Project Number

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Name of the project

Estuarine fish biodiversity and food web structure in southern and western Hong Kong waters

Organization /Project Leader

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1. Executive summary

Estuaries are highly productive ecosystems that provide essential habitats for a diverse range of fish species. Despite their ecological significance, our understanding of estuarine fish biodiversity remains incomplete, with only a handful of published local studies and a particular focus on estuaries in the eastern waters of Hong Kong. Furthermore, estuaries are among the most modified ecosystems globally; over half of the world's population resides in coastal areas, making these ecosystems particularly vulnerable to pollution from both marine and freshwater sources. To enhance our understanding of estuarine fish biodiversity and the potential impacts of nutrient pollution, this project accomplished three key objectives:

1. Investigated the species composition of estuarine fish in river mouths across southern and western Hong Kong;
2. Examined how such composition of fish varies with seasons (i.e., wet and dry) and levels of nutrient pollution; and
3. Assessed variations in trophic niche diversity and area among fish species between estuaries with relatively high and low levels of nutrient pollution.

<u>Objectives 1 and 2:</u>

During the project period, we conducted 40 field surveys to assess fish communities across ten estuaries in southern and western Hong Kong waters. Generally, total nutrient loads (the sum of ammonia, nitrite, and nitrate) were higher in the western estuaries and during the dry season. Despite this, most estuaries exhibited relatively good water quality, with total nutrient loads remaining below 1 mg/L. However, occasional spikes in ammonia were detected, indicating substantial inputs of organic waste entering the river.

Average fish abundance was higher during the wet season, being 60% greater than in the dry season, likely due to spawning events of multiple estuarine fish species. Additionally, during the wet season, increased total nutrient loads contributed to a rise in fish abundance. This suggests that nutrient-driven enhancement may have promoted primary productivity, thereby increasing food availability for estuarine fishes. However, fish abundance did not vary significantly between estuaries in southern and western Hong Kong. Similarly, fish richness remained unaffected by season, total nutrient loads, or geographical location. Fish composition varied seasonally and spatially, but showed no response to changes in nutrient loads. For example, the gobies *Mugilogobius abei* and *Pseudogobius poicilosoma* were more abundant during the wet season and in western Hong Kong, while species such as *Ambassis gymnocephalus* and *A. vachellii* (Ambassidae), and *Gerres macracanthus* (Gerreidae) were more abundant during the dry season and in southern waters.

Objective 3:

Nine fish taxa were selected from seven estuaries for SIA and GCA to assess how their trophic niches varied in relation to nutrient loads and seasonal changes. Our findings demonstrated that the trophic niche of fish varied based on these two predictors; however, the responses to season and nutrient loads differed across species. For instance, we detected a negative relationship between total nutrient load and standard ellipse area (SEAc) for several predatory species, including *Favonigobius* spp., *Mugilogobius* spp., *Ambassis* spp., and *Acanthopagrus* spp. (Sparidae). This indicates that these taxa converge on a narrower set of prey under higher nutrient conditions. Additionally, increased nutrient loads caused a shift in the carbon isotope signal in several fish taxa, suggesting dietary alterations under such conditions. Conversely, the opposite trend was observed in *Mugil cephalus* (Mugilidae), where SEAc increased while carbon signals remained unaffected by nutrient levels. Seasonal variation in trophic niches was also evident, with all three goby taxa (*Favonigobius* spp., *Mugilogobius* spp., and *Pseudogobius* spp.) exhibiting increased predatory behavior during the dry season, as indicated by both elevated nitrogen isotope signals and gut content analysis.

In conclusion, this project demonstrated that estuarine fish communities exhibit spatial variation between river mouths in southern and western Hong Kong, as well as seasonal differences. While total nutrient loads primarily affected fish abundance, SIA and GCA revealed that they also influenced the trophic niche and led to diet shifts among multiple species. Future work should incorporate data on prey availability, microhabitat use, and fish movement between estuarine and marine environments to better understand the underlying mechanisms of these niche shifts. Additionally, although the three predictors studied had no impact on fish richness, incorporating measures of habitat complexity should provide valuable insights into biodiversity.

Overall, with the support of the Marine Conservation Enhancement Fund, this project has advanced our understanding of estuarine fish biodiversity patterns and how these patterns may be influenced by nutrient loads and seasonal changes. This knowledge can inform future conservation efforts, especially given the occasional spikes in pollutant emissions. Furthermore, it can guide future research aimed at enhancing our understanding of biodiversity and addressing the environmental challenges facing estuarine ecosystems.