How will climate driven shifts in coral reef communities influence their suitability as fish habitat?

Preliminary results of my 2nd PhD chapter

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Coral reefs are important, but in danger

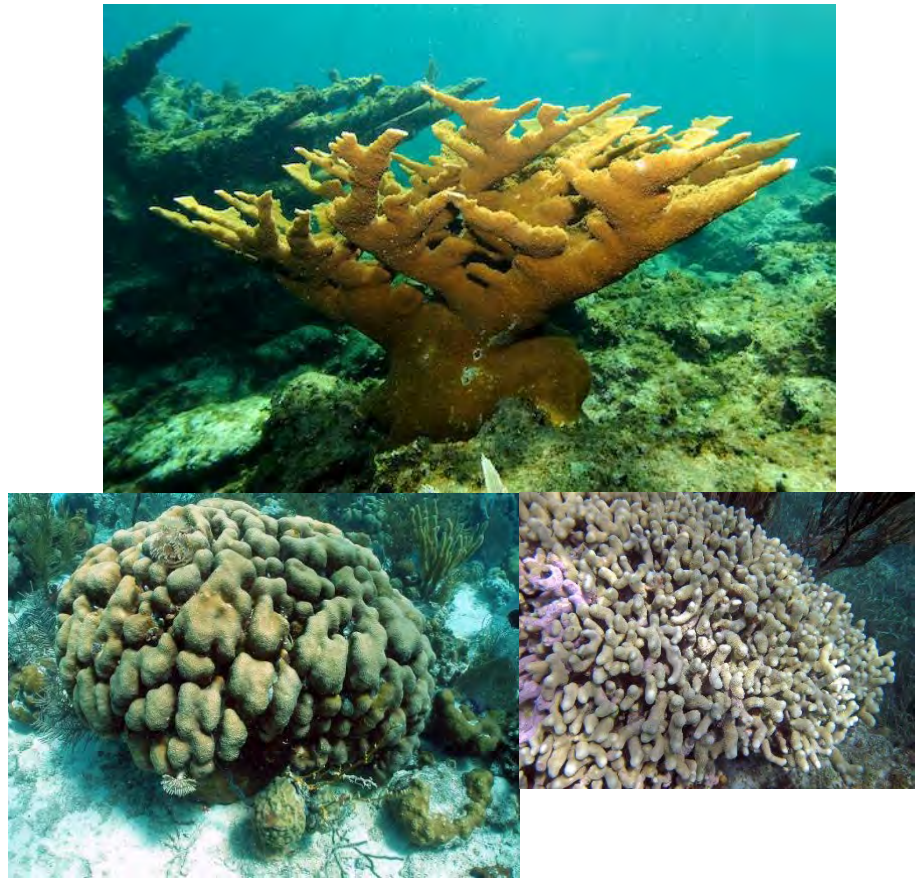
- Corals are important habitat for fish communities
- Coral fisheries support important local and global supply chains
- Sensitive to changes in their physical environment

Morphology-specific responses to thermal stress related to ‘mass-transfer’

“…the potential exchange rate of gases and metabolites across corals’ boundary layers.”

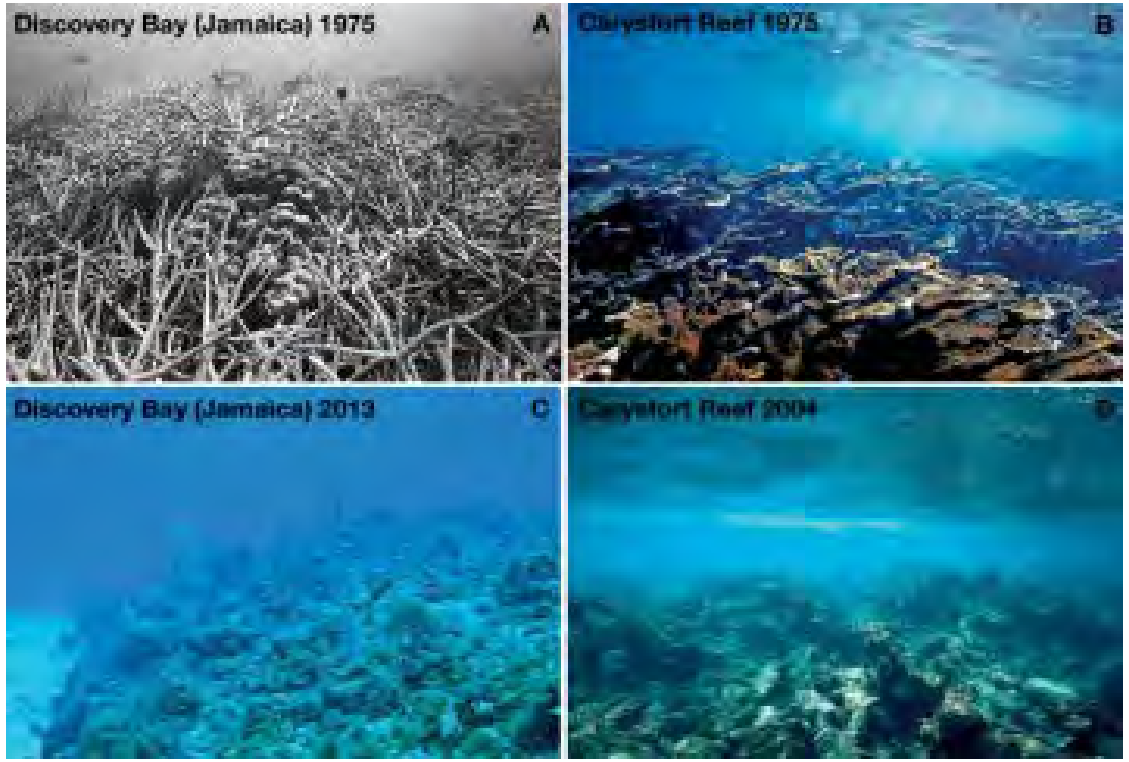
- This rate is lower on larger, branching colonies
- Metabolic processes more vulnerable under environmental stress

van Woesik et al. 2012



Coral mortality leads to impacts on fish communities and fisheries

- Dead coral susceptible to physical and chemical erosion
- Results in declining habitat complexity
- Reduced complexity affects fish communities



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Regional variability in the sensitivity of Caribbean reef fish assemblages to ocean warming

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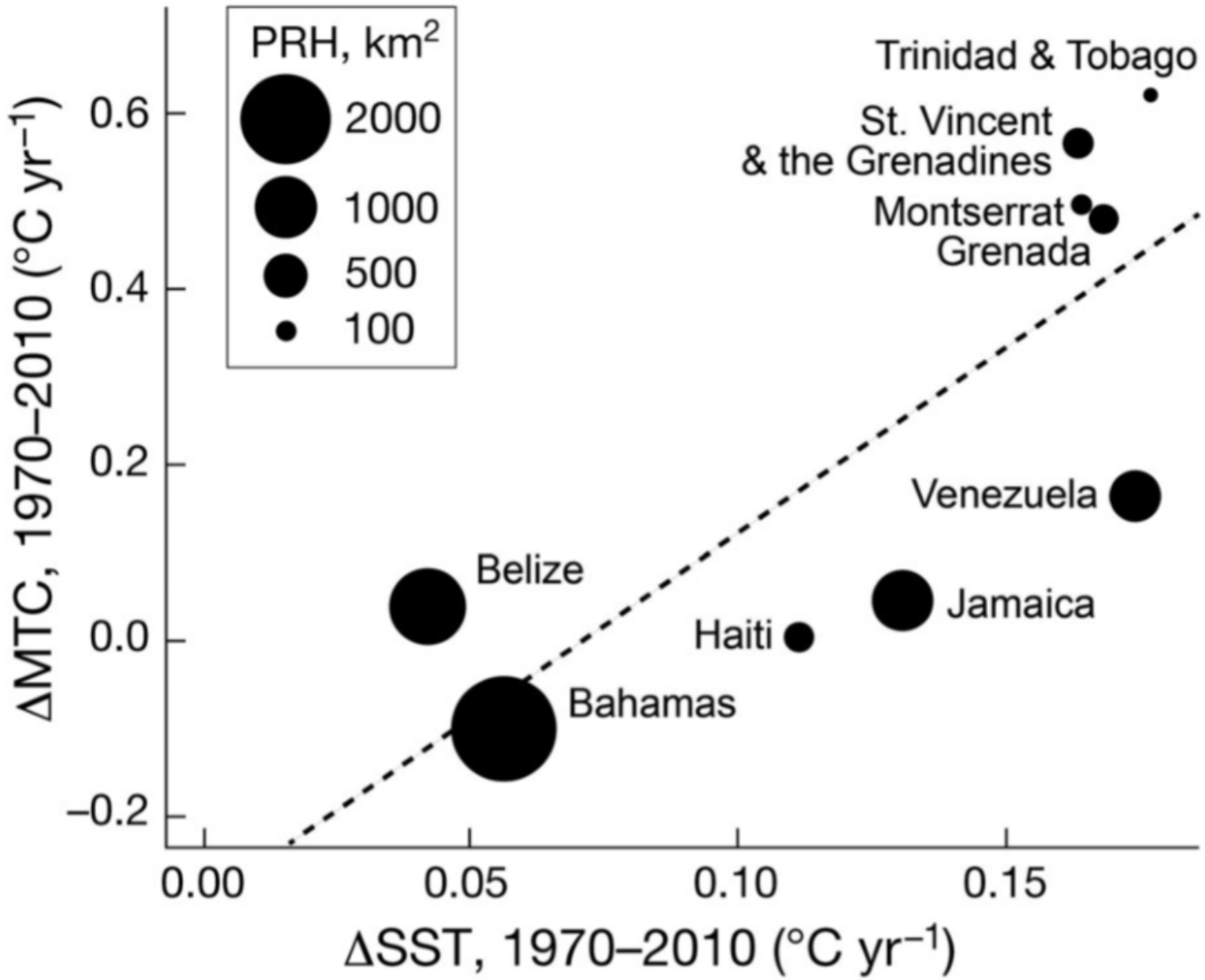

PRH, km²
2000
1000
500
100
Trinidad & Tobago
St. Vincent
& the Grenadines
Montserrat
Grenada
Venezuela
Belize
Jamaica
Haiti
Bahamas
ΔMTC, 1970–2010 (°C yr⁻¹)
0.6
0.4
0.2
0.0
–0.2
0.00
0.05
0.10
0.15
ΔSST, 1970–2010 (°C yr⁻¹)

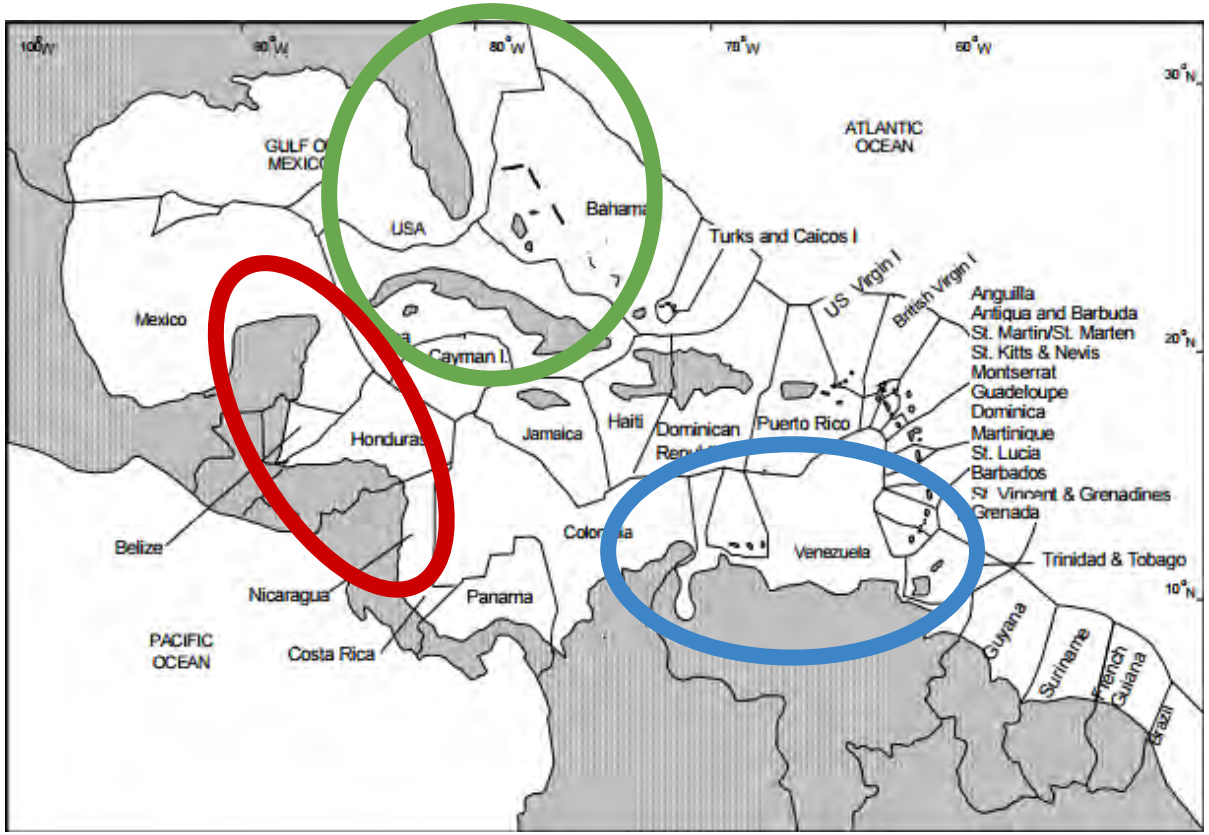
Research questions

1. How will projected changes in the oceanic environment influence shifts in the distribution of morphology groups?

1. How may this influence the quality of habitat provided to fish by reef communities?

Area of study – Caribbean Large Marine Ecosystem

- Not as speciose as Pacific
- Habitat quality declined significantly 1980-2000
- North: The Bahamas, US East, Cuba
- Central: Mexico, Honduras, Nicaragua, Belize
- South: Trinidad & Tobago, Venezuela, Colombia



Predict distribution of corals using Species Distribution Models

"…SDMs create representations of species' fundamental niche which can be extrapolated into space and time (Habitat Suitability Index)…"

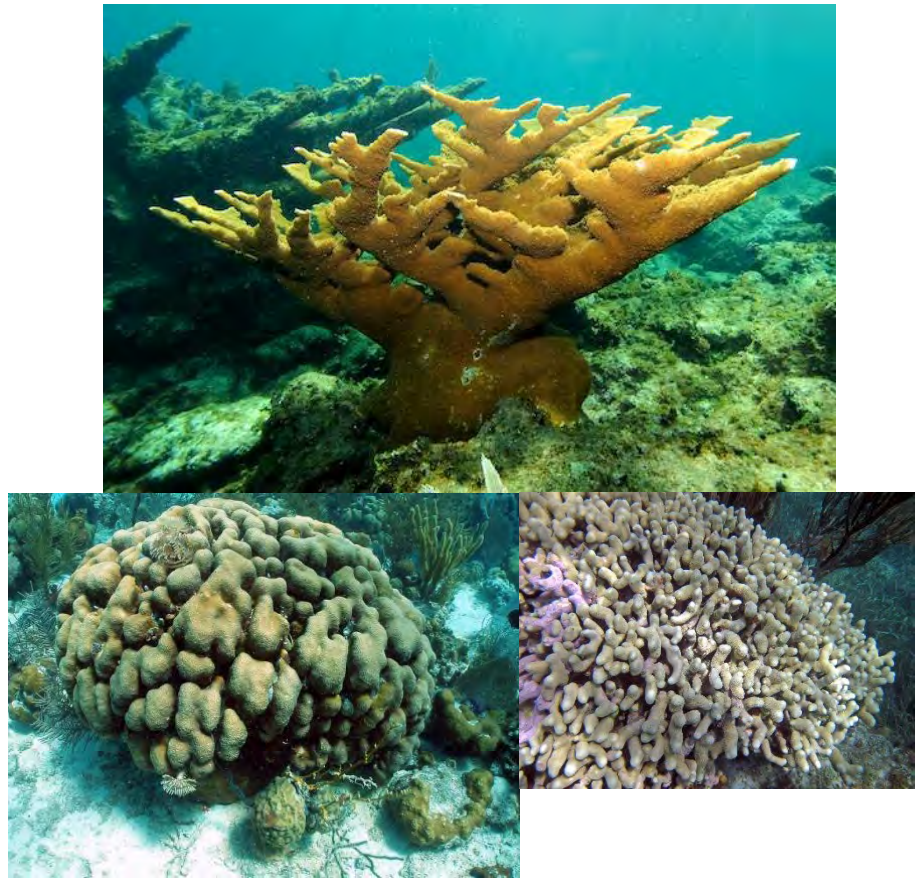
- Species occurrence data
  - 63 species (56% of species with occurrence data)
- Environmental variables
  - 7 climatologies (1970-2000)
  - 2 climate scenarios (RCP 2.6 & 8.5)
  - 2 future periods (2050, 2100)
  - 3 earth system models (IPSL, MPI, GFDL)
- Used to model species, functional groups and habitat types
  - ANN, Maxent, GBM

Morphological categories and ranks

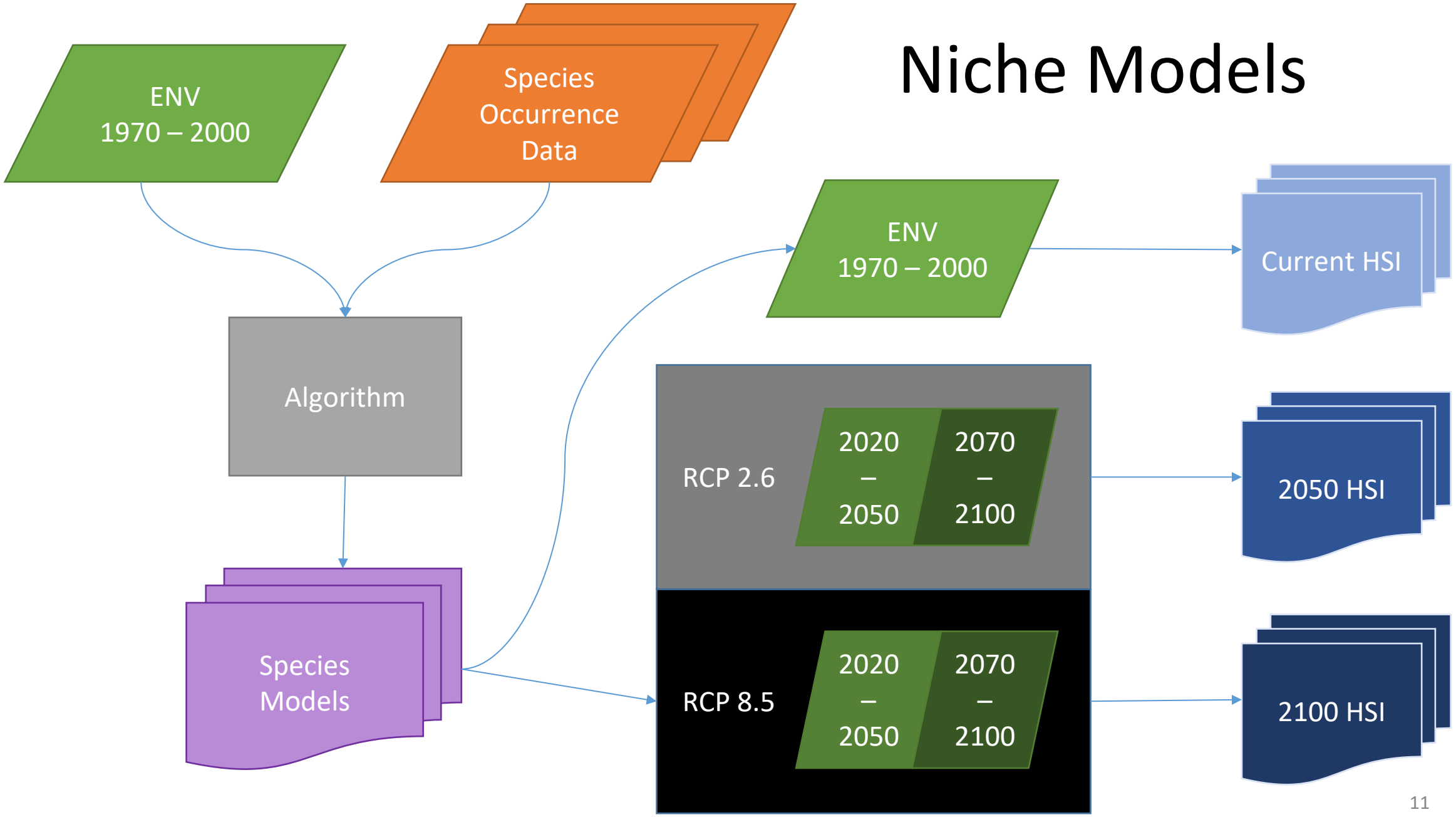
- Categories from the coral trait database (www.coraltrait.org)

- Morphology classes
  - Acroporid corals – 3
  - Sub-massive and Massive corals – 2
  - Non-acroporid branching and encrusting corals – 1

    (Edinger and Risk, 2000)

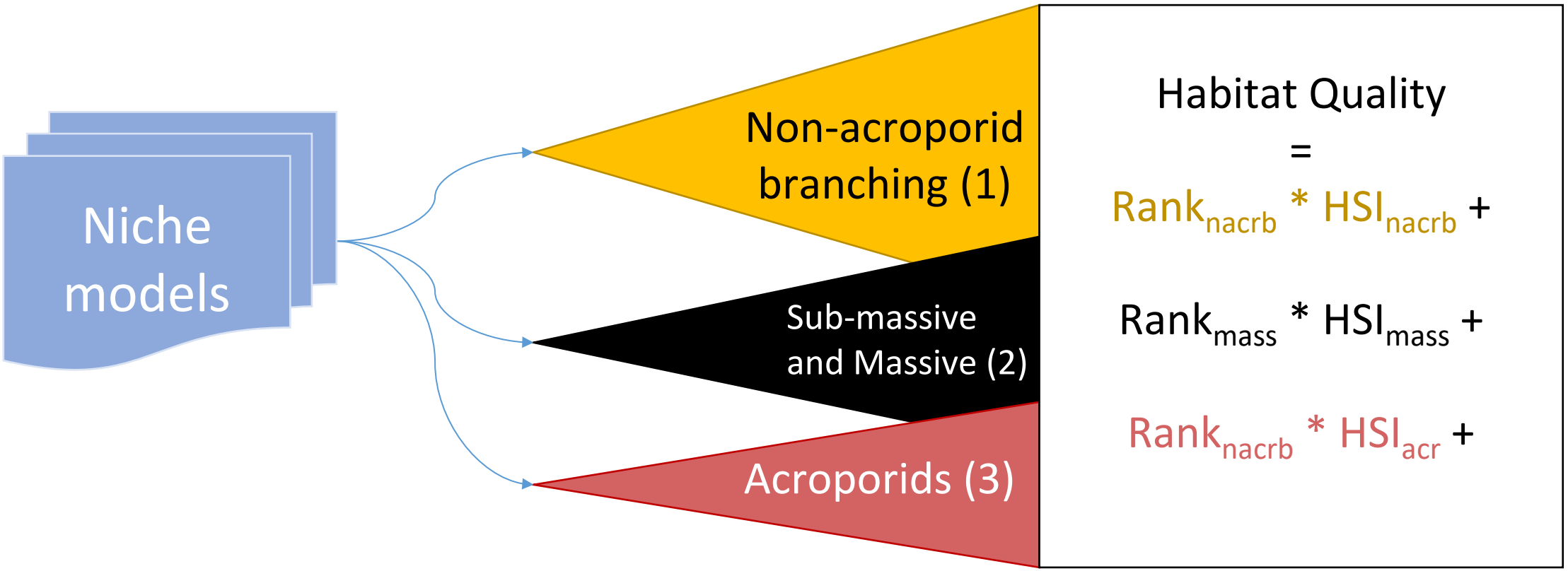


Niche Models

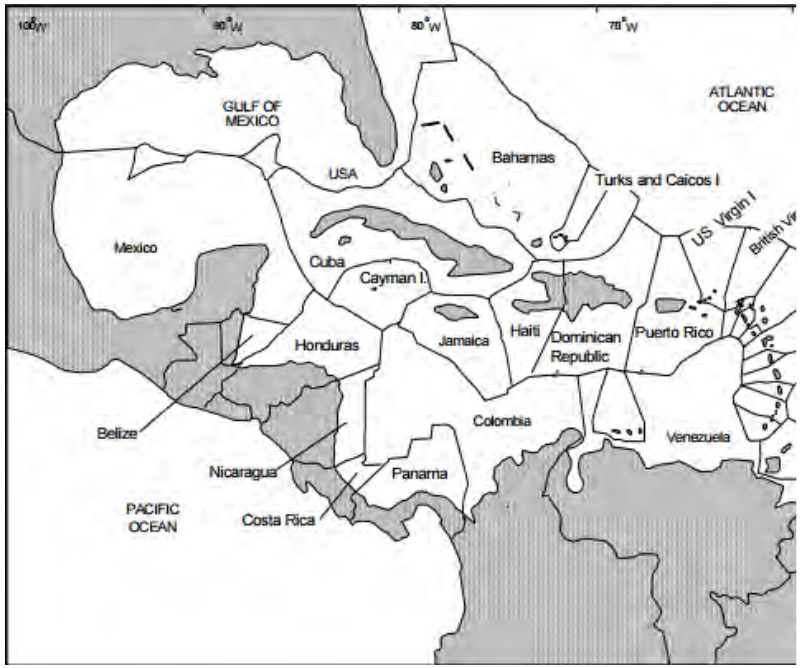


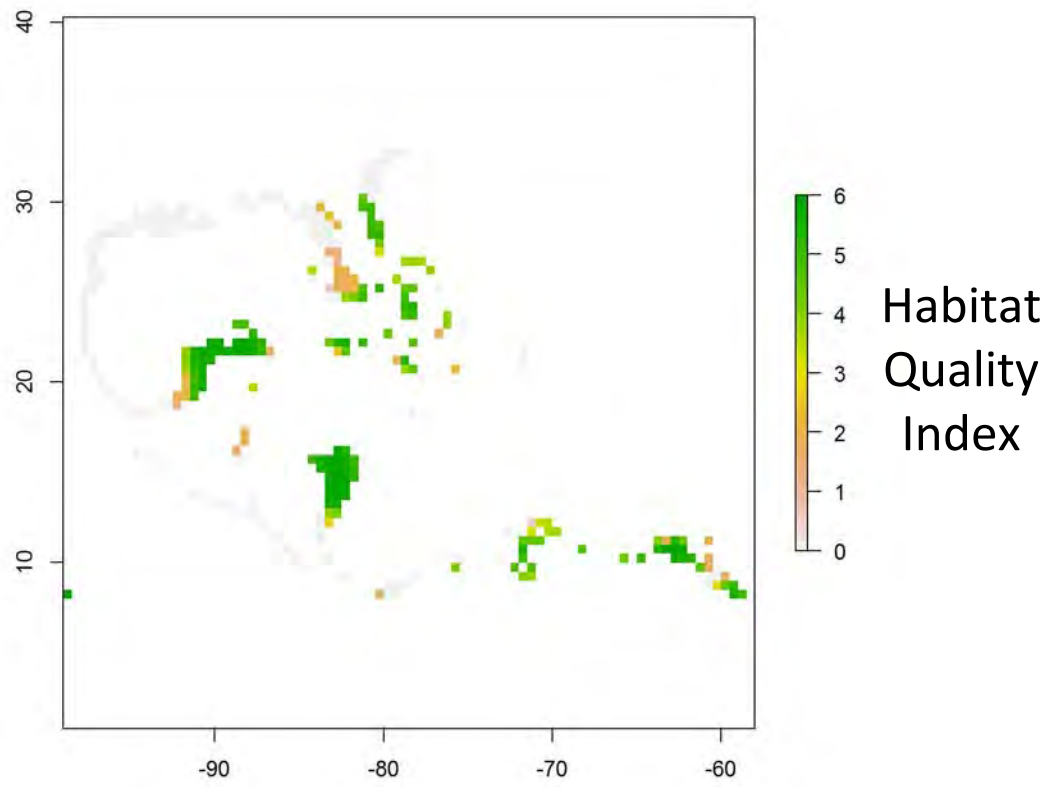
Habitat Quality Index

Higher as HQ -> 6
Lower as HQ -> 0



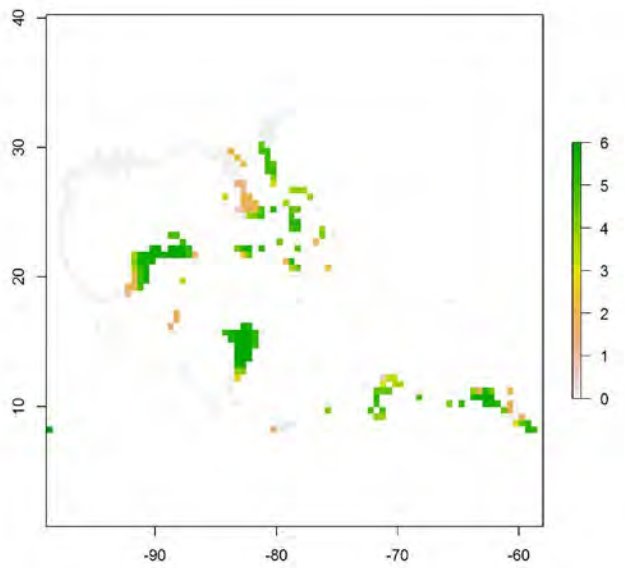
Habitat Quality
Regional Baseline (1970-2000)





Habitat Quality Future Projections

Current

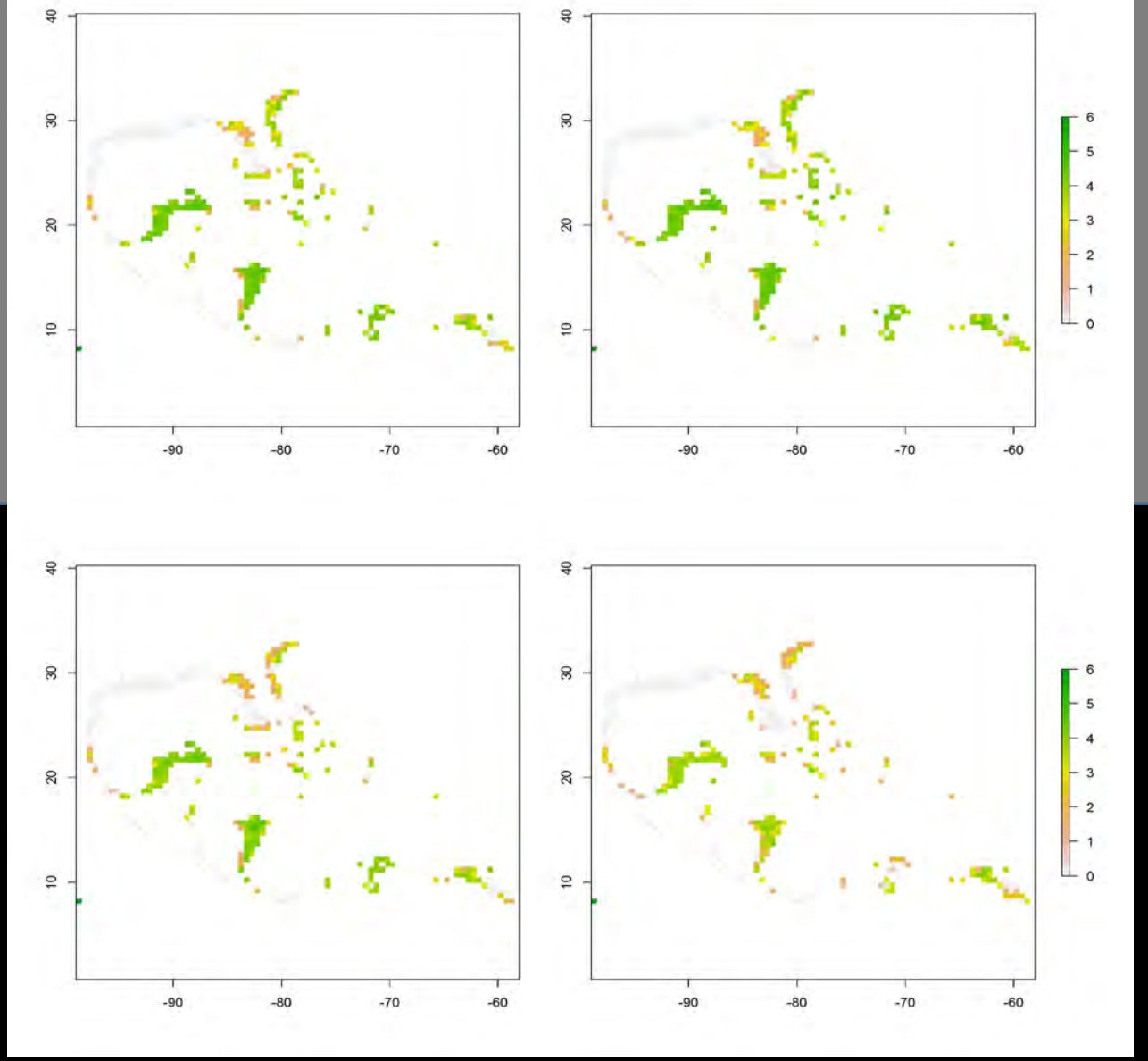


2050

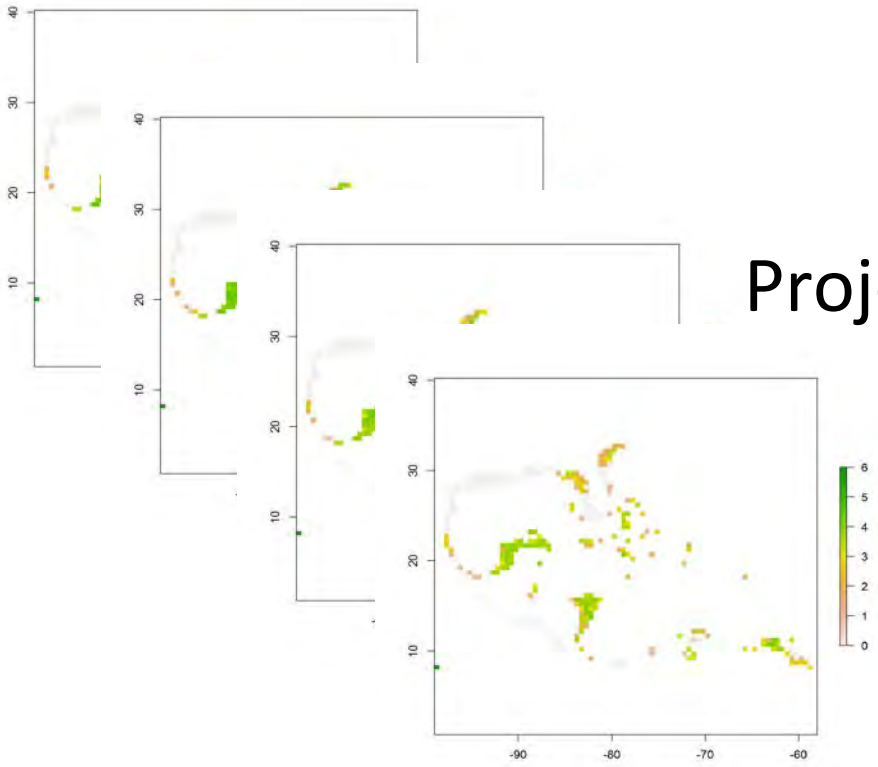
2100

RCP 2.6

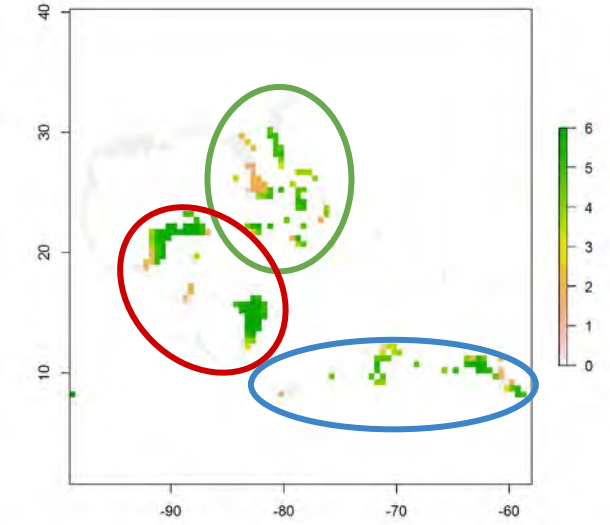
RCP 8.5



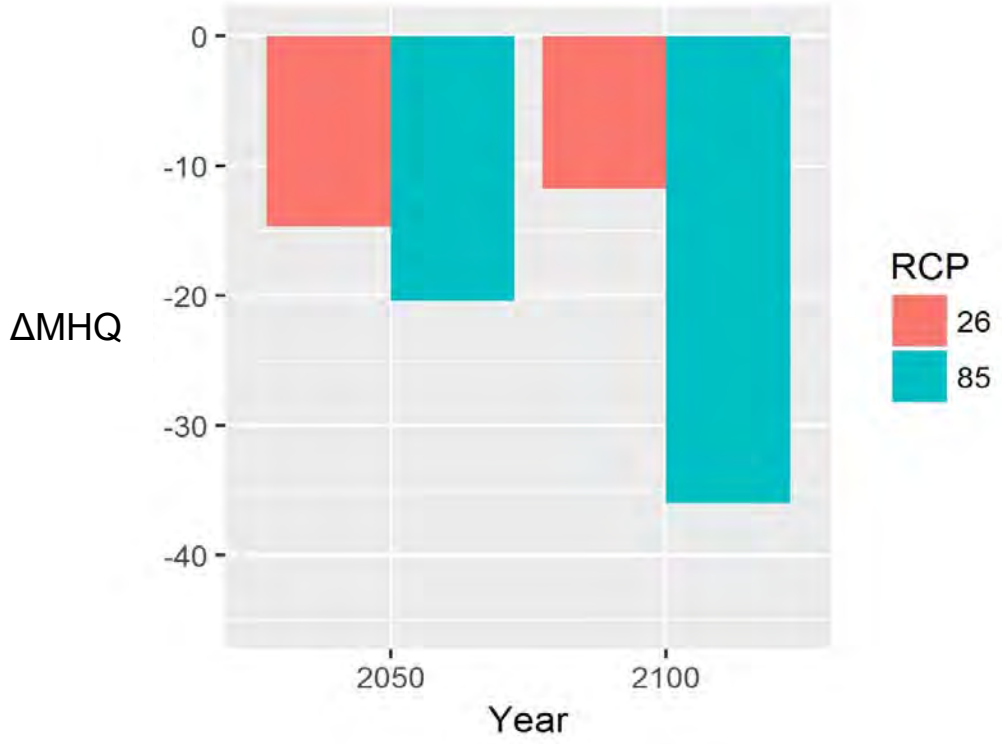
Area Trends



Projections – Baseline

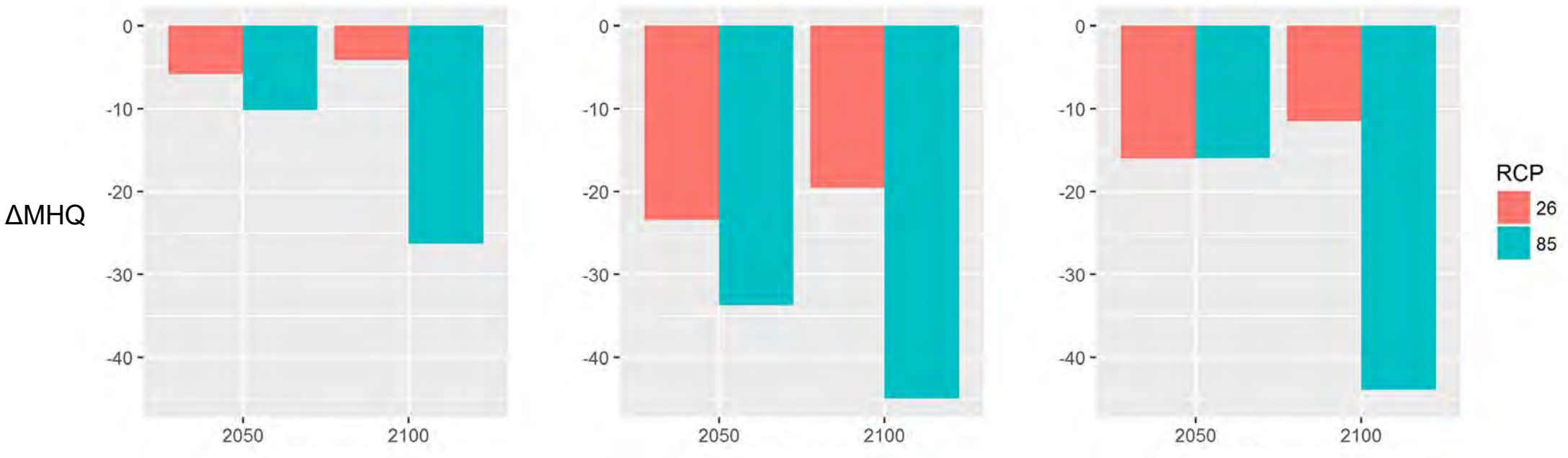


% Change in Mean Regional Habitat Quality



Regional

% Change by Area from Regional Baseline



Central

North

South

Key observations

- RCP scenarios produce vastly different futures for habitat quality
- Stabilization of HQ under 2.6, but drastic declines under 8.5
- Patterns among areas are similar, but vary greatly in ΔMHQ

Preliminary conclusions

- Habitat management may be useful; spatial trends must be considered
- Central America may act as a climate refuge
- Other important variables may affect these trends
- Higher emissions scenario may require adaptation of local fisheries if fish communities are affected (more on that later next year…)

Future Analyses

- What are the shifts in coral communities by morphology and species?
- What are the key environmental variables?
- What are the consequences for fish communities?

Acknowledgements