Quantitative tools for assessing threatened coral species in the Caribbean

Coral project team

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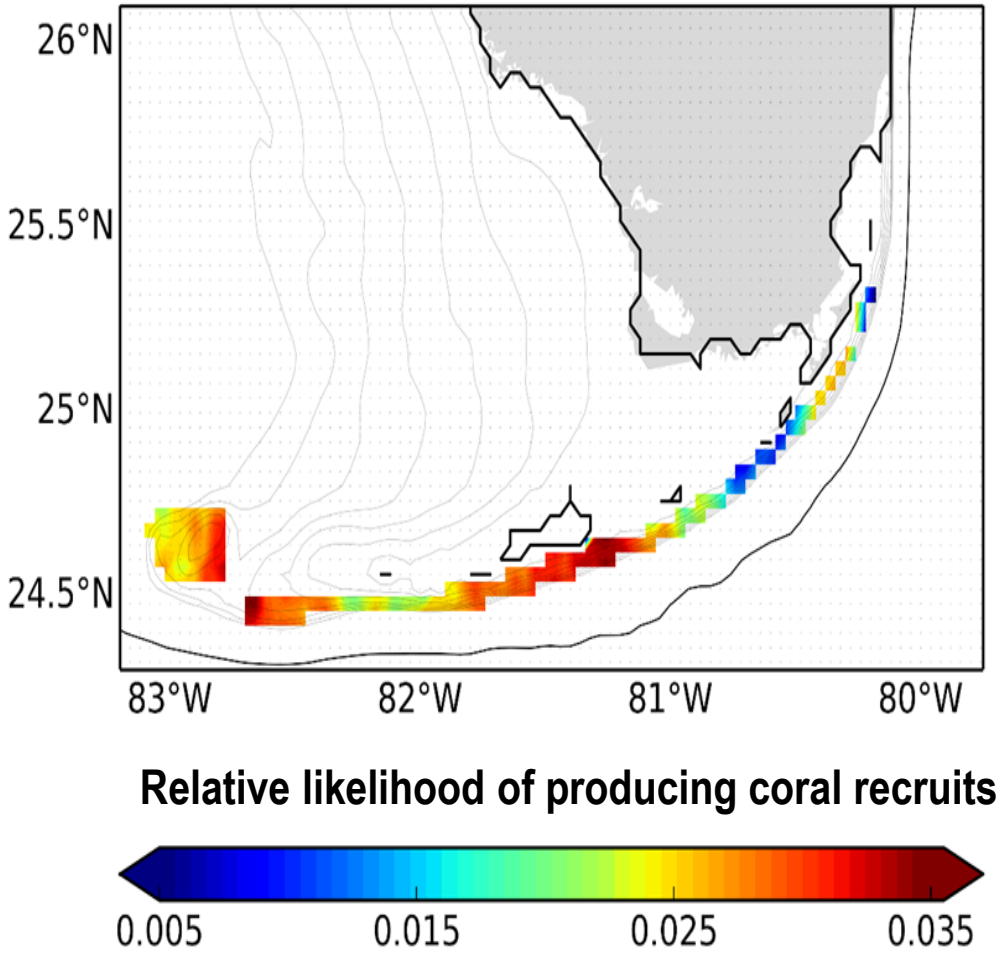
Project components for tool development:

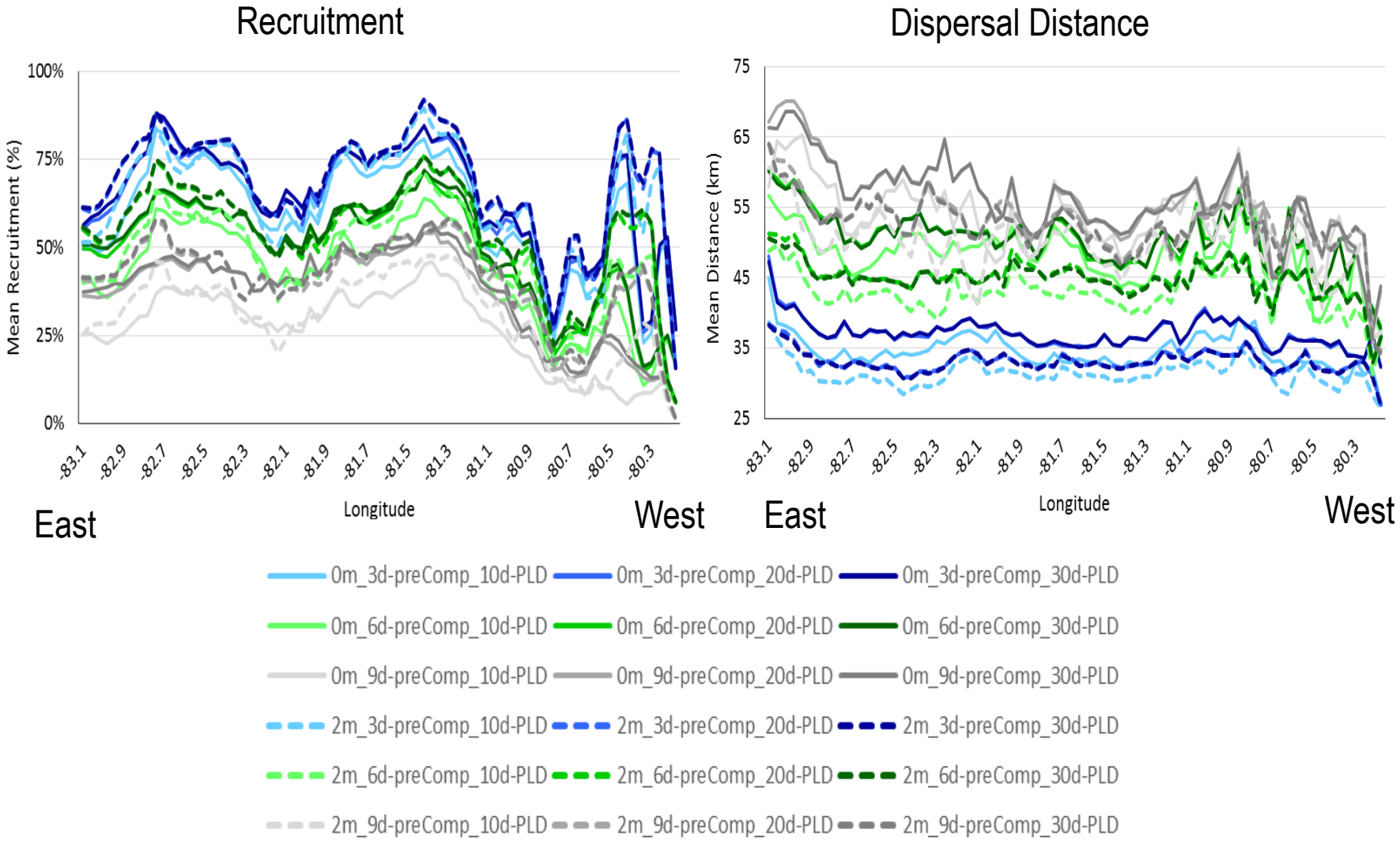
- **Connectivity and recruitment model**
  - Paul Richards and Nathan Putnam
- **Population assessment and Spatial demographic model**
  - Dione Swanson
- **Predictive species distribution models**
  - Shay Viehman

Coral project team: Connectivity and recruitment model

From which locations does a coral larvae have the best chance of recruiting to the Florida Keys?



How does location and larval physiology impact probability of recruitment and distance to recruitment?



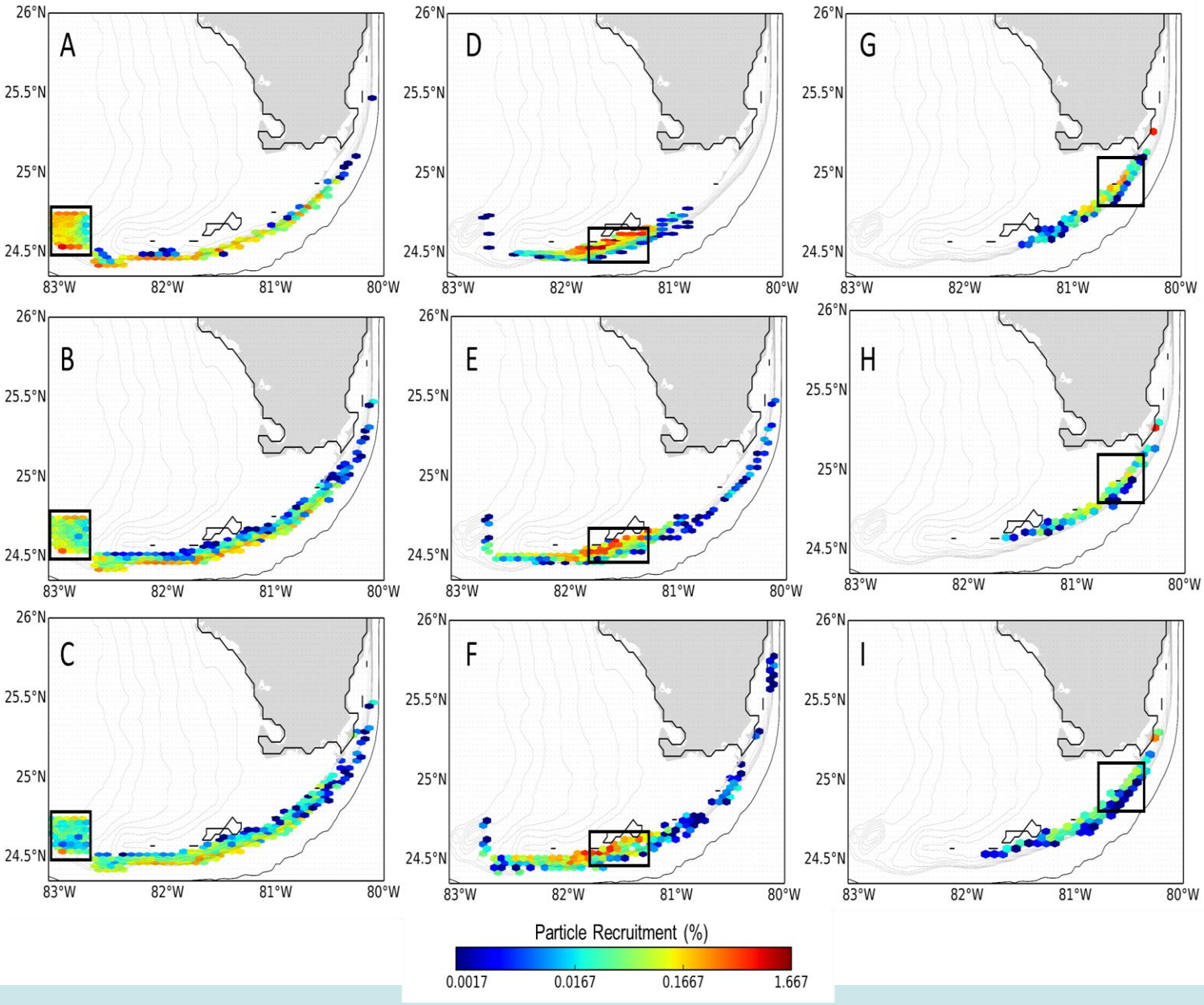
Where are coral larvae from particular areas most likely to recruit?

Pre-Competency Period

3 days

6 days

9 days



Coral project team: Population assessment

Assessment of ESA corals:

Environ Monit Assess
DOI 10.1007/s10661-011-1912-2

Probability sampling of stony coral populations in the Florida Keys

Steven G. Smith · Dione W. Swanson · Mark Chiappone · Steven L. Miller · Jerald S. Ault

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Abstract Principles of probability survey design were applied to guide large-scale sampling of populations of stony corals and associated benthic taxa in the Florida Keys coral reef ecosystem. The survey employed a two-stage stratified random sampling design that partitioned the 251-km^2 domain by reef habitat types, geographic regions, and management zones. Estimates of the coefficient of variation (ratio of standard error to the mean) for stony coral population density and abundance ranged from 7% to 12% for four of six principal species. These levels of survey precision are among the highest reported for comparable surveys of marine species. Relatively precise estimates were also obtained for octocoral density, sponge frequency of occurrence, and benthic cover of algae and invertebrates. Probabilistic survey design techniques provided a robust framework for estimating population-level metrics and optimizing sampling efficiency.

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Keywords Coral reefs · Stratified random survey design · Population estimation

Introduction

Prior to observations of dramatic coral reef declines in Florida, the Caribbean (Gardner et al. 2003), and the Pacific (Done 1999), monitoring programs focused on questions of ecology, addressing how predation, competition, zonation, and disturbance affected coral community dynamics (e.g., Loya 1972; Lang 1973; Connell 1973). Typically, these studies were conducted at single reefs or were restricted to a limited number of habitat types. Still, much was learned about processes affecting the structure and dynamics of coral reefs (Grigg and Maragos 1974; Burns 1983). By the 1980s, monitoring programs adopted many of the methods and statistics of experimental ecology to assess population status and trends. While these programs documented coral declines at specific sites from various causes such as coastal development, pollution, overfishing, and coral disease and bleaching (Brown and Howard 1985; Glynn 1996; Knowlton 2001), none were conducted in a manner that allowed extrapolation from a single or a few reefs being monitored to the population level.

Interestingly, field methodologies and statistical designs used to monitor and assess coral

Springer

Florida Keys Population Abundance Estimates for Nine Coral Species Proposed for Listing Under the U.S. Endangered Species Act

April 2013

Steven L. Miller, William F. Precht, Leanne M. Rutten and Mark Chiappone

Nova Southeastern University Oceanographic Center

Technical Series Report (submitted)

NOVA SOUTHEASTERN UNIVERSITY NCRI NATIONAL CORAL REEF INSTITUTE

Coral project team: Assessment of coral population abundance and distribution

Goals:

1. **To effectively assess the status threatened coral populations**
   - Quantitative assessment of coral populations in U.S waters using habitat use analysis

2. **Provide information to managers about the status of threatened coral populations**
   - Develop a useable tool for managers that translates the analytical results

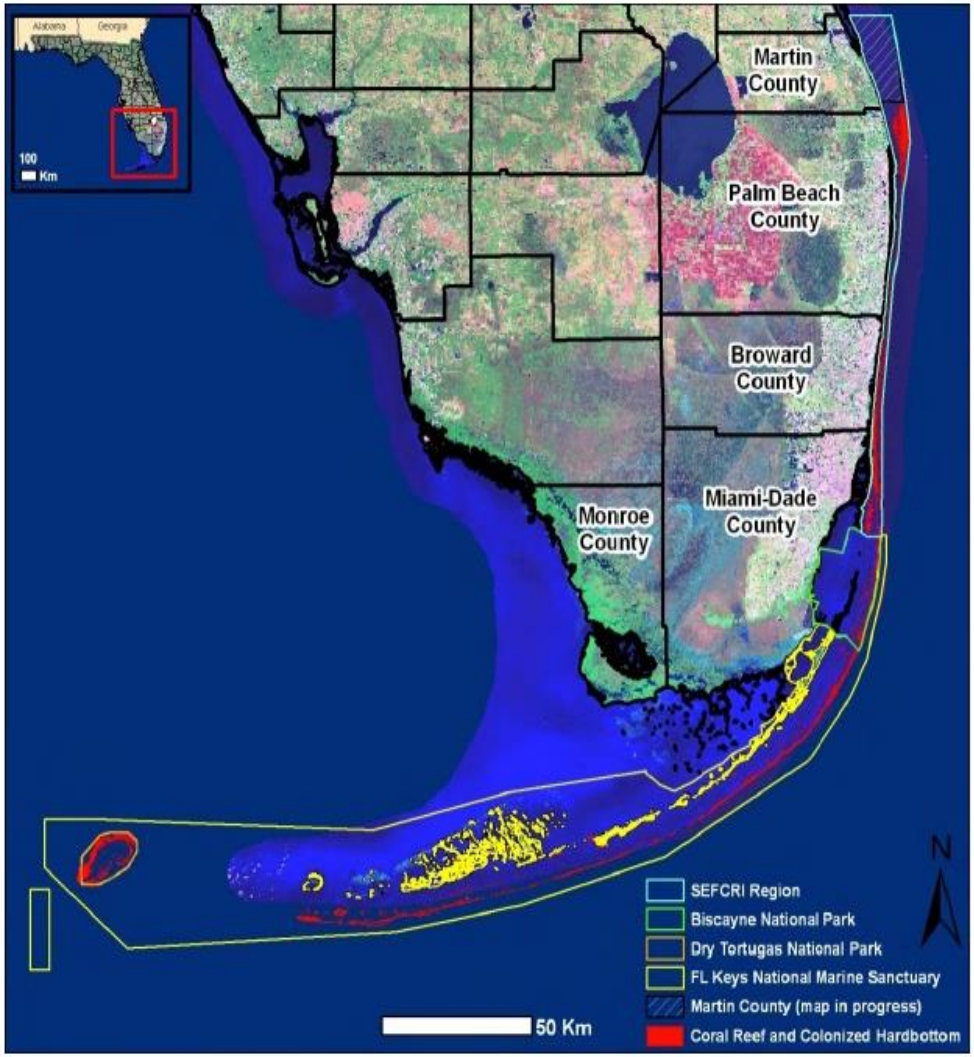
3. **Evaluate survey performance to inform future survey efforts**

Population assessment

South Florida

- **Survey data (2013-2016)**
  - NCRMP StRS data
    - S. Miller (NOVA)
    - NCCOS
    - SEFSC
  - FRRP StRS data (TNC)

- **Habitat use analysis – focal species**



Fundamental concepts

Regulatory factors: physical and biological, natural and anthropogenic, beneficial and detrimental

collectively regulate demographic rate processes

Resource Selection Theory: The strategies used by a species to occupy habitat-space have been found to be closely intertwined with mechanisms of population regulation and persistence through time (**demographic rate processes: growth, survival, and recruitment).**

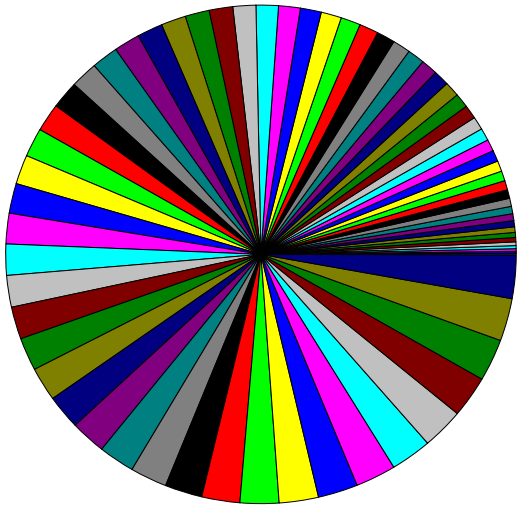
Assessment of coral populations using habitat use analysis:

-provides estimates of abundance and variance

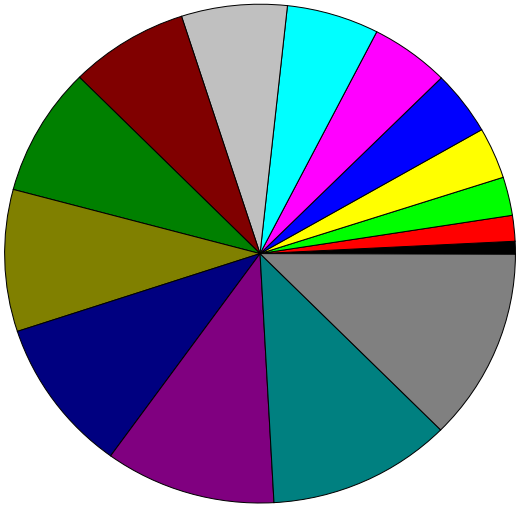
-inference about how growth-survival varies across ecosystem space

Post-stratification: Habitat use

Sampling strata



Species–specific habitat strata



Population and stratum-specific estimates

- Abundance
- Size structure

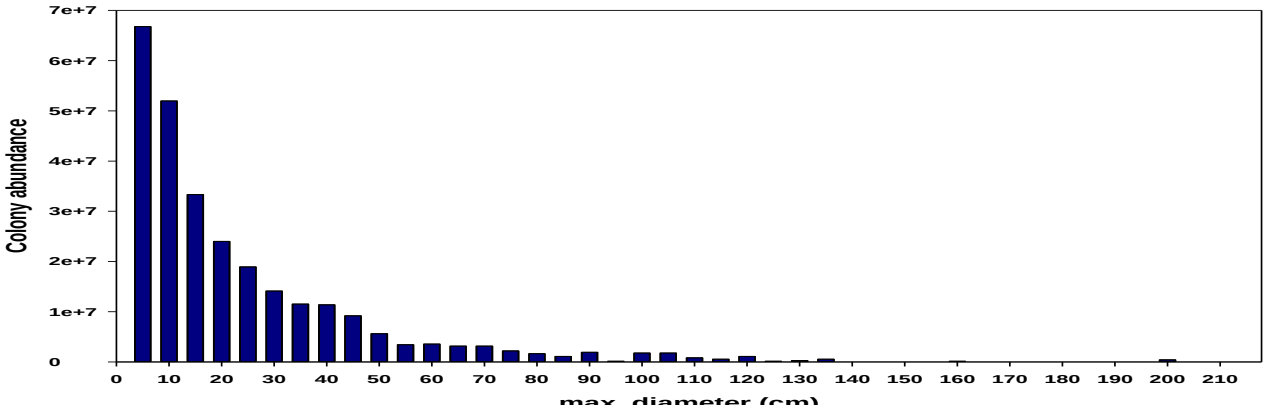
Density and proportion occurrence relative to area weighted domain mean

Habitat use determination

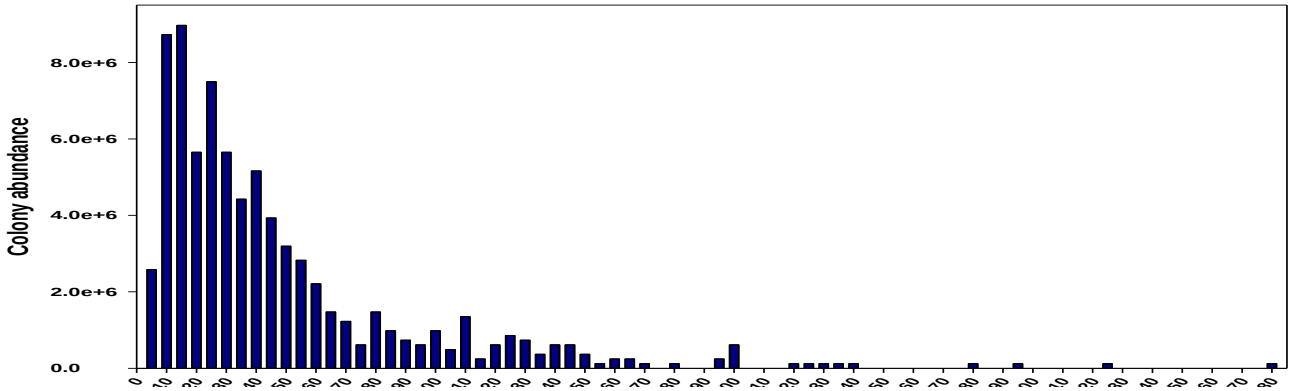
Habitat use	Area and abundance comparison
positive	% stratum area < % population abundance
neutral	% stratum area = % population abundance
negative	% stratum area > % population abundance

Preliminary results: Comparison of population size structure

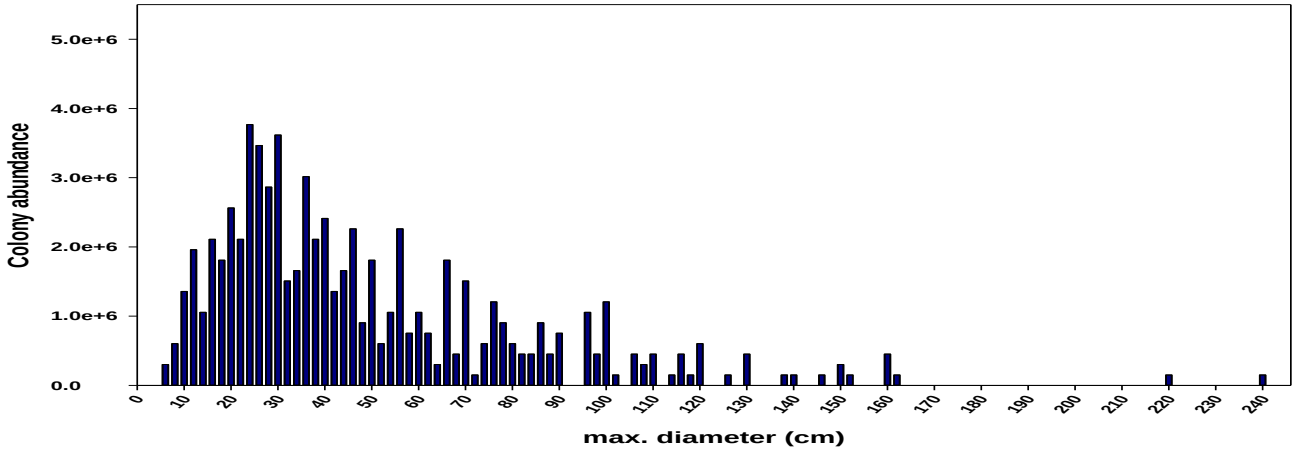
M. cavernosa
abundant



O. faveolata
threatened



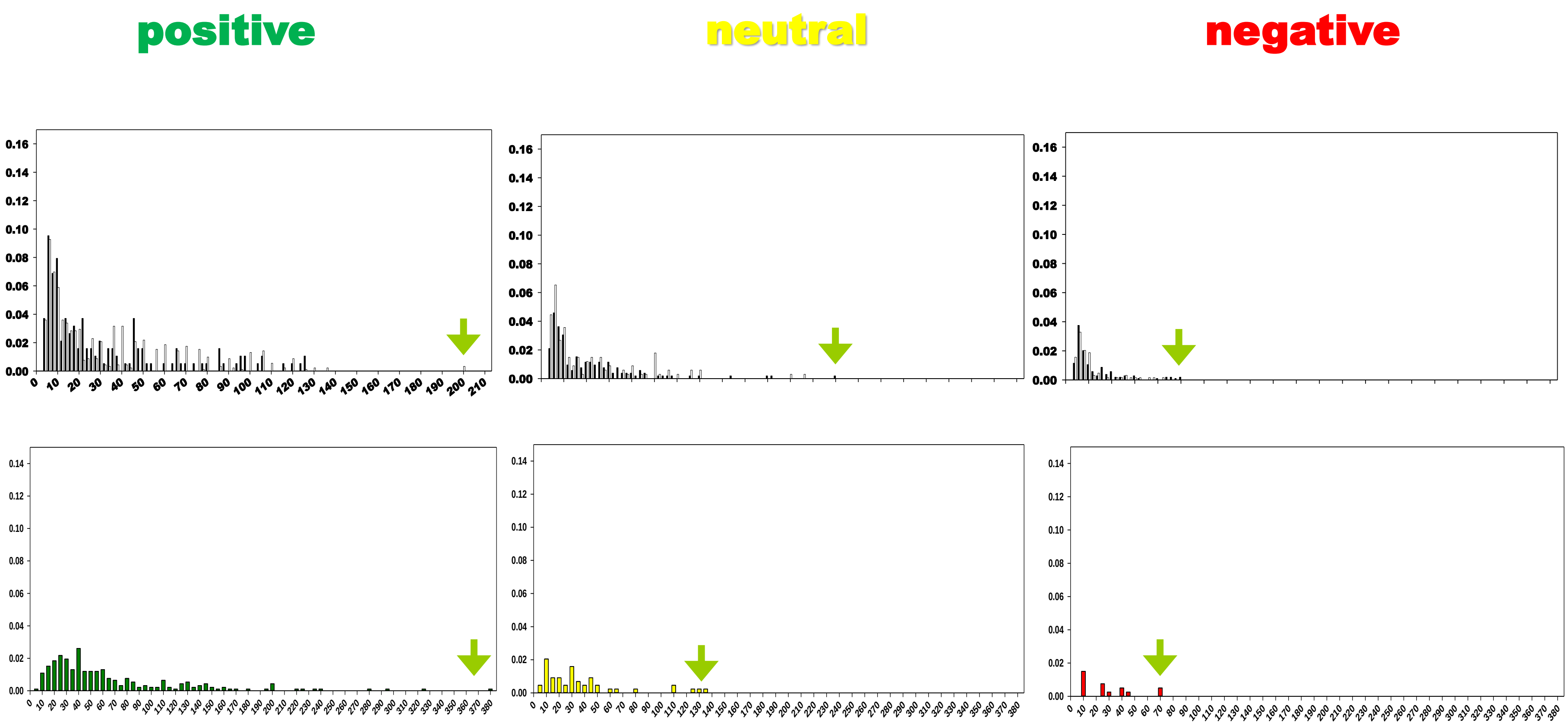
O. franksi
threatened



Preliminary results: Comparison of habitat use strata

			% of strata	
species	**status**	**positive**	**neutral**	**negative**
M. cavernosa	abundant	23	38.5	38.5
O. faveolata	threatened	12	44	44
O. franksi	threatened	18	36	46

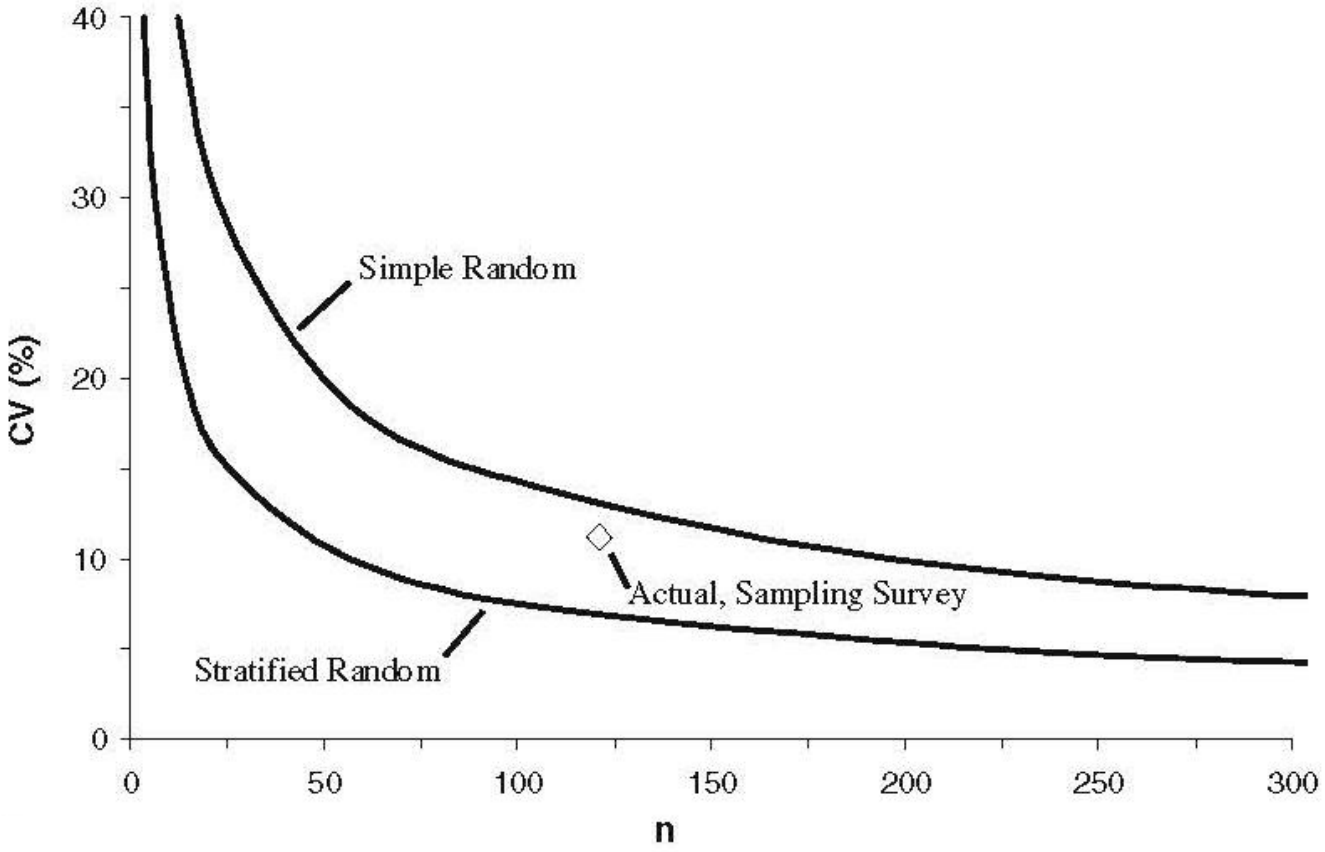
Preliminary results: Comparison of habitat use strata



Map tool: proof of concept

http://arcg.is/iPveS

Evaluation of survey performance: all regions



Coral project team: Spatial demographic model

Spatial demographic model development

Length based model that incorporates spatial results from population assessment (habitat use analysis)

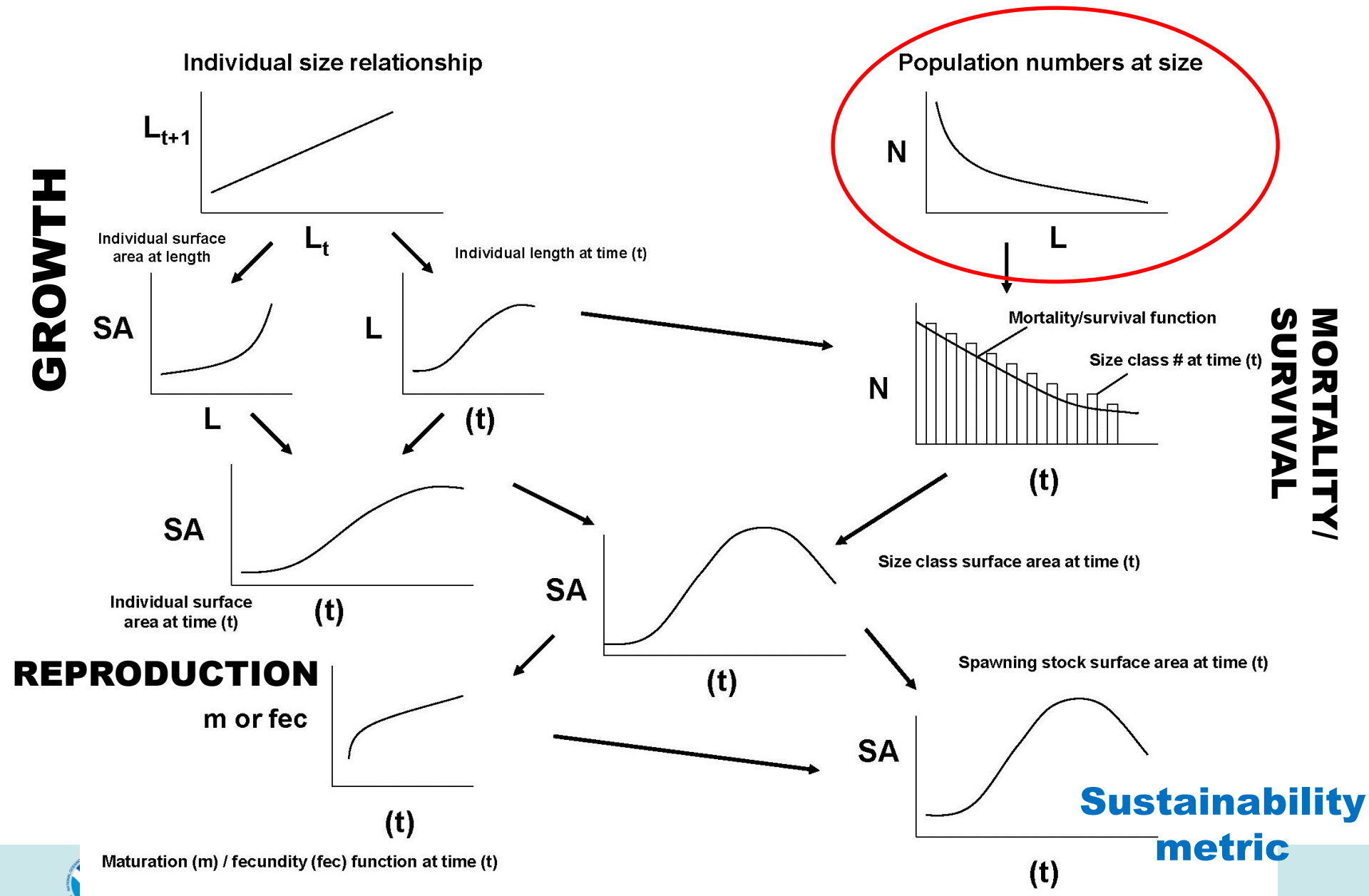
- -numbers at size across habitat space as initial conditions
- -variable rates of recruitment, growth, and survival

Builds on a CRCP funded coral demographic projects

Parameterized using existing life history information

- -Species-specific rates across size

Quantitative demographic approach



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Others:

Members of the PS toolbox Coral demographic team

Steve Smith (UM RSMAS)

PIFSC Ecosystem Sciences Division staff members: Ecospatial and Benthic Teams

Coral project team: Predictive species distribution models

This PDF was later amended to make the document 508 compliant.