

A Review of the Status of the Indo-Pacific Humpback Dolphin (*Sousa chinensis*) in Chinese Waters

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Abstract

The status of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Chinese waters (including Taiwan) is reviewed. Within China, humpback dolphins range from the Vietnam border north to the mouth of the Yangtze River, and there are estimated to be about eight populations in China. Little is known of stock structure, except for a preliminary conclusion that animals in Xiamen and Hong Kong represent separate populations. Abundance has been estimated only for Hong Kong and the Pearl River Estuary (about 1,500 animals) and Xiamen (80 dolphins). In the early 1960s, 36 animals were killed in Xiamen Harbor, but other direct takes appear to be rare. Incidental catches are known in Hong Kong and the Pearl River Estuary, but their impacts are not known. Only preliminary work on life history has been conducted. There appears to be a calving peak from spring to summer, and calves are about 100 cm long at birth. Scant data indicate that sexual maturity in females may occur at about 9-10 years of age, with males maturing later. Dolphins in Hong Kong and the Pearl River Estuary have individual ranges averaging 99.5 km², only a small portion of the population's range. Humpback dolphins in China feed on several species of demersal and estuarine fishes, with little evidence of predation on cephalopods or crustaceans. Contaminants have been evaluated in some areas, and mercury and DDT concentrations in particular appear to be high and potentially health-threatening. An assessment of trends and stranding mortality in the Hong Kong and the Pearl River Estuary population suggests that this stock is probably not decreasing at present. The Xiamen stock is thought to be decreasing, but its status has not been reliably assessed. Essentially, nothing is known of the status of other populations in China, and this shortcoming should be addressed as a matter of priority.

Key Words: China, Chinese white dolphin, Hong Kong, Indo-Pacific humpback dolphin, review, *Sousa chinensis*, southeast Asia, status

Introduction

Although the Indo-Pacific humpback dolphin (*Sousa chinensis*) has an extensive range in the Indo-Pacific, from northern Australia and central China to South Africa (Jefferson & Karczmarski, 2001; Ross et al., 1994), there have been very few studies of the population ecology of the species. Within Chinese waters, the species essentially was unstudied until a large number of specimens were collected from Xiamen Harbor in the early 1960s and some life history studies were conducted (Wang, 1965, 1995; Wang & Sun, 1982).

In the mid-1990s, long-term research projects began on the ecology of populations in Xiamen (Huang & Chou, 1995; Huang & Liu, 2000a, 2000b; Huang et al., 2000; Liu & Huang, 2000) and Hong Kong and the Pearl River Estuary (the latter hereafter referred to as the PRE) (Hung, 2000; Hung & Jefferson, 2002, 2004; Jefferson, 2000; Jefferson & Leatherwood, 1997; Minh et al., 1999, 2000a, 2000b; Parsons, 1997, 1998a, 1998b, 1999; Parsons & Chan 1998, 2001; Parsons & Jefferson, 2000; Porter, 1998; Torey, 2000). This paper summarizes information on the status of humpback dolphin populations in Chinese waters (including Taiwan).

Distribution and Stock Structure

Humpback dolphins occur in several areas of China, south of 33°N (Figure 1). The northernmost records are around the mouth of the Yangtze River (Wang & Han, 1996; Zhou et al., 1997). The southernmost records are in the Gulf of Tonkin (also called the Beibu Gulf or Beibu Wan), near the border with Vietnam (Wang & Sun, 1982). Recently, humpback dolphins have been confirmed to occur in the waters along the west coast of Taiwan (Wang et al., 2004). During a five-day

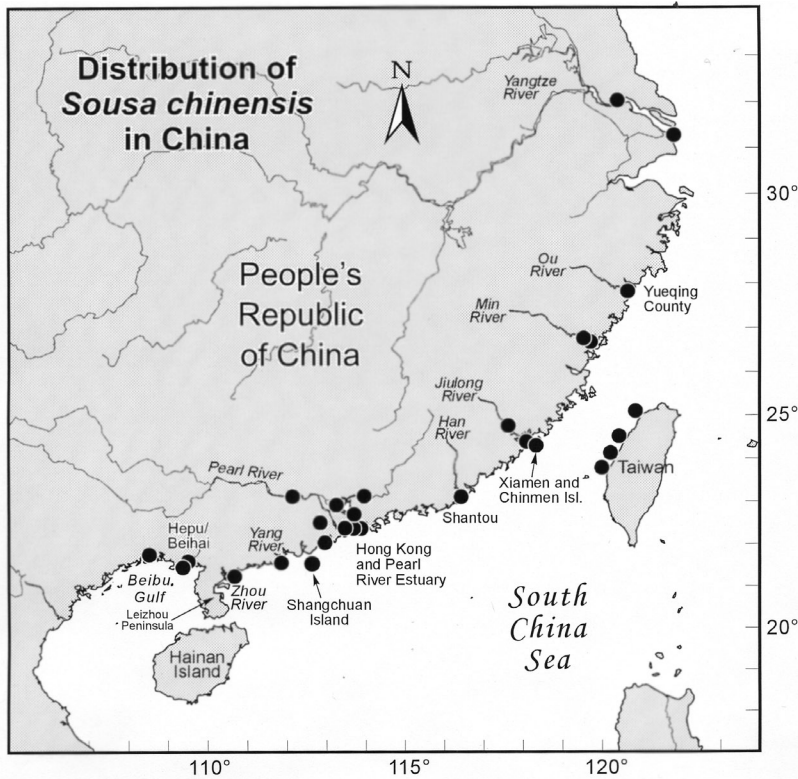


Figure 1. Reliable records of occurrence of *Sousa chinensis* in Chinese waters; updated from Jefferson (2000).

vessel survey in 2002, ten groups of humpback dolphins were sighted near Taichung Harbor and along the coast of Miaoli and Taichung counties. This population is believed to extend south and north of Taichung along the west coast of Taiwan, but further surveys are needed to define the range and assess population status. It is unknown if this is a separate population, or if animals there mix with those from the western Taiwan Strait (Xiamen and the Chinmen [= Jinmen] Islands).

Jefferson (2000) hypothesized that there were about eight populations of humpback dolphins in Chinese waters. For some time, there has been a resident population of humpback dolphins in Hong Kong (Jefferson, 2000; Parsons, 1998b; Parsons et al., 1995) and Xiamen (Huang et al., 1995; Wang, 1965). Also, humpback dolphins occur in the Gulf of Tonkin year-round (Wang & Sun, 1982). Chinese humpback dolphins sometimes swim long distances (up to 300 km) up large rivers (Wang, 1984; Wang & Han, 1996; Zhou et al., 1980, 1997); however, the belief that *Sousa* occurs as far as 1,200 km up the Yangtze River

(near Hankow) is erroneous (see Allen, 1938; Wang & Han, 1996). This apparently derives from statements made by Swinhoe (1870), who must have mistook baiji (*Lipotes vexillifer*) for "white porpoises" (a name he used for *S. chinensis*).

Extensive vessel-based and helicopter surveys have been conducted since 1995 on the Hong Kong population by the Ocean Park Conservation Foundation (OPCF) and Hong Kong Cetacean Research Project (HKCRP) (Jefferson, 2000; Jefferson & Leatherwood, 1997). Within Hong Kong, humpback dolphins only occur regularly in the western waters, those influenced by the freshwater runoff from the PRE. By far, most of the animals in Hong Kong occur north and west of Lantau Island. The distribution of the population extends across the PRE (Qiu & Chen, 2001) and even to the southwest of Macau (Figure 2). There are seasonal shifts in density, and the main shift of this type appears to be a movement to the south in the wet season (summer and autumn) (Parsons, 1998a; Jefferson, 2000).

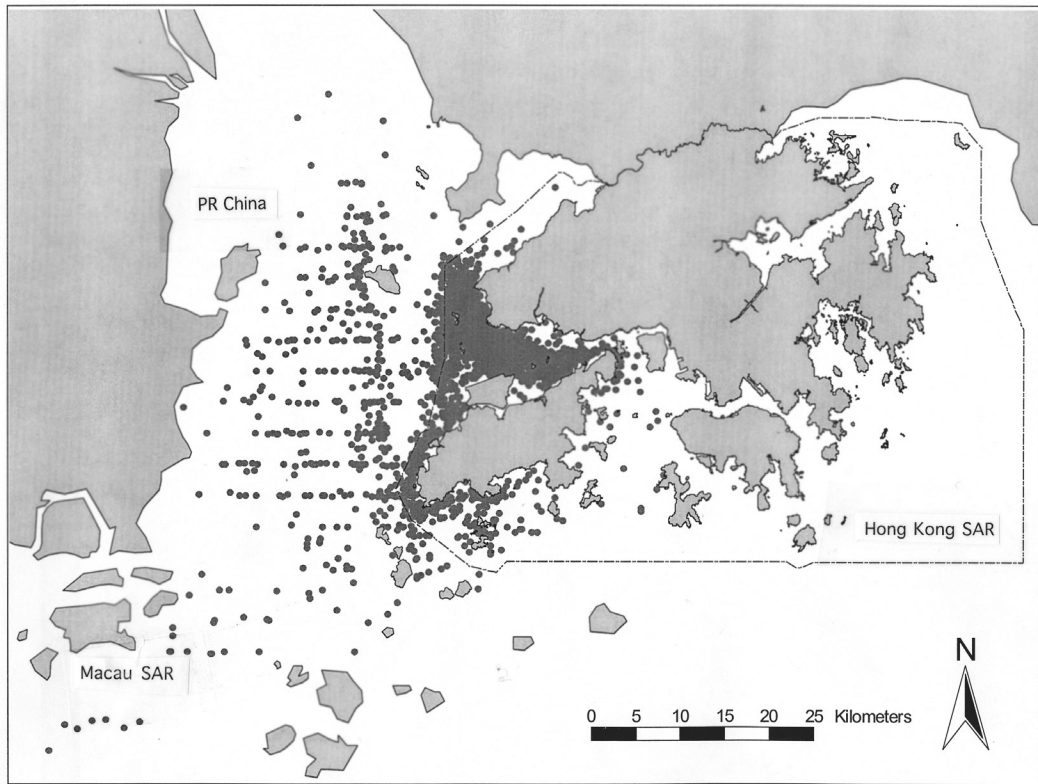


Figure 2. Sightings of humpback dolphins in waters of Hong Kong and the Pearl River Estuary based on the HKCRP database 1995-2001. Hong Kong and Macau are Special Administrative Regions (SARs) within the People's Republic of China (PRC).

The Xiamen population also was surveyed (from 1994-1999), although much less extensively than that in Hong Kong/PRE. These surveys used both vessel-based and land-based platforms. The animals occur year-round throughout much of the 700 km² area around Xiamen Island. They sometimes swim several kilometers up the nearby Jiulong River, but apparently do not usually extend offshore to the Chinmen (= Jinmen) or Wuyu Islands (Huang & Liu, 2000; Liu & Huang, 2000a). They occur in the highest densities in Xiamen's west harbor and the mouth of Tongan Bay (Liu & Huang, 2000). Detailed analyses of potential seasonal patterns in Xiamen have not been conducted.

Preliminary surveys were conducted in 2001 on the humpback dolphin population in the Beibu Gulf in Guangxi Province. Humpback dolphins were sighted in the Hepu State Dugong Reserve near Shatian (Hung, pers. observ.), and local officials reported regular sightings of humpback dolphins within the state reserve near Beihai City

and the mouth of Taifongjiang. In addition, there have been sightings in recent years of humpback dolphins on the Vietnam side of the border near Haiphong (Smith et al., 2003).

Stock structure has not been thoroughly studied in Chinese waters. Porter (1998) stated that there was evidence of two populations with little interchange in Hong Kong; however, the evidence was weak, and additional studies have not supported this theory (Jefferson, 2000). There is preliminary evidence from both photoidentification records and molecular genetic analyses suggesting that animals in Hong Kong/PRE and Xiamen are from two different populations (Jefferson, 2000; Rosenbaum et al., 2002).

Abundance

Line transect analysis has been used to calculate estimates of density and abundance for Hong Kong/PRE (Jefferson, 2000, 2002; Jefferson & Leatherwood, 1997). Resulting estimates of

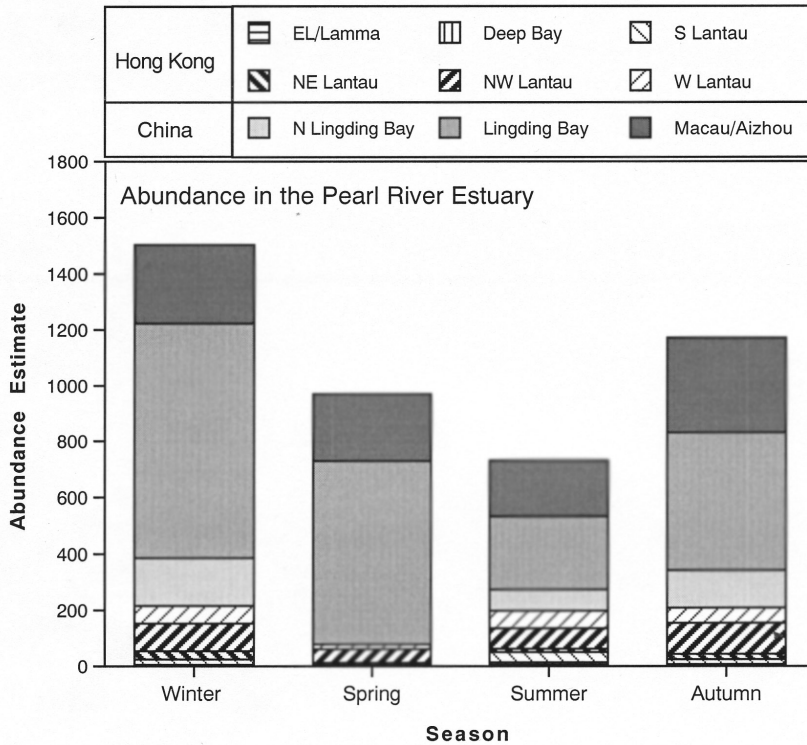


Figure 3. Composite estimates of abundance based on line transect analysis for the Hong Kong/PRE humpback dolphin population (details of analysis in Jefferson, 2002). Seasons are winter (December-February), spring (March-May), summer (June-August), and autumn (September-November).

abundance for humpback dolphins in Hong Kong/PRE, stratified by season and area, are shown graphically in Figure 3. Due to the larger sample sizes and our new pooling strategy, the estimates generally have higher levels of precision than previous estimates in Jefferson (2000) and Jefferson & Leatherwood (1997).

A minimum estimate of the overall population size of the Hong Kong/PRE humpback dolphin population can be derived by adding the estimates for individual areas. The highest such estimate, 1,504 animals, occurred in the winter season (see Figure 3; Jefferson, 2002). This estimate must be considered somewhat preliminary, however, due to the high coefficients of variation for some areas and seasons. The large variation among estimates for different seasons suggests that some dolphins move out of the study area, especially in summer months, and, therefore, that we still have not surveyed the entire range of the population. Survey work continues and we will update these analyses in the future.

Photo-identification of humpback dolphins in Hong Kong and the PRE has been conducted

since late 1995. In recent years, the number of new dolphins identified has leveled-off somewhat, but there probably are still other individuals outside the main study area that we have not photographed. We calculated a mark-recapture estimate of the size of the population, based on identification of individual dolphins. The resulting estimate of population size was 753 dolphins (95% CI = 635-943) (Jefferson, 2002). Although this is quite a bit lower than the line transect estimate discussed above, it must be remembered that each technique has its own strengths and biases. The mark-recapture estimate is thought to be biased on the low side, due largely to the fact that there probably are still a significant number of animals that have not been identified (see Jefferson, 2002). Nevertheless, both the line transect and mark-recapture estimates suggest that the population size is well over 800 dolphins.

Liu & Huang (2000) estimated that about 60 humpback dolphins occur in Xiamen waters, although this appears to be little more than a guess based on a cursory analysis of identification photographs. The Ocean Park Conservation

Foundation, in association with the Third Institute of Oceanography, Xiamen, conducted several line transect surveys in the Xiamen area in 1997-1998, for the purposes of clarifying the population status of this species along the coast of China. During these surveys, 1,208 km of line transect survey effort were conducted, and 28 groups of humpback dolphins were sighted. Based on a preliminary line transect analysis of these data, and using the average value of the probability density function $[f(0)]$ calculated from an extensive database of surveys in Hong Kong (Jefferson, unpublished), we estimated an abundance of 80 humpback dolphins in the Xiamen population ($CV=1.08$). While both these estimates are highly preliminary, they suggest that the Xiamen population is much smaller (probably by at least an order of magnitude) than that of Hong Kong/PRE.

Exploitation

The only known directed takes of humpback dolphins in China have been the deliberate capture of 36 animals from Xiamen Harbor between 1960 and 1962 (Wang, 1965, 1995). These animals were collected using fixed nets by the Fisheries Research Institute of Fujian Province. The intention was to reduce competition with fisheries, but there also was an attempt to determine if leather could be made from the skin (Wang, 1965, 1995; Wang Weiyang, pers. comm.). Some additional specimens have been collected directly for scientific research (e.g., Flower, 1870; Huang et al., 1978; Tang & Huang, 1940; Wang & Han, 1996; Wang & Sun, 1982). We know of no large scale fishery for the species in Chinese waters.

Incidental takes in gill nets and trawl nets are known in Hong Kong/PRE, but the levels of mortality have not been estimated (Parsons & Jefferson, 2000; Torey, 2000). The primary threat is probably large-scale pair trawl nets. Dolphins in Hong Kong and surrounding waters feed behind these nets in large groups, and there is evidence of their capture from both strandings and photographic records of live animals (Jefferson, 2000; Parsons & Jefferson, 2000). Torey (2000) suggested that an onboard observer program be developed to determine levels of by-catch, and the Hong Kong Government has initiated this. A single observer has recently conducted on-board observations on various types of fishing vessels (M. Torey, pers. comm.).

Between 1994 and 1999, two records of incidentally caught humpback dolphins were found in Xiamen (Huang & Liu, 2000b); however, fishing mortality is probably less common in Xiamen than in Hong Kong, due to the paucity of

fishing activity in the main nearshore habitat of the Xiamen population (Jefferson, pers. observ.).

Habitat Degradation

Hong Kong is arguably the most aggressively developing city in the world (Leatherwood & Jefferson, 1997). In Hong Kong waters, habitat degradation is a major threat to humpback dolphins. This comes in the form of pollution, coastal and seabed modification, water quality deterioration, prey depletion, and vessel disturbance and collisions (Parsons, 1997; Parsons & Jefferson, 2000; Porter, 1998; Torey, 2000). A major concern in Hong Kong has been the effects of coastal seabed reclamation, in particular the development of Hong Kong's new international airport, which opened in 1998 on a large, partially human-made island (see Leatherwood & Jefferson, 1997; Liu & Hills, 1997). Due to the lack of any baseline data, the effects of the habitat loss cannot be determined with any certainty; however, the airport construction did appear to have some behavioral impacts on the dolphins, including increased swimming speeds during piling work periods and a temporary reduction in density around the work area (Jefferson, 2000).

An ongoing long-term habitat analysis of humpback dolphins in Hong Kong waters currently is underway to determine the critical habitats for these animals (see Hung & Jefferson, 2002). Recommendations of protective measures from this study will be provided to the Hong Kong government to minimize further habitat loss.

Along the west coast of Taiwan, river alteration projects and reclamation works have resulted in loss of preferred habitats for humpback dolphins (Hung, pers. observ.). Oil refineries, nuclear power plants, and factories also discharge large amounts of pollutants into the coastal waters, which could be a major threat to the humpback dolphin population in Taiwan. In Xiamen and Beihai, extensive mariculture and oyster farms in the inshore waters have resulted in habitat loss for local humpback dolphins, and destructive fishing practices also have resulted in habitat degradation and appear to pose serious threats to the dolphins (Hung, pers. observ.).

Life History

Very little work has been done on the life history of this species in China until recently. Wang (1965) and Wang & Sun (1982) found that the mating season for the Xiamen population appears to be April to June, and gestation was thought to last 10-12 months.

Jefferson (2000) provided some highly preliminary data on growth and reproductive parameters for humpback dolphins from southern China. The oldest animal aged so far was 34 years old ($n=47$), but we expect that dolphins of this population live to at least 40 years (see Cockcroft, 1989). Age and length at sexual maturity has not been analyzed adequately for humpback dolphins in southern China; however, based on an extremely small sample of data, females appear to reach sexual maturity at about 9-10 years of age, and males probably do so a few years later (Jefferson, 2000).

Southern Chinese humpback dolphins are born at a length of about 100 cm, and growth during the first year is extremely rapid (see Jefferson, 2002). Calves are born throughout the year, with a modest peak (or possibly two peaks) between April and August. Newborn calves make up about 5-10% of the population in Hong Kong/PRE (Jefferson, 2000). In Xiamen, newborn calves recently were estimated to make up about 6.2% of the population (Huang & Liu, 2000a). Group composition varies by area, but does not differ much by season (other than an increase in the percentage of calves during and after the peak calving season) (Jefferson, 2000). Work on the growth and reproductive parameters of humpback dolphins in southern China is continuing, and in the near future we hope to update the analyses of Jefferson (2000, 2002).

Ecology

Ranging patterns of Hong Kong/PRE humpback dolphins have been studied in detail (Hung, 2000; Hung & Jefferson, 2004). These studies found that 40 individual dolphins had range sizes of 24-304 km², with an average of 99.5 km² (Hung & Jefferson, 2004). This represents only a small portion of the overall population range of at least 1,800 km². Individual range sizes were influenced by age class, reproductive status, food resources, and human activities (especially distribution of pair trawl fishing vessels).

Humpback dolphins in Chinese waters appear to have behavioral patterns that are typical for the species elsewhere. They occur mostly in small groups of less than ten individuals, and they have a very fluid social structure (Jefferson, 2000; Parsons, 1998a). Larger groups gather behind fishing vessels, especially pair trawl fishing vessels in Hong Kong/PRE (Jefferson, 2000).

Wang (1965, 1995), Huang et al. (1978), and Parsons (1997) all provided preliminary data on feeding habits of Chinese humpback dolphins. Feeding habits of Hong Kong humpback dolphins have been analyzed in detail, based on specimens

from strandings (Barros et al., 2004). Of the 29 specimens analyzed, 15 stomachs contained identifiable prey. Fish remains were the main constituent, with at least 24 species in 14 families represented. Croakers (*Johnius* spp.), lionhead (*Collichthis lucida*), and anchovies (*Thryssa* spp.) were the most common prey. Only one species of cephalopod was found, and it was only found in a single stomach. Wang (1965) studied the feeding habits of Xiamen humpback dolphins based on 36 captured specimens. Mugil, ilisha, and coilia were the most common prey genera. Several common themes to all these studies have been found: (1) prey species are mainly fish, with little evidence for feeding on cephalopods or crustaceans; and (2) most of the fish species are demersal, estuarine species. Wang (1995) stated that most stomachs of Xiamen dolphins were empty in summer and autumn ($n=7$), but this may have been a sample size issue.

Levels of environmental contaminants in the animals' bodies have been studied for specimens from Hong Kong (Minh et al., 1999, 2000a, 2000b; Parsons, 1999; Parsons & Chan, 1998) and Xiamen (Huang et al., 2000). The general pattern has been for concentrations of most metals to be relatively low, but for mercury levels to be quite high. Similarly, most organochlorines were low to moderate, but PCB and especially DDT concentrations tended to be high. There is concern that such high levels in pregnant and lactating females may be affecting reproduction and survival of calves (Jefferson, 2000; Parsons & Chan, 1998). Further discussion can be found in Parsons (2004).

Status

To detect trends in abundance for Hong Kong humpback dolphins, the period of the overall OPCF/HKCRP study from December 1995 to November 2002 was divided into 14 time periods, each consisting of six months (Figure 4; see Jefferson, 2002). Abundance estimates for the North Lantau area were calculated for each of these periods, using a fully stratified analysis. Only North Lantau data were used because this is the only area that has been surveyed with consistently high effort since the start of the study in 1995. The assumption is made here that changes in North Lantau abundance may be indicative of the overall population trend. The general trend, based on a least squares regression, is for a decreasing trend from the start of the study until about 1998, with an increasing trend since then, and then a leveling-off (Figure 4). This is interesting, as the new airport opened in July 1998, about the time when the trend apparently reversed. It seems likely that the previous decrease was related to disturbance

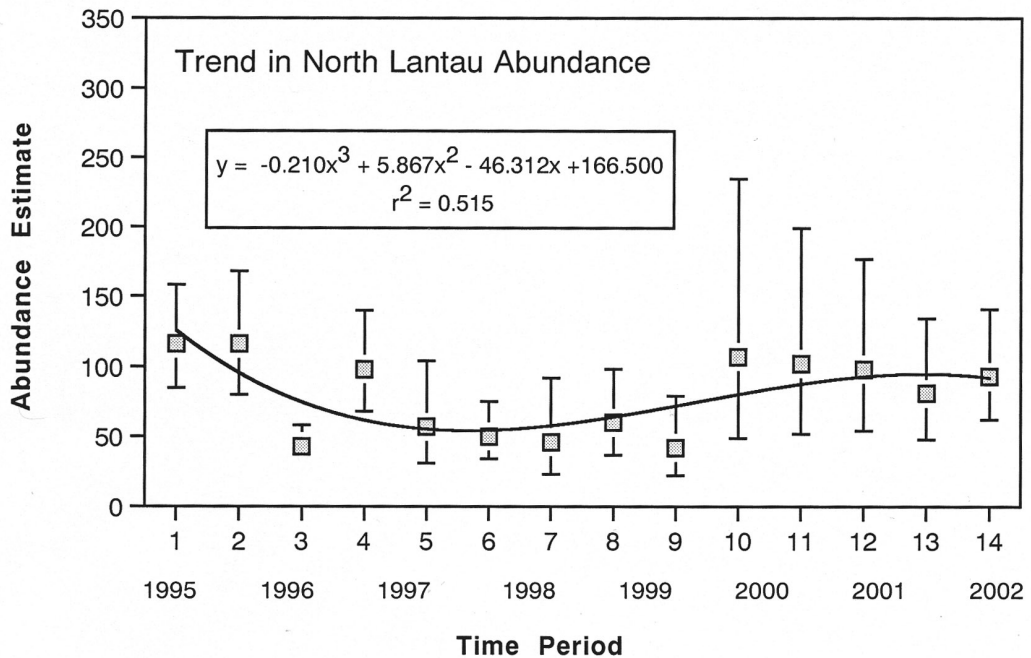


Figure 4. Trend in abundance of humpback dolphin in the north Lantau area of Hong Kong, 1995-2002; updated from Jefferson (2000, 2002).

from the airport construction work, and the numbers may have rebounded since the completion of construction (see Jefferson, 2000).

The number of dolphin strandings in Hong Kong has been monitored for more than eight years (see Jefferson, 2002; Parsons, 1998b), and if we assume that strandings are proportional to deaths, we can use these data as an approximate indicator of the population's mortality rate (Figure 5). Overall, the humpback dolphin stranding rate has been fairly consistent, with most years having between 7 and 11 strandings. The average number from 1996-2003 was 9.6 (\pm SD 2.56, $n=8$) strandings per year. For unknown reasons, 2003 was a relatively high year, with 14 humpback dolphin strandings.

Between 1994 and 1999, 13 dead humpback dolphins were recorded in Xiamen waters (Huang & Liu, 2000b). The mean mortality of 2.2 dolphins per year represents nearly 3% of the best available estimate of abundance for the population, and since this is a minimum, it clearly indicates the need for caution in managing this population's status. There is a belief that the Xiamen population is decreasing, but there are no solid data to support this (Huang et al., 1995; Liu & Huang, 2000). The long-term effects of the

killing of 36 animals in the early 1960s are unknown (see Wang, 1965, 1995).

Conclusions

Good information is available on the status of the humpback dolphin population in Hong Kong and the Pearl River Estuary (e.g., approximate estimate of overall population size, preliminary data on trends, regular monitoring of mortality in parts of the range), and some information is available on the Xiamen population (e.g., minimum estimate of abundance). The Hong Kong/PRE population is relatively large (*ca* 1,500 animals) and appears to be viable. The Xiamen population is small (*ca* 80 dolphins), and its future looks rather bleak.

Essentially, nothing is known of the status of other populations in China. Even how many populations exist and their distributional limits are unknown. These shortcomings should be urgently addressed to ensure the survival of these animals in such a highly damaged and degraded part of the world. The establishment of a stranding network for China would represent a good start, and there has been some recent progress on that front. In addition, some survey work in other areas of China where humpback dolphins are thought to occur would be very useful. If dolphins are indeed

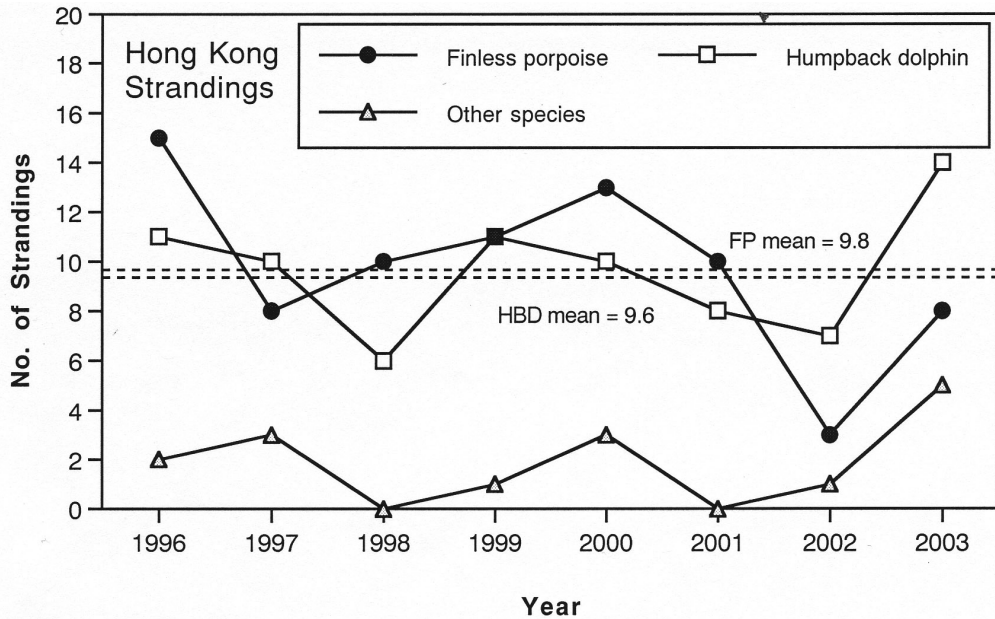


Figure 5. Strandings of humpback dolphins in Hong Kong, 1996-2003; data for finless porpoises and other species are shown for comparison (updated from Jefferson [2002]). The dashed lines show the eight-year averages from 1996 to 2003. There was no significant difference in the number of humpback dolphin strandings from 1996-2003 (Chi-square=5.55, df=7, $p>0.05$).

found, biopsy sampling to collect tissue samples that would assist in assessing population structure should be considered. These should be the first steps to a fuller understanding of the population biology of humpback dolphins in Chinese waters.

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