Endocrine disrupting chemicals and organochlorines in coastal ecosystems: wildlife injury, pollution control, and environmental recovery

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Persistent organochlorine pollutants continue to be important food chain contaminants in coastal ecosystems, even though most organochlorine pesticides have been highly regulated or banned for agricultural use. Two important case studies in the United States and Canada document the duration of persistence in temperate climates, with data from both industrial and agricultural runoff. The Mussel Watch programs administered by the US National Oceanographic and Atmospheric Administration (NOAA) and the State of California have monitored mussels and clams in coastal areas since 1968. The programs have documented substantial DDT and DDE in runoff from agricultural areas, which peaked in 1972, and declined rapidly thereafter. By 1976, the predominant DDT residues were industrial in origin, and these persisted as biologically available to bivalves, fish and birds in southern California until the present. Agricultural runoff declined nearly to baseline levels within four years of the cessation of use of DDT, indicating that burial in estuarine and coastal ocean sediments can remove these organochlorines from the food web. High levels of DDE were found in Southern California fish in 1984–5, and fish eating birds monitored in 1992 continued to have high levels in eggs. Research conducted for the US lawsuit against Montrose Chemical Company indicated that the geographic distribution of residues in bird eggs closely correlated with industrial discharge of DDT between 1947–1970. The industrial discharges of DDT remained bioavailable for more than 20 years.

Canadian Wildlife Service monitoring of Herring Gull eggs at colonies surrounding the Great Lakes of North America indicate that organochlorines from both industrial and agricultural use have declined by about 90% over the past 25 years. The Great Lakes are now being used for studies measuring atmospheric deposition of volatile organochlorines, such as DDT and toxaphene, which continue to be detected in significant amounts in fish and birds. Industrial organochlorine pollutants in the Great Lakes also remained bioavailable in the ecosystem longer than agricultural pesticides. The apparent reason for environmental availability of industrial pollutants compared to agricultural pesticides in river runoff may be related to other sediments in rivers. Because suspended sediments in rivers accompany the transported agricultural pesticides, concomitant sedimentation of sediments and pesticides may physically trap and bury the pesticides, making them less bioavailable as layers of sediments build up in estuaries and near-shore coastal sediments. Major storm events, however, can displace the recent sediments and reintroduce the persistent organochlorines into the ecosystem.

Other endocrine disrupting chemical may also be transported with river runoff into coastal areas. Industrial alkylphenol detergents in estuarine sediments have resulted in exposure to flatfish in English and European waters. Some fish acquire residues during the breeding migration into estuaries, and remain contaminated after leaving the estuaries to forage in coastal oceans.

Influence of anthropogenic inputs on the nitrogen and phosphorus budgets of some Philippine marine embayments

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A budget describes the rate of material delivery to the system, the rate of material removal from the system, and the rate of change of material mass within the system. Some materials may undergo internal transformations of state that lead to appearance or disappearance of these materials. Stoichiometrically linked C, N, P budgets provide a good description and understanding of nutrient dynamics by identifying and quantifying important fluxes in and out of the coastal zone.

The stoichiometrically linked water-salt-nutrient budgets were calculated using the LOICZ Biogeochemical Guidelines and constructed in a prescribed order (Gordon et al., 1996). The system or bay is defined as a box. The water budget was constructed first and this accounts for all freshwater inflows and evaporative outflows from the coastal marine system, the difference balanced by the residual flow. The residual flow carries salt and this is replaced through the mixing flux, a flux associated with tides, winds, density and large-scale circulation patterns. All dissolved materials will exchange between system of interest and adjacent system according to the criteria established in the water and salt budgets. Deviations of material concentrations from predictions based on these two previous steps are quantitatively attributed to net non-conservative reactions of materials in the system. The non-conservative flux of dissolved P is an approximation of net metabolism (autotrophy, heterotrophy) at the scale of the ecosystem, and the net non-conservative flux of dissolved N can be assigned to other processes (denitrification, N-fixation) in a quantitative manner.

The important sources of N and P into a coastal system may be runoff, groundwater, and anthropogenic inputs. Runoff and groundwater concentrations can be directly measured but this may not be easy for anthropogenic wastes. Estimation of waste load from various human activities was developed (McGlone and Caringal, 1998). This involved the identification of relevant human activities within the coastal area, determination of the activity level at the local level, and approximation of TN and TP from the activity level and discharge coefficient (WHO, 1993). DIN and DIP were approximated using the ratios given in San Diego-McGlone et. al. (2000).

N and P budgets were constructed for 6 bays in the Philippines, these are Lagonoy Gulf, Lingayen Gulf, Manila Bay, San Miguel Bay, Carigara Bay, and Sogod Bay (Dupra, et al., 2000). The major waste load contributor is agriculture (for 5 bays) except for Manila Bay where domestic sewage predominates. Initial P budget results show that Lingayen Gulf, Lagonoy Gulf, San Miguel Bay and Sogod Bay are net autotrophic (p–r>0) while Manila Bay and Carigara Bay are net heterotrophic (p–r<0). Based on the N budgets, Manila Bay, San Miguel Bay, Carigara Bay and Sogod Bay are net denitrifying, while Lingayen Gulf and Lagonoy Gulf are net N-fixing.

Human activities have altered nutrient (N and P) loading to coastal embayments. In the Philippines, high population density and continuing population growth and development in the coastal areas are issues of concern that have ecological implications. The consequences of altering the major inputs by anthropogenic influence are given in Tables 1 and 2. The effect of changing the waste load can be as drastic as a change in ecosystem metabolism. Doubling the current load shifts the system to autotrophy which will eventually affect the assimilative capacity of the bay or its ability to process waste inputs. This on the long run may bring in eutrophication and anoxic conditions, and will eventually affect the fisheries in a bay. Since the budget provides insights on the biogeochemical dynamics of the system, it may find application as a management tool.

Table 1. Effects of changing waste load on (p–r).

Bays	Current load ($mol\ m^{-2} yr^{-1}$)	0 load ($mol\ m^{-2} yr^{-1}$)	2x load ($mol\ m^{-2} yr^{-1}$)	Waste load (P) ($10^6 mol\ yr^{-1}$)
Lingayen Gulf	+6	−0.5	+11	116
Manila Bay	−2	−6.3	+1.3	61
Lagonoy Gulf	+0.05	−0.73	+0.07	2
San Miguel Bay	+0.37	+0.11	+0.72	5
Carigara Bay	−0.06	−0.25	+0.14	1
Sogod Bay	+1.63	+1.46	+1.66	4

Table 2. Effects of changing waste load on (*nfix–denit*).

Bays	Current load ($mol\ m^{-2} yr^{-1}$)	0 load ($mol\ m^{-2} yr^{-1}$)	2x load ($mol\ m^{-2} yr^{-1}$)	Waste load (N) ($10^6 mol\ yr^{-1}$)
Lingayen Gulf	+0.3	−0.03	+0.9	874
Manila Bay	−1.13	−1.35	−0.9	600
Lagonoy Gulf	+0.07	+0.073	+0.09	173
San Miguel Bay	−0.13	0	−0.36	199
Carigara Bay	−0.07	−0.037	−0.11	32
Sogod Bay	−0.02	−0.03	+0.26	59

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Nutrient and biotic fluxes in relation to dispersal of pollutants in Ponggol estuary, Singapore

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Ponggol estuary located on the northeastern coast of Singapore is a mangrove fringed habitat, highly impacted by