Analysis of Tissue Contaminant Levels for Selected Fauna in the Intertidal Mudflat of the Mai Po Inner Deep Bay Ramsar Site

Executive Summary

Tender Ref: AFD/SQ/92/00

Prepared by
Centre for Coastal Pollution and Conservation

Submitted to
Agriculture, Fisheries and Conservation Department

Submitted by

CityU Professional Services Limited

CPS Ref.: BCH-1411
March 2001

Executive summary

1.   Coastal wetlands in Hong Kong, particularly the Mai Po Inner Deep Bay Ramsar Site, are of considerable conservation value. In Hong Kong, the Mai Po and Inner Deep Bay wetland is the largest remaining wetland system, and was listed as a Wetland of International Importance under the Ramsar Convention in September 1995. The Site is managed with a view to i) conserve, maintain and enhance biological diversity, particularly of birds; and ii) encourage and promote wise use of wetland resources.

2.   Apart from habitat destruction, caused by land reclamation and urban developments, environmental pollution in general, and water pollution in particular, has long been considered one of the major threats to wetland-associated wildlife, including birds. The Mai Po mudflat receives a rich supply of sediment with high organic matter content from the Pearl River, Shenzhen River and nearby streams. The organically-enriched sediments provide an abundant supply of food to benthic fauna, which constitute a crucial component in the mudflat food web. Recent studies have revealed relatively high concentrations of heavy metals and persistent organic pollutants in the sediments of the Mai Po mudflat and of the mangrove area. These contaminants can, depending on their concentrations and bioavailability, pose serious risks to the aquatic organisms themselves, as well as to their consumers, mainly waterbirds. To date, there has been no systematic and comprehensive study on the tissue contaminant levels of common animals in the intertidal mudflat, *gei wais* and fish ponds of the Mai Po Inner Deep Bay Ramsar Site.

3.   Given that many of the aquatic animals are important food species for wetland-dependent birds, the present study was commissioned to analyse the tissue loadings of key contaminants in 8 faunal groups commonly occur in the Mai Po mudflat area. The main objectives of this investigation are:

  i)   To provide information for an assessment of the risks of various pollutants to the birds; and

ii)   To provide baseline data for future monitoring of the ecological integrity of the Mai Po and Inner Deep Bay ecosystem.

4.   The following 8 faunal groups/species were selected:

Faunal group	**Common name**	**Scientific names**	**Sampling site**
Shrimps	*Gei wai* shrimp	*Metapenaeus ensis*	*Gei wais*
		Exopalaemon styliferus	*Gei wais*
Fish	Grey Mullet	*Mugil cephalus*	*Gei wais*
	Tilapia	*Tilapia mossambicus*	*Gei wais*
	Mudskipper	*Boleophthalmus pectinirostris*	Mudflat
Crabs	Fiddler crab	*Uca arcuata*	Mangroves
		Varuna litterata	*Gei wais*
Polychaetes	Bristle Worm	-	Mudflat

5.   Tissue concentrations of persistent organic pollutants (petroleum hydrocarbon, chlorinated pesticides, polychlorinated biphenyls and polycyclic aromatic hydrocarbons) and metals (Cr, Zn, Cd, Mn, Fe, Cu, Pb and Hg) were analysed for the above eight faunal groups. The results are summarised in the following tables:

Summary of mean tissue levels of metals in the eight faunal groups. Standard deviations are given in parentheses.

Tissue concentration, µg/g								
	Zn	Fe	Mn	Cu	Hg	Cd	Cr	Pb
Boleophthalmus pectinirostris	84.61 (7.06)	197.78 (60.30)	12.56 (4.32)	2.08 (0.37)	0.02 (0.03)	0.012 (0.009)	1.104 (0.35)	1.56 (0.88)
Metapenaeus ensis	55.16 (5.43)	132.85 (38.36)	80.91 (23.89)	48.00 (6.19)	0.02 (0.001)	0.017 (0.007)	0.748 (0.218)	0.204 (0.0082)
Uca arcuata	88.75 (8.48)	2340.20 (732.67)	385.40 (182.74)	70.11 (19.65)	0.07 (0.03)	0.49 (0.22)	2.555 (0.93)	5.985 (1.923)
Mugil cephalus	75.50 (10.169)	969.84 (1030.35)	67.63 (24.10)	3.24 (1.65)	0.0084 (0.0036)	0.0071 (0.0026)	1.326 (1.314)	0.58 (0.44)
Tilapia mossambicus	100.03 (12.42)	1480.00 (840.00)	122.25 (81.02)	5.76 (1.37)	0.015 (0.0034)	0.010 (0.0038)	1.40 (0.43)	0.74 (0.38)
Exopalaemon styliferus	63.41 (5.73)	75.27 (19.95)	110.15 (34.97)	55.16 (2.51)	0.0065 (0.0021)	0.0052 (0.0024)	0.17 (0.068)	0.044 (0.012)
Varuna litterata	75.24 (9.61)	947.46 (112.04)	371.99 (92.25)	54.98 (7.17)	0.016 (0.0054)	0.017 (0.018)	0.25 (0.083)	0.16 (0.033)
Polychaetes	129.89 (3.92)	2795.35 (40.27)	38.36 (0.69)	20.17 (0.41)	0.0094 (0.0038)	0.018 (0.0049)	1.85 (0.11)	1.48 (0.052)

Summary of mean tissue levels of persistent organic pollutants in the eight faunal groups. Standard deviations are given in parentheses.

Tissue concentration, µg/g								
	Total PAHs	Total petroleum hydrocarbons	Total HCHs	Heptachlor	Chlordane	DDE	DDT	Total PCBs
Boleophthalmus pectinirostris	0.854 (0.58)	175.35 (30.64)	0.021 (0.014)	0.007 (0.0026)	0.082 (0.11)	0.063 (0.040)	0.015 (0.022)	0.77 (0.30)
Metapenaeus ensis	0.93 (0.31)	91.25 (36.62)	0.015 (0.024)	0.0012 (0.00038)	0.0015 (0.00057)	0.014 (0.0074)	0.0010 (0.0006)	0.069 (0.036)
Uca arcuata	0.75 (0.33)	151.84 (62.53)	0.0037 (0.0051)	0.0039 (0.0024)	0.00055 (0.00021)	0.00048 (0.00038)	0.0010 (0.00044)	0.011 (0.009)
Mugil cephalus	0.98 (0.19)	574.35 (110.11)	0.0060 (0.0014)	0.0018 (0.0011)	0.0020 (0.0011)	0.0011 (0.0005)	0.0013 (0.0007)	0.200 (0.050)
Tilapia mossambicus	1.443 (0.214)	672.0 (84.6)	0.019 (0.022)	0.0009 (0.0007)	0.0041 (0.0010	0.0018 (0.0005)	0.0028 (0.0017)	0.086 (0.025)
Exopalaemon styliferus	0.99 (0.159)	679.93 (82.16)	0.011 (0.0033)	0.0022 (0.0009)	0.0020 (0.0010)	0.0014 (0.0011)	0.0012 (0.0010)	0.239 (0.080)
Varuna litterata	1.28 (0.108)	697.26 (82.60)	0.017 (0.0097)	0.0023 (0.0015)	0.0029 (0.0010)	0.0005 (0.0004)	0.0008 (0.0009)	0.275 (0.033)
Polychaetes	1.49 (0.358)	1213.66 (116.76)	0.013 (0.0018)	0.0016 (0.0006)	0.0573 (0.042)	0.0066 (0.0018)	0.0040 (0.0014)	0.488 (0.077)

6. Relatively high lead contents were found in the fiddler crabs (*Uca arcuata*), the mudskipper (*Boleophthalmus pectinirostris*) and the polychaetes. The body lead burden of the mudskippers (1.56 μg/g) was very similar to that of the polychaetes (1.48 μg/g), probably reflecting high exposure levels on the mudflats. The polychaetes collected on the mudflats had high tissue levels of total PAHs, total petroleum hydrocarbons, chlordane and total PCBs. The mudskipper (*Boleophthalmus pectinirostris*), also associated with the mudflats, again had high levels of persistent trace organic pollutants, such as total HCHs, heptachlor, chlordane, total PCBs, DDE and DDT. These levels are generally higher than those recorded in other faunal groups collected from the mangroves and from the *gei wais*. These results suggest that the mudflats may be under particularly serious pollution threats from persistent organic contaminants. Thus, a well-structured surveillance programme should be put in place to monitor the situation.

7. In this project, the potential risks of the contaminants to wildlife in Mai Po were assessed by comparing environmental conditions (e.g., environmental concentrations of toxic chemicals) with threshold values likely to cause adverse effects in the targets under consideration. In the type of risk assessment undertaken in this project, this is made explicit as a risk quotient (RQ) or hazard quotient (HQ) that is the ratio of an environmental concentration [either predicted (PEC) or measured (MEC)] with a predicted no-effect concentration (PNEC) for the target of concern (RQ or HQ=P(M)EC/PNEC), such that an RQ < 1 indicates a low, and thus acceptable risk, and an RQ ≥ 1 indicates a level of concern and possibly the deployment of management programmes.

8. A risk assessment based on concentrations of various toxicants in the sediments revealed that HQ values were all greater than one except for fluoranthene, pyrene and endrin in the mudflat; and benzo(a)pyrene and dibenzo(1,2,5,6)anthracene in the mangroves. HQ values for copper and heptachlor epoxide were all greater than 10. These results suggest that the levels of contaminants in the Mai Po mudflats and mangroves pose a substantial risk to aquatic organisms inhabiting

the area. No data is available on the sediment concentrations of manganese and mercury, thus precluded analyses on these two toxicants.

9. A risk assessment based on tissue contaminant loading suggested that tissue lead levels in fish were high, resulting in HQs > 1, and in some cases > 10. Based on this analysis, adverse effects are expected both in regard to the fish themselves, and to their consumers, waterbirds. Results of this study further indicate that PCBs in the biota, except for *Uca arcuata*, pose a substantial risk to the waterbirds via food consumption. It was also observed that certain chlorinated pesticides (dieldrin and DDE, a metabolite of DDT) in the mudskippers (*Boleophthalmus pectinirostris*) are at levels that may cause harm to fish-eating birds.

10. Tissue levels of polycyclic aromatic hydrocarbons were not directly relevant in the risk assessment process as many organisms, particularly fish, rapidly metabolise and excrete PAH compounds. This together with the lack of information on the critical effects concentrations for many toxicants precluded analyses on all contaminants. Nonetheless, this project illustrates how the information can be used in a risk assessment so that this work can be repeated and information updated when new data becomes available.

11. In 2000, an ecological monitoring programme was established for the Mai Po and Inner Deep Bay Ramsar site. It is noted that in the manual for the long-term monitoring of environmental pollutants, only levels in the physical compartments (water and sediment) were included in the programme. As the maintenance of the Ramsar site as a suitable/favourable habitat for wildlife, particularly birds, is of primary importance, it would be instructive to monitor the contaminant levels in selected biota in the area, which may be potential food items for the birds. Thus, the information contained in this report will not only provide important information for assessing the risks to waterbirds via the consumption of potentially contaminated food, but will also establish a baseline dataset for future monitoring programme in the Ramsar site.