Environmental DNA Metabarcoding Reveals Highly Diverse Vertebrate and Crustacean Communities in Hong Kong Waters

环境DNA应用于香港水域脊椎动物和甲壳类的生物多样性监测

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ResearchGate LingU

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Research Areas

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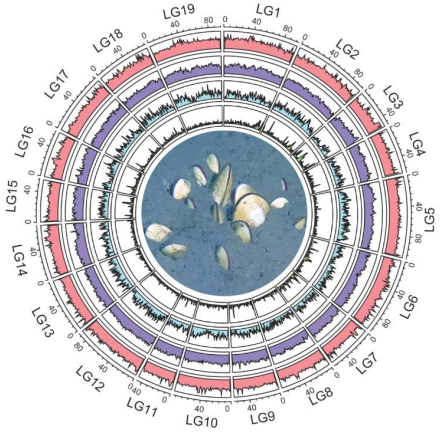
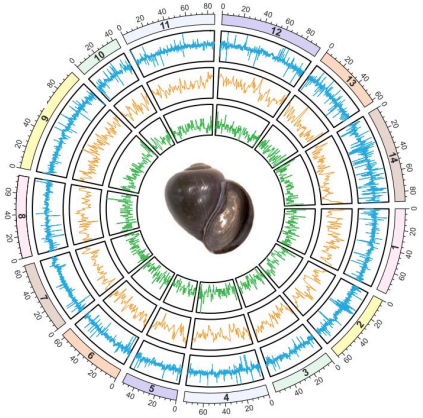
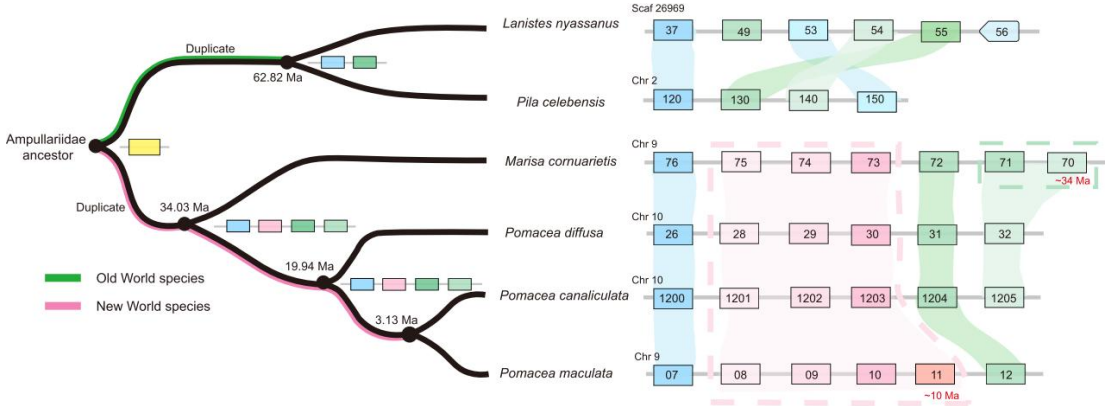
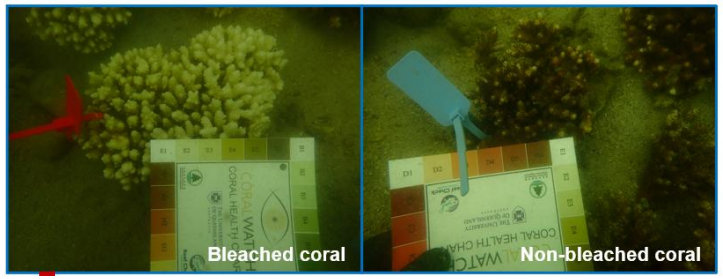
- *Genome Evolution and Adaptation*
- ***Aquatic Biodiversity via Climate Change***
- *Sustainable Aquaculture*







Molluscan genomics



Coral genomics

Contributes towards the SDGs:

Research Areas

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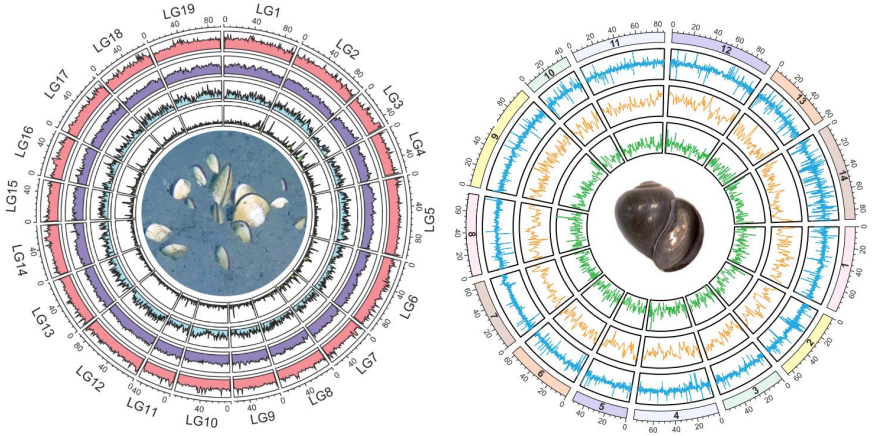
- ***Aquatic Biodiversity via Climate Change***
- *Sustainable Aquaculture*



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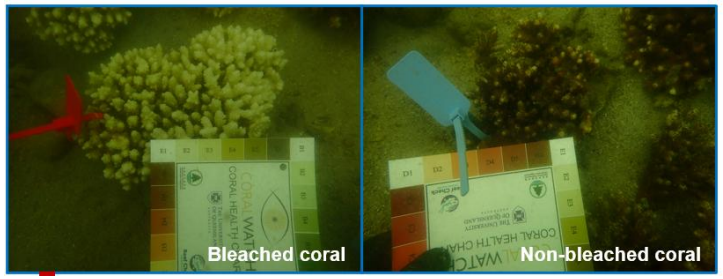
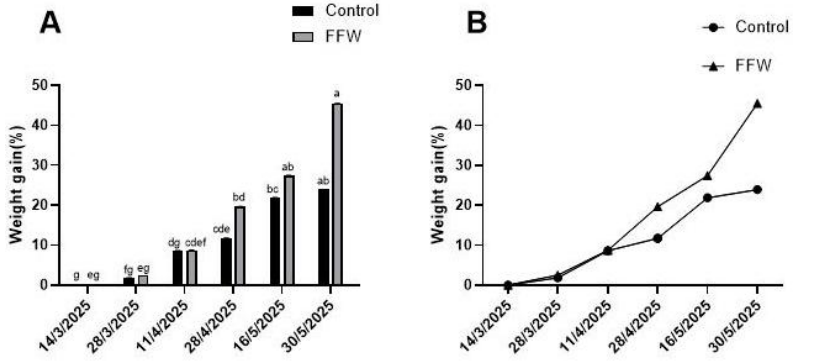


Coral genomics



Contributes towards the SDGs:

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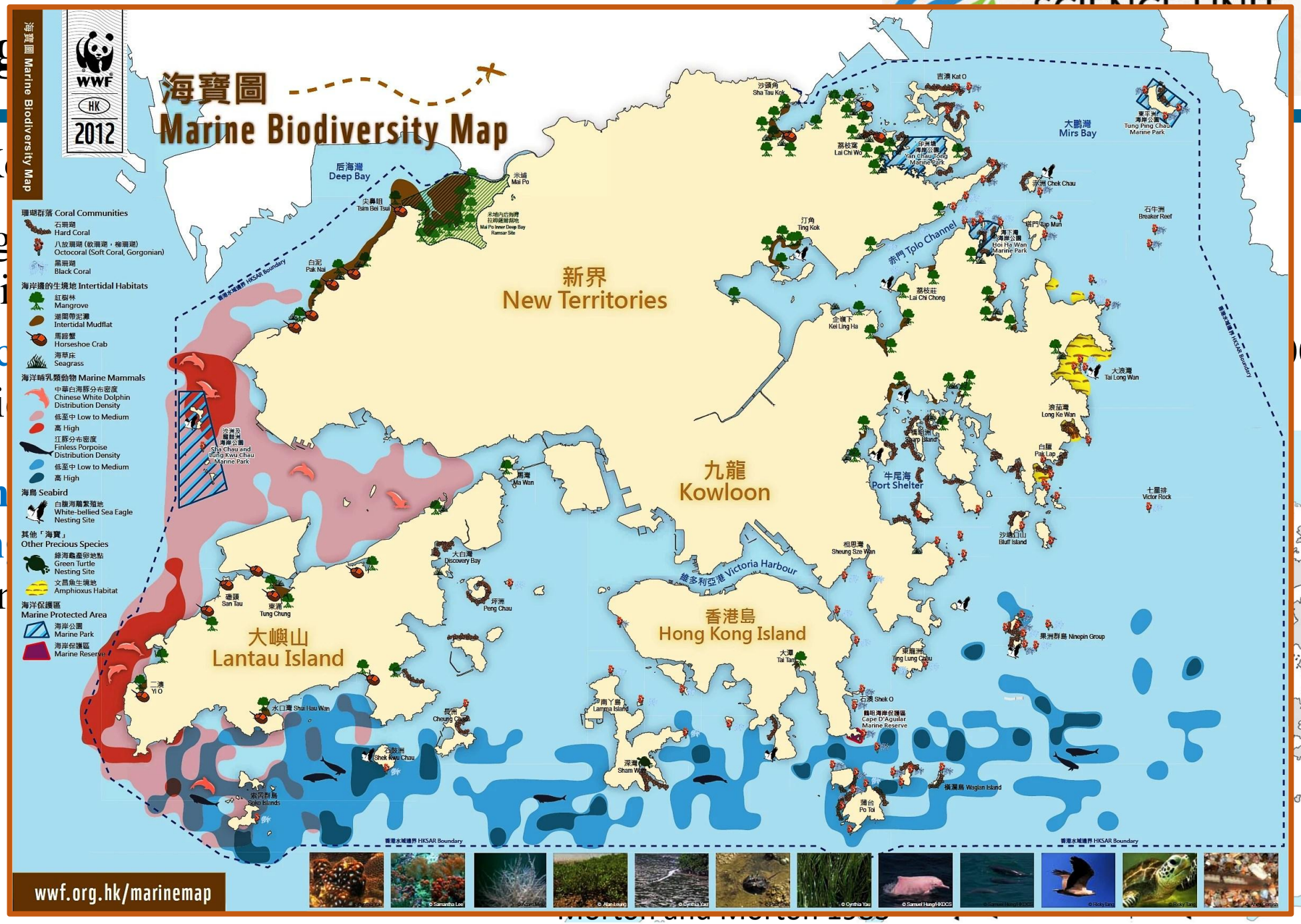

Background

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Hong Kong - an urbanized subtropical estuary 香港—城市化的亚热带河口

- Recognizing the importance of marine conservation, HK government has implemented a number of management measures, such as **9 marine protected areas** (since 1996**), restoration, trawling ban** (Dec 31, 2012), and **regulator monitoring.**
- Biodiversity Strategy and Action Plan (**BSAP**)
- EPD marine water quality monitoring

AFCD HKSAR

Background

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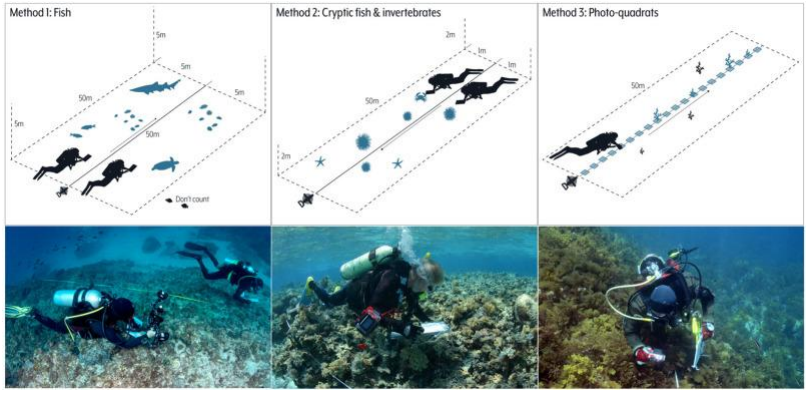
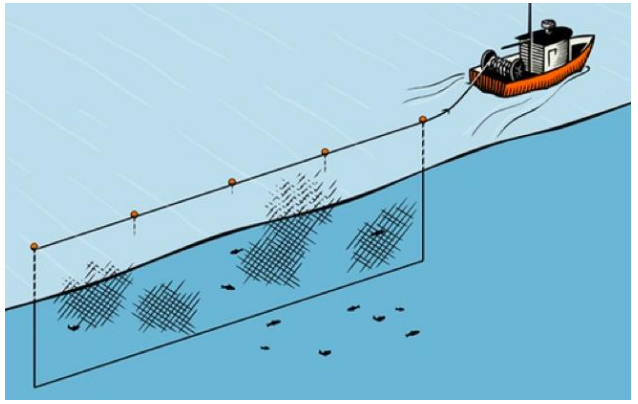
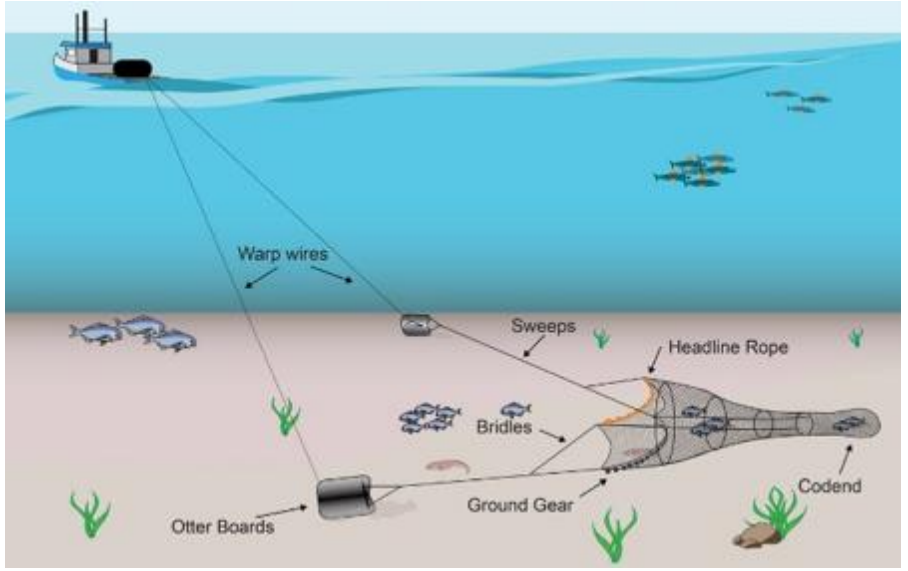
Biomonitoring and limitation in estuary Ecosystem 河口生态系统的生物监测与限制

- Biomonitoring aquatic organisms in estuaries is challenging due to their complex environmental conditions (e.g., salinity and turbidity) and diverse habitats.
- Traditional surveys like trawling and gillnetting have negative effects on fishery resources and ecosystems.
- Non-destructive sampling methods like underwater visual censuses and echo sounder surveys have **limitations in data quality and habitats**.
- These conventional surveys are **cost and labor intensive**.



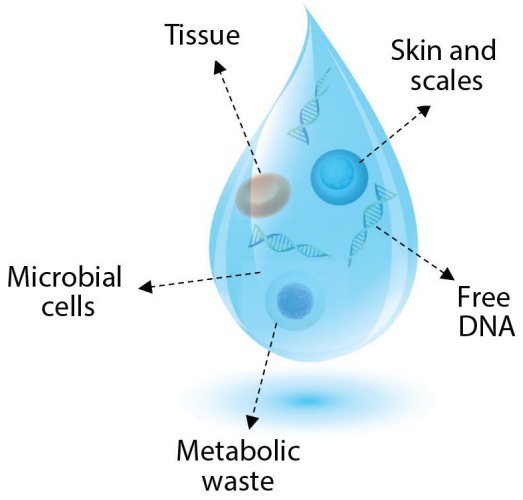


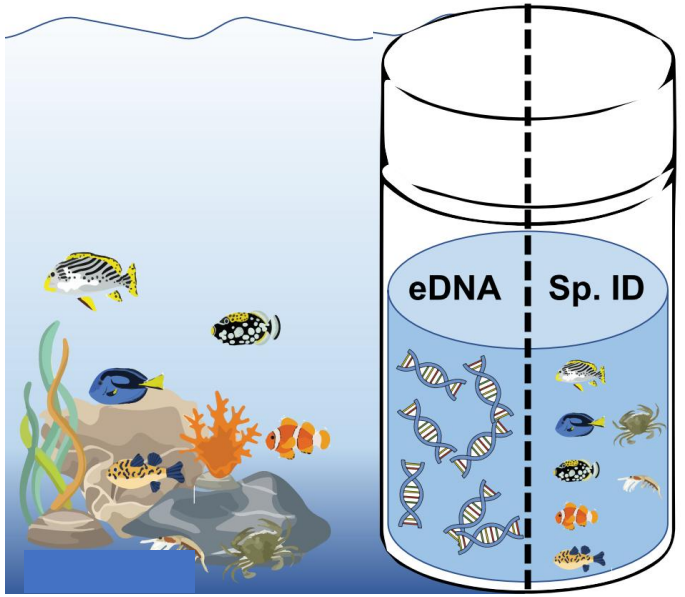


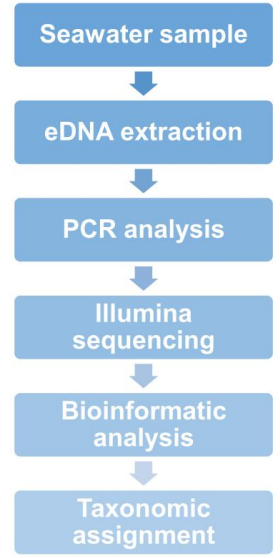
Background

Environmental DNA

- A new method called environmental DNA (eDNA) metabarcoding has revolutionized the way we monitor fish and other aquatic communities.
- Instead of physically capturing organisms, this method collects and analyzes DNA left behind by organisms in the water.
- eDNA metabarcoding allows for comprehensive biomonitoring without causing harm or disturbing the ecosystem.





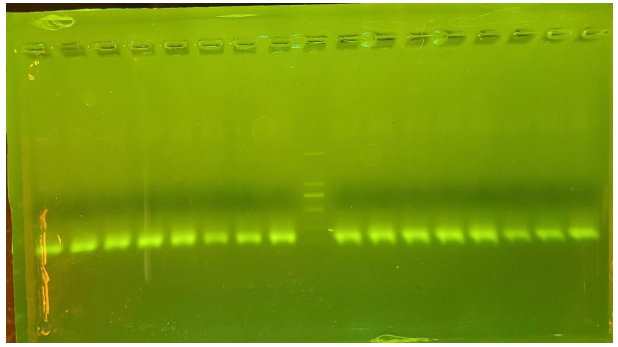


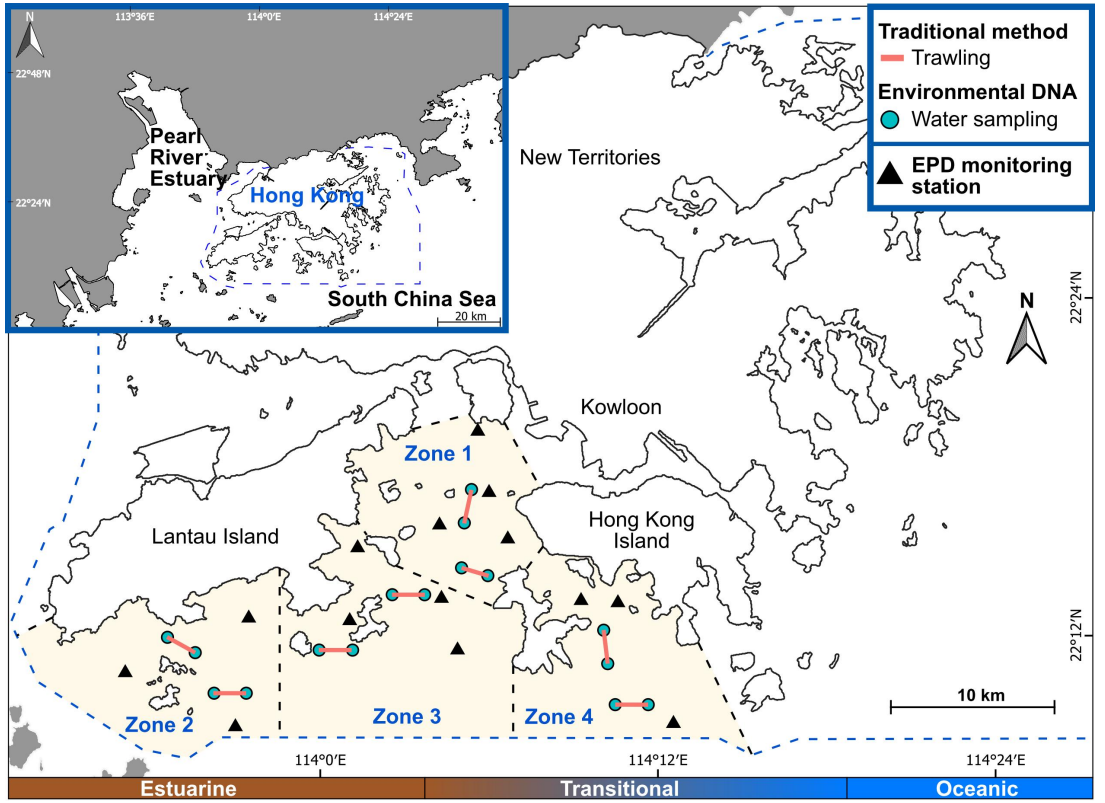
Comparison of eDNA and convectional surveys

In 2022, Bottom trawling in Southern waters

eDNA sampling

- 8 trawl sites (start and end)
- 2-L seawater x 2 replicates
- Target taxa: marine vertebrates (12S-V5, MiFish-U, Berry-Fish), and crustacean (MiDeca)



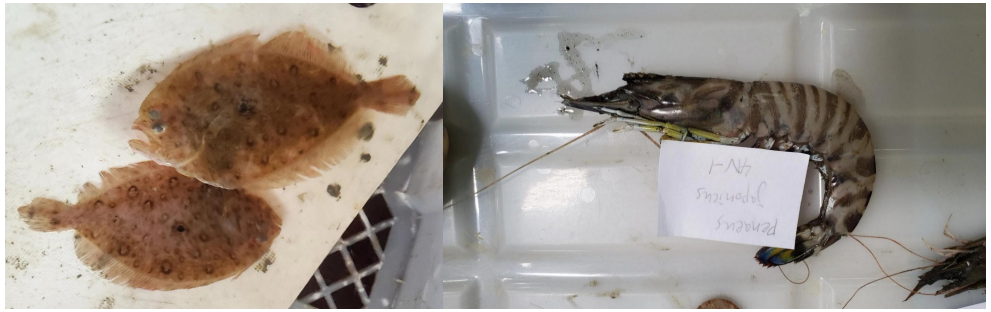


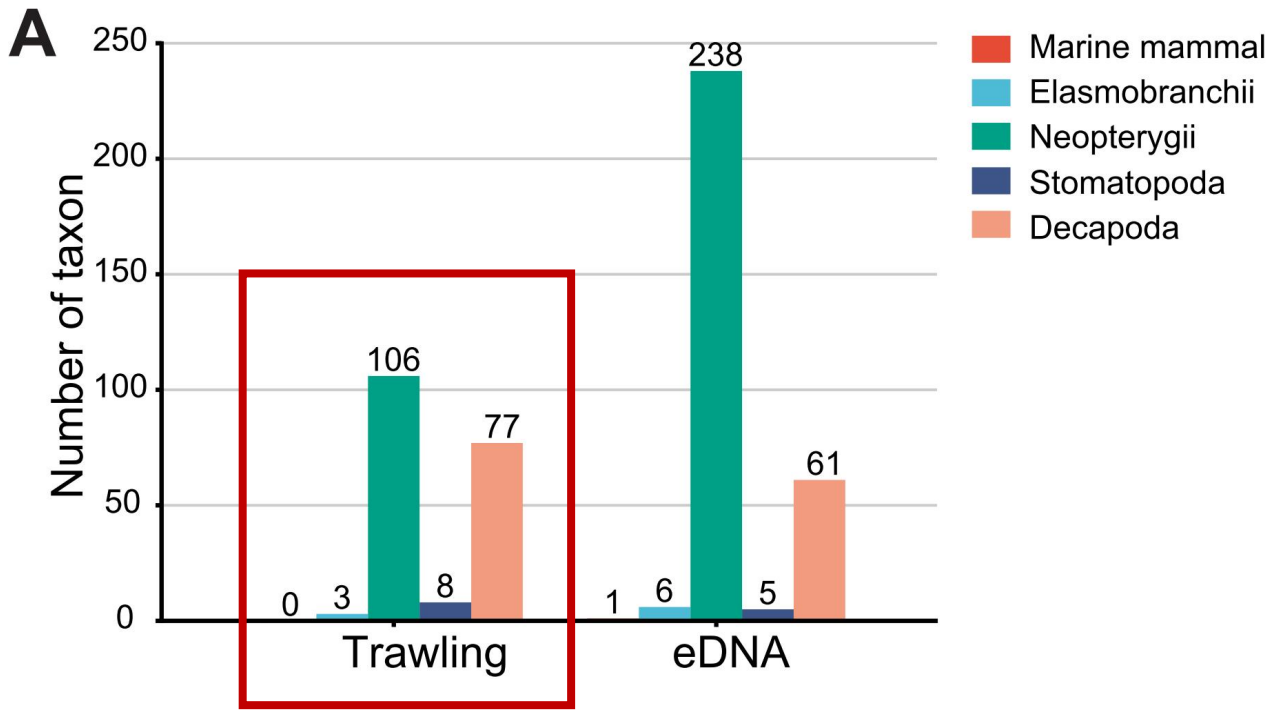
LCF project, HKSAR 2022-2025; SKLMP project 2022-2024

Comparison of eDNA and convectional surveys

Comparison between trawling and eDNA methods

- Workload for trawling: **Eight researchers** and experts for sampling on the boat and subsequent laboratory works, taking > **two months** to process.
- Trawling captured a total of **236 taxa from 8 trawl sites**
  - ❑ 3 elasmobranchs
  - ❑ 106 bony fishes
  - ❑ 85 crustaceans

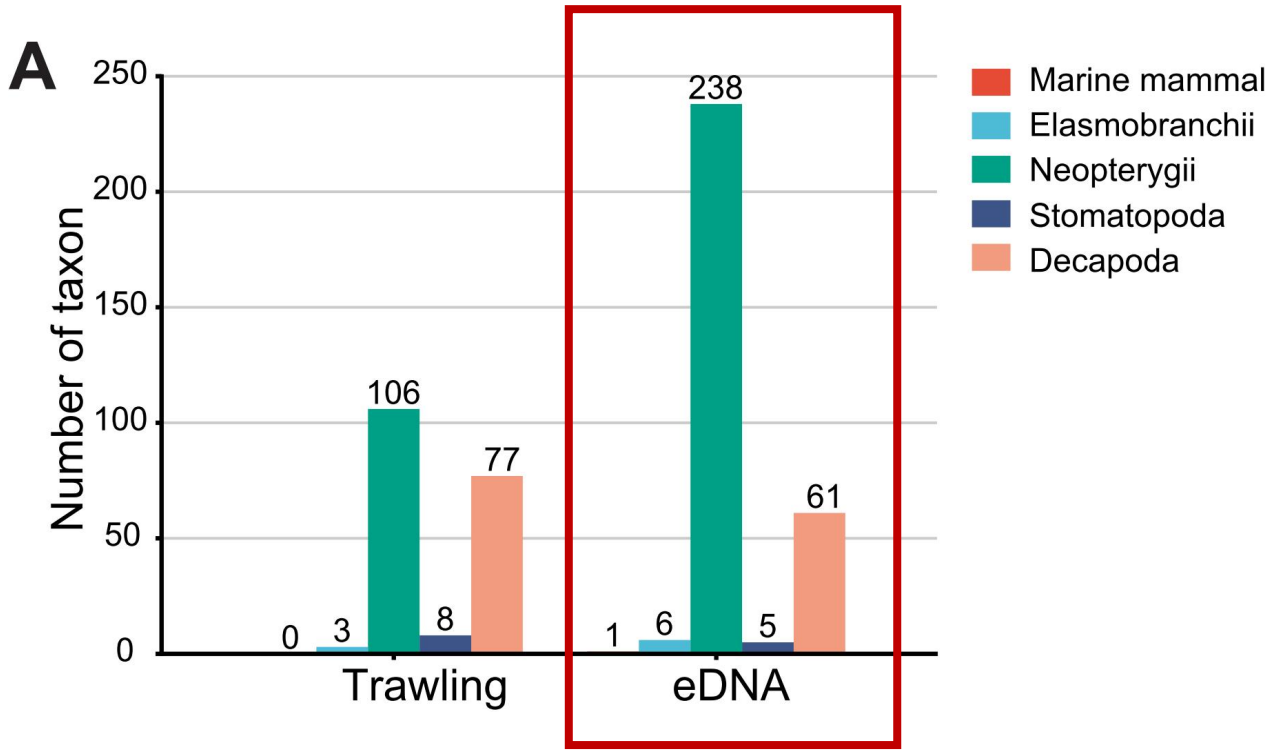




Comparison of eDNA and convectional surveys

Comparison between trawling and eDNA methods

- Workload for eDNA: **One researcher** for sampling on the boat and subsequent laboratory works, taking ~**one month** to process.
- eDNA identified a total of **311 taxa from trawl sites**
  - ❑ 1 marine mammal
  - ❑ 6 elasmobranchs
  - ❑ 238 bony fishes
  - ❑ 66 crustaceans
- Primer performances
  - ❑ 12S-V5 detected more vertebrates
  - ❑ BerryFish (16S) more specific on bony fishes
  - ❑ **Muti-assays** enhance the detection



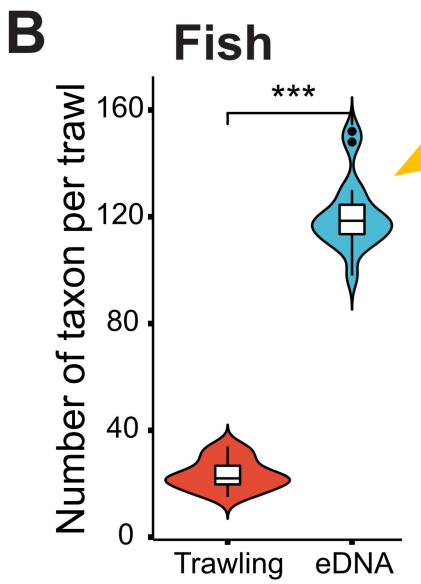
Comparison of eDNA and convectional surveys

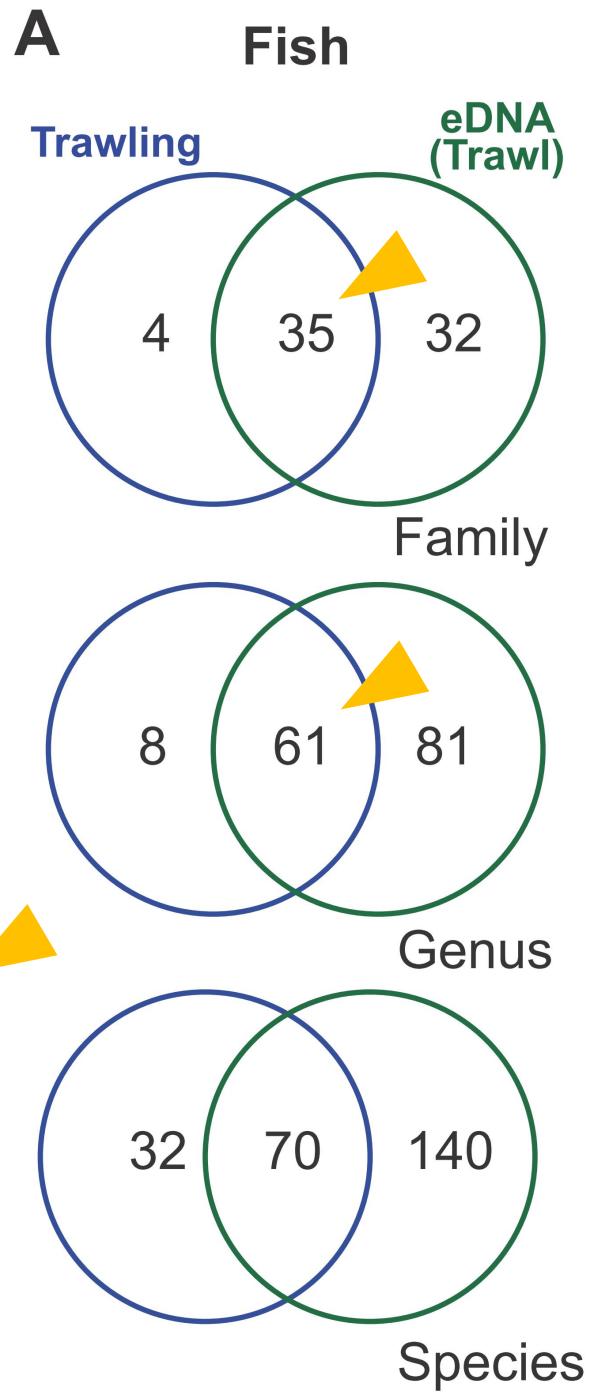
Comparison between trawling and eDNA methods

Fish community

- Trawling: 109 taxa, **102 species** from 39 families
- eDNA: 238 taxa, **210 species** from 67 families
- eDNA data covered most of the family (35/39) and genera (61/69) detected in trawling
- eDNA detected higher diversity and more fish per sample

In 2024, western waters surveys
Bottom trawling captured 85 fish species
eDNA approach detected 162 fish species





Comparison of eDNA and convectional surveys

eDNA as a sustainable tool for monitoring rare and threatened species

- Trawling captured **three threatened species**: two Vulnerable elasmobranchs (*Gymnura japonica* and *Telatrygon zugei*), Endangered Threadfin Porgy (*Evynnis cardinalis*).
- eDNA identified **nine threatened species**, including one marine mammals *N. phocaenoides*, two elasmobranchs, and Critically Endangered *Larimichthys crocea*, and Endangered *E. cardinalis*.

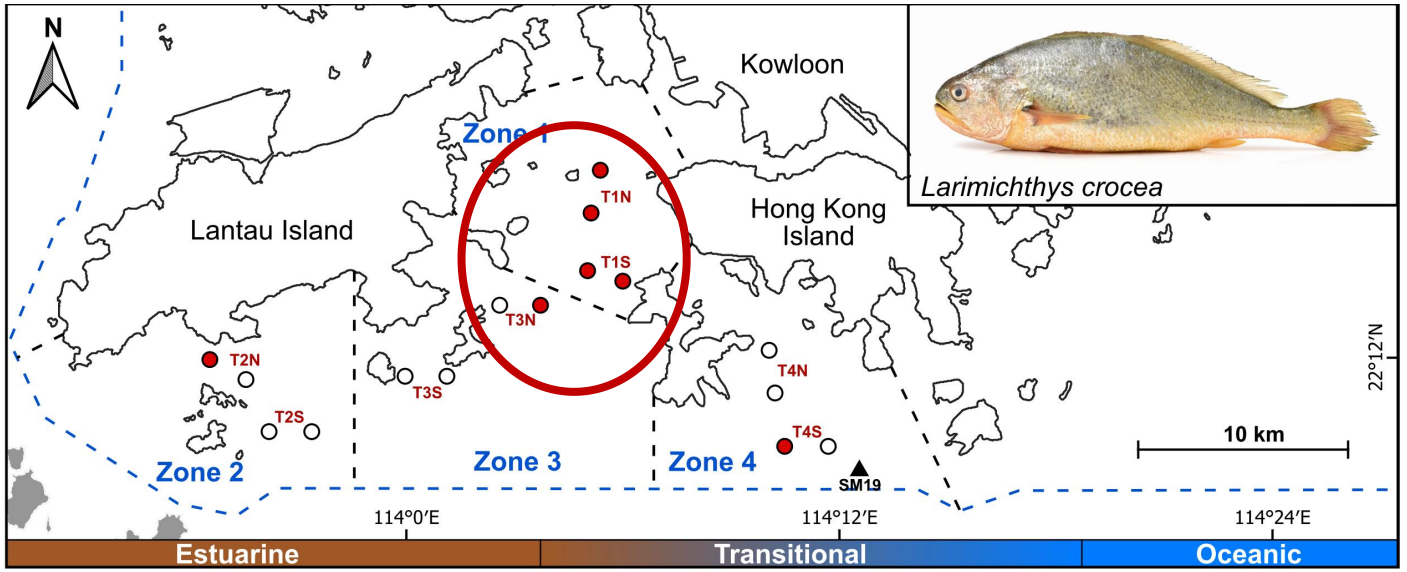
Large yellow croaker

ORIGINAL ARTICLE | Open Access

Bottom Trawling and Multi-Marker eDNA Metabarcoding Surveys Reveal Highly Diverse Vertebrate and Crustacean Communities: A Case Study in an Urbanized Subtropical Estuary

Jack Chi-Ho Ip, Hai-Xin Loke, Sam King Fung Yiu, Meihong Zhao, Yixuan Li, Yitao Lin, Chun-Ming How, Jiezhang Mo, Meng Yan, Jinping Cheng, Vincent Chi-Sing Lai, Leo Lai Chan ... See all authors

First published: 04 November 2024 | https://doi.org/10.1002/edn3.70031



Ongoing Biodiversity Projects

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Southern & Western Waters

1. LNG-MCEF: Mangrove habitat eDNA
2. MEEF: Chinese Bahaba eDNA
3. ECF: SLMP's AR & habitat restoration

Eastern Waters

4. GRF – Coral-Zooxanthellae health
5. ECS – Coral and coral reef eDNA

Hong Kong Coastline

6. ECF: Intertidal biodiversity & connectivity

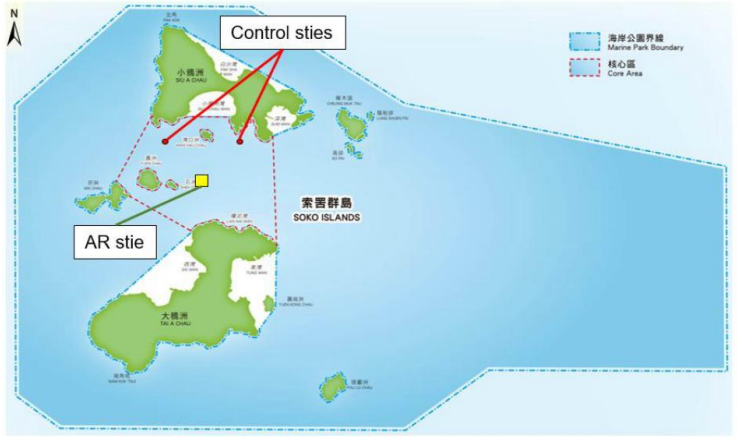
Fishery Enhancement

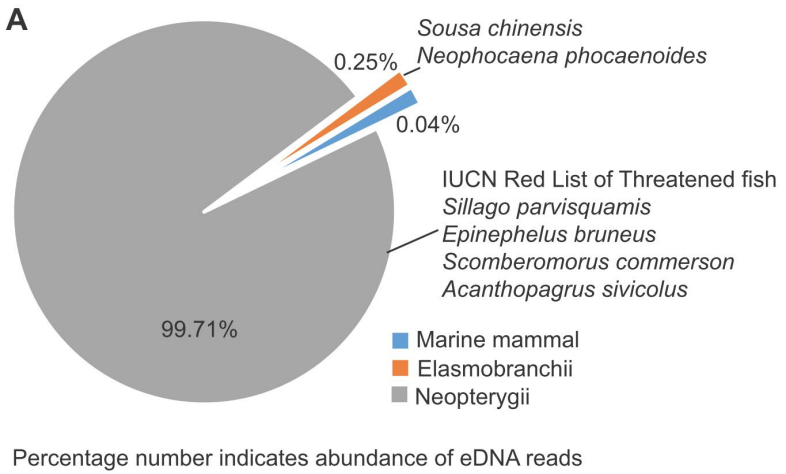
7. LNG-FEF: Upcycling fruit waste as adductive aquafeed

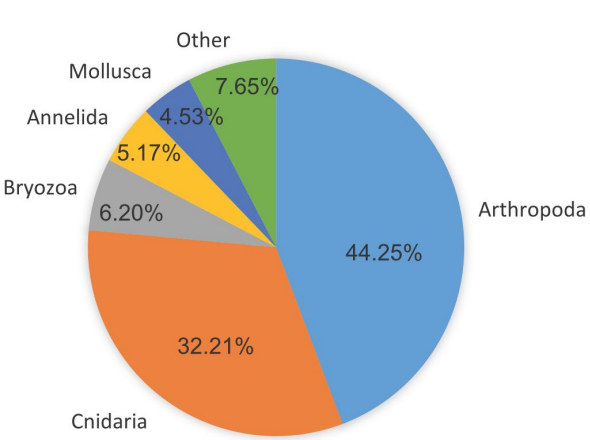
Ongoing projects -eDNA surveys

Monitoring Artificial reef communities in South Lantau Marine Park

- Monitoring the species communities' changes before and after the deployment of AR in SLMP
- Evaluate the AR performance using eDNA and convectional approaches
- Detected over **150 fish species** and **two marine mammals** in premonitoring surveys







Percentage number indicates abundance of eDNA reads

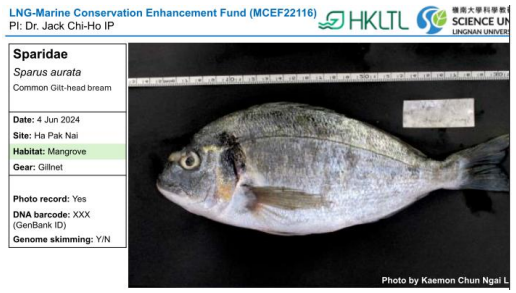
ECF, HKSAR project 2024-2026

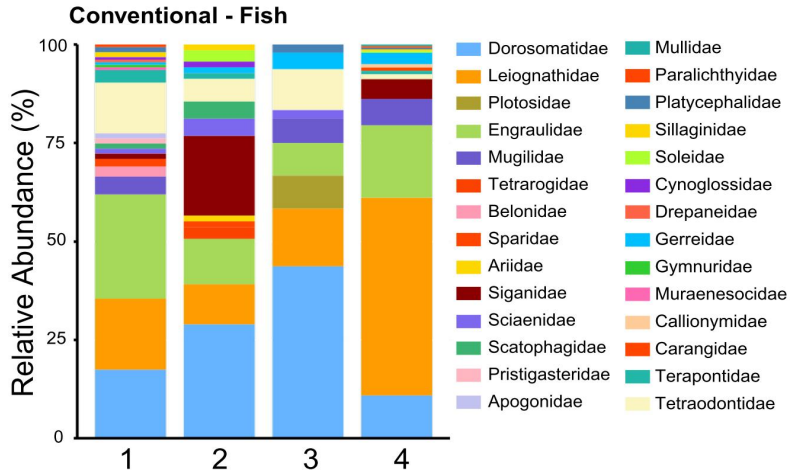
PI: Dr. Jack Chi-Ho Ip (LU), Co-I: Prof. Jian-wen Qiu (HKBU)

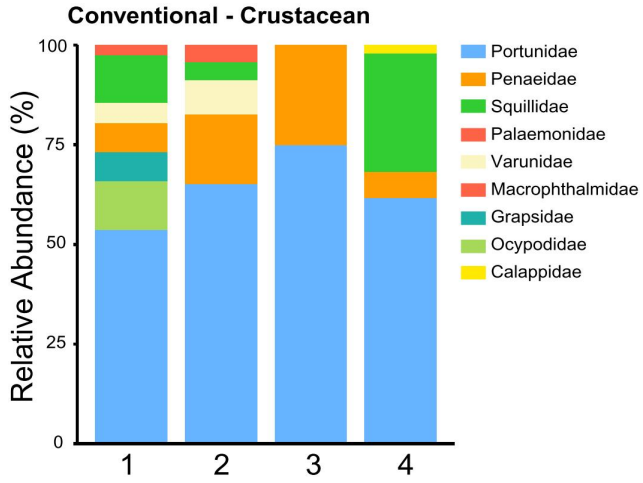
Ongoing projects -eDNA surveys

Monitoring mangrove communities using eDNA and gill netting surveys

- Survey the biodiversity of fish and crustaceans in mangrove habitat
- Conventional surveys captured **626 individuals from 76 species**
- Submitted for sequencing







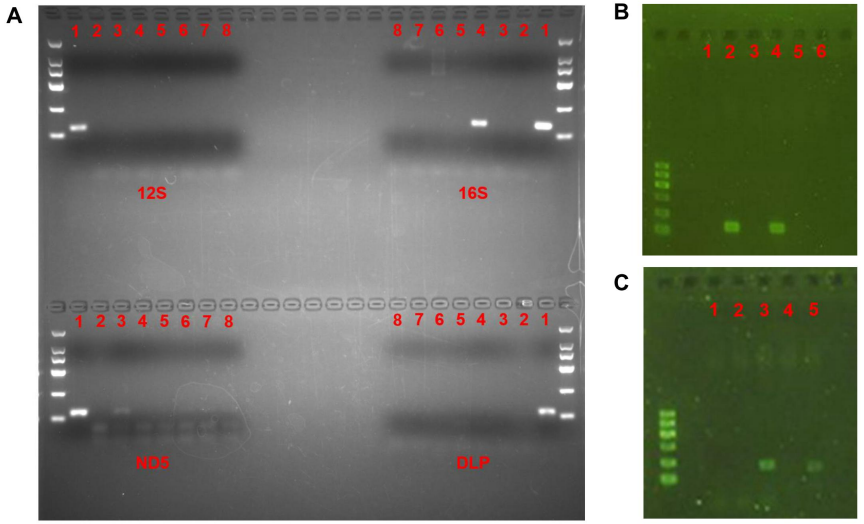
LNG-MCEF project 2024-2025

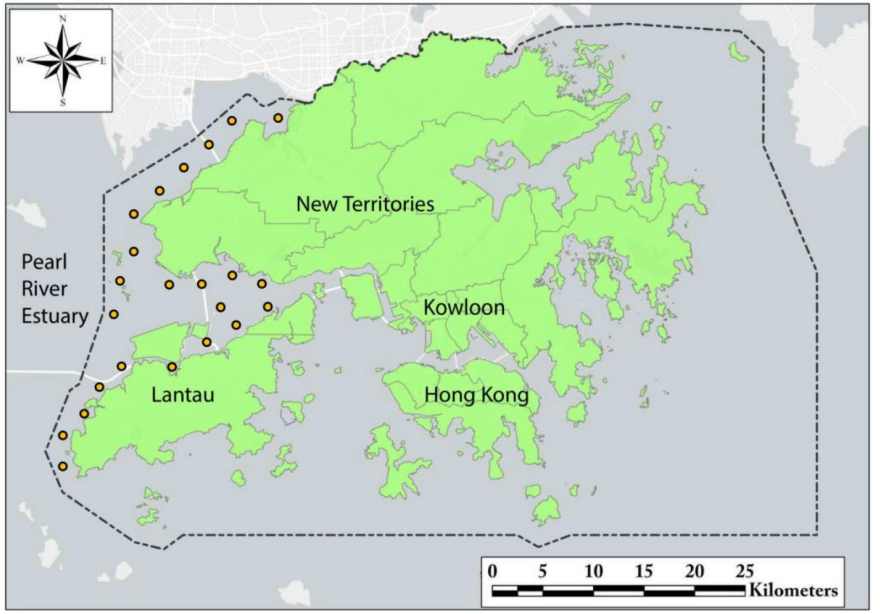
PI: Dr. Jack Chi-Ho Ip (LU), Co-I: Prof. Jian-wen Qiu (HKBU), Dr. Meng Yan (SKLMP)

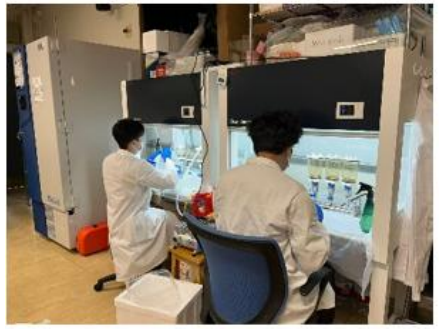
Ongoing projects -eDNA surveys

Monitoring Chinese bahaba 黃唇魚 in Hong Kong western waters

- Conduct eDNA surveys using a species-specific qPCR approach to trace any Chinese Bahaba in western Hong Kong waters.







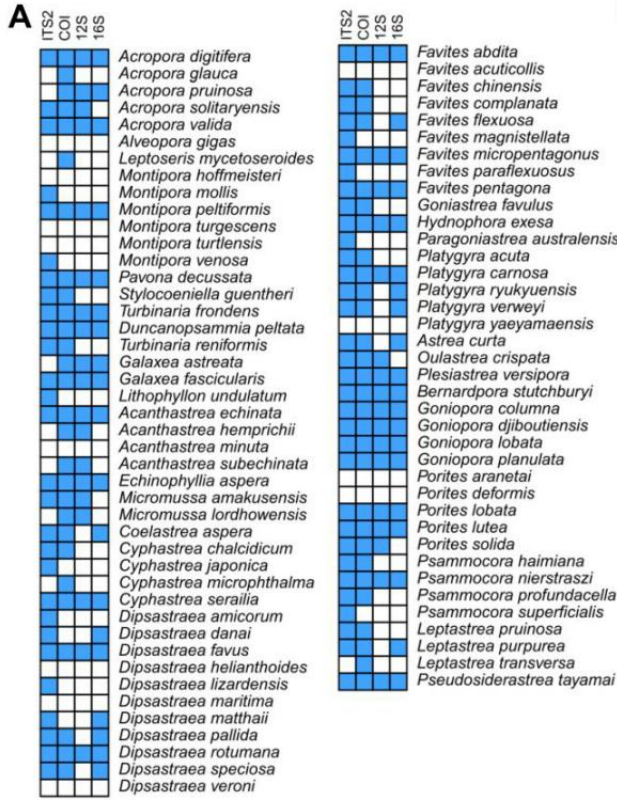
MEEF, HKSAR project 2024-2026

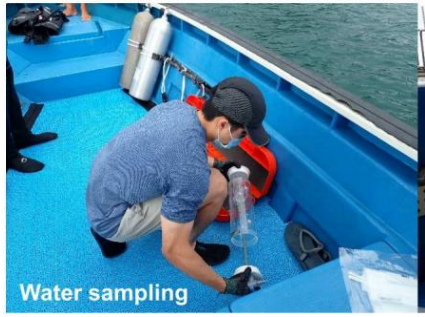
PI: Dr. Jack Chi-Ho Ip (LU), Co-I: Dr. Junjie Wang (SCNU)

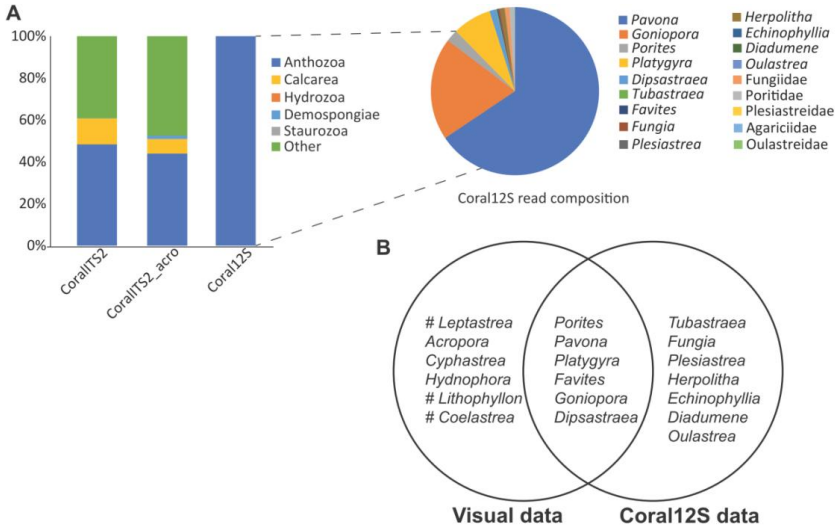
Ongoing projects -eDNA surveys

Monitoring coral communities using eDNA and SCUBA

- Enhance scleractinian DNA reference database
- developing new scleractinian-specific primers
- Assess the performance of eDNA method by comparing eDNA results with visual data
- establish a comprehensive baseline of spatial and temporal variation in scleractinian assemblages in **33 reef check sites**



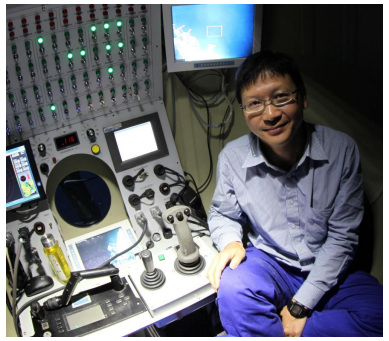




ECS, UGC, HKSAR project 2025-2027
PI: Dr. Jack Chi-Ho Ip (LU)

Acknowledgements

Collaborators



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(王俊杰; SCNU)

Prof. Gray A Williams
(HKU)

Dr. Tommy Hui
(LU)

Fundings support

- **Dr. Jack Ip: Early Career Scheme** (23100224), **General Research Fund** (12102623), **Environmental and Conservation Fund of Hong Kong** (122/2022; 84/2024), **Marine Conservation Enhancement Fund** (MCEF22116), **Marine Ecology Enhancement Fund** (MEEF2024012), **Fisheries Enhancement Fund** (FEF23101)

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