



# Enhancing fish inventories in Karimunjawa National Park, Indonesia, Through eDNA Metabarcoding



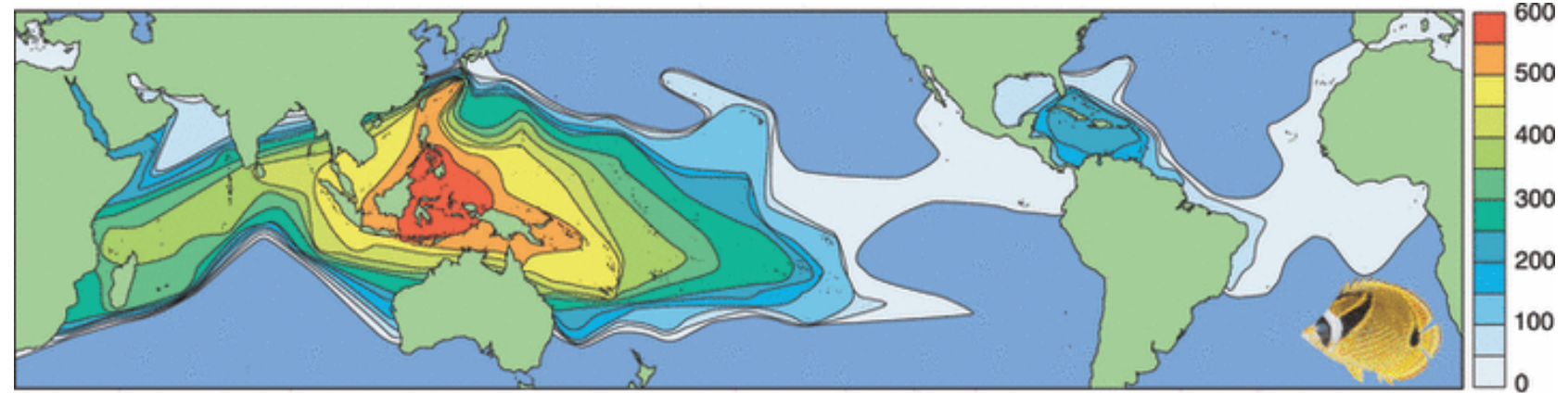
**Presenter:**

Muhammad Danie Al Malik

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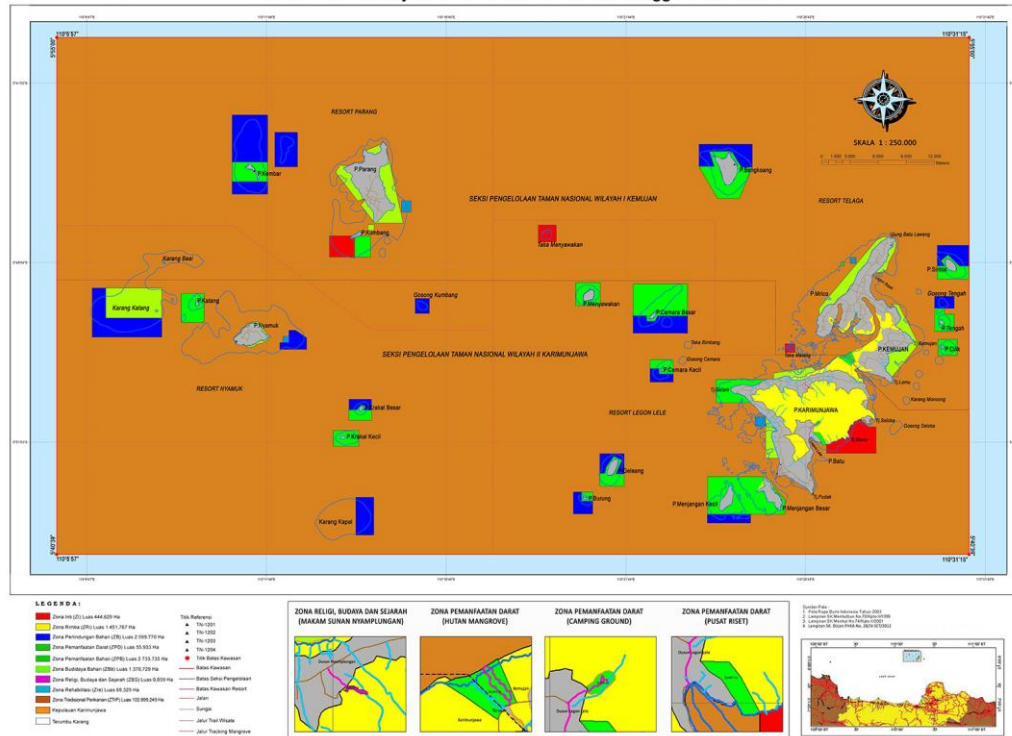


# Research Background



Sources: Bellwood and Mayer (2009)

**PETA ZONASI TAMAN NASIONAL KARIMUNJAWA**  
Berdasarkan SK.Dirjen PHKA No. 28/IV-SET/2012 Tanggal 6 Maret 2012



- Efforts to protect marine biodiversity include establishing Marine Protected Areas (MPAs)<sup>1</sup>.
- In Indonesia, MPAs like Karimunjawa National Park are monitored to track biodiversity changes and manage sustainability<sup>2</sup>.
- However, accurately detecting biodiversity, particularly taxonomy composition, remains challenging due to the limitations of current methods like visual census<sup>3</sup>.

Image sources: Fauzi et al. (2023) and BTNKJ

<sup>1</sup>Edgar, G. J., Stuart-Smith, R. D., Willis, T. J., Kininmonth, S., Baker, S. C., Banks, S., ... and Thomson, R. J. 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature*, 506(7487), 216-220.

<sup>2</sup>Muhidin, Rizki, P.H., and Pardede, S. 2022. Karimunjawa Coral Reef Ecosystem Monitoring Brief Report 2022. Wildlife Conservation Society, Bogor. [Indonesian]

<sup>3</sup>Aglieri, G., Baillie, C., Mariani, S., Cattano, C., Calò, A., Turco, G., ... and Milazzo, M. 2021. Environmental DNA effectively captures functional diversity of coastal fish communities. *Molecular Ecology*, 30(13), 3127-3139.

Fauzi, A. I., Azizah, N., Yati, E., Atmojo, A. T., Rohman, A., Putra, R., ... & Wikantikita, K. (2023). Potential Loss of Ecosystem Service Value Due to Vessel Activity Expansion in Indonesian Marine Protected Areas. *ISPRS International Journal of Geo-Information*, 12(2), 75.

# Visual Census as a Current Standard Method for Marine Biodiversity in Indonesia

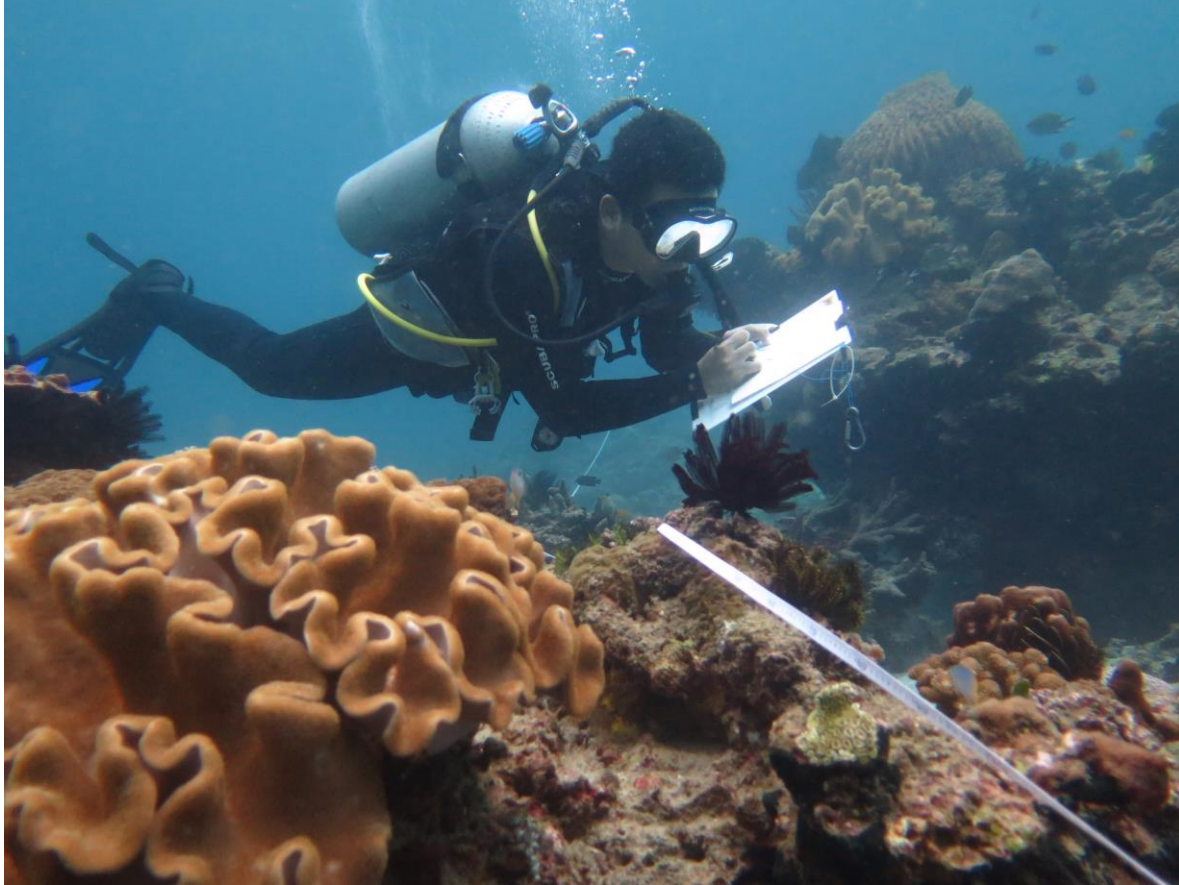


Image sources: Personal documentation

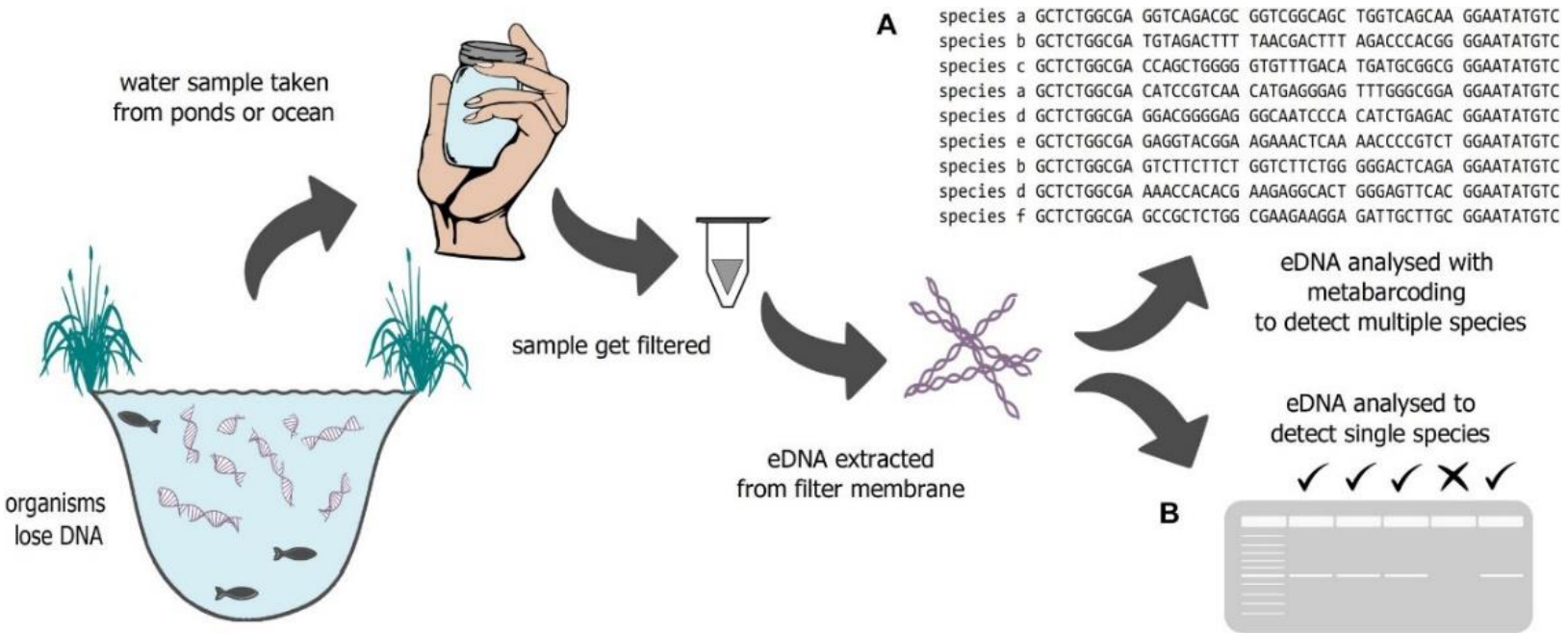
Potentially bias because of different observer will get different identification result

Lack to detect small or cryptic species

Need good quality of water and current to able do monitoring

# Environmental DNA (eDNA) as a Potential Complement to Visual Census

eDNA is a non-destructive method to detect various living organisms that leave traces of their DNA through cells, dirt, skin, or any part of the living body itself that contains genetic material<sup>1</sup>



**Using environmental DNA or eDNA could be an answer to complement conventional results such as visual census.**

Image sources: Schadewll et al. (2021)

<sup>1</sup>Pilliod, D.S., Goldberg, C.S., Laramie, M.B., and Waits, L.P. 2013. Application of environmental DNA for inventory and monitoring of aquatic species: U.S. Geological Survey Fact Sheet 2012-3146, 4 p.

<sup>2</sup>Sahu, A., Kumar, N., Singh, C. P., and Singh, M. 2022. Environmental DNA (eDNA): Powerful Technique for Biodiversity Conservation. Journal for Nature Conservation, 126325.

Schadewell, Y., and Adams, C. I. 2021. Forensics meets ecology—environmental DNA offers new capabilities for marine ecosystem and fisheries research. Frontiers in Marine Science, 8, 668822..

# Research Focus

Our team promotes the use of eDNA for marine biodiversity monitoring in Indonesia, demonstrated by successful research in Karimunjawa National Park and sharing our findings with the public as a provoke to adapt in standard method complement with visual census.



Image sources: Personal documentation

**TEMPO** Ⓧ 🔍

[Lingkungan](#)

🔒 Jika Tentara Menertibkan Kawasan Hutan Gempa M5,0 dari Lembah Masurai Jambi, BMKG Jelaska

**Lingkungan**

## Keunggulan eDNA Mendeteksi Biodiversitas Laut

Metode pendataan eDNA bisa menjangkau area lebih luas dan ramah lingkungan. Bisa mendeteksi ikan nokturnal atau ikan migrasi.

12 Desember 2024 | 15.00 WIB

Aa 🔗 🔖

Menu **THE CONVERSATION** 👤

Seorang penyelam perempuan sedang memegang kantong infus yang berisi air laut sebanyak 1 liter sebagai sampel eDNA. Author provided (no reuse).

## Menguji efektivitas teknologi baru eDNA, ampuh mendeteksi biodiversitas laut lewat sisa sel hingga jejak kotoran

Diterbitkan: Desember 11, 2024 8.03am WIB

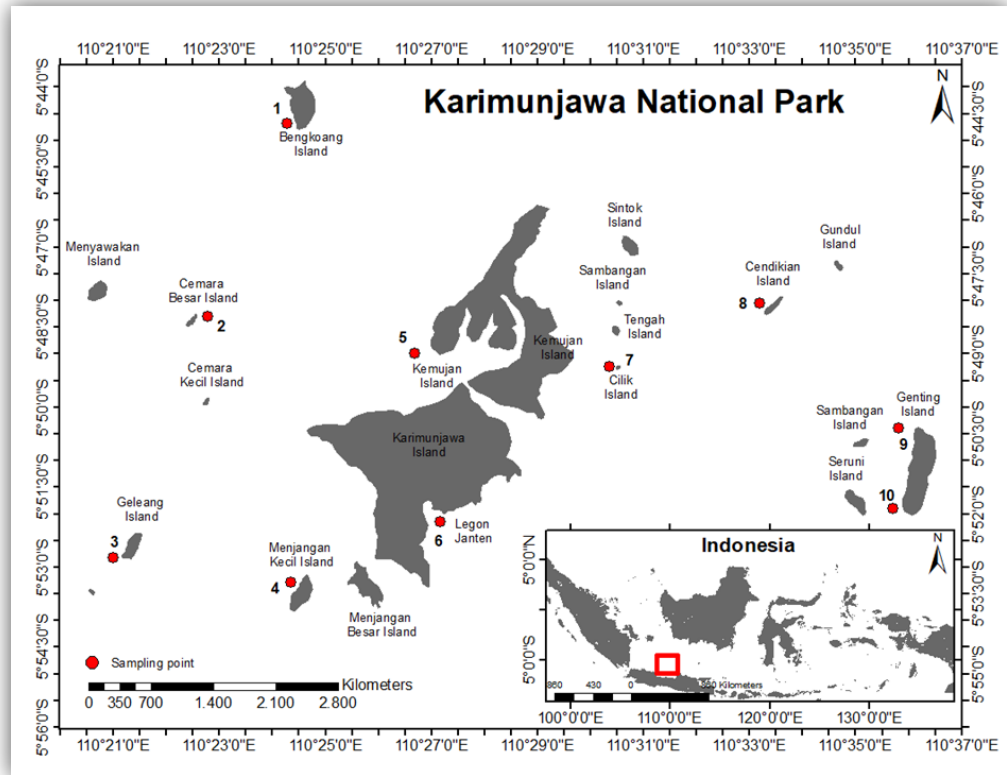
👤 **Muhammad Danie Al Malik, Ni Kadek Dita Cahyani**, Universitas Diponegoro

**Penulis**

**Muhammad Danie Al Malik**  
Peneliti di Diponegoro Biodiversity Project (DBP), Universitas Diponegoro

**Ni Kadek Dita Cahyani**  
Dosen, Universitas Diponegoro

# Comparing eDNA versus Visual Census



## Mission:

eDNA as complementary monitoring method in the future.

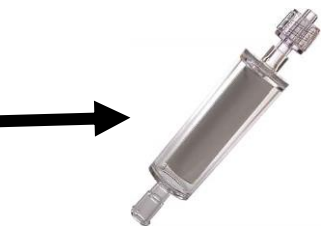
## Purpose:

This study aims to comprehensively detect fish diversity within coral reef ecosystems across 10 locations in Karimunjawa National Park (KNP) using eDNA alongside Oxford Nanopore sequencing, and to compare the results with visual censuses reported by the local authority in KNP. Additionally, this study aims to differentiate functional traits between eDNA and visual census, informed by the FishBase database.

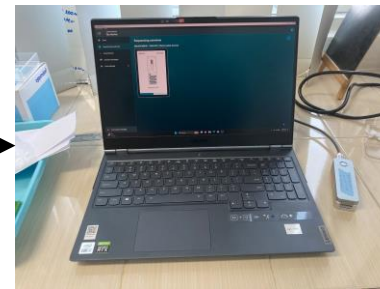
We used 12S rRNA locus to detect fish composition.



Pengambilan air di kedalaman



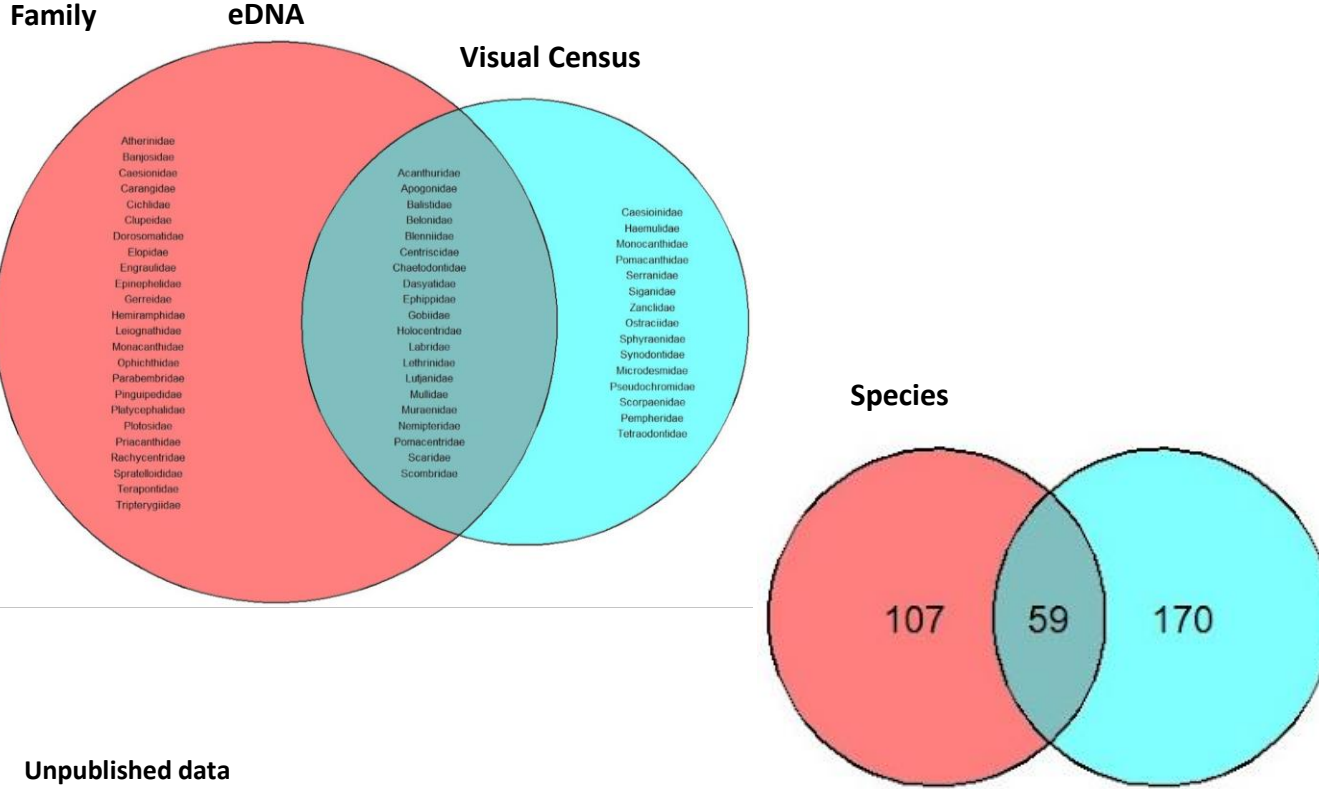
sterivex (pore size of 0.22  $\mu$ m)



## Supported by:



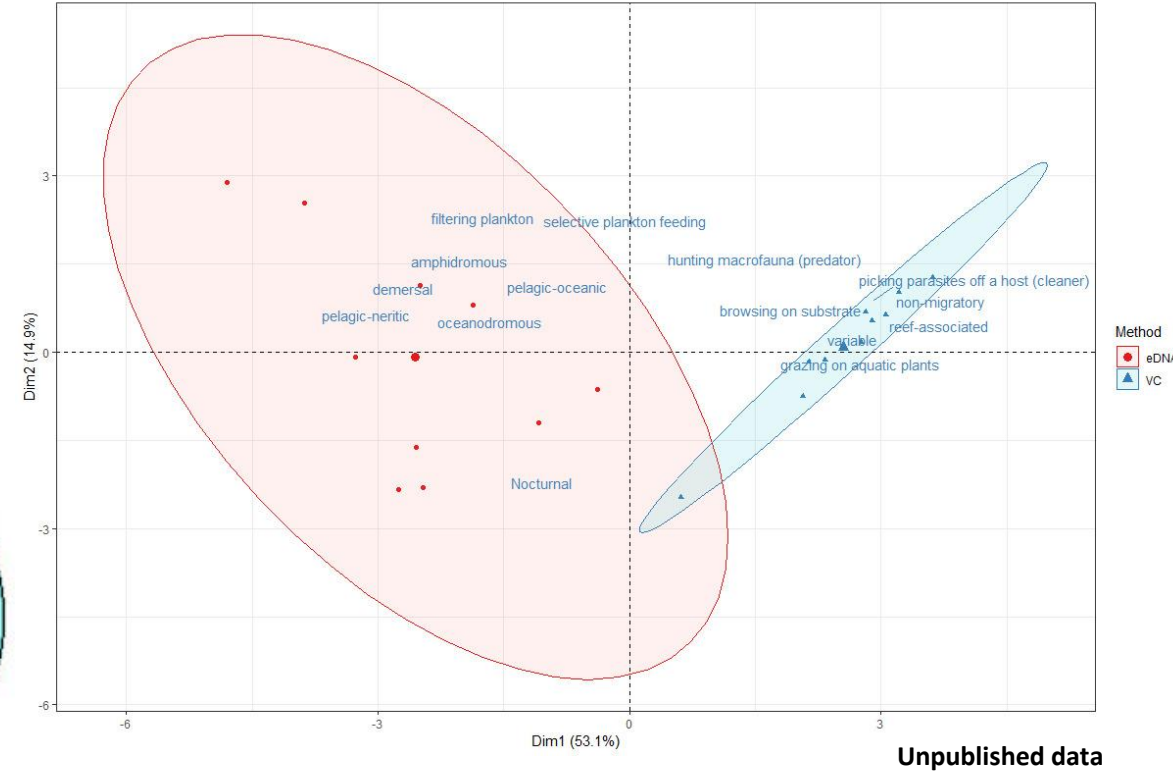
# Comparing eDNA versus Visual Census



Unpublished data

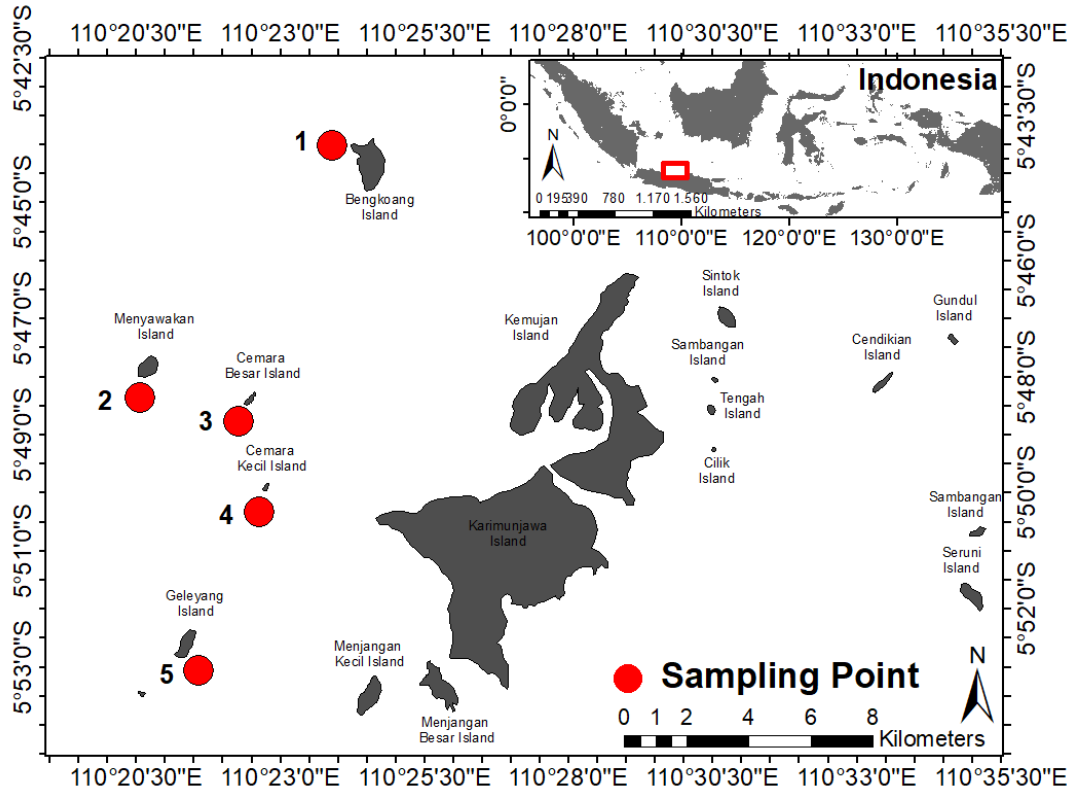
A comparison between eDNA and visual census results showed that approximately **20 families, or 57%**, detected in the visual census were also detected by eDNA. Furthermore, around **59 species, or 27%**, identified through the visual census were detected by eDNA.

Principal component analysis (PCA) of the fifteen functional trait proportions of fish assemblages identified by the eDNA and Visual Census (VC) techniques.



The eDNA correlated more strongly with fish with functional traits such as **nocturnal, oceanodromous, pelagic-neritic, demersal**, and filtering plankton. Otherwise, the visual census method correlated with fish that have functional traits such as being **non-migratory, reef-associated**, and those that graze and browse on substrates.

# Comparing Fish from Shallow and Upper-Mesophotic Coral Reef Ecosystems (MCEs)



## Mission:

eDNA can uncover fish diversity in Upper- Mesophotic Coral Reef Ecosystems (MCEs) that has never been explored before in Karimunjawa National Park (KNP) due to the limitations of visual census methods.

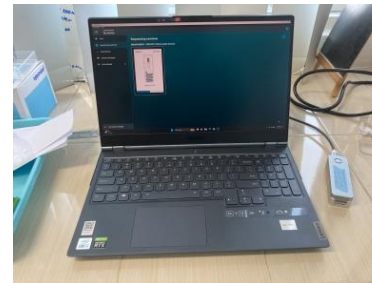
## Purpose:

- (a) provide a snapshot of fish diversity between shallow waters (5-10 meters) and upper MCEs (30-40 meters), and
- (b) understand taxon sharedness and distinctiveness between upper MCEs and shallower reef areas

The seawater was filtered using a vacuum pump with 0.45  $\mu\text{m}$  filter paper (Pall Corporation).



Pengambilan air di kedalaman



Supported by:



# Comparing Fish from Shallow and Upper-Mesophotic Coral Reef Ecosystems (MCEs)

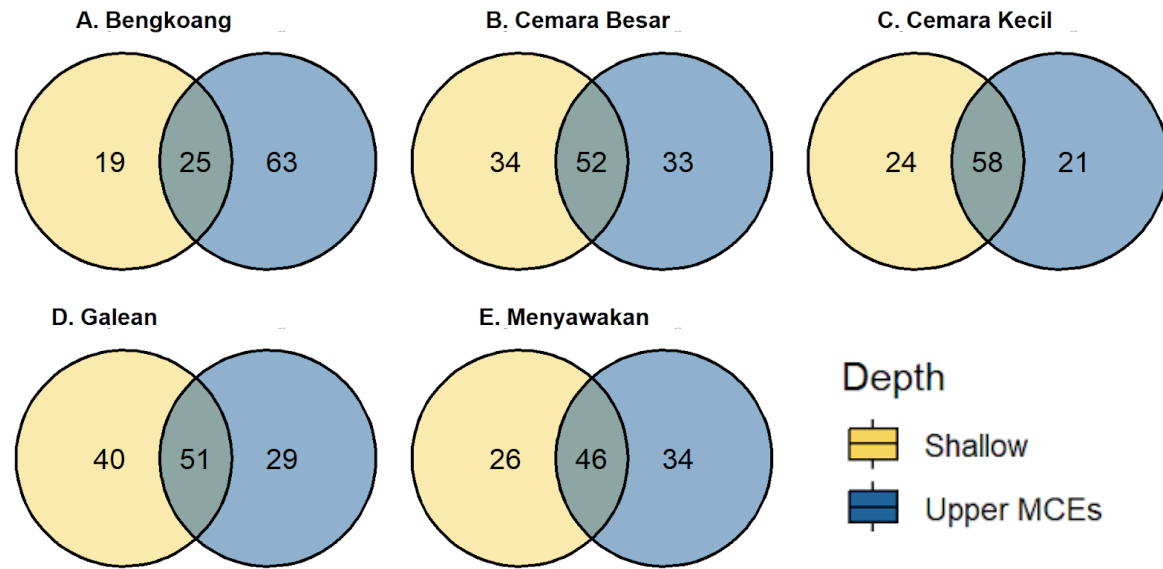
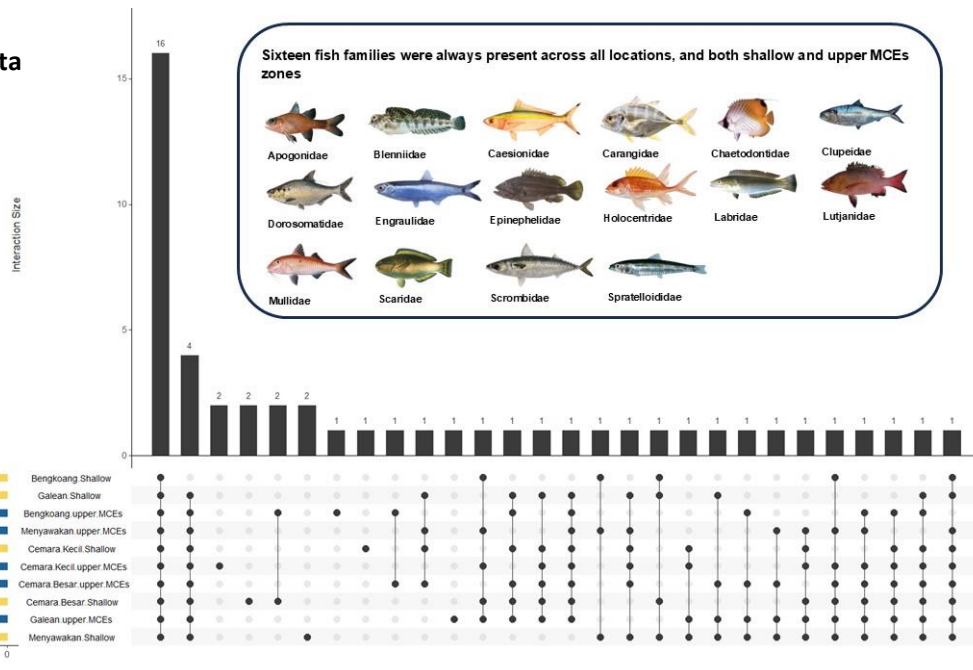


Image sources: Personal, Coral reef Ecosystems in Karimunjawa

## Unpublished data



The overlap in species between depths is substantial, ranging from 28.4% to 73.4%, with an average of over 50%.

We identified 16 taxa representing ecologically and economically important fish families as major contributors to the taxa shared between depths.

# Looking for what has never been looked for Elasmobranch in Karimunjawa

## Mission:

We aim to inventory elasmobranch distribution in Karimunjawa, recognized as one of the Important Shark and Ray Areas (ISRA). Currently, their presence, these species have not been detected in visual census monitoring by local authorities.

## Purpose:

Testing elasmobranch detecting with eDNA using **12S MiFish-E primer** in the Cage from Karimunjawa.

## Result:

Family	Genus	Species	Number of Reads
Carcharhinidae	Carcharhinus	<i>Carcharhinus melanopterus</i> (black tip)	149
Carcharhinidae	Triaenodon	<i>Triaenodon obesus</i> (white tip)	25
Glaucostegidae	Glaucostegus	Unidentified (inconsistent with different species with in the cage)	93

Note: Unpublished data

Supported by:



- Top : *Carcharhinus melanopterus* (black tip)
- Middel: *Triaenodon obesus* (white tip)
- *Glaucostegus typus* (guitar)

Image source: Antara and detik photo.

# Conclusion and Suggestion

- Our study in an **Indonesian Marine Protected Area (MPA)** found that **eDNA detected unique taxa not identified by visual census**, revealing a broader range of taxa and **potential connections between shallow and upper MCEs**. Additionally, eDNA showed potential in **detecting elusive elasmobranch species with visual census**, particularly in the Karimunjawa Islands.
- Indonesia has a total of **452 Marine Protected Areas (MPAs)** covering 29 million hectares. **By 2035**, this area is projected to increase to 32.5 million hectares, **encompassing 10% of Indonesia's territorial waters**.

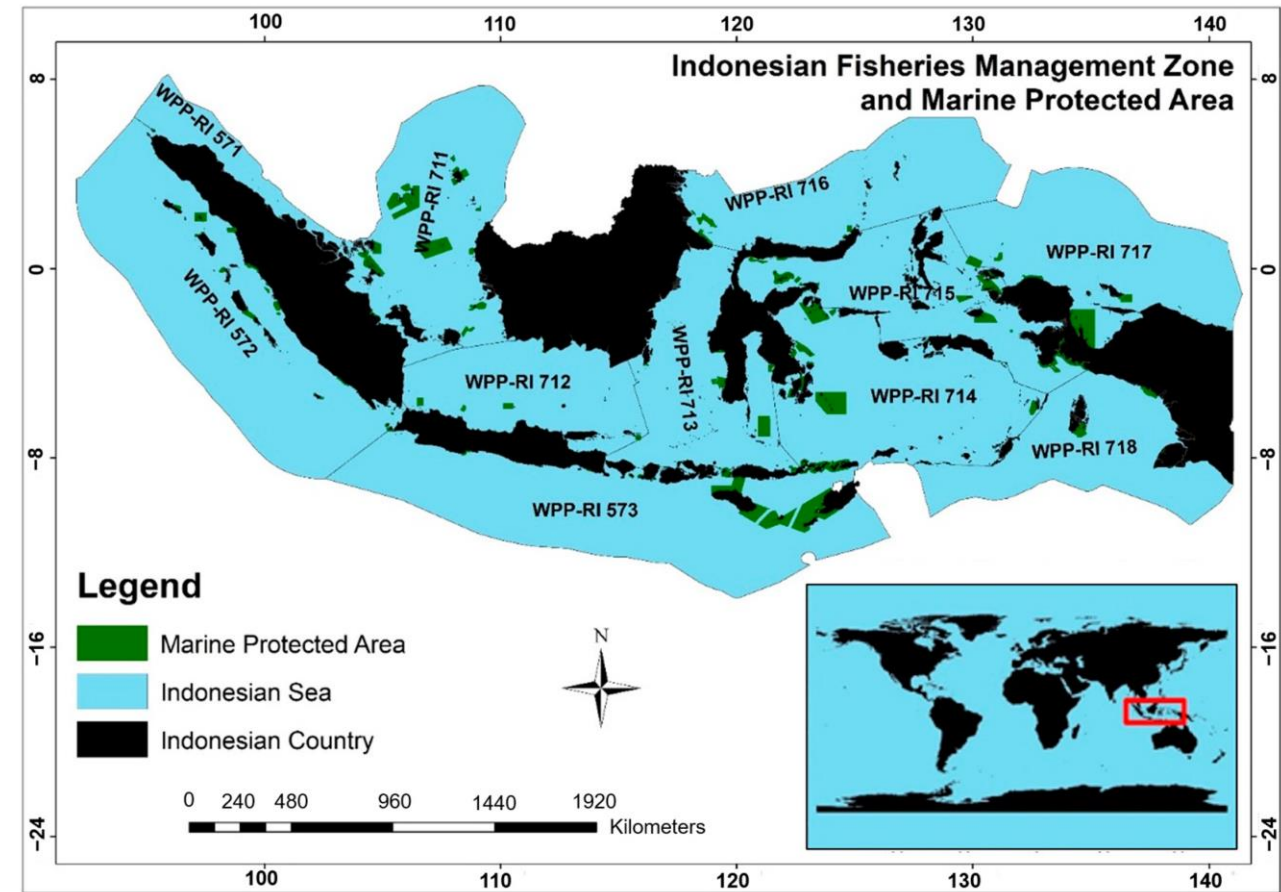
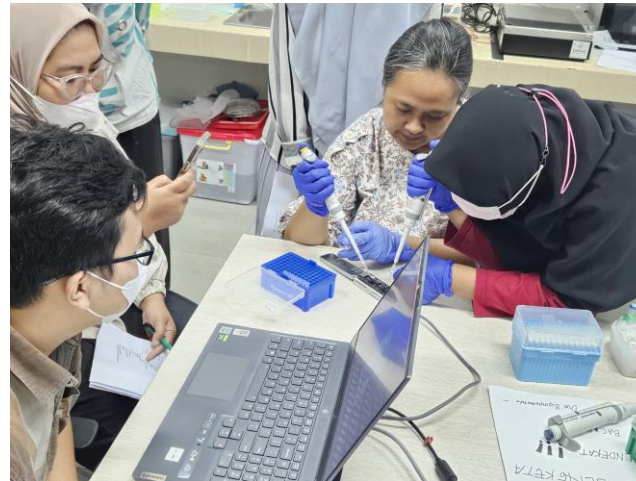


Image source: Fauzi et al (2023).

# Let's collaboration with our team

Visit our lab website: <https://dbplab.org/about/>



**Tena koutou / Terimakasih**