

7. FISHERIES

7.1 Introduction

This chapter reviews existing information on Tai O fisheries, summarises the findings of fisheries surveys conducted for this Study, and assesses the positive and negative fisheries impacts associated with construction and operation of the Tai O sheltered boat anchorage. It also proposes mitigation measures to ensure that identified impacts are within acceptable levels. The need for a fisheries monitoring programme is assessed.

7.2 Legislation and Applicable Standards

Hong Kong Government ordinances and regulations relevant to the consideration of fisheries and mariculture include:

- Fisheries Protection Ordinance (Cap. 171) and associated subsidiary legislation;
- Marine Fish Culture Ordinance (Cap. 353) and associated subsidiary legislation; and
- Environmental Impact Assessment Ordinance (Cap. 499) and associated Technical Memorandum on Environmental Impact Assessment Process (the EIA TM).

This assessment is conducted in accordance with the guidelines set forth in the EIA TM, particularly Annexes 9 and 17.

7.3 Review of Existing Information

Evaluation of fisheries at Tai O is complicated by the fact that until 1 July 1997 Tai O fishing areas lay outside Hong Kong waters, and no fisheries surveys offshore of Tai O were conducted until after that date. Due to the paucity of published information on Tai O fisheries, the literature review undertaken has relied to some extent on information from other fishing areas in north Lantau. **Appendix 6** lists studies that have been consulted for this assessment and summarises relevant information therefrom. Information of key importance includes common fisheries species, number and type of fishing vessels, number of fishermen employed and total fisheries production. Relevant findings are summarised below.

Existing information indicates that a wide variety of fisheries species are exploited in north Lantau waters and hence probably in the Tai O area. The north Lantau area as a whole is fairly important on an SAR scale in terms of fish production, but is not identified as important for fry production. In surveys in 1979-84 (see **Appendix 6, Section A6.2.2**), Tai O consistently had the highest production in terms of weight and value of all fishing areas surveyed off north Lantau; more recent production data for Tai O are not available.

AFD surveys in 1982-83 (AFD 1985) and the Study on Tonggu Waterway in 1997-98 (Scott Wilson 1998a,b,c) have documented seasonal variations in fisheries species occurrence and abundance off north Lantau (see **Appendix 6, Sections A6.2.1 and A6.2.3**, especially **Tables A6.2, A6.4 and A6.7**), in the general vicinity of Tai O. Peaks appear to occur at different seasons of the year, and appear in almost all cases to be associated with recruitment of juveniles.

Catches in the Tonggu Waterway surveys were dominated by juveniles, suggesting that mature individuals are largely fished out in this area and that new recruits are carried into the survey area rather than being recruited from a locally reproducing population. This indicates that the local fishery is under severe fishing pressure.

The P4/7 has come to be the most common type of fishing vessel at Tai O in the 1990s. This is probably due to its speed, versatility, and its small size and shallow draft which suit it to existing conditions at Tai O (see **Appendix 6, Section A6.2.7**). A 1991 survey (AFD 1991) showed fishing crews to be overwhelmingly made up of family members (86% of total), with the dominance of family crew much greater on traditional vessels than on modern vessels. PRC crew constituted about 11% of the total, and Hong Kong hired crew made up the remainder (see **Appendix 6, Section A6.2.8**).

7.4 Fisheries Surveys at Tai O

No firsthand fisheries field data were collected off Tai O prior to 1 July 1997. Indirect information was obtained from interviewing fishers at the port (AFD 1991 and 1998), on-board observations and helicopter surveys (AFD 1998). Other existing information, reviewed in Section 7.3 and **Appendix 6**, comes from areas at least 6km from Tai O, collected in exposed, offshore waters with environmental conditions markedly different from those at Tai O. Impacts of anchorage construction at Tai O would be largely confined to Tai O Bay, as such existing data were concluded to be inadequate to allow the assessment of the project's impacts upon local fisheries. Therefore, fisheries surveys and fisher interviews have been carried out at Tai O to provide local data on fisheries resources. The methodology and the results of the surveys and interviews are reported in **Appendix 7** and are summarised below.

7.4.1 Handlining and Gillnetting Surveys

Fisheries surveys were conducted during spring 1999 to define baseline fisheries resources in Tai O Bay. Surveys utilised fishing techniques used by local fishers, namely handlining and gillnetting. Surveys were conducted at the impact site (Sites 1 and 2, in Tai O Bay) and also at a control site (Sites 3 and 4, in the neighbouring bay of Yi O) (refer to **Appendix 5, Figure A5.1b**), to establish the fisheries importance of Tai O in comparison to nearby fishing areas with generally similar conditions. Methodology used in handlining and gillnetting surveys is outlined in **Appendix 7 (Sections A7.1.1 and A7.1.2 respectively)**.

Only two fish were caught during handlining sampling, one Russell's snapper *Lutjanus russelli* and one Rock fish *Sebasticus marmoratus* (see **Appendix 7, Section A7.2.1**). Both were caught close to the Shek Tsai Po pier. Local fishers report that handlining catches vary significantly with the seasons, and handlining is not normally practised between late autumn and May. Small catches from handlining in March are thus not unexpected.

A total of 319 individual organisms was collected through gillnet sampling, representing 24 fish species and 12 crustaceans species (refer to **Table 7.1**). Species caught were among those captured in the Tonggu Waterway studies (see **Appendix 6**), and are considered common and widespread throughout Pearl River estuary waters. Most of the species and genera recorded are of commercial value, and according to the Port Survey 96/97 are caught in significant quantities by Hong Kong capture fisheries (AFD 1998).

Table 7.1: Species Collected in Gillnetting Survey.

Family	Scientific name	Common name	Tai O	Yi O
Clupeidae	<i>Sardinella jussieu</i>	Green pilchard		*
Clupeidae	<i>Clupanodon punctatus</i>	Gizzard shad	*	
Engraulidae	<i>Thrissa mystax</i>	Horned anchovy	*	*
Mugilidae	<i>Mugil affinis</i>	Mullet	*	*
Sillaginidae	<i>Sillago sihama</i>	Sand borer		*
Sciaenidae	<i>Collichthys lucida</i>	Lion head		*
Sciaenidae	<i>Sciaena russelli</i>	Croaker	*	
Sciaenidae	<i>Johnius belengeri</i>	Croaker	*	*
Leiognathidae	<i>Leiognathus daura</i>	Pony fish	*	*
Gerridae	<i>Gerres lucidus</i>	Silver biddy	*	*
Lutjanidae	<i>Lutjanus russelli</i>	Russell's snapper	*	*
Sparidae	<i>Sparus latus</i>	Yellow sea bream	*	*
Pomadasyidae	<i>Pomadasyus hasta</i>	Head grunt	*	*
Pomadasyidae	<i>Hapalogenys nigripinnis</i>	-	*	
Theraponidae	<i>Therapon jarbua</i>	Crescent tigerfish	*	*
Drepanidae	<i>Drepane punctata</i>	Spotted sicklefish		*
Labridae	<i>Halichoeres nigrescens</i>	-	*	*
Siganidae	<i>Siganus fuscescens</i>	Rabbitfish	*	*
Trichiuridae	<i>Trichiurus savala</i>	Hairtail		*
Gobiidae	<i>Acanthogobius flavimanus</i>	-	*	*
Triglidae	<i>Chelidonichthys kumu</i>	-	*	*
Platycephalidae	<i>Platycephalus indicus</i>	Flathead	*	
Bothidae	<i>Paralichthys olivaceus</i>	Flounder	*	
Soleidae	<i>Solea ovata</i>	Sole	*	
Portunidae	<i>Portunus sanguinolentus</i>	3-spot crab	*	*
Portunidae	<i>Portunus pelagicus</i>	Blue crab	*	*
Portunidae	<i>Charybdis helleri</i>	-	*	*
Portunidae	<i>Charybdis affinis</i>	-	*	*
Portunidae	<i>Charybdis lucifer</i>	-		*
Portunidae	<i>Thalamita crenata</i>	-	*	*
Portunidae	<i>Scylla serrata</i>	Mud crab	*	*
Calappidae	<i>Calappa philargius</i>	Box crab		*
Penaeidae	<i>Penaeus penicillatus</i>	-	*	*
Penaeidae	<i>Penaeus japonicus</i>	-		*
Penaeidae	<i>Metapenaeus joyneri</i>	-	*	*
Squillidae	<i>Oratosquilla oratoria</i>	Mantis shrimp		*

The most abundant species were the Horned anchovy *Thrissa mystax* and Pony fish *Leiognathus daura*. The fish *Halichoeres nigrescens* and the 3-spot crab *Portunus sanguinolentus* were also well represented. Fishes of the genera *Thrissa* and *Leiognathus* and the 3-spot crab are commercially important in Hong Kong; *Halichoeres nigrescens* is less important in terms of production, but can be found in local markets. Details of catch size, yield, number of species

and diversity of catches from each of the sampling sites are provided in **Appendix 7 (Section A7.2.2)**.

A comparison of catches at Yi O (control site) and Tai O (impact site) (refer to **Appendix 7, Section A7.2.2, Table A7.4**) indicates that Yi O appears to be a more productive fishing ground than Tai O. Catches from Yi O Bay had a higher yield, number of individuals and total number of species than those from Tai O Bay.

The majority of fish caught during the gillnetting surveys were subadults or adults. Juvenile fish contributed only a small portion of the catches. Examination of gonads on selected fish specimens revealed they had not reached the spawning stage. This suggests that Tai O is not significant as a spawning or nursery ground, at least not during the spring season.

In summary, the fisheries surveys indicate that Tai O Bay has no special value for fisheries resources in the area in terms of species composition or catches. Both species composition and catches from surveys in Tai O Bay were similar to, but slightly lower than, those from Yi O. Information gathered does not indicate that Tai O Bay is a significant nursery ground.

7.4.2 Fisher Interviews

Interviews with locally based fishers were conducted to supplement the findings of fisheries surveys. Interviewees included fishers using the full range of fishing methods used in the Tai O area (including the salt pans). Interviews sought information on fishing methods, major species caught, estimated catch size and CPUE or YPUE, fishing areas, seasonality of fishing activity, and evidence of spawning activity or nursery sites near Tai O. Interviews were conducted by telephone (see **Appendix 7, Annex A7a** for questionnaire). Names and telephone numbers of interviewees were provided by a local fisherman's society. Discussions were held with the fishermen's society before and after the interviews for purposes of information exchange. A total of 20 locally based fishers were interviewed (see **Appendix 7, Annex A7d** for detailed reports of interviews).

Most fishers (90%) performed small scale fishing activities using vessels below 30 feet in length. Gillnetting was the most common fishing method, with handlining being the second most commonly used. Most Tai O fishing vessels were reported to operate outside, rather than inside Tai O Bay. Preferred fishing sites include Mainland waters and coastal areas of western Lantau Island including Tong Fuk, Shek Pik, Fan Lau and Peaked Hill. Only 3 out of 20 fishers claimed Tai O Bay, mainly the outer part, as one of their regular fishing sites, while 7 others reported they seldom fished the bay. The remainder did not fish inside Tai O Bay. The major reason reported for not fishing in Tai O Bay was low catches. The major species caught inside Tai O Bay were mullet *Mugil affinis* and 3-spot crab *Portunus sanguinolentus*.

Fisher operations were determined by weather conditions and the season. In winter to early spring, fishing activities are less intense; some, such as handlining, may even stop. In summer, fishers may fish over 20 days a month, provided that the weather conditions are fine. Their target species change with the seasons. April-May is the white herring season and October-November is sea bass season. Snapper, crab and mullet can be caught in most seasons of the year. Catch sizes and yields vary seasonally and from day to day, and no conclusive information could be obtained on this point. Most fishers reported they could earn from 300 to 900 dollars for one day's fishing work. No fish fry collection is currently reported in the Tai O area. Two

fishers reported that fish fry were collected in the Tai O area before construction of the new airport, when marine fish culture still existed at Tung Chung. Juvenile snappers were collected either by handlining or caging at Tai O.

7.4.3 Summary of Surveys and Interviews

Fisheries surveys indicate that Tai O Bay is not an important fishing ground. Handlining surveys were unproductive, due in part to the season of the year in which surveys were conducted. Gillnetting surveys recorded mostly common fisheries species for the area, and yields were not large. Catch size, number of species and species composition of catches from Tai O Bay were generally similar to those from Yi O, but catches from Yi O showed overall higher yields, numbers of individuals and numbers of species. This may be attributable to the lower levels of pollution from domestic sewage at Yi O. While Yi O appears to be a more productive fishing ground than Tai O Bay, neither Yi O nor Tai O is reported to be one of the most popular fishing sites for Tai O based fishers.

Juvenile fish did not constitute a major proportion of the catches from the two areas, and indications were that Tai O Bay is not significant as a spawning or nursery ground, at least not during the spring season. Fry collection at Tai O has been discontinued since the closure of mariculture operations at Tung Chung. Ecological surveys found that the salt pans are not important as a nursery area. However, the marsh and reedbed area to the east of the salt pans, and the tidal zone of Tai O Creek above the village, were found to support larger numbers of juvenile fish (see **Appendix 5, Section A5.2.8**). These areas may provide refuges for juvenile fish and hence act as a nursery.

Economically, few or no fishers appear to depend significantly upon Tai O Bay, particularly the inner bay, for their livelihood. Moreover, fishers reported that the outer bay is more important than the inner bay.

7.5 Construction Phase Impacts

7.5.1 Assessment Methods and Sources of Impact

The significance of fisheries impacts has been evaluated based primarily on the criteria set forth in Annex 9 of the EIA TM:

- duration and reversibility of impact;
- size of affected area;
- loss of fisheries resources/production;
- destruction and disturbance of nursery and spawning grounds;
- impact on fishing activity; and
- impact on aquaculture activity.

Impacts are generally ranked as "minor", "moderate" or "severe". The ranking assigned varies

based on the criteria listed above. The major factors giving rise to a given ranking are noted in the text.

The following construction activities are potential sources of negative impacts to fisheries:

- dredging of anchorage, approach channels and breakwater site;
- placement of dredged material into the salt pans and area reworking;
- off-site disposal of dredged sediments; and
- breakwater construction.

These are assessed in detail below. Positive impacts of the project are also identified and evaluated where they occur.

Potential fisheries sensitive receivers are identified as commercial fisheries resources (adult fish and invertebrates harvested for market) and fish and invertebrates serving as prey for commercial species.

7.5.2 Dredging of Anchorage, Approach Channels and Breakwater Site

Dredging would adversely affect water quality in Tai O Bay during the works phase (refer to Section 5.7). Where suspended solids levels are elevated, mobile species would tend to temporarily avoid the area. An increase in the water column's suspended solids load could decrease dissolved oxygen levels which could affect stationary species, whilst mobile species would tend to avoid the area. An elevated suspended solids load in the water column could reduce sunlight penetration, and thus lower the rate of photosynthesis of phytoplankton, which in turn could lower primary productivity.

The water quality modelling exercise (refer to Chapter 5) indicates that dredging has the ability to locally increase suspended solids levels, which could have knock-on effects for fish and marine life. However, the modelling results illustrate that the mean suspended solid concentration outside Tai O Bay during dredging would not exceed 4.6mg/L (thus being compliant with the suspended solids WQO). As such, any of the above impacts would be short-term, localised, and temporary, and would arise in an area where seasonal fluctuation in sediment loads occurs due to the influence of the Pearl River. The predicted mean suspended solids concentration inside and outside Tai O Bay during dredging is significantly less than the standard of 50mg/L as set out in the allowance scheme developed for mariculturists affected by dredging or dumping projects in 1993. Given that the 50mg/L standard applies to culture fish enclosed in floating cages, the effect of suspended solids derived from the proposed dredging project on wild marine fish is predicted to be minimal.

The sediments in the areas to be dredged are not contaminated, therefore, re-suspension of contaminants is not anticipated to be a problem – this has been confirmed through water quality modelling of TIN and BOD (refer to Chapter 5). Given these factors, and the limited fisheries importance of Tai O Bay, impacts of dredging upon commercial fisheries are predicted to be minor.

Areas which appear to serve as nursery areas have been identified in the reedbeds and marsh east of the salt pans. Sedimentation in these areas could affect survival of juvenile organisms. However, these areas are hydrologically remote from dredging areas and are, therefore, predicted not to be affected by dredging (refer to Section 5.8).

7.5.3 Placement of Dredged Material in Salt Pans

A small volume of dredged sediment will be placed in the salt pans in order to raise bottom levels to a level suitable for mangrove colonisation or plantation over a large area. Material placement will slightly reduce the volume of water available to marine fish. The frequent presence of fishermen and small boats with fishing gear in the salt pans indicates that this area is actively harvested. Local fishermen reported that fish caught in the salt pans are typically for personal use, and are not sold on the open market. Reworking the salt pans would eliminate a small fishing area and produce a small local decline in fishing activity, but would not result in significant direct economic losses. Given that ecological surveys of fish and crustaceans in the salt pans found low yields and no evidence that this area is a nursery area, impacts due to the loss of fishing areas in the salt pans are ranked as minor.

Short-term water quality impacts may result from salt pan reworking. Such impacts would be similar in type to those predicted for dredging, the key concern being the release of sediments into the water column, with potential effects on fishery species. Impacts are anticipated to be confined within the salt pan area, and escape of suspended sediments outside the salt pans is predicted to be limited in extent (refer to Section 5.8). Impacts would persist only during the reworking period. Given that the salt pans are not identified as important fishing areas, potential water quality impacts are ranked as minor. In addition, it is noted that the salt pan area will not be hydraulically sealed during the works phase, and as such any fish within the salt pan will be able to escape.

The ultimate objective of reworking the salt pans is to create a mangrove habitat. Mangroves are widely acknowledged as providing important functions including provision of nursery habitats for aquatic organisms. Reworking the salt pans is the initial step toward restoration of these functions which are expected to enhance the quality of the local fishery. Therefore, the impact of reworking the salt pans is predicted to be positive when assessed over a time frame of 3 years and longer.

7.5.4 Off-site Disposal of Dredged Material

Most of the sediment to be dredged will be disposed of off-site at an approved site. This issue has been described in Chapter 4. Ecological impacts resulting from spoil disposal are not anticipated given that separate EIAs have been undertaken for the relevant designated disposal sites.

7.5.5 Breakwater Construction

Permanent loss of approximately 2.2ha of seabed and some marine habitat will occur due to breakwater construction. The area proposed for the breakwater, like most of Tai O Bay, is not a highly important fishing area. The site is used more frequently for mooring trawlers. Some gillnetting and handlining takes place near the proposed breakwater site, but fish caught are primarily for local consumption and are of little or no commercial significance. The impact of

loss of this fishing area is ranked as insignificant. Potential impacts on the mooring or operation of local fishing vessels are expected to be minimal due to the very small number of vessels involved, the small size and manoeuvrability of the vessels, and the tendency of the vessels to moor at the mouth of Tai O Creek, which is outside the dredging area.

The construction process will entail deposition of fill and placement of rock onto the breakwater site. The impacts of these works will be very localised, and would not interfere with or affect fisheries in Tai O Bay or the surrounding waters offshore.

The rock armouring of the breakwater can be designed to act as an artificial reef, creating a microhabitat which simulates a rocky shore and subtidal zone. This may benefit juvenile fish or small fish species through provision of escape cover, and all age classes of fish through provision of a foraging habitat.

7.5.6 Summary of Construction Phase Impacts

Predicted fisheries impacts due to project construction are summarised in **Table 7.2**.

Table 7.2: Construction Phase Impacts.

Activity	Receiver	Potential Impact	Severity	Requirement for Mitigation
Dredging of anchorage, approach channels and breakwater site	Commercial fishery in Tai O Bay and offshore	Temporary water quality degradation	Minor	Yes
	Potential nursery areas in reedbed and marsh	Temporary water quality degradation	Insignificant	No
Placement of dredged material into salt pans	Local fishery	Loss of fishing area	Minor	No
	Local fishery	Creation of mangrove site which may provide nursery functions	Positive	N/A
	Local fishery	Temporary water quality degradation in the salt pans	Minor	Yes
Breakwater construction	Local fishery	Loss of fishing area	Insignificant	No
	Local fishery	Creation of artificial reef	Potentially positive *	No

* Breakwater surface will be designed to provide simulated boulder shore habitats which may be used by juvenile/adult fisheries species as shelter or foraging area. Importance of this function will depend on breakwater design and operational-phase activities at the breakwater.

7.6 Operational Phase Impacts

7.6.1 Assessment Methods and Sources of Impact

The significance of operational phase fisheries impacts has been assessed in the same manner as described for construction phase impacts (refer to beginning of Section 7.5).

The following operation phase activities are potential sources of impact to fisheries:

Negative impacts:

- occupation of the anchorage;
- discharge of sewage, bilge and other wastes from boats;
- maintenance dredging of approach channels; and
- operation of boat maintenance facilities on the western reclamation.

Positive impacts:

- provision of sheltered anchorage for Tai O fishing fleet; and
- habitat creation and enhancement in the salt pans and at the breakwater.

The potential impact of these activities upon fisheries is assessed in detail below.

7.6.2 Occupation of the Anchorage

Occupation of the anchorage will eliminate some 8ha of Tai O Bay within the anchorage as a fishing area. Local fishers reported that the inner parts of Tai O Bay are not important fishing areas, and fish caught here would be mostly for local consumption rather than commercial sale. No fish nursery areas were identified in this area. Quantitative information on fish catches in Tai O Bay is not available for use in assessing the degree of impact, but given the 8ha area of the anchorage versus the 100ha area of Tai O Bay and the assessment by local fishers that the inner bay is not an important fishing area, loss of the anchorage area as a fishing area would be expected to reduce production within the bay by not more than 8%. This impact is thus ranked as insignificant.

7.6.3 Discharge of Sewage, Bilge and Other Wastes from Boats

Section 5.9 outlined the potential impacts upon water quality during anchorage operation, principally related to the assimilation of pollutants in the anchorage area. Any adverse impact upon water quality has the potential to affect fisheries resources in local waters. However, such discharges are anticipated at most a minor impacts on commercial fisheries in the area due to the localised impact of the discharges, the low importance of inner Tai O Bay as a fishing ground and the diluting effect of seawater.

In addition to the above, due to the on-going sewerage connection programmes in Tai O, the

total volume of untreated sewage discharged to the bay during anchorage operation is predicted to be significantly lower than that currently received. The overall long-term cumulative impacts caused by effluent discharges is thus considered to be an improvement on the current situation.

7.6.4 Maintenance Dredging of Approach Channels

Occasional maintenance dredging may be required due to the gradual sedimentation of the anchorage and its approaches. The impacts identified for dredging during the construction phase could recur during maintenance dredging. These impacts would be short-term and localised and would not affect important fishing areas. The predicted volume of sediments to be dredged at 5-year intervals is some 6% of that to be dredged in the construction project. For these reasons the impacts of maintenance dredging are ranked as minor.

7.6.5 Operation of the Reclamation Areas

Wastewater generated by the potential boat maintenance facilities on the western reclamation has the potential to release contaminants which could adversely affect fisheries in Tai O Bay. However, impacts upon fisheries are anticipated to be minor if the water quality mitigation measures defined in Section 5.11.5 are implemented.

7.6.6 Provision of Sheltered Anchorage for Tai O Fishing Fleet

The prime benefit of the project in terms of fisheries will be the creation of a sheltered, year-round anchorage site suitable for some 220 boats, with associated boat maintenance facilities. This will enable fishers declaring Tai O as their homeport to moor and service their boats at Tai O, and is expected to have both positive social and economic impacts. As Tai O has historically been strongly associated with the fishing industry, it is appropriate that an adequate anchorage be provided near the village. The Tai O sheltered boat anchorage may prove to be a popular base for boats fishing primarily in Mainland Chinese waters, given its location close to the SAR-Mainland boundary and its strategic position in the Pearl River Estuary.

The presence of a locally based fishing fleet, with its attendant visual and cultural interest, is also expected to enhance the attractiveness of Tai O to both local and overseas tourists. The popularity of Aberdeen and Cheung Chau to tourists is due in large part to the scenic appeal of their boat anchorages and resident fishing fleets. The anchorage is thus expected to contribute to the SAR Government's goal of revitalising Tai O.

7.6.7 Habitat Creation and Enhancement

Mangroves typically provide many benefits to coastal and offshore fisheries by providing a nursery area for juvenile fish and organisms which are prey items of fish. Reworking of the salt pans to create a mangrove habitat will enable the area to more effectively serve as a fish and shrimp nursery area, due to the increased physical complexity and diversity of available habitats and to the increased energy and nutrient flows which will result from the metabolic activity of the mangrove trees.

Construction of the breakwater to protect the anchorage presents an opportunity to use surfacing materials on the seaward wall of the breakwater to attract fish through provision of escape and shelter habitats. This follows the approach of the artificial reef programme being

undertaken by AFD. Artificial reefs attract fish by increasing the foraging sites and protective cover. Use of boulder pavement on the seaward wall of the breakwater would maximise surface roughness to provide substrates for the attachment of sessile organisms, thereby increasing foraging habitat for some species of fish. A second benefit would be provision of cover for fish to escape predation. Both functions would be beneficial to the local fishery resources. The design and materials used in breakwater facing should be in accordance with that recommended in Section 6.6.5.

7.6.8 Summary of Operation Phase Impacts

Predicted positive and negative impacts to fisheries due to project operation are summarised in **Table 7.3**.

Table 7.3: Operation Phase Impacts.

Activity	Receiver	Potential Impact	Severity	Requirement for Mitigation
Occupation of the anchorage	Local non-commercial fishery	Loss of fishing area	Insignificant	No
Discharge of sewage, bilge and other wastes from boats	Commercial fishery; non-commercial fishery	Water quality degradation, physiological stress	Minor	No
Maintenance dredging of approach channels	Commercial fishery; non-commercial fishery	Water quality degradation, physiological stress	Minor	Yes
Operation of boat maintenance facilities on the western reclamation	Commercial fishery; non-commercial fishery	Water quality degradation, physiological stress	Minor	Yes
Provision of sheltered anchorage for Tai O fishing fleet	Fishing fleet	Benefit to fishing families	Positive	N/A
Habitat creation and enhancement	Commercial fishery; non-commercial fishery	Potential benefit to fishery due to enhanced reproduction and survival	Positive	N/A

7.7 Mitigation of Construction Phase Impacts

7.7.1 Dredging of Anchorage, Approach Channels and Breakwater Site

Release of sediments during dredging will be controlled by various measures to minimise loss of sediments to surrounding waters. Mitigation measures to be applied are defined in Section 5.10.1.

7.7.2 Placement of Dredged Material into Salt Pans

Sediments will be placed in the salt pans mechanically, using a grab dredger. Mechanical placement of sediments will introduce less water to the salt pans than hydraulic dredging and will reduce the potential for sediment loss. Measures to mitigate potential adverse water quality

impacts during salt pan reworking are defined in Section 5.10.3. In addition, in order to allow fish escape during the salt pan reworking, the hydraulic sealing of the area should be avoided.

7.8 Mitigation of Operational Phase Impacts

7.8.1 Maintenance Dredging of Approach Channels

Maintenance dredging should be carried out under the same set of mitigation measures as specified for construction dredging. Because the annual recruitment of juvenile fish in the Pearl River Estuary takes place primarily in April-August (He and Li 1991), maintenance dredging should be avoided during this period.

7.8.2 Operation of Boat Maintenance Facilities on New Reclamation

The measures specified in Section 5.11.5 will ensure that reclamation area activities do not impact upon fisheries.

7.9 Fisheries Monitoring

Given the identified low importance of fisheries in the Tai O area and the predicted minor nature of potential impacts, fisheries monitoring is not recommended for the project. Construction phase water quality monitoring as detailed in Section 5.12 will be adequate for fisheries protection purposes.

7.10 Conclusions

Surveys and interviews with local fishers indicate that the site of the proposed anchorage is not of key importance to fishers based in Tai O. Impacts to fisheries from anchorage construction and operation and mangrove area preparation are predicted to be minor. As such, fisheries monitoring during construction and operation is not considered necessary.

Taking into consideration the benefits associated with provision of a local boat anchorage and creation of a large mangrove area and the creation of breakwater habitats, the project is predicted to have a net positive impact upon Tai O fisheries.