Current Analyses and/or Figures Available from Thesis Manuscript

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Parameters used to run prioritizr:

Planning region

Planning region is the entire Pacific ABNJ.

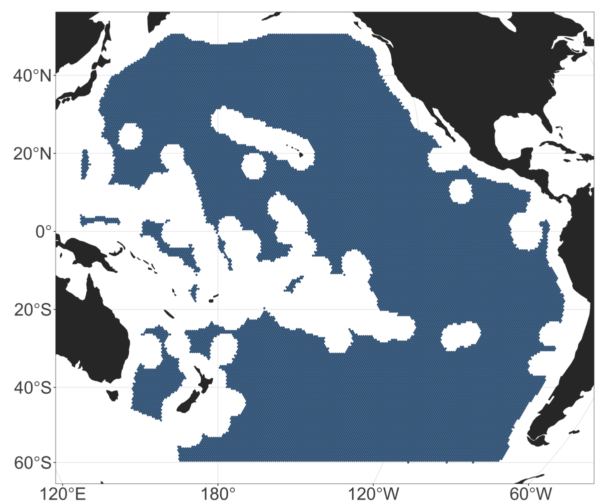

Figure 1: Planning region

Thoughts:

- Not sure if the Pacific ABNJ may be the best study area for this paper. Might be good to rethink –maybe use a smaller area?

Pelagic fisheries conservation features

There are a total of four large pelagic species' spawning grounds and five marine turtle bycatch distributions used.

Thoughts:

- I should increase number of conservation features. Maybe use more species from the IUCN database or simply change to AquaMaps
- If using AquaMaps: maybe rethink representation targets (uniform or inverse area-basaed)?

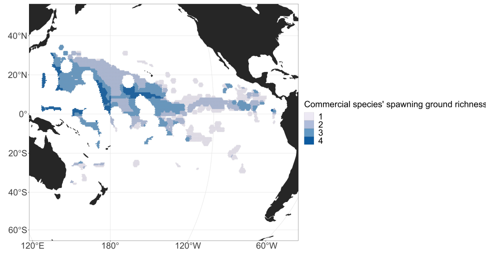

Figure 2: Summary of Spawning Ground layers

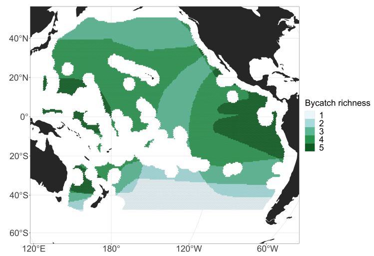

Figure 3: Summary of Spawning Ground layers

Climate-smart features

We used RCE and climate velocity as climate metrics, computed under three different climate scenarios (SSP 1-2.6, SSP 2-4.5, and SSP 5-8.5). The projected temperatures forced under these three climate scenarios were from a multi-model ensemble (11 General Circulation Models).

RCE was calculated as follows:

$$RCE = \frac{\Delta°C \ \ (absolute \ \ change \ \ 2050 - 2100)}{\Delta°C \ \ (seasonal \ \ range \ \ 2015 - 2020)}$$

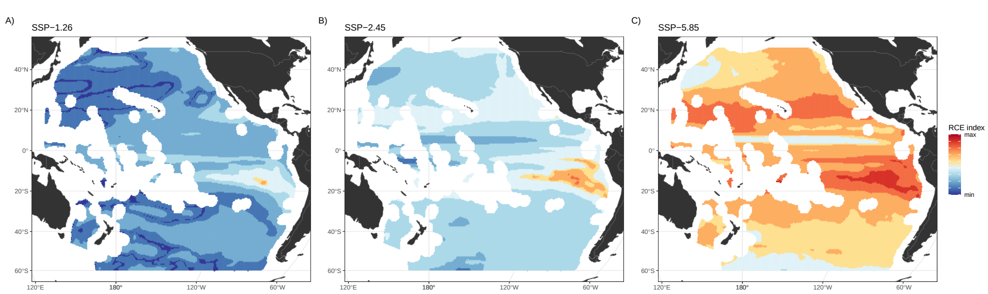

Figure 4: RCE

Climate velocity was calculated as follows:

$$Climate\ \ velocity = \frac{\Delta°C\ \ yr^{-1}(2050-2100)}{\Delta°C\ \ km^{-1}(2050-2100)}$$

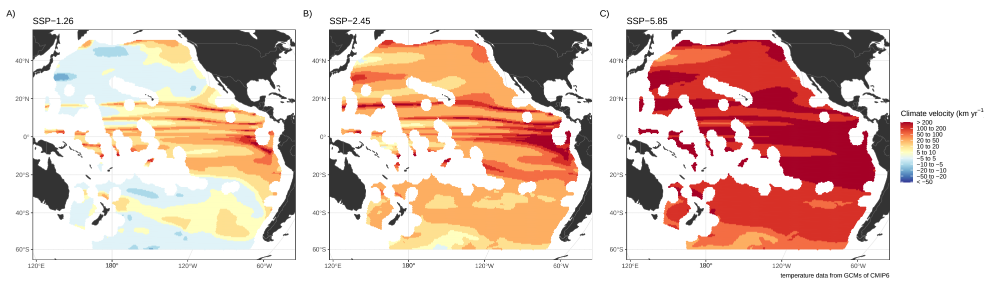

Figure 5: Climate Velocity

Thoughts:

- If we're using 2015-2020 as the denominator for RCE (seasonal range), then shouldn't the others used to calculated both RCE and velocity be changed to 2015/2020 - 2100 instead of 2050-2100?
- Might be good to calculate 'exposure' for pH and oxygen (absolute changes 2020 (current) to 2100)
- Maybe have runs that use RCE alone and runs that use velocity alone

Cost layer

We only used large and medium pelagics for the computation of the cost layer. Cost layer was from Watson (2017) and Tai et al. (2017) using the 2006-2015 catch data. We also smoothened out the cost layer.

Cost layer was calculated as:

$$Cost\ \ layer(USD) = total\ \ catch(kg)\ \ \cdot\ \ ex - vessel\ \ price(USD\ \ kg^{-1})$$

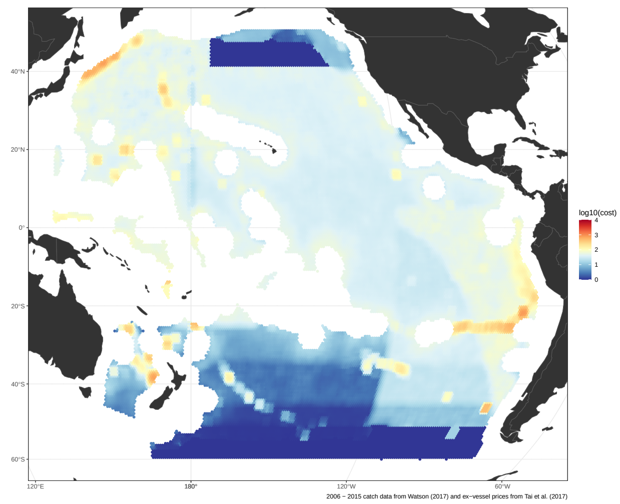

Figure 6: Cost layer

Thoughts:

- I think we should increase scope and generalize by adding all the species available for the cost layer.
- Maybe tweak how cost was calculated/defined? Not sure on how to do this, but if there's a way to possibly incorporate fishing effort from Global Fishing Watch?

Different analyses done:

Climate-uninformed and climate-smart approaches: Overview

Each of the four different approaches listed below were run with varying targets from 5 to 25% (in increments of 2.5%).

1. Climate-uninformed

- used no climate-smart metrics

2. "Feature"

- incorporated climate-smart metrics as features, with targets set similar to conservation features

3. "Percentile"

- incorporated climate-smart metrics as features but only if they intersected with conservation features
- prioritized protection of areas of slowest velocity and lowest RCE (defined as 25th percentile)

4. "Penalty"

- velocity and RCE were treated as penalties, where areas of higher velocity and RCE were penalized for being selected

Climate-smart approach: Feature

Climate velocity and RCE were treated as conservation features. Conservation feature layers were created by selecting areas of slowest velocity and RCE (areas of velocity/RCE within their first quartiles). Then, targets were assigned to velocity and RCE.

Conservation features (apart from velocity and RCE) had uniform targets (i.e. each run had a uniform target from 5 to 25%). To know the targets for velocity and RCE for the *Feature Approach*, the following equation was used:

$$\mathrm{E}ffective\ \ target\ \ (\%) = 0.25 \times \mathrm{R}epresentation\ \ target$$

where $\mathrm{E}ffective\ \ target$ represents the actual targets for each feature (5-25%) similar to the targets of the conservation features for that specific run, and the $\mathrm{R}epresentation\ \ target$ represents the value that will be inputted as "target" for each of the climate-smart features (RCE and velocity) in `prioritizr`.

For example, if the targets used for the spawning areas for this particular run is 25%, then the target assigned to velocity and RCE in this run was 100%.

Climate-smart approach: Percentile

The areas of the slowest climate velocity and lowest RCE were defined as areas that had velocity and/or RCE within their first quartiles (25th percentile) and intersected with conservation features.

The actual targets for the conservation features using the *Percentile Approach* were assigned using the equation:

$$\mathrm{E}ffective\ \ target\ \ (\%) = 0.25 \times \mathrm{R}epresentation\ \ target$$

where $\mathrm{E}ffective\ \ target$ represents the actual targets for each feature (5-25%) and the $\mathrm{R}epresentation\ \ target$ represents the value that will be inputted as "target" for each of the features in `prioritizr`.

For example, to have an effective target of 25% (comparable to Feature and Penalty approaches), the target inputted into `prioritizr` was 100%.

Thoughts:

- What happens when percentiles are changed too? Instead of just using 25th percentile, like in Nur's paper, maybe explore other percentiles (e.g. 5 - 35th percentiles, increments of 5?)

Climate-smart approach: Penalty

Penalties for each run were calculated as follows:

$$Penalty = \sum_{i=1}^{I} P \times D_i \times X_i$$

where P represents the *penalty scaling*, D_i represents penalty data (RCE / velocity values) for each planning unit i, and X_i represents the decision variable (1 - selected planning unit i/0 - not selected planning unit i).

Analyses done to determine **penalty scaling** (and other important details):

- Climate velocity and RCE were treated as independent penalties
- Each climate metric was scaled to 30% of the cost (penalty scaling) (e.g. scaled the range of velocity and RCE values forced under SSP 2-4.5 to 30% of the cost)
- But different scaling were also explored (20, 30, 40, 50%),
- The magnitudes of resulting cost increased with increasing scaling factor (for each climate scenario)
- The magnitudes of RCE remained constant with increasing scaling factor
- The magnitudes of velocity decreased with increasing scaling factor
- Total area (km^2) selected for protection remained the same

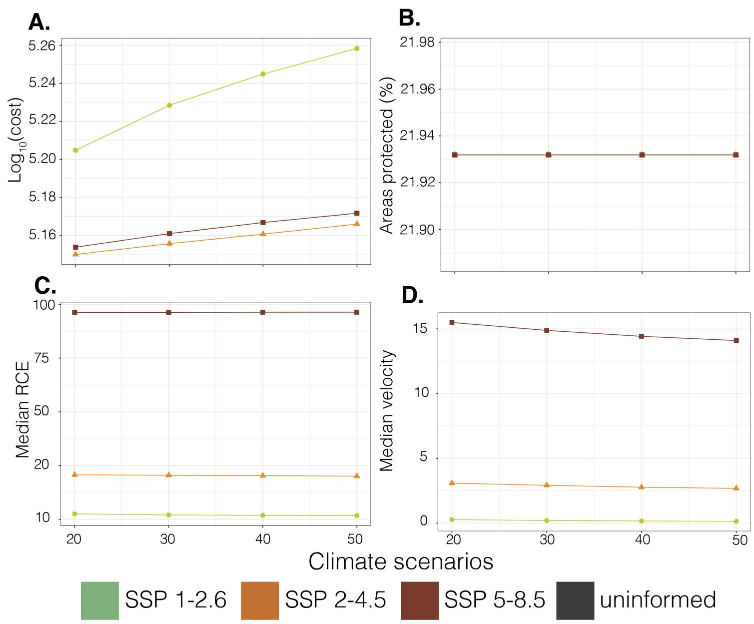

Figure 7: Summaries of sensitivity analyses. A. Total cost. B. Total area selected for protection. C. Median RCE. D. Median velocity.

Post-prioritizr analyses

Cohen’s Kappa Correlation

Cohen’s Kappa was used to show degrees of agreeability between spatial plans created under different climate scenarios **but** under the same approach.

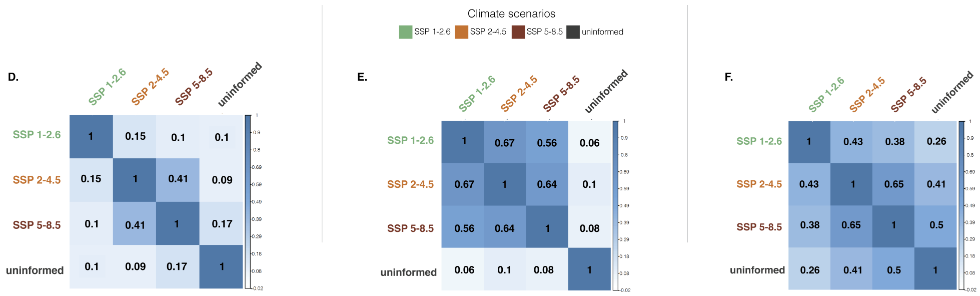

Figure 8: Correlation matrices. D. Feature approach. E. Percentile approach. F. Penalty approach

Thoughts:

- Also cross-compare different approaches using Cohen’s Kappa
- Like in Nur’s paper, use Kruskal-Wallis to compare area, cost, median velocity, and median RCE between approaches and within approaches as well?
- Possibly just focusing the discussion on the resulting spatial plans forced under the same climate scenario (e.g. SSP 5-8.5)?

“No-regret” spatial plans

“No-regret” spatial plans were created for each climate-smart approach. Planning units were included in the “no-regret” spatial plan if they were selected for protection in all the three climate scenarios (SSP 1-2.6, SSP 2-4.5, and SSP 5-8.5).

Frequencies of selection

Frequencies of selection of each planning unit were also mapped out for each climate-smart approach. The minimum frequency is 0 wherein said planning unit was not selected in all climate scenarios. The maximum frequency is 4 wherein said planning unit was selected in all 4 climate scenarios (climate-uninformed, SSP 1-2.6, SSP 2-4.5, and SSP 5-8.5).

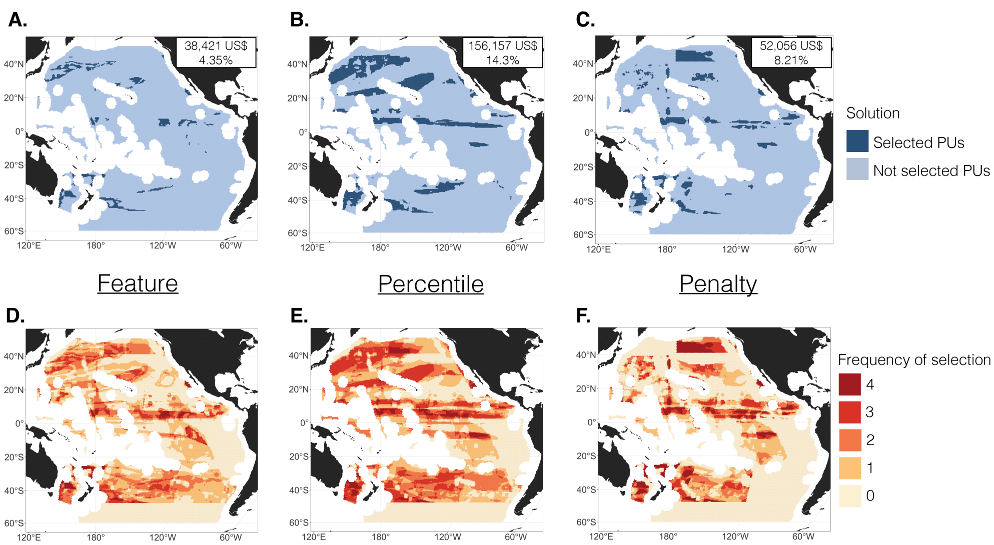

Figure 9: No-regret spatial plans (A-C) and Frequencies of selection (D-F).