EVALUATE THE IMPACTS OF ALTERNATIVE MANAGEMENT SCENARIOS FOR THE EASTERN PACIFIC TROPICAL TUNA SPECIES WITH POSEIDON

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EPO Poseidon overview
Stock assessments
- Biomass
- Recruitment
- Natural Mortality

SDM models

2018-2021
Buoy locations
HYCOM vectors

Fish prices

Existing Measures

Observed data
Operating costs

Model inputs
- operating model based on 6 modules
- Informed by various data sources
- Represented on a spatial $1^\circ \times 1^\circ$ square grid cells
ABM dynamics

- fleet dynamics are emergent based on calibrated behavior
- produces realistic trip trajectories, timing and actions (FAD distributions, FAD sets and other purse seine sets)
Model Fitting

**Targets**
- Develop a list of calibration targets using observed values known from data

**Bound**
- Select plausible ranges to bound free parameters

**Search**
- Run a search algorithm to find the combination of free parameters that produces values close to calibration targets
Model fit

Calibration results (2022)
Mean error: 2.33%

Number of actions
- Sets on own FADs
- Sets on others’ FADs
- Non-associated sets
- FAD deployments
- Dolphin sets

Catches from sets on own FADs (t)
- Bigeye
- Skipjack
- Yellowfin

Catches from non-associated sets (t)
- Bigeye
- Skipjack
- Yellowfin

Catches from dolphin sets (t)
- Bigeye
- Skipjack
- Yellowfin

Total catches (t)
- Bigeye
- Skipjack
- Yellowfin

Trip durations (h)
- Average trip duration
- Average hours out

Legend:
- Above target
- Below target
- On target
ABM and Management
→ Simulate reductions of current individual vessel active FAD limits (by vessel class) at different levels

→ Calculate the corresponding % reduction in global and per vessels’ number of active FADs monitored and some other associated metrics of interest.

→ Compare the difference between the two assumptions

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>2022 limit</th>
<th>2023 limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 6.a</td>
<td>400</td>
<td>340</td>
</tr>
<tr>
<td>(1,200m³ and greater)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 6.b</td>
<td>270</td>
<td>255</td>
</tr>
<tr>
<td>(&lt;1,200m³)</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Simulations</th>
<th>Assumptions</th>
<th>FAD Limit Scenarios</th>
<th>Stochasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>Deploy at emergent rate from calibrated 2022 model</td>
<td>5% increments (0-100% current)</td>
<td>8</td>
</tr>
<tr>
<td>160</td>
<td>Deploy at maximum rate allowed</td>
<td>5% increments (0-100% current)</td>
<td>8</td>
</tr>
</tbody>
</table>
1. Relationship between FAD limits and active FADS
2. Relationship between FAD limits and fleet
3. Effect of FAD limits on OBJ sets and catch
4. Multispecies outcome
5. Behaviors behind the results
Proportional relationship between proportion of FAD limit and number of active FAD per vessel

25% reduction in FAD limit
→ 60 active FADs per class 6 vessel
→ 200 maximum active FADs per class 6 vessel

Can regulate number of active FADs in the ocean with efficacy by adjusting FAD limit
Relationship between FAD limits and Fleet

At 100% of the current FAD limit:

→ 58% of vessels are affected by the regulation

At 70% of the current FAD limit:

→ 68% of vessels are affected by the regulation

At 15% of the current FAD limit:

→ 90% of vessels are affected by the regulation

Vessels are not affected uniformly
Effect of FAD limits on OBJ sets and catch

- No impacts to total OBJ sets and catch between 100 and 75% of current FAD limits
- Reducing OBJ sets and catch may require very low FAD limits relative to current levels

25% reduction of FAD limit can increase ecological benefits without impacting the fishery (~5.8% FAD stranding rate)

IFLs lower than 13% of current FAD limits are needed to reduce biological impacts (Total catch and reduced bycatch)
Fishers adapt to a loss of active FADs in the ocean by shifting to UNA and DEL sets.

- Settype composition changes as
  - Effort shifts to other settypes
    - Spatial shift in effort to regions BET rich - west/south/south-west
  - Few vessels go over BET limit
Multispecies outcomes

![Graph showing multispecies outcomes with different catch levels for various species. The x-axis represents the proportion of FAD limit, and the y-axis represents total catch in thousands of metric tons (t). The graph shows different catch levels for Skipjack, Yellowfin, and Bigeye species.]
• Species composition changes as
  • Effort shifts to other settypes
  • Spatial shift in effort to regions BET rich - west/south/ south-west
  • Few vessels go over BET limit

Spatial shift changes the composition of available biomass under FADs

Explore alternative secondary spatial measures geared to mitigate impact on Bigeye Tuna
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Spatial shift changes the composition of available biomass under FADs

Explore alternative secondary spatial measures geared to mitigate impact on Bigeye Tuna
Could additionally explore effectiveness and responses to the BET limit

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● POSEIDON is a flexible support tool for fishery management.

● The coupled agent-based bio-economic model, POSEIDON, was adapted to represent the EPO tropical tuna FAD fishery. The adaptive nature of the agents allows for the evaluation of complex management scenarios while assessing social, biological, and economic tradeoffs.
Take away - Management

- Reducing the percentage of active Fish Aggregating Devices (FADs) per vessel to 80% of the current FAD limit could significantly reduce ecological impacts associated with FADs, such as reduced stranding, while maintaining the number of sets at levels consistent with those observed at the current FAD limit.

- To effectively mitigate the biological impact on tropical species populations, managers could consider implementing drastic reductions in the Fishery Aggregating Device (FAD) limit or regulations covering all three set types.

- Additionally, combining these measures with spatial regulations is advisable, especially considering the non-uniform effort impact on all three tropical tuna species.

- Note that these results are one of the possible outcomes according to current model specifications. POSEIDON can provide additional sensitivity analysis to model assumptions that can help map out the array of potential outcome for a specific management strategy.

- Additionally more research would be desirable to support management decision dependant on unknown processes link to FAD fishery.
Thank You & Questions

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