

Will *Acropora palmata* be around in 20 Years?



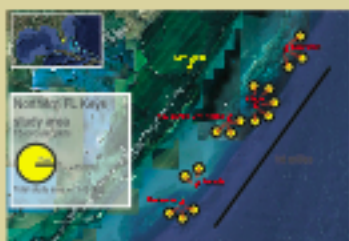
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Study area & data



- Annual surveys conducted since 2004
- Number of colonies surveyed/yr ≈ 300
- This is and has been the area of highest *A. palmata* density in the Keys.

Size-based matrix model

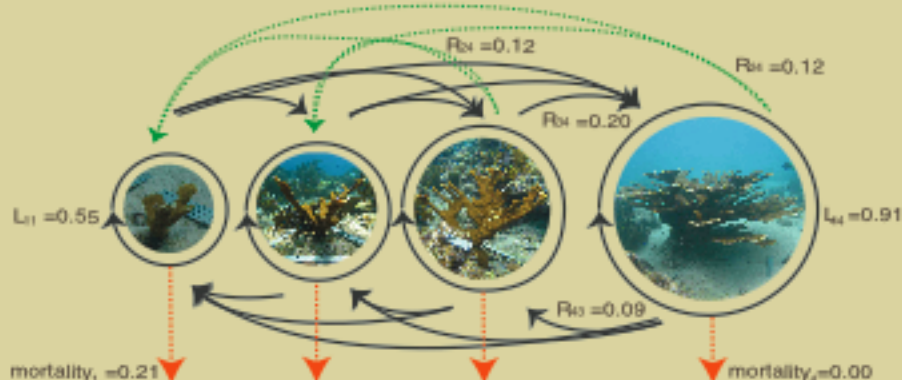
$$n(t+1) = A n(t)$$

n = population size structure, at time t

$$A = \begin{bmatrix} L_{11} & S_{12} & R_{13}+S_{13} & R_{14}+S_{14} \\ G_{21} & L_{22} & R_{24}+S_{24} & R_{24}+S_{24} \\ G_{31} & G_{32} & L_{33} & S_{34} \\ G_{41} & G_{42} & G_{43} & L_{44} \end{bmatrix}$$

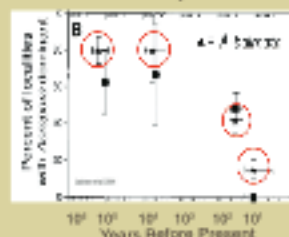
L_{ij} = probability of looping, or staying in the same size class
 G_{ij} = probability of growing from size class j to i
 S_{ij} = probability of shrinking from size class j to i
 R_{ij} = per capita recruitment rate by size class j to size class i (sexual and asexual recruitment are not distinguished)

Size Class 1 < 100 cm² Size Class 2 < 900 cm² Size Class 3 < 4000 cm² Size Class 4 > 4000 cm²



Context and results

A. palmata dominated 80% of shallow reefs until recent history.



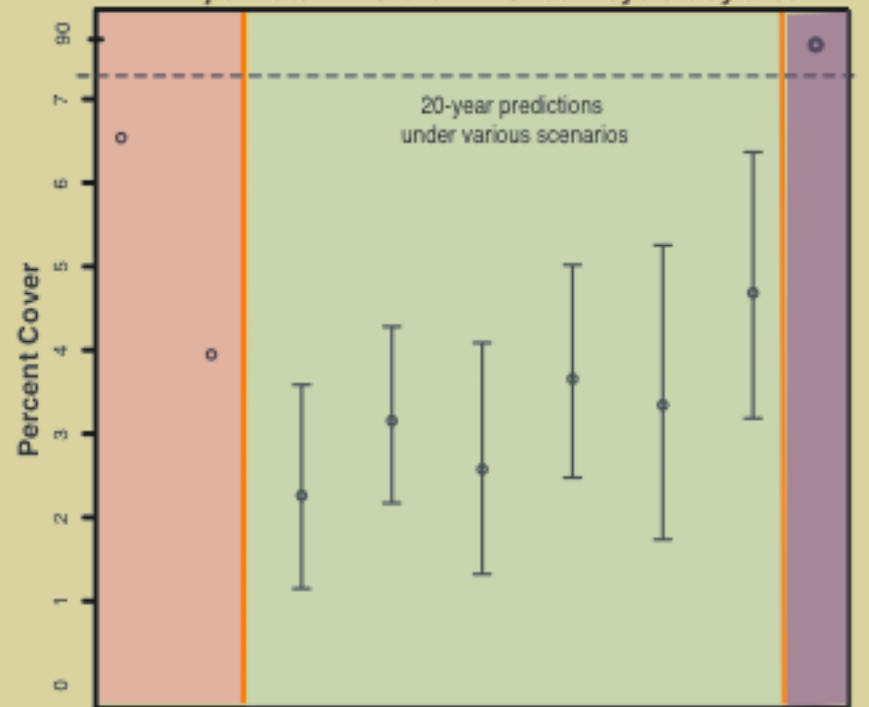
In the past few decades the Florida Keys, Jamaica, and other areas of the Caribbean have suffered > 97% loss of *A. palmata*.



Based on a comprehensive Coral Reef Monitoring Program survey (1999-2001), the northern Florida Keys study area represents the highest density and percent cover remaining in the Keys. (Acropora Biological Review Team 2005).

| Location | Mean % Cover |
|--------------------------------|--------------|
| Florida Keys | 0.05 % |
| Spur and grooves only | 0.2 % |
| Northern Keys spur and grooves | 0.3 % |

A. palmata in northern Florida Keys study area



2004 First Survey 2009 Most Recent Survey
 Status Quo: Assume population parameters will stay the same for the next 20 years.
 No Whammies: "No Whammies": exclude the potential for a year like 2005, when Wires, Dennis, Dietschy and disease caused 30% mortality and more partial mortality.
 Outplant 5: "Outplant 5": plant 40 small (< 100cm²) *A. palmata* coral colonies per year for 5 years.
 Outplant 20: "Outplant 20": plant 40 colonies per year for 20 years.

Conclusions

Without a drastic change in environment, *A. palmata* can not recover in the northern Florida Keys.

Population parameters are fundamentally different now from what they must have been before the 1980s

Future directions

What were *A. palmata* population parameters before 1980?

How do *A. palmata* population parameters and future population predictions differ for various areas of the Caribbean (e.g. Curaçao, Puerto Rico)?

What are the most important life history parameters, or combination of parameters for *A. palmata* recovery?

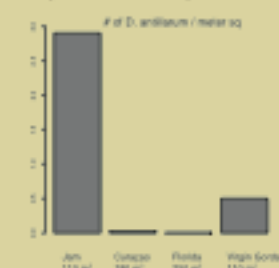
Works cited

Jackson, J.C., M. Riebel, M. Riebel, G. Sponberg, S.J. Storz, M. Storz, P.J. Cohen, J.D. Schemm, J.D. Schemm, T.R. Hughes, S. Huber, D.R. Lirman, H. Lirman, J.B. Powell, C. Powell, M. Powell, S.J. Storz, M. Storz, 2004. Mortality, weathering and the recent collapse of shallow corals. Science 303: 629-632.
 Acropora Biological Review Team, 2005. Atlantic Acropora Status Review Document. Report to National Marine Fisheries Service, Southeast Regional Office, February 15, 2005. 128 p. + App.

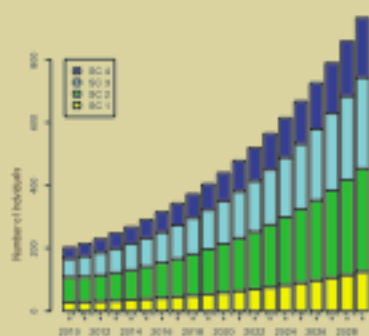
Insights from Jamaica

Annual surveys conducted since 2007
Number of colonies surveyed/yr 100-200

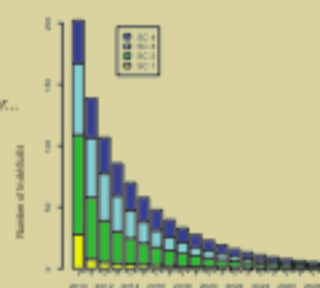
The *A. palmata* population was obliterated in 1980 by Hurricane Allen. Density of the long-spined sea urchin, *Diadema antillarum*, is two orders of magnitude higher in the Jamaica study area compared with that in Florida. Perhaps these urchins are the key to recovery?



A "good year", exhibits the potential for 9% annual growth in population size ($\lambda = 1.09$). That's higher than the highest rate we see in Florida ($\lambda = 1.01$).



However...



Jamaica's relatively young population exhibits a trend towards dominance by large, reproductively viable individuals. This trend holds for populations projected 20 years into the future. This trend is absent in Florida.

