Catch community diversity analysis of purse seine in the tropical Western and Central Pacific Ocean

Jiaojiao Fei, Jian Zhang, Xiao Wang, Yuntao Wu, Yuxiu Teng

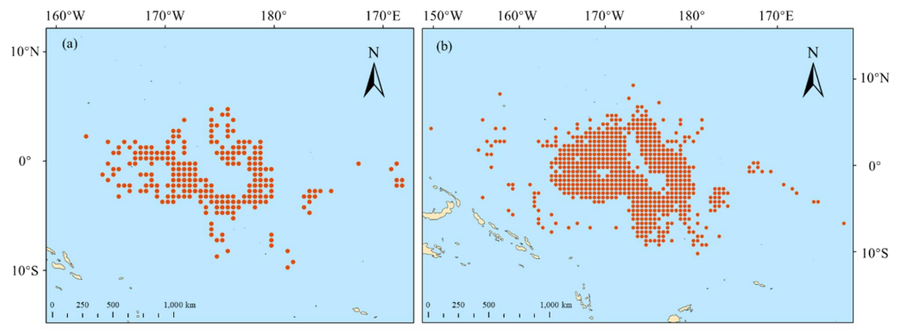
Introduction

The Western and Central Pacific Ocean (WCPO) hosts the largest tuna fishery in the world, characterized by its highly diverse fishing methods and target species, making it a crucial player in global fisheries. The purse seine fishery, as a key component of this region, primarily targets skipjack, yellowfin tuna, and bigeye tuna， In recent years, the widespread use of drifting fish aggregating devices (DFADs) has allowed purse seine fisheries to more effectively capture fish schools associated with natural or artificial floating objects. However, different purse seine strategies lead to variations in catch community composition, influenced by factors such as resource diversity, environmental conditions, and interspecies interactions.Understanding these processes is key to protecting pelagic ecosystems and achieving sustainable fisheries management.

Data sources

1.Fisheries Data

Daily fishery data of seven purse seine vessels for 2014–2022 were provided by Shanghai Kaichuang Marine International Co., Ltd of China. This dataset includes information regarding fishing date, fishing location (longitude and latitude), fishing vessel name, catch, and school association codes.



2.Marine environmental data

Surface sea temperature (SST), surface sea salinity (SSS), chlorophyll-a (Chl-a), nitrate ($NO3^-$), dissolved oxygen (DO), and pH, were sourced from the Copernicus Marine Environment Monitoring Service website (https://data.marine.copernicus.eu/).

Data processing

1.Community composition and dominant species

The index of relative importance (IRI) was employed to determine the dominant species (IRI ≥ 1,000).

2.Analysis of community diversity

Community diversity was assessed using the Shannon–Wiener diversity index (H'), Margalef richness index (D), and Pielou's evenness index (J).

One-way analysis of variance (ANOVA; $P \leq 0.05$) was employed to analyze the differences in fish species diversity indices between the two communities.

The Mantel test was performed to assess the influence of environmental distance on the Shannon–Wiener diversity index, Marglef richness index, and Pielou's evenness index.

3.Correlation analysis of fish species

The mechanisms of symbiosis and coexistence in catch communities were mainly reflected through the correlations between fish species. Spearman correlation analysis was performed to test the relationships between fish species.

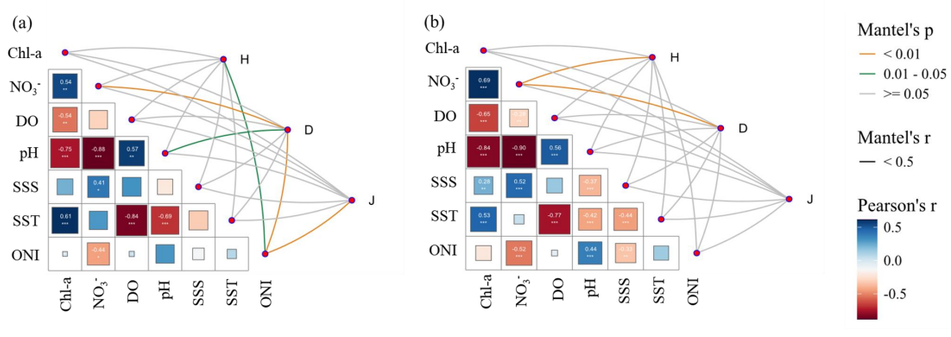
Results

1.Community composition and dominant species

From 2014 to 2022, a total of 66 species of catch were collected by purse seine vessels in the WCPO, belonging to 1 phylum, 4 classes, 23 orders, 37 families, and 58 genera.

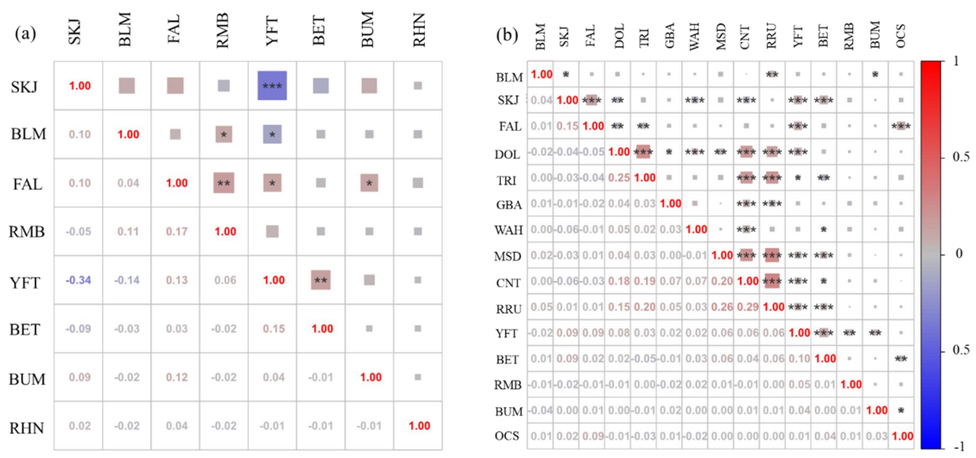
2.Community diversity analysis

The environmental factors significantly affecting the diversity of the FSC community were NO3- , pH, and ONI. The environmental factor significantly affecting the diversity of the DFAD community was NO3-.



3.Correlations between community species

The correlations between different mid-upper layer species in the communities based on Spearman's correlation analysis ($p < 0.05$) are shown in Figure.



Conclusion

✱The overall diversity of the purse seine catch communities in the tropical WCPO is low. Changes in fishing strategies have resulted in variations in species diversity across different habitats. In this study, species coexistence and co-occurrence mechanisms are primarily demonstrated through species correlations. In both FSC and DFAD communities, YFT is positively correlated with BET and FAL. In the FSC community, YFT is negatively correlated with SKJ and BLM, whereas in the DFAD community, YFT is positively correlated with SKJ and shows no correlation with BLM.

✱Moreover, the diversity indices are significantly influenced by sample size, sampling effort, and natural environmental variability, leading to varying impacts of environmental factors on the diversity of different fish communities. The NO3- significantly impacts the diversity of both FSC and DFAD communities. The pH is closely linked to the Margalef richness index of the FSC community, and the ONI affects all three indices of the FSC community, emphasizing the higher mobility of free-swimming tuna schools and their susceptibility to environmental conditions.

References

C. Li et al., "eDNA assessment of pelagic fish diversity, distribution, and abundance in the central Pacific Ocean," Regional Studies in Marine Science, vol. 56, p. 102661, 2022.

L. A. Ñacari, R. Escribano, C. Harrod, and M. E. Oliva, "Combined use of carbon, nitrogen and sulfur stable isotopes reveal trophic structure and connections in deep-sea mesopelagic and demersal fish communities from the Southeastern Pacific Ocean," Deep Sea Research Part I: Oceanographic Research Papers, vol. 197, p. 104069, 2023.

O. C. Basurko et al., "Fuel consumption of free-swimming school versus FAD strategies in tropical tuna purse seine fishing," Fisheries Research, vol. 245, p. 106139, 2022.

Contact: fei20502022@163.com