Assessment of Sea Cucumber (*Isostichopus badionotus*) Stock in the Northeast of Isla de la Juventud, Cuba

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INTRODUCTION

The sea cucumber *Isostichopus badionotus* is a valuable commercial resource in Isla de la Juventud, but recent trends in catch numbers and CPUE have shown a decline since 2014 (Figure 1). Additionally, the total catch over the past five years has remained below the total allowable catch (TAC) for the entire area.

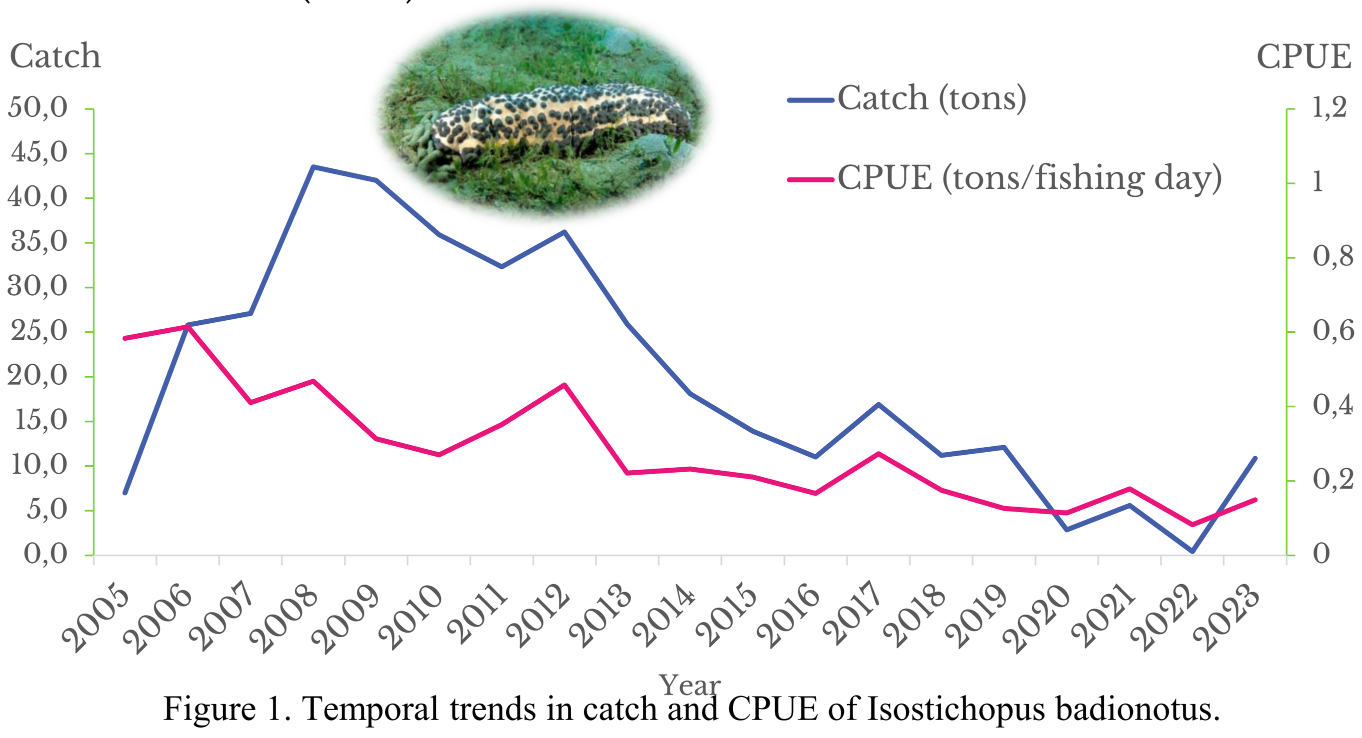

Figure 1. Temporal trends in catch and CPUE of Isostichopus badionotus.

Objective:

Develop a spatial and spatiotemporal distribution model (sdmTMB) to estimate sea cucumber density at each fishing site northeast of Isla de la Juventud, derive the corresponding fishable biomass, and compare the outcomes with those from the surplus production model (SPM).

METHODOLOGY

Study area

Each site was defined based on the original location and the grouping of transects during the sampling period.

Data:

- Time-series data of catch and effort (2005-2023) reported by PESCAISLA.
- Biological surveys were conducted during the reproductive season (June-October) annually from 2014-2019, and in 2023. These surveys reported transect coordinates, as well as the ventral length and eviscerated weight of each individual.

Data analysis:

- The sdmTMB model using the R package (sdmTMB) fits spatial and spatiotemporal GLMMs (Generalised Linear Mixed Effects Models).

Response variable: density

Predictor variable: year

Predictions per site: 400

Formula: $\mathbb{E}[y_{s,t}]=\mu_{s,t}$,

$\mu_{s,t}= g^{-1}(X_{s,t}\beta + \omega_s + \epsilon_{s,t})$

- X: model matrices multiplied by a coefficient vector β
- g^{-1}: a link function
- ω_s & $\epsilon_{s,t}$: spatial and spatiotemporal intercept random fields

RESULTS

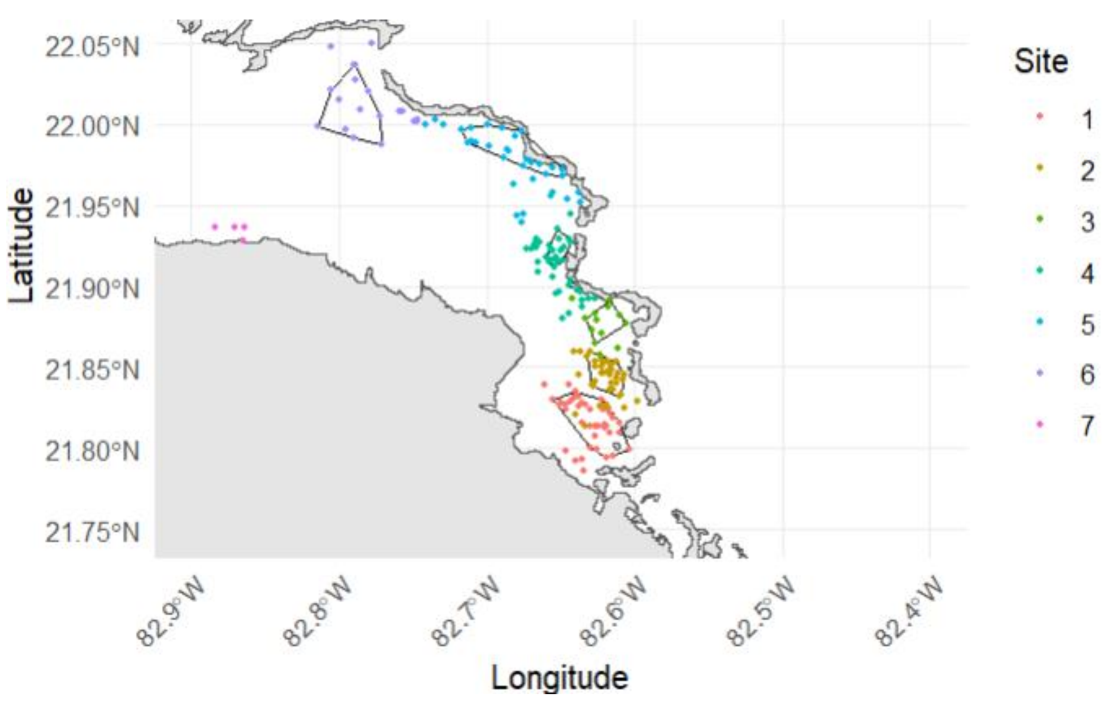

Figure 2. Newly defined fishing sites for analysis. Balandra (1), Doña María (2), La Cruz (3), Quitasol (4), Cayo Grande (5), Bajo la Malanga (6).

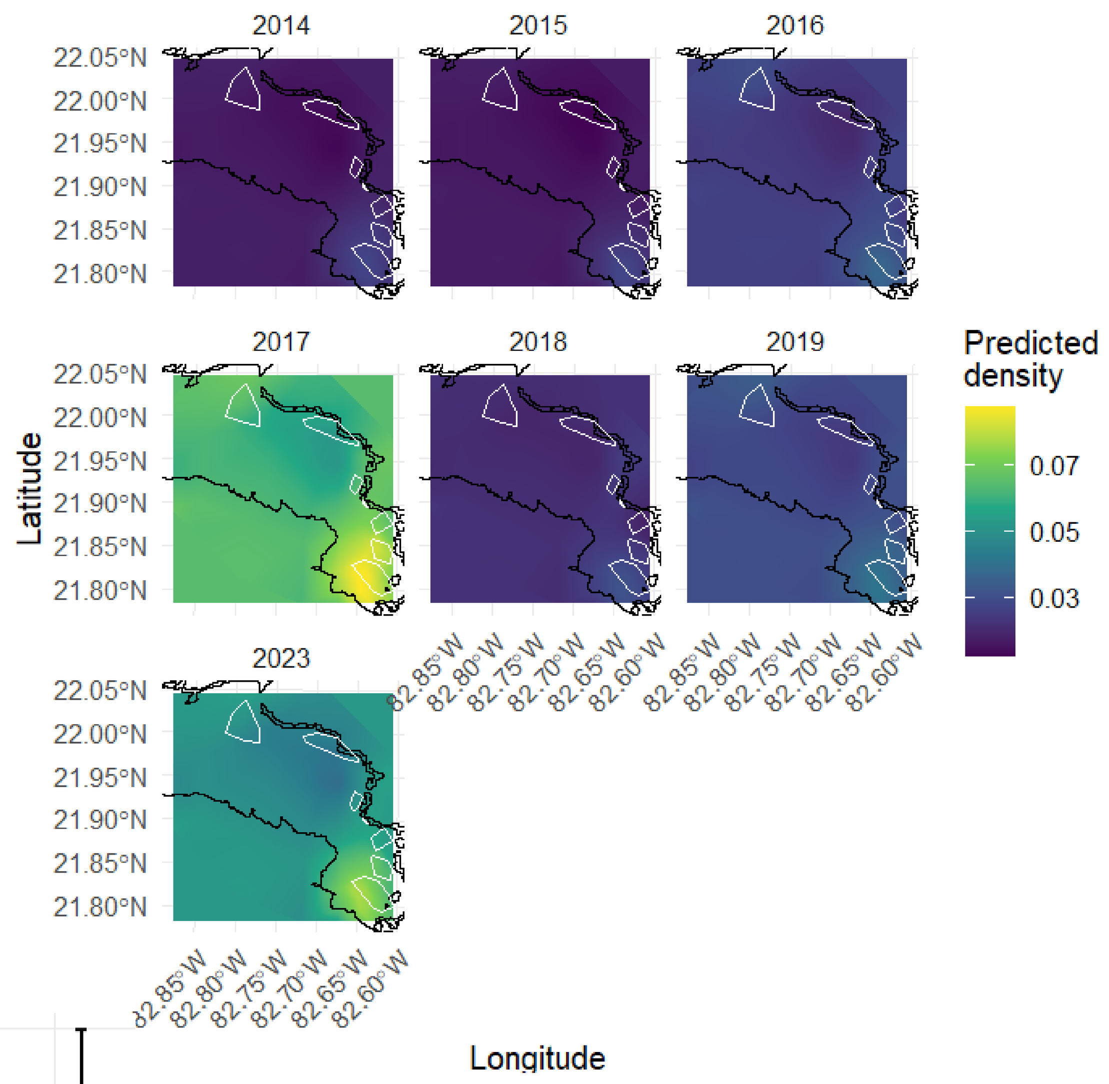

Figure 3. Spatiotemporal estimation of population density (2014-2019 and 2023) using sdmTMB.

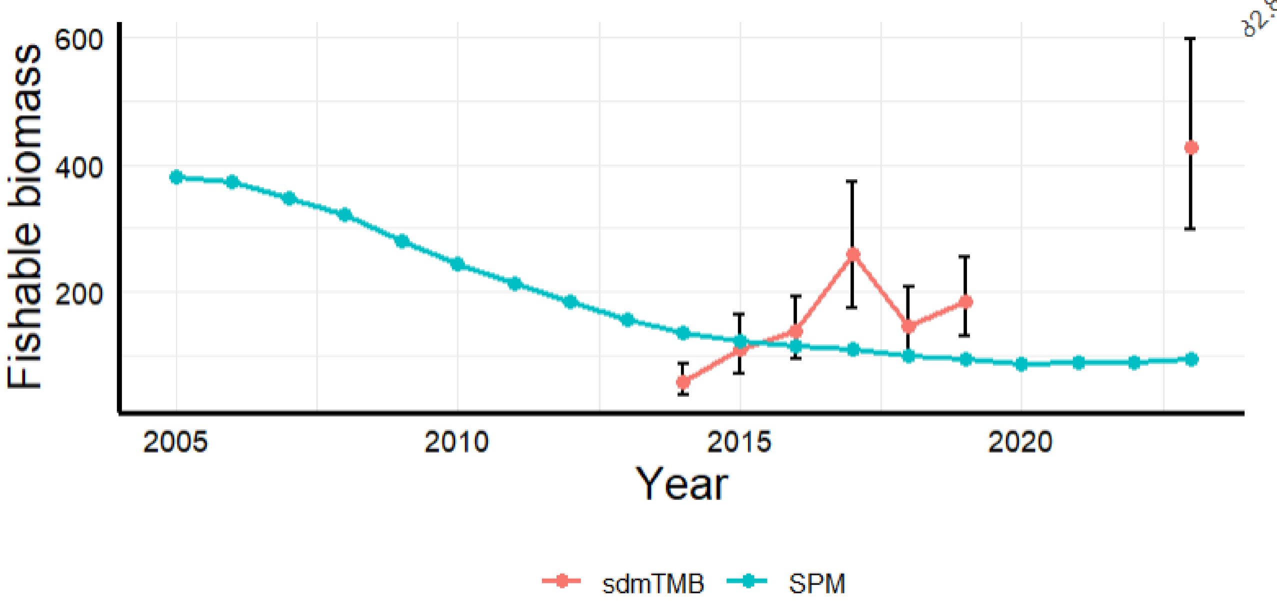

Figure 4. Total biomass comparison: sdmTMB vs. Surplus production model (SPM).

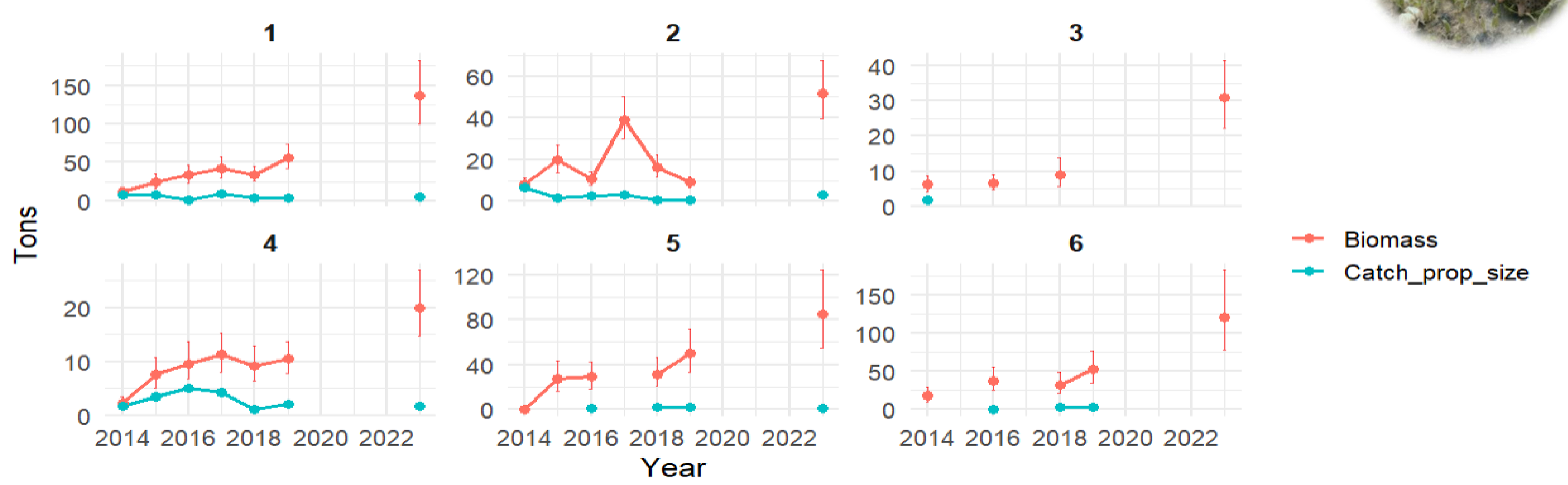

Figure 5. Comparison between estimated biomass and catch per site using average sampling weight (Catch_prop_size), estimated by sdmTMB.

- Fishing sites were defined by geo-referenced transects, with labels reassigned to avoid overlap.
- Tweedie GLMM captured both spatial and temporal variations, estimating densities ranging from 0.02 to 0.09 n/m², with peaks observed in 2017 and 2023. Sites 1, 2, and 6 showed the highest density values.
- The sdmTMB model estimated higher fishable biomass values than the SPM model. The sdmTMB model indicates signs of recovery, while the SPM model shows stability. However, in 2015, both models estimated similar biomass levels.
- Spatial analysis revealed localised clusters of high biomass at Sites 1, 5, and 6. While no catches were reported at Sites 3 and 6 during the sampling years, these sites still exhibited high values of fishable biomass.

DISCUSSION

- The estimated densities recorded above the FAO minimum (0.005 n/m²) (FAO, 2010) are comparable to national reports. As shown in Figure 1, Site 1 has consistently maintained optimal values since the beginning of the study, while the other sites initially recorded densities below the FAO minimum.
- sdmTMB models can overestimate densities when accessibility and connectivity factors are not taken into account (Pennino et al., 2019). In contrast, SPM models can homogenise stocks and underestimate dense patches (Horbowy *et al.*, 2017).
- The SPM model indicates that stock depletion has been occurring since 2014, whereas the sdmTMB model suggests that stocks are healthy at all surveyed sites, despite reported catches being below the TACs. This discrepancy may imply either an underutilisation of the resource at the established survey sites or challenges in accurately locating the stock.

RECOMMENDATIONS

- Increase the number of transects and sampling surveys, ensuring accurate georeferencing at each site.
- Include fishery monitors to record location data, effort, and biological data for each site.
- Set TACs at 2-5% of the fishable biomass. Additionally, increase the frequency of biological sampling at sites 3 and 6 to more accurately assess the distribution and status of the sea cucumber stock.
- Integrate the sdmTMB and SPM models to avoid underutilisation of local aggregations and overexploitation of marginal sites.

CONCLUSION

- The sdmTMB model reveals density peaks (0.02–0.09 n/m²) in 2017 and 2023, well above reproductive thresholds.
- The sdmTMB model highlights local aggregations that contribute to increased fishable biomass, while the SPM indicates an overall decline in the resource.
- The high levels of fishable biomass, combined with the absence of catches in certain years, specifically at sites 3 and 6, suggest that fishing efforts are not being directed toward areas where the stock is sampled. Alternatively, there may be challenges in locating the stock. This mismatch could contribute to a decline in catches.

ACKNOWLEDGEMENTS

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References

- FAO (2010) "Putting into practice an ecosystem approach to managing sea cucumber fisheries". Rome. 81p
- Pennino, M. G., et al (2019). *Ecology and Evolution*, 9(1), 653–663.
- Horbowy J., & Tomczak, M. T. (2017). PLOS ONE 12(11): e0186830.