Mapping Sustainable Skipjack Tuna Habitats in the Sri Lankan EEZ: Integrating Machine Learning and Satellite-Derived Environmental Data.

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INTRODUCTION

Current fisheries management faces challenges in sustainability due to the dynamic nature of oceanographic conditions, data limitations, and traditional methods that lack predictive capabilities. Incorporating machine learning and satellite-derived data can enhance habitat mapping and improve resource allocation.

- Importance of skipjack tuna in Sri Lanka's EEZ
- Challenges in sustainable management
- Aim: Using machine learning and satellite-derived data

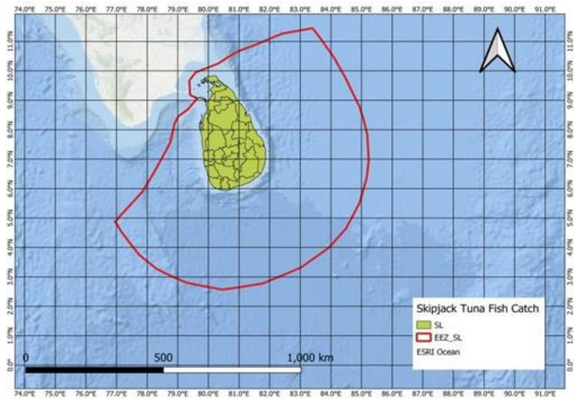

Figure 1: Sri Lankan EEZ Map (Study Area)

DATA & METHODOLOGY

- Data: Fisheries catch data, SST, Chl-a (Aqua MODIS, 2018–2022)
- Data Preprocessing: Gap-filling using DINEOF and DINCAE techniques
- Machine Learning Models: Artificial Neural Networks (ANN) and Ensemble Learning
- Habitat Classification: Low, Moderate, High suitability zones

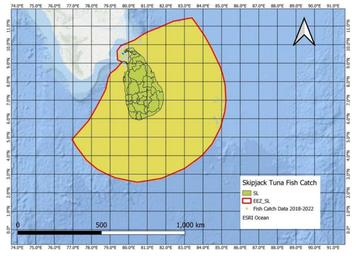

Figure 3: Habitat Suitability Map

RESULTS

- Habitat Suitability Mapping
- Seasonal variation in hotspots
- Model performance: $R^2 = 0.98$
- Higher CPUE was observed in areas where SST ranged between 26–30°C and Chl-a concentrations exceeded 5 mg/m³.

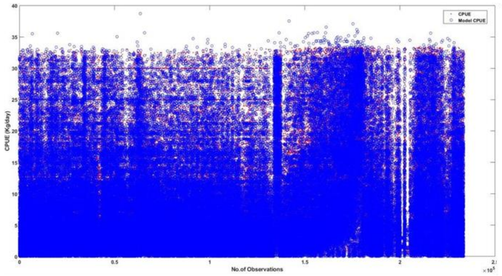

Figure 5: CPUE Model Estimate

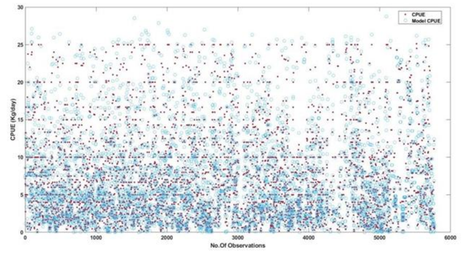

Figure 6: CPUE Model validation Estimate 2023

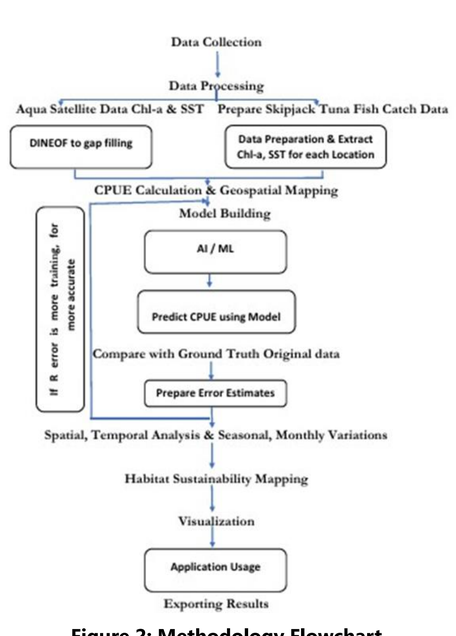

Figure 2: Methodology Flowchart

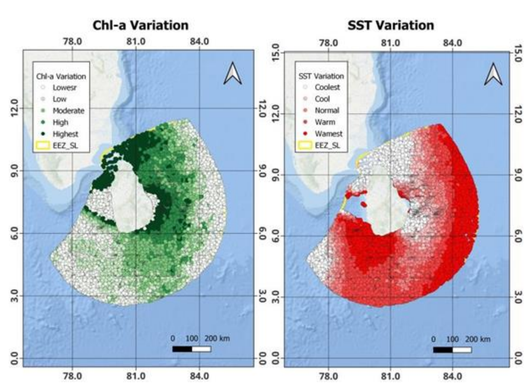

Figure 4: Chl-a & SST Maps

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DISCUSSION & FUTURE APPLICATIONS

- Data-driven fisheries management
- Real-time monitoring tools enable fisheries managers to adaptively optimize fishing efforts while minimizing environmental impact by providing up-to-date insights into habitat suitability.
- Future enhancements: Incorporating ocean currents, dissolved oxygen, and other oceanographic parameters for improved habitat prediction.
- Policy impact: The study's findings can inform fisheries policies by integrating data-driven approaches into national and regional management frameworks, supporting sustainable fishing quotas, reducing overfishing risks, and improving marine conservation efforts.

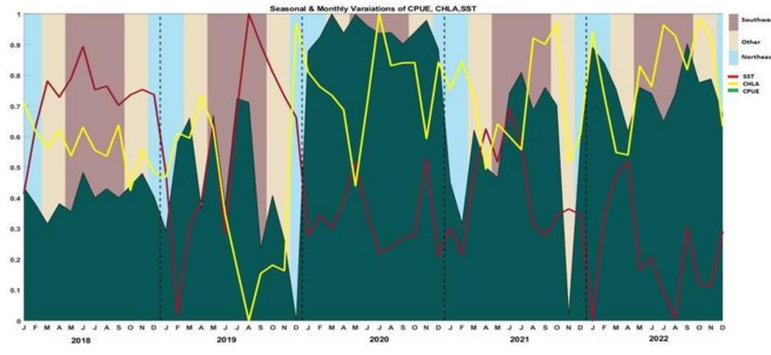

Figure 7: Seasonal Variations (CPUE, Chl-a, SST)

Conclusions

This study highlights the potential of machine learning and satellite-derived environmental data to enhance fisheries management in Sri Lanka's EEZ. The integration of artificial neural networks and ensemble learning successfully mapped skipjack tuna habitats, revealing seasonal variations and environmental drivers such as sea surface temperature and chlorophyll-a. The high model accuracy ($R^2 = 0.98$) confirms the effectiveness of predictive analytics in fisheries science. These insights can support data-driven decision-making for sustainable tuna fisheries, reducing overfishing risks while optimizing resource allocation. Future advancements incorporating ocean currents and dissolved oxygen will further refine habitat predictions, strengthening the link between science and policy for marine conservation and fisheries sustainability.

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