Western and Central Pacific Fisheries Commission

Habitat distribution modeling of the loggerhead sea turtle (*Caretta caretta*) in the Western an Central Pacific ocean using integrated multi-source fisheries data

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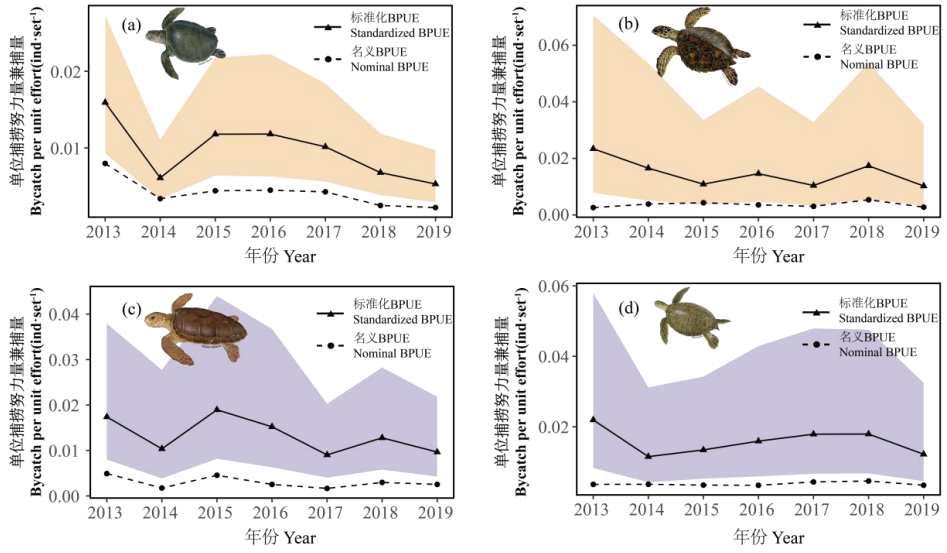
Quantitative Fisheries Stock & Ecosystem Assessment and Management Lab, FSA Lab

Why sea turtles matter

- Ancient marine reptiles (>100 million years)
- **High ecological, scientific, and socio-economic value**
- Long lifespan and slow population recovery

Key life-history traits

- Late maturity: typically >**20** years
- Long-distance migration between foraging and nesting grounds
- **Conservation requires basin-scale perspective**



(Xie et al.,2026)

Major threats

- **Fisheries bycatch**
- Predation and egg loss
- Climate change, coastal development, and pollution

Fishery relevance

- **Longline**, **purse seine**, trawl, and gillnet operations may catch sea turtles incidentally
- Bycatch can cause high mortality and population-level impacts

Study focus

- Identify habitat suitability patterns for loggerhead turtles

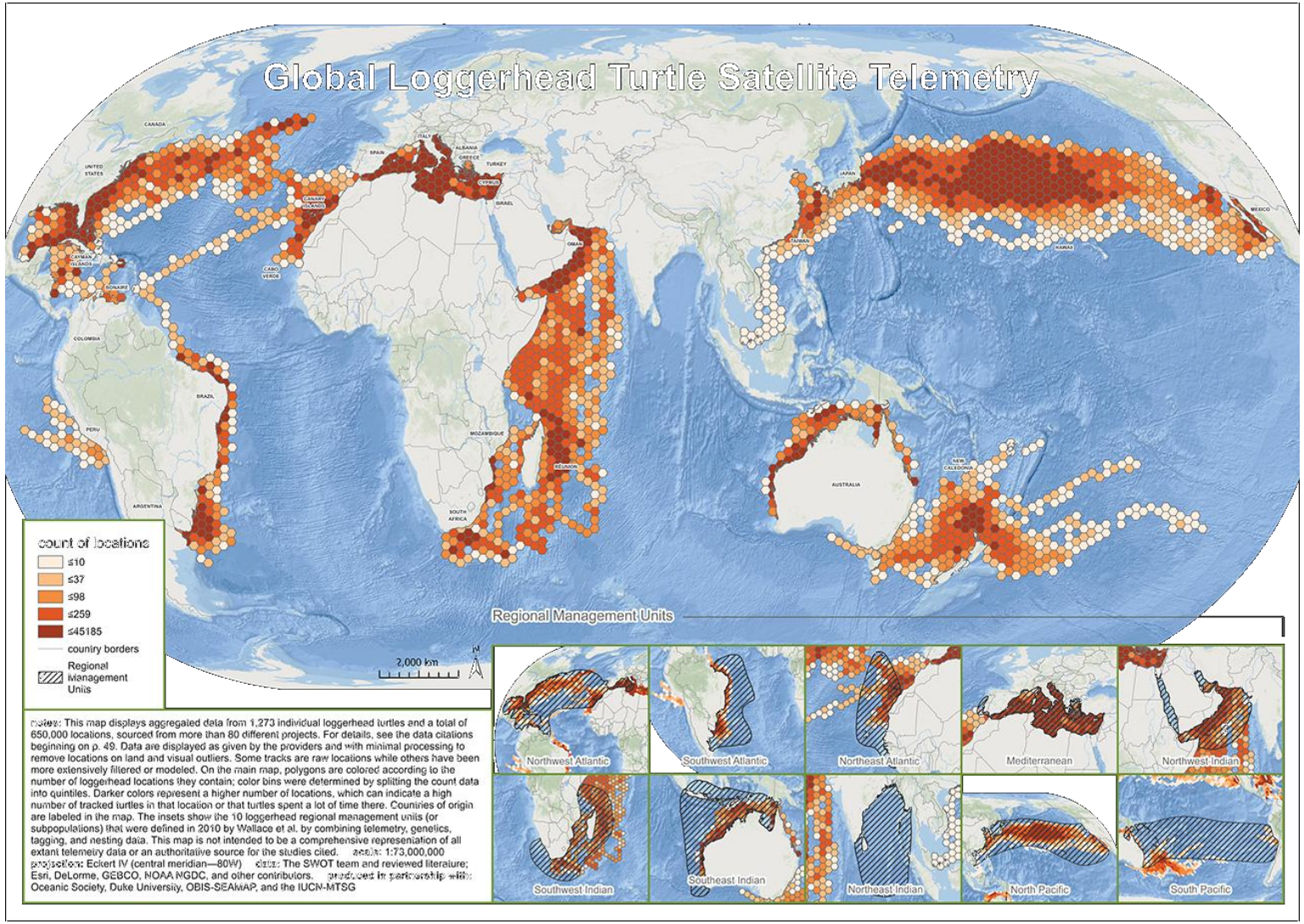
- Compare predictions from longline, purse seine, and integrated data

- Locate fishery overlap and potential bycatch hotspots

Research objectives:

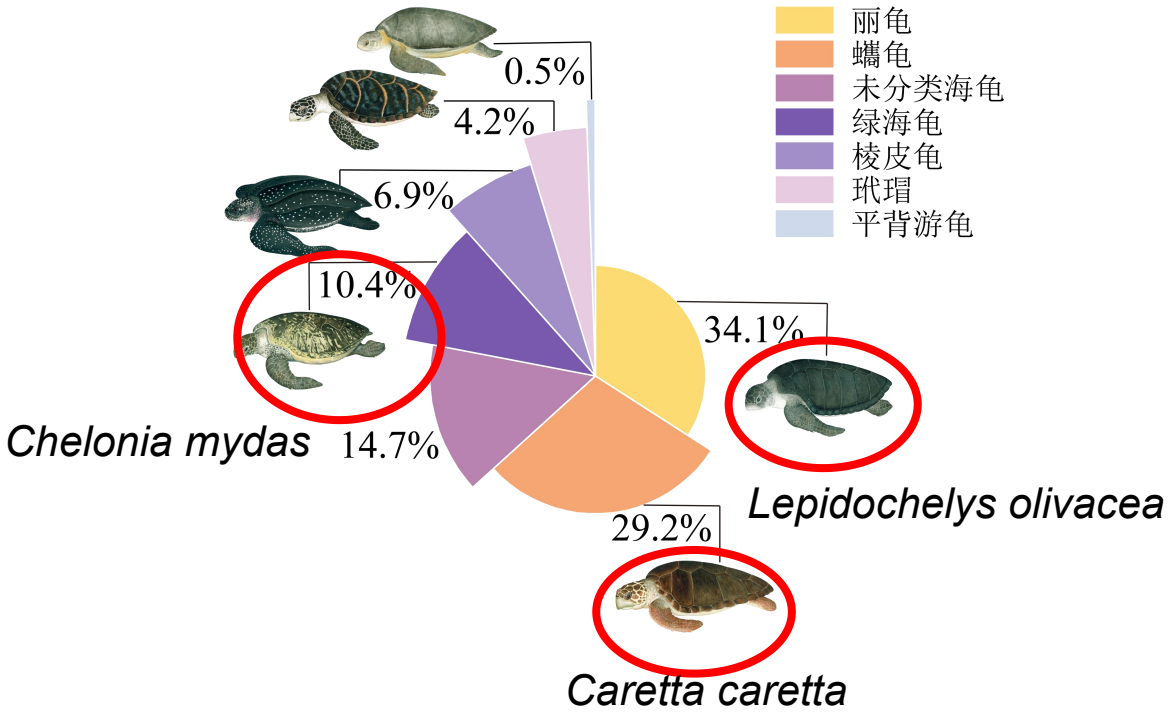
- Supports spatially explicit bycatch mitigation

- Provides evidence for RFMO conservation measures



(SWOT,2022)

Database of the WCPFC Regional Observer Programme (2013-2024)



Proportional species composition of sea turtle bycatch in tuna **longline fisheries** in the Western and Central Pacific Ocean

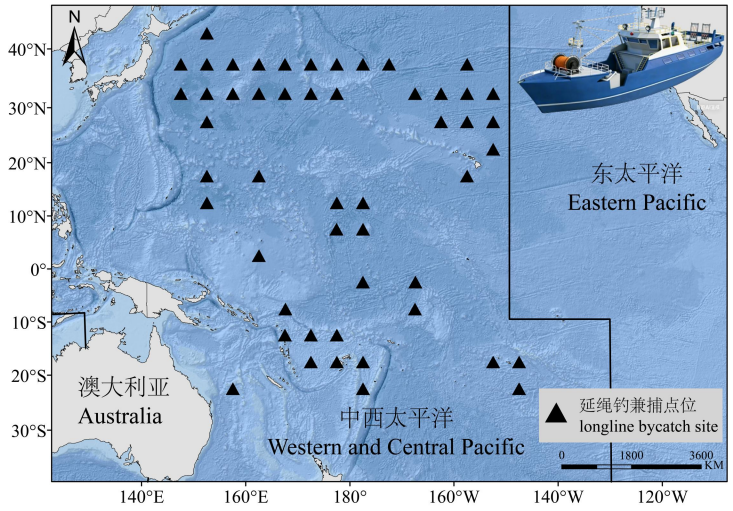
Main bycatch species

- Olive ridley turtle
- Loggerhead turtle
- Green turtle

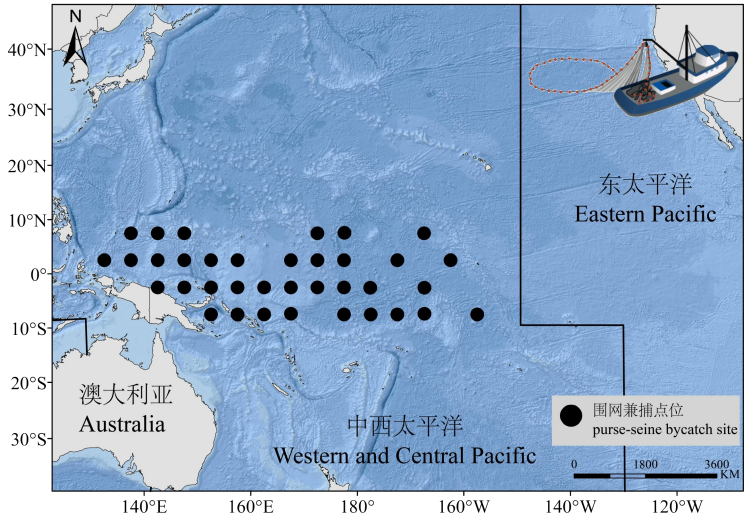
longline bycatch number

species	number
FLATBACK TURTLE	13
HAWKSBILL TURTLE	120
LEATHERBACK TURTLE	193
GREEN TURTLE	295
MARINE TURTLES NEI	373
LOGGERHEAD TURTLE	838
OLIVE RIDLEY TURTLE	884

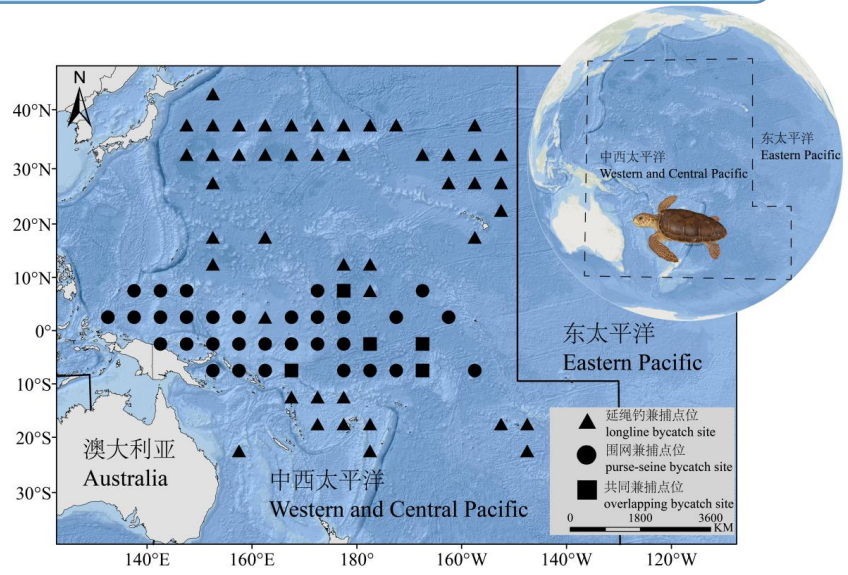
Species occurrence data → **Database of the WCPFC Regional Observer Programme (2015-2019)**



Longline species occurrence data



Purse seine species occurrence data

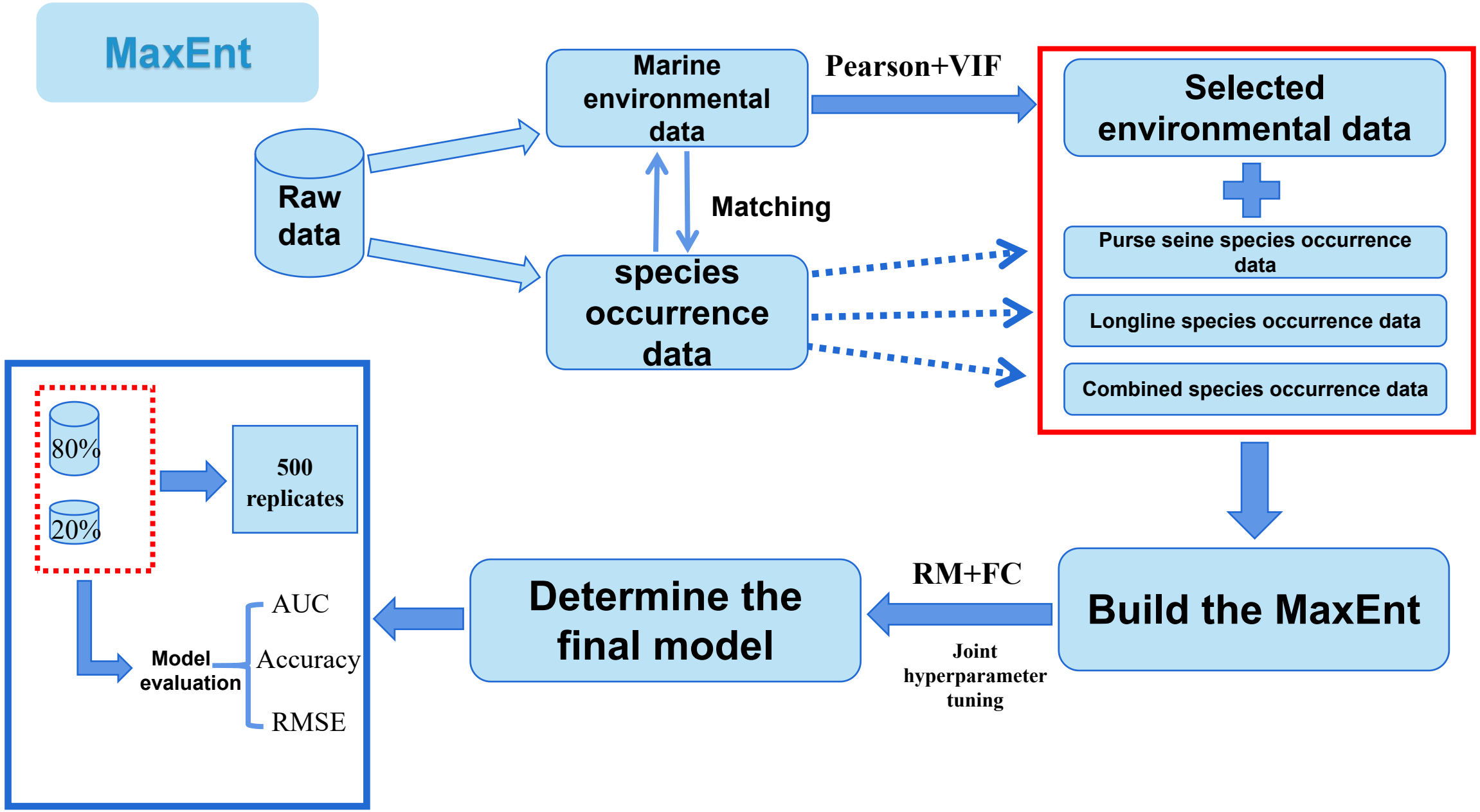


Combined species occurrence data

Marine environmental data → **Copernicus Marine Service website**

- Sea Surface Temperature(SST)
- Sea Surface Salinity(SSS)
- Dissolved oxygen concentration(DO)
- Eastward seawater velocity(u)
- Northward seawater velocity(v)
- Chlorophyll-a concentration(CHL)
- Mixed Layer Depth(MLD)
- Distance to shore(DTS)

$$EKE=\frac{1}{2}((u-\bar{u})^2+(v-\bar{v})^2)$$


MaxEnt
Raw data
Marine environmental data
Pearson+VIF
Matching
species occurrence data
Selected environmental data
Purse seine species occurrence data
Longline species occurrence data
Combined species occurrence data
Build the MaxEnt
RM+FC
Joint hyperparameter tuning
Determine the final model
80%
20%
500 replicates
Model evaluation
AUC
Accuracy
RMSE

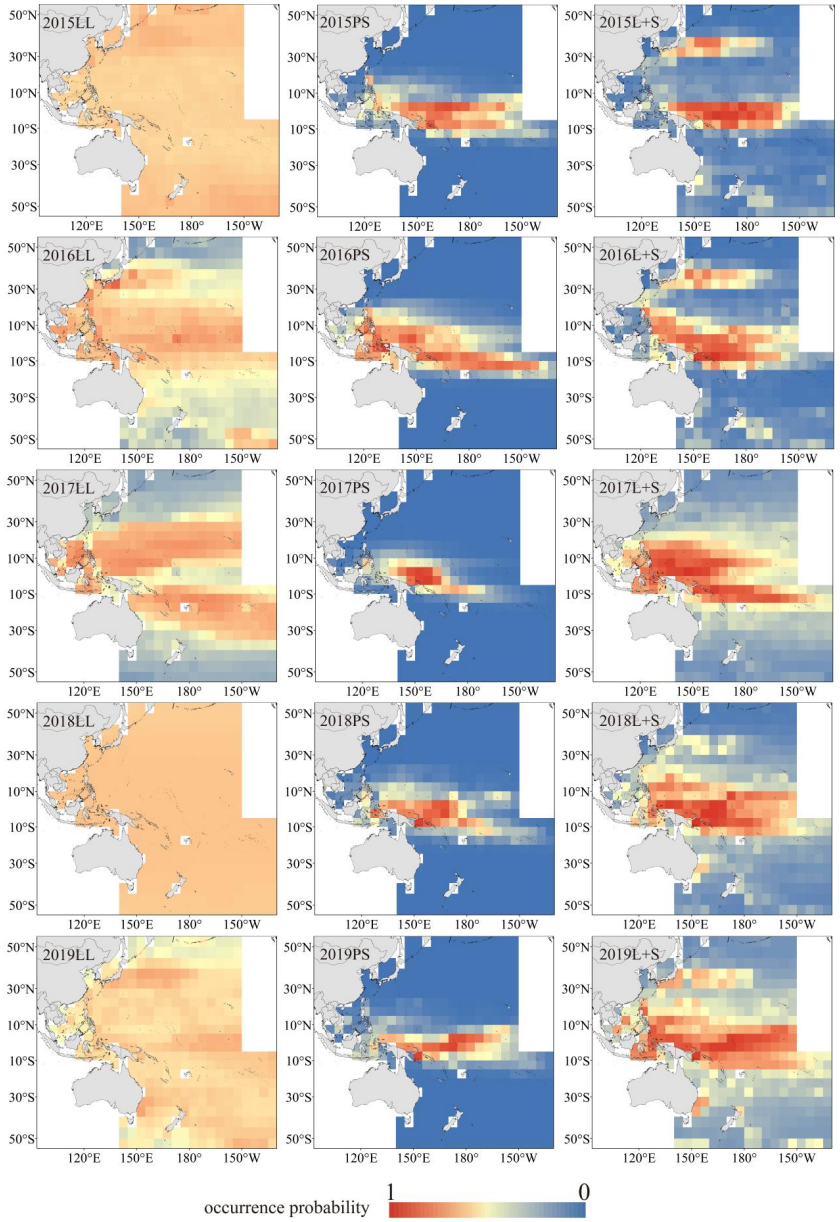
Habitat suitability patterns

Key findings

- Longline-only model: higher probabilities in northern and western areas

- Purse seine-only model: **equatorial hotspot band**

- Integrated model: broader, more connected hotspot pattern extending southeast

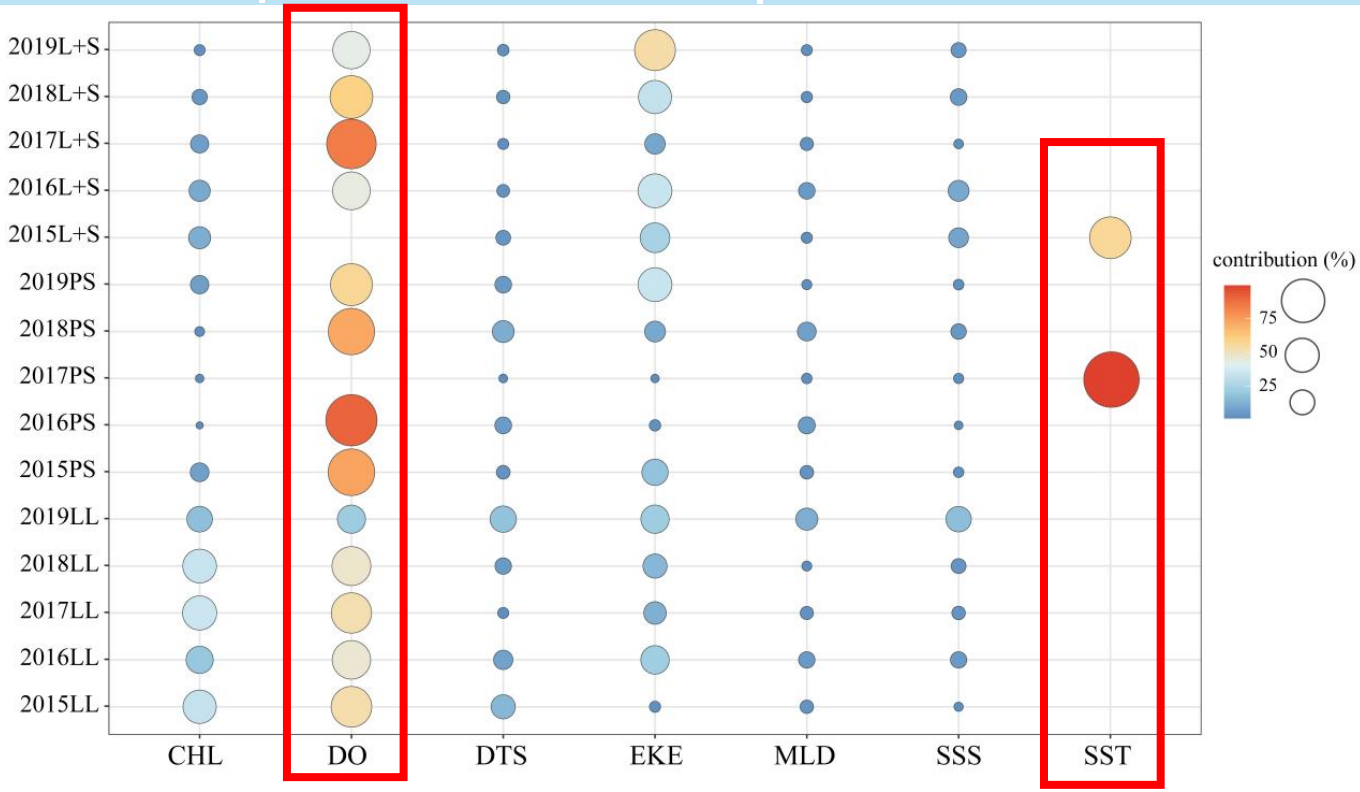


Model Predicted distribution hotspots of the *Caretta caretta* in the Western and Central Pacific

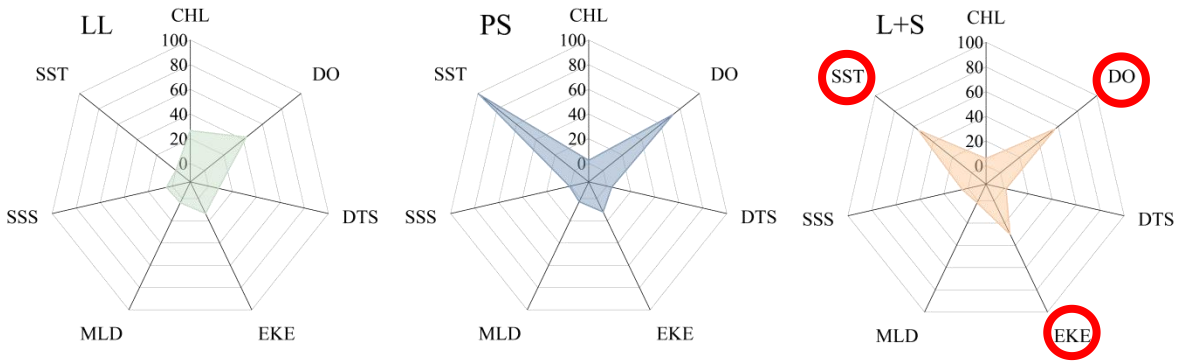
Drivers and model performance

Variable importance

- PS model mainly driven by SST and DO
- LL model relied more on CHL and DO
- Integrated model showed more balanced contributions



Bubble plot of environmental variable contributions to model predictions

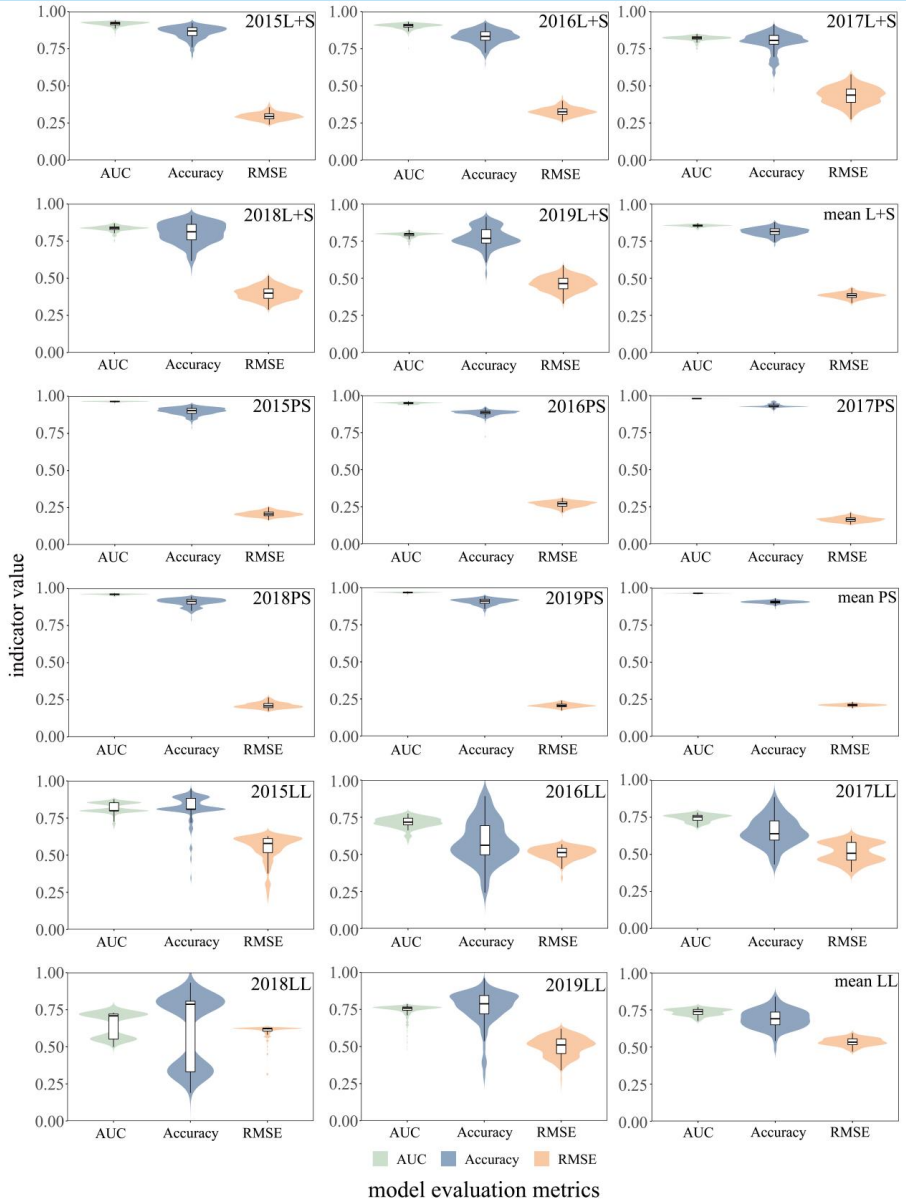


Radar chart of mean environmental predictor contributions (%) to model predictions

- **DO and SST remained key predictors across models**

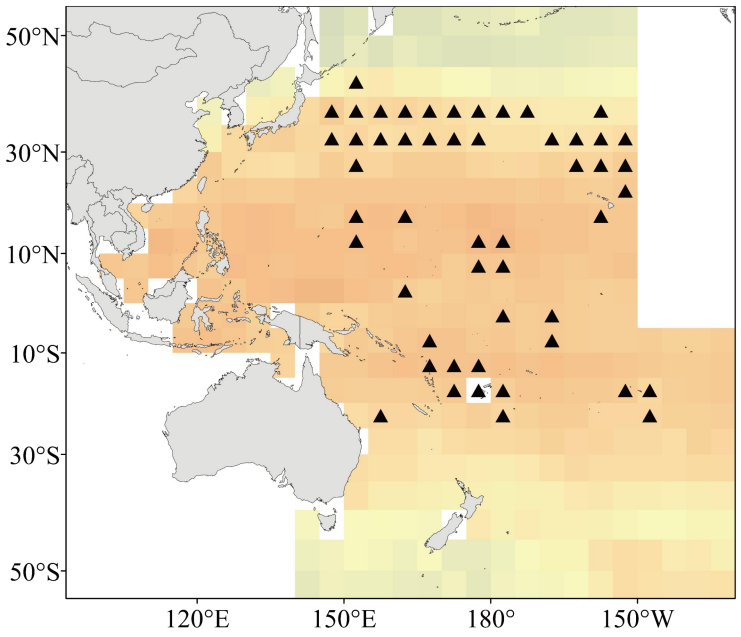
Model evaluation

- LL model showed stronger interannual variability
- PS model had good performance but less stable yearly pattern
- Integrated model achieved both higher performance and better stability

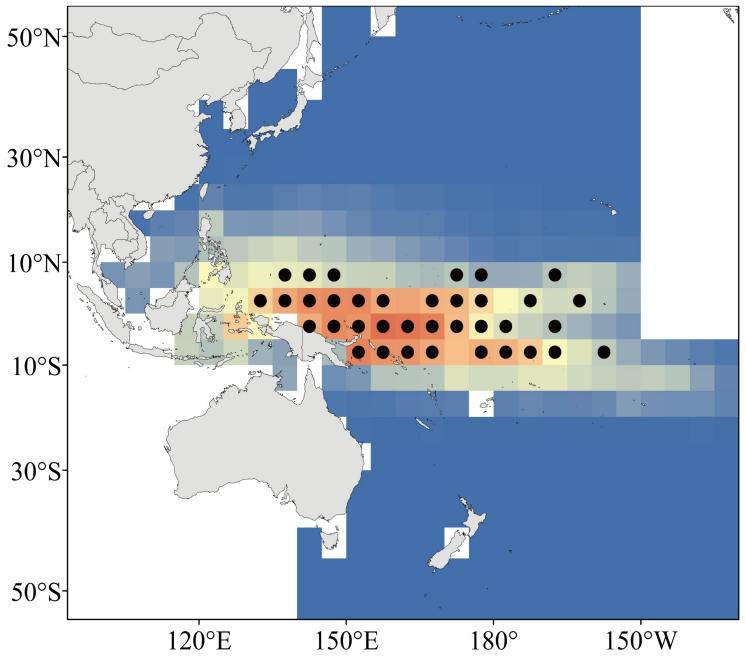


Comprehensive evaluation of model performance for *Caretta caretta* models based on different data sources across 2015-2019

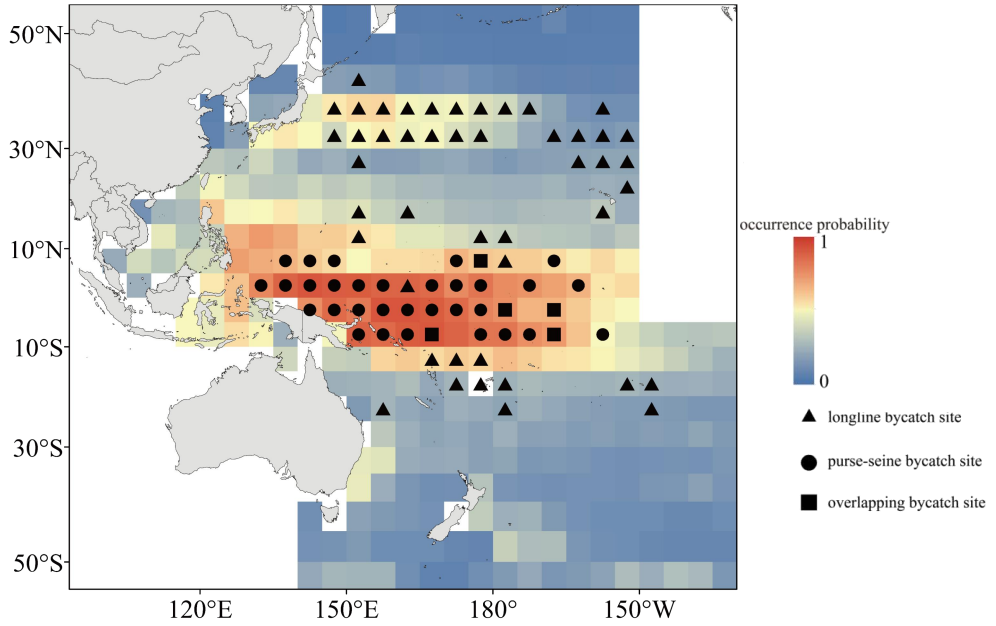
Comparison of the mean predicted probabilities from the three models overlaid with loggerhead turtle occurrence points



Prediction results based solely on longline observer data



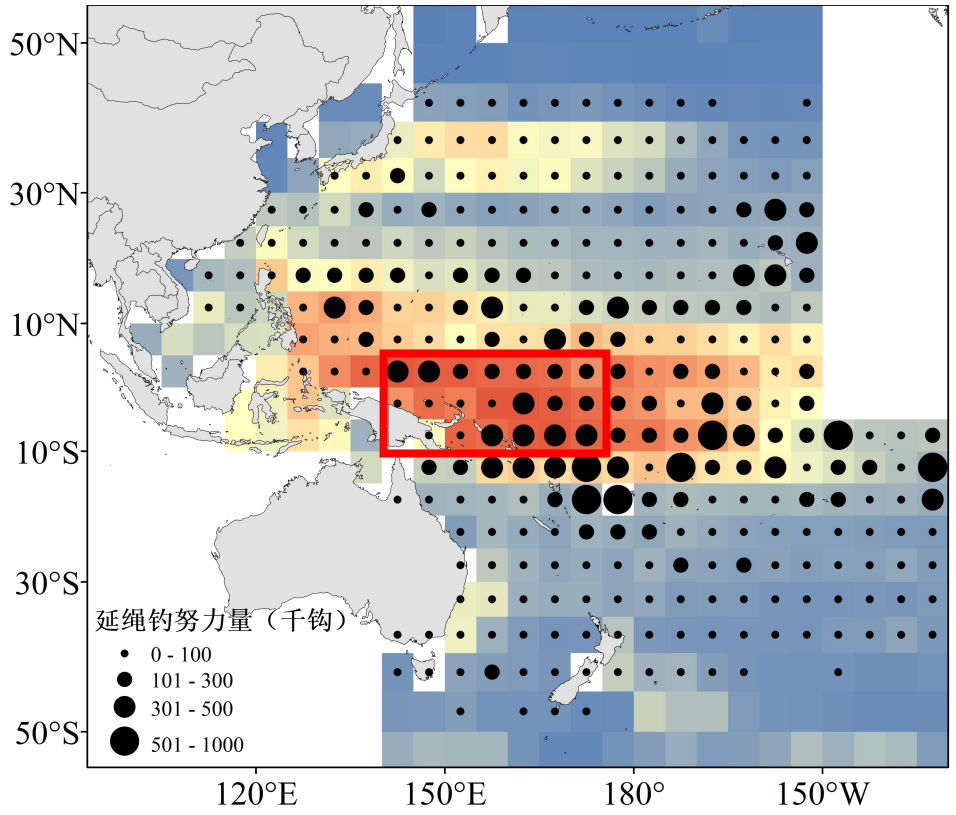
Prediction results based solely on purse seine observer data



Prediction results based on combined longline and purse seine observer data

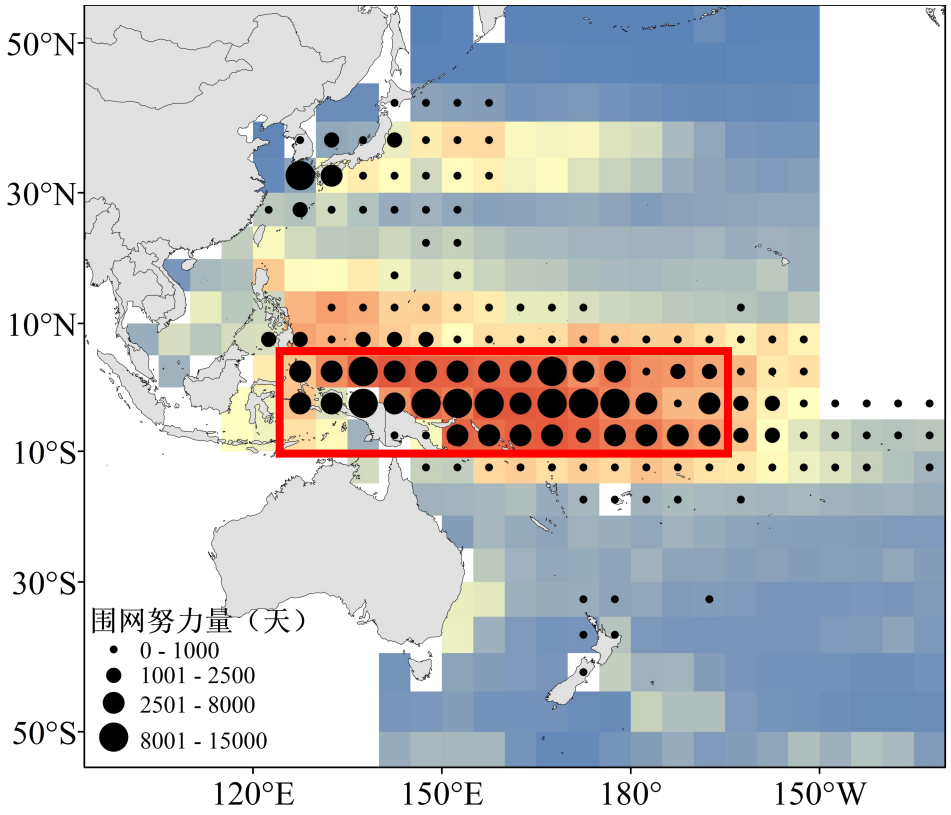
The combined longline + purse seine model better matched observed occurrence points and produced broader, more connected hotspot areas.

Interaction with the longline fishery



High-effort longline areas partially overlapped with loggerhead turtle high-suitability habitats.

Interaction with the purse seine fishery



Purse seine effort showed substantial overlap with loggerhead turtle habitat hotspots.

Work in progress

- After reasonably predicting the habitat suitability of the major bycaught sea turtle species, we plan to overlay fishing effort to conduct a spatial risk analysis, so as to provide a sound basis for management recommendations
- Future work will also include, for sea turtles caught as bycatch in longline fisheries, an analysis of their on-deck condition using the original observer logbook data submitted by observers, in order to evaluate which operational or environmental factors may contribute to mortality in bycaught sea turtles
- In addition, we also expect to further assess the severity of sea turtle bycatch based on PSA (Productivity–Susceptibility Analysis) in combination with conservation and management measures
- All of the above work is aimed at providing a stronger scientific basis for management recommendations

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THANK YOU!

QUESTIONS AND COMMENTS!

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