A Model of Fish Preference and Mortality under Hypoxic Waterin the Coastal Environment

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Eutrophication and associated occurrence of hypoxic condition could cause significant damage to marine ecosystems, resulting in considerable economic losses to fisheries and aquaculture and is a major source of stress that fish often have to contend with in order to survive. This problem is likely to be exacerbated in the coming years, since the wastewater treatment facilities is unlikely to catch up with increasing human activities. Moreover, large-scale reclamation projects in coastal areas have recently been increased and these activities certainly have adverse impacts on water quality and fisheries resources. Coastal construction has a significant role in the development of hypoxic water by changing the current and mixing pattern of water. Changes in species composition and decreases in species richness and diversity have been well documented in hypoxic systems. Hypoxia could cause endocrine disruption in fish and eliminate populations of sensitive species. Shallow coastal areas are of great importance for the especial nursery of fish and shellfish and land reclamation in this areas cause a strong damage of fishery. Although the tolerance of aquatic life to hypoxia is known, there is no information about the mortality of fish caused by hypoxia, because fish can swim and avoid it and no modeling study yet been carried out. Criteria that influence the movement of fish are the amount of food, water temperature and depth, dissolved oxygen concentration and nature of seabed, however, among these, water temperature and dissolved oxygen are the most crucial parameters that affect survival, movement and growth of fish. In this paper, a model of fish preference and mortality for environmental conditions was developed and applied to the Hakata Bay, where hypoxic water would occur in every summer. For the purpose, field survey of fish behavior under hypoxic water was conducted by releasing marbled sale in the inner bay. Moreover, a series of preference tests for DO, salinity and temperature in the laboratory were conducted in order to decide preference parameters of fish. Using the results of both field and laboratory studies, a sub-module of fish preference and mortality was coded within an integrated hydrothermal and eutrophication model (CHEM) to predict the behavior and mortality of marbled sale when hypoxia would occur in the bay. The model could simulate reasonably the behavior of the fish under hypoxia. An assessment of the impact of the ongoing land reclamation project of about 401 ha in the Wajiro tidal flat zones at the head of the bay on the fisheries resources was also conducted using the model and the results showed that the artificial land will be lowered the mortality rate of fish under hypoxic condition in the bay during summer period.