES 1973; Bowen and Avise 1994; Jones 1994).

Portions of two mitochondrial (mt) DNA loci, the control region (~ 800 base pairs, bp) and cytochrome b gene (~ 500 bp), were amplified for primary species identification as described previously (Baker et al. 2007 & 2008). Reactions were prepared for cycle sequencing using SAP/ExoI treatment (incubation with shrimp alkaline phosphatase and exonuclease I; Werle et al. 1994). Cycle sequencing reactions used an ABI Prism Big-Dye Terminator Ready Reaction Kit (v3.1, Applied Biosystems, Inc) and DNA sequencing was performed on an ABI3730 Automated DNA Sequencer (Applied Biosystems, Inc).

Identification of species and market individuals.

Species identification analysis was performed using the phylogenetic methods described by Baker and Palumbi (1994) and Baker et al. (1996a) as reviewed by Dizon et al (2000). Briefly, identification of 'test' sequences was performed using phylogenetic reconstruction methods based on maximum parsimony (MP) and neighbour joining (NJ) genetic distance algorithms available in the computer program PAUP* (Swofford 1999). Each test sequence was compared with a suite of 'type' or 'reference' sequences to make an initial assignment to family, and in some cases, genus. Test sequences identified to the same family were then grouped for secondary phylogenetic comparison to additional type sequences of the same or related species and appropriate outgroups. The consistency of species identification was estimated using 1,000 bootstrap simulations for both primary and secondary phylogenetic analyses. The phylogenetic methods of species identification used in this and previous surveys have been implemented in the web-based programme, DNA Surveillance, (www.DNA-surveillance.auckland.ac.nz; Ross et al. 2003). Individual identification was based primarily on variation in control region sequences augmented by sex information where available.

RESULTS

Species identification of market products

Amplification of the two mtDNA fragments was attempted from a total of 59 products, of which 57 produced reliable nucleotide sequences for either the mtDNA control region or cytochrome *b* gene, or both, for identification to the species level (Table 1).

Baird's beaked whale. One product was identified as a male Baird's beaked whale.

Sei whales. Three products were identified as sei whale (2 males and 1 unknown). Based on the number of unique mtDNA haplotypes and sex, the three products represent three individual sei whales.

Bryde's whale. One product was identified as Bryde's whale (unknown sex).

Humpback whale. One product was identified as a female humpback whale.

North Pacific minke whales. Eighteen products were identified as North Pacific minke whales. These represented at least 13 different individuals. Using the informative nucleotide sequence-based system of stock identification (allowing identification of haplotypes characteristic of J-and O-stock animals – 'haplogroups') developed in previous surveys (Baker et al 2000; Goto and Pastene, 1998), 9 of the products (representing at least 8 individuals) were identified as 'J' type likely to have originated from the East Sea/Sea of Japan and perhaps other coastal waters of Japan.

Antarctic minke whales. Six products were identified as Antarctic minke whales, two males, and four females. Based on sex and unique mtDNA sequences these 6 products represent 6 individuals.

Fin whales. Twenty-seven products were identified as fin whales, 19 females, 6 males and 2 unknowns. Based on haplotype variation and sex, at least 12 individuals were represented.

Expected number of fin whale market individuals

To determine the expected number of individual fin whales on the market, we reviewed annual progress reports to the IWC and the Marine Mammal Stranding Data Base (The National Science Museum/The Institute of Cetacean Research, http://svrsh1.kahaku.go.jp/). The JARPA II programme reported killing 10 fin whales (4 males: 6 females) during the 2005/06 season, 3 fin whales during the 2006/07 season (1 males: 2 females) and no fin whales during the 2007/08 season. Three strandings of fin whales during 2005 and 2006 seemed to have been disposed of rather than released to market (22nd Jan 2005, Okinawa, 2nd Feb 2005, Akita, 19th Mar 2006, Nagasaki). One fin whale was found in a set net alive and then died (or was killed) on 17th Dec 2007, in Iwate. A second was bycaught in a set net on 27 Dec 2008, in Wakayama. Both of these were reportedly released to the market. It is our understanding that fin whale products imported from Iceland were not released from Japanese customs until October 2008. Only three fin whale products (representing two individuals) in our survey were purchased after this date. One was labelled in store as 'Antarctic fin whale meat' and the first product purchased from the other individual was advertised as from the Wakayama bycatch. Consequently, we expected to find no more than 15 market individuals over all surveys, from 2006 to 2008/09.

Observed number of fin whale market individuals

Contrary to the expectation of 15 fin whales from reported sources, at least 20 fin whale market individuals were represented in market surveys since 2006, based on haplotype variation alone (Table 2). Of the 12 individual fin whales represented in the 2008/09 survey, 5 matched to the 8 individuals represented in the 2006 survey and these same 5 were also found in the 2007 survey. An additional 2 matched to the 7 other individuals in the 2007 survey, giving a minimum census of 20 market individuals (6 males:14 females). One of the 12 haplotypes from the 2008/09 survey matched to a haplotype found on the market in 1999 and again in 2000.

CONCLUSIONS

Market survey results have previously raised concerns for Illegal, Unreported or Undocumented (IUU) takes from stocks of at least five species of whales: sei, Bryde's, humpback, gray and North Pacific minke whales. Here, we present additional evidence for IUU takes from a sixth species, the fin whale. Unfortunately, in the absence of information reportedly available in the Japanese DNA register of whaling, we cannot confirm the identity of whales in scientific hunting and coastal bycatch, or the

source of the potential IUU takes. Nor can we exclude with certainty the potential that products from the Icelandic hunt are finding their way to Japanese markets through non-documented transport (e.g. smuggling). Based on the limited availability of reference sequences, however, we suggest that some IUU take of fin whales from the North Pacific or Southern Hemisphere has been ongoing since the start of market surveys in 1993.

To improve control of commercial whale-meat markets and estimation of IUU takes, we once again **recommend** that information from the Japanese and Icelandic DNA register be reported annually to the Scientific Committee or through the data availability procedure of the IWC Scientific Committee.

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Table 1: Species origins of whale, dolphin and porpoise products purchased in commercial markets of Japan between 1993 and April 2009, as determined by phylogenetic reconstruction of sequences from the mtDNA control region. All identifications of species or family were supported by high bootstrap values >95% using the methods described previously (Baker et al. 1996b; Baker and Palumbi 1994). Sample sizes indicate number of products identified to species, not necessarily the number of unique individuals represented by the products (see text for discussion).

Species	Japan 1993-03	Japan 2003/04	Japan 2006	Japan 2007	**Japan 2008/09**	Last legal source or year of international protection
Mysticeti						
Northern Pacific minke, *Balaenoptera acutorostrata*	231	40	5	15	18	Japanese scientific whaling, ongoing since 1994
Antarctic minke, *B. bonaerensis*	466	20	2	6	6	Japanese scientific whaling, ongoing since 1987/88
Common-form Bryde's whale, *B. brydei* following Wada et al. 2003	23	4	-	13	1	1986 moratorium, or 1987 by Japan under objection. Japanese scientific whaling (JARPNII) since 2000.
coastal-form Bryde's whale, *B. edeni* following Wada et al. 2003; also Baker *et al*. 1996b, Yoshida and Kato, 1999)	0	-	-	-	-	Species not formally recognised until 2003 but presumably protected since 1986 moratorium, or 1987 by Japan under objection
Sei, *B. borealis*	16	16	6	21	3	1986 moratorium, 1977/78 for Antarctic; 1977, Brazil; 1978, Peru; 1979, Chile, 1979; 1980, Spain; 1988 Iceland; 2002 for Japan (JARPNII)
Fin, *B. physalus*	35	2	15	39	27	1986 moratorium, or 1989 for Iceland scientific whaling; Japanese scientific whaling in the Antarctic (JARPAII) since 2005/06
Blue/Fin hybrid* (confirmed in 2008)	2	-	-	-	-	1989, Iceland scientific whaling (Cipriano & Palumbi 1999)
Humpback, *Megaptera novaeangliae*	7	1	3	5	1	1966
Gray, *Eschrichtius robustus*	7	-	-	-	-	1937
Odontoceti						
Sperm whale, *Physeter macrocephalus*	6	-	-	-	-	1986 moratorium, or 1988 by Japan under objection. Japanese scientific whaling (JARPNII) since 2000.
Dwarf Sperm, *Kogia simus*	1	-	-	-	-	No international protection
Beaked whales, *Berardius bairdii, Ziphius cavirostris, Mesoplodon carlhubbsi, M. densirostrus*	56	3	-	-	1	No international protection
Killer whales, *Orcinus orca*	1	-	-	-	-	No international protection
False killer whale, *Pseudorca crassidens*	1	-	-	-	-	No international protection
Dolphins – including pilot whales and members of the *Stenella-Tursiops-Delphinus* complex etc (>6 species)	119	6	-	-	-	No international protection
Finless porpoise, *Neophocaena phocoenoides*	0	-	-	-	-	No international protection
Dall's porpoise, *Phocoenoides dalli*	14	-	-	-	-	No international protection
Other mammals						
Sheep	2	-	-	-	-	n/a
Horse	3	-	-	-	-	n/a
Total	990	92	31	99	57	1269 (Grand Total)

Table 2: Individual fin whales identified in the three market surveys (2006, 2007 and 2008/09) and the number of products of each individual that were sampled in each survey.

Individual information		Market survey		
Haplotype code	Sex	2006	2007	2008/09
JMarket 1	F	3	1	4
JMarket 2	F	2		
JMarket 3	M	3	6	1
JMarket 4	F	2	3	1
JMarket 5	M	2	2	2
JMarket 6	F	1		
JMarket 7	F	1		
JMarket 8	M	1	1	1
JMarket 9	F		14	11
JMarket 10	F		1	
JMarket 11	F		1	
JMarket 12	M		6	1
JMarket 13	F		1	
JMarket 14	M		1	
JMarket 15	F		1	
JMarket 16	F			1
JMarket 17	F			1
JMarket 18*	M			1
JMarket 19	F			2
JMarket 20	F			1
Cumulative number of products		15	53	80
Cumulative observed number of individuals		8	15	20
Cumulative expected number of individuals		10	13^	15#

* Haplotype JMarket18 was also found in samples collected in 1999 and 2000

^ Excludes the bycaught animal reported 17 Dec 2007 based on mtDNA identity and sampling dates (see Baker et al 2008)

Includes 2 bycaught animals, excludes JARPA II 2008/09 catch of 1 fin whale based on sampling dates. Also excludes import of product from Iceland (see text for details).