6 Pelagic Ecology

6.1 Introduction

6.1.1.1 This section presents the approach to and the findings of the pelagic ecology baseline assessment and the Project impact assessment. Pelagic ecology concerns open sea habitat, species and communities, and for the purposes of this EIA Study also includes reef fishes.

6.1.1.2 The aim of the pelagic ecological impact assessment is to present representative baseline ecological conditions within the Study Area and evaluate these against potential impacts from Project development with a view to protection and enhancement of the natural environment.

6.2 Objectives

6.2.1.1 The pelagic ecological assessment has been undertaken in accordance with the criteria and guidelines in Annexes 8 and 16 respectively of the EIA-TM, and with reference to the requirements of *Clause 3.4.2* of the EIA Study Brief.

6.2.1.2 The key objectives are as follows:

- Review the findings of relevant studies/surveys and collate the available information regarding the ecological characters of the assessment area;
- Evaluate information collected and identify any information gap relating to the assessment of potential ecological impact;
- Conduct marine mammal field survey of at least 12 months covering 4 seasons to fill information gaps identified in Section 3.4.2.4 (ii) of the ESB;
- Establish the general ecological profile of the Study Area taking into account seasonal variations, and describe the characteristics of each habitat found. Major information shall include inter alia the types / locations of habitats and species of conservation interest such as marine mammals, in particular finless porpoises;
- Identify and quantify as far as possible impacts or disturbance (e.g., physical injury, underwater noise) to marine mammals in particular finless porpoises during construction (e.g., dredging of turbine foundations, cable installations, pile driving for installation of turbine foundations) and during operation (e.g., underwater noise generated by the wind turbines).
- Evaluate the significance and acceptability of such impacts during Project construction and operation;

- Recommend all possible alternatives and practicable mitigation measures to avoid adverse ecological impacts during Project construction and operation upon pelagic species;
- Evaluate the feasibility and effectiveness of any recommended mitigation measures, quantify as far as practicable the residual impacts of mitigation measure implementation and evaluate the acceptability of any residual impacts using the criteria in Annex 8 of the TM; and
- Review any requirements for ecological monitoring.

6.3 Legislation, Standards & Guidelines

6.3.1.1 Reference has been made to the following local legislation governing conservation of marine ecological resources:

- Wild Animals Protection Ordinance (Cap. 170) provides for the protection of species listed in ' Schedule 2 ' of the Ordinance by prohibiting the disturbance, taking or removal of such animals, their nests and eggs. This Ordinance excludes fish and marine invertebrates, but does allow for the protection of all marine mammals found in HKSAR waters.
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) controls the local possession of any endangered species of animals and plants listed in its schedules. These include both species of marine mammal resident in the HKSAR.
- Fisheries Protection Ordinance and Regulations (Cap. 171) regulates fishing practices, aims to prevent activities detrimental to the fishing industry and aims to protect fishes and other marine biota in HKSAR waters.

6.3.1.2 Relevant Mainland regulations include the Wild Animals Protection Law that *inter alia* protects the habitats of all wild fauna, including the creation of Class I /II protected species lists (Class I species being of greater concern). Chinese white dolphin and Finless porpoise are listed as Class I and Class II National Protected Species, respectively.

6.3.1.3 Other relevant international regulations include:

- Convention on International Trade in Endangered Species (CITES) [of Wild Flora and Fauna] has listed Chinese white dolphin and Finless porpoise as Appendix I species, i.e. most endangered species which are prohibited from international trading.
- The International Union for Conservation of Nature and Natural Resources (IUCN) Red List has listed Chinese white dolphin and Finless porpoise as data deficient species, i.e. insufficient data on abundance and / or

distribution.

- Convention on the Conservation of Migratory Species of Wild Animals (CMS) has listed Chinese white dolphin and Finless porpoise as Appendix – II Species, i.e. migratory species conserved through Agreements.

6.4 Assessment Approach

6.4.1 Desktop Review

6.4.1.1 A review of available data and information was conducted. The most relevant updated sources of data / information for marine mammals includes *inter alia*:

- AFCD, 2000. Conservation Biology of the Finless porpoise (Neophocaena phocaenoides) in Hong Kong Waters Final Report. Agriculture Fisheries and Conservation Department (AFCD), HKSAR Government.
- AFCD, 2005. Monitoring of Finless Porpoise (Neophocaena phocaenoides) in Hong Kong Waters (2003-05). Final Report. AFCD, HKSAR Government.
- AFCD, 2006. Monitoring of Hump-backed Dolphins (Sousa chinensis) in Hong Kong Waters Data Collection and Final Report. AFCD, HKSAR Government.
- AFCD, 2008, Monitoring of marine mammals in Hong Kong waters – data collection (2007 – 2008). AFCD, HKSAR Government.
- Jefferson, T.A., 2000. Population Biology of the Indo-Pacific Hump-backed Dolphin in Hong Kong Waters. Wildlife Monographs, Vol. 64.

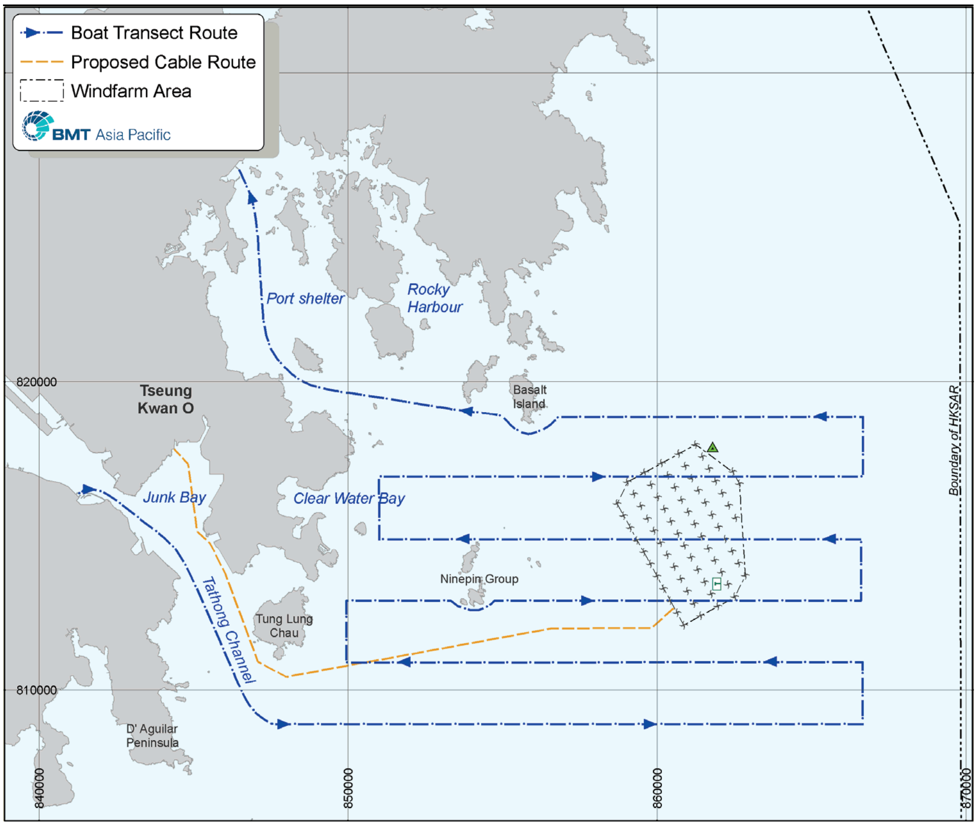
6.4.1.2 Key data sources on the fish species of the HKSAR and Eastern Waters included:

- Binnie Consulting Ltd., 1994. South of Ninepins Borrow Area, Environmental Impact Assessment, Civil Engineering Department (CED), Geotechnical Engineering Office.
- Binnie Consulting Ltd., 1995. South Mirs Bay Environmental Impact Assessment, Initial Assessment Report. CED, Geotechnical Engineering Office.
- Binnie Consulting Ltd., 1995. Marine Ecology of Hong Kong: Report on the Underwater Dive Surveys, Vol I and II. CED, Geotechnical Control Office.

6.4.2 Marine Mammal Survey

6.4.2.1 As required by the EIA Study Brief, a 12-month boat-based marine mammal survey was conducted between June 2006 and July 2007. The survey adopted the survey route used for past studies in the Study Area, with reference to the methodology adopted AFCD, 2006. Figure 6.1 illustrates the survey route.

Figure 6.1 The Boat Transect Route for Marine Mammal Survey



6.4.2.2 Searches and observations were conducted on the open upper deck of the survey vessel (a 15 metre coastal vessel) from the flying bridge area at an elevation of 4 - 5 metres above the water surface. A principal observer conducted the searches aided by suitable magnifying binoculars (e.g., 8 x 42) for scanning a search area in front of the vessel (between 270˚ and 90˚ in relation to the bow as 0˚). A secondary observer primarily conducted searches without the aid of binoculars and recorded data.

6.4.2.3 The data recorded during the course of each survey included time, distance and position of initial sighting (measured using a hand-held GPS), size and age composition of groups and behaviour, including response to the survey vessel.

6.4.2.4 All sighting data was only validated when the sea state at the time of sighting was between 0 and 3 on the Beaufort scale. Accordingly, survey dates were mainly informed by weather forecasts issued by the Hong Kong Observatory (HKO) resulting in some irregularly in the survey schedule during the survey period.

Appendix 6A presents the wind data collected at Waglan Island meteorological station.

6.4.2.5 The survey vessel travelled along the route at a constant speed of 15km / hour throughout the entire survey, with vessel navigation controlled by DGPS real time on board system digitally recording the survey route. For each survey event an annotated vessel track plot was produced to verify the transect route. These records are presented in Appendix 6B.

6.4.3 Independent Expert Appraisal

6.4.3.1 The consultancy services of marine mammal behaviour and ecology expert Dr. Bernd Würsig were engaged in starting April 2008 to conduct a peer review of marine mammal activity / sensitivity to the Project, and to advise on monitoring and management requirements of the proposed Project area. This Section of the EIA Report therefore incorporates the suggestions of Dr Würsig.

6.5 Ecological Baseline Profile

6.5.1 Marine Mammals: Literature Review

6.5.1.1 There has been much research carried out in Hong Kong on marine mammals since the early 1990's, originally relative to construction of the Chek Lap Kok International Airport and the fuel receiving facility for it, but then expanded to other projects (for example: Jefferson, 2000; Jefferson *et al*, 2002).

6.5.1.2 Almost all of the work carried out north and west of Lantau Island was relative to Indo-Pacific humpback dolphins, *Sousa chinensis*. Less research has been conducted in the Eastern Waters of Hong Kong, and most of this work has concentrated on finless porpoises, *Neophocaena phocaenoides*. These two species of marine mammals are resident in some of HKSAR waters all year.

6.5.1.3 **Indo-Pacific hump-backed dolphins** are mostly white or pinkish colour with shaped spots and flecks (Jefferson, 2000). Black marks surround their eyes and their body shape is strong with large, broad flippers and flukes. Their average length is approximately 2.5 metres, and their beaks account for 6-10% of total length.

6.5.1.4 These dolphins, most frequently observed in waters off North Lantau, usually travel in small schools of less than 10 individuals and are commonly found associated with fishing vessels, such as pair trawlers, in the western HKSAR waters. Common behaviour includes travelling, foraging, feeding and socialising. Their mean dive time is about 40-60 seconds (Parsons, 1997).

6.5.1.5 Common prey species include croakers *Johnius* spp., lionhead *Collichthis lucida* and anchovies *Thryssa* spp. (AFCD, 2006). Studies of the stomach content of carcasses suggest that this species does not consume many cephalopods or crustaceans, but mostly feeds on demersal estuarine fish species (Barros *et al*., 2004).

6.5.1.6 Indo-Pacific hump-backed dolphins display a seasonal distribution, although their range appears to be largely restricted to the estuarine waters of the Pearl River Delta. There are few observation records in Eastern Waters of the HKSAR that have a dominant oceanic influence (Parsons, 1997; Jefferson, 2000; and AFCD, 2006). Figure 6.2 illustrates the seasonal distribution of *Sousa chinensis*.

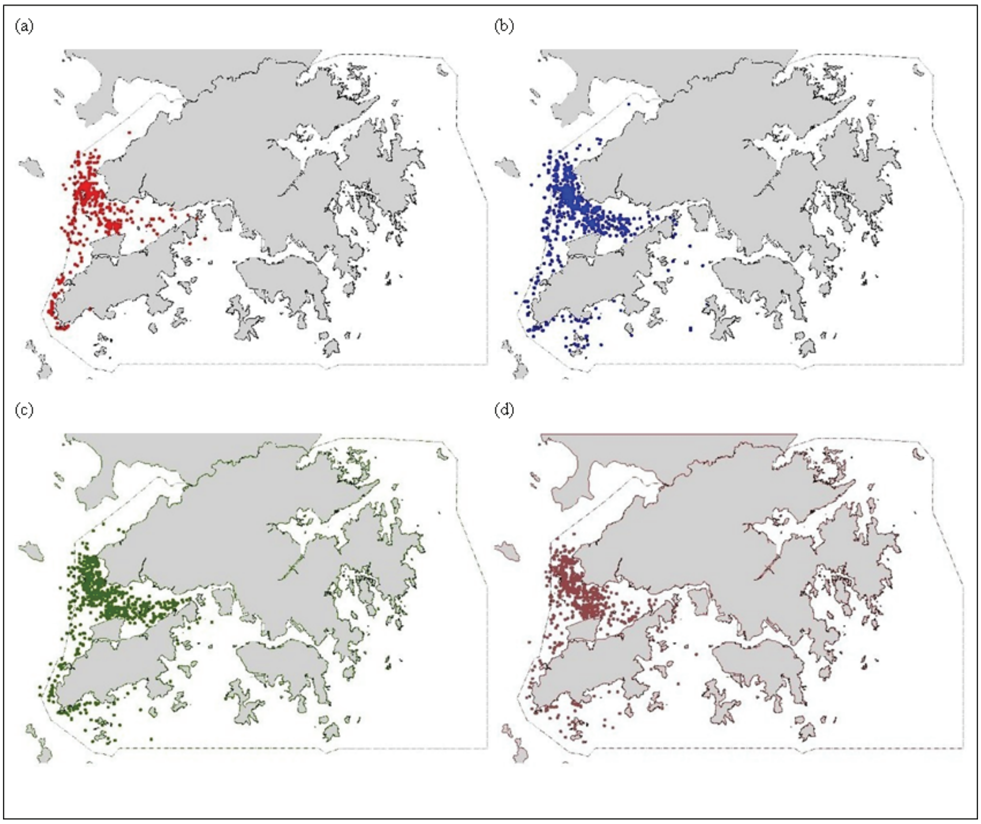
6.5.1.7 **Finless porpoises** have no dorsal fin, rostrum nor beak. They are smaller than dolphins, growing to less than 2 metres in length. Adults are generally light grey in colour, while the juveniles are a darker grey.

6.5.1.8 The relatively cryptic nature of finless porpoises, with shallow and brief surfacing behaviour and very limited breaching or aerial behaviour, hinders the detection or study of these species (Jefferson, 2000). They are most commonly seen during feeding, travelling and milling.

6.5.1.9 This species feeds on mostly cephalopods of the families Loliginidae, Octopodidae, and Sepiidae, and on demersal fish families including Apogonidae, Carangidae, Clupeidae, Congridae, Engraulidae, Leiognathidae, Maemulidae, Mugilidae, Nemipteridae, Sciaenidae, and some panaeid shrimps (Barros *et al*. 2002; Parsons 1997). Based on their prey species it has been suggested that finless porpoises predominantly seek coastal and non-estuarine species (AFCD, 2005).

6.5.1.10 Although the activity of finless porpoises extends to and overlaps with that of *Sousa chinensis* around south Lantau and Lamma Island, these two species have not been reported to be interacting which may indicate a partitioning of habitats within HKSAR waters (Jefferson and Braulik 1999; Parsons 1998a).

Figure 6.2 Seasonal Distribution of Indo-Pacific Hump-Backed Dolphins

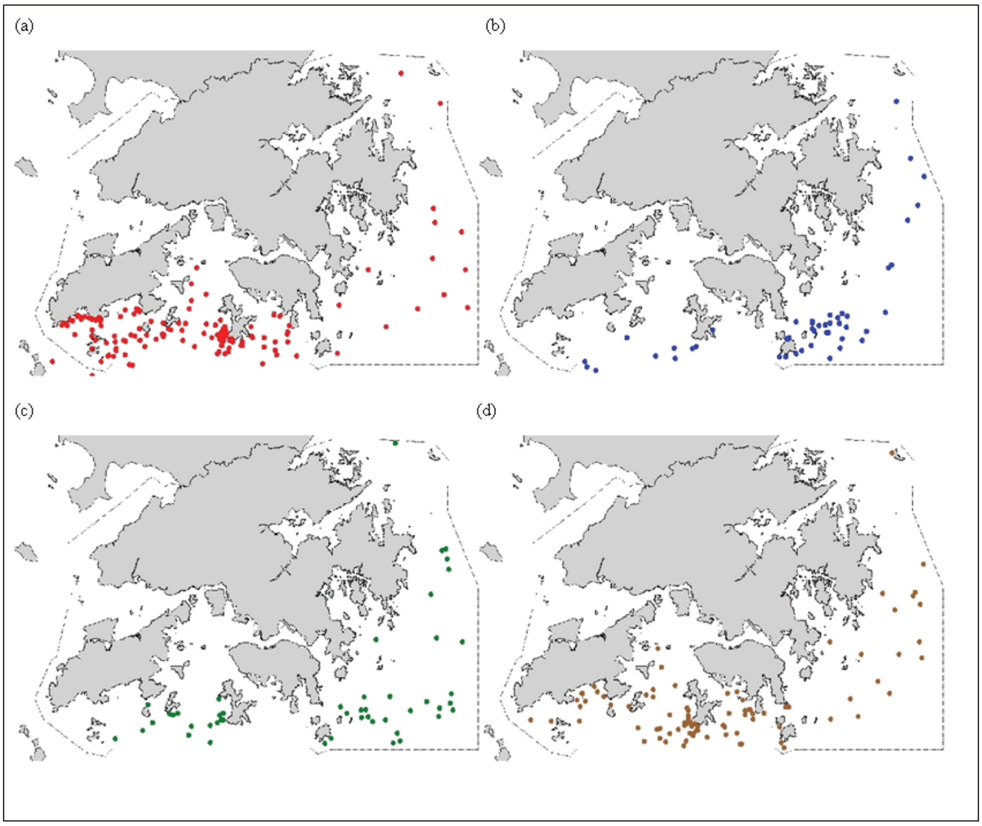


Source*: AFCD (2007a)*
Notes*: (a) Spring; (b) Summer; (c) Autumn; (d) Winter*

6.5.1.11 Figure 6.3 displays seasonal distribution data for finless porpoises in HKSAR waters. These data may be broadly summarised as follows:

- Spring (March to May): peak season with significant numbers in southern waters.
- Summer (June to August): western areas of south Lantau and Lamma vacated by finless porpoises.
- Autumn (September to November): abundance appears to reach a low point possibly due to offshore movement of animals south into Mainland waters.
- Winter (December to February): move into waters of South Lantau and Lamma.

Figure 6.3 Seasonal Distribution of Finless Porpoises



Source: *AFCD (2005)*
Notes*: (a) Spring; (b) Summer; (c) Autumn; (d) Winter*

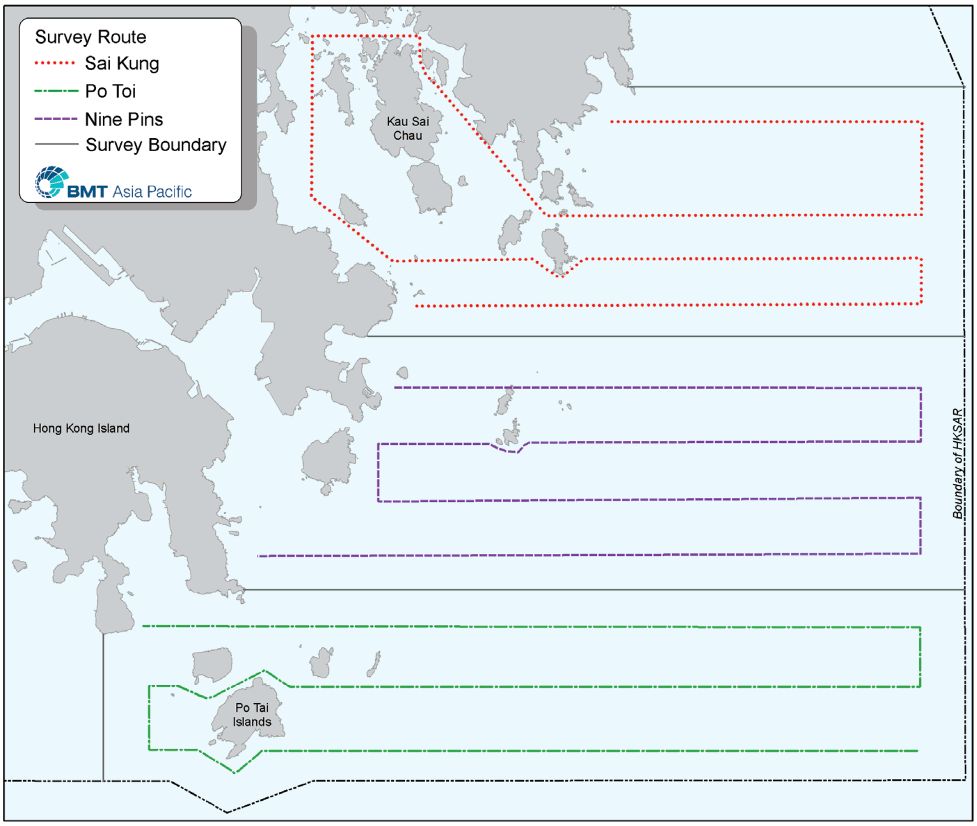
6.5.1.12 As regards non-resident species of marine mammals, there are HKSAR observation records for a total of 16 such species (Jefferson & Hung, 2007). Table 6.1 summarises confirmed sightings of ten non-resident species that have been observed in the general vicinity of the Study Area in recent years.

Table 6.1 Confirmed Non-Resident Cetacean Sighting Records

Common Name	Scientific Name	Conservation Status*			Confirmed Hong Kong Records
		IUCN Red List	CITES	CMS	
Bryde's whale	*Balaenoptera edeni*	Data Deficient	App. I	App. II	Stranding confirmed near Tolo Harbour in 2005
Long-beaked common dolphin	*Delphinus capensis*	Low Risk Least Concern	App. II	App. II	Carcass found offshore Po Toi Island in May 2004.
Risso's dolphin	*Grampus griseus*	Data Deficient	App. II	App. II	3-4 strandings reported near Tolo Harbour in June 1986.
Pantropical spotted dolphin	*Stenella attenuata*	Low Risk Conservation Dependent	App. II	-	Carcass discovered near Starling Inlet in Mirs Bay in 2000.
Striped dolphin	*Stenella coeruleoalba*	Low Risk Conservation Dependent	App. II	-	A carcass was discovered at Shek O in 1996.
Common bottlenose dolphin	*Tursiops aduncus*	Data Deficient	App. II	App. II	Carcass discovered by Tung Lung Chau in 2001.
Indo-Pacific bottlenose dolphin	*Tursiops truncatus*	Data Deficient	App. II	App. II	Carcass found in waters offshore Double Island / Crescent Island in 2004.
False killer whale	*Pseudorca crassidens*	Low Risk Least Concern	App. II	-	A carcass was reported on Town Island in Sai Kung in 2005.
Rough-toothed dolphin	*Steno bredanensis*	Data Deficient	App. II	-	A carcass was found near Ching Chau in Sai Kung in May 2003.
Sperm whale	*Physeter macrocephalus*	Vulnerable	App. I	App. I	Stranding record in July 2003 at Tai Wan in Sai Kung.

6.5.1.13 Given the prevalence of more visible marine mammal activity in the western HKSAR, relatively less effort has been placed into surveys of Eastern Waters. The most recent 2-year survey programme for finless porpoises was to investigate distribution and behaviour in southern waters, but also including waters around Po Toi, Ninepins and Sai Kung. Figure 6.4 presents the vessel transects adopted for these surveys.

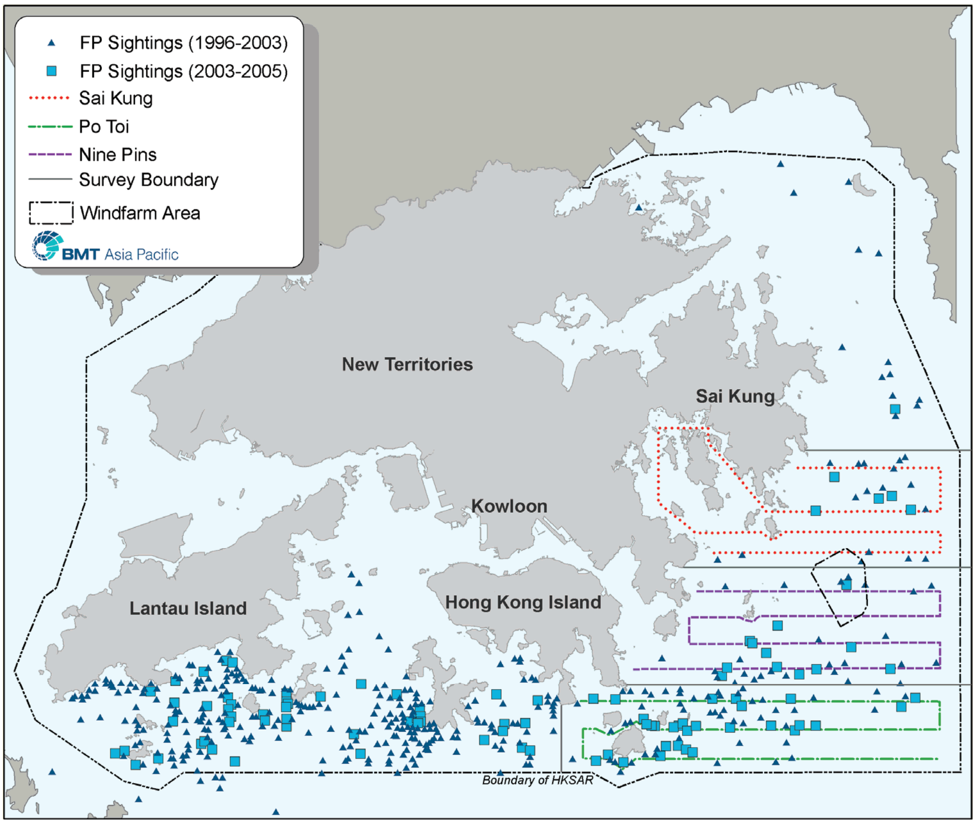
Figure 6.4 AFCD Marine Mammal Survey Transect Routes



Source: AFCD (2000)

6.5.1.14 Figure 6.5 presents the location of sightings recorded between 1996 and 2005. It is immediately evident that there is variation in the spatial distribution of sightings across surveyed waters.

Figure 6.5 Finless Porpoise Sighting Records in the HKSAR, 1996-2005

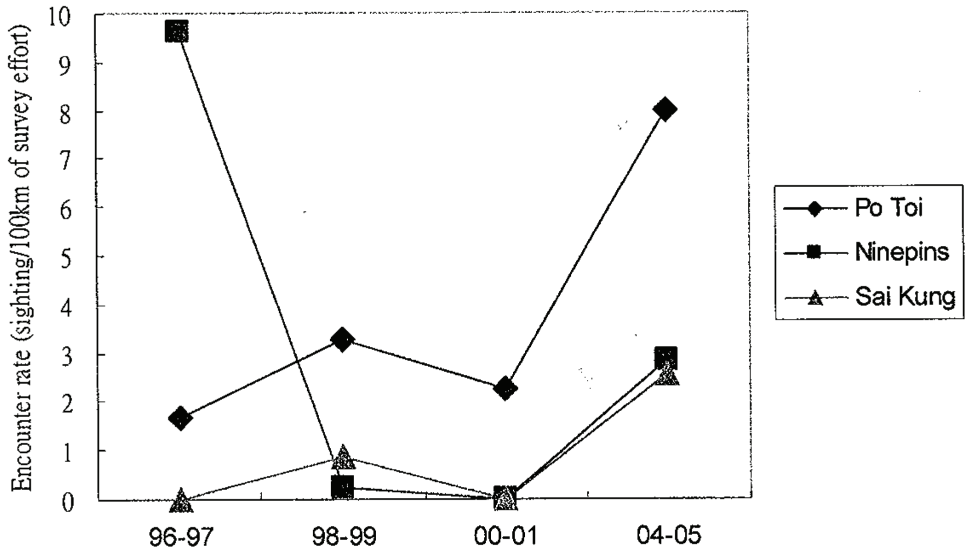


Source: AFCD (2005)

6.5.1.15 An average biennial encounter rate of 2.9 per 100km was obtained from 5 survey zones across the HKSAR from the most recent AFCD survey, including the 3 zones in Eastern Waters (Figure 6.4 refers) as well as the coastal waters off South Lantau and Lamma (AFCD, 2005). The 2005 AFCD survey also recorded high localised encounter rates of 7.6 at Po Toi and 3.1 at the Ninepin Islands during summer months.

6.5.1.16 It is noted that these latest encounter rate data are somewhat higher than past data collected in Eastern Waters over the past decade. Figure 6.6 summarises the summer encounter rate per 100km in each of the three survey zones in Eastern Waters: Sai Kung, Ninepins and Po Toi. It is apparent that when considering a longer-term data set that there is considerable variation in encounter rate both within and between these zones. For example, within the Ninepin survey zone a summer biennial encounter rate of 9.6 sightings / 100 km was recorded in the 1996/97 survey, while only one sighting was recorded in the subsequent 1998/99 survey (i.e., encounter rates of approximately 0.2 sightings / 100 km) and with no sightings in the 2000/01 survey. Also, while the 2005 survey recorded a summer encounter rate of 7.6 in Po Toi, the latest AFCD study in 2008 recorded a summer encounter rate of only 1.9 there (AFCD, 2008). The 2008 survey did not conduct surveys in Sai Kung and the Ninepins.

Figure 6.6 Temporal Trend of Biennial Encounter Rates of Finless Porpoises in Summer Months in Each Eastern Survey Area



Source: AFCD (2005)

6.5.1.17 Jefferson (AFCD, 2000) cautioned about drawing linkages between encounter rates and actual abundances. He stated that "*any trends observed in the estimates, even if real, may simply reflect local movements of animals and not necessarily changes in overall abundance of the population (e.g. the redistribution factor)*". Jefferson (AFCD, 2000) pointed out that variation in the encounter rate is reasonable as finless porpoises can travel freely between local and regional waters, and more importantly, the survey area does not contain any closed finless porpoise population.

6.5.1.18 Environmental conditions likely play an important role in the distribution of finless porpoises. Parsons (1998b) set forth a correlation between physical environment and the relative abundance of the species in local waters. Finless porpoises appear to respond positively with cooler water of higher salinity, which may explain the overall higher encounter rates during winter and spring (AFCD, 2007). Other elements that may affect finless porpoise distribution patterns include reproductive cycles, hydrography, diurnal patterns and tidal state (Parsons, 1998b).

6.5.1.19 In conclusion, although finless porpoises are present in Eastern Waters year-round, analyses show sporadic and low occurrence in all seasons and large fluctuations in different areas / zones.

6.5.2 Marine Mammals: 2006/07 Field Survey

6.5.2.1 Updated baseline data on marine mammals utilising the Study Area was collected specifically for the purposes of this EIA Study through a series of boat-based transect surveys. Surveys were undertaken on 25 days during the year, equivalent to one event approximately every 15 days. The survey frequency was dictated by offshore weather conditions, and despite reliance on general weather forecasts for the offshore area obtained from the Waglan Island meteorological station, unpredictably rough seas led to some survey events being abandoned while in progress.

6.5.2.2 Overall the average length of each transect was ~120 km per event, with a cumulative distance of ~3,000 km covered by these boat-based surveys. A total of ~2,500km of survey effort was conducted at or below Beaufort 3.

6.5.2.3 The survey area covered Ninepins and part of the Sai Kung transect routes adopted by previous surveys commissioned by AFCD (2000 & 2005) (Figure 6.1 and Figure 6.4 refer). The survey was focussed on offshore Eastern Waters, the proposed wind farm footprint area - some 5km east of the Ninepin Islands, was also included.

6.5.2.4 The surveys resulted in only five individual resident finless porpoises being observed 'on effort' over two days, equal to an average encounter rate of about 0.2 sightings per 100km. A further five incidental observations of finless porpoises were made during the survey period. Three of these incidental sightings were recorded within and in the vicinity of the Wind Farm. No further observations of finless porpoises were made in the period May – July 2007.

6.5.2.5 While the encounter rate of 0.2 finless porpoise sightings per 100km is lower than the AFCD data collected between 2003 to 2005, the literature review indicates that the encounter rate of finless porpoise in Eastern waters could be highly variable and sporadic. The encounter rate during the latest 2008/09 AFCD survey (AFCD pers. comm.) in Po Toi was 3.6 sightings per 100 km, but that for 2007-08 was only 1.9. The lack of encounters during the 2006/07 BMT summer season survey may be considered comparable with the low encounter rate (e.g. in 2000-2001, Figure 6.6) reported within AFCD data.

6.5.2.6 The variable but generally low encounter rate does not suggest that finless porpoises are absent from Eastern Waters. For example, anecdotal evidence obtained through discussions with fishermen for this EIA study would strongly suggest that the species is present year-round in waters around the Ninepins (defined in the broadest sense), although not in any significant numbers. There are also strong indications from the survey completed for this EIA study and from expert opinion (for example, Würsig, *pers. comm.*) that the visual observation method used in isolation in a low encounter rate area may be of limited effectiveness; a fact that cannot be overlooked when considering options for future monitoring and management of the marine environment for the benefit marine resources [sub-section 6.10.1 refers].

6.5.2.7 A total of 15 False killer whales *Pseudorca crassidens* – an occasional migrant – were also observed 'on effort' in a single day in open waters. A pod of 12 specimens was also incidentally observed at close quarters a few days before during sediment sampling at the northeast of the proposed Wind Farm area, enabling video and photographic records to be taken (Figure 6.7). It is likely that these observations were of the same pod.

Figure 6.7 False Killer Whale *Pseudorca crassidens* observed in May 2007

6.5.2.8 Figure 6.8 presents the locations of all observations made, while Table 6.2 presents a summary of the sightings.

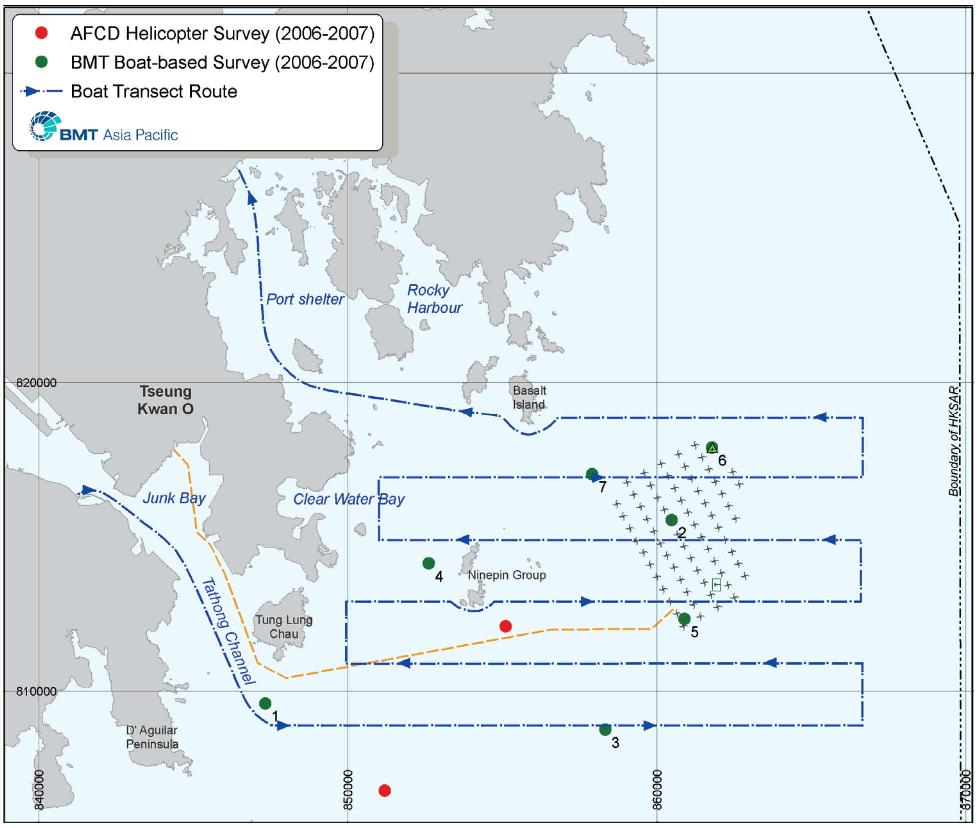
Table 6.2 Summary of Marine Mammal Observations

Obs. Ref.	Date (2007)	Species	Count	Coordinates		Sighting Angle^	Observer Distance (m)	Beaufort Scale
				Northing	Easting			
1	14 Feb	Finless Porpoise	4	809,757	847,094	090˚	200	2
2	10 Mar	Finless Porpoise	1	815,696	860,249	N.A.*	<50	4
3	13 Apr	Finless Porpoise	1	808,897	808,897	270˚	8	2
4	16 Apr	Finless Porpoise	1	814,274	852,385	N.A.*	100	1
5	16 Apr	Finless Porpoise	3	812,491	860,654	N.A.*	100	1
6	4 May	False Killer whale	12	817,876	861,805	0 - 360˚*	4 - 200	1
7	7 May	False Killer whale	15	817,165	857,679	270˚ - 90˚	10	2

Notes: ^ Sighting angle from vessel (bow = 0 degrees)

* Incidental observations

Figure 6.8 Marine Mammal Sighting Locations, 2006/2007 Survey



6.5.3 Fish

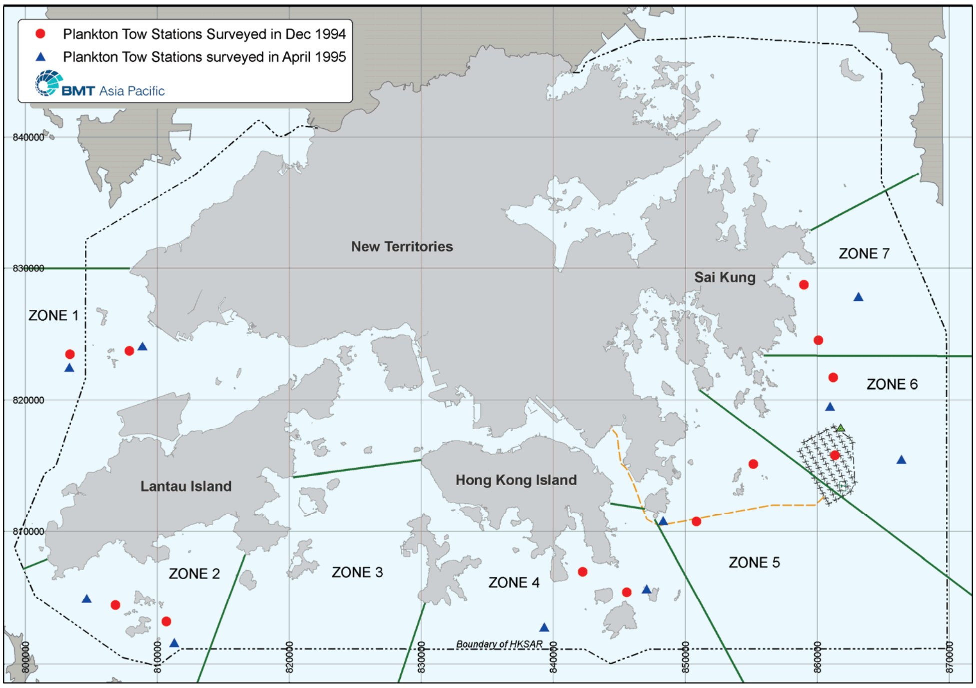
6.5.3.1 There has been a general dramatic decline in fish abundance in HKSAR waters from the middle of the last century. In the 1950s the catch per unit effort for trawlers in local waters was about 90-140 kg per haul, but by the 1980s the catch per unit effort had declined ~15 kg per haul (Cheung and Sadovy, 2004). By the 1980s, reef species such as groupers, yellow croakers and giant croakers had become rare catches, with the biomass of these predatory species estimated to have fallen by around 80% (*ibid.*).

6.5.3.2 This general decline continued through the 1990s and early 2000s, by which time local catches of fishes and invertebrates were dominated by juvenile fishes and small and fast growing species such as pony fish (Leung, 2000; WWF, 2005). The similarity in catch over these years suggested that the marine ecosystem was stable at a depressed level (Sumaila *et al*, 2007).

6.5.3.3 Given the absence of any major project development in Eastern Waters in the intervening period, and the general decline in fisheries productivity through the 1990s to the present day, the results of two ichthyoplankton surveys conducted in the mid-1990s are still valid.

6.5.3.4 Figure 6.9 presents the coverage and nature of these surveys, with the proposed wind farm in 'Zone 6' as displayed. There were 40 species of fish larvae and 29 species of fish eggs identified in these two surveys. The average density of fish larvae and fish eggs in Zone 6 was 0.008 - 0.012 and 0.054 - 0.097 individuals / m^3, respectively (Binnie Consulting Ltd, 1995a, b). These levels were significantly lower than the mean densities from other surveyed waters.

Figure 6.9 Ichthyoplankton Survey Locations



Source: *Binnie Consulting Limited (1995a, b)*

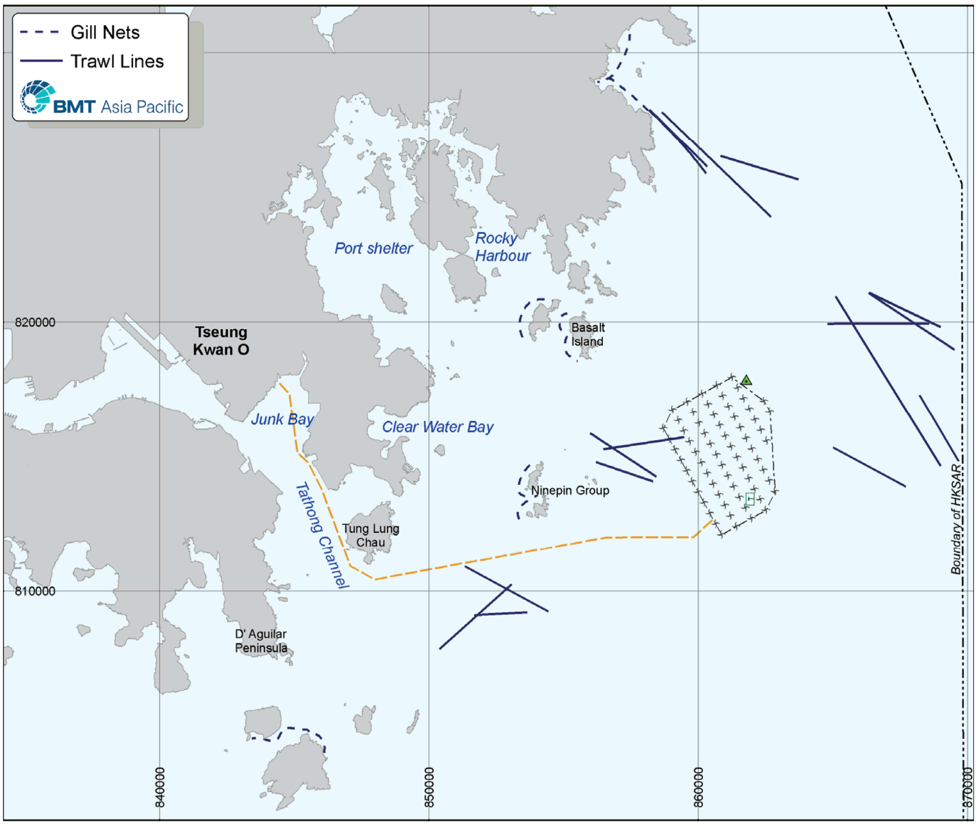
6.5.3.5 The ichthyoplankton survey's result are consistent with the findings of the Port Surveys 1996/1997 and onwards that Eastern Waters is not a major spawning ground in Hong Kong (Section 8 refers).

6.5.3.6 A series of trawl and gillnet surveys were undertaken during the early and mid 1990s in waters off Basalt Island, the Ninepin Islands and Po Toi. Figure 6.10 displays the survey locations using these two methods.

6.5.3.7 The trawl survey recorded a total of 41 species of fish and 67 species of invertebrate. The dominant fish catch was the rifle cardinal (62% of catch) which is known as a highly resilient species (Binnie Consulting Ltd, 1994). Conversely, species with a relatively high value / low resilience only made up a small fraction of the catch. The average fish biomass was < 10g, with very few specimens with a biomass > 1kg (*ibid*).

6.5.3.8 The species composition caught using gillnetting was generally different from that using trawling, with greyfin croaker, Belenger's croaker and lizard fish making up 40% of total catch in the survey area. Table 6.3 presents a record of reef associated fish species caught in waters around the Ninepin Islands during the gillnetting survey, with the majority of reef associated species being resilient to fishing pressure.

Figure 6.10 Trawl and Gillnet Fish Survey Locations



***Source**: Binnie Consulting Limited (1995a, b)*

Table 6.3 Reef-Associated Fish Species around the Ninepins

Species Name	Common Name	Habitat Description	Resilience to Fishing Pressure
Apogon kiensis	Rifle cardinal	reef-associated; brackish; marine; depth range 0 – 50 m	High (population doubling time = 15 months)
Apogon ellioti	Flag-in cardinal-fish	reef-associated; marine; depth range 18 – 106 m	High (population doubling time = < 15 months)
Engyprosopon grandisquama	Large-scale flounder	Reef-associated; marine; depth range 7 – 200 m	High (population doubling time = < 15 months)
Chaetodon modestus	Brownbanded butterfly fish	reef-associated; oceanodromous; marine; depth range 40 – 190 m	High (population doubling time = < 15 months)
Sillago sihama	Silver sillago	reef-associated; amphidromous; brackish; marine; depth range 0 – 60 m	High (population doubling time = < 15 months)
Aesopia cornuta	Horned sole	reef-associated; marine; depth range 8 – 100 m	Medium, population doubling time = 1.4 – 4.4 years

***Source:** Binnie Consulting Limited (1994); www.fishbase.org*

6.5.4 Sharks, Rays & Skates

6.5.4.1 Occasional sightings of sharks are generally made in local waters during the months of May through September. Historic records indicated that various sharks used to be somewhat common in local waters, although there have been no recent records of species such as the Spottail shark and the Whitetail shark since the 1930's (Lin, 1949). The last recorded observation of the Silky shark and Slender bamboo shark were from the 1960's (Ni and Kwok, 1999).

6.5.4.2 No formal field research has been conducted in local marine waters, although past desk-based research indicates that several species have been observed within HKSAR since the 1990's. Table 6.4 summarises these species.

Table 6.4 Shark, Ray & Skates in HKSAR Waters

Family	Species Name	Common Name	Conservation Status
Orectolobiformes (Carpet sharks)	*Chiloscyllium plagiosum*	Whitespotted bambooshark	IUCN –Near Threatened
Carcharhiniformes (Ground sharks)	*Carcharhinus macloti*	Hardnose shark	IUCN – Near Threatened
	Rhizoprionodon acutus	Milk shark	IUCN – Least Concern
	Scoliodon laticaudus	Spadenose shark	IUCN – Lower Risk Near Threatened
	Narcine indica	Large spotted numbfish	Not Listed
Rajiformes (True rays & skates)	*Narke japonica*	Japanese sleeper ray	Not Listed
	Aetomylaeus niehofii	Banded eagle ray	Not Listed
	Platyrhina sinensis	Fanray	Not Listed
	Anacanthobatis melanosoma	Blackbodied leg skate	Not Listed
	Raja hollandi	Yellow spotted skate	Not Listed
	Raja kwangtungensis	Kwangtung skate	Not Listed
	Dasyatis akajei	Red stingray	IUCN – Near Threatened
	Dasyatis bennetti	Bennett's stingray	Not Listed
	Dasyatis kuhlii	Bluespotted stingray	Not Listed

Family	Species Name	Common Name	Conservation Status
	Dasyatis zugei	Pale-edged stingray	IUCN – Near Threatened
	Himantura gerrardi	Sharpnose stingray	Not Listed
	Gymnura bimaculata	Twin-spot butterfly ray	Not Listed
	Aetobatus flagellum	Longheaded eagle ray	Endangered
	Aetobatus milvus	Eagle ray	Not Listed

Source: Ni and Kwok (1999).

6.5.4.3 There have been a number of incidental observations of other sharks in more recent years, with the most recent (as of the time of writing) being in August 2007 when the carcass of a juvenile Black tip shark was found trapped in fishing nets in Hoi Ha Wan Marine Park.

6.5.4.4 As sharks, rays and skates appear to be only occasional visitors to HKSAR waters and in small numbers, this group of animals is unlikely to be exposed to impacts from Project development and is not considered further in this assessment.

6.5.5 Sea Turtles

6.5.5.1 Five species of sea turtle have been recorded in HKSAR waters: the Loggerhead, Green Turtle, Leatherback, Hawksbill and Olive Ridley. Only the green turtle is known to breed in Hong Kong.

6.5.5.2 A female green turtle was observed on the sandy beach at Tai Long Wan in September 2006, and this observation led to 65 eggs collected being artificially incubated, successfully hatched and all juveniles released at Tai Long Wan in July 2007. The remaining 18 eggs were kept on site for natural incubation. The previous documented green turtle nesting event at Tai Long Wan was in the 1970s.

6.5.5.3 AFCD's Green Turtle satellite tracking programme has followed one female egg-laying turtles returning from Sham Wan beach at south Lamma Island to feeding grounds in coastal waters off Hainan Island to the west of the HKSAR (Chan *et al*, 2003). An AFCD press release stated that tracking had indicated that the Green Turtle typically dived for 15 to 30 minutes to eat sea grass and sea weed before surfacing to breathe before the next dive, and travelled to the feeding ground at a speed of 0.5 – 2.0 kilometres per hour (AFCD, 2002).

6.5.5.4 Data from the programme has also tracked adult Green Turtle movements through Eastern Waters, with tracks indicating movement through waters off Tai Long Wan, around Basalt Island and past the eastern coast of Tung Lung Chau en route to HKSAR southern waters (AFCD, unpublished data.). However, the programme has not led to any conclusion as to the origin or destination of the adult females that laid eggs at Tai Long Wan in 2006.

6.5.5.5 Commonly documented threats to sea turtles in the marine environment include fishing activity and floating debris. Fishing activity using long-lines and gill-nets can lead to entanglement and drowning, or may lead to flipper injury due to constriction by fishing lines or trawling nets, while marine debris such as plastic bags may converge with natural food prey such as jellyfish in oceanographic drift zones, leading to ingestion and suffocation (NOAA, 2008). The issue of floating debris is a particular problem for sea turtles that spend a significant portion of their life cycle in the pelagic environment (e.g., juvenile green turtles).

6.5.5.6 During the Construction Phase it is anticipated that as major sections of the windfarm are installed the windfarm footprint will be progressively designated as a controlled waterspace through the deployment of byelaws or similar legal instruments that will be sought for the windfarm site. Waterbourne access would be restricted to vessels that have received approval from the authority specified in the legal instruments.

6.5.5.7 Given the low volume and low speed of vessel traffic present during construction operations due to the designation a controlled waterspace, any sea turtles present in the area should be able to easily avoid the slow moving construction vessels. The controlled waterspace mentioned above will also be in effect during the Operations Phase which will ensure that vessel traffic will not significantly change from present levels.

6.5.5.8 As jetting of the cable route will only cause temporary, localized disturbances at the specific location along the cable route being jetted at any particular time, the most likely behavior for any turtles present will be to avoid the immediate area around the jetting works.

6.5.5.9 There is a regional tradition of hunting sea turtles, with turtle scales, skins and shells being ingredients in traditional Chinese medicine. For example, in March 2000 over 450 kilograms of sea turtle skin and shells found hidden inside containers from Indonesia and the Philippines en route to the Mainland. Based on the quantities of skins and shells seized, it was estimated that 600 sea turtles had been illegally poached (C&E, 2000).

6.5.5.10 Locally, there has been a tradition of sea turtle egg collection, while other terrestrial threats to the nesting Green Turtles at the Sham Wan, Lamma Island – a Site of Special Scientific Interest and a Restricted Area – include floating refuse that is washed ashore and climbing plants. Both of these threats may block the movement of adult Green Turtles and hatchlings, and at Sham Wan require active management before the onset of the restricted period for egg-laying, which at Sham Wan is June through October each year.

6.5.5.11 The proposed Project will not contribute to any of the existing marine or terrestrial threats referred above, although the issue of turbine lighting that may potentially lead to disorientation of adult and hatchling Green Turtles is discussed under the operational phase impact assessment in sub-section 6.7.5. The potential noise impacts of the low level of construction vessel traffic that will be present during the Construction Phase is dealt with in sub-section 6.6.3.

6.6 Construction Phase Impact Assessment

6.6.1.1 Given the construction method, the primary potential ecological impact on pelagic species is indirect water quality induced impacts associated with marine construction activities. Construction noise shall be a relatively minor issue as no marine piling shall be undertaken for the project.

6.6.2 Water quality induced impacts

6.6.2.1 Numerical modeling has been conducted to predict the increase in levels of suspended sediment at representative locations within the Study Area, including at coral reefs inhabited by reef fish and open waters where marine mammals have been observed. Details of the methodology for the assessment of water quality induced impacts are presented in sub-section 4.6.

6.6.2.2 Movements of reef fish at the underwater pinnacles of Victor Rock and One Foot Rock may be restricted due to the isolation of these features, with the result that the impact of elevated levels of suspended sediment on reef fish, and pelagics that feed on them, at these receivers may be greatest. In contrast, the larger contiguous area of reef habitat at the rocky islands would enable reef fish to avoid any sediment plume by swimming into unaffected waters around the coast.

6.6.2.3 Numerical water quality modelling, presented in sub-section 4.7.3, predicts no increases in the level of suspended solids at sensitive receivers. All increases, except at CC26, CC27 and CC11, were significantly below WQO criteria. The exceedances at CC26, CC27 and CC11, resulted in the adoption of mitigation measures such as silt curtains and restrictions on dredging rate presented in sub-section 4.9.

6.6.2.4 Table 6.5 presents the predicted results for the mitigated scenarios which confirm full compliance with WQO criteria at these sites. Hence, no adverse impacts are anticipated for coral, fish and any associated pelagic activity at these WSR, regardless of whether it is an underwater pinnacle or continuous reef habitat.

Table 6.5 Predicted SS Increases (in mg/L) at representative Coral Community Water Sensitive Receivers: Mitigated Scenario

ID	Coral Community	Allowable Elevation		Mitigated peak concentration above baseline* / Scenario				
		Dry	Wet	1	2	3	4	5
CC26	Junk Bay	2.24	2.03	0.91	0.91	0	0	0

		Allowable Elevation		Mitigated peak concentration above baseline* / Scenario				
CC27	Junk Island	2.24	2.03	0.94	0	0	0	0
CC11	Fat Tong Chau West	2.24	2.03	0.02	0	0.80	0.77	0.77

6.6.2.5 Marine mammals and other truly pelagic species that routinely travel long distances thoughout HKSAR waters would be able to swim into open waters to avoid sediment impact. Also, as marine mammals surface to breathe, their respiratory surfaces are not affected by suspended sediment in the water.

6.6.2.6 The unlikelihood of any adverse impacts to marine mammals is further supported by the water quality modelling results. Suspended sediment increases were only predicted at two sites, presented in Table 6.6, where increases were very small and remained significantly below WQO criteria without the need for any mitigation.

Table 6.6 Predicted SS Increases (in mg/L) at representative Marine Mammal Water Sensitive Receivers: Unmitigated Scenario

ID	Name	Allowable Elevation		Unmitigated peak concentration above baseline / Scenario				
		Dry	Wet	1	2	3	4	5
MM8	Sighting Point of Marine Mammal	2.24	1.87	0	0.32	0	0.32	0
MM11	Sighting Point of Marine Mammal	2.24	1.87	0	0.09	0	0.09	0

6.6.2.7 Water quality modelling predicts that the levels of suspended solids at all representative pelagic sensitive receivers shall be significantly below the WQO impact evaluation criteria. Accordingly, no adverse impacts upon fish, marine mammals or other pelagic species are anticipated.

6.6.3 Underwater Noise

6.6.3.1 A comprehensive review and assessment of underwater noise effects on marine mammals and fish has been conducted by Thomsen *et al* (2006) based on wind farm developments in the North Sea. The following assessment is largely based on this recent work.

6.6.3.2 Studies have shown that European harbour porpoise *Phocoena phocoena* communicate with a range of sounds, and can hear in the range of 16 – 140 kHz (Kastelein *et al.*, 2002). The sounds emitted by this species – in the same taxonomic Family as the finless porpoises resident in HKSAR waters – have been categorised as follows based on Verboom and Kastelein (1995):

- Low frequency sounds at 1.4 – 2.5 kHz for communication
- Sonar-clicks (echolocation) at 110 – 140 kHz
- Low-energy sounds at 30 – 60 kHz
- Broadband signals at 13 – 100 kHz

6.6.3.3 Sonar clicks have been found to be the main sound emitted by the harbour porpoise (ibid.). Similarly, studies of the finless porpoise suggest that it produces similar sonar clicks at a peak frequency of 142 kHz (Goold & Jefferson, 2002).

6.6.3.4 As regards potential construction phase impacts, marine dredging / jetting works and large marine vessels typically emit sound in the range of 0.02 to 1 kHz (Goold & Jefferson, 2002; Popper et al, 2003). Medium sized offshore support and supply vessels typically generate noise at frequencies between 0.02 to 10 kHz (Richardson et al. 1995), with marine vessel noise measured near the Urmston Road in western HKSAR waters at 2.5 kHz (Würsig and Greene, 2002). These underwater noises are thus generally below the hearing range of finless porpoises, and certainly below the documented peak hearing range of ~140 kHz for porpoises.

6.6.3.5 Construction noise levels are also generally below the 8 - 90 kHz hearing range of the Indo Pacific Hump-backed dolphin, *Sousa chinensis* reported by Richardson et al (1995), although this species is uncommon outside its preferred estuarine habitat and thus a very uncommon sighting in the Study Area. Construction noise levels are also below the most sensitive hearing range of false killer whales, *Pseudorca crassidens* reported by Thomas et al (1988) was between 16 -64 kHz.

6.6.3.6 It is clear from past AFCD visual and acoustic studies, and the present BMT visual study, that finless porpoises and other cetaceans do not use the east Hong Kong proposed Wind Farm area to a high extent (for example, Jefferson et al., 2002; AFCD, 2005, 2007). The foundation structures of the proposed Wind Farm are to be installed using the relatively non-noisy suction can foundation system. While there may be some avoidance of the immediate area (within about 200 to 500 m) during construction (based on data from various reports on European harbour porpoises e.g. Koschinski et al., 2003), no adverse impacts on marine mammals are anticipated during marine construction activities.

6.6.3.7 A 2006 study by the Woods Hole Oceanographic Institution on the hearing ranges of sea turtles found that juvenile green turtles have the broadest hearing range (100-800 Hz; best sensitivity 600-700 Hz). This is within the anticipated range of noise generated by construction activity. However given the low number and low speed of construction vessels, and the fact that construction activities are taking place in the open ocean, it is expected that temporary avoidance behaviour will be the norm for sea turtles during the construction phase and there will be no significant adverse noise impacts.

6.6.3.8 The hearing ranges of fishes has been studied less, although a hearing range for fish of 30 Hz to 1 kHz is generally agreed, recognizing that some species can hear sound below or above this range (Popper *et al*, 2004). Accordingly, noise from construction activities may affect fishes in the Study Area.

6.6.3.9 Construction activities will lead to an increase in the number of marine vessels at the proposed wind farm from the present (low) baseline average of 20 vessels / day, and thus marine vessel activity shall be the primary noise source for fishes. Construction marine traffic will include the heavy lift vessel for turbine installation, a dedicated cable laying vessel and a variety of tugs and work boats to support operations. Work at the proposed wind farm will occur in concentrated periods and during the busiest days up to 15 vessels may be operating (BMT, 2007). Although this would effectively create a short term doubling of vessels, the marine traffic density would be less than 0.2% that of Hong Kong's busier fairways.

6.6.3.10 The seabed of the proposed wind farm is exposed and offers no habitat for fin fishes, while no turbine installation activities shall be in proximity to reef fish habitat at the Ninepin Islands or Basalt Island. Given these considerations and the low overall marine traffic volume associated with construction, no significant adverse impacts on fishes are anticipated.

6.7 Operational Phase Impact Assessment

6.7.1.1 Potential sources of operational phase impacts are associated with noise from turbine operation, noise and collision risk upon marine mammals associated with maintenance vessel activity, and electro-magnetic field effects from transmission and array cabling. Section 4.8 identified that normal project operation will cause no significant changes in water quality, which indicates that there will be no indirect ecological impacts on finless porpoises, false killer whales, green turtles and other pelagic species during the operational phase.

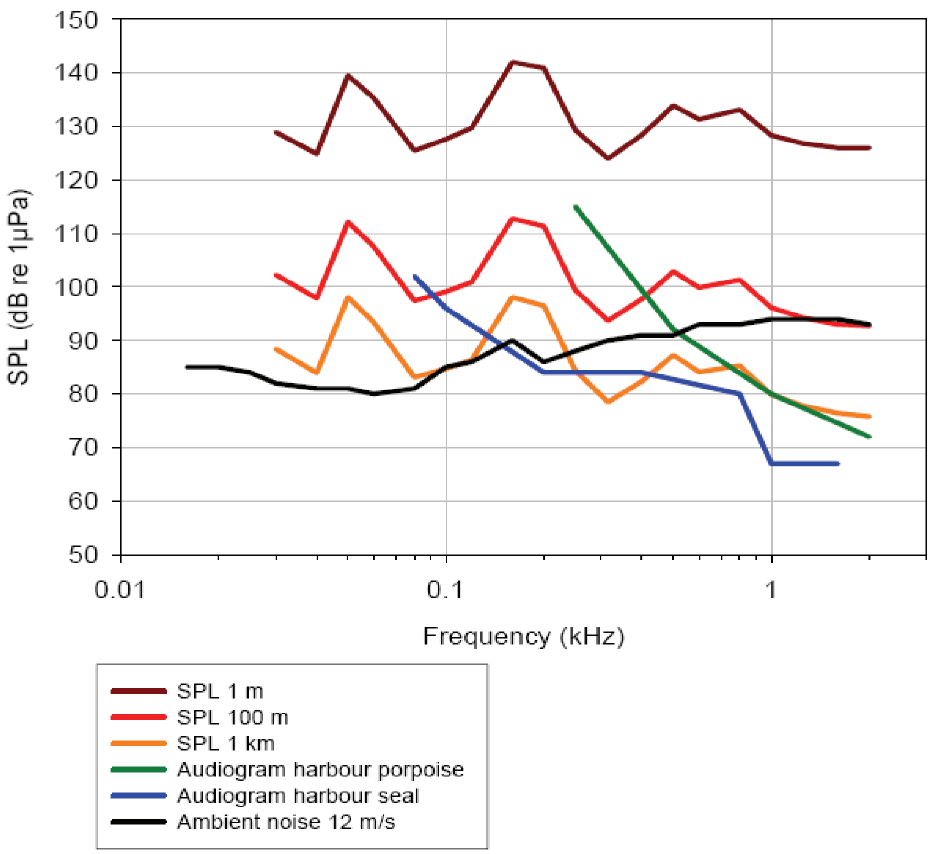
6.7.1.2 The positive ecological impact associated with the presence of a cumulative surface area of over 100,000m^2 of foundation structure has been mentioned in sub-section 5.8. The general benefits to fisheries are further elaborated in sub-section 8.7.

6.7.1.3 Although 0.06% of their habitat that will be occupied by turbine structures (conservatively estimated based on 67 turbines each with 10 meter diameter central support and three 5m diameter tripod legs, in 30m water depth), it is also possible that the contiguous array of wind farm underwater structures will attract fishes and invertebrates to the area, and that porpoises and false killer whales might make use of this newly-created resource in their habitat, as has been found in situations in northern Europe (Diederichs et al., 2008).

6.7.2 Underwater Noise

6.7.2.1 With reference to Thomsen *et al* (2006), underwater noise data from a 1.5MW turbine operating in winds of 12 m/s collected by ITAP (2005) was used to predict sound pressure levels at distances of 1 m, 100 m and 1 km from the turbine. Figure 6.11 shows the plot of sound pressure levels along with ambient noise and audiograms of the European harbour porpoises and harbour seal.

Figure 6.11 Underwater Noise from a 1.5 MW Turbine



***Source**: Thomsen et al (2006), compiled from various sources.*

6.7.2.2 Using the harbour porpoise as a proxy for the finless porpoise (sub-section 6.6.3 refers); noise may be audible at a distance of 100m from the turbine, but not at a distance of 1 km (ibid.). The results are broadly similar to observations of response to underwater noise from a simulated 2 MW turbine, with the distance of approaches by harbour porpoise increased from a median of 120 to 182 m (Koschinsk et al, 2003).

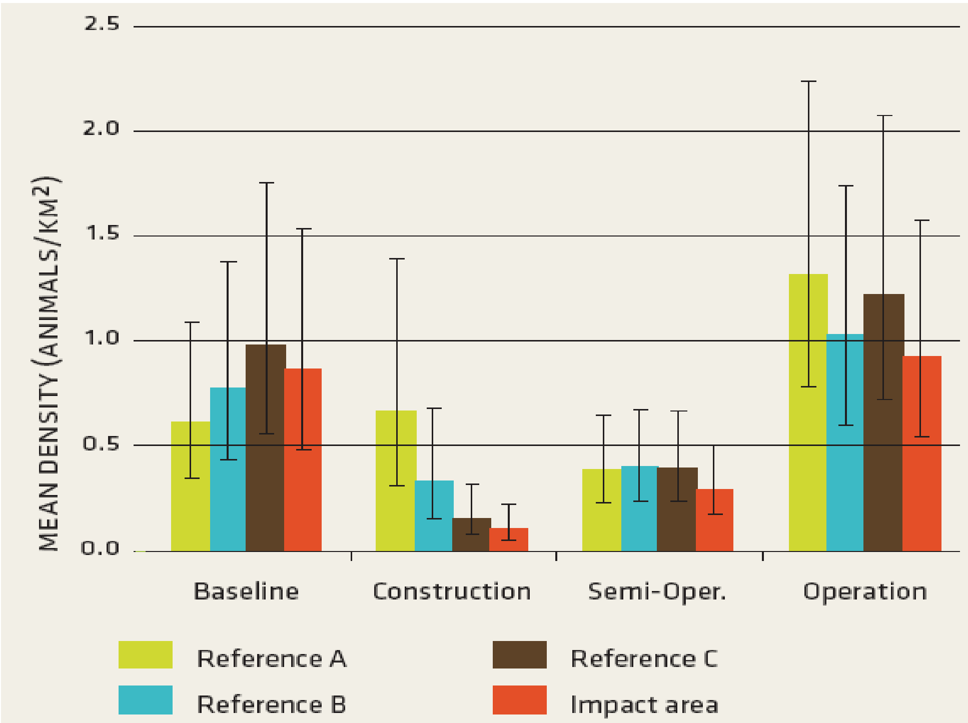
6.7.2.3 Figure 6.12 displays data from boat-based surveys at Horns Rev Offshore Wind Farm presenting a drop in porpoise distribution during piling, but recovery to baseline levels during operation. Thus, while it appears that there may potentially be a behavioural response from finless porpoises to turbine noise, significant adverse impacts are not anticipated.

6.7.2.4 As referred previously, we can assume a general hearing range for fish of 30 Hz to 1 kHz (Popper et al, 2004), although it has also been suggested that fish display a weak response to sounds in the range 50 Hz to 1 kHz and that in this range the influence of turbine noise is likely to be minor (Knudsen et al, 1994; Westerberg, 1995).

6.7.2.5 Low frequency noise below 50 Hz is considered to be of most importance for fish, and this has been suggested as the reason why fish display a consistent behavioural response and even an attraction to low frequency disturbance (Knudsen et al, 1994; Westerberg, 1995). Wahlberg and Westerberg (2005) estimate the range within which fish may be scared away from a turbine to be less than 5 metres. Accordingly, significant adverse underwater noise impacts on fish are not anticipated.

6.7.2.6 Studies of medium sized offshore support and supply vessels indicate noise is mainly generated at frequencies between 20 Hz and 10 kHz (Richardson et al. 1995) and thus outside the key frequencies of concern.

Figure 6.12 Harbour porpoise density at Horns Rev Wind Farm



Source: Teilmann et al (2006).

6.7.3 Marine Vessel Collision Risk

6.7.3.1 The stand-alone Marine Navigation and Safety Risk Assessment (BMT, 2007) has concluded that access restriction is required in order to manage anticipated human behavioural responses such as scaling of turbine towers, trawling immediately adjacent to foundations and entry of un-seaworthy sight-seeing vessels.

6.7.3.2 In order to manage these risks, it is proposed that the wind farm area is designated as a controlled waterspace through the development of byelaws or similar legal instruments. Waterborne access would be restricted to vessels that have received approval from the authority specified in the legal instruments. Marine access would be restricted to vessels directly associated with wind farm maintenance / control operations, Government craft and permitted vessels. This proposal would significantly reduce the volume of marine traffic within the wind farm boundary and accordingly would reduce the risk of collision compared with baseline levels.

6.7.3.3 The marine control measures, the low baseline traffic volume of the wind farm site, and the low density of marine mammal and sea turtle activity in Eastern Waters will result in a negligible level of collision risk. Especially when compared with the marine traffic volume of over 2,000 vessel movements per day through the core habitat of the Indo Pacific hump-backed dolphin Sousa chinensis on a daily basis.

6.7.4 Electro-magnetic Field

6.7.4.1 Most marine species can detect electromagnetic fields, although some species are considered to be potentially more susceptible than others. Concerns regarding effects on prey detection of rays and sharks, for example, have been raised in the past although current knowledge is limited in terms of species-specific data. The industry standard 132kV cables to be adopted by the proposed project have been shown to produce a magnetic field of 1.6μT and an induced electric field of approximately 91μV/m. This magnetic field is small in comparison the Earth's natural geomagnetic field of 50μT, and is estimated to fall to background levels at a distance of ~20m from the cable corridor (Gill *et al*, 2005).

6.7.4.2 As two parallel cables are to be installed for the wind farm operation there shall be a cumulative effect, although the strength of the field is limited when cables are buried as sediment dissipates the induced electric field much more rapidly than sea water (*ibid*.). Accordingly, the effects of the field on fishes and other marine life are anticipated to be negligible.

6.7.5 Artificial Lighting

6.7.5.1 Existing potential marine threats to sea turtles from marine traffic (6.7.3 refers) and floating debris will not increase during Project operation as the wind farm area would be under strict management control.

6.7.5.2 As regards terrestrial threats associated with project operation, artificial lighting could deter an adult female Green Turtle from emerging from the sea to nest, although there shall be no lighting within some 10 km of the nesting beach at Tai Long Wan while well-lit container vessels use the approach to Yantian Port 24-hours a day. In this context, and given that Green Turtles have been tracked passing through HKSAR Eastern Waters (e.g., AFCD, 2003 and AFCD, unpublished data) under existing baseline conditions, artificial lighting from the offshore turbines is not anticipated to result in any adverse impact on adult female Green Turtles that may come into the area.

6.7.5.3 For Green Turtle hatchlings, lighting behind a nesting beach may disorient emerging hatchlings away from the sea as hatchlings tend to move towards the brightest direction (NOAA, 2008). In the case of the proposed Project, this direction would still be towards the broad horizon of the open sea, and no adverse impact would arise.

6.8 Mitigation Measures & Best Practice

6.8.1.1 Referring to Thomsen et al (2006), if less noisy construction methods to percussive piling exist, these should preferentially be used. For the proposed project, considerable effort has been taken to investigate the feasibility of the suction caisson foundation option, with this construction method selected as preferred to avoid adverse impacts. In addition, as a precautionary measure, a 250 metre exclusion zone shall be implemented around the works barge during installation of foundations and turbine sub-structures.

6.8.1.2 Controls on dredging and jetting activities as referred in sub-section 4.9.1 shall ensure that impacts on reef fish at minor coral communities in Junk Bay are avoided.

6.9 Residual Impact Assessment

6.9.1.1 Due to the use of low impact suction caissons and the implementation of the marine mammal exclusion zone, no significant adverse impacts are anticipated during the construction phase. Previous sections have also identified that that the already negligible operational phase impacts will be further reduced by the designation of the wind farm area as a controlled water space. As a result, no specific mitigation is required as no adverse impacts on the pelagic ecosystem are anticipated. Accordingly, there shall be no residual impacts.

6.10 Environmental Monitoring & Audit Requirements

6.10.1 Monitoring of Marine Mammals

6.10.1.1 It has been well-documented for all but Dall's porpoises (*Phocoenoides dalli*), that porpoises of the family phocoenidae (as opposed to most dolphins, delphinidae) tend to be cryptic while they surface to breathe, and are therefore difficult to see. This is exacerbated in the finless porpoise, as it is small and even more difficult to see than other species due to the lack of a dorsal fin, as well as a muted gray coloration that often makes the porpoise blend in with a slightly choppy water surface (Jefferson and Hung, 2004).

6.10.1.2 Furthermore, following literature review and the 2006/07 field survey event for this Project, it is evident that there are factors that amplify limited data in areas with an already low encounter rate. These include:

- Changes in local distribution pattern: fluctuating porpoise utilization rate has been recorded across eastern waters (Figure 6.6 refers).

- The survey methodology: Studies at Nysted Offshore Wind Farm in Denmark for example concluded that as porpoises were mostly active at night-time, there were fundamental limitations in visual only (i.e., day-time) surveys.

- Weather conditions: the vessel-based observation method is highly weather dependent and can be compromised greatly by, for example, low sunlight intensity (Evans, 2008). Locally, Jefferson (AFCD, 2000) concluded that the overall abundance, which is a function of sighting rate and probability density function, could drop by as much as 42% when survey observations were conducted in unfavourable environmental condition.

6.10.1.3 For such reasons, cetacean studies for international offshore wind farm developments, such as the monitoring conducted at Nysted Offshore Wind Farm, have modified the approach by deploying acoustic devices which are less weather-dependent and can allow for continuous monitoring. Such devices, or passive acoustic monitors (PAMs), are invaluable for detecting the high frequency clicks of porpoises that are easily-distinguished from sounds of other marine animals.

6.10.1.4 Most monitoring work of this type has been carried out on European harbour porpoises, Phocoena phocoena (Villadsgaard et al., 2007; Evans, 2008), although the technique has also been experimentally demonstrated locally for finless porpoises using towed recording devices jointly engaged during line transects. (Jefferson et al. 2002: Goold and Jefferson, 2002).

6.10.1.5 One type of PAM is the T-POD (for, “timing porpoise detectors”) which is used specifically for monitoring porpoise clicks and can be mounted on the seabed to give a 24-hour-day record of marine mammal presence within a detection range of 75 to up to about 200m. A more recent development is the C-POD, for “cetacean porpoise detector”, that more accurately records vocalizations of porpoises plus all other echolocating toothed whales and dolphins (www.chelonia.co.uk).

6.10.1.6 Given the above, we do not suggest further stand-alone use of the visual observation method to obtain more information on porpoise occurrence patterns in the general area. We have also explored the possibility of using visual surveys in conjunction with towed acoustic sensing devices (T-PODs) as were used by Jefferson et al. (2002) for detecting finless porpoises. While this double-system of evaluation was useful for corroboration of visual sightings, it is apparent that porpoises are at times shutting off their active acoustics due to the presence of the line-transect research vessel, and we have received expert advice (Nick Tregenza, Chelonia Ltd.) that as a result, it is unlikely that towed systems enhance visual surveys for finless porpoises, at least with present resolution and capabilities.

6.10.1.7 Considering the above, it is apparent that effort exploring the habitat use of finless porpoises and other marine mammals in the Study Area is necessary. Accordingly, we recommend the use of C-PODs to monitor the activity of finless porpoises both day and night and in all weather conditions due to their greater reliability relative to sensing porpoises as well as other marine mammals. Further details of the proposed monitoring programme shall be provided in the Project's stand-alone Marine Environment Monitoring Plan (MEMP) to be developed in parallel with the engineering design, although the two core elements shall involve:

- Joint visual / C-POD Calibration survey: As bottom-mounted acoustic monitoring devices have not previously been used for detecting finless porpoises, it is important that these be calibrated relative to visual surveys. It is thus proposed that a line transect survey be conducted in conjunction with placement of C-PODs using standard approved line transect methodology (as per AFCD, 2005, etc.) for calibration purposes. Given the low level of sightings (and, hence potentially, acoustic contacts), the line transects and C-PODs should be engaged in for sufficient time for statistical robustness relative to inter-calibration.

  One option for this work, to be discussed and agreed with AFCD prior to commencement, is to conduct the joint acoustic / visual survey in HKSAR *western* waters where finless porpoise activity is relatively high (compared with offshore eastern waters), and hence with greater potential for good quality calibration data. Under this scenario, for example, deployment of 2-3 C-PODs combined with a 3-month visual survey would likely yield good quality data for C-POD calibration. Ultimately the number of C-PODs to be deployed and the necessary duration of visual transect survey for calibration would depend on exactly where this part of the survey programme was to be conducted.

- Placement of C-PODs: After inter-calibration of acoustic and visual data to support generation of an accurate estimate of finless porpoises by the C-PODs, the second aspect of the programme shall involve placement of these devices within and just outside the wind farm area (for example, Teilmann et al., 2006). As Porpoise clicks are substantially above 100 kHz in frequency, not very loud (Goold and Jefferson, 2002) the detection distance is likely to be on the order of low 100's of meters from the bottom-mounted C-PODs. This will influence the number and configuration of C-PODs deployed, with exact details of the number and positioning of the devices to be presented in the MEMP.

  The C-PODs deployed will need to be serviced every three to four months to download accumulated data and replace batteries. It is proposed that the C-PODs be installed after installation of the turbines when security from trawling damage / loss can be afforded, and for a sufficient period of time to obtain a robust record of marine mammal usage of the area, especially due to the great inter-seasonal and inter-year differences already known for finless porpoises.

6.10.1.8 The MEMP shall detail the integrated monitoring requirements associated with pelagic ecology, benthic ecology and fisheries resources within the Project area, and development and implementation of the MEMP shall form a condition of the Environmental Permit.

6.10.2 Water Quality Monitoring

6.10.2.1 Focussed water quality monitoring shall be conducted at Junk Bay to monitor levels of suspended sediment from marine dredging activities. Details are provided in the EM&A Manual.

6.11 Conclusions & Recommendations

6.11.1.1 A comparison of marine mammal distribution between HKSAR waters and Eastern Waters, it is evident that the waters of the proposed wind farm are not frequented by Indo-Pacific hump-backed dolphins and are only lightly utilized by finless porpoises – with this species preferring more sheltered coastal waters around the Ninepins and Po Toi islands. Given this low usage of the Study Area and the preferred construction method, no adverse long-term impacts are anticipated during construction and no mitigation measures are proposed. Nevertheless, monitoring of marine mammals over a suitable period of time is recommended in order to be able to detect overall changes in use of the area.

6.11.1.2 Quantitative assessment predicts either no or only a marginal increase in suspended sediment above baseline levels at most locations. Although the worst-case assessment scenario of concurrent marine dredging and jetting at Junk Bay is predicted to result in elevated sediment levels at the reef fish community at Fat Tong Chau, levels are still significantly below the WQO criteria.

6.11.1.3 A review of potential noise impacts has been completed, and this does not suggest any adverse impacts from marine vessel activity during Project construction or operation, or from underwater turbine noise. Adverse impacts from the electromagnetic field are not anticipated.

6.11.1.4 The Project offers the opportunity for artificial reef development, with the presence of the foundations possibly attracting fish. Over time the establishment of epifauna on foundation structures is expected to support a more diverse reef habitat. Combined with restrictions on trawling and other marine traffic activity, the Project has the potential to generate a net positive impact.

6.12 References

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