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HONG KONG RED LIST ASSESSMENT

Indo-Pacific humpback dolphin (*Sousa chinensis*)



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The Indo-Pacific humpback dolphin (*Sousa chinensis*), locally in China and Taiwan known as the Chinese White Dolphin

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October 2014

1a. Scientific name

Sousa chinensis (Osbeck, 1765)

1b. Synonym(s)

The taxonomy of the humpback dolphin, genus *Sousa*, has been unresolved for decades. Between one to five nominal species have been proposed (Ross et al. 1994, Rice 1998).

The most recent proposed taxonomy identifies four species, based on molecular genetics, skeletal and external morphology, coloration, and biogeography. These include the Atlantic humpback dolphin (*S. teuszii*) off West Africa, the Indian Ocean humpback dolphin (*S. plumbea*) in the Indian Ocean from South Africa to Myanmar (Burma), the Indo-Pacific humpback dolphin (*S. chinensis*) which ranges from eastern India throughout Southeast Asia to central China, and the Australian humpback dolphin (*S. sahulensis*) which occurs in the waters of the Sahul Shelf from northern Australia to southern New Guinea (Frère et al. 2011, Mendez et al. 2013, Jefferson & Rosenbaum 2014 *In Press*).

Until recently (up until 2013), the commonly accepted taxonomy have combined *S. chinensis* and *S. plumbea* into one species - the Indo-Pacific humpback dolphin *S. chinensis* - ranging from South Africa in the west to southeast China and northeast Australia in the east; with dolphins in the central and western Indian Ocean referred to as the *plumbea* form, and those in the eastern Indian Ocean and western Pacific referred to as the *chinensis* form. Even though this taxonomy was disputed (e.g. Rice 1998), up until recently it was adopted in much of the published scientific literature, including the global IUCN assessment.

1c. English common name(s)

Indo-Pacific humpback dolphin

1d. Chinese common name(s)

中華白海豚

1e. Other common names

English: Indo-Pacific Hump-backed Dolphin, Indo-Pacific Humpbacked Dolphin, Chinese White Dolphin

French: Dauphin À Bosse De L'Indo-pacifique

Spanish: Bufeo Asiático, Bufeo Asiático, Delfín blanco de China

2a. Order

2b. Family

Cetacea	Delphinidae
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3. GLOBAL distribution

Humpback dolphins, the genus *Sousa*, inhabit shallow coastal waters within the tropics and subtropics. The range of the four currently recognized species is shown in Figure 1.

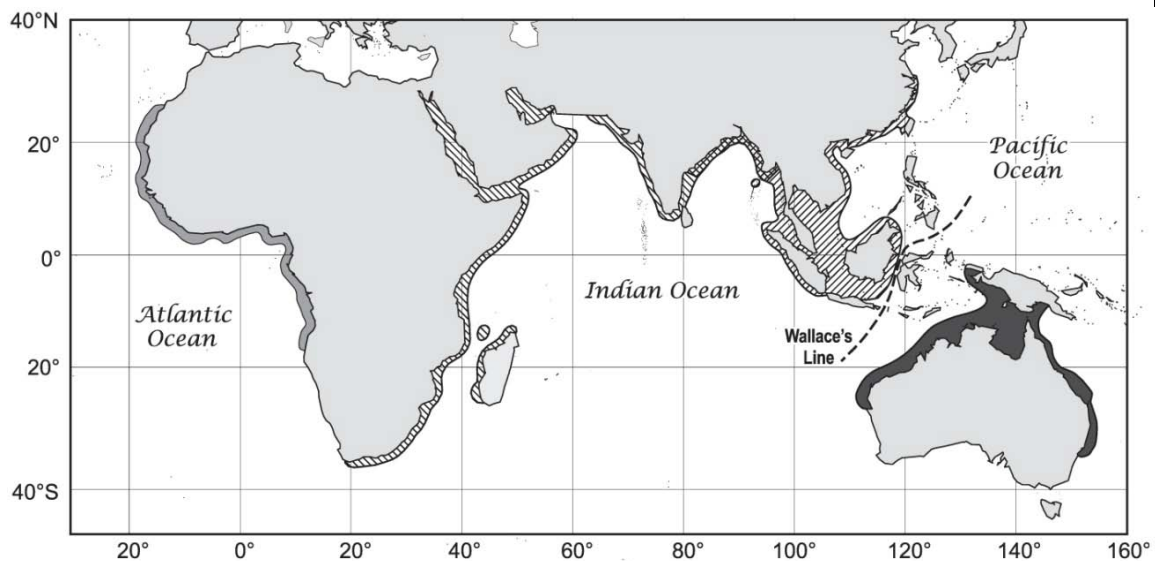


Figure 1. The distribution and range of the recently proposed four species of the humpback dolphin: *S. teuszii* (light shading), *S. plumbea* (135° hatching), *S. chinensis* (45° hatching), and *S. sahalensis* (dark shading); after Jefferson & Rosenbaum (2014 *In Press*).

The Indo-Pacific humpback dolphin, locally in China and Taiwan known as the Chinese White Dolphin, occurs in near-shore waters from central China (the Yangtze River mouth) southwards along the Chinese coast to Leizhou Peninsula and Beibu Gulf (Fig. 2) and throughout the coastal waters of Southeast Asia at least as far southeast as the coast of Borneo, and as far west as the Orissa coast of India, where it apparently partially overlaps in range with *S. plumbea* (Jefferson & Karczmarski 2001, Jefferson & Rosenbaum 2014 *In Press*). Currently, however, this range appears to be discontinuous with several possibly relict populations. Countries of occurrence include the People's Republic of China (including the Special Administrative Regions of Hong Kong and Macau), Taiwan, Vietnam, Cambodia, Thailand, Myanmar (Burma), Bangladesh, India, Indonesia, Malaysia, Singapore, and Brunei Darussalam.

Off the coast of China, the gaps in the distribution shown in Figure 2 are believed to be real and there are concerns that the degree of population discontinuity has been increasing in the recent past.

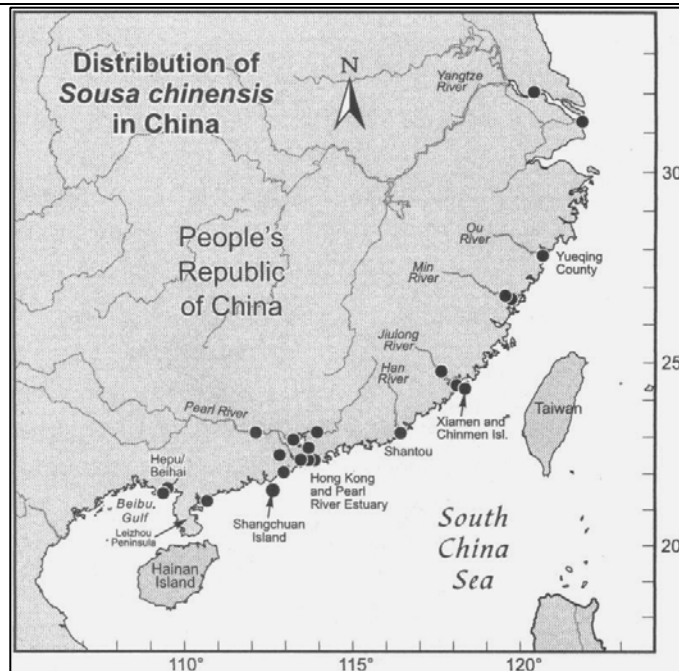


Figure 2. Known records of Indo-Pacific humpback dolphins (black dots) in the coastal waters of China (from Jefferson 2000).

3a. HONG KONG Red List Assessment RESULT (using the revised 2001 IUCN system)

Check **ONE** of the following:

- ☐ Extinct (EX)
- ☐ Extinct in the Wild (EW)
- ☐ Regionally Extinct (RE)
- ☐ Critically Endangered (CR)
- ☒ **Endangered (EN)**
- ☐ Vulnerable (VU)
- ☐ Near Threatened (NT)
- ☐ Least Concern (LC)
- ☐ Data Deficient (DD)
- ☐ Not Evaluated (NE)
- ☐ Not Applicable (NA)

3b. Fill in the Red List Criteria met (e.g. A2c+3c; B1ab(iii); D) alongside the appropriate Red List Category:

A3b, C1

Note: If one of the threatened categories is selected (i.e. CR, EN or VU) then **ALL** the criteria, subcriteria and sub-subcriteria met for that category must be listed in the box provided.

4. Rationale for the HONG KONG Red List Assessment

The latest abundance estimate, based on line-transect surveys across the Pearl River Estuary (PRE) region, suggests that there are at least 2517 – 2555 Indo-Pacific humpback dolphins in the waters of PRE (Chen et al. 2010). A recent demographic study (Huang et al. 2012) applied the Siler's competitive risk model of survivorship (Siler 1979) to empirical life table parameters and constructed a modeled life table, which was then used to calculate demographic rates of humpback dolphins in PRE. Age-at-death records were obtained from carcasses stranded along both the Mainland coast of PRE and Hong Kong waters (Jefferson 2000, Jefferson et al. 2012, Huang et al. 2012). Demographic rate estimate revealed a continuous decline according to the instantaneous rate of increase (r), $r = -0.0249$. The age-specific survivorship was calculated according to the latest abundance estimate (Chen et al. 2010) and predictive model of the population change was constructed for the next three generations (Huang et al. 2012).

The study by Huang et al. (2012) provides a strong quantitative evidence of continuous rate of population decline of ~2.5% per annum. It was projected that if the estimated rate of decline remains constant, the current population will be diminished by ~74% after only three generations (approximately 51 years, Figure 3) and ~58% of model simulations meet the criteria for conservation status classification as Endangered under Criterion A3b (Figure 4), applying IUCN Red List Categories and Criteria Version 3.1. Under a more pessimistic scenario, with ~40% probability (SD 1.25%, CI: 37.7 – 41.3%), the model projection suggests that the PRE humpback dolphins will decline by more than 80% of current population numbers within 51 years (three generations).

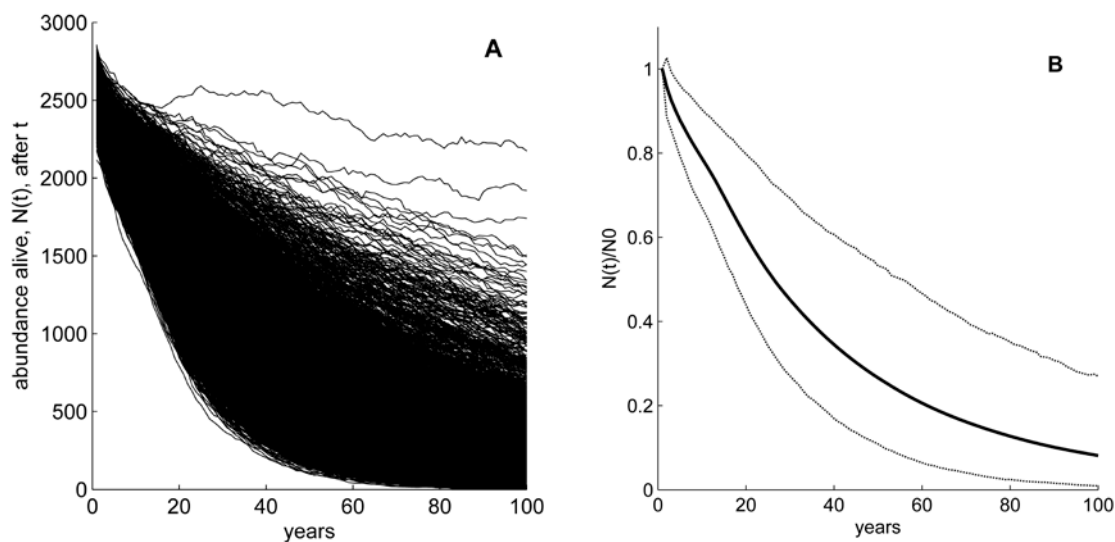


Figure 3. Abundance fluctuations of the PRE humpback dolphin after t years, shown by [A] stochastic plots that illustrate variation in prediction and [B] deterministic plot of median (solid-lines) and CI (dashed lines) of percentage of population alive (reproduced from Huang et al. 2012).

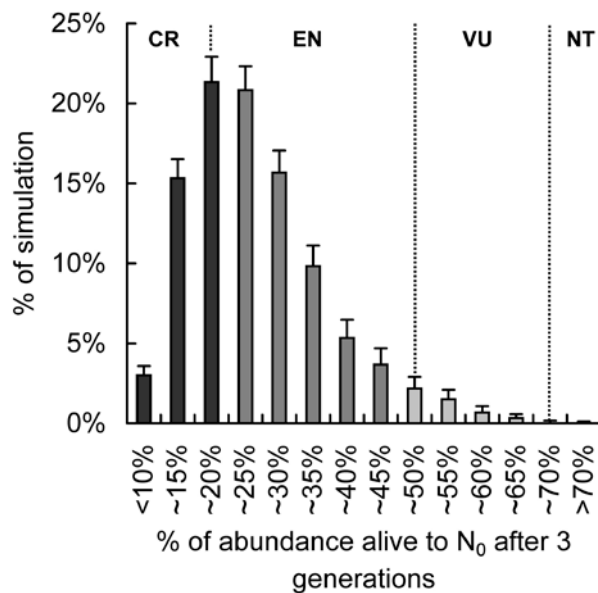


Figure 4. Percent distribution (% + SD) of abundance alive after three generations, indicating percentage of simulations meeting the criteria for classification as critically endangered (CR: 39.33%), endangered (EN: 57.60%), vulnerable (VU: 2.89%) or near threatened (NT: 0.05%) for rate of decline (Criterion A3b: IUCN, 2001) (reproduced from Huang et al. 2012).

Under Criterion A3b (“A population size reduction of $\geq 80\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (b) an index of abundance appropriate to the taxon”) **and Criterion C1** (“Population size estimated to number fewer than 2500 mature individuals and an estimated continuing decline of at least 20% within five years or two generations, whichever is longer”) **the Indo-Pacific humpback dolphin in Hong Kong and the greater PRE is classified Endangered (EN).**

Further considerations:

The actual extinction risk of the PRE humpback dolphins may in fact be higher than our predictions because of a range of factors that have not been included in the current assessment. This status assessment can be further refined, with the preset classification either upgraded or downgraded, by assessing the degree of isolation, especially immigration from neighboring populations (IUCN 2003). However, as immigration from outside the eastern PRE seems unlikely (Hung 2008; Chen et al. 2010) and immigration from outside the western PRE remains unknown, the above assessment is unlikely to change anytime soon and is highly unlikely to be downgraded. The PRE region has one of the fastest growing economies in the world, a process that is accompanied by increasing anthropogenic pressures over a wide range of factors exerted on variety of biota. The dolphins inhabiting PRE waters are exposed to many adverse effects of human activities which, as the human population grows larger, are likely to further increase in the coming years. The cumulative effect of those impacts can gradually decrease the dolphin population survival rates. If the current environmental conditions of the PRE continue to worsen without effective mitigation and management measures, the rate of decline of humpback dolphins in the region is likely to accelerate. Consequently, the status assessment presented here should be seen as the current most optimistic scenario. If the environmental conditions in PRE continue to worsen and conservation management measures remain similarly ineffective as they have been so far, the level of threat to humpback dolphins in Hong Kong, expressed in the Red List status assessment, may need to be risen.

5. Current population trend

- ☐ Increasing
☒ **Decreasing**
☐ Stable
☐ Unknown

6. Date of assessment (day/month/year) 1 October 2014

7. Name(s) of assessor(s)

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8. CURRENT GLOBAL RED LIST STATUS if any

The current IUCN Red List assessment, conducted in 2007 and released in 2008, lists *Sousa chinensis* as Near Threatened (Reeves et al. 2008). However, concerns have been raised that this global IUCN listing might not accurately reflect the actual current conservation status and threats (e.g. Karczmarski 2007, Huang & Karczmarski 2014). Furthermore, considering that it was conducted prior to the recent taxonomic revisions of the genus *Sousa*, the current global IUCN classification of humpback dolphins should be re-visited as a matter of urgency.

9. BRIEF NOTES

9a. Taxonomy

The taxon subject of this assessment is the population of Indo-Pacific humpback dolphin found in the Pearl River Estuary (PRE). For the purpose of this assessment, the dolphins inhabiting Hong Kong waters are treated as a subpopulation of the PRE population.

9b. Geographic range in Hong Kong

Although the extent of occurrence and/or occupancy of the PRE humpback dolphin is not sufficiently defined, the total ranging area is unlikely to exceed 20,000 km² and could be confined to 5,000 km² (Chen et al., 2010). The Hong Kong waters seem to represent the eastern boundary of the PRE population (Hung 2008), while the western boundary of this population remains undetermined (Chen et al., 2010).

Historically, humpback dolphins may have been distributed continuously along the 500-km long coast between PRE and Xiamen (Wang et al. 2010). The lack of genetic differentiation between humpback dolphins in PRE and off the Xiamen coast may suggest that there was some degree of gene flow between these two sites in a recent history (Lin et al. 2012). However, much of the coastal habitat between PRE and Xiamen has been heavily degraded in recent decades making much of the area unsuitable for humpback dolphins, which effectively fragments the previously continuous distribution to apparently relict populations in the PRE and, considerably smaller, in the coastal region of Xiamen. Sightings of humpback dolphins between PRE and Xiamen has become very infrequent in recent years (Wang et al., 2010).

Administratively, the PRE region is divided into Hong Kong waters, which represents only a fraction of the PRE coastal ecosystem at its eastern boundary, and Chinese waters (People's Republic of China) which encompass the rest of the PRE. Dolphin movement across the administrative border is well documented through photographic identification and it has been suggested that "part" of the "Hong Kong subpopulation" of humpback dolphins moves frequently across the border into Chinese waters (Chen et al. 2010). However, what this "part" represents in biological terms remains undetermined, as are the majority of population parameters, both in Hong Kong and Mainland Chinese waters.

In Hong Kong, humpback dolphins are seen almost exclusively in the western section of Hong Kong's territorial waters, a pattern likely determined by the estuarine influence of the Pearl River delta (Jefferson 2000). The region of west and southwest Lantau Island and the vicinity of Lung Kwu Chau Island are known to attract high dolphin density (Fig. 5A) (Hung 2008, Or et al. 2013). However, there is evidence that the dolphin distribution in Hong Kong waters has changed over the course of the past two decades, likely following the change/increase in the intensity of anthropogenic impacts and the extent and scale of habitat degradation. Although a quantitative comparison across temporal time scale is not possible, as the data held by the Agriculture, Fisheries and Conservation Department (AFCD) has not been made available for the purpose of this assessment, a comparison of previously published (Fig. 5B) and recently reported data may indicate a substantial shift in dolphin distribution.

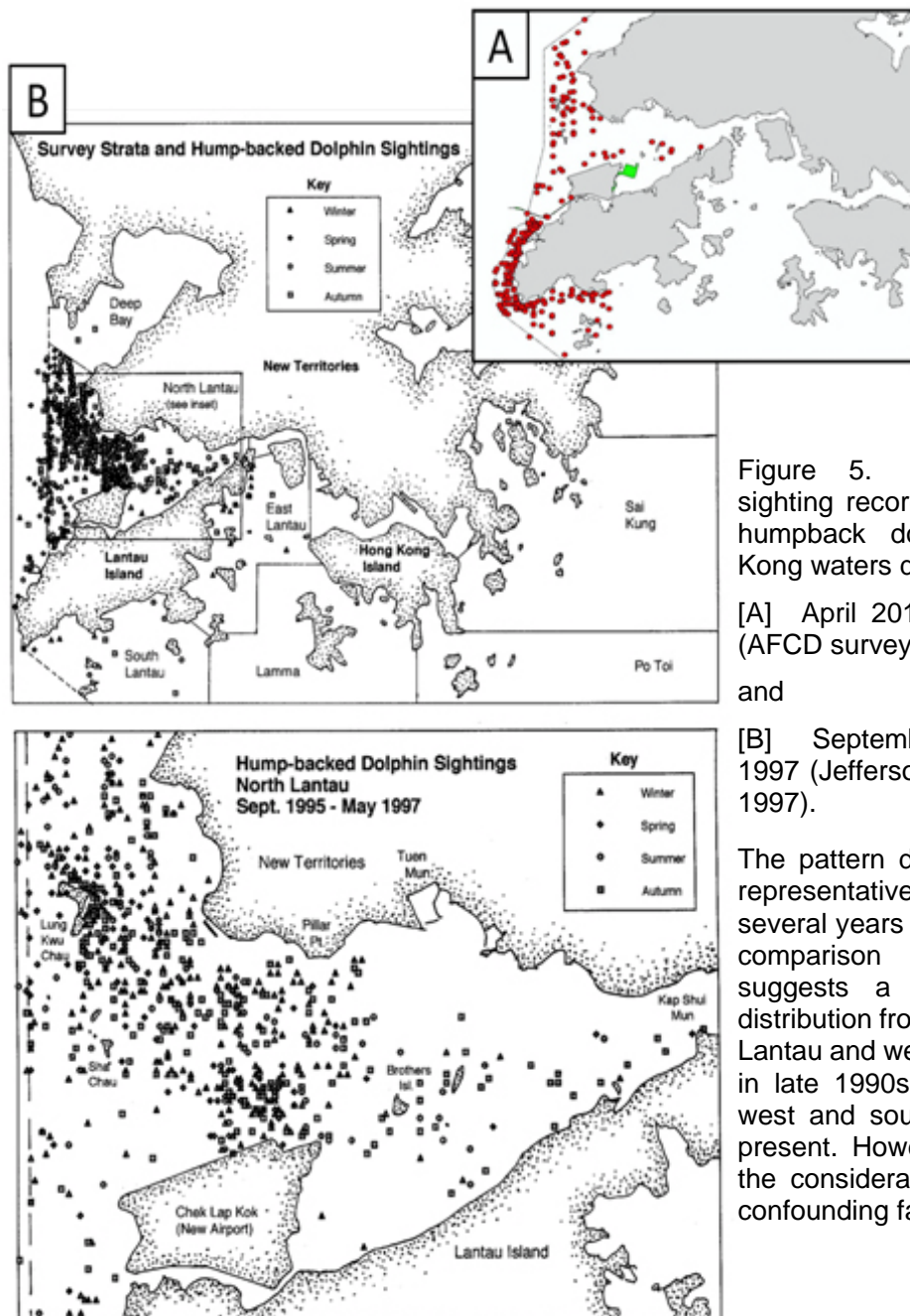


Figure 5. Distribution of sighting records of Indo-Pacific humpback dolphins in Hong Kong waters during:

[A] April 2013 – March 2014 (AFCD surveys, Hung 2014)

and

[B] September 1995 - May 1997 (Jefferson & Leatherwood 1997).

The pattern displayed in [A] is representative for the recent several years (Hung 2014). The comparison presented here suggests a shift in dolphin distribution from waters off north Lantau and west New Territories in late 1990s to the region of west and southwest Lantau at present. However, see text for the consideration of potentially confounding factors.

The comparison of dolphin sighting records separated by almost two decades (Fig. 5) seem to suggest a substantial shift in dolphin distribution, from waters off north Lantau and west New Territories in late 1990s to the region of west-southwest Lantau at present. However, as the original data is not available and both Hung (2014) and Jefferson & Leatherwood (1997) depict sighting records only, with no consideration of effort (there is no account for the number of sightings per km of search effort), limits of such comparison have to be acknowledged and the apparent conclusion has to be viewed cautiously. The shift of the administrative border of HK SAR that occurred during the time separating these two studies may have also contributed to varying distribution of research efforts in various parts of Hong Kong waters. Consequently, the apparent shift of dolphin distribution cannot be verified at present. However, a shift in animal distribution of the scale and magnitude indicated in Figure 5, if indeed occurred, would have likely carried considerable implications affecting their pattern of range utilization, habitat use and socio-behavioural dynamics. In Hong Kong, however, these have never been investigated.

9c. Population

Note: Use the standard IUCN definition of **LOCATION** given below.

“A geographically or ecologically distinct area in which a single threatening event (e.g. pollution) can rapidly affect all individuals of the taxon present (not a locality or site).”

A location usually, but not always, contains all or part of a subpopulation of the taxon, and is typically a small proportion of the taxon's total distribution.

The current abundance estimate of Indo-Pacific humpback dolphins in Pearl River Estuary, based on line-transect surveys, ranges from 2517 animals in wet-season to 2555 animals in dry-season. However, this estimate carries a considerable degree of uncertainty (CV 18.98 ~ 88.62%) and was generated using a simplistic analytical approach (Chen et al. 2010). Consequently, these numbers should be viewed with caution. Furthermore, the frequently cited estimate of the number of dolphins in Hong Kong waters remains debatable. Local abundance estimate, which represents the number of dolphins present in Hong Kong waters at the time of field surveys, is often confused with the population size estimate, which represents the number of animals that use Hong Kong waters at any given time. This misconception obscures the actual scale of the conservation issue. Direct comparison between some of the publicized estimates of dolphin numbers is simply incorrect and misleading.

Even though some estimates of population parameters remain debatable, there is a strong body of evidence that the humpback dolphin population in PRE and Hong Kong is declining at an alarming rate of 2.5% annually. If nothing is done to slow down this trend, the population will decline by over 70% in a lifespan of just three generations of these animals (less than 60 years). Under the IUCN criteria, such population projection classifies it as Endangered (for more details see section no. 4 on page 5).

Although the dolphins in Hong Kong waters have been observed and monitored for almost 20 years (AFCD monitoring program), their population parameters, size and structure remain poorly understood. It is known that the animals move across the administrative border and the dolphins from Hong Kong can be seen off the Macau-Zhuhai coast. It is unknown, however, how frequently they undertake such travel and how long they remain in any particular location. The current lack of data and lack of knowledge of some of the most basic population processes that shape the daily existence of humpback dolphin in Hong Kong and the greater PRE remains the major

obstacle in the development and implementation of scientifically sound management strategy for these animals.

9d. Habitat and ecology

Sexual maturity is reached at the age of 9-11 years. Calving interval ranges between 3 and 5 years, with only one calf (Fig. 6) born at a time (Jefferson 2000; Jefferson et al. 2012). The humpback dolphin population size therefore has a very low natural rate of increase, as reported also for other members of the genus *Sousa* (Karczmarski 2000), indicating that any natural population recovery would be slow.



Figure 6. Newborn Indo-Pacific humpback dolphins are uniformly dark gray, but become light gray as juveniles and white to light pink as adults.

Throughout their range, Indo-Pacific humpback dolphins associate with shallow-water coastal habitats; usually in waters < 20 m deep and areas with diverse physiographic features such as estuaries, coastal lagoons, channels, reefs and sheltered areas that facilitate natural aggregations of their prey (Karczmarski 2000, Karczmarski et al. 2000, Jefferson 2000, Stensland et al. 2006). Even though the choice of specific habitats might differ between locations and regions in response to varying coastal environments and habitat patches, the overall pattern frequently re-occurs and represents one of the most characteristic feature of all four species of the genus *Sousa* (Jefferson & Karczmarski 2001, Parra & Ross 2009).

In Hong Kong waters, this species inhabits exclusively areas with estuarine influence (Jefferson 2000). Hung (2008) suggested that the dolphins are more densely located in deeper water (20 - 30m) and areas with steeper benthic slopes, although currently on-going study indicates that the dolphins prefer water depth of 5 - 15m and are often within just meters off the shore (HKU - Cetacean Ecology Lab, unpublished data). Similar pattern has been reported in western reaches of PRE, with the depth of 20m limiting their offshore distribution and majority of sighting recorded in waters < 10m deep (Chen et al. 2011).

Long-term line-transect monitoring surveys conducted by AFCD identified regions within western Hong Kong waters that serve as foraging/feeding grounds and suggested that similar may perhaps apply also to some other behaviours (Fig. 7). A socio-behavioural sub-division into two interacting communities has also been suggested; one community

off north Lantau and the other off southwest Lantau island, with an overlapping area at northwest Lantau (Dungan et al. 2012). If confirmed, such socio-behavioural structure within a small spatial and temporal scale may have a substantial conservation implications, increasing susceptibility to behavioural disturbance and environmental change.

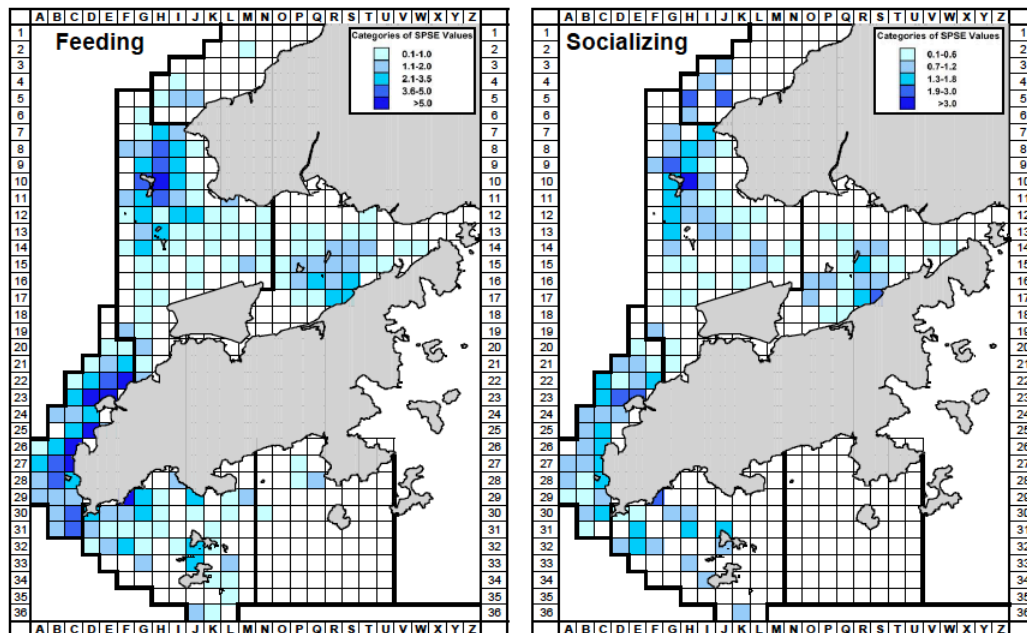


Figure 7. Density of Indo-Pacific humpback dolphins per 1-km² grid, categorised as engaged in feeding (left) and socializing (right) in Hong Kong waters during 2001-12 (Hung 2014).

An ongoing behavioural study (Or, Wong, Gailey & Karczmarski, study in progress) provides further fine-scale evidence of the dolphins' high selectivity for areas and sites used for key behaviours such as foraging/feeding; confirming the pattern initially described by Karczmarski et al. (2000) for *S. plumbea*. This data indicate that the dolphins' core areas are located along natural coastline and close inshore. In Hong Kong, foraging represents the predominant behaviour and its core areas are highly restricted (Fig. 8), while travelling range extends over a considerably larger area, connecting the core foraging and milling sites.

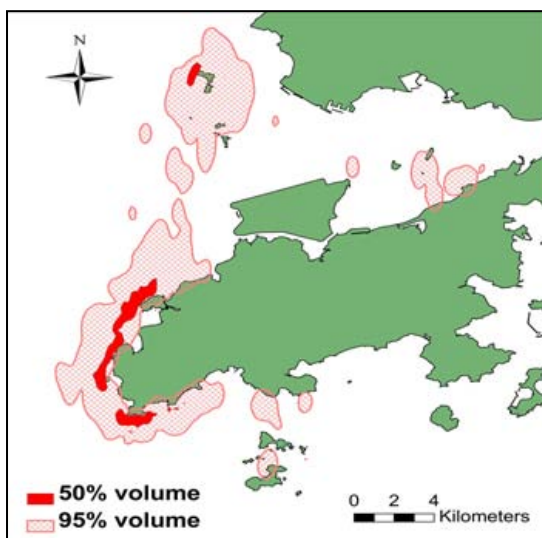


Figure 8. Foraging represents the predominant behaviour in Hong Kong waters. It occurs close inshore and the foraging/feeding core areas are highly restricted. The figure to the left illustrates kernel density analyses of foraging behaviour (Or & Karczmarski, unpublished data).

The use of Hong Kong western waters throughout the year and frequent engagement in essential activities such as foraging, indicates that this region of PRE represents an important area for the dolphins' annual energetic requirements and other daily activities, such as socializing and reproduction.

9e. Utilization

There is no record of any direct or indirect use and trade of humpback dolphins in Hong Kong. Human consumption of this species is extremely rare and restricted to isolated individual cases (S. Wong, personal communication; June 2014). However, by-catch is among the main causes of mortality in the Mainland part of PRD (Y. Mo, personal communication, January 2014).

10. Notes on main threats to the species, current regulations/policies for management, conservation actions in place, and priorities for future conservation efforts in Hong Kong.

Note that both positive and negative impacts from areas close to Hong Kong (particularly in relation to reproduction and habitat) can influence the status of a species in Hong Kong

10a. Threats (main threats to the species in Hong Kong and adjacent region/cross-border areas)

Threats affecting long-term survival of humpback dolphins in Hong Kong include habitat degradation and in some cases a complete destruction and habitat loss, intense marine traffic, pollutant accumulation, entanglement in fishing gear, and wide range of anthropogenic disturbance. Identification and assessment of impacts specific to a specific threat, however, remains qualitative and descriptive rather than quantitative.

Habitat loss, habitat degradation, and coastal development

Intense land reclamation and dredging activities related to major-scale urbanization and industrialization processes around PRE have already permanently removed some natural habitats and altered the ecological characteristics of others, offsetting the ecological balance essential to the survival of dolphins' prey (Huang & Karczmarski 2014). Although the extent of habitat degradation in the past and habitat loss specific to humpback dolphins ecological needs have not yet been quantitatively assessed, the pressure from habitat degradation and fragmentation is likely to only intensify, especially in western Hong Kong waters, due to the continuous growth and development of that region (Zhou et al., 2007; Chen et al., 2009).

The mitigation monitoring for the Hong Kong–Zuhai–Macau Bridge (HZMB) provides for the development of a robust analytical process for quantifying changes in distribution and habitat use during and after HZMB construction activities. The approach presented to management authorities is now in year three and will continue until two years post construction. This study conducts detailed surface density modeling and will test the often used prediction stated in Hong Kong EIAs that CWD will return to their habitat once construction activities/disturbing factors have ceased. As this presumption features strongly in the EIA for the intended expansion of the international airport, it is important to test if the EIAs the management authorities currently rely on are valid. If this is not the case, the impact of proposed works in the dolphins habitat are far greater than currently

stated and increase the urgency for the designation of comprehensive habitat protection.

Currently, the intended expansion of the Hong Kong International Airport into a 3-runway system is a cause of major concern. The expansion plan includes a large-scale land reclamation (650 hectares) and massive coastal construction works, both scheduled to begin shortly after the completion of the Hong Kong–Zhuhai–Macao bridge project that spans across the entire eastern PRE. The cumulative effects of two such large-scale projects following one after the other, with the combined impacts of habitat loss and massive behavioural disturbance, are likely to be vast and injurious to dolphins' ecological and behavioural needs. Although the scale of impairment cannot be reliably estimated at present, the damage to the overall ecological health of humpback dolphins in Hong Kong may be long-lasting. Dolphin movement will be affected and their use of waters between north Lantau and west New Territories will be weakened, forcing the animals to further increase and intensify their use of west-southwest Lantau as the only available habitat refuge. The effectiveness of the proposed Brothers Islands Marine Park will be severely compromised, undermining or perhaps completely voiding its usefulness for dolphin conservation. The usefulness of the currently existing Sha Chau - Lung Kwu Chau Marine Park will also be compromised, although the extent to which it will be affected is not possible to predict at present. This, however, raises the obvious concern whether the only remaining viable habitat refuge of west-southwest Lantau will be sufficient to facilitate a long-term persistence of humpback dolphins in Hong Kong waters. The view of the team of assessors compiling this report is that it will not.

As exemplified by the Environmental Impact Assessment (EIA) for the "Expansion of Hong Kong International Airport into a Three-Runway System" (EIA-223/2014), there are considerable flaws in the application and implementation of environmental assessments, mitigation and protection measures in Hong Kong. The 'best available science' is not applied even in a project with territory-wide impacts. Considering the extent of coastal development and the scale of coastal construction in Hong Kong, the lack of 'international best practice' in environmental assessment, mitigation, and protection has to be seen among the greatest threats challenging the continuous presence of humpback dolphins in Hong Kong waters.

Marine traffic

The routes of high-speed ferry transportation between Hong Kong, Shenzhen, Zhuhai and Macau directly pass through some of the distribution hot spots of humpback dolphins. The intense vessel traffic within Hong Kong waters has shown to induce longer dive time of the dolphins (Ng & Leung 2003), likely affecting their daily behavior budget. Negative impact on foraging and socializing, with transition into travelling behaviour as avoidance mechanism is frequently seen in both Hong Kong and elsewhere in PRE (Zheng, Wu & Karczmarski, project in progress). Cases of fatal collisions with boats are known to occur in Hong Kong (Parsons & Jefferson 2000) as well as Mainland waters (Lin, Zheng & Wu, Sun Yat-sen University; unpublished data).

Marine traffic in Hong Kong is projected to intensify further during the expansion of the Hong Kong International Airport. It is projected that during the peak reclamation and construction period (2016/2017), there will be 120 construction-related vessels operating in the area daily, with another 120 stationary vessels located within the construction zone. It is estimated that in combination with other water crafts, there will be more than 400 daily vessel movements in the vicinity of the project area. Adverse effects on the dolphins are unavoidable; they are likely to be severe and could be long-lasting.

Pollutant accumulation

The efflux of persistent organic pollutants in PRE waters, such as PCB (polychlorinated biphenyl), OCP (organochlorine pesticide), PBDE (polybrominated diphenyl ether) and

heavy metals shows a concerning trend (Parsons 1997, Parsons & Chan 1998, Minh et al. 1999, Jefferson 2000, Parsons 2004, Leung et al. 2005, Xing et al. 2005, Hung et al. 2006, Kajiwara et al. 2006, Ramu et al. 2005, Isobe et al. 2007, Wu et al. 2013, Gui et al. 2014a) that is likely to increase the vulnerability of the PRE dolphins (Jefferson et al. 2006). Many of these persistent organic pollutants are thought to be endocrine disruptive, with further demographic and developmental consequences (Guillette et al. 1994, Cheek & McLachlan, 1998, Vartiainen et al. 1999, Crews et al. 2000).

Hong Kong discharges over 2 billion liters of sewage into the surrounding waters daily. Parsons (1997) estimated that a humpback dolphin's minimum daily intake of sewage bacteria through ingestion of contaminated seawater could be up to 70,500 faecal coliforms. To put this in a context, a one-off ingestion rate of 200-300 coliforms is considered unacceptable for humans (Parsons 2004).

The disposal of contaminated mud from Hong Kong's dredging and reclamation projects poses an indirect risk to humpback dolphins via their consumption of contaminated prey (Clarke *et al.* 2000). Hong Kong is one of the major coastal ports in Asia that host large volumes of ship traffic; consequently, the water and dolphin's prey are likely to be highly contaminated with butyltin (BT) (Tanabe et al. 1998; Tanabe 1999; Parsons 2004). The latest analyses on the concentrations of bioaccumulative pollutants in blubber samples from stranded dolphins and their prey fishes reveal a substantial magnification between prey-predator transmission; ca. 100 times increase from prey fish to dolphin tissue and even up to 200 times for DDT transmission (Gui et al., 2014a). Concentrations of POPs in blubber and hepatic tissues in PRE humpback dolphin are higher than cetaceans from other geographical regions (Gui et al., 2014a, b).

Entanglement in fishing gear

Fishery activities of various sort take place in Hong Kong waters year round, altering between different fishery hotspots (S. Wong, unpublished observations; June 2014). Humpback dolphins have been seen in association with fishing boats, following pair-trawlers, hang trawlers, shrimp trawlers, single trawlers, gill-netters and purse-seiners. Among those dolphin sightings, feeding behind pair-trawlers is the most common (52%), compared to hang trawlers (17%), shrimp trawlers (18%) and single trawlers (11%) (Hung 2008). Lesions resulting from net entanglements have been seen on dolphins stranded in both Hong Kong and on the Mainland coast (Parsons & Jefferson 2000), and by-catch seem to represent a substantial cause of dolphin mortality in the Mainland part of PRD (Y. Mo, Sun Yat-sen University; unpublished data). An ongoing photo identification study (2012 – to date) indicates that over 50% of dolphins bear the scars of previous entanglements or still have net and/or fishing line entangled around the neck, pectoral fin, dorsal fin or tail stock area (Porter et al. in prep).

Behavioural disturbance

Large scale coastal construction work and other related human activities (e.g. piling and dredging) generate a wide range of anthropogenic disturbance (Jefferson 2000, Ng & Leung 2003, Hung 2008, Jefferson et al. 2009). Noise pollution is a major factor affecting humpback dolphins in Hong Kong. Boat traffic, especially high-speed ferries and middle size fishing boats, may interfere with the dolphin's acoustic communication and affect their ability to locate food (Van Parijs *et al.* 2001). The severity of noise pollution can be expected to reach particularly high levels in the vicinity of coastal underwater works. In the past, underwater percussive piling was thought to represent a particularly heavy disturbance factor (Jefferson 2000, Jefferson et al. 2009). Currently, percussive piling is not allowed in Hong Kong construction works and the alternative, bored piling and vibration piling, is considerably quieter (L. Porter, personal obs.). However, there is no sufficient biological data that could quantitatively explain the related effects on dolphins and how other human activities in Hong Kong coastal waters add to the impact of

anthropogenic noise.

A Hong Kong-specific case of behavioural disturbance relates to a small-scale dolphin watch operations off west Lantau. The code of conduct for dolphin watching activities is available and encouraged in Hong Kong, but it is not enforced and can be applied on voluntary basis. This makes the dolphin watching activities in Hong Kong almost completely unregulated. In some areas, such as near Tai O village on the southwest coast of Lantau, this has grown into a considerable conservation issue. In Tai O, small-scale dolphins watching is an important income-generating activity, with many dolphin watching boats operating daily. However, some of the local boat operators are incautious and frequently aggressive in their approach to the animals (Tse 2010, Wong 2010), causing a low-level but almost constant, chronic behavioural disturbance in an area that represents one of the primary foraging ground for humpback dolphins in Hong Kong.

Other threats from outside of Hong Kong waters

Anthropogenic impacts due to coastal urbanization and development in PRE outside Hong Kong waters remain mostly unquantified, but are likely to be substantial (Huang & Karczmarski 2014). One such major coastal construction plan posing a potential threat to humpback dolphins is an offshore wind farm project proposed in the vicinity Sanjiao Mountain Islands (<http://www.doc88.com/p-3079069328261.html>). The construction site is located in one of the known dolphin's hotspot, in close proximity to the Pearl River Estuary Chinese White Dolphin National Nature Reserve. If the wind farm project goes ahead, it is likely to cause a major habitat loss and substantial habitat degradation in neighbouring locations, along with a wide range of behavioural disturbance during the construction process.

The Jiangmen nuclear power station in western PRE, where humpback dolphins are frequently seen in large groups, might alter natural habitat by the continuous discharge of warm waters (heat pollution) and high level of anti-fouling agents (mostly BT).

Exclusion of humpback dolphins from utilizing some of their preferred habitats due to development of oyster farms can be seen off the Mainland coast of PRE (S. Chan, C. Or, W. Lin and S-L. Huang, personal observation; June 2014). Furthermore, various trawling fishery continues year-round in PRE waters outside Hong Kong, with the only exception of short fishing ban periods.

10b. Conservation measures CURRENTLY IN PLACE and of relevance to the species in Hong Kong and adjacent region/cross-border areas

Current marine protected areas specifically designated for the conservation of Indo-Pacific humpback dolphins and their habitats include:

- Pearl River Estuary Chinese White Dolphin National Nature Reserve (460 km² in Mainland China waters)
- Taishan Daijin Island Chinese White Dolphin Provincial Nature Reserve (108 km² in Mainland China waters)
- Sha Chau and Lung Kwu Chau Marine Park (12 km² in Hong Kong waters)

Cumulatively, this provides a legal protection over 580 km². However, cargo ships and

high-speed ferries routinely go through the China's Reserve, and the construction of infrastructure such as the Hong Kong-Zhuhai-Macau bridge has been allowed, crossing the designated core, buffer and experimental zones, which seemingly undermines the very purpose of the protected area designation.

The Brothers Island Marine Park is intended to serve as the second marine park dedicated to humpback dolphin conservation in Hong Kong waters after the completion of the Hong Kong-Zhuhai-Macau bridge in 2016 (ARUP 2009). However, its potential future effectiveness in dolphin conservation has already been severely compromised (see section 10a, page 13-14). Not a single marine reserve has yet been designated for dolphin conservation in Hong Kong.

Since 2013, there is a year-round ban of all mid-water and bottom trawling activities in all Hong Kong waters. Fishing using pair, stern, shrimp and hang trawlers in local waters are all prohibited. However, illegal trawling is still occasionally seen in Hong Kong (S. Wong, personal observation; June 2014).

In summary, the Indo-Pacific humpback dolphin faces a major challenge in Hong Kong waters, with their critical habitats restricted and increasingly limited. The current conservation measures in Hong Kong do not secure the necessary quantity nor quality of the habitat, nor do they adequately restrict anthropogenic intrusion. The Sha Chau and Lung Kwu Chau Marine Park is far too small and inadequate to sufficiently protect the species, while the effectiveness of the currently planned Brothers Island Marine Park has been compromised well before the intended park has even come into existence. Human-induced, chronic behavioural disturbance takes place daily, while the overall state of the environment severely degrades the dolphin's ecological health. Overall, the current conservation measures for humpback dolphins in Hong Kong are severely inadequate, misguided, and, consequently, highly ineffective. To date, there is no detailed conservation management plan for this population in Hong Kong waters.

**10c. Conservation ACTION OPTIONS recommended for the species Hong Kong.
HIGHLIGHT PRIORITY ACTIONS LIKELY TO BE EFFECTIVE FOR THE SPECIES**
(include need for protected areas, legislation and other measures).

The establishment of development-free Marine Protected Area (MPA) off West and Southwest Lantau and Soko Islands, with several specific sites within the MPA designated as Marine Reserves, should be seen as top priority for conservation actions. This is the largest area with high dolphin density in Hong Kong, with much of the area relatively unaltered and precisely the type of habitat that the dolphins depend on. If designated as MPA with several strict reserves, west-southwest Lantau could serve as a habitat refuge for the dolphins. However, to provide a minimum chance to be effective, such MPA would have to adopt more stringent conservation measures than that of a marine park, with no coastal development, limited boat traffic and further restricted human encroachment in the designated reserves. Only then can such an area have a chance to provide a functional "refuge" where the animals can concentrate their daily activities when other regions of Hong Kong waters are fast becoming uninhabitable to them.

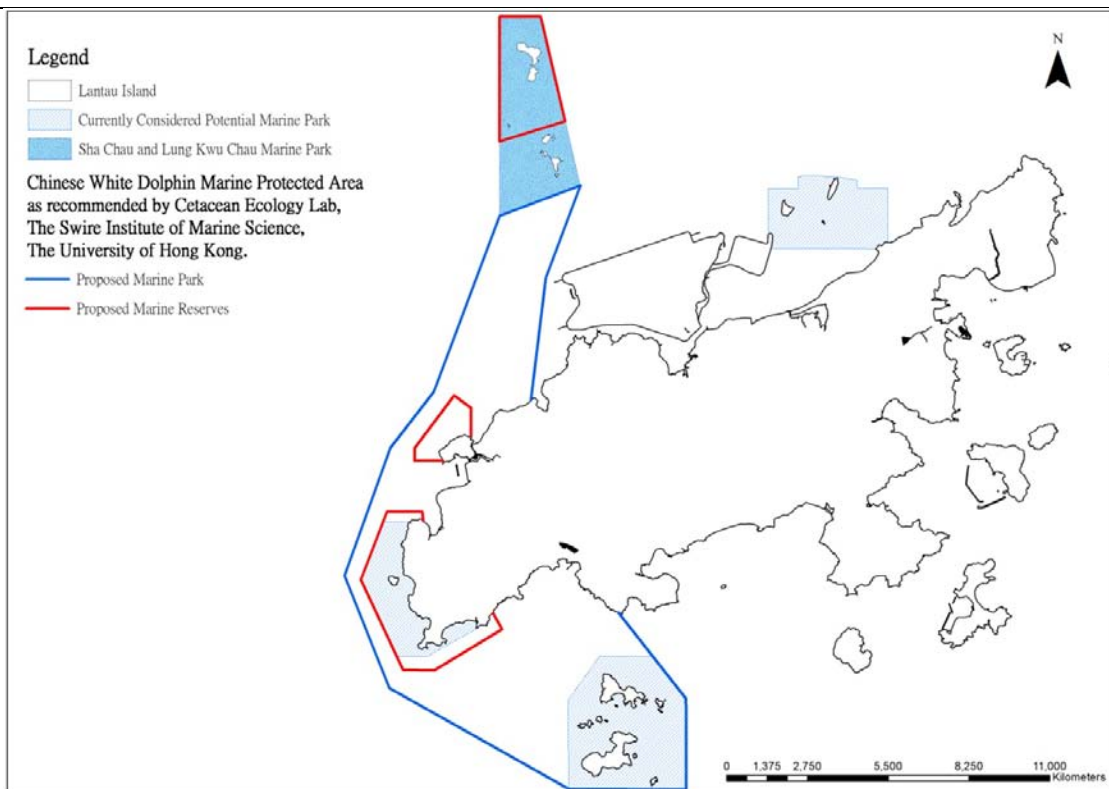


Figure 9. The area of west and southwest Lantau and Soko Islands, and corridor connecting to the existing Sha Chau and Lung Kwu Chau Marine Park, should be designated as development-free Marine Protected Area for dolphin conservation, with several specific sites within the MPA designated as Marine Reserves.

The waters off Tai O village on southwest Lantau Island, one of the primary foraging grounds of humpback dolphins in Hong Kong, host small-scale dolphin watch operations conducted by local inhabitants. These activities are completely unregulated and frequently aggressive when approaching the animals. Proper management measures of the Tai O dolphin watching tours should be implemented with the goal of reaching a low-impact and sustainable ecotourism industry. All dolphin watching activities should be a subject to monitoring and regulations on legal basis.

As Hong Kong territorial waters represent only part of the range of the dolphins seen in Hong Kong, the population integrity will not be assured without a comprehensive conservation and management action plan that covers the entire Pearl River Delta (PRD) and spans across the administrative border between the Hong Kong S.A.R. and Guangdong Province. Such a plan should consider fishery regulations with effective monitoring mechanisms, as entanglement in fishing gear is among the main causes of dolphin mortality in Mainland waters. A broader network of marine protected areas across PRD, designated after consideration of scientifically-sound field-based evidence, has to be seen as instrumental in achieving conservation objectives. Currently, various construction development projects are in stark violation of the very purpose of the MPAs in both Hong Kong and Mainland. However, as much of the dolphin range use pattern in PRD remains unknown, a focused research study that identifies critical areas and dolphin range use is urgently needed to aid in the enhancement of current protection measures and, along with complementary studies on population structure and connectivity, facilitate the establishment of a network of protected areas that could provide a sufficient assurance of conservation effectiveness. Consequently, a focused ecological research should be encouraged and seen as vital part of conservation actions.

Bio-accumulative persistent and newly emerging pollutants represent a growing challenge, following the rapid industrial development and human-population growth in the PRD region. Prompt actions for comprehensive control of sewage discharge, sewage reprocessing, and stricter standards for pollutant discharge are required to mitigate pollutant accumulation. This can only be achieved through regional cooperation between Hong Kong and the Guangdong Province.

10d. International/regional considerations (CITES listing, status in China Red List, protective measures in areas adjacent to Hong Kong if known, etc.)

The Indo-Pacific humpback dolphin is listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I and the Convention on Migratory Species (CMS) Appendix II. In Hong Kong waters, this species is protected under Wild Animals Protection Ordinance (Cap 170) and Protection of Endangered Species of Animals and Plant Ordinance (Cap 586); while in Mainland China, it is listed as a “Grade One National Key Protected Species.” However, in the day-to-day practice, there are considerable legal deficiencies in the protection of humpback dolphins in Hong Kong waters (Jefferson et al. 2009; Whitfort et al. 2013).

10e. Data gaps and information needs for the future in Hong Kong (highlight information needs for assessment of conservation status if currently DD, and/or details of how protection might be improved, etc.)

The Hong Kong's Agriculture, Fisheries and Conservation Department (AFCD) has been conducting dolphin monitoring program for the past two decades. Although summary reports from these surveys are in the public domain, they have not been peer-reviewed and as such are only partially informative. An assessment of these reports and data provided by marine mammal biologists, fisheries biologists and ecotoxicologists was conducted by an independent panel of marine mammal experts and Hong Kong management authority staff. The report provided information on data gaps and recommended the analyses required which would subsequently lead to defining the population status of the Hong Kong and PRD population of humpback dolphins. Of the reports main conclusions, it was highlighted that no other population of small coastal delphinids was exposed to the extent and degree of threatening anthropogenic activities as that which occur in Hong Kong and adjacent waters and, further, that despite the then more than a decade of extensive data collection on the ecological processes and dolphin ecology, no effective management plan was in place and the population decline perceived at the time continued unchecked (Wilson et al 2008). None of the recommendations made by the expert report have been incorporated into management authority processes to date.

No data has been made available by AFCD for the purpose of the Hong Kong Red List Assessment presented here, which is of a major disadvantage to its thoroughness. The data archived with AFCD should be made freely available for a greater use in research and conservation.

As the population size and structure, and many vital population parameters remain insufficiently known, there is an urgent need for a focused research that applies modern quantitative techniques to addresses the considerable gaps in the current knowledge of

the population ecology, demography, spatiotemporal patterns and socio-behavioural dynamics of humpback dolphins in Hong Kong and across PRE. As much of the dolphin range use in PRD remains unknown, a focused research that identifies critical areas and spatial pattern of dolphin range use is urgently needed to aid in the enhancement of current protection measures and, along with complementary studies on population structure and connectivity, facilitate the establishment of a network of protected areas that could provide adequate habitat protection. Ecotoxicological research and detailed studies of foraging ecology should be encouraged to complement a broader understanding of factors that influence population processes, determine ecological resilience, and affect the ecological health of the Indo-Pacific humpback dolphins in Hong Kong and the greater PRE. Consequently, an orchestrated and focused ecological research should be encouraged and given high priority.

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