An ecologically based statistical probe into the longitudinal status of reef fish of Grand Cayman Island

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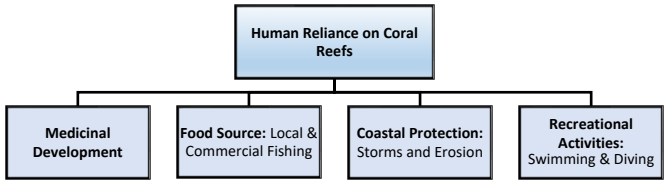
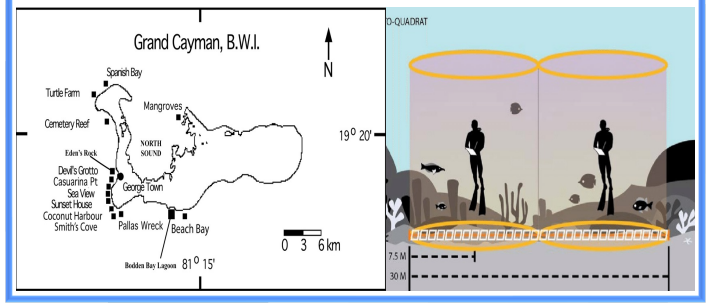
BACKGROUND

- Coral reefs support more species per unit area than any other marine environment in the world (Ogden and Lobel, 1978)
- Fish are an integral part of reefs, so their abundance serves as a major indicator of overall reef health
- Long-term health is a priority for humans

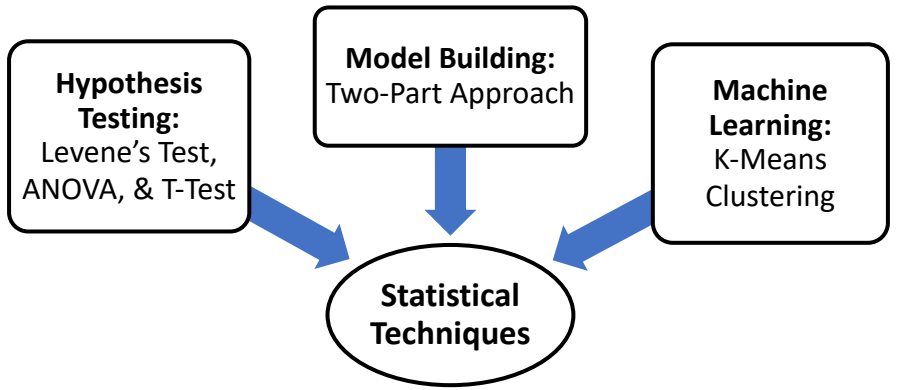


DATA COLLECTION

- Lawrence University Marine Program (LUMP)
- Grand Cayman Island 1998-2018
- Reef Environmental Education Foundation (REEF) roving diver techniques



METHODS & RESULTS



Families in Decline:

- **Predators**
  - Lutjanidae
  - Serranidae
  - Holocentridae
- **Herbivores**
  - Scaridae
  - Pomacentridae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Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']
Formula: DENSITY_INDEX ~ YEAR1998 + DIET + SCIENTIFIC_FAMILY + (YEAR1998 |
    SPECIES_NAME)
   Data: CAYMAN_NO_ZEROS

REML criterion at convergence: 8318.6

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.3376 -0.6208 -0.0392  0.6299  4.0417

Random effects:
 Groups       Name        Variance  Std.Dev. Corr
 SPECIES_NAME (Intercept) 0.2127850 0.46129
              YEAR1998    0.0003699 0.01923  -0.62
 Residual                 0.2541073 0.50409
Number of obs: 5208, groups:  SPECIES_NAME, 231

Fixed effects:
                                Estimate Std. Error         df t value Pr(>|t|)
(Intercept)                     1.915148   0.241492 258.333586   7.930 6.60e-14 ***
YEAR1998                       -0.008237   0.002016 114.681163  -4.085 8.19e-05 ***
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CONCLUSIONS

Reef Health in Decline:

- Ineffective Marine Protected Areas
  - Result of lack of continuous habitat (Mosquera et al., 2003)
- 71% of families in decline are major predators or herbivores
  - “Phase-Shifts” occurring (Williamson et al., 2014)
- Increasing invasive Lionfish densities
  - Decreasing abundance and biomass of native reef fish (Benkwitt, 2015)

Future Remediation Efforts

- Restructuring Marine Protected Areas
- Quantifying macroalgae overgrowth
- Commercial fishing regulations for predator and herbivore families
- Developing community-wide education programs

REFERENCES

1. Benkwitt, C. E. (2015). Non-linear effects of invasive lionfish density on native coral-reef fish communities. *Biological Invasions.* 17, 1383-1395.
2. Mosquera I., Coté, I. M., Jennings S., Reynolds J. D. (2000). Conservation benefits of marine reserves for fish populations. *Animal Conservation.* 4, 321-332.
3. Ogden, J. C., and Lobel, P. S. (1978). The role of herbivorous fishes and urchins in coral reef communities. *Environmental Biology of Fishes. 3*(1), 49-63.
4. Williamson, D. H., Ceccarelli, D. M., Evans, R. D., Jones, G. P., and Russ, G. R. (2014). Habitat dynamics, marine reserve status, and the decline and recovery of coral reef fish communities. *Ecology and Evolution. 4(4)*, 337-354.