Status review of small cetacean species targeted by direct hunts in Japan

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ABSTRACT

In the last 70 years, over a million small cetaceans have been killed in direct hunts in Japan. Major declines in catches have occurred in six of the nine species targeted, occurring prior to and extending beyond catch reductions incurred by the introduction of quotas, indicating potential declines in the exploited populations. Objective data on catch per unit effort and catch composition is lacking, but despite a data poor situation, changes in catch composition indicative of over-exploitation have been observed in three of the nine species hunted. Although 2007-2013 has seen progressive quota reductions in six of the nine species targeted by hunts, recent assessments of current catch limits indicate that for eight species, catch limits are unlikely to be sustainable, let alone sufficient to allow recovery of exploited populations. In addition to likely unsustainable levels of mortality, there are additional unquantified but potentially population level consequences of hunts that may be reducing the fitness of remnant populations and limiting their ability to recover. This report reviews historical catch and quota data and the information currently available on the status of exploited stocks. The status of Dall's porpoise is covered separately in SC/65a/SM11 by the same authors. Despite multiple indications of population declines, assessments of the structure and abundance of exploited populations (with the exception of some populations of Baird's beaked whales, Dall's porpoise and the Pacific white-sided dolphin) are based on surveys conducted 20 years ago and urgently require updating.

HUNTING METHODS

Small-type coastal whaling

Small-type coastal whaling vessels target Baird's beaked whales (*Berardius bairdii*), short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*) and false killer whales (*Pseudorca crassidens*) (Fisheries Research Agency, 2012a; Kasuya, 2007). Hunts occur for the most part within 50 nautical miles of the coast operating from whaling bases in Hokkaido, Miyagi, Chiba and Wakayama (Fisheries Research Agency, 2012a). In 2011 a new whaling base was established in Kushiro (Hokkaido) for the summer hunt to compensate for the destruction of the Ayukawa whaling base in Miyagi during the Great East Japan Earthquake. The autumn and winter hunt resumed out of Ayukawa (Fisheries Research Agency 2012a).

There has been a decline in overall catches by small-type coastal whaling in the last decade (Figure 1), largely due to declining catches of both forms of the short-finned pilot whale (see Appendix 1, Table 1). This decline is particular marked for the northern form, with none caught from 2007-2010 (see Appendix 1). In 2008, a quota of 20 false killer whales was added and the 20 Risso's dolphins were removed, however no false killer whales have been caught since the quota was established (see Table 1 and 2).

In 2012 there has been an expansion of the hunts' effort with regards to Baird's beaked whales, with an expansion of permitted hunting seasons and an increase in the number of licensed vessels allowed to conduct hunts in the Okhotsk Sea. Hunts in the Sea of Japan are permitted from May to June, the Pacific Ocean hunt runs from July-August and is now extended to allow hunting in November and December, while in the Okhotsk Sea the whaling season has been extended to permit hunts in September as well as August. An additional vessel has been licensed to hunt Baird's beaked whales in the Okhotsk Sea, such that out of the five licensed vessels, one is licensed for the Sea of Japan, four for the Pacific Ocean and three for the Okhotsk Sea (Fisheries Research Agency, 2012b).

Drive hunts

Drive hunts were widespread from the 14th until the late 19th/early 20th century. In the early 20th century they gradually declined such that by the mid 20th century villages along the Sea of Japan and Pacific coasts

had ceased drive hunting and hunts were limited to the Izu coast, Taiji, Nago and the Nagasaki prefecture (Kasuya, 2007). They are now licensed to occur in two locations, Futo on the Izu coast (Shizuoka prefecture) and Taiji (Wakayama prefecture) (Kasuya, 2007). Although Futo has a drive hunt quota, Taiji is the only town currently conducting drive hunts. It is unclear whether this reduction to just two hunting areas was caused by a decline in dolphin populations, decreased demand or other factors. However, though the number of villages hunting declined in the 20th century, the efficiency and potential range of hunts expanded with the introduction of faster vessels, allowing the capture of greater numbers of cetaceans in a smaller amount of time (Kasuya, 2007).

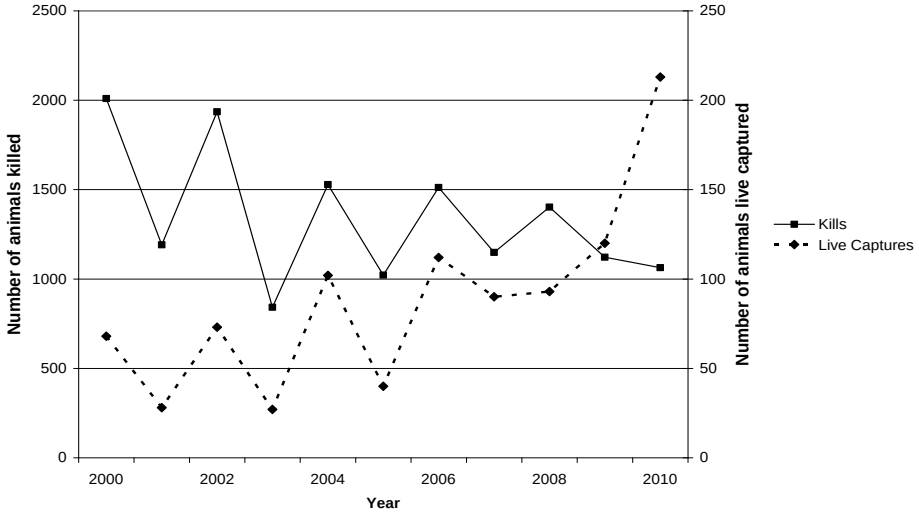
Historically, the striped dolphin (*Stenella coeruleoalba*) has been the main target of the drive hunt. Between 1963 and 1980 a total of 132,282 striped dolphins were killed, with catches peaking at 16,247 in 1980 (Kasuya, 1999a; National Research Institute of Far Seas Fisheries, 1979-2010). While the number of hunts operating remained the same, the annual catch of this species declined after 1980, most likely due to a population decline in this species (Kasuya, 1999). The numbers and species permitted under current quotas for drive hunts are shown in Table 1.

Trends in live captures

Drive hunts supply animals both for live trade and for consumption. While 99% of the catches over the last decade have been for consumption, the live dolphin trade is highly profitable. Over 1,500 small cetaceans have been caught for sale to national and international aquaria over the past 20 years (1990-2010), for 660,000-7,712,000 yen ($8,406 - $98,222) per dolphin between 2002 and 2012 (Elsa Nature Conservancy *pers. comm.*). Bottlenose dolphins (*Tursiops truncatus*) are the main target, constituting 76% of the catch, with false killer whales (9% of live catch) and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) (7% of live catch) also popular. The quota for Pacific white-sided dolphins was issued in the 2007-2008 season, although live captures did occur prior to this.

The number of live captures has fluctuated from year to year but over the last decade the number of cetaceans killed has gradually declined while the number of live captures has increased; from a mean of 45 live captures per year from 1999-2000 to a mean of 90 per year between 2001 and 2010 (Figure 1), concomitant with an increase in international exports.

Figure 1: Trends in live captures and kills in drive hunts in Taiji between 1986 and 2010, as reported in Japan's progress reports to the IWC.



Hand harpoon hunts

The largest hand-harpoon hunt is the northern Dall's porpoise hunt, which is examined in detail in SC/65a/SM11. The hand harpoon hunts in southern Japan are at a smaller scale than the drive hunts. Wakayama-based hunters are authorised to catch bottlenose, Pacific white-sided, Risso's, spotted (*Stenella attenuata*) and striped dolphin, while hunters in Chiba have quotas for striped dolphin only (Table 1).

Table 1: Quotas for 2012-13 by species and prefecture (Elsa Nature Conservancy, 2013).

Type of hunt	Prefecture	Number of operational months in 2010 (dates)	Number of vessels	Species										
				Baird's beaked whale	Bottlenose dolphin	Dall's porpoise (*dalli*)	Dall's porpoise (*truei*)	False killer whale	Pacific white-sided dolphin	Risso's dolphin	Short-finned pilot whale (northern)	Short-finned pilot whale (southern)	Spotted dolphin	Striped dolphin
Small-type whaling	Hokkaido	1-2 (25th May–30th June in Hakodate, 20th June-31st August in Abashiri)	5	14										
	Miyagi	~2 (20th June-31st August)		52							36			
	Chiba	~2 (20th June-31st August)										36		
	Wakayama	unknown						20						
Drive hunting	Shizuoka	7 (1st Jan-31st March and 1st Sept-31st Dec)	50		51			10	36				181	28
	Wakayama	10 (1st Jan-30th June and 1st Sept-31st Dec)	17		604			70	134	270		161	400	450
Harpoon hunts	Hokkaido	4.5 (1st May-15th June and 1st Aug-31st Oct)	16			1,192	83							
	Aomori	6 (1st Jan–30th April and 1st Nov-31st Dec)	8			8								
	Iwate		196			5,726	6,611		154					
	Miyagi		7			221	214							
	Chiba		11											32
	Wakayama	8 (1st Jan-31st Aug)	100		68				36	226			70	100
	Okinawa	9 (1st Jan-31st Aug and 1st Dec-31st Dec)	6		7			20				53		
TOTAL				66	730	7,147	6,908	120	360	496	36	250	651	610

STATUS OF TARGETED SPECIES

Baird's beaked whale (*Berardius bairdii*)

Distribution and abundance

Three subpopulations of Baird's beaked whales have been identified in the western North Pacific (Sea of Japan, Okhotsk Sea, and Pacific Ocean) with other possible populations in the eastern North Pacific and Bering Sea (Taylor *et al.*, 2008a). Abundance is estimated to be 7,000 for the three populations in Japanese waters (Barlow *et al.* 2006; Taylor *et al.*, 2008a), comprising 3,950 (CV=0.28) for the Pacific coast, 1,260 (CV=0.45) for the eastern Sea of Japan and 660 (CV=0.27) for the southern Okhotsk Sea (IWC, 1992b; Miyashita, 1990). An updated estimate of 7,307 (from surveys in 2009) to 10,190 (from surveys in 2008) was provided for areas off the Pacific coast in 2012 (Funahashi & Kasuya, 2012; Okamura *et al.*, 2012). It should be noted that different areas were surveyed in the two years and these may not be comparable with those surveyed in previous surveys. No analysis of trends in abundance has been published (Funahashi & Kasuya, 2012; Okamura *et al.*, 2012). With the exception of the Pacific population, estimates for the other areas (Okhotsk Sea and Sea of Japan) are based on surveys conducted twenty years ago and, given the continued exploitation of these populations of Baird's beaked whales, urgently require updating.

Hunts

Hunting of Baird's beaked whales began around 1600, primarily in the seas around Chiba prefecture in hand harpoon hunts (Fisheries Research Agency, 2012b). Hunting by small-type coastal whaling vessels began in the early 20th century and increased sharply following World War II, spreading to Hokkaido, the north-east (Sanriku) coast and to the Sea of Japan (Funahashi & Kasuya, 2012; Kasuya, 2007; Taylor *et al.*, 2008a). Hunts now occur primarily on the Pacific coast and in the Okhotsk Sea (Fisheries Research Agency, 2012b).

Regulation began with limits on the number of chaser boats in Chiba in 1920 and a licensing system for small-type whaling vessels in 1947 (Funahashi & Kasuya, 2012). In 1983 an annual catch limit of 40 animals was established, rising to 54 after 1990 when it became one of the main species targeted by small-type whaling following implementation of the commercial whaling moratorium in coastal waters in 1986. Quotas have since been increased several times and currently total 66 Baird's beaked whales - 10 from the Sea of Japan, four from the Okhotsk Sea and 52 from the Pacific Ocean (Fisheries Research Agency, 2012a; Figure 3). In 2012, the hunting season and number of vessels licensed to hunt Baird's beaked whales in specific areas was increased (Fisheries Research Agency, 2012a). The reason for this increase in effort is unclear as the allocated quotas are already being reached (Figure 2).

Catches between 1815 and 1869 are reported to have varied between zero and 25 whales per year (Funahashi & Kasuya, 2012). Over this period they declined and the ratio of 'good' to 'bad' years decreased, interpreted by some as indicating a decrease in the number of Baird's beaked whales migrating close to the inshore fishing ground (Funahashi & Kasuya, 2012). Catches peaked at 322 in 1952, though this figure (and data for 1959 to 1974) may include misreported sperm whales (Funahashi & Kasuya, 2012; Kasuya 1999a). Subsequent catches progressively declined, falling to 4% of the 1952 catch by 1976 (Funahashi & Kasuya, 2012). Since 1976 catches have stabilised, with between 90% and 100% of the allocated quota being caught (Funahashi & Kasuya, 2012; Figure 4).

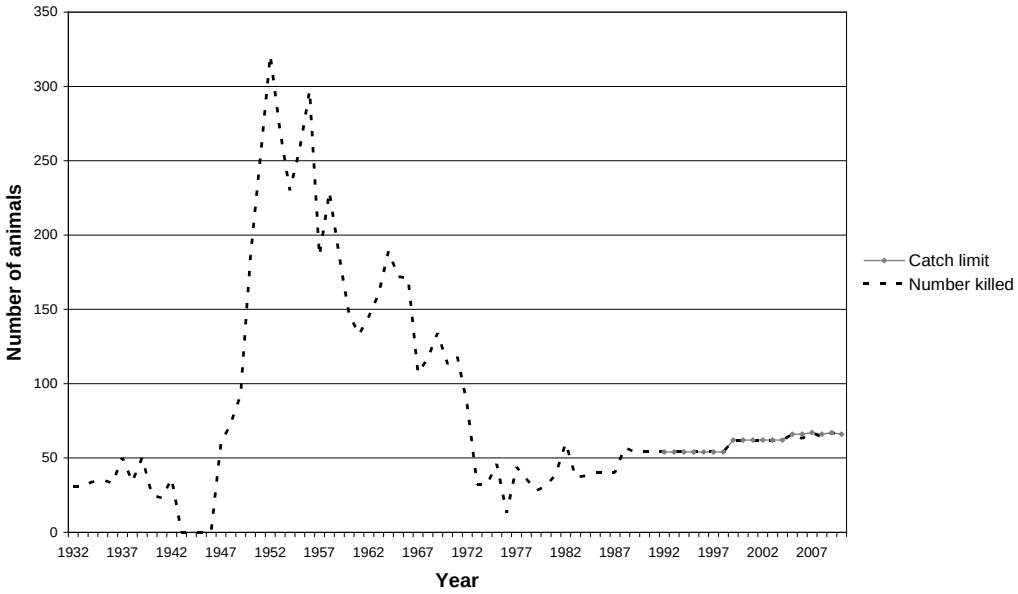
Status

For populations in Japan's waters, the Japanese Fisheries Research Agency states that it is unclear what effect catches have had on resource levels, that it is difficult to foresee current levels having any negative impact, but also states that, that said population estimates date from the 1980s-1990s, with no estimate of their levels from recent years (Fisheries Research Agency, 2012a; Taylor *et al.*, 2008a). The Japanese Fisheries Agency also notes that, given their restricted distribution and small populations, it is difficult to say that Baird's beaked whales are in an optimal state, and probably valid to say that they are in average condition, with no indication of an increase or decrease in levels from changes in catch composition (Fisheries Research Agency, 2012a). The three populations off Japan are assessed as Rare by the Japan Fisheries Agency and Mammalogical Society of Japan (Funahashi & Kasuya, 2012).

The IWC small cetacean sub-committee has noted that the current catch level "represents about 1% of the estimated population size and in the absence of an estimate of gross reproductive rate, was unable to

determine whether or not the population could sustain the catches" (IWC, 2012). Both the IWC Scientific Committee and Fisheries Research Agency highlight the need for updated abundance estimates (Fisheries Research Agency, 2012a; Funahashi & Kasuya, 2012). Reiterating previous advice (IWC, 1991), the Scientific Committee therefore recommended in 2012 that: "(1) It is especially important to clarify population structure and geographical boundaries of the stocks off Japan, particularly as long as hunting continues there; (2) Improved and updated abundance estimates are needed for each population, and trends in abundance should be assessed. These needs particularly apply to exploited stocks" (IWC, 2012).

Figure 2: Catches of Baird's beaked whales between 1932 and 2010, as reported in Japan's progress reports and Kasuya (2012).



Short-finned pilot whale *(Globicephala macrorhynchus)*

Distribution and abundance

Two geographical forms of short-finned pilot whale occur off Japan, known as northern and southern forms, which differ in external and cranial morphology. These may represent separate species or subspecies but are currently treated as a single taxonomic unit (Taylor *et al.*, 2011). In coastal waters off the Pacific coast of Japan the northern form is estimated to number 4,239 (CV=0.61) and the southern form 14,000 (CV=0.23) for inshore waters north of 30°N, west of 145°E based on surveys from 1983-1991 (Miyashita, 1993). An updated estimate of 15,057 (CV=0.71) for the southern form was published in 2007 (based on surveys from 1998-2001) but this covers a much larger area – north of 10°N, west of 180°E and differences in the season and area of the surveys prohibits any analysis of trends of exploited stocks (Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012a).

Hunts

Short-finned pilot whales were historically targeted by commercial hunts in the western North Pacific (Taylor *et al.*, 2011). The northern form, which is found along Japan's Pacific coast, is now targeted by small-type coastal whaling. The southern form is distributed over a broad area to the south of the northern form and is targeted by the drive, hand harpoon and cross-bow hunts as well as small-type coastal whaling. The southern form continues to be killed in larger numbers and over a larger geographical area than the northern (Figures 3 and 4). In addition to kills in hunts, bycatch of pilot whales has occurred in passive nets and traps set by Japanese fisheries; previously estimated to kill 350-750 annually (Bernard & Reilly, 1999).

Prior to the establishment of quotas, catches (of both forms combined) varied from a minimum of 90 in 1979 to 685 in 1980, with over 11,000 taken between 1963 and 1993. Quotas of 50 northern form and 500 southern form short-finned pilot whales were established in 1993. They remained at these levels until 1999 when they were increased but have since been reduced, such that in 2012-13 they are set at 36 for the

northern form and 250 for the southern form (National Far Seas Research Institute 1979-2010; Figure 3 and 4).

Since the establishment of quotas, catches have continued to fluctuate; particularly those of the southern form (Figure 3). The quota for the southern form short-finned pilot whale has never been filled and catches declined to their lowest in 2010, with only 16% of the reduced quota reached (National Far Seas Research Institute, 1979-2010; Figure 3). Catches of the northern form largely reached quotas between 1993 and 2003, but since 2003 have sharply declined, taking a maximum of 61% of the quota in 2005 and since 2007 none have been caught (Figure 4 and Appendix 1, Table 1).

Without data on effort made to catch the whales, the reason for such catch declines is unclear, potentially indicating a decline in effort, reduced catches due to population declines or a combination of the two (Funahashi & Baker, 2011). Changes in catch composition as far back as the 1980s indicated overhunting, with a decline in the proportion of old and large individuals in the catch of the northern form but no up to date information on catch composition has since been published (IWC, 1987). Despite recent quota reductions for both forms, permitted catches of the southern form exceed likely sustainable levels, while those for the northern form are yet to be assessed. Funahashi & Baker (2011) applied the Potential Biological Removal (PBR) threshold to approximate sustainable catch for the populations targeted by Japanese drive hunts (Funahashi & Baker, 2011; Wade *et al*., 2008). This method is designed to prevent populations from declining below their maximum net productivity level, thought to be a level between 50-80% of carrying capacity (Taylor & Demaster, 1993;Taylor *et al*., 2000). Based on the PBR calculation, the 2012-13 catch limit is 1.8 times higher than the PBR threshold (with a recovery factor of 0.5) and average catches (2006-2010) are 1.9 times higher than the PBR threshold (Funahashi & Baker, 2011; Appendix 1, Table 2). The sustainability of the quota for northern form short-finned pilot whales has not been assessed, but the 2012-2013 catch limit equates to 0.8% of the estimated abundance.

Figure 3: Catches of southern-form short-finned pilot whales between 1986 and 2010, as reported in Japan's progress reports.

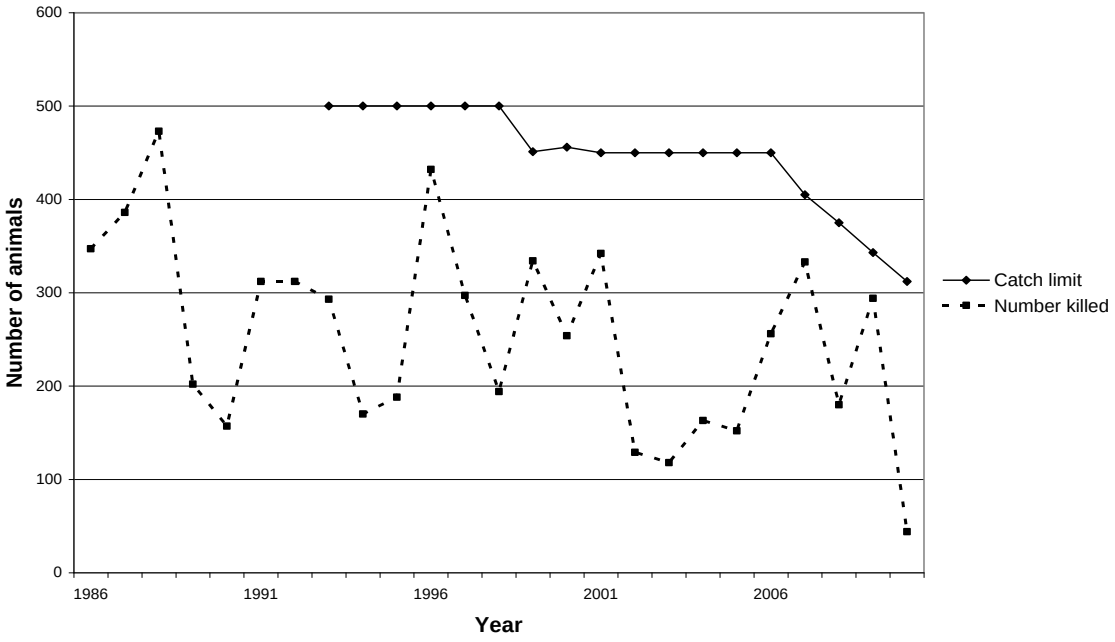
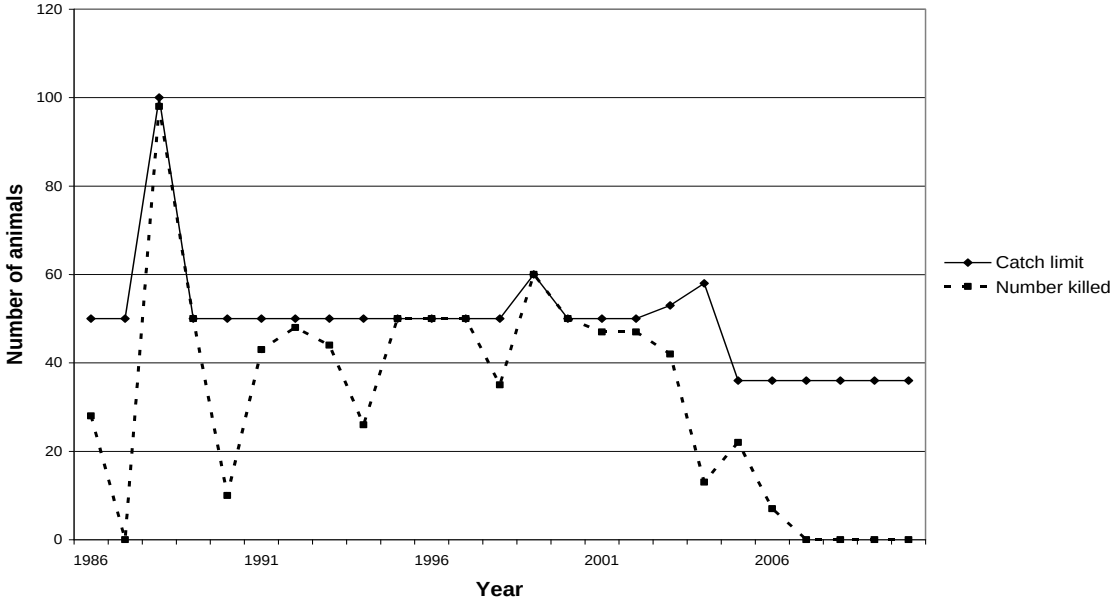


Figure 4: Catches of northern-form short-finned pilot whales between 1986 and 2010, as reported in Japan's progress reports.



Status

The short-finned pilot whale is classified as *Data Deficient* by the IUCN and there is no information on global trends (Taylor *et al.* 2011). The southern form short-finned pilot whale is considered depleted in Japanese waters (Taylor *et al.* 2011). If the different forms are indeed separate species, it has been noted that the separate taxonomic units may warrant being listed as *threatened* (Taylor *et al.*, 2007; Taylor *et al.* 2011).

Pilot whales were last reviewed by the IWC Scientific Committee in 1989 and in the context of Japanese drive hunts in 1992 (IWC 1990b and IWC 1992b). The Committee highlighted that available data suggests the northern population has declined, with a decline in the number and size of adult males having the potential to cause a decline in the reproductive potential of the stock. It stated that "*it was desirable that no animals be taken until we have a clearer understanding of the status of the stock*" (IWC, 1987). The situation requires urgent attention, particularly given the lack of catches in the last four years, despite an allocated quota.

Risso's dolphin *(Grampus griseus)*

Distribution and abundance

The Risso's dolphin population was estimated to number 31,012 (CV=0.21) based on surveys in waters off Japan north of 30°N and west of 145°E from 1983-1991 (Miyashita, 1993). From surveys in 2006-2007 it has been estimated at 32,864 (CV=0.45) for a considerably larger survey area, covering waters north of 30°N and west of 180°E (Fisheries Research Agency, 2012b; Minamikawa *et al.*, 2007). The differences in season and survey area of these surveys prohibit any analysis of trends and effort applied to coastal blocks was low, potentially limiting the accuracy of the more recent estimate (Minamikawa *et al.*, 2007).

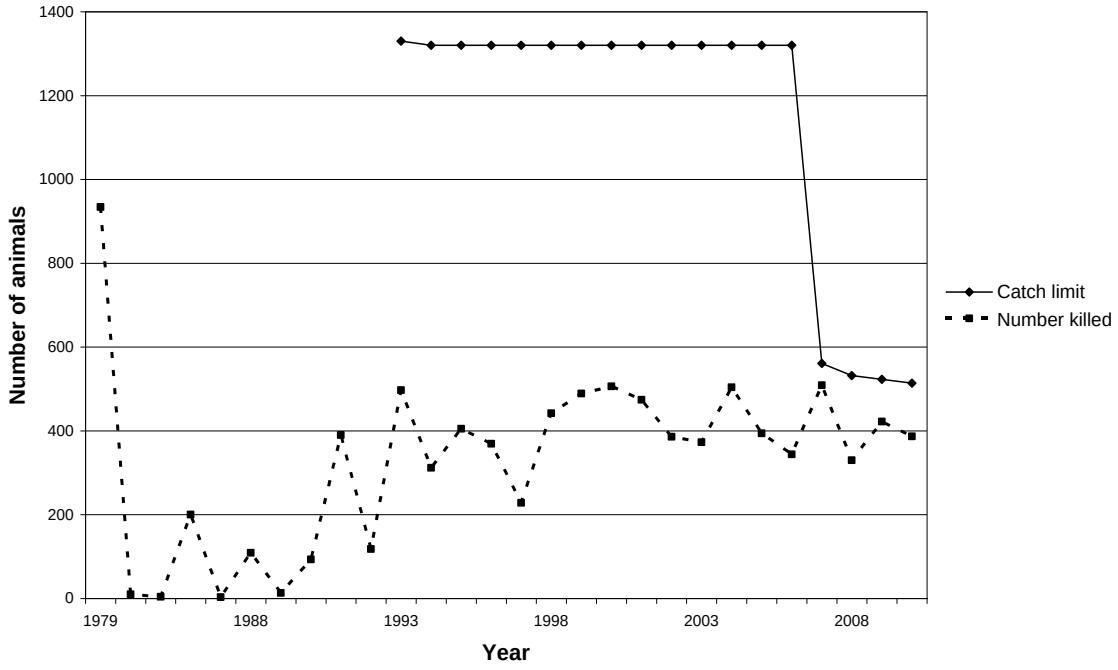
Hunts

Japanese drive hunts, small-type coastal whaling and hand harpoon hunts have all regularly hunted Risso's dolphins, both for food and for live captures (Taylor *et al.*, 2008b). The highest annual catch of 934 occurred in 1979, but catches largely remained below 100 per year throughout the 1960s-80s (Figure 5), though it should be noted that catch data prior to 1978 may be incomplete as they were not formally

reported until this date. Catches increased during the 1990s, perhaps in response to the declining catches of more popular species, and hunts have since killed approximately 200-500 animals per year between 1993 and 2010 (Figure 5).

Japan's quotas for Risso's dolphins have historically been set relatively high at 1,300 animals per year but have never been filled, with an average 30% of the quota taken between 1993 and 2006. In 2007 quotas were significantly reduced to 541 animals and in 2008 Risso's dolphins were removed from small-type coastal whaling quotas. Quotas have been gradually further reduced since, standing at 496 for 2012-13 (see Table 1). However, current quotas are still almost double (1.9 x PBR threshold) likely sustainable levels, calculated using a PBR threshold (with a recovery factor of 0.5) (Funahashi & Baker, 2011; Appendix 1, Table 2), with average catches (2006-2010) equating to 1.5 times this threshold (see Appendix 1, Table 2).

Figure 5: Catches of Risso's dolphins between 1979 and 2010, as reported in Japan's progress reports.



Status

This species has not been reviewed by the IWC other than in the context of their periodic reviews of direct takes of small cetaceans where it was concluded that there was insufficient information to determine the status of Japan's exploited populations (IWC, 1992b).

Striped dolphin *(Stenella coeruleoalba)*

Distribution and abundance

Abundance estimates for striped dolphin populations in the western North Pacific comprise a total of 570,000 individuals based on surveys from 1983-1991, of which the inshore population (north of 30°N, west of 145°E) was estimated at 19,631 (CV=0.696) (Miyashita, 1993). The estimated population level based on 2006 and 2007 surveys of a larger survey areas north of 30°N, west of 180°E was lower at 503,436 (CV=0.55) animals but there is no breakdown available for the inshore stock targeted by hunts and the authors note that given the large school sizes observed, abundance of striped dolphins may be overestimated (Miyashita, 1993; Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012b). Differences in season and survey area for the two estimates prohibits any analysis of trends and effort applied to coastal blocks was low, further limiting the accuracy of the more recent estimate (Minamikawa *et al.*, 2007).

Hunts

For over 100 years striped dolphins have been heavily hunted in Japanese waters in drive and hand-harpoon hunts, forming 8.9% of total small cetacean catches from 1979-2010 (Kasuya, 1999b). Prior to the introduction of quotas, over 157,000 striped dolphins were killed between 1963 and 1992 and it is thought that by the 1990s the Japanese drive hunt "*had depleted coastal stocks of striped dolphins to less than 10% of the post-World War II level*" (Kasuya, 1999b). Average annual catches declined from 7,856 per year 1961-1970 to 2,333 per year from 1981-1990, despite a large expansion of the fisheries geographic range over this period (Kasuya, 1999b; National Far Seas Research Institute, 1979-2010; Figure 6). In the 1990s and 2000s catches have averaged 562 per year.

In Futo region (Shizuoka prefecture) in particular, hunts may have led to the complete eradication of the striped dolphin migration (Kasuya, 1999b). Catches in this region dropped from 10,000-20,000 per year in the 1960s, to less than 5,000 throughout most of the 1970s, and then to less than 2000 per year during the 1980s, despite a constant number of vessels operating throughout this period (Kishiro & Kasuya, 1993; Figure 7). By the 1990s only tens of dolphins were caught most years and since 2000, not a single striped dolphin has been caught from Futo (Figure 7). Similarly in Chiba, they have not been successfully hunted since 1995 (Fisheries Research Agency, 2012b). In response, the Japanese Fisheries Agency has permitted the transfer of the Chiba and Shizuoka quota for this species to Wakayama and Okinawa, allowing an increase in exploitation elsewhere in the species range.

In 1993 a quota of 725 was introduced. It remained at this level until 2007 when it was reduced to 685 (Figure 6). In each year post-2007 it has been incrementally reduced, such that by 2012-13 it has seen a 16% reduction to 610 individuals (Fisheries Research Agency, 2012a).

In addition to the observed decline in catch per unit effort, a decrease in age of sexual maturity and an increase in the searching range required to locate striped dolphins have been documented (Kasuya, 2007), all indicative of over-exploitation (IWC, 1993a; Kasuya, 2007).

The Fisheries Agency states that it is formulating a resource management model that reflects reality more accurately than the "ultraconservative" PBR (Fisheries Research Agency, 2012a). The decrease in the quota has been acknowledged by the Fisheries Agency to be "*because captures have exceeded the number consistent with sustainable consumption of dolphins; but quotas could not be suddenly be decreased because of concerns about untoward effects on the fishermen's livelihoods*" (ELSA Nature Conservancy, 2011).

Figure 6: Catches of striped dolphins between 1942 and 2010, as reported in Japan's progress reports and Kasuya (1999b).

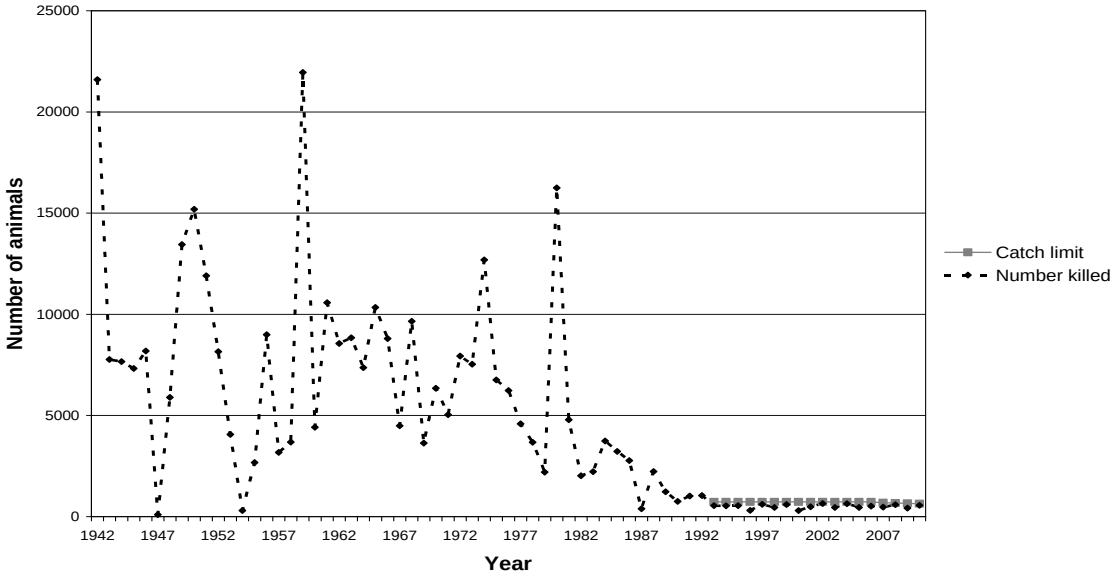
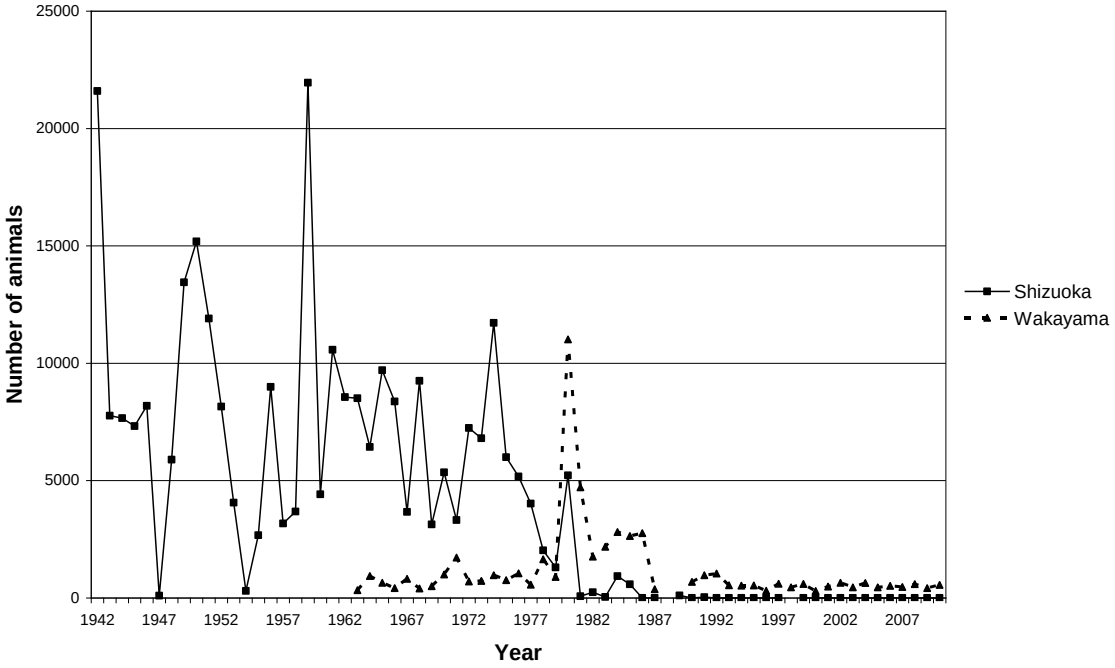


Figure 7: Catches of striped dolphins between 1942 and 2010 in Shizuoka and Wakayama prefectures, as

reported in Japan's progress reports and Kasuya (1999).



N. B. Data are not shown for 1989 as catches by prefecture are not given in the progress reports for this year. Data for Wakayama are incomplete for 1942-1963 (Kasuya, 1999).

Status

In Japan's national waters, population structure of the striped dolphin remains undetermined but available biological information suggests the presence of a heavily depleted coastal population(s) or even local 'extinction' (Kasuya, 1999b). The Fisheries Agency (1993) stated that "*It is reasonable to assume that the local coastal population [of striped dolphins] upon which Japan's drives have been dependent have sharply declined…..Current [1993] stocks are in all likelihood less than one-tenth 1950 levels*".

For over thirty years, the IWC Scientific Committee has repeatedly expressed concern on Japan's striped dolphin stock(s) (IWC 1982, 1992a, 1992b, 1993a, 1993b, 1998), noting that:
- Total catches of striped dolphins had been declining over the last 30 years despite little concomitant decline in effort;
- Reproductive parameters have changed in a manner consistent with a density decline;
- Drive fishermen have reported a decline in their abundance; and
- Quotas appear to be largely set on the basis of past catches rather than a calculation of sustainable catches.

On the basis of this it was concluded that the population could not sustain continued exploitation at the current level and it was strongly advised that there should be an interim halt to direct catches until a population assessment was conducted (IWC, 1992b). Two resolutions were passed by the commission in 1992 and 1993 asking the Japanese government to "take appropriate action as soon as possible that will allow recovery of the population" (IWC, 1992a; IWC, 1993b). However, the quota was not reduced until 2007 and by 2011 has seen only a 14% decrease from 1993 levels. Even the reduced 2012-13 quota is 5.3 times higher than the likely sustainable level based on a PBR threshold (with a recovery factor of 0.5). Average catches for the last five years are 4.4 times this PBR threshold and equate to 2.5% of the estimated abundance (Funahashi & Baker, 2011; Miyashita, 1993; Appendix 1, Table 2). Meanwhile no up to date assessment of the different stocks(s) has been conducted or management system implemented.

Pan-tropical spotted dolphin *(Stenella attenuata)*

Distribution and abundance

There is little information on the stock structure of the populations of spotted dolphins which are targeted by Japan's drive fisheries. Surveys from 1983-1991 estimated the population at 15,900 (CV=0.40), from sightings north of 30°N, west of 145°E (Miyashita 1993). The latest abundance estimate, which covers a much larger area north of 10°N and west of 180°E comprises 397,515 individuals (CV=0.42) based on surveys in 2006 and 2007, but the size of the inshore stock(s) targeted by hunts remains unknown (Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012a).

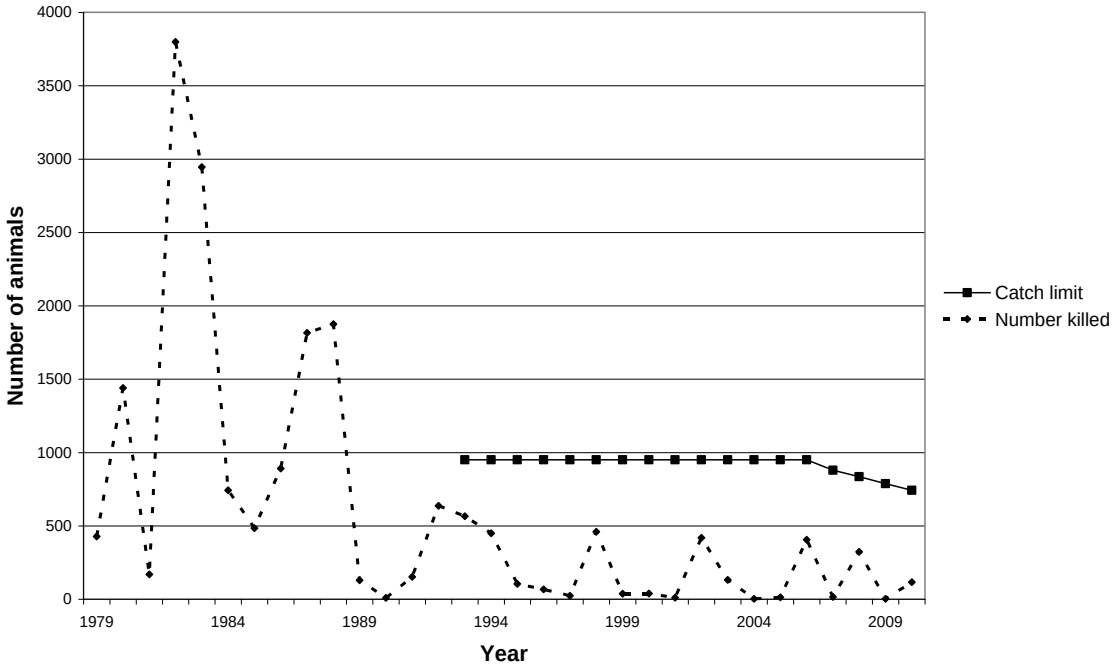
Hunts

Spotted dolphins are killed in large numbers by drive hunts in Japan (Hammond *et al.*, 2008a; Kasuya, 2007). Drive hunt catches have fluctuated dramatically from one year to the next, ranging between zero and 4,184 animals per year from the 1960s to the 1980s, though it should be noted that catch data was not formally reported until 1978 and may be incomplete prior to this date (National Research Institute of Far Seas Fisheries, 1979-2010, Figure 8).

Declines in catches occurred in the late 1980s and early 1990s, with a maximum of 636 killed per year in this period (Figure 8). Since the quota of 950 was introduced in 1993, catches have never filled the quota, with between 2 and 565 individuals killed per year. Throughout the 1990s and 2000s catch declines have continued. Mean annual catches have declined from 218 per year between 1993 and 2000 to a mean of only 134 per year from 2000-2010. Alongside the decline in catches, a possible decline in the minimum age of sexual maturity in females (Kasuya, 1985) and a decline in catch per unit effort (IWC, 1992) has been observed, indicative of an abundance decline in the local population.

Annual quotas were finally revised in 2007, and have been reduced to 651 for 2012-2013 (Figure 8 and Table 1). Despite these signals of overexploitation, quotas remain considerably higher than any catch attained since 1988. They are 5.7 times higher than the PBR threshold (with a recovery factor of 0.5) (Funahashi & Baker, 2011; Appendix 1, Table 2).

Figure 8: Catches of spotted dolphins between 1979 and 2010, as reported in Japan's progress reports.



Status

The status of the population(s) within Japan's waters is not known. Quotas are 5.7 times the PBR threshold (with a recovery factor of 0.5) (Funahashi & Baker, 2011; Appendix 1, Table 2). Here, as in other regions, populations have likely historically been subject to significant levels of bycatch as well as direct hunting and there are multiple signs of a decline in their abundance (Kasuya, 1985; IWC, 1992b).

Common bottlenose dolphin *(Tursiops truncatus)*

Distribution and abundance

In the north-western Pacific the bottlenose dolphin population is estimated at 168,000, of which 36,791 (CV=0.25) occur in Japanese coastal waters (north of 23°N, west of 180°E) (Miyashita, 1993). An updated abundance estimate of 38,829 (CV=0.63) was published in 2007 but for a much larger survey area (above 10°N, west of 180°E) (Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012a). Differences in season and survey area for the two estimates prohibit any analysis of trends (Minamikawa *et al.*, 2007).

Hunts

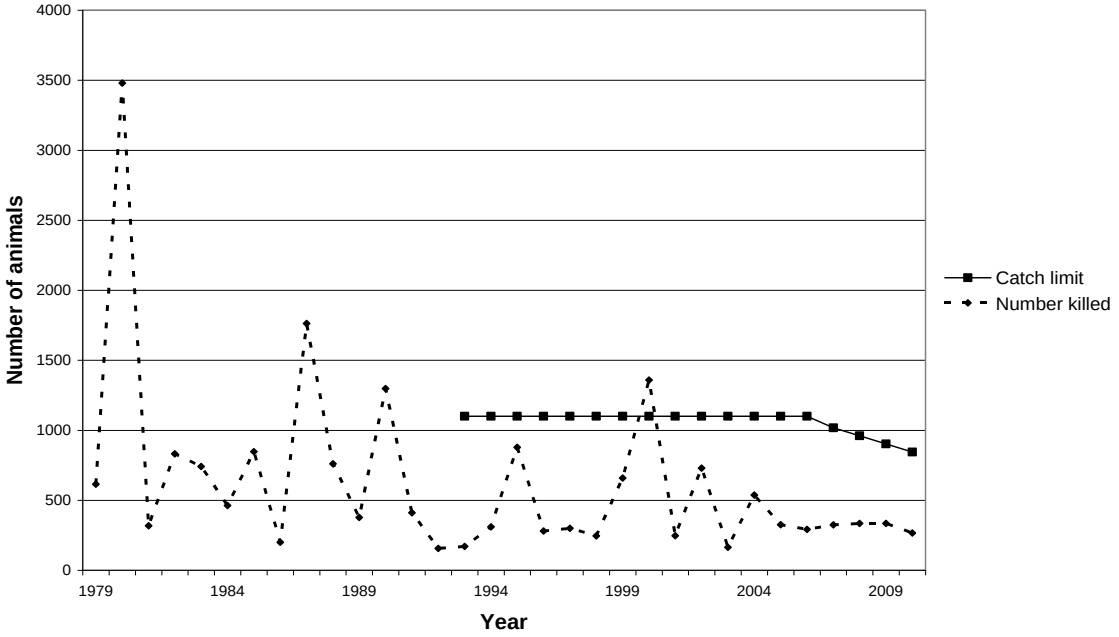
Japan's drive and hand-harpoon hunts have targeted bottlenose dolphins for human consumption and live capture (Wells & Scott, 1999). Culls alone previously killed several hundred annually off Iki Island and the Kii Peninsula between the late 1970s and 1995 (Wells & Scott, 1999; Kasuya, 2007). Bottlenose dolphins have been the main species targeted for the live capture trade and comprise 76% of the live captured individuals with a total of 1,196 captured since 1986 when records of live captures begin (National Research Institute of Far Seas Fisheries, 1979-2010).

Catches of bottlenose dolphins were low during the 1960s, with an average 34 animals killed per year (Kishiro & Kasuya, 1993), though this may reflect low rates of reporting rather than catches as they increase with the commencement of official reporting to the IWC (see Figure 9). An average of 127 per year were killed in the 1970s, increasing in the 1980s to 978 per year (Figure 10 and Appendix 1, Table 1). In 1993, an annual quota of 1,100 was set and it remained at this level until 2007 when it was reduced to 1,018 (Figure 10). It has been gradually reduced since, down to 730 for the 2012-2013 hunting season. This signifies a drop of 34% since 1993, but it remains more than double (2.4 times) the PBR threshold (Funahashi & Baker, 2011; Appendix 1, Table 2). Since 2001, catches have not exceeded 500 animals per year, with average catches (2006-2010) equating to 42% of the current quota (Figure 9 and Appendix 1, Table 1).

Status

In Japan, there is no information on the status of the exploited bottlenose dolphin stock(s) but quotas are set significantly higher than likely sustainable levels, where the PBR threshold is applied as an approximation of the sustainable catch (Funahashi & Baker, 2011). Even the recently reduced quotas remain 2.4 times the PBR threshold (with a recovery factor of 0.5) (IWC, 1992b; Funahashi & Baker, 2011; Appendix 1, Table 2).

Figure 9: Catches of bottlenose dolphins between 1979 and 2010, as reported in Japan's progress reports.



NB: Although it may appear than catches exceeded the quota in 2000, this is reported to be due to the difference between the management year (seasonal) and reporting year (calendar year) (National Research Institute of Far Sea Fisheries, 2008).

False killer whale *(Pseudorca crassidens)*

Distribution and abundance

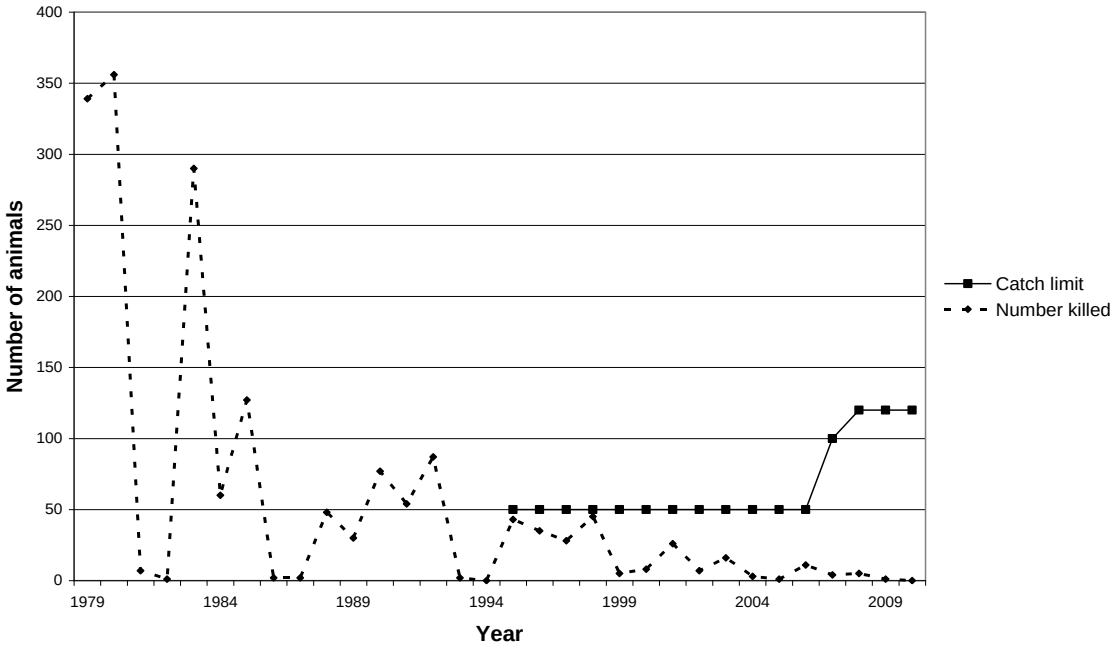
Although distributed over a wide area, the false killer whale does not occur in high abundance (Taylor *et al.*, 2008c). Historically it appears to have been relatively common off the Japanese coast, and for the western North Pacific population abundance was estimated at 2,029 (CV=0.429) (north of 30°N, west of 145°E) (Miyashita, 1993). The most recent estimate is 40,392 (CV=0.55) animals for waters north of 10°N, west of 180°E (Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012a). This covers a considerably larger area than the previous survey and was conducted in a different season prohibiting any extrapolation of population trends (Minamikawa *et al.*, 2007; Fisheries Research Agency, 2012a).

Hunts

Although targeted by all three hunts (hand harpoon, drive hunts and small-type whaling) false killer whales are currently killed in relatively small numbers (see Appendix 1, Table 1 and Figure 11). As well as being hunted for consumption, they are live-captured for the aquarium trade and have also previously been killed for their depredation of fisheries (Odell & McClune, 1999). Over 900 were culled between 1965 and 1980 around Iki Island in Japan due to interactions with the yellowtail fishery (Odell & McClune, 1999).

Catches were highest in the 1970s and 1980s, peaking at 356 killed in 1980. Following this, catches declined and from 1986 to 1992 did not exceed 100 per year with many years of zero, or near-zero, catches. Since the 1993 quota of 50 per year was established, catches have not even reached 50% of the quota in 12 of the 18 years (Figure 10). Despite this the quota was increased from 50 to 100 animals in 2007 and in 2008, 20 false killer whales were added to small-type coastal whaling quotas, giving a total quota of 120 for this species (Figure 10). The quota has remained at this level, which is a level at least 8.6 times higher than the PBR threshold (Funahashi & Baker, 2011; Appendix 1, Table 2).

Figure 10: Catches of false killer whales between 1979 and 2010, as reported in Japan's progress reports.



Status

The false killer whale is classified as data deficient by the IUCN, with global trend and abundance data unknown (Taylor et al., 2008c). The low abundance of this species suggests that it may be vulnerable to even low level threats (Taylor et al., 2008c). As such, with the combined threats of anthropogenic noise and bycatch alone, a 30% global reduction over three generations cannot be ruled out (Taylor et al., 2008c). There remains inadequate study and insufficient information to determine the status of the population(s) exploited by Japan's hunts (IWC, 1992b), but quotas are clearly set far above likely sustainable levels, being 8.6 times the PBR threshold (with a recovery factor of 0.5) and 5.9% of the abundance estimate (Funahashi & Baker, 2011; Appendix 1, Table 2).

Pacific white-sided dolphin *(Lagenorhynchus obliquidens)*

Distribution and abundance

Pacific white-sided dolphins are found in temperate waters of the North Pacific and some adjacent seas, including the Sea of Japan, southern Okhotsk Sea, southern Bering Sea and southern Gulf of California (Hammond *et al.*, 2008b). The most recent estimate for Japanese waters is 56,764 animals (waters north of 30°N, west of 145°E) (Miyashita *et al.*, 2007; Fisheries Research Agency, 2012b). Sub-populations have been identified off Japan (Hayano *et al.*, 2004). The coastal Pacific-Sea of Japan population is genetically distinct from the offshore North Pacific population, and there is further sub-division within the coastal population (Hayano *et al.*, 2004). It is unknown whether those that occur on the Pacific coast of southern Japan in autumn-winter are derived from the same Sea of Japan population as those on the northern coast (with a segregated migration on the basis of age or reproductive condition) or whether they comprise a separate population (Hayano *et al.*, 2004).

Hunts

Catch statistics begin in 1979 and report very high catch levels in 1983 (1,605) and 1984 (2,760). Subsequently catches have remained below 50 per year (Figure 11). Hunts for consumption ceased in 1993 when a quota was not created for this species but live captures continued, with 102 Pacific white-sided dolphins caught between 1993 and 2009 (National Research Institute of Far Seas Fisheries, 1979-2010). A catch limit for Pacific white sided-dolphins was added for the 2007-08 season, with an annual limit of 360

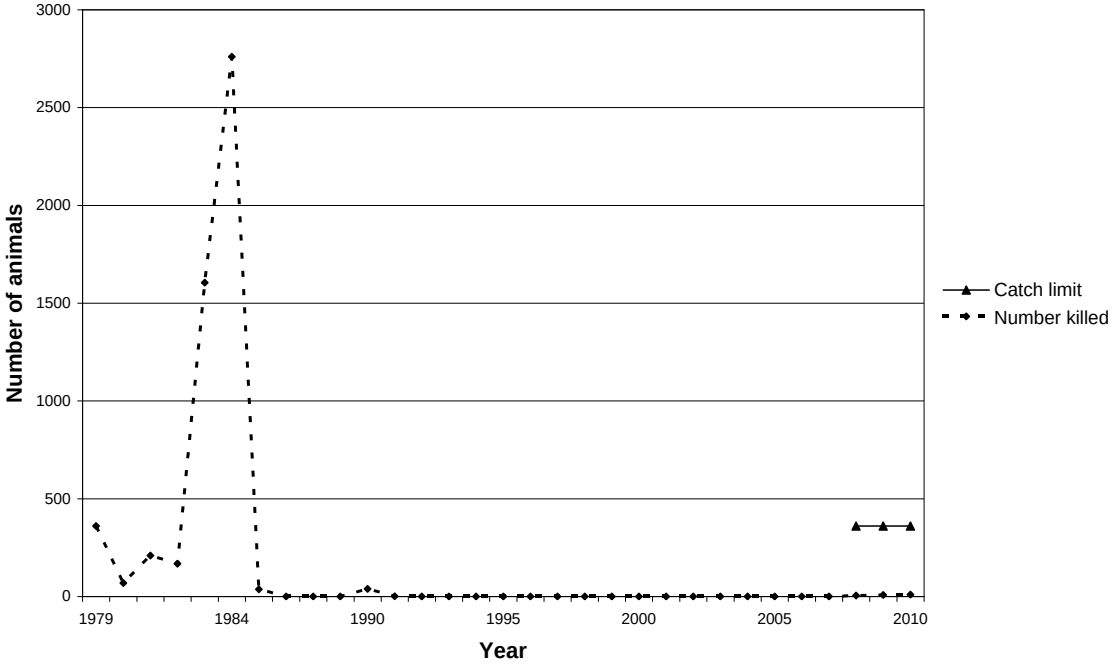
dolphins for the hand harpoon and drive hunts from 2008-2013. This new quota could represent an effort to compensate for declining catches of other species or may also be due to demand for this species by the aquarium industry (Elsa Nature Conservancy, 2007). Live captures have certainly increased in recent years, with 29 caught in 2008 and 2009 combined.

The current hunts target population(s) that may have been depleted by the high rates of bycatch in the 1970s and 1980s (Hobbs & Jones, 1993). In Japanese and Korean western Pacific driftnet fisheries the Pacific white-sided dolphin was one of the most commonly caught species in the 1970s-1990s, and, as an example of bycatch rates over this period, in 1990 bycatch from all fisheries was estimated at 5,759 in the North Pacific (Hobbs & Jones, 1993; Hammond *et al.*, 2008b). The Japanese government also supported cull programs for this species, killing 466 Pacific white-sided dolphins between 1976 and 1980 (Brownell *et al.*, 1999). The current quota is 1.1 times the PBR (Funahashi & Baker, 2011; Appendix 1, Table 2).

Status

In 2008 the IUCN review of this species concluded that as the population(s) being hunted show evidence of population substructure there should be a re-examination of the threat to this species (Hammond *et al.*, 2008b).

Figure 11: Catches of Pacific white-sided dolphins between 1979 and 2010, as reported in Japan's progress reports to the IWC.



UNKNOWN AND UNQUANTIFIED IMPACTS OF HUNTING

The officially reported catch data has demonstrated high and likely unsustainable levels of mortality for all of the populations of cetaceans exploited by hunts, with the exception of Baird's beaked whale and the northern form of the short-finned pilot whale which have not been assessed (Funahashi & Baker, 2011; Appendix 1, Table 2). Added to these reported catches are additional mortalities, neither monitored nor reported and likely sub-lethal effects that may reduce the survivorship and reproductive success of remnant populations and impede their recovery.

Undocumented mortalities

In the past, published figures have significantly under-reported the landed catches of Japan's small cetacean hunts. Examination has focused on the Dall's porpoise hunt but the incomplete prefectural coverage, lack of access to records from all fish markets, and omissions due to sale of landings outside the prefecture of

registration, may also extend to catch statistics of other small cetacean species taken by hand harpoon hunts.

In addition to under-reporting of landed catches, there are additional mortalities that are not reported in official figures. Struck and lost individuals are not included in such figures, neither are the deaths of dependent juveniles, and until 1986, reports did not include live captures – although these still remove individuals from wild populations. Struck and lost rates have only been reported for the Dall's porpoise hand harpoon hunt, where they were estimated to result in a total mortality 1.1-1.14 times (i.e. 10-14%) higher than the number landed (Fujise *et al.*, 1993). To our knowledge, those in small-type coastal whaling hunts or other hand harpoon hunts have not been reported. Additionally, the separation of mother-calf pairs is likely to result in the death of dependent juveniles given the extended period of juvenile dependency in odontocetes (Wade *et al.*, 2012). Such deaths are undocumented and unaccounted for in any of the hunts. Even the known juvenile deaths that occur in drive hunts, those that die 'naturally' in the drive hunt enclosure, are discarded and not considered part of the catch (Kasuya, 1999b). Additionally, intrinsic in all cetacean hunts is the inability to identify and avoid pregnant animals, reducing the recruitment potential of the population.

Population level impacts of stress

Individually and cumulatively, Japan's drive, hand harpoon and small-type whaling hunts repeatedly disturb targeted populations. In all three hunts, vessel noise and the pursuit itself is likely to not only induce stress in animals selected for killing but also non-target individuals in the immediate social group as well as animals in the wider geographical area.

Vessel noise alone has multiple adverse effects on cetaceans, reducing communication range and provoking avoidance behaviour that results in decreased energy acquisition and increased energy expenditure. It can also cause temporary and permanent shifts in distribution (Williams *et al.*, 2006; Lusseau & Bedjer 2007). This can affect populations to the extent that long-term declines in dolphin abundance have been linked to increased vessel activity (Bejder, 2005; Bedjer *et al.*, 2006).

The next event in the hunts, the pursuit phase, can also have severe detrimental effects at an individual and potentially a population level. Pursuit has been shown to cause stress-induced pathology in mysticete species that can lead to disease and unobserved mortality in animals that are not killed (Maas, 2003). Effects include impaired immune function, reduced fecundity and growth, and exertional myopathy (Maas, 2003). The latter disease is characterised by lesions and necrosis in cardiac and skeletal muscles and is frequently fatal (Maas, 2003). Given that the duration of the pursuit phase is a major factor in its development, the prolonged pursuit time of hand harpoon hunts and drive hunts may increase rates of such stress-induced pathology.

In drive hunts the stress on individuals which are not killed is likely to be particularly amplified, both in terms of the numbers of individuals affected and the level of stress. Drive hunts typically employ sound, using 'trumpets' that cause dolphins to swim away from the sound source, allowing hunters to drive dolphins towards the coast. Source levels of 205dB are sufficiently high that cetaceans at distances of up to 1.2km may receive levels that elicit this behavioural response with the result that non-target individuals over a wide geographic area may be disturbed and displaced by the hunt (Akamatsu, 1993; Brownell, 2008).

In addition to effects on non-target individuals in the wider geographical area, drive hunts regularly pursue dolphins for an extended period of time but may ultimately fail to catch them, or pursue, drive and confine a larger number of animals than they intend to kill. Large numbers of dolphins may be released after being subjected to a prolonged pursuit, acute noise and confinement. No formal reporting of the numbers caught and then released is required, but releases have often been documented by observers of the hunt. Given the number of animals involved, the rate of lethal and sub-lethal stress-induced physiological and behavioural changes may be common enough in released individuals to have population-level consequences. Not only would any delayed stress-induced mortalities add to the known high levels of mortality that populations are experiencing but the potential sub-lethal consequences of reduced immune function, growth and fecundity from stress-induced pathology could further reduce the reproductive potential of populations and their ability to recover from such removals. Such impacts have, to our knowledge, not been studied, nor taken into account in the management strategy and setting of catch limits.

Social disruption and other factors slowing recovery

The life-history, social and behavioural characteristics of odontocetes may make them less resilient to overexploitation than mysticete species (Wade *et al.*, 2012). The life-history characteristics of a relatively old age of first reproduction and a low calving rate lead to low maximum rates of increase (≤4% per year) in odontocete populations. They can therefore be overexploited with catches of only a few percent per year (Wade *et al.*, 2012). Recovery is further delayed if exploitation has selectively targeted reproductive-aged individuals due to the time taken for individuals to reach sexual maturity and replenish the breeding stock (Wade *et al.*, 2012). Studies now indicate a lack of strong recovery in some heavily exploited odontocete populations' even decades after intense exploitation has ceased (Wade *et al.*, 2012).

Added to life-history traits that limit odontocetes' rates of recovery, the highly social structure of odontocete societies means that social disruption caused by exploitation may reduce survivorship and reproductive potential of the remaining stock (Wade *et al.*, 2012). In several studied cetacean species (including pilot whales, killer whales and spotted dolphins) there is evidence of a decrease in birth rates following exploitation (Wade *et al.*, 2012). Recovery may be limited by factors such as:

- Reduced calf survival due to the loss of non-reproductive females that nurse calves;
- Decreased foraging success due to loss of cultural knowledge;
- Collapse of social networks and increased dispersal following the removal of key individuals; and
- Increased predation risk due to reduced school size and loss of social connection.

There are therefore multiple causes for concern regarding the ability of Japan's small cetacean populations to recover, even in the absence of continued exploitation.

MANAGEMENT OF HUNTS

A number of problems have been identified with the existing management of hunts. These include:

- A lack of transparency regarding methods used to set catch quotas.

  According to the Fisheries Agency, since 2007 the 'concept' of the PBR has been introduced to calculations of catch limits of Dall's porpoise (Fisheries Research Agency, 2012b), however the details of the calculations used to calculate catch limits for the Dall's porpoise or any of the other species have not been made public. The Fisheries Agency states that "*Formulation of a resource management model that reflects reality more accurately than the ultraconservative PBR is an extremely important task, and deliberation about such reforms is currently ongoing*"(Fisheries Research Agency, 2012b).

- Quotas for all species examined (Baird's beaked whale and the northern form of the short-finned pilot whale have not been assessed) are set considerably above likely sustainable levels, based on calculations using a PBR threshold (Funahashi & Baker, 2011; Appendix 1, Table 2).

  Permitted catches are 1.1 to 8.6 times higher than the PBR threshold, even where this is calculated assuming only moderate exploitation (i.e. a recovery factor of 0.5) and no other sources of anthropogenic mortality (Funahashi & Baker, 2011). It should be noted that given the duration and intensity of exploitation of these populations, that a recovery factor of 0.1 may be more appropriate for some species (Funahashi & Baker, 2011).

- Abundance estimates have not been regularly updated.

  Assessments of the abundance of the targeted populations are now more than twenty years old for all species, with the exception of some populations of Baird's beaked whales and the Pacific white-sided dolphin (17 years old) (Appendix 1, Table 2). Although surveys were conducted in 1998-2001 these do not provide discrete abundance estimates for the populations targeted by hunts, covering a much larger survey area than previously. Published guidelines for assessing marine mammal stocks advise that population assessments should be updated at least every 8 years and that in the absence of this, thereafter, the minimum population estimate for a stock should be decreased by 10 % per year, applied retroactively from the time of the last survey (Moore & Merrick, 2011). Up to date abundance estimates

and further data on stock structure of the populations exploited by Japan's hunts are urgently needed.

- Lack of regulation and enforcement of quotas.

  Even were existing quotas sustainable, there are flaws in the regulation and enforcement of quotas. Although quotas are set by the Japanese Fisheries Agency, the season of the hunts is determined locally. The months of hunt operation can and have previously been extended when quotas could not be filled (2010-2011), allowing progressive increases in effort (Elsa Nature Conservancy, 2011). Similarly the ability to transfer unused quotas between prefectures undermines any limits they impose. Quota violations are reported to have occurred in 1996 drive hunts, with dolphins being captured beyond the established quotas and under-reporting of the numbers of dolphins caught documented (Elsa Nature Conservancy, 2011).

- Incomplete reporting.

  Historically there have been problems with under-reporting and for many years live captures were not included in reported statistics. Reported catches also fail to take into account struck and lost animals, and no information on struck and lost rates is available. It is essential that actual mortality levels are taken into account in order to develop reliable management advice on sustainable levels of exploitation.

CONCLUSION

Catch limits for all species studied (striped, spotted, bottlenose, Risso's and Pacific white-sided dolphins, southern form short-finned pilot whales and false killer whales), with the exception of Baird's beaked whales and the northern form of the short-finned pilot whale which have not been assessed, are likely be above sustainable levels (Wade *et al.*, 1998; Wade et al., 2008; Funahashi & Baker, 2011). In addition to potentially unsustainable levels of direct mortalities in hunts, hunt induced stress and social disruption may cause declines in survival and reproductive success in the remnant populations, impeding populations' ability to recover from exploitation.

Catches have declined in six of the nine species (including Dall's porpoise, see SC/65a/SM11) targeted by hunts, potentially due to population declines. In the majority of species these declines occurred prior to the introduction of quotas and have exceeded the reductions invoked by catch limits. Catch limits therefore cannot account for the declining catches, and although data on catch per unit effort is not available, PBR thresholds suggest that hunting pressure has been, and continues to be unsustainable. In the last decade, catches for most species have failed to fill even the reduced quotas, and those of favoured species such as the striped dolphin and short-finned pilot whale have fallen to unprecedentedly low levels. Although changes in catch composition indicative of overexploitation and population decline have been observed in three of the nine species hunted these have not stimulated adequate adjustment of catch limits or prompted a detailed reassessment of populations' status.

Assessments of the abundance of the targeted populations are now more than twenty years old for all species, with the exception of some populations of Baird's beaked whales (2 years old), Dall's porpoise (10 years old) and the Pacific white-sided dolphin (17 years old) (Appendix 1, Table 2). Up-to-date assessments of the status of exploited populations and the development of a scientific management approach which takes into account the multiple anthropogenic and environmental threats these populations are facing and their inherent capacity to recover is urgently required in order to prevent further declines and the potential of localised population extinctions. The IWC Scientific Committee has repeatedly expressed concern regarding the sustainability of catches, noting *inter alia* the lack of sufficient information to determine status and the need for up to date assessments of population status and data on catch composition (IWC, 1982, 1987, 1992a, 1992b, 1993a, 1993b, 1998, 2012). We wish to reiterate these, and make the following recommendations with regards to reforming the management of small cetacean hunts in Japan:

- An immediate suspension of hunting of species showing the most severe signs of over-exploitation, in particular the Dall's porpoise, short-finned pilot whale and

striped dolphin, is required as a precautionary measure;

- An up-to-date assessment of the status of all species taken by small cetacean hunts, including studies of population structure and life-history characteristics, should be undertaken as soon as feasible;
- Targeted small cetacean populations should be monitored for stress-induced impacts and the effects of social disruption;
- The management strategy needs reforming to bring it in line with modern international conservation management strategies that take into account other mortalities such as struck-and-lost individuals, bycatch and other environmental/anthropogenic threats, and which are based upon rigorous, up to date population assessments and knowledge of intrinsic recovery rates. The strategy should include the establishment and enforcement of time and area restrictions on hunts in order to protect cetacean species during sensitive breeding and calving periods.
- Catch limits should be both sustainable and allow for population recovery; and
- Independent observation of landed catches of all hunts should occur and data should be collected on struck and lost rates, catch per unit effort and sex, reproductive status and age composition of catches.

REFERENCES

Akamatsu, T., Hatakeyama, Y. and Takatsu, N. (1993) Effects of pulse sounds on escape behaviour of false killer whales. *Bulletin of the Japanese Society of Scientific Fisheries* 59(8): 1297-303.

Bejder, L. (2005) Linking short and long-term effects of nature based tourism on cetaceans. PhD thesis, Dalhousie University, Halifax

Bejder, L., Samuels, A., Whitehead, H., Gales, N. *et al.* (2006) Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. Conservation Biology 20: 1791–1798

Bernard, H. J. and Reilly, S. B. (1999) Pilot whales *Globicephala* Lesson, 1828. In: S. H. Ridgway and R. Harrison (eds), *Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises*, pp. 245-279. Academic Press, San Diego, CA, USA

Brownell, R., Nowacek, D. & Ralls, K. (2008) Hunting cetaceans with sound: A worldwide review. *Publications, Agencies and Staff of the U.S. Department of Commerce.* Paper 94.

Butterworth, A., Brakes, P., Vail, C. & Reiss, D. (2013) A Veterinary and Behavioral Analysis of Dolphin Killing Methods Currently Used in the "Drive Hunt" in Taiji, Japan. *Journal of Applied Animal Welfare Science*, 16 (2): 184-204.

EIA (2000) Towards Extinction: The exploitation of small cetaceans in Japan.

Elsa Nature Conservancy (2007) Pacific white-sided dolphins. Available at http://en.elsaenc.net/report/publiccomment/

Elsa Nature Conservancy (2011) The dolphin drive hunt: Appropriate Management?

Fisheries Research Agency (2012a) The State of International Fishing Resources in 2011 - Baird's beaked whales.

Fisheries Research Agency (2012b) The State of International Fishing Resources in 2011 – Small Cetaceans.

Fujise, Y., Ishikawa, H., Saino, S. & Kawasaki, M. (1993) Catch and struck-and-lost rate in the Japanese Dall's porpoise hand-harpoon fishery. SC/44/SM18 in *Report of the International Whaling Commission* 43: 453-457.

Funahashi, N. & Baker, C. S. (2011) Japan's hunting of dolphins – Is it sustainable? Presentation at the 2011 Society for Marine Mammalogy conference.

Funahashi, N. & Kasuya, T. (2012) Review of Baird's Beaked Whale (*Berardius bairdii)* around Japan, exploitation, current knowledge and suggestions for future research. SC/64/SM8 Presented to the IWC Scientific Committee, June 2012.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. (2008a). *Stenella attenuata*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **03 October 2012**

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. (2008b). *Lagenorhynchus obliquidens*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **03 October 2012**

Hayano, A., Yoshioka, M., Tanaka, M. and Amano, M. (2004) Population differentiation in the Pacific white-sided dolphin *Lagenorhynchus obliquidens* inferred from mitochondrial DNA and microsatellite analyses. *Zoological Science* 21: 989-999

Hobbs, R.C. and Jones, L.L. (1993). Impacts of high seas fisheries on marine mammal populations in the North Pacific. *International North Pacific Fisheries Commission Bulletin* 53(II):409-34.

IWC (1987) *Annual Report of the International Whaling Commission* 37: 51

IWC (1991) *Annual Report of the International Whaling Commission* 41: 80

IWC (1992a) Chairman's Report of the Forty-Fourth Meeting, Appendix 10. Resolution on the directed take of striped dolphins in drive fisheries, *Report of the International Whaling Commission* 43:51-2.

IWC (1992b) Report of the scientific committee. Annexe G: Report of the Standing Sub-Committee on Small Cetaceans. 42: 178-221

IWC (1993a) Report of the scientific committee 43: 82-85

IWC (1993b). Chairman's Report of the Forty-Fifth Annual Meeting, Appendix 10. Resolution on the directed take of striped dolphins. *Report of the International Whaling Commission* 44:34.

IWC (1998) *Annual Report of the International Whaling Commission* 48: 106-112

IWC (2012) Report of the scientific committee. Annexe L: Report of the Sub-Committee on Small Cetaceans International Whaling. Unpubl; Available at http://iwcoffice.org/cache/downloads/arsnoxddh008o0kkcgsw48o08/Annex-L-SM.pdf

Kasuya T (1985): Effect of exploitation on reproductive parameters of the spotted and striped dolphins off the Pacific coasts of Japan. Scientific Report of the Whales Research Institute 36, 107–138

Kasuya, T. (1999a): Examination of the reliability of catch statistics in the Japanese coastal sperm whale fishery. *Journal of Cetacean Research & Management* 1 (1) 109–121.

Kasuya, T. (1999b). Review of the biology and exploitation of striped dolphins in Japan. *Journal of Cetacean Research and Management* 1(1): 81-100.

Kasuya, T. (2007) Japanese Whaling and other cetacean fisheries. *Environmental Science and Pollution Research* 10: 39-48.

Kishiro, T. and Kasuya, T. (1993): Review of Japanese dolphin drive fisheries and their status. *Report of the International Whaling Commission* 43, 439–452

Maas, B. (2003) The potential stress effects of whaling operations and the welfare implications for hunted cetaceans. IWC/55/WK19. International Whaling Commission.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. *Reports of the International Whaling Commission* 43: 417-437.

Minamikawa, Shingo, Hiroyuki Shimada, Tomio Miyashita, and Hideki Moronuki. (2007). Estimates of Stock Levels for Six Cetacean Whaling Species from 1998-2001 Visual Inspection Data. Lecture Executive Summary Collection of the 2007 Japan Society of Fisheries Science Fall Conference. p151. In Japanese.

Miyashita, Tomio, Toshihide Iwasaki, and Hideki Moronuki. (2007). An Estimate of Pacific White-Sided Dolphin Stock Levels in the Vicinity of Japan from 1992-96 Visual Inspection Data. The Mammological Society of Japan 2007 Conference Program Collection of Executive Summaries. p.129. In Japanese.

Moore, J.E., and Merrick, R., editors. (2011). Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS III Workshop, February 15 – 18, 2011, La Jolla, California. Dept. of Commerce, NOAA Technical Memorandum NMFS-OPR-47.

National Research Institute of Far Sea Fisheries (1979-2010). Japanese Progress Reports on small cetacean research. Reports from 1979-1998 are published within IWC annual reports, SC/32-SC/52. Those from 1999-2010 are available online at http://www.jfa.maff.go.jp/j/whale/w_document/

Odell, D. K. and Mcclune, K. M. (1999) *Pseudorca crassidens* (Owen, 1846) In: Handbook of Marine Mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises, pp. 213-244.

Okamura, H., Iwasaki, T. and Myashita, T. (2008) Toward sustainable management of small cetacean fisheries around Japan. *Fisheries Science*, 74: 718–729

Okamura, H., Minamikawa, S., Skaug, H. and Kishiro, T. (2012) Abundance estimation of long-diving animals using line transect methods. *Biometrics* 68: 504-513.

Taylor, B. and D. Demaster (1993) Implications of non-linear density-dependence. *Marine Mammal Science* 9:360-371.

Taylor, B.L., Wade, P.R., DeMaster, D.P., Barlow, J. (2000) Incorporating Uncertainty into Management Models for Marine Mammals. *Conservation Biology* 14:1243-1252.

Taylor, B. L., Chivers, S. J., Larese, J. and Perrin, W. F. (2007) Generation length and percent mature estimates for IUCN assessments of Cetaceans. Southwest Fisheries Science Center.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. & Pitman, R.L. (2008a) *Berardius bairdii*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **21 August 2012**.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. & Pitman, R.L. (2008b) *Grampus griseus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **21 August 2012**

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. & Pitman, R.L. (2008c). *Pseudorca crassidens*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **03 October 2012**.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. & Pitman, R.L. (2011) *Globicephala macrorhynchus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on **21 August 2012**.

Wade, P. R., Reeves, R. R. and Mesnick, S. L. (2012) Social and Behavioural Factors in Cetacean Responses to Overexploitation: Are Odontocetes Less "Resilient" Than Mysticetes? *Journal of Marine* Biology, 15 pages. doi:10.1155/2012/567276

Wade, P. R., Bass, C. L. & Kasuya, T. (2008) A comparison of methods for calculating thresholds for evaluating levels of catch of Japan's Dall's porpoise (*Phocoenoides dalli*) hand-harpoon hunt. SC/60/SM24 presented to 60th annual meeting of the IWC Scientific Committee in Santiago, Chile.

Wells, R. S. and Scott, M. D. (1999) Bottlenose dolphin - *Tursiops truncatus* (Montagu, 1821) In: Handbook of marine mammals (Ridgway SH, Harrison SR, eds.) Vol. 6: The second book of dolphins and porpoises. pp. 137-182.

Appendix 1

Table 1: Catches by species, 1932-2010.

Year	Baird's beaked whale	Bottlenose dolphin	Dall's porpoise	Dall's porpoise (*dalli*)	Dall's porpoise (*truei*)	False killer whale	Pacific white-sided dolphin	Risso's dolphin	Short-finned pilot whale	Short-finned pilot whale (northern)	Short-finned pilot whale (southern)	Spotted dolphin	Striped dolphin	Grand Total
1932	31													N/A
1933	31													N/A
1934	34													N/A
1935	35													N/A
1936	33													N/A
1937	50													N/A
1938	34													N/A
1939	50													N/A
1940	25													N/A
1941	23													N/A
1942	36												21,591	N/A
1943	0												7,763	N/A
1944	0												7,660	N/A
1945	0												7,319	N/A
1946	0												8,180	N/A
1947	60												95	N/A
1948	73												5,892	N/A
1949	92												13,441	N/A
1950	186												15,186	N/A
1951	252												11,899	N/A
1952	321												8,152	N/A
1953	270												4,059	N/A
1954	230												298	N/A
1955	258												2,669	N/A
1956	297												8,991	N/A
1957	186												3,172	N/A
1958	229												3,681	N/A
1959	186												21,953	N/A
1960	147												4,418	N/A
1961	133												10,569	N/A
1962	145												8,554	N/A

Year	Baird's beaked whale	Bottlenose dolphin	Dall's porpoise	Dall's porpoise (*dalli*)	Dall's porpoise (*truei*)	False killer whale	Pacific white-sided dolphin	Risso's dolphin	Short-finned pilot whale	Short-finned pilot whale (northern)	Short-finned pilot whale (southern)	Spotted dolphin	Striped dolphin	Grand Total
1963	160	29	9,040			0		59	287			0	8,840	18,415
1964	189	50	9,440			0		73	464			0	7,362	17,578
1965	172	23	9,180			0		58	167			0	10,338	19,938
1966	171	14	7,980			0		36	52			0	8,793	17,046
1967	107	28	5,150			0		83	248			0	4,483	10,099
1968	117	66	6,020			0		37	247			0	9,650	16,137
1969	134	31	7,020			0		33	652			435	3,629	11,934
1970	113	34	8,060			0		21	116			2,711	6,345	17,400
1971	118	63	5,210			0		26	300			37	5,032	10,786
1972	86	65	5,190			0		62	260			674	7,935	14,272
1973	32	92	7,230			0		20	205			1,162	7,526	16,267
1974	32	144	6,470			0		15	212			0	12,682	19,555
1975	46	103	7,350			0		7	512			1,298	6,755	16,071
1976	13	108	9,899			0		0	420			0	6,228	16,668
1977	44	18	9,358			0		0	550			757	4,582	15,309
1978	36	30	8,426			123		0	402			4,184	3,672	16,873
1979	28	615	6,872			339	360	934	93			427	2,193	11,861
1980	31	3,480	6,718			356	69	0	686			1,440	16,247	29,027
1981	39	317	9,803			7	209	10	546			169	4,783	15,883
1982	60	831	12,833			1	168	4	395			3,799	2,014	20,105
1983	37	741	12,776			290	1,605	200	503			2,945	2,219	21,316
1984	38	462	9,764			60	2,760	0	512			743	3,737	18,076
1985	40	847	10,378			127	37	0	805			484	3,217	15,935
1986	40	200	16,515			2	0	0	375	28	347	891	2,770	20,793
1987	40	1,763	25,600			2	0	3	386	0	386	1,815	389	29,998
1988	57	761	40,367			48	0	109	571	98	473	1,875	2,227	46,015
1989	54	377	29,048	15,953	13,095	30	0	13	252	50	202	129	1,225	31,128
1990	54	1,298	21,802	9,360	12,442	77	39	93	167	10	157	9	749	24,288
1991	54	410	17,634	4,671	6,457	54	1	390	355	43	312	153	1,017	20,068
1992	54	156	11,403	3,394	8,009	87	0	118	360	48	312	636	1,045	13,859
1993	54	171	14,318	5,731	8,587	2	0	497	337	44	293	565	544	16,488
1994	54	310	15,947	8,093	7,854	0	0	312	196	26	170	449	535	17,803
1995	54	878	12,396	7,002	5,394	43	0	405	238	50	188	105	537	14,656
1996	54	280	16,100	8,038	8,062	35	0	369	482	50	432	67	303	17,690

Year	Baird's beaked whale	Bottlenose dolphin	Dall's porpoise	Dall's porpoise (*dalli*)	Dall's porpoise (*truei*)	False killer whale	Pacific white-sided dolphin	Risso's dolphin	Short-finned pilot whale	Short-finned pilot whale (northern)	Short-finned pilot whale (southern)	Spotted dolphin	Striped dolphin	Grand Total
1997	54	299	18,540	8,533	10,007	28	0	228	347	50	297	23	602	20,121
1998	54	245	11,385	5,303	6,082	45	0	442	229	35	194	460	449	13,309
1999	62	658	14,807	6,379	8,428	5	0	489	394	60	334	38	596	17,049
2000	62	1,358	16,171	7,513	8,658	8	0	506	304	50	254	39	300	18,748
2001	62	247	16,650	8,430	8,220	26	0	474	389	47	342	10	484	18,342
2002	62	729	15,949	7,614	8,335	7	0	386	176	47	129	418	642	18,369
2003	62	164	15,720	8,308	7,412	16	0	373	160	42	118	132	450	17,077
2004	62	537	13,789	4,614	9,175	3	0	504	176	13	163	2	637	15,710
2005	66	325	14,664	6,880	7,784	1	0	394	174	22	152	13	455	16,092
2006	63	292	12,014	4,212	7,802	11	0	344	263	7	256	405	515	13,907
2007	67	324	11,357	4,070	7,287	4	0	509	333	0	333	16	470	13,080
2008	64	334	7,226	2,594	4,632	5	5	330	180	0	180	323	593	9,060
2009	67	335	9,540	1,773	7,767	1	8	422	294	0	294	3	419	11,089
2010	66	266	4,919	1,256	3,663	0	10	387	44	0	44	116	456	6,264
Grand Total	6,732	20,908	594,028	139,721	175,152	1,843	5,271	9,775	15,816	820	6,362	29,957	342,213	1,017,909

N.B. Data is only complete for all species from 1979 onwards (Japan's progress reports to the IWC). Live captures are not included. Data on Baird's beaked whale catches are included from 1932 onwards (Kasuya, 2012) and for striped dolphin from 1942 onwards (Kasuya, 1999b) but these should not be considered to represent total catches of these species during these years due to incomplete reporting. Data from 1963-1978 are derived from Kishiro & Kasuya (1993) and Kasuya (1982). Shaded cells and N/A indicate years when data are not available.

Table 2: Recent quotas and catches in relation to abundance data and PBR thresholds.

Species	Estimated abundance (CV)	Survey period	Reference	Area surveyed	Catch limit (2012-2013)	Average catch (2006-2010)	PBR threshold (0.5) (Funahashi & Baker, 2011)	Catch limit/PBR	Average catch (2006-2010)/PBR	Catch limit as a % of abundance	Average catch (2006-2010) as a % of abundance
Berardius bairdii	4,200 (CV=0.295)	1984	Miyashita 1986	Pacific coast	52	65.4 (for Pacific, Sea of Japan and Okhotsk Sea combined)	-	-	-	1.0%	0.9% (for Pacific, Sea of Japan and Okhotsk Sea combined)
	3,950 (CV=0.28)	1983-1989	Miyashita, 1990								
	5,029 (95% CI = 1,801-14,085)	1991-1992	Miyashita & Kato, 1993								
	10,190 (nd)	2008	Okamura *et al.* 2011 cited in Funahashi & Kasuya, 2012								
	7,307 (nd)	2009	Okamura *et al.* 2011 cited in Funahashi & Kasuya, 2012								
	1,260 (CV=0.45)	1983-1989	Miyashita, 1990	Sea of Japan	10		-	-	-	0.8%	
	660 (CV=0.27)	1983-1989	Miyashita, 1990	Okhotsk Sea	4		-	-	-	0.6%	
Globicephala macrorhynchus (northern form)	5,344 (nd)	1984-1985	IWC, 1992	Unknown	36	1.4	-	-	-	-	-
	4,239 (CV=0.61)	1986-1988	Miyashita, 1993	Pacific ocean						0.8%	0.0%
Globicephala macrorhynchus (southern form)	14,012 (CV=0.229)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	214	221.4	116	1.8	1.9	0.8%	1.6%
	15,057 (CV=0.71)	1998-2001	Minamikawa *et al.*, 2007	north of 10 ^{0} N, west of			-	-	-	-	-

Species	Estimated abundance (CV)	Survey period	Reference	Area surveyed	Catch limit (2012-2013)	Average catch (2006-2010)	PBR threshold (0.5) (Funahashi & Baker, 2011)	Catch limit/PBR	Average catch (2006-2010)/PBR	Catch limit as a % of abundance	Average catch (2006-2010) as a % of abundance
				180^0 E							
Grampus griseus	31,012 (CV=0.211)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	496	398.4	260	1.9	1.5	1.6%	1.3%
	32,864 (CV=0.45)	1998-2001	Minamikawa *et al.*, 2007	north of 30^0 N, west of 180^0 E			-	-	-	-	-
Stenella coeruleoalba	19,631 (CV=0.696)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	610	490.6	116	5.3	4.4	3.1%	2.5%
	503,436 (CV=0.547)	1998-2001	Minamikawa *et al.*, 2007	north of 30^0 N, west of 180^0 E			-	-	-	-	-
Stenella attenuata	15,900 (CV=0.401)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	651	172.6	115	5.7	1.5	4.1%	1.1%
	397,515 (CV=0.424)	1998-2001	Minamikawa *et al.*, 2007	north of 30^0 N, west of 180^0 E			-	-	-	-	-
Tursiops truncatus	36,791 (CV=0.250)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	730	310.2	299	2.4	1.0	2.0%	0.8%
	38,829 (CV=0.629)	1998-2001	Minamikawa *et al.*, 2007	north of 30^0 N, west of 180^0 E			-	-	-	-	-
Pseudorca crassidens	2,029 (CV=0.429)	1983-1991	Miyashita, 1993	north of 30^0 N, west of 145^0 E	120	4.2	14	8.6	0.3	5.9%	0.2%
	40,392 (CV=0.546)	1998-2001	Minamikawa *et al.*, 2007	north of 30^0 N, west of 180^0 E			-	-	-	-	-
Lagenorhynchus obliquidens	56,764 (CV=0.8)	1992-1996	Miyashita *et al.*, 2007b	north of 30^0 N, west of 145^0 E	360	4.6	314	1.1	0.0	0.6%	0.0%

N.B. The PBR thresholds calculated by Funahashi & Baker use a recovery factor of 0.5. However they note that for some species it could be argued that a recovery factor of 0.1 is more appropriate, this would result in even lower thresholds (see Funahashi & Baker, 2011).