Does habitat quality influence reef fish biomass recovery in temperate Marine Protected Areas (MPAs)?

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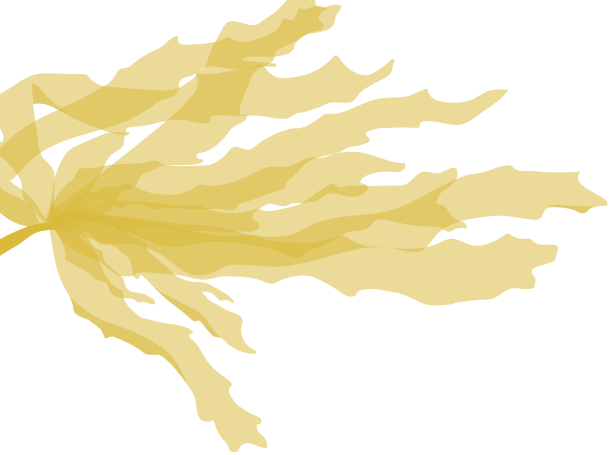


Marine Protected Area effectiveness

- Positive outcomes for reefs if MPAs are well…
  - Designed: no-take, large, isolated[1]
  - Managed: staff/budget capacity[2]
  - Enforced: actively monitored/enforced[1-2]

- Varying degrees of ecological effectiveness[1, 3]

→ How important is the broader seascape context?

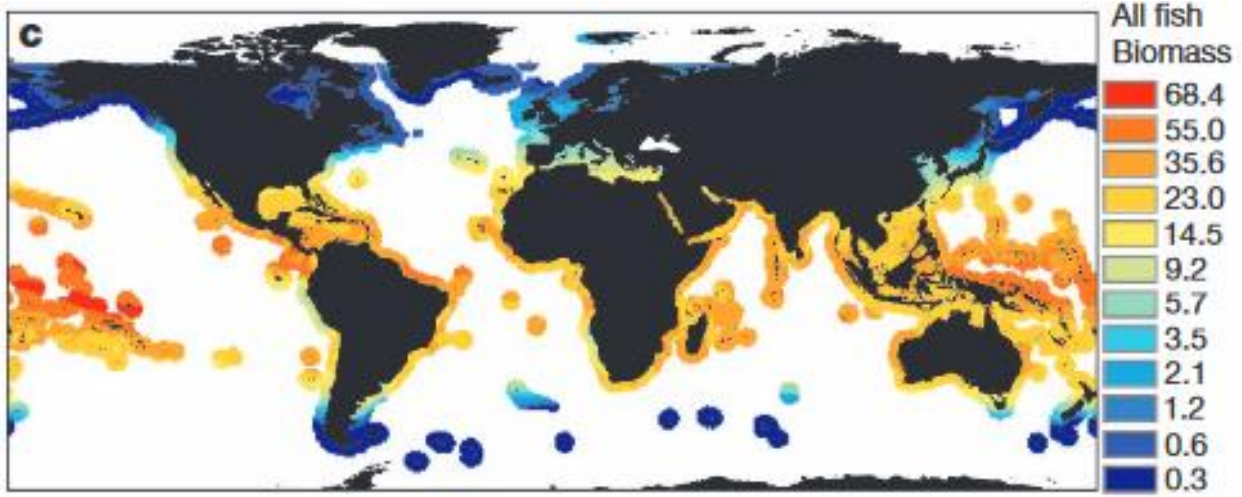
Local influences on MPA effectiveness

- Reef communities shaped by a range of environmental, biological, physical, and anthropogenic factors

- Importance of local factors unknown
  - Confound assessments & conclusions of MPA effectiveness
  - Influence long-term conservation outcomes
  - Insights into improving ecological effectiveness

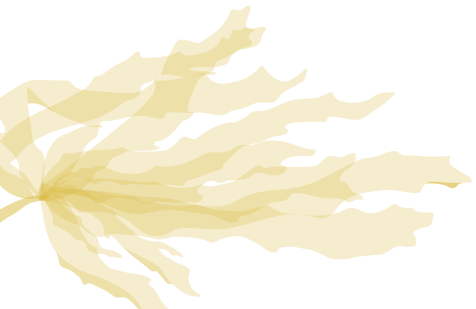
Challenges identifying local factors important for MPA effectiveness

- Small-scale assessments & meta-analyses
  - Paired inside/outsides comparisons[4]
- Large-scale assessments
  - Focus on management
  - Confounded by intrinsic broadscale gradients[1]



Modelled global distribution of total reef fish biomass[1]

To determine the importance of local biological, physical, and anthropogenic factors in shaping distributions of reef fish biomass across temperate Australia, relative to MPA management and after accounting for broad-scale environmental influences.



Multi-staged approach

- Stage 1 – Predicting biomass on openly fished reefs
  - Random Forest model
  - Total reef fish biomass (RLS, ATRC, Parks Vic)
  - Broad-scale environmental factors (SST, salinity etc)

- 2,074 openly fished sites
- 47 countries.

Multi-staged approach

- Stage 2 – Comparing observed & predicted biomass

- Biomass predicted for
  - 7,369 surveys from 850 sites
  - 2008 – 2021
  - Co-located biological, physical & anthropogenic data

475 fished sites

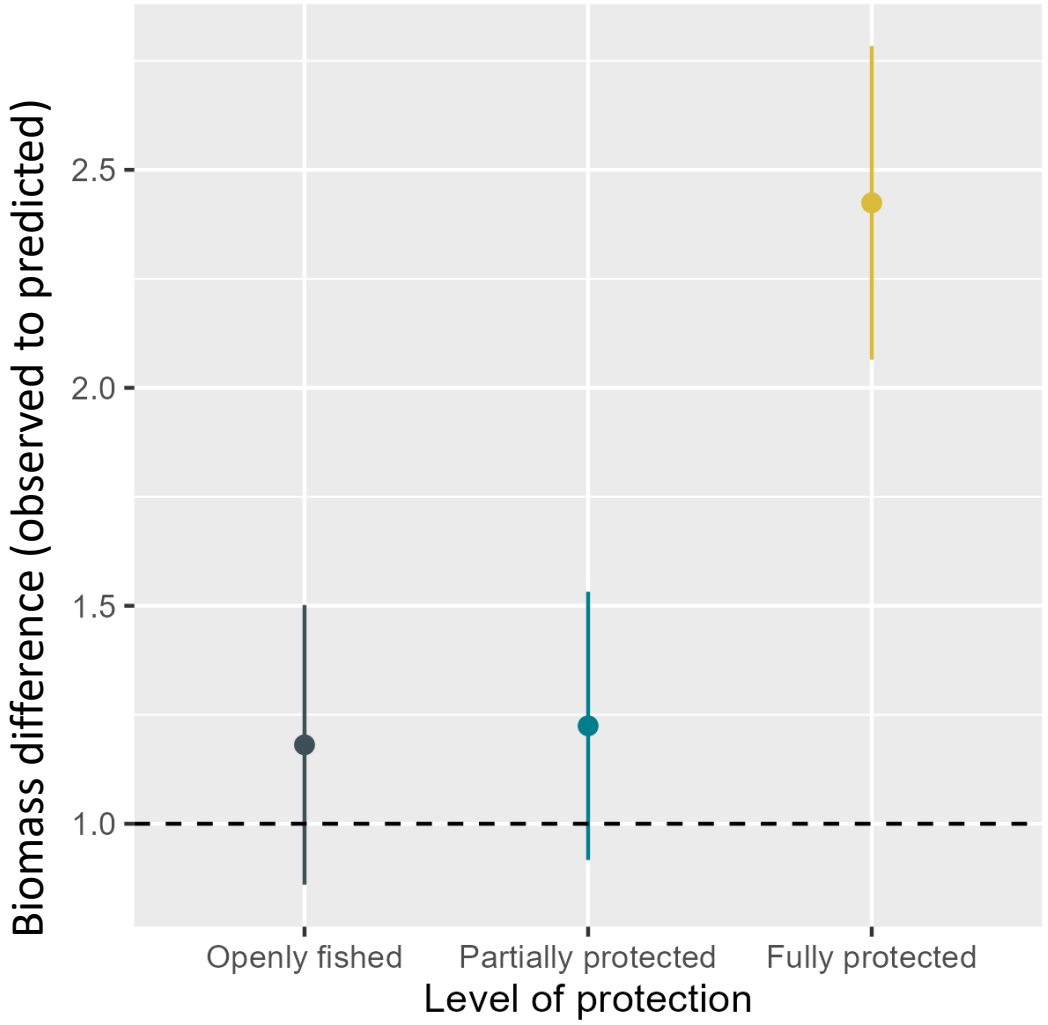
178 partially protected sites

197 no-take sites

Multi-staged approach

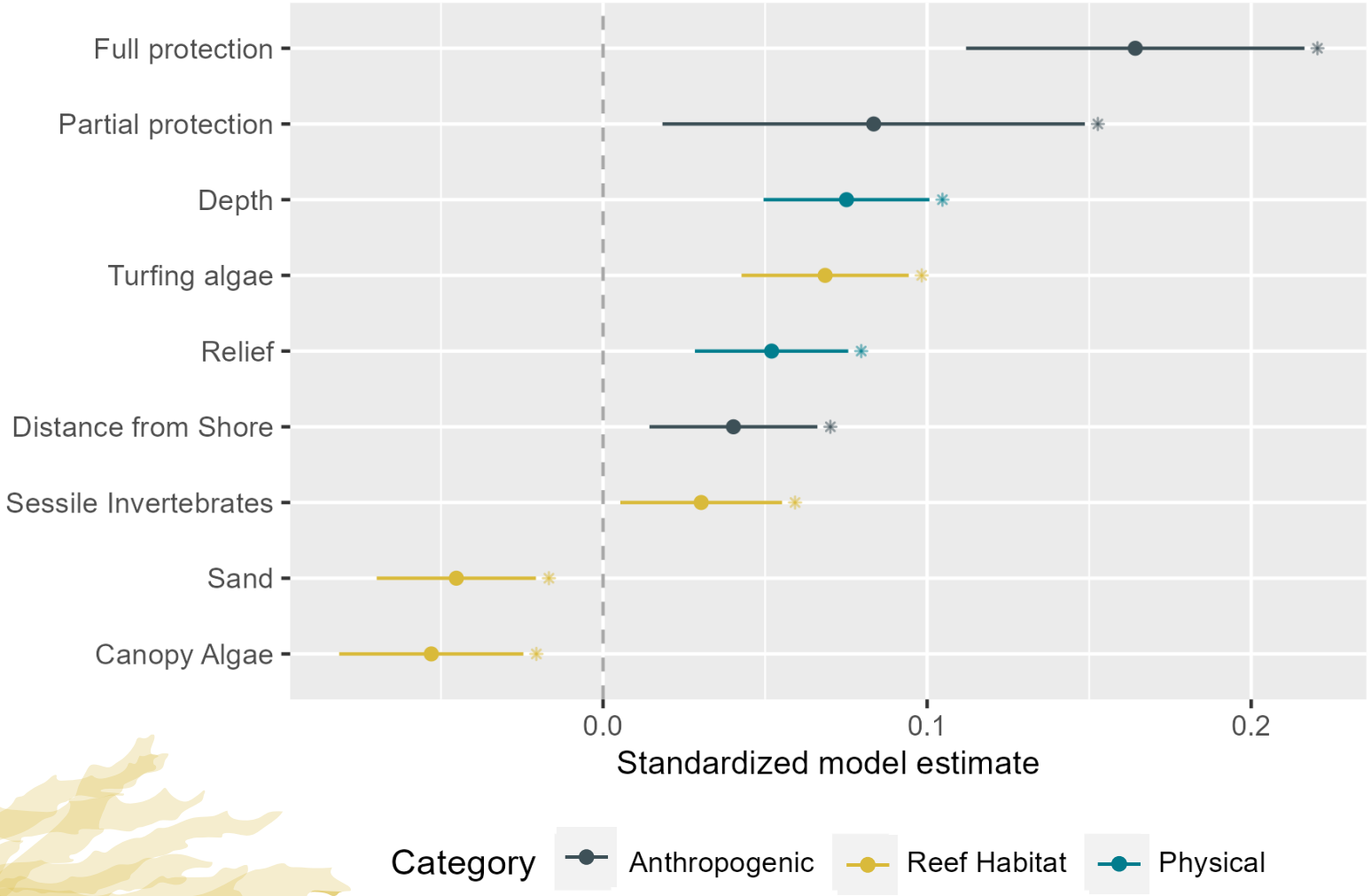
- Stage 3 – Identifying important local factors in MPA effectiveness
  - Biomass differences ~ biogenic habitat + physical + anthropogenic
  - GLMMs & multi-model inference
  - Top global model fit to fished, partially protected, & fully protected data

Differences in biomass by protection level



Reef fish biomass inside fully protected MPAs across temperate Australia is, on average, **2.4x higher** than predicted based on broadscale environmental conditions.

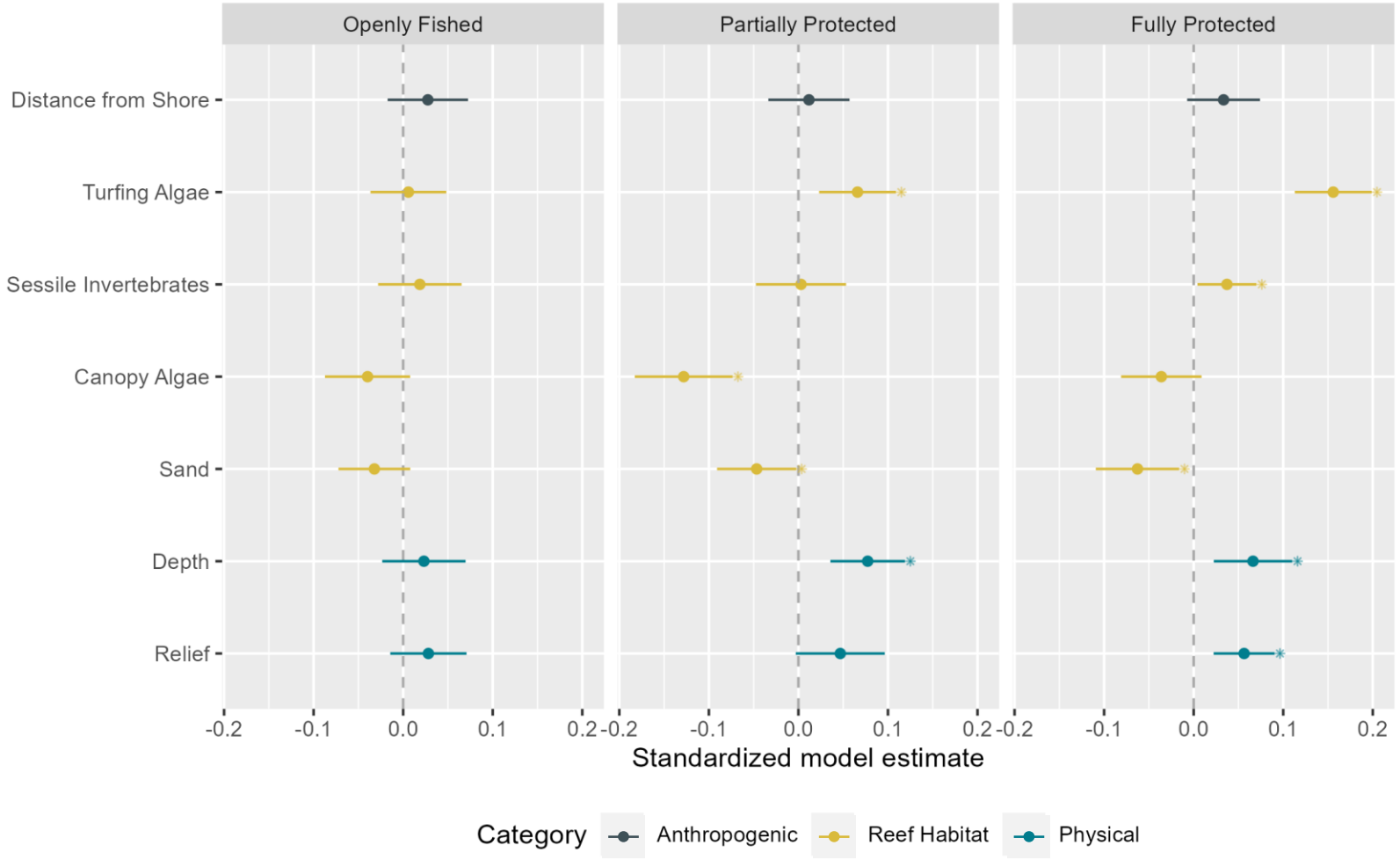
Important local factors



After accounting for broadscale environmental conditions, fishing pressure appears to be the most important factor shaping fish biomass distributions across temperate Australia.

Interactions between local factors and management

Local biogenic & physical habitat factors are significant in shaping MPA ecological outcomes across temperate Australia, but are not important in shaping variations in biomass across openly fished sites.



Conclusions

- Fishing pressure critically important in shaping fish biomass across temperate Australia

- Based on broad-scale environmental conditions, fish biomass was significantly higher than expected inside fully protected MPAs, but not significantly different in partially protected MPAs across temperate Australia

- Ecological effectiveness of MPAs can be promoted or limited by the state of biogenic and physical reef habitat
  - Important lessons for MPA design, management & enforcement

References

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Thank you!

Rick, Graham, Camille, Freddie, Lizzie, Toni, Jennie, all NRMN surveyors & Parks Victoria.

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