8 Fisheries

8.1 Introduction

8.1.1.1 This section presents the approach to and the findings of the fisheries baseline assessment and the project impact assessment.

8.1.1.2 The purpose of the assessment is to examine all fisheries resources within the assessment area to ensure their protection.

8.2 Objectives

8.2.1.1 The aim of the fisheries impact assessment is to evaluate baseline conditions and assess the potential short-term and long-term impacts on the local fishing industry from development of the proposed Project.

8.2.1.2 The fisheries impact assessment has been conducted in accordance with the criteria and guidelines in Annexes 9 and 17 respectively of the EIA-TM, and with reference to the following requirements as stated in Clause 3.4.2 of the EIA Study Brief:

- Review the findings of relevant studies/surveys and collate the available information regarding the ecological characters of the assessment area;
- Describe the physical environment background and describe and quantify existing capture and culture fisheries activities;
- Identify and quantify any impacts of fisheries during Project construction and operation;
- Evaluate impacts and make recommendations for any mitigation measures required to protect fisheries, including *inter alia* staff and financial implications for subsequent management and maintenance; and
- Review the need for monitoring and, if necessary, recommend a monitoring and auditing programme.

8.3 Legislation, Standards & Guidelines

8.3.1.1 In addition to the requirements of the EIAO (Cap. 499), the following statutory requirements are also applicable:

- Fisheries Protection Ordinance (Cap. 171) exists "to promote the conservation of fish and other forms of aquatic life within the waters of Hong Kong and to regulate fishing practices and to prevent activities detrimental to the fishing industry."; and
- Marine Fish Culture Ordinance (Cap. 353) exists to protect any fish in any fish culture zones from being injured; as well as to protect the waters in fish culture zones from pollution.

8.4 Assessment Approach

8.4.1 Desk-top Review

8.4.1.1 A desk top review was undertaken to provide background data and information on the development of local commercial fisheries. Key references included various research studies and scientific papers from local tertiary institutes, and data from Port Survey 1996/1997, 2001/2002 and 2006.

8.4.2 Geophysical Survey

8.4.2.1 A marine geophysical survey was conducted in August 2006 to detect anomalies on the seabed. This survey is able to produce a record of substrate type and condition, and is a useful method for indicating the intensity of trawling activity in offshore waters. Trawl marks may be identified by side-scan sonar that clearly represents the surface profile across the surveyed areas. Distinctive ploughing features may be evident, from trawling and readily identified"

8.4.3 Marine Radar Data Analysis

8.4.3.1 In parallel with the EIA Study, BMT conducted a Marine Navigational Safety Risk Assessment (MNSRA) for the Project. Marine traffic radar data collected between June and September 2006 were analysed to estimate the intensity of fishing activity in the wind farm area. Figure 8.1 displays the coverage of this survey.

8.4.3.2 The collected radar data provided information on vessel movements, including the position (in terms of x and y), vessel speed, direction and vessel length & beam. Using this data it was possible to isolate data specifically associated with fishing vessels to generate a credible representation of the intensity of fishing activity.

8.4.3.3 Historical data cited by Leung (2003) indicated that active trawlers in HKSAR waters operate at less than 6 knots and have a typical length up to 40 metres as presented in Table 8.1 and Table 8.2, respectively.

8.4.3.4 The radar data sought to discriminate fishing vessels from other types of vessels using the following criteria proposed by BMT, however it is noted that the particular type of vessel cannot be defined :

- Sizes < 40 metres
- Conservative trawling speed < 6 knots; and
- Looping route patterns characteristic of trawling activity.

Figure 8.1 Field Survey Study Area – Marine Traffic Radar Data Coverage

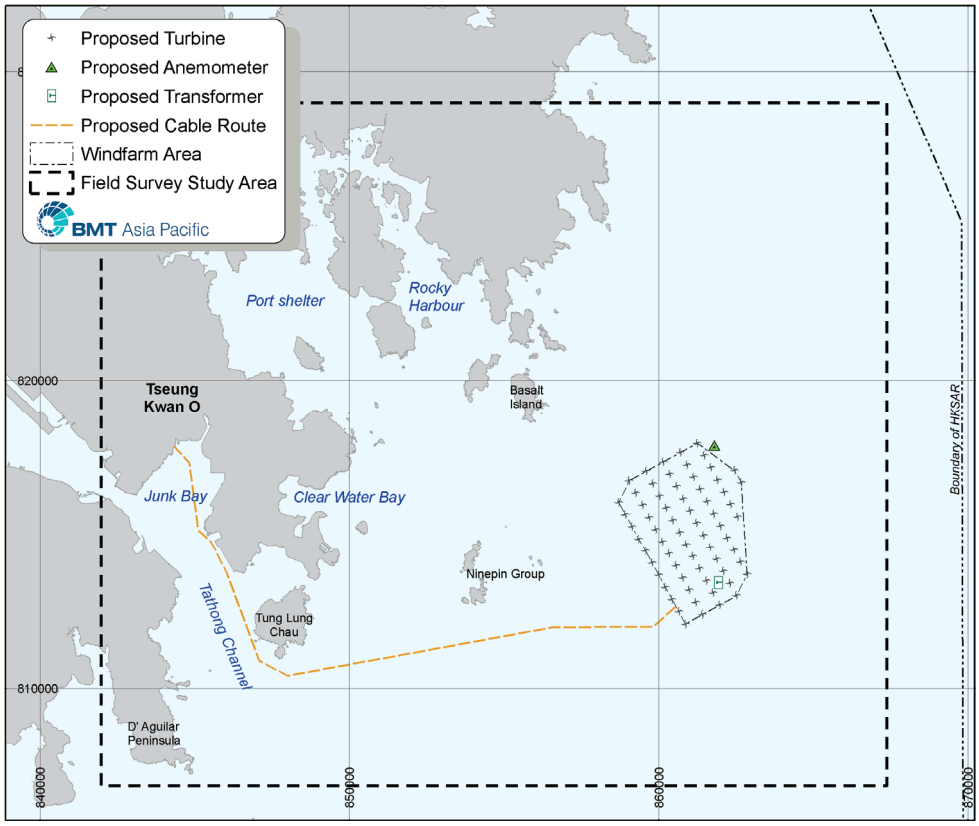


Table 8.1 Typical Trawling Speed

Pair & stern trawl[1]	Shrimp trawl[2]	Unit
3.1	3	Nm/hr
5.7	5.6	Km/hr

Notes: [1.] AFCD Pair and Stern Trawl Survey (1992 – 1995)

[2.] AFCD's Shrimp Trawl Survey (1981 – 1982)

Source: Leung A.W.Y. (2003).

Table 8.2 Typical Vessel Sizes

Size (m)	Total	Pair trawler	Stern trawler	Hang trawler	Beam trawler	Long liner	Hand liner	Gill netter	Purse seiner	Maricraft*	Miscellaneous
					Distribution (m)						
<5.00	252					11	20	57	1	139	24
5.0 - 9.9	2,325				21	103	30	185	27	1,593	366
10.0 - 14.99	455			1	44	58	48	134	76	3	91
15.0 - 19.99	254	5	27	2	100	52	18	29	17	4	
20.0 - 24.99	563	39	101	4	246	73	51	30	1		
25.0 - 29.99	736	381	82	12	97	47	46	71			
30.0 - 34.99	218	156	11	6	7	16	1	21			
>35.0	6	4	1			1					
All Sizes	4,809	585	222	25	515	361	214	527	122	1,739	499
Mean size (m)	18.8	28.5	24.2	26.1	20.8	16.8	18.3	14.8	12.5	5.6	8.5

Note: * Mariculture craft

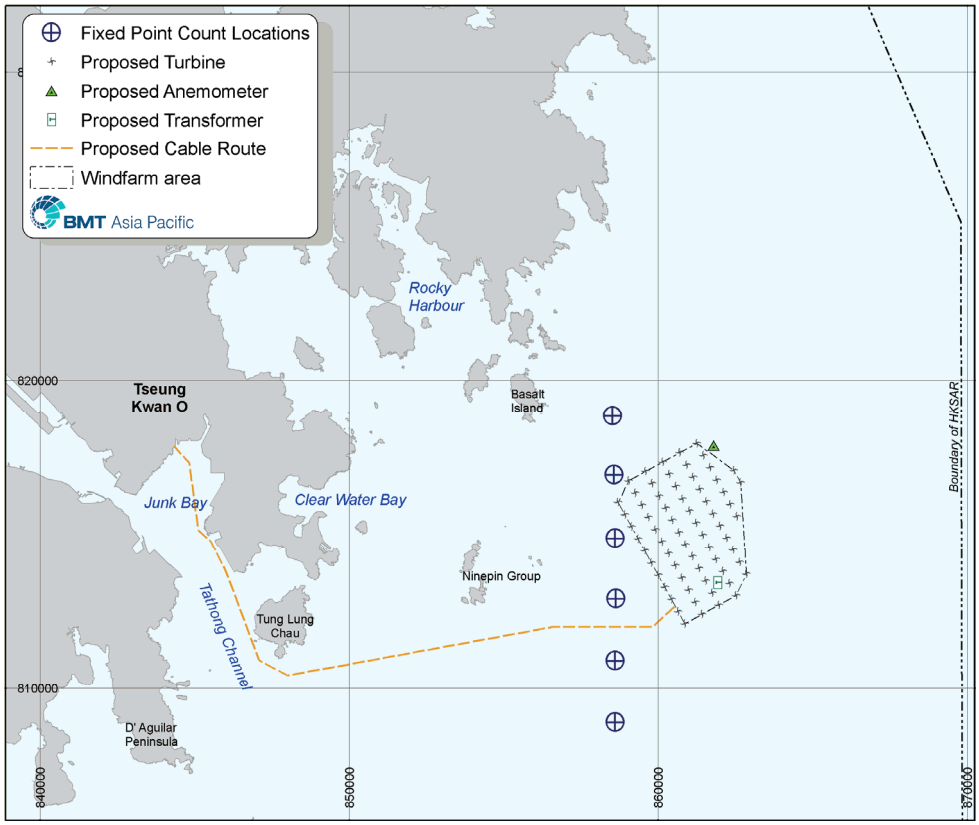
Source: Leung A.W.Y. (2003).

8.4.3.5 Table 8.2 supports the view that any assessment of fishing vessel activity from remote sensing by radar should focus on the movement of vessels of under 40m Length.

8.4.4 Boat-Based Observations of Fishing Activity

8.4.4.1 An opportunistic series of boat-based observations were conducted between January and July 2007 in parallel the Marine Mammal Survey to support the findings of the radar marine traffic analysis. These boat-based surveys were conducted when the sea-states were calm, i.e. Beaufort scale ≤ 3. Figure 8.2 illustrates the observation locations.

Figure 8.2 Boat-Based Observation Locations



8.4.5 Semi-Structured Fishermen Survey

8.4.5.1 With the assistance of a group of retired fishermen, a focussed questionnaire was developed with which to interview fishermen from Shau Kei Wan, Lei Yue Mun, Sai Kung and Aberdeen homeports. The rationale for selecting these homeports was:

- A large proportion of fishing activity in Eastern Waters is derived from Shau Kei Wan. Thus, this survey group is familiar with fishing activity in the Study Area.
- Sai Kung and Lei Yue Mun represent two homeports in relative proximity to the Study Area that traditionally fished in Eastern Waters. Both of these homeports support only a small number of boats still engaged in fishing, with many boat owners having made the transition into other industries.
- Aberdeen was selected as it is the largest homeport in Hong Kong, although on the opinion of the pre-consultation with the retired fishermen it was anticipated that fishing activity from this port would be focussed in Southern and Western Waters.
- The costs of operating fishing vessel, notably fuel costs, generally preclude significant fishing activity in the Study Area derived from other homeports.

8.4.5.2 The survey sample size was targeted at around 70 interviewees, with this target being roughly double those from previous semi-structured surveys (Sumaila *et al*, 2007; Sadovy *et al*., 2004).

8.4.5.3 The survey questionnaire was developed to collect the following information:

- Crew size & nationality;
- Primary fishing grounds, fishing effort and fishing seasons;
- Target species;
- Commonly caught species;
- Reasons for selection of primary fishing grounds; and more generally
- Actual and perceived threats to the fishing industry and the most effective ways to increase fisheries resources in Eastern Waters.

8.4.5.4 The target interviewees were boat captains who manage and / or own fishing vessels > 15 m that are capable of operating in exposed waters. The questionnaire is presented in Appendix 8A.

8.5 Fisheries Baseline – Literature Review

8.5.1 Historical Overview of Hong Kong Capture Fisheries

8.5.1.1 From the second half of the 20th century the local commercial fishing industry has experienced various transitions. Government loans in the 1950s enabled rapid growth in fleet size and fishing effort and, with improvements in fishing equipment, by the 1960s there had been a substantial increase in the size of the capture fisheries industry. The catch per unit effort for trawlers at this time was ~90-140 kg per haul (Cheung *et al*, 2004).

8.5.1.2 By the 1970s the decline of the industry was becoming apparent, with smaller pelagic fish such as sardines the dominant catch and the catch per unit effort showing signs of decline. In the 1980s species such as groupers and croakers had become uncommon catches and a general decline in the finfish catch was observed, with the trawler catch per unit effort having fallen to ~15 kg per haul (*ibid*). Through the 1990s the average trawler catch was ~10 kg with juvenile fish comprising most of the catch (Leung, 2000).

8.5.1.3 By the end of the 1990s the local catch of fishes and invertebrates had declined significantly over the prior 50 years, with an estimated 80% decline in fish biomass over this period (Lee et al., 2000; Leung and Leung, 2000; Cheung, 2001). Additional information on historical fisheries productivity is presented in Section 6.5.3. The continued decline in the local capture fisheries industry in more recent years is reflected by the decrease in fishing vessels and fishermen, as displayed by Figure 8.3 and Figure 8.4, respectively.

Figure 8.3 Number of Fishing Vessels (1967 and 2001 – 2006)

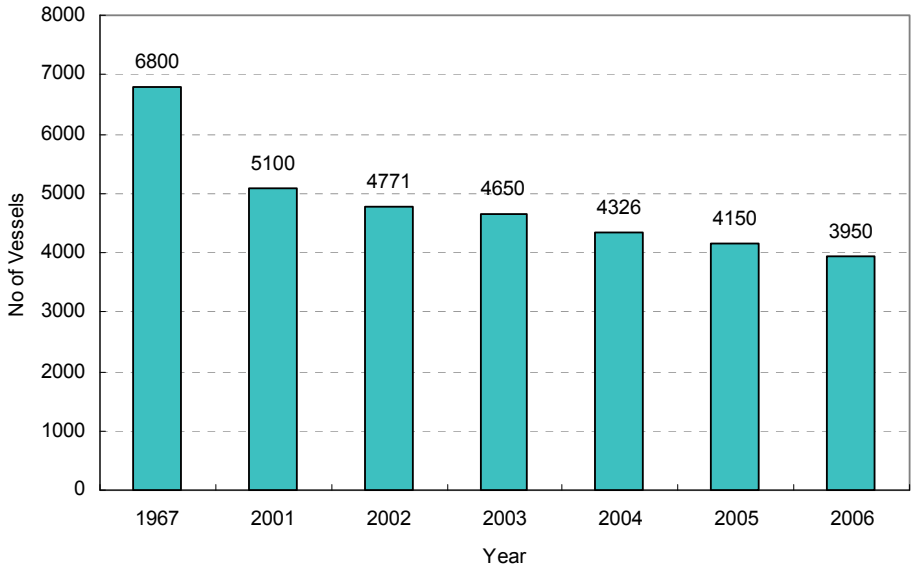
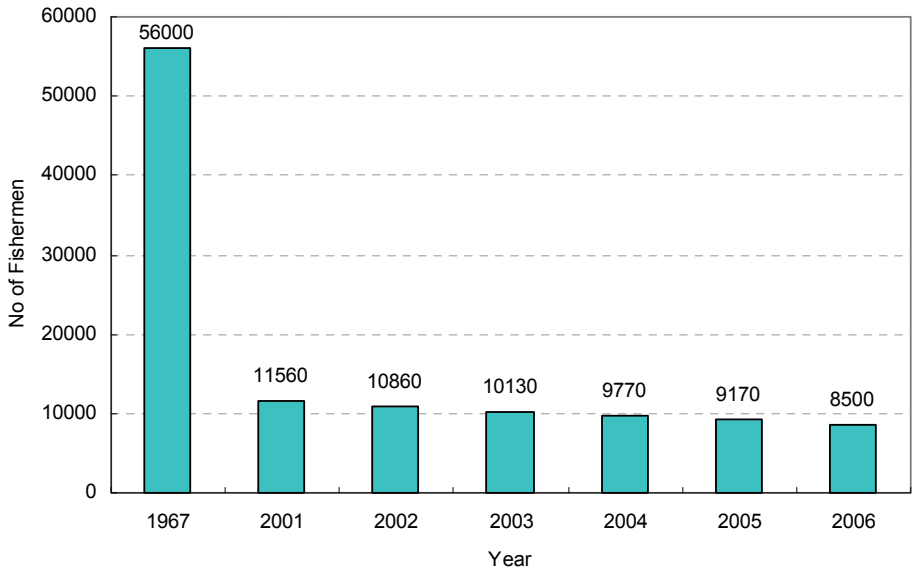


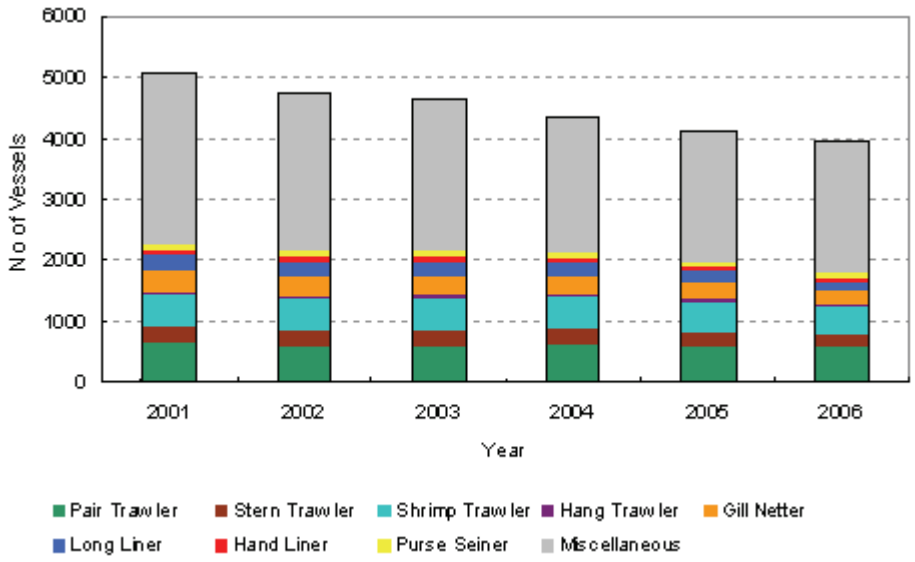
Figure 8.4 Number of Fishermen (1967 and 2001 – 2006)



***Sources**: AFCD Annual Reports (2001-2007) and Williamson (1968)*

8.5.1.4 Figure 8.5 shows that the greatest decline in vessel category is a ~30% drop in 'miscellaneous' craft which comprise small boats employing lining, netting and trapping techniques to target more expensive species like rockfish and snapper (Sumaila *et al*, 2007). This decline reflects a general decrease in catch size and quality.

Figure 8.5 Composition of Fishing Fleet (AFCD, 2001 – 2007)



Source: AFCD Annual Reports (2001-2007)

8.5.2 Capture Fisheries in the Study Area

8.5.2.1 Table 8.3 summarises the top ten most commonly caught species reported by the three Port Surveys conducted in 1996/1997, 2001/2002 and 2006. The similarity in species composition suggests the marine ecosystem stabilised at a depressed level between surveys.

Table 8.3 Top 10 Most Commonly Caught Species

Rank	96/97 Port Survey	01/02 Port Survey	2006 Port Survey
1	Mixed fish	Mixed fish	Mixed fish
2	Scad	Rabbit fish	Scad
3	Sardine	Sardine	Shrimp
4	Croaker	Croaker	Rabbit fish
5	Anchovy	Scad	Squid
6	Crab	Squid	Croaker
7	Rabbit fish	Shrimp	Crab
8	Shrimp	Anchovy	Mullet
9	Pony Fish	Crab	Sardine
10	Rock fish	Sea bream	Sea bream

8.5.2.2 In order to enable a comparison of fishing activity, Table 8.4 presents an indicative ranking system developed with reference to Port Surveys 2001/2002 and 2006.

Table 8.4 Fishing Activity Ranking

Ranking	Number of Fishing Vessels active in region (*)
None	0
Negligible	>0 & ≤10
Very Low	10 – 50
Low	50 – 100
Moderate	100 – 400
High	400 – 700
Very High	700 – 1000

(*) http://www.afcd.gov.hk/english/fisheries/fish_cap/fish_cap_latest/fish_cap_latest.html

8.5.2.3 Figure 8.6 and Figure 8.7 illustrate the coverage and the zonation of fishing areas from the Port Survey studies across the Study Area.

Figure 8.6 Fishing Areas based on Port Survey 1996/1997

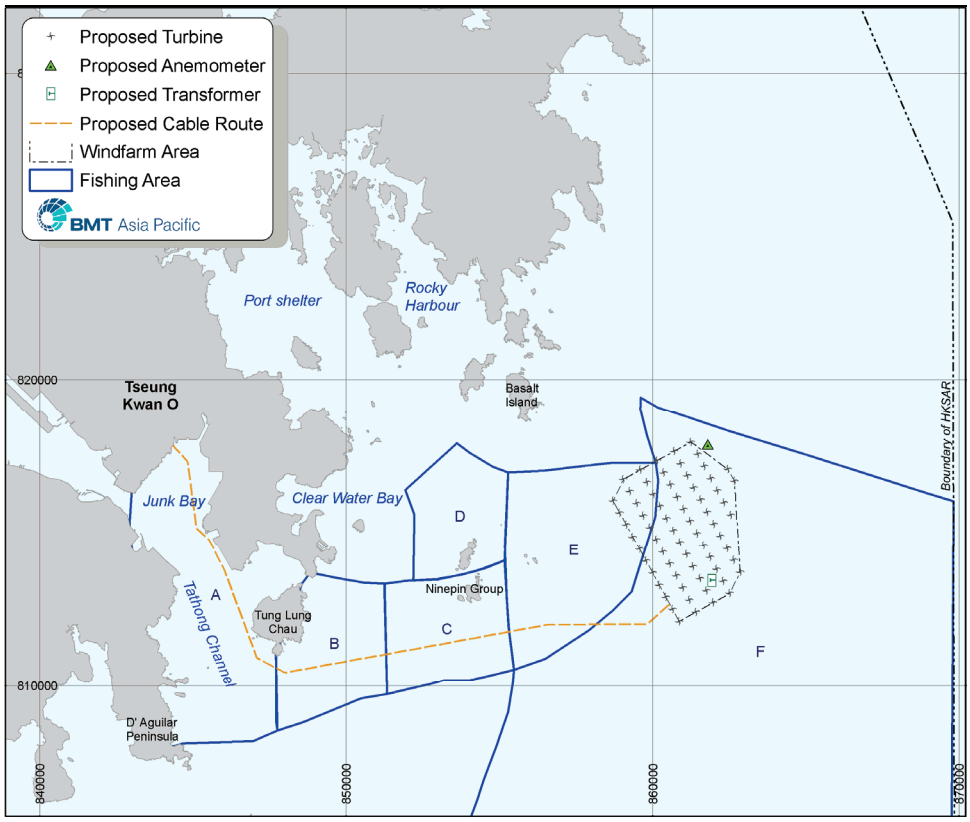
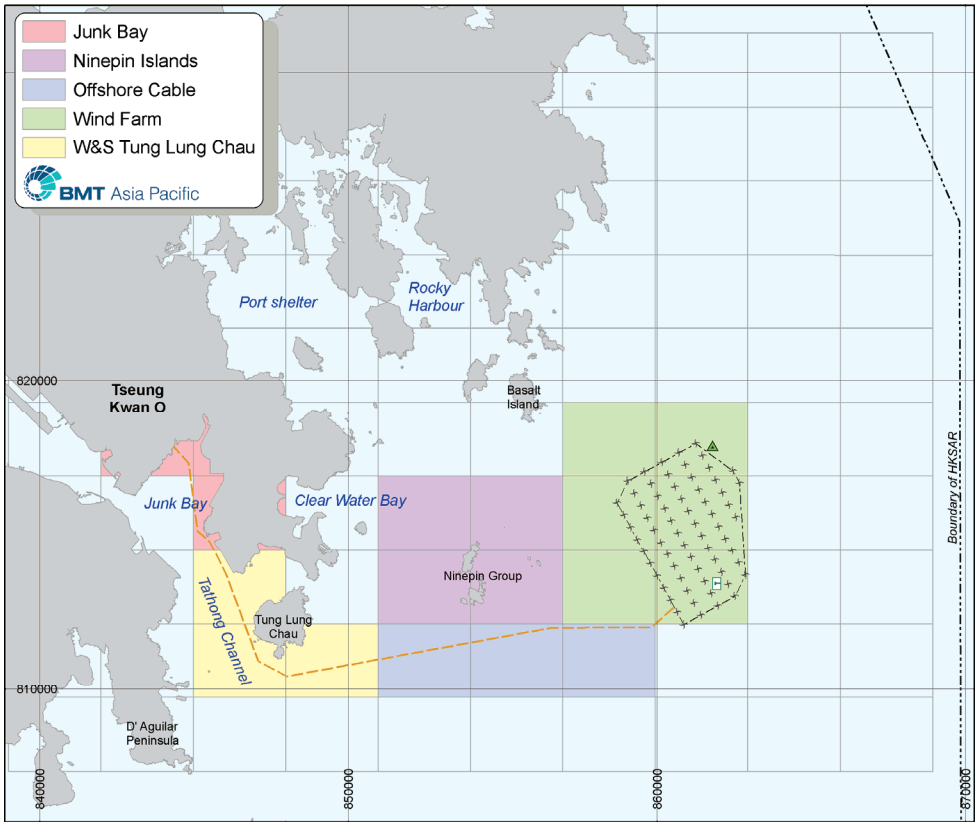


Figure 8.7 Fishing Areas based on Port Surveys 2001/2002 and 2006



8.5.2.4 Table 8.5 summarises the level of fishing activity within the Study Area based on the Port Survey studies. It appears that only small number of vessels >15 m length (classed as large vessels for the purposes of this assessment) operate within the Study Area, with most found around the Ninepin Islands.

8.5.2.5 Vessel use of the fishing areas defined for Port Survey 2001/02 and 2006 is more easily interpreted, and the dominance of vessels < 15 m length (classed as small vessels) in coastal waters is evident.

Table 8.5 Fishing Activity in the Selected Fishing Areas

Port Survey	Area	Vessels < 15 m	Vessels > 15 m
1996/1997	Zone A	Very High	Very Low
	Zone B	Moderate	Very Low
	Zone C	Moderate	Very Low
	Zone D	Moderate	Very Low
	Zone E	Moderate	Very Low
	Zone F	Negligible	Negligible

Port Survey	Area	Vessels < 15 m	Vessels > 15 m
2001/2002 and 2006	Tseung Kwan O	Moderate	Negligible
	Tung Lung Chau	Moderate / High	Negligible / Very Low
	Cable Route	Very Low / Moderate	Low / Moderate
	Ninepins	High / Very High	Moderate
	Wind Farm	Negligible / Very Low	Very Low / Moderate

8.5.2.6 With reference to the above table, Port Survey data consistently suggests there is little fishing activity in offshore waters, although the Port Survey 2006 data notably suggests an increase in larger vessels activity in the vicinity of the proposed wind farm relative to both earlier Port Surveys (i.e., “Negligible / Very Low” (1996/97), “Very Low” (2001/02) and “Very Low / Moderate” (2006)).

8.5.2.7 Port Survey 2006 data also suggests that fishing activity by small and large vessels alike in all areas of offshore Eastern Waters (north and south) except near the proposed wind farm remains “Negligible / Very Low”.

8.5.2.8 A baseline review of capture fisheries productivity has also been conducted. Table 8.6 displays a productivity ranking system that has been devised based on Port Survey 2001/02 and 2006 to support the baseline review.

Table 8.6 Fisheries Productivity Ranking

Ranking	Overall Value (HK$ / ha)	Adult Fish (kg / ha)	Fry (tails / ha)	By Species (kg / ha)
None	0	0	0	0
Negligible	>0 & ≤500	>0 & ≤50	>0 & ≤50	≤5
Very Low	500 – 1K	50 – 100	50 – 100	5 – 10
Low	1K – 2K	100 – 200	100 – 500	10 – 20
Moderate	2K – 5K	200 – 400	500 – 1k	20 – 40
High	5K – 10K	400 – 600	1K – 2K	40-60
Very High	10K– 20K	600 – 1K	2K – 3K	>60

8.5.2.9

8.5.2.10 Table 8.7 summarises the relative productivity of capture fisheries in the Study Area using the ranking system displayed in Table 8.6.

Table 8.7 Fish Productivity across the Study Area

Port Survey	Area	Overall Value (HK$ / ha)	Adult Fish (kg / ha)	Fry (tails / ha)
1996/1997	Zone A	High	Low	Very Low
	Zone B	Moderate	Low	Negligible
	Zone C	Moderate	Moderate	Very Low
	Zone D	Moderate	Moderate	Very Low
	Zone E	Moderate	Low	Negligible
	Zone F	Negligible	Negligible	None
2001/2002 and 2006	Tseung Kwan O	Moderate	Low	Negligible
	Tung Lung Chau	Moderate / High	Low / High	Negligible
	Cable Route	Low / Moderate	Low / Moderate	Negligible
	Ninepins	High / Very High	Very High	Negligible
	Wind Farm	Negligible / Low	Negligible / Low	None / Negligible

8.5.2.11 From the above table it is apparent that the reported productivity of capture fisheries in the Study Area of the proposed project has remained fairly stable over the past decade. The Port Survey data from 2001/02 and 2006 suggests that overall dollar catch value and adult fish productivity is consistently high around the Ninepin Islands and mostly low in waters further offshore, including the location of the proposed wind farm. Adult fish productivity along the cable route and at Tung Lung Chau is somewhat variable, possibly reflecting differences in fishing practice and specific location.

8.5.2.12 All three Port Survey studies indicate that Eastern Waters has negligible or very low fish fry productivity, and this suggestion is consistent with the findings of the systematic ichthyoplankton surveys conducted in Eastern Waters in 1994 as referred in sub-section 6.5.

8.5.2.13 As regards the species present in the Study Area and making use of data from the latest Port Survey 2006, Table 8.8 presents the most commonly caught species in HKSAR waters (Table 8.3 refers) and presents the productivity of each of these species across the Study Area.

Table 8.8 Productivity of Top HKSAR Species in the Study Area

Fish Species	Tseung Kwan O	W & S Tung Lung Chau	Offshore Cable	Ninepins	Wind Farm
Scad	Negligible	Negligible	Very Low	Very High	Negligible to Low
Shrimp	Negligible	Negligible	Low to Moderate	Low to Moderate	Negligible to Moderate
Rabbitfish	Moderate to High	Moderate	Very Low	Moderate	Negligible
Squid	Negligible	Negligible	Low	High to Very High	Negligible to Very Low
Croaker	Negligible to Very Low	Very Low to Low	Very Low	Moderate	Negligible to Very Low
Crab	Very Low to Low	Low	Very Low	Low	Negligible to Low
Mullet	Negligible	Negligible	Negligible	Low	None to Negligible
Sardine	Negligible to Very Low	Negligible to Very Low	Very Low	Low	Negligible
Seabream	Low to Moderate	Very Low to Low	Negligible	Low	Negligible

Source: AFCD, Port Survey 2006 (no data available for 'mixed fish')

8.5.2.14 The above data displays the generally negligible productivity for the most common species in the vicinity of the wind farm, although productivity for certain species is locally high around the Ninepins. Productivity of all other HKSAR-wide common species is generally not high in other waters of the study area.

8.5.3 Mariculture in the Study Area

8.5.3.1 Common mariculture species in the HKSAR are various species of groupers and snappers, and pompano. Fry for mariculture are mainly imported from the Mainland (PRC), Taiwan, Thailand, Philippines and Indonesia (www.afcd.gov.hk).

8.5.3.2 There are currently 1,066 licensed mariculture operators across 26 fish culture zones in the HKSAR, with these zones collectively occupying a surface area of ~209 hectares. Nine of the 26 fish culture zones are located in the vicinity of the

Study Area. Table 8.9 summarises the nine zones, with their locations displayed by Figure 8.8.

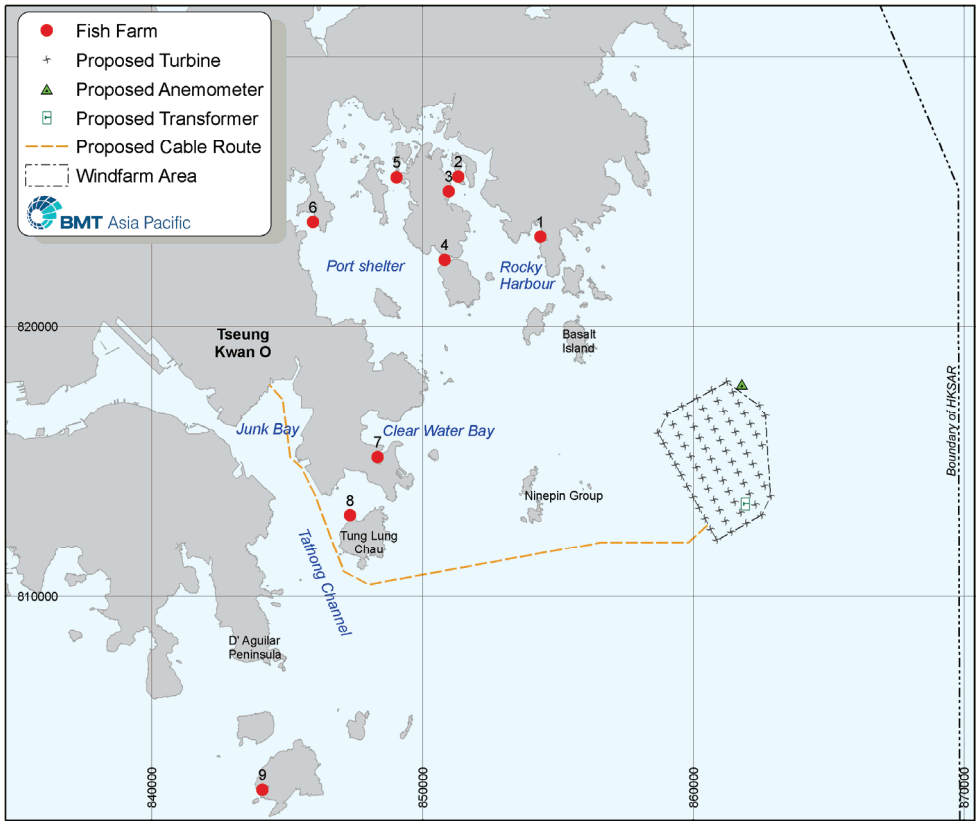
8.5.3.3 Tung Lung Chau is the largest fish culture zone in the Study Area and is understood to function, in part, as a temporary holding area for imported live fish (pers com). This fish culture zone is also the closest to proposed dredging works at Junk Bay and jetting works in the Tathong Channel, and thus may potentially be exposed to increased suspended solids and / or decreased dissolved oxygen levels during these activities.

Table 8.9 Summary of Fish Culture Zones in the Study Area

ID	Fish Culture Zones
1	Leung Shuen Wan
2	Tai Tau Chau
3	Tiu Cham Wan
4	Kau Sai
5	Kai Lung Wan
6	Ma Nam Wat
7	Po Toi O
8	Tung Lung Chau
9	Po Toi.

Source: AFCD, 2008

Figure 8.8 Mariculture Zone Locations



Source: AFCD website

8.5.4 Spawning and Nursery Sites

8.5.4.1 Key species recorded by the 1998 Fisheries Resources and Fisheries Operations report that spawn in eastern inshore waters include *Apogon Quadrifasciatus* (Twostripe cardinal), *Parapristipoma Trilineatum* (Chicken grunt), *Sebasticus Marmoratus* (False Kelpfish), *Trichiurus Haumela* (Hairtail), *Upeneus Sulphureus* (Sulphur goatfish) and *Upeneus Tragula* (Freckled goatfish).

8.5.4.2 The 1998 report notes that areas in eastern inshore waters of Sai Kung and including the coastal perimeter of Sharp Island, Basalt Island, Waglan Islands and the Ninepin Islands, “at certain times of the year, appear to be important spawning grounds for commercial species.”

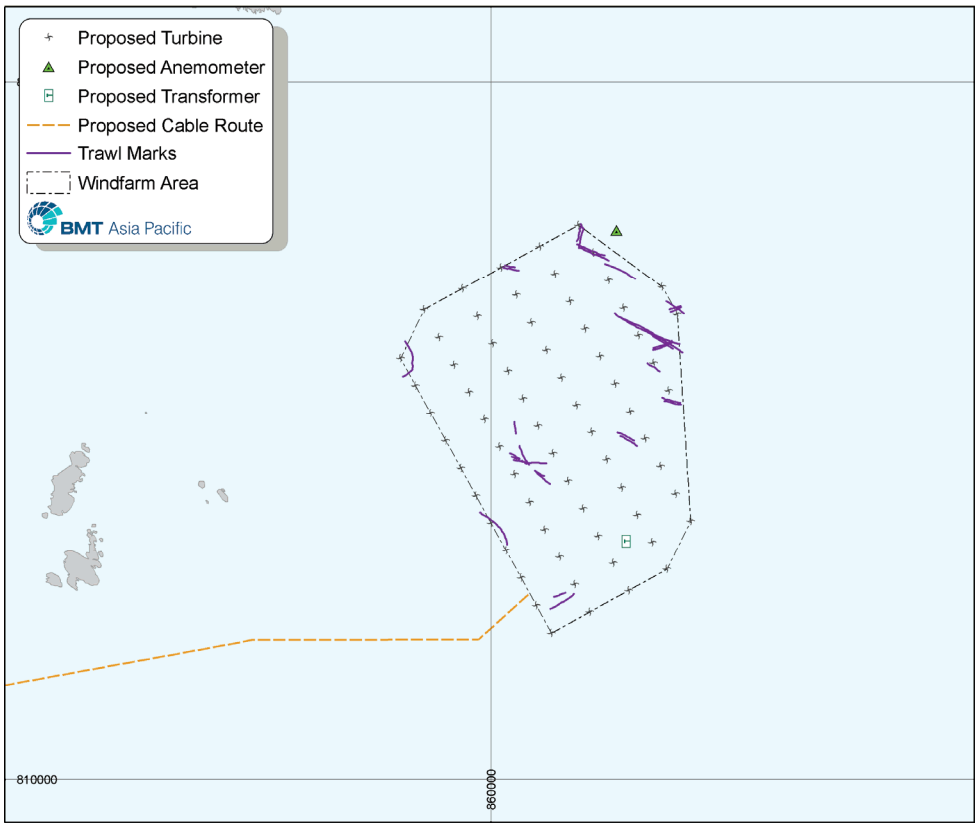
8.5.4.3 The 1998 report also identifies that the most important nursery sites of commercial species in Hong Kong lie in Northeast Waters, within Port Shelter, south of Lamma Island and south of Lantau.

8.6 Fishery Baseline – Field Surveys

8.6.1 Marine Geophysical Survey

8.6.1.1 As illustrated by Figure 8.9, the side scan sonar survey was able to identify discreet trawl marks on the seabed at the proposed wind farm area. These marks are relatively sparse across an area of about 16km^2, suggesting that trawling is limited.

Figure 8.9 Trawl Marks at the proposed Wind Farm

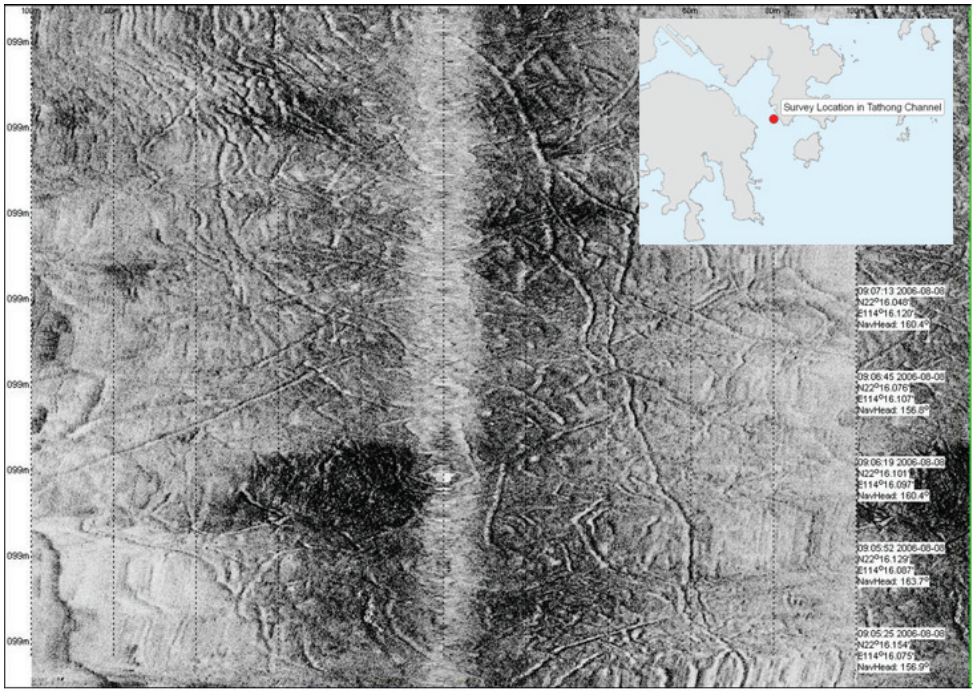


Source: Cosine Limited, 2006

8.6.1.2 However, it may be considered that trawl marks do not easily persist in the soft sediments of the wind farm site, and hence are not an absolute marker of trawling activity, but may provide information on the distribution. On this basis it is identified that the principal area for trawling activity is focussed on the north-east corner of the site.

8.6.1.3 Figure 8.10 illustrates a sample of trawl marks, in this case from the firmer sediments of the Tathong Channel.

Figure 8.10 Trawl Marks in Tathong Channel

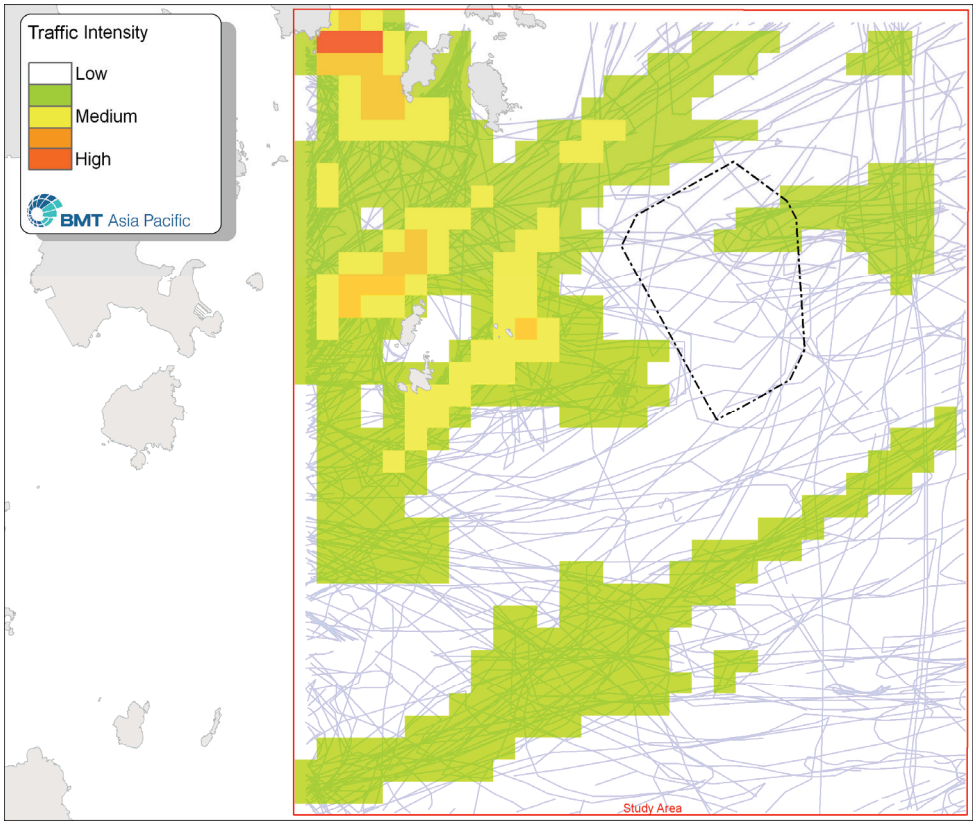


Source: Cosine Limited, 2006

8.6.2 Marine Traffic Radar Data Analysis

8.6.2.1 Figure 8.11 illustrates the distribution of sampled fishing activity between June and early July, during the fishing moratorium in the South China Sea. It is evident that most fishing activity is limited to inshore waters and those around the Ninepin Islands. The proposed wind farm site is not within the main fishing area in Eastern Waters.

Figure 8.11 Fishing Intensity in the Study Area



Note: Intensity illustrated on the basis of total track length per grid square

8.6.3 Boat-Based Observations

8.6.3.1 Figure 8.12 displays all fishing vessels recorded during boat-based observations between January and July 2007. More detail on vessel observations is presented in Appendix 8B.

8.6.3.2 In order to facilitate data analysis vessels were broadly divided into two categories: trawlers and non-trawlers. Trawlers include stern, pair, hang and shrimp trawlers, while non-trawling vessels comprise purse seiners, gill-netters, long liners, hand liners and sampans. Figure 8.13 and Figure 8.14 display the density of trawler and non-trawler vessels, respectively.

8.6.3.3 It is apparent that the densities in these figures corresponds strongly with the findings of the Marine Radar Data Analysis (Figure 8.11 refers) and with data from the Port Survey studies (Table 8.5 refers).

8.6.3.4 Figure 8.13 indicates that trawling is concentrated in waters south of the wind farm, with some activity in waters to the northwest and east of the wind farm, but little within the proposed wind farm area. Figure 8.14 illustrates that non-trawling activity is focussed around more sheltered islands, notably west of the Ninepin Islands and Basalt Island, although there were also observations of these small vessels offshore when sea state was very calm (i.e., Beaufort scale ≤ 2). The activity of small vessels near the proposed wind farm appears to be very low.

Figure 8.12 Overall Distribution of Fishing Vessels (January – July 2007)

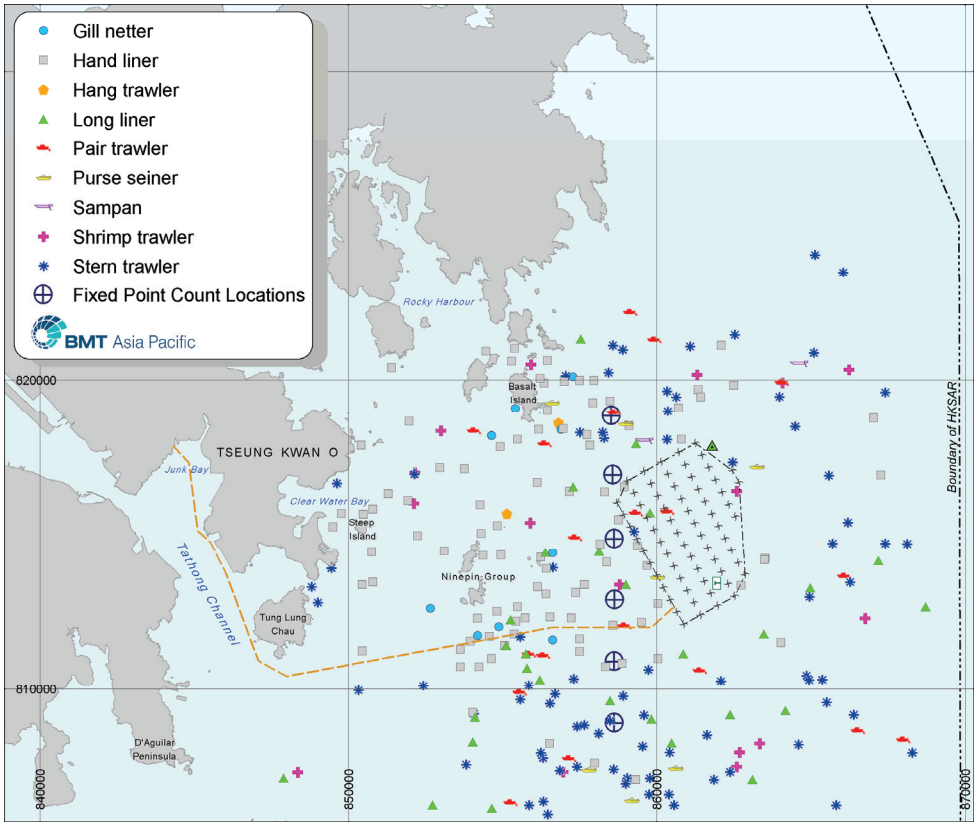


Figure 8.13 Trawler Fishing Intensity (January – July 2007)

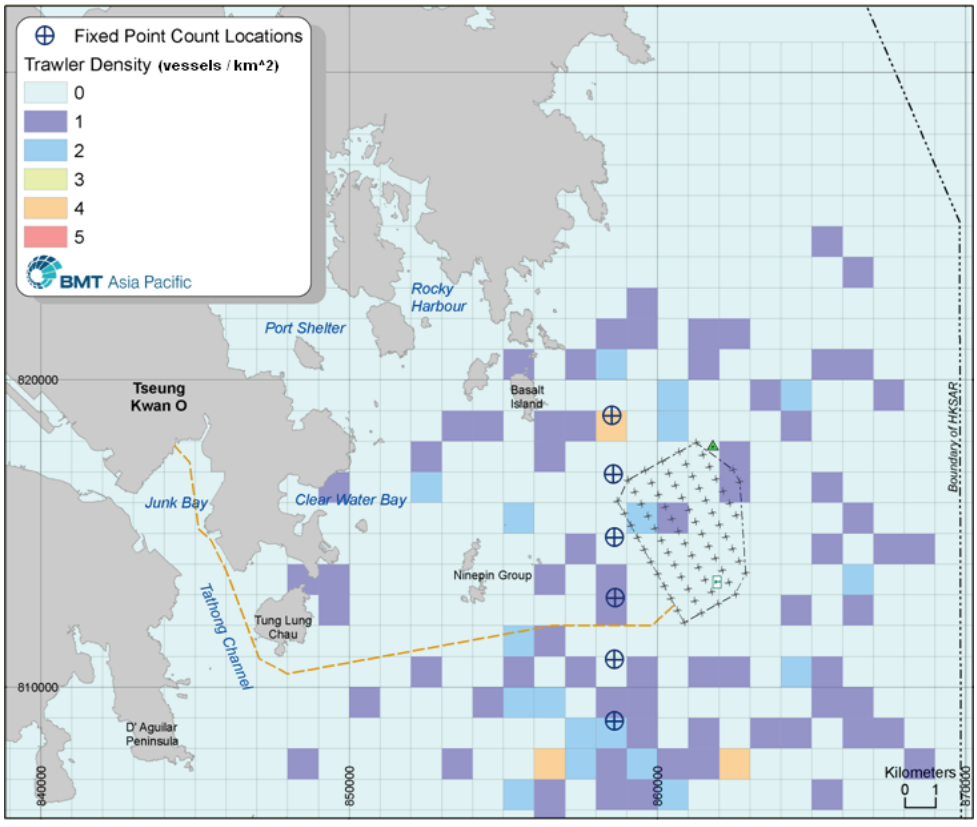
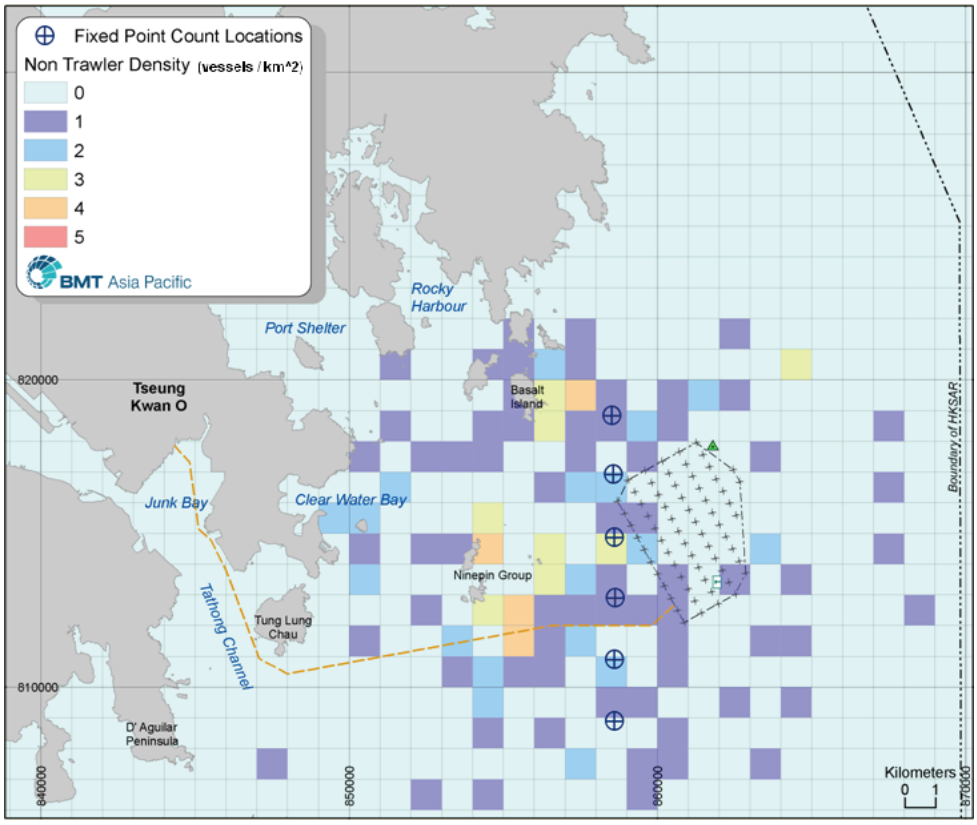


Figure 8.14 Non-Trawl Fishing Intensity (January – July 2007)



8.6.3.5 As the “Reference Sheet” in Appendix 8B shows trawlers use fishing gear that is distinctively different from non-trawlers, and the boat-based observers using binoculars with at least 10X magnification could clearly make this distinction. However, it should be noted that the smaller vessels, such as those illustrated as "Gill Netting" and "Hand Lining" vessels on the Appendix 8B "Reference Sheet ", can switch fishing gears flexibly between gill netting, long-lining and hand lining, or other methods. Hence, the identification of specific vessel types contains a level of uncertainty for these smaller vessels, particularly when viewed from a distance. As such the fishing type illustrated in Figure 8.12 is representative rather than definitive.

8.6.4 Semi-Structured Fishermen Survey

8.6.4.1 Semi-structured interviews with 68 fishing boat captains from Shau Kei Wan, Lei Yue Mun, Sai Kung and Aberdeen were conducted between February and early March 2007.

8.6.4.2 Figure 8.15 presents the breakdown of interviewees to homeport. Most interviews were held at Shau Kei Wan which supports a relatively large number of vessels fishing in Eastern Waters. Very few fishing vessels were harboured in Sai Kung or Lei Yue Mun, with only a small number of interviewees from these homeports. Aberdeen boat captains were the second largest group interviewed as it is the largest homeport in the HKSAR.

8.6.4.3 Figure 8.16a and b show the type of fishing gear used by the interviewees.

Figure 8.15 Homeports of Interviewed Boat Captains

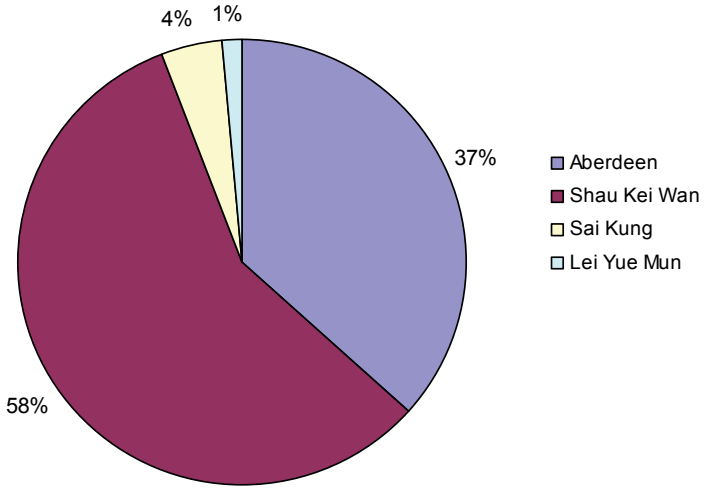


Figure 8.16a Fishing gear operated by Homeport

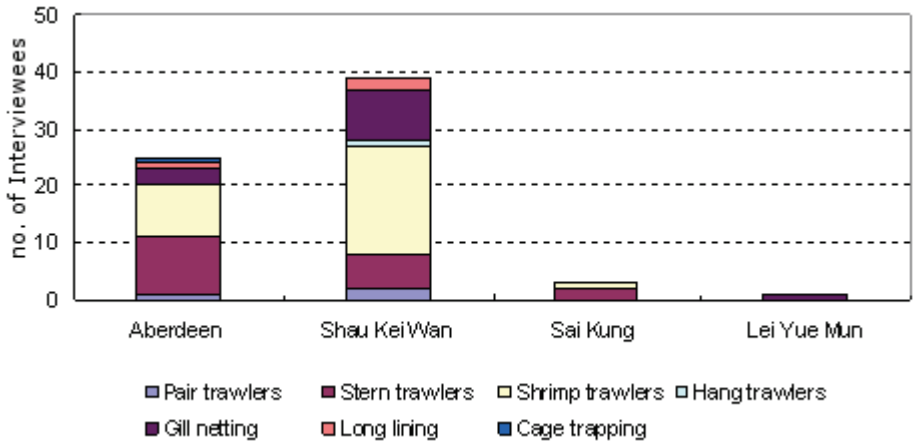
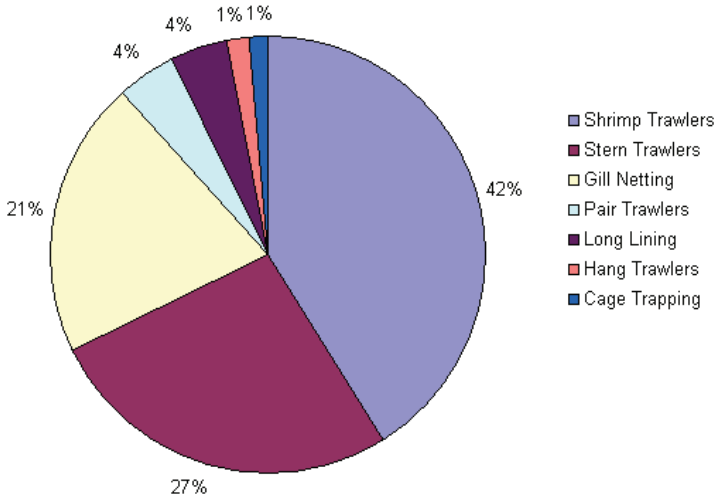


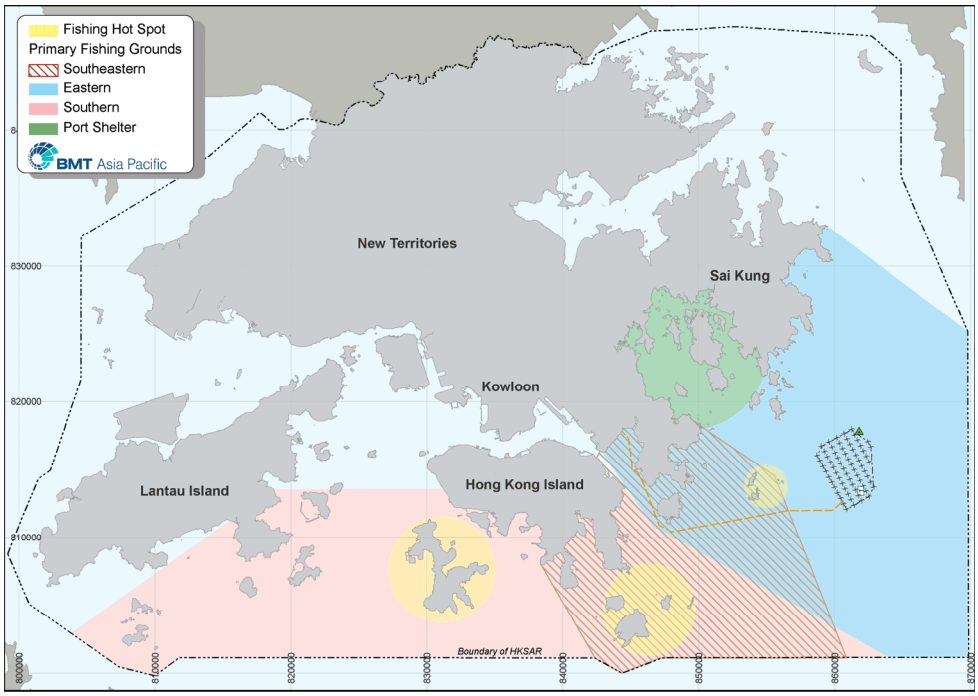
Figure 8.16b Fishing Gear of Interviewed Captains



8.6.4.4 All vessels are family-owned with an average of four crew members per vessel on board. An average of two family members work on board, with other crew recruited from the Mainland to minimise operating costs.

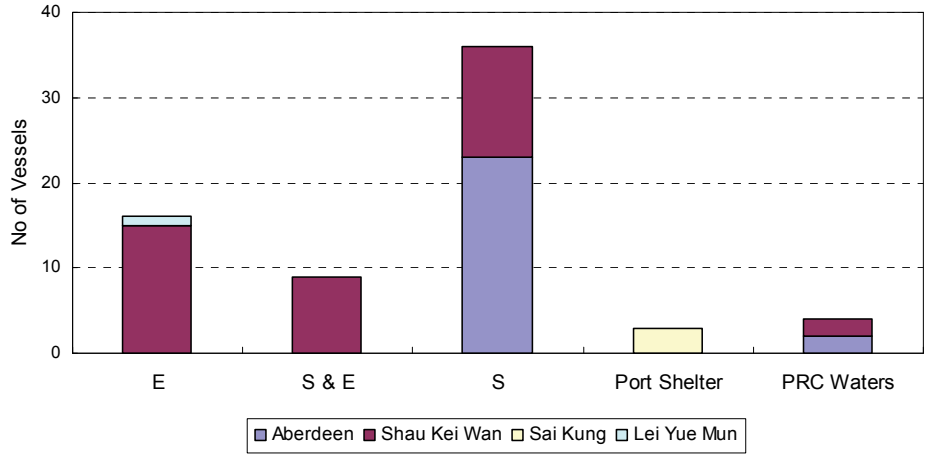
8.6.4.5 Figure 8.17 displays the primary fishing grounds with have been broadly defined as eastern, southern, south-eastern and Port Shelter. According to the interviewees, most fishing activity is conducted in 'hot spots' around Po Toi and the Ninepin Islands which is entirely consistent with the marine traffic radar data and visual observations of fishing activity made during the fisheries baseline studies.

Figure 8.17 General fishing grounds



8.6.4.6 Figure 8.18 illustrates the relationship between homeport and fishing ground. It is noted that about ~40% of Shau Kei Wan respondents fished exclusively in Eastern Waters, while almost all Aberdeen respondents reported that their primary fishing ground was Southern Waters. Only Shau Kei Wan fishermen reported activity at both the Ninepin Islands and Po Toi, with no interviewees from other homeports claiming the same combination of fishing ground activity. The Sai Kung fishermen reported to primarily fish within Port Shelter.

Figure 8.18 Primary Fishing Ground of the Interviewed Fishers



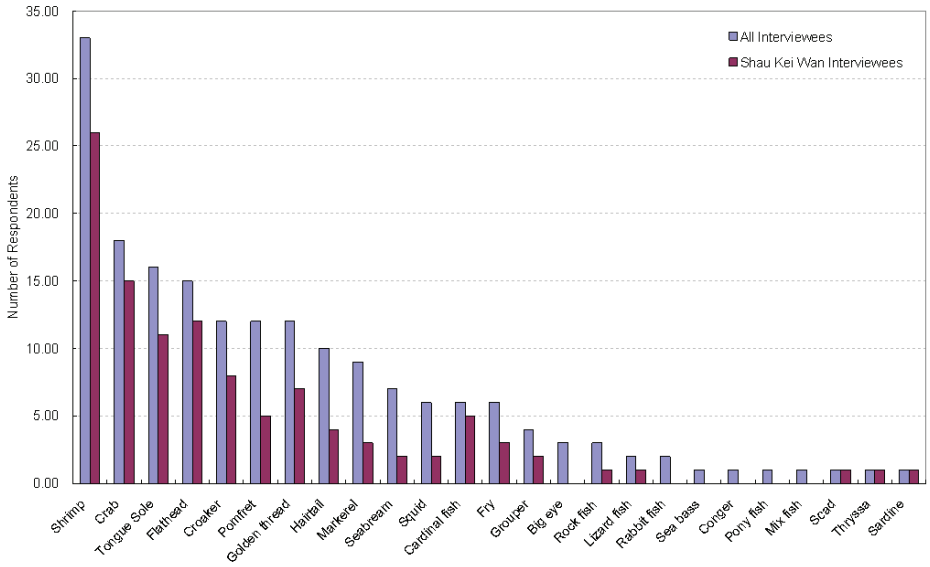
8.6.4.7 Specific observations of the homeports visited were made during the survey:

- Aberdeen is clearly still a very important homeport for commercial fishing, and many large vessels were observed. Many interviewees reported that Po Toi, Lamma Island and Cheung Chau were favoured fishing locations.
- Shau Kei Wan is a smaller homeport than Aberdeen with fewer commercial fishing vessels, particularly larger sized vessels. Quite a number of small recreational craft were moored there. Most interviewees reported fishing around the Ninepin Islands, while some reported Po Toi Islands and outside Stanley Bay.
- Sai Kung is dominated by recreational vessels. Only a few small craft were evident at the homeport, with few commercial fishing vessels seen.
- Lei Yue Mun was described as *"dead"* by interviewees as only two large (>15m) commercial fishing vessels were seen during two visits.

8.6.4.8 From all interviewees, a total of 23 species of fish species were reported as being among the 'top five' most commonly caught fish. Figure 8.19 presents a summary of common caught species, with data for Shau Kei Wan isolated as a proxy for the general catch in Eastern Waters.

8.6.4.9 Shau Kei Wan respondents reported 16 common species (excluding fry and mixed fish) with the common catch being 'shrimp', 'crab', flathead, tongue sole and croaker. Only Shau Kei Wan interviewees also reported scad among the common catch, with the Port Survey 2006 indicating very high productivity of this species around the Ninepin Islands (Table 8.8 refers). The same data indicates that the productivity of 'shrimp' and 'crab' in offshore Eastern Waters is generally low.

Figure 8.19 Commonly caught species by all respondents



8.6.4.10 With reference to Figure 8.19 the top ten most commonly caught species have been identified and an indicative value has been assigned based on mean wholesale prices (HK$ / kg) as published by the Fish Marketing Organization (FMO) in October 2007. Table 8.10 presents this value ranking system, and Table 8.11 summarises the assigned value for the species brought to Sha Kei Wan homeport.

Table 8.10 Indicative species value ranking system

Ranking	Wholesale Price (HK$ / kg)
Very Low	up to 10
Low	11 – 30
Moderate	31 – 60
High	61 – 91
Very High	>90

Table 8.11 Value of common catch from Shau Kei Wan

Common Name	Commercial Value
Shrimp	Low to high
Crab	Low to high
Flathead	Low to medium
Tongue sole	*Not available*
Croaker	*Not available*
Golden thread	Very low to low
Promfret	Low to medium
Cardinal fish	Very low
Mackerel	Very low
Hairtail	Low

8.6.4.11 With reference to Table 8.11 it is apparent that the finfish species caught in Eastern waters are of relatively low commercial value, although the value of the crustaceans varies according to species and age.

8.6.4.12 The survey also asked fishermen the reasons for selection of preferred fishing grounds and reported four important factors (in order):

1. Proximity to homeport
2. Sea state
3. Abundance of fish resources
4. Familiarity with fishing ground(s)

8.6.4.13

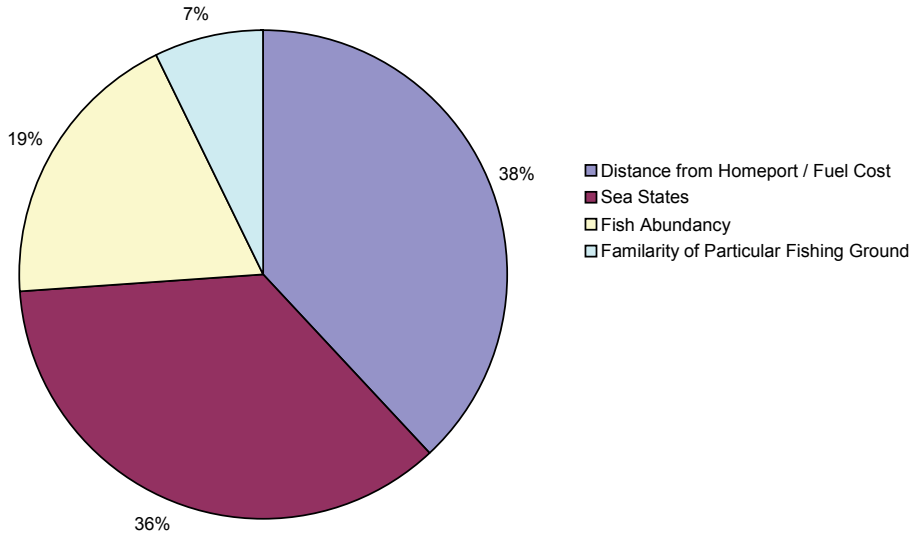
8.6.4.14

8.6.4.15

8.6.4.16 Figure 8.20 summarises the responses. The main reason for selection was proximity to homeport which was stated as a crucial factor in controlling fuel costs which continue to rise. The abundance of fish and familiarity with the fishing

ground(s) were reported as being of less importance.

Figure 8.20 Criteria for selection of primary fishing ground(s)

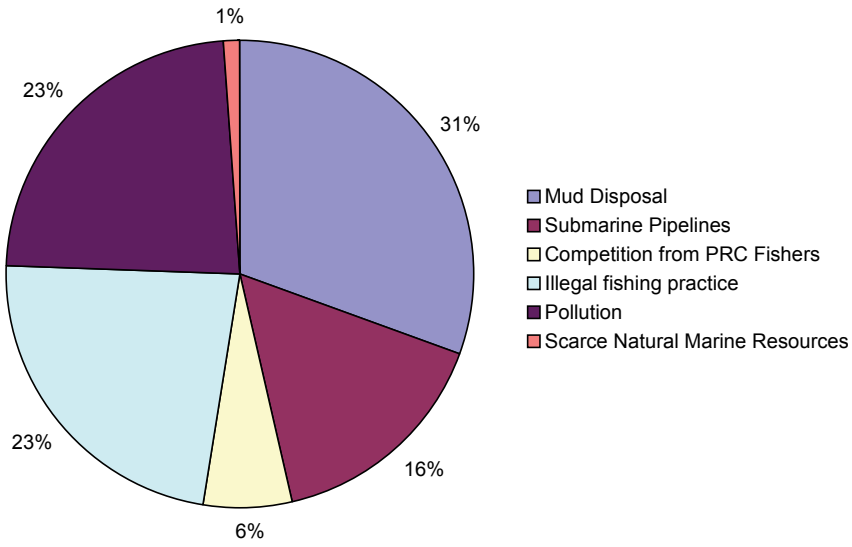


8.6.4.17 Following on from a more general discussion of threats facing the fishing industry six issues were identified:

- Dredging and mud disposal were referred as the main threat, with these activities considered to be the key reasons for the decline in fish abundance over the past two decades.
- Pollution was identified as the second biggest threats to the local fishing industry.
- Illegal fishing practices, particularly the reported use of indiscriminate electro-fishing by Mainland fishermen.
- Rock armour protection for submarine pipelines it was felt was responsible for damaging trawler nets, and a particular problem for vessels without sonar.
- Competition from Mainland fishermen illegally operating in HKSAR waters.
- Scarcity of marine resource within HKSAR waters was only considered by a small number of respondents to be a threat to the local fishing industry.

8.6.4.18 Figure 8.21 presents the relative significance of these threats.

Figure 8.21 Threats to the local fishing industry



8.6.5 Formal Consultation with Fisheries Organisations

8.6.5.1 A series of formal consultation meetings have been held with fisheries organisations. The key concerns raised by organisations consulted are as follows:

- Seabed impacts from Project construction creating major disturbance and fish kills.
- Implications for fishing vessel access into the wind farm, and if the Project would further reduce the fishing ground.
- Navigation and safety hazards from the presence of wind turbines.
- Concern regarding the responsiveness of emergency rescue.

8.7 Construction Phase Impact Assessment

8.7.1 Introduction

8.7.1.1 Potential impacts on fisheries during Project construction are:

- A decline in water quality associated with dredging, jetting and / or foundation installation.
- An increase hazard to fishing vessels due to increase in construction vessel movements; and
- Temporary loss of fishing ground due to necessary construction activity.
- Temporary, localized disturbance to spawning grounds due to jetting works.

8.7.2 Water Quality

8.7.2.1 The Project will require cabling which will involve dredging in Junk Bay and jetting in the remaining area. There shall also be foundation installation activities for the wind turbines and the offshore transformer station.

8.7.2.2 All fish culture zones in the Study Area and potential sensitive receivers included in the numerical assessment of water quality impacts (Section 4 refers). Table 8.12 summarises the water quality results for unmitigated construction activities.

Table 8.12 Predicted suspended sediment concentrations (in mg/L) at representative fisheries receivers: Unmitigated Scenario

Fish Culture Zone / ID	Peak Baseline	Unmitigated concentration* / Scenario				
		1	2	3	4	5
Ma Nam Wat (FCZ1)	3	3	3	3	3	3
Kau Sai (FCZ2)	41	41	41	41	41	41
Kai Lung Wan (FCZ3)	3.9	3.9	3.9	3.9	3.9	3.9
Leung Shuen Wan (FCZ4)	130	130	130	130	130	130
Po Toi O (FCZ5)	8.1	8.1	8.1	8.1	8.1	8.1
Tung Lung Chau (FCZ6)	8.4	8.4	8.4	8.4	8.4	8.4
Tai Tau Chau (FCZ7)	16	16	16	16	16	16
Po Toi (CC29)	15	15	15	15	15	15

8.7.2.3 Despite the proposed cable installation activity in the Tathong Channel, the modelling results indicate that levels of suspended sediment at the Tung Lung Chau fish culture zone will not exceed baseline levels. Levels of dissolved oxygen at the fish culture zone will also not be affected by cable installation. Accordingly, there shall be no adverse impacts at any fish culture zone during construction.

8.7.2.4 With regard to capture fisheries, Table 8.13 displays the predicted mixing zone associated with marine construction activities.

Table 8.13 Mixing zone radii for marine construction activities

	Construction method		
	Jetting	Dredging	Suction Caisson
Dry	< 130 m	<180 m	< 190 m
Wet	<120 m	< 180 m	< 190 m
m above seabed	1.5 – 3.0	Entire water column	< 10 m

8.7.2.5 As fish are highly mobile and the large volume of seawater in which to swim, the relatively small mixing zones are not anticipated to cause any significant adverse impacts on capture fisheries.

8.7.2.6 As demonstrated by Port Survey data, fish fry productivity is negligible in the Study Area although water quality impacts are not in any case anticipated. No areas of coral reef that could potentially offer localised spawning and nursery habitat for capture fisheries recruitment will be adversely affected by construction activities (sub-section 5.7.3 refers).

8.7.3 Hazard to Fishing Vessels

8.7.3.1 During the construction of the wind farm, the increased marine traffic flow within the site and along the proposed cable routes will pose an additional marine navigation risk. The identified risks include:

- Construction vessel collision on-site
- Construction vessel collision with structure
- Construction vessel encounters (Jack-ups or anchors) underwater obstruction (Cable, pipeline etc)
- Construction vessel jacks-up or anchors onto unexploded ordnance
- Man overboard during personnel transfer operations

- Dropped Object during major lifting operations

8.7.3.2 Therefore, a 500m radius safety / exclusion zone will be closed to all vessels during construction phase. The standard fisheries liaison and notification procedures for the installation of offshore structures will be implemented.

8.7.3.3 It is anticipated that as major sections of the windfarm are installed the windfarm footprint is 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.

8.7.3.4 With these safety measures in place, no additional significant hazard to fishing vessels will be anticipated.

8.7.4 Impact to Traditional Fishing Ground

8.7.4.1 All vessels will be restricted from accessing the safety / exclusion zone during installation of cable routes and turbine construction, and hence a temporary loss of fishing ground will occur.

8.7.4.2 As presented in the baseline, relatively little fishing takes place at the wind farm site and restrictions on access will be over a small area. Construction activities may drive fish away from the area and consequently the implementation of restricted access measures will not result in any significant adverse impacts. Accordingly, there shall be no significant adverse impacts on fisheries due to loss or restricted access to traditional fishing ground.

8.7.5 Impact to Spawning and Nursery Grounds

8.7.5.1 The wind farm footprint lies more than 4km away from the identified spawning grounds in eastern Hong Kong waters and will not affect these areas. Jetting will cause temporary localized disturbances along the cable corridor. The cumulative extent of areas that may be disturbed, assuming a conservative 130m mixing zone established by water quality modelling in Section 4, comprise a tiny percentage (0.6%) of spawning grounds in eastern waters. It is not anticipated that there will be significant impacts to spawning grounds for this localised and transient operation.

8.7.5.2 Both the wind farm site and the cable route lie far from important nursery sites of commercial species in Hong Kong (in Northeast Waters, within Port Shelter, south of Lamma Island and south of Lantau).These identified sites which will not be affected by the Project works.

8.7.6 Summary of Construction Phase Impacts

Critera	Description
Nature of impact	Impacts are temporary and short term.
Size of affected area	500m radius safety / exclusion zone and wind farm footprint progressively designated as a controlled waterspace. This represents a small area of a low-productivity section of Hong Kong's fishing grounds. Jetting of a cable corridor which may affect less than 0.6% of spawning grounds in eastern waters on a transient basis.
Loss of fisheries resources / production	Temporary access restrictions to relatively low-productivity fishing grounds.
Destruction and disturbance of nursery and spawning grounds	No impact on important nursery grounds. Jetting will cause temporary localized disturbances along the cable corridor. The total cumulative extent of areas that may be disturbed comprise a tiny percentage of spawning grounds in eastern waters.
Impact on fishing activities	Temporary access restriction to a small, relatively low-productivity and low fishing intensity section of Hong Kong's fishing grounds.
Impact on aquaculture activities	No impacts on the aquaculture activities,

8.8 Operational Phase Impact Assessment

8.8.1.1 As identified in Section 4, the operation of the wind farm project will not induce any water quality impacts. Potential impacts on commercial fisheries lie in:

- Potential hazard to fishing vessels;
- Permanent loss of fishing ground, and
- Potential for beneficial impact on fisheries in the wind farm area.

8.8.2 Hazard to Fishing Vessels

8.8.2.1 A Marine Navigation Safety Risk Assessment (MNSRA) has been conducted to assess impact of the wind farm on the existing and future marine traffic profile in south-eastern waters (Appendix 2A refers).

8.8.2.2 The assessment included a comprehensive analysis of the marine navigation safety risk implications arising from the establishment of an offshore wind farm in south-eastern Hong Kong waters and included the identification of key hazards and the quantification of associated risks. It was identified that the impact of the proposed wind farm on marine users is minor, and 'Acceptable' given the design features and management measures proposed to accompany the Project.

8.8.2.3 However, a review of the key risks identified a series of hazards that cannot be readily mitigated by engineering / operational measures alone. These hazards are associated with a variety of "created behaviours" that may be displayed were unrestricted marine activity to be permitted, and include:

- Scaling turbines for fishing with the potential for falls, or stranding on turbines due to boats being unable to return and pick-up;
- Capsizing due to un-seaworthy vessels accessing the wind farm area for sight-seeing activities; and
- Trawlers snagging nets / colliding with turbines whilst taking advantage of the anticipated local aggregation of fish.

8.8.2.4 The MNSRA concluded that restriction is required to manage "created behaviours" anticipated within the wind farm area. In order to manage these risks it is proposed that the Windfarm area is designated as a controlled waterspace through the development of byelaws or similar legal instruments. Waterbourne access would be restricted to vessels that have received approval from the authority specified in the legal instruments." The following vessel restrictions are proposed:

- Marine vessel management with a designated Marine Restricted Area;
- Trawling activity would be prohibited;
- Permitted marine vessels would include all Government vessels and wind farm maintenance vessels, and may be extended to include dive boats, tourist launches, hand-line fishing vessels, etc.; and
- Permitted marine vessels are anticipated to be required to carry Automated Identification System (AIS) transmitters to monitor and safeguard their operations, and ensure they are seaworthy for offshore conditions.

8.8.3 Impact to Commercial Fishing Activities

8.8.3.1 Considering all fishing vessels will be excluded from the wind farm area for marine navigation safety reasons, a total of <16 km^2 of sea area will be permanently lost as a fishing ground. This is equivalent to less than 1% of the Hong Kong territorial waters (1,650 km^2) and given the relatively low productivity of the site area, impact on fisheries production will be insignificant. Nevertheless, some local fishermen (particularly trawlers) who habitually fish in the wind farm site will be affected to a limited extent.

8.8.3.2 However, the following characteristics of the proposed wind farm site discount its overall value to the local fishing industry:

- Uniform and exposed muddy seabed with no habitat diversity is unattractive to fish as a shelter or feeding area.

- Very limited to no spawning activity in the area specifies its low importance as a potential spawning / nursery ground for replenishing depleted fisheries (ERM , 1998).
- Low productivity and commercial value in waters..
- Rough sea conditions for much of the year make it unsafe for smaller vessels to operate in this area.
- Remoteness of the site coupled with it large expanse and low productivity decreases its commercial value due to the high fuel cost.

8.8.3.3 While the wind farm components will only occupy the equivalent of ~0.3% of the entire wind farm footprint (see 5.7.2.14), the remaining 99.7% will remain as open waters and viable habitat for the existing fish stock. Accordingly, set against the low baseline fisheries productivity and hence value of the wind farm area, a negligible adverse impact on the fisheries stock habitat of Eastern waters may be anticipated..

8.8.3.4 The existing baseline productivity of capture fisheries in the Study Area is low. Given the proposed management of the site area in relation to the Project, the waters in the site area could be used as a fisheries enhancement area. This is beyond the scope of this EIA and Project, but the Project Proponent acknowledges the potential, Sub-section 8.8.4 presents options for potential benefits to fishery.

8.8.4 Potential Benefits to Fisheries

Danish Offshore Wind Farms

8.8.4.1 The Danish Energy Authority conducted an environmental monitoring programme between 2000 and 2006 for the two Danish offshore wind farms (DONG Energy *et al*, 2006):

- Horns Rev Offshore Wind Farm, operational since 2002, is located 14-20 km off the coast in the North Sea. It consists of 80 turbines with maximum capacity of 160 MW.
- Nysted Offshore Wind Farm commissioned in 2002-2003 consists of 72 turbines situated 10 km from the coast. The total output of the wind farm is about 166 MW.

8.8.4.2 This study provides qualitatively evaluation on the actual environmental performance at the wind farm sites during the operation phase. The key findings of this monitoring study related to fishery resources are summarised as follows:

- Presence of wind farm structures: The overall habitat heterogeneity and species richness has increased as a result of introducing artificial structures in the previously homogenous sandy seabed, permitting colonisation by an epibenthic community.

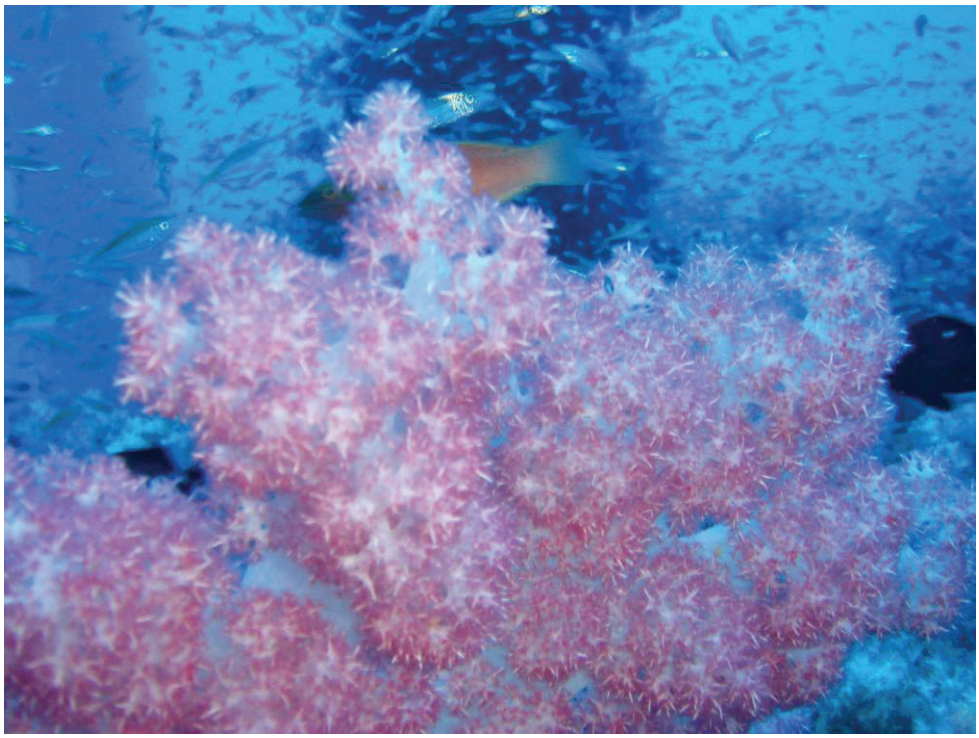
- Exclusion of fishing activity in the wind farms: The absence of fishing activity, particularly trawling, is deemed key to boosting the abundance and diversity of the benthic ecosystem.
- Impacts on fish communities as a result of operation of the wind farms: Statistically, no adverse impacts on fish population have been identified. The study has forecasted that the potential for enhancing fish supply cannot be overlooked once the benthic communities become fully established in the wind farm areas.

Dive Observations at Offshore Oil and Gas Platforms in the South China Sea

8.8.4.3 With reference to sub-section 5.8 the established marine fouling and coral communities on the surface of the oil and gas platforms in the South China Sea support rich pelagic species.

8.8.4.4 Predator fish species such as barracuda, tuna and snappers have been observed in the area with some of the fish size reach as long as 1.5m. Other reef fishes, lobsters and moray eels are also residents in these ecosystems. The fish species richness at the platform sites is unique as number of fish becomes scarce in waters 10m to 15m away from the platforms. Figure 8.22 illustrates the abundance of fish species living in this environment.

Figure 8.22 Fish aggregation at an oil platform in the South China Sea



Source: Asiatic Marine Limited

Opportunities for the Local Fishing Industry

8.8.4.5 With the exclusion of all fishing vessels within the wind farm area, losses primarily of highly resilient species and juvenile fish from trawling and other non-trawling fishing activity will cease. The wind farm area is therefore potentially beneficial to fisheries resources.

8.8.4.6 Based on the Baseline Site Design, presented in Section 2.6, it is expected that the marine foundation structures will offer a cumulative surface area of >100,000 m^2 (67 tripod structures with legs nominal 5m diameter in 30m water depth) This area would be available as an artificial reef substrate for colonisation by epibenthic flora and fauna, including communities of corals similar to those found at the offshore oil and gas platforms in the South China Sea to the south of the proposed wind farm. Species with a preference for low light and low / medium current speeds such as the black coral *Cirripathes* sp. could also colonise the foundation structures.

8.8.4.7 Once the artificial reef systems begin to develop, natural (unaided) spawning / nursery area are likely to become naturally established (Figure 8.22 refers). Assisted spawning / nursery areas may also be achieved through manual stocking of fry and larvae in the wind farm area to supplement naturally recovering fisheries resources.

8.8.4.8 Overall the proposed wind farm project and the proposed restrictions on fishing activity in the wind farm area provide an opportunity to replenish the heavily exploited fisheries resources in Eastern Waters. Establishment of artificial reef communities on marine foundations will benefit the overall abundance and diversity of fisheries resources, and will provide a test case for further large scale fisheries protection and sustainable fisheries management in the HKSAR.

8.8.4.9 If after the EIA process has been completed, Government, other agencies or key stakeholders would like to implement enhancement and management of fisheries resources within the wind farm site, beyond those already inherent within the Project's design and management (i.e. the potential for turbine substructures to naturally act as artificial reefs and the management of the windfarm footprint as a controlled waterspace), the Project Proponent will work with such bodies in the context of an initiative led by a 3rd party to formulate and explore such additional measures.

8.8.5 Summary of Operational Phase Impacts

Critera	Description
Nature of impact	Long term, permanent presence of wind farm and associated fishing exclusion zone
Size of affected area	16km^2 are of wind farm footprint. However wind farm tower components only occupy about 0.3% of the site with the remaining 99.7% of open waters available as viable habitat for fish.
Loss of fisheries	Loss of 16km^2 of relatively low productivity fishing grounds. This is equivalent to less than 1% of the Hong Kong territorial waters (1,650

Critera	Description
resources / production	km2) and given the relatively low productivity of the site area, impact on fisheries production will be insignificant. Nevertheless, some local fishermen (particularly trawlers) who habitually fish in the wind farm site will be affected to a limited extent. Potential benefits from >100,000 m^2 of turbine substructures available as artificial reef substrate for fishery enhancement by providing rare deep water substrate.
Destruction and disturbance of nursery and spawning grounds	No adverse impact on important nursery and spawning grounds Presence of tower structures provides potential habitat
Impact on fishing activities	Loss of 16km^2 area of relatively low-productivity and low-fishing intensity fishing grounds.
Impact on aquaculture activities	No impact on aquaculture activities.

8.9 Cumulative Impacts

8.9.1.1 As presented in Section 4, no cumulative water quality impacts are anticipated as a result of the operation of the East Ninepins and East Tung Lung Chau Sediment Disposal Areas, or from construction activities associated with Further Development of Tseung Kwan O.

8.9.1.2 No cumulative impacts are anticipated during operation of the proposed wind farm.

8.10 Mitigation Measures & Best Practice

8.10.1.1 As the fisheries impacts are directly associated with the water quality, therefore, mitigation measures and best practices to avoid water quality impacts presented in Section 4 of this EIA Study Report shall be adopted and implemented during the works.

8.10.1.2 No significant adverse impacts are expected during the operational phase.

8.11 Potential Benefits

8.11.1.1 Positive impacts are anticipated following the implementation of the fishing exclusion zone at the wind farm site which would contribute to effective fisheries resource enhancement in Eastern Waters.

8.11.1.2 As referred in sub-section 8.8.4, the sub-structure of the wind turbine foundations shall provide a net increase in the surface area of hard substrate available as an artificial reef for colonization by reef dwelling organisms.

8.12 Residual Impact Assessment

8.12.1.1 No significant residual impacts are anticipated during construction and operational phase of the wind farm.

8.13 Environmental Monitoring & Audit Requirements

8.13.1.1 As no significant adverse construction and operation phase impacts are anticipated, no environmental monitoring and audit is proposed.

8.14 Conclusions & Recommendations

8.14.1.1 The Project will lead to the permanent loss of approximately 16 km^2 of relatively low productivity / value fishing ground within Hong Kong waters. Both the wind farm site and cable route lie far from, and will not affect, identified nursery grounds of commercial species. Jetting of the cable route will cause temporary localized disturbances within an identified spawning ground in Eastern waters, however the total area impacted by this transient operation is extremely small, and impacts will be negligible. There is unrestricted fisheries habitat of similar character and value in waters contiguous with the proposed wind farm throughout the Study Area.

8.14.1.2 No significant water quality-induced impacts are predicted on the popular fishing area around the Ninepin Islands or any of the fish culture zones in the Study Area during Project construction.

8.14.1.3 The operational Project will lead to loss in fishing ground, although the potential for a significant net positive impact may be achieved.

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