A pilot, cooperative fishery independent survey of Saint Croix, US Virgin Islands

Meaghan D. Bryan, Todd Gedamke, John F. Walter, and Jennifer Schull
Southeast Fisheries Science Center
Miami, Florida

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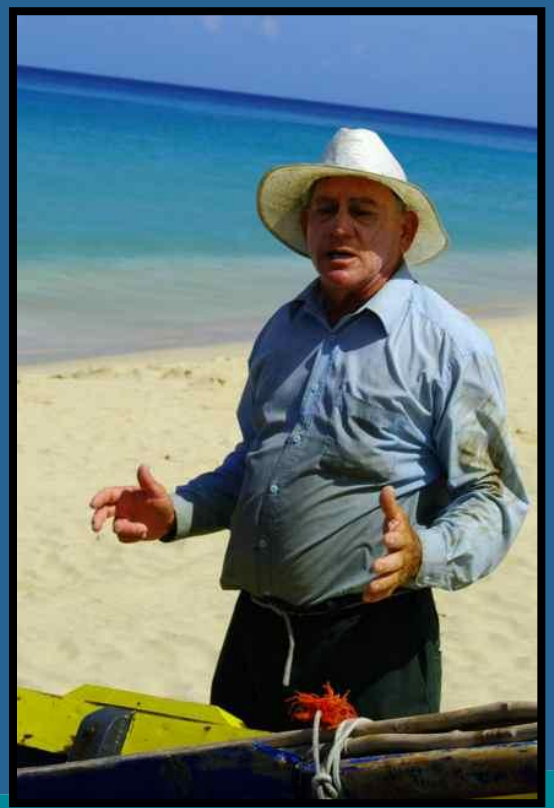


Data in the US Caribbean with emphasis on the US Virgin Islands

- Limited species-specific information
  - Commercial reporting was by species group (e.g., snappers or groupers)
  - Supplemental fishery-dependent programs have sampled a small fraction of total catch and have lacked a rigorous statistical design
  - Existing fishery-independent surveys were conducted on a small spatial scale or were conducted intermittently

Objectives

- Provide a spatially comprehensive, fishery-independent snapshot of the relative reef fish abundance in the US Caribbean
  - Can one survey capture the abundance trends for multiple species?
- Design a cost-effective survey program
  - Use of NOAA 'white vessels' is costly given the overall value of US Caribbean Fisheries (~$14 million/year)
- Engage stakeholders and increase their participation in the process
  - Foster trust and build bridges between the industry and the scientists/managers

Objectives

- Provide a spatially comprehensive, fishery-independent snapshot of the relative reef fish abundance in the US Caribbean
  - Two methods were evaluated to determine information gains when using a stratified random sampling design (SRS) coupled with a spatially optimal model based design
  - Use a model based design approach to fill in gaps that result from SRS and provide complete relative abundance maps

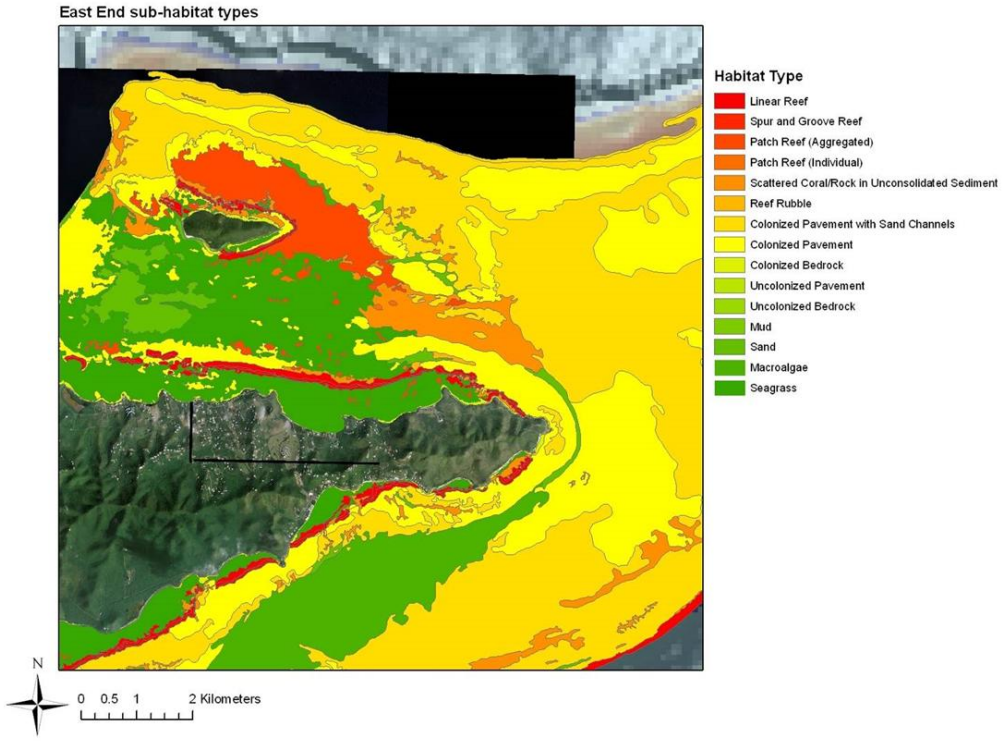
In the field

- All fishing was done in St. Croix
- Fishermen designed and built 40 identical traps
- Local fishermen and vessels were used to conduct the study
- Traps were soaked for 24 hours, on average
- All fish were identified and measured by scientific staff
- Sampling was conducted for one month (October – November, 2010)

NOAA FISHERIES

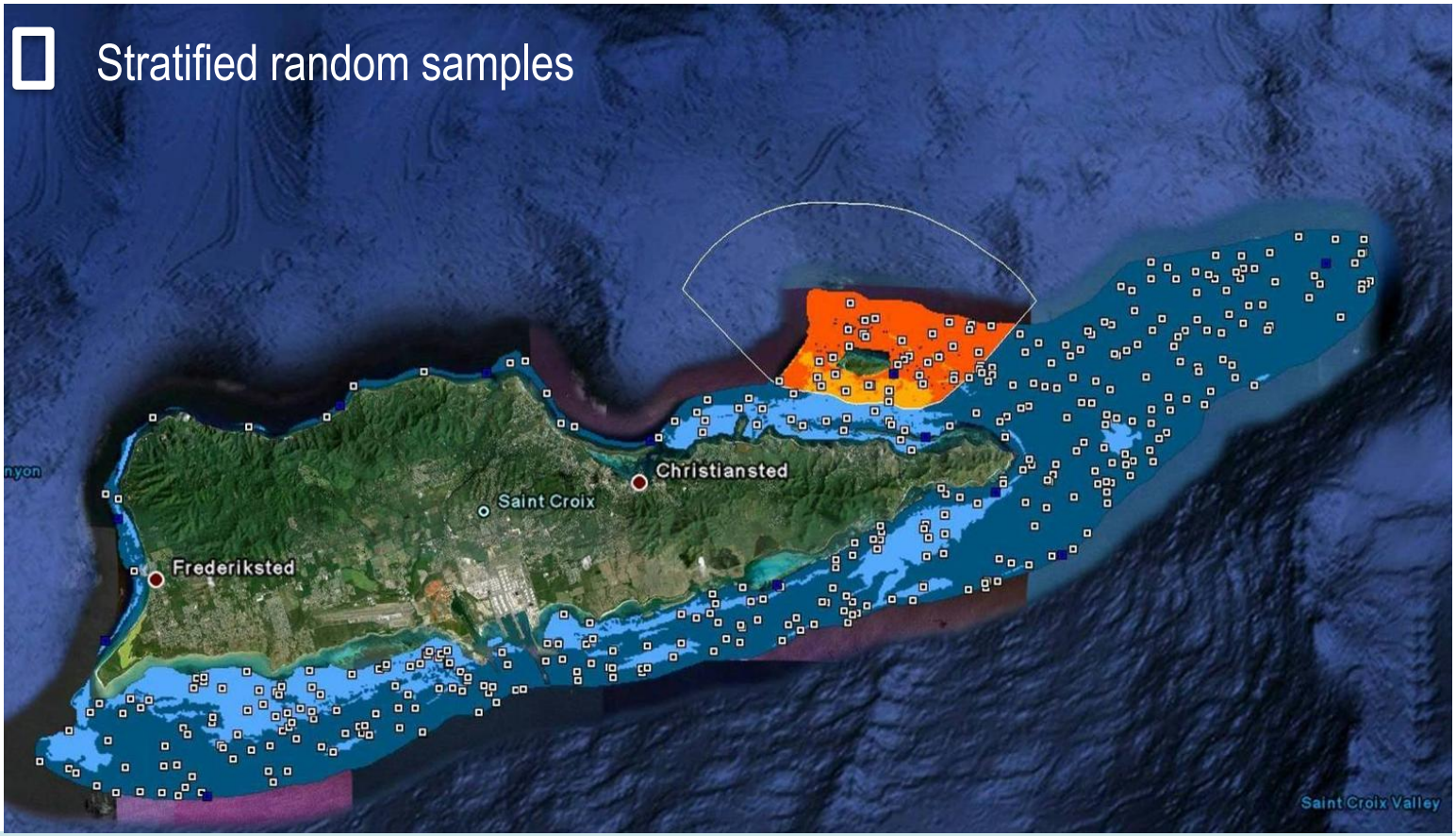
Comprehensive statistical design

- Entire shelf was surveyed (600 total stations)
  - Design-based (stratified random sampling) and spatially optimal based sampling
- The shelf was stratified according to habitat (soft and hard bottom habitat) and spatial management (open and closed areas)
  - Partnered with NOS-Biogeography Branch and students at UVI for GIS/survey design support



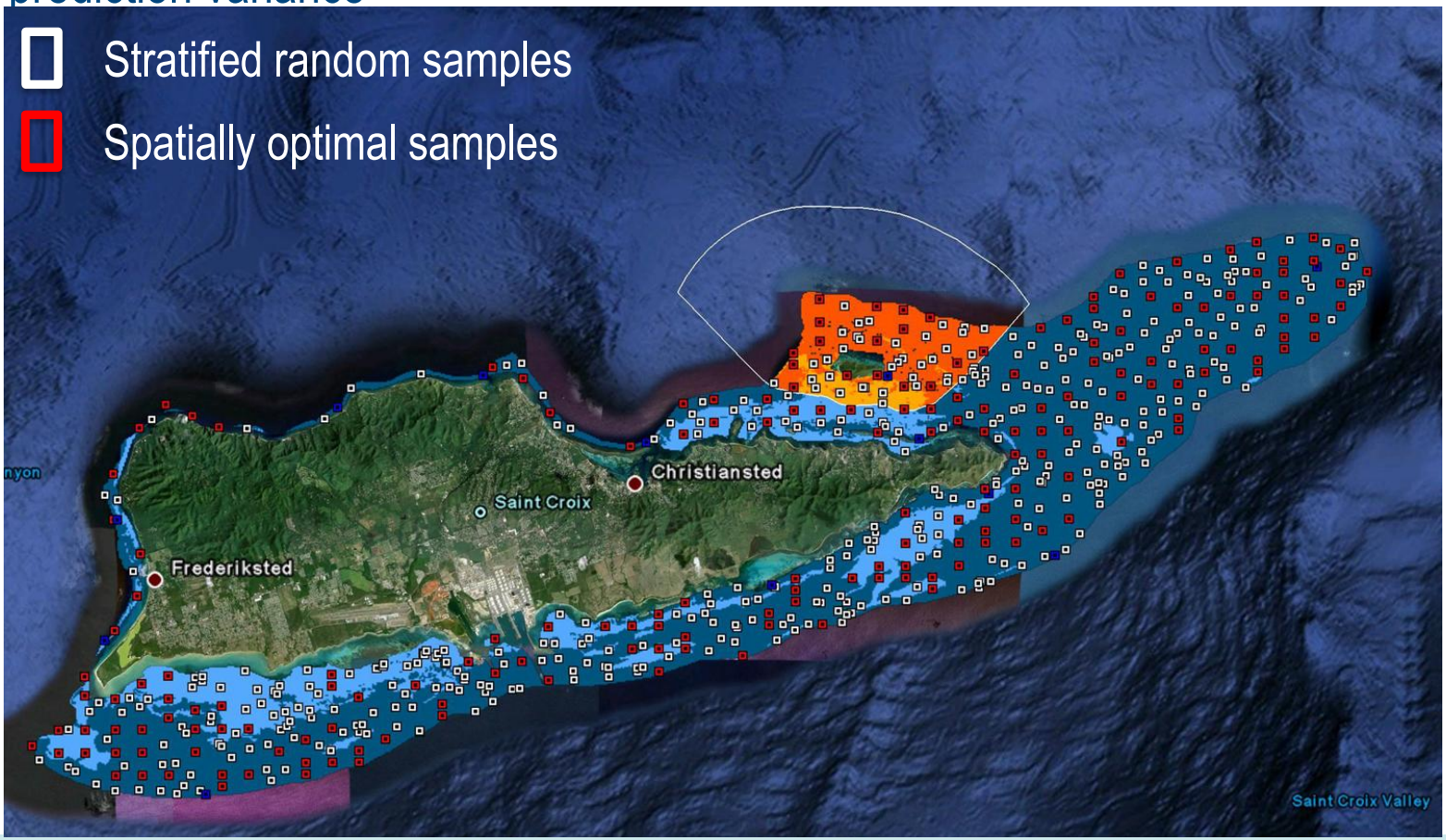
Stratified random design

- 400 stratified random stations allocated proportionally by strata
  - 10 stations were paired with fixed stations that represent UVI time series

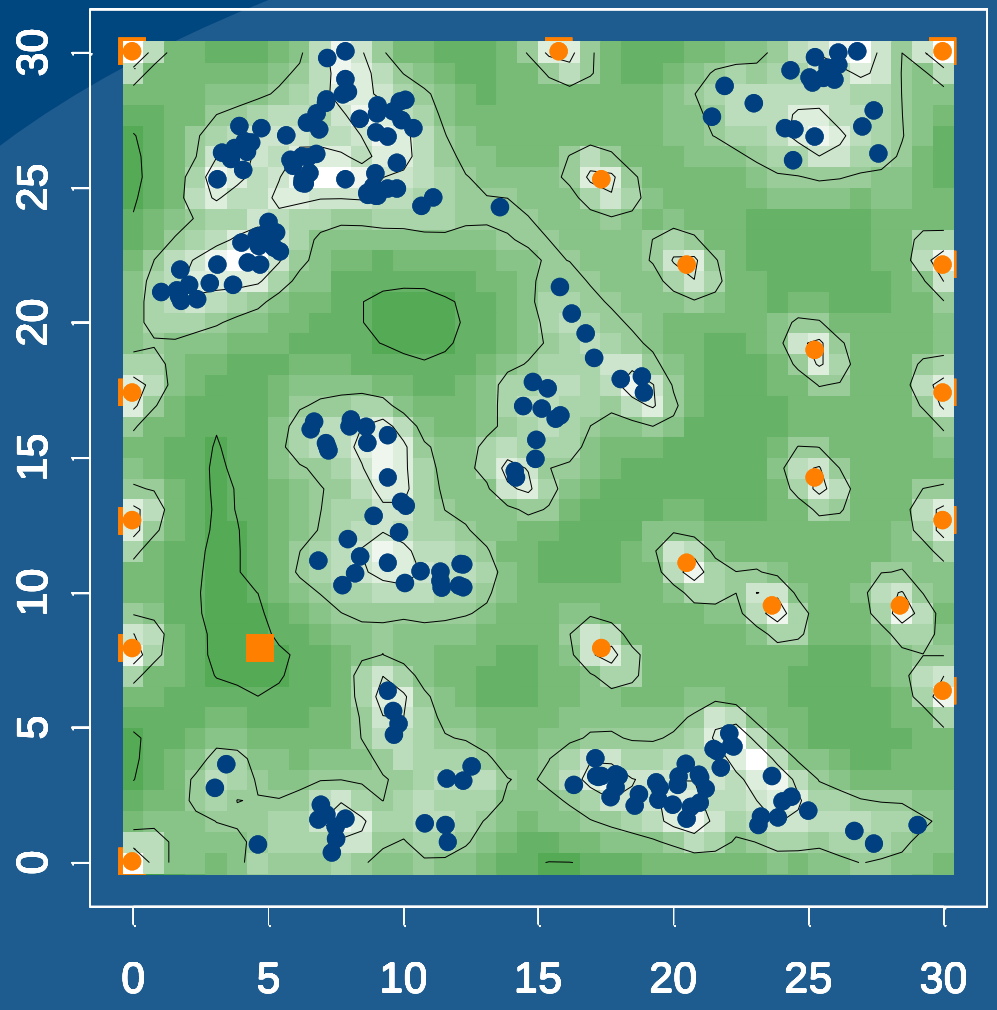


Spatially optimal design

- An additional 200 stations were added using a novel spatially optimal allocation design developed by John Walter and Todd Gedamke. Entire shelf was searched over 30m resolution for a sample location that minimized the prediction variance



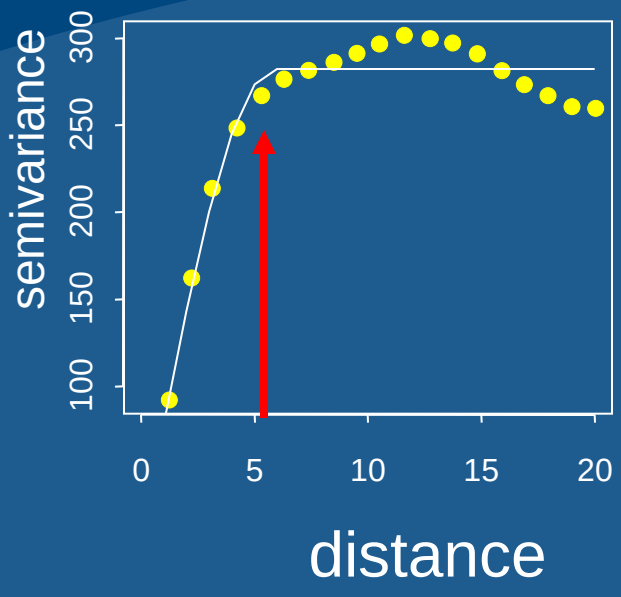
Using the prediction variance to allocate samples

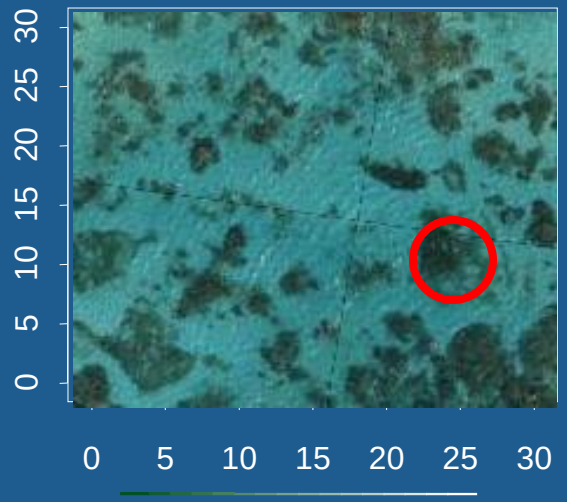


- In this example, optimally add 20 samples to minimize the prediction variance
- Assume a functional relationship that defines the variogram (describes the degree of auto-correlation among sites
- Additional sites reduce the overall spatial variance
- Goal is to provide a method to increase efficiency in spatial mapping

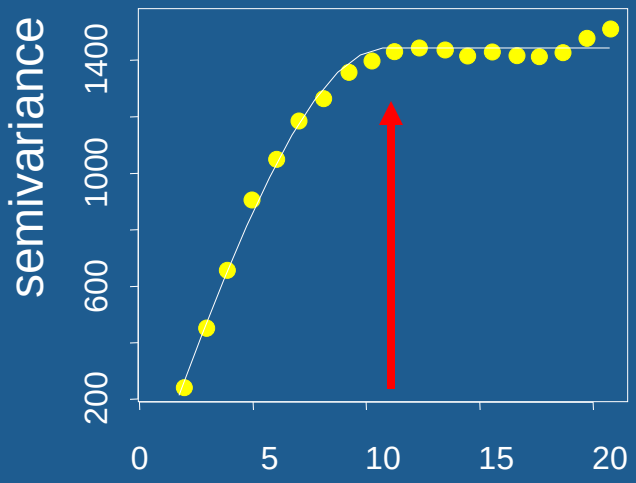
An intuitive feel for the variogram

Range of 5

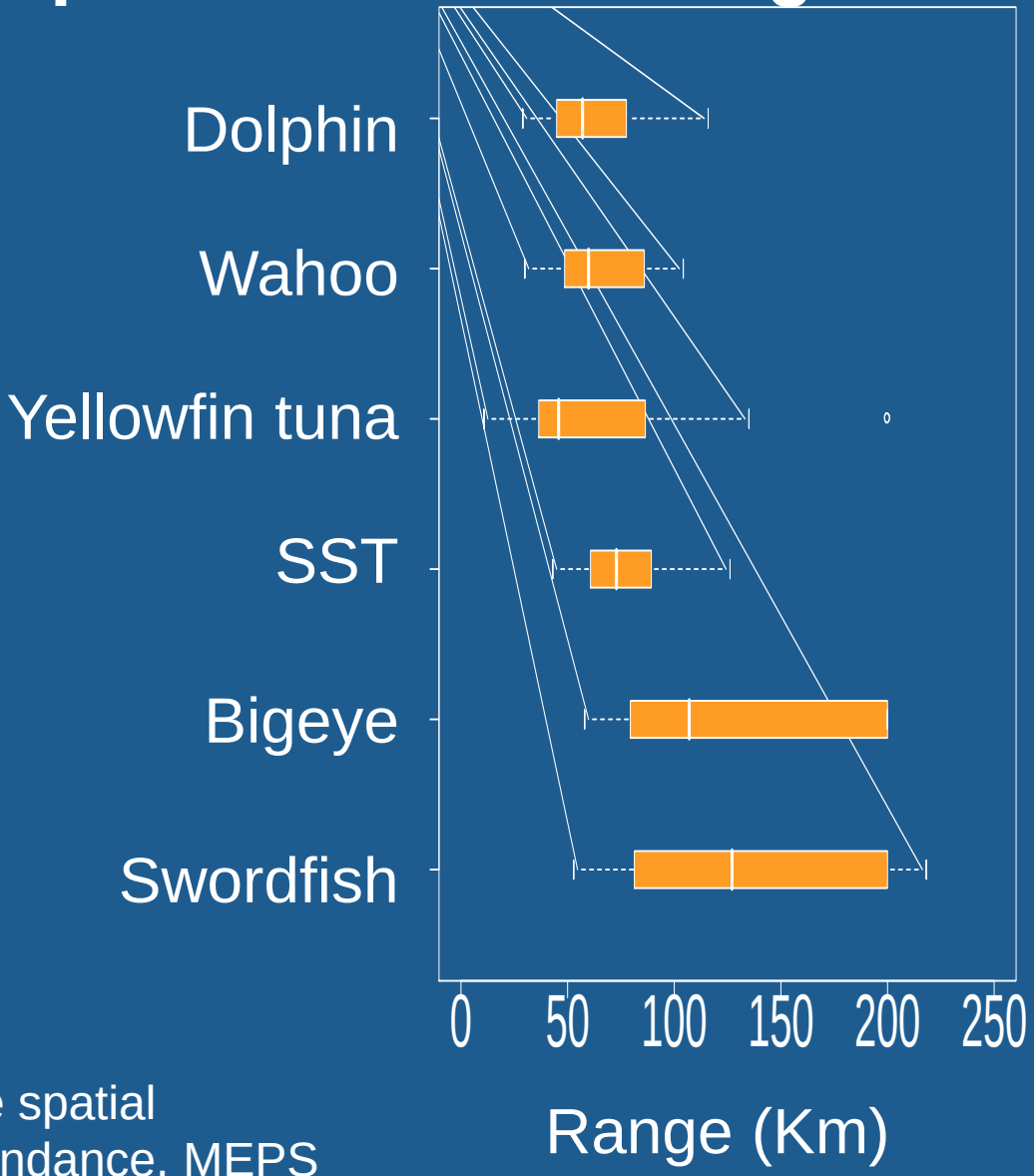




Range of 10

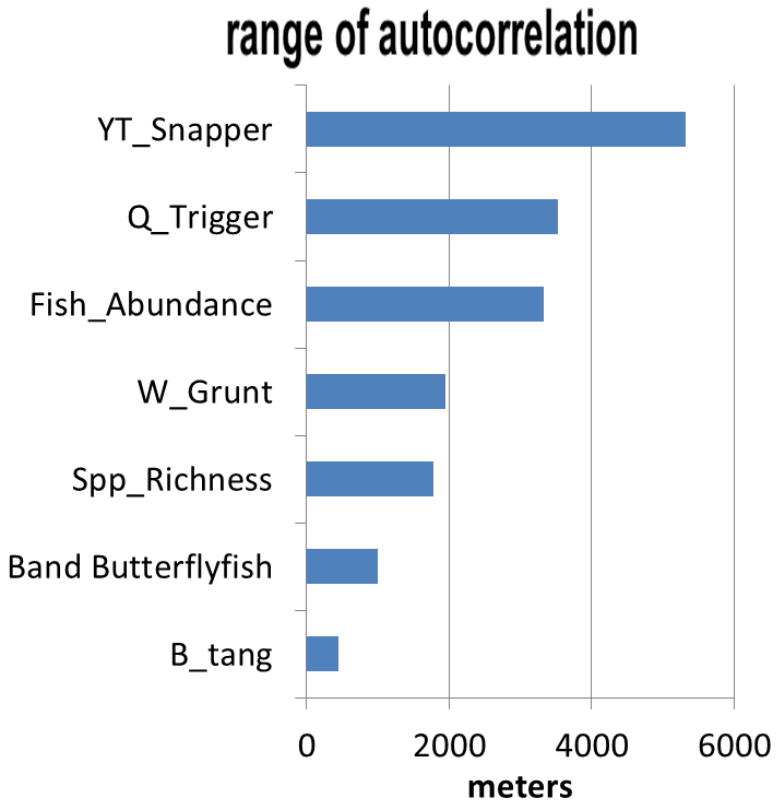


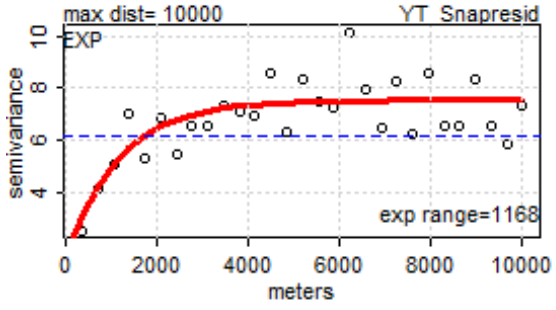
An ecological interpretation of the range

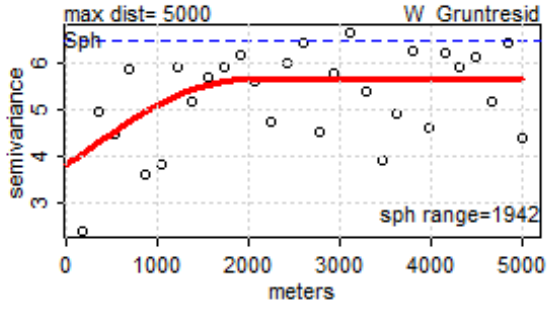


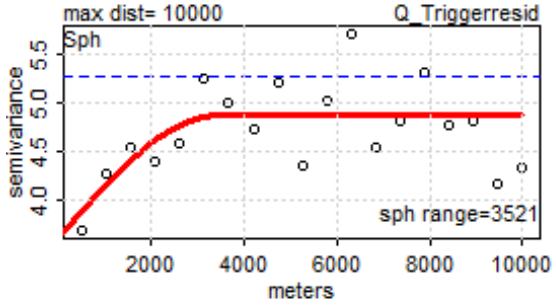
Kleisner, et al. 2010. Modeling the spatial autocorrelation of pelagic fish abundance. MEPS

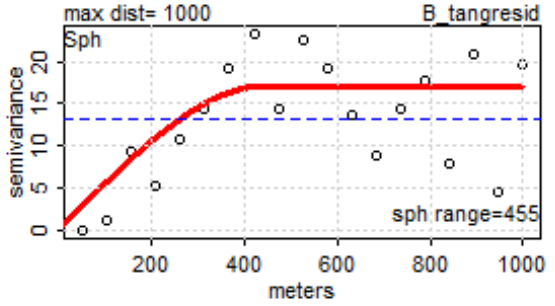
Variogram used to determine spatial gap filling throughout the St. Croix shelf assumed a range of 1km

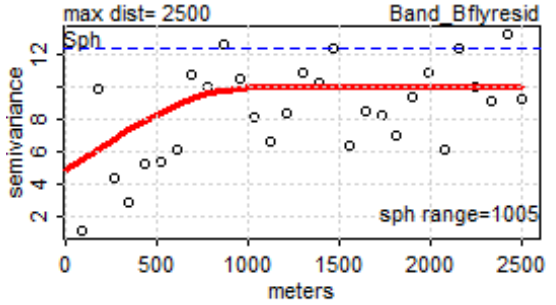


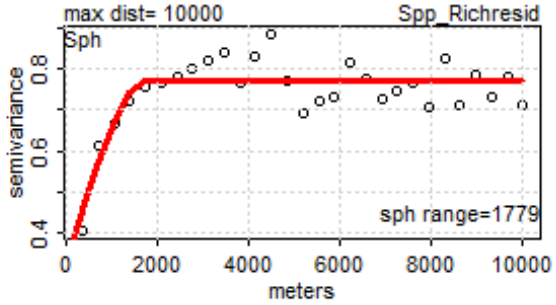


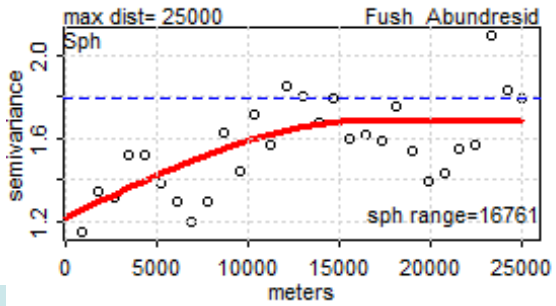




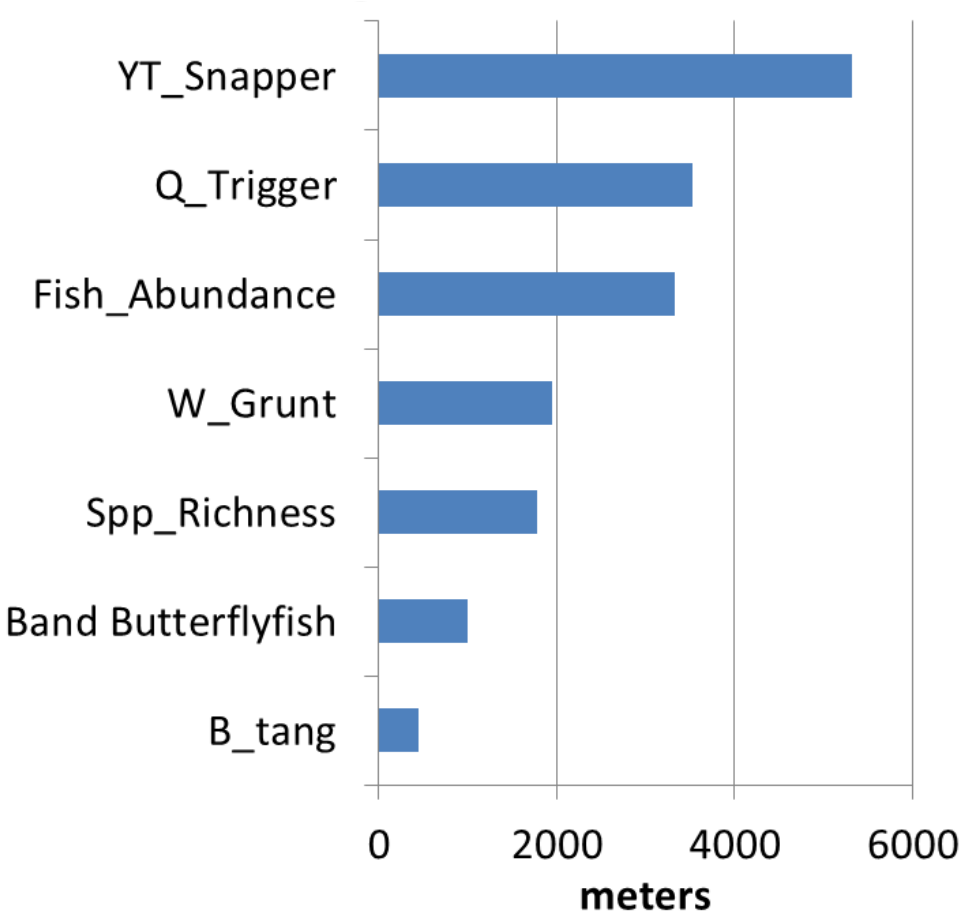




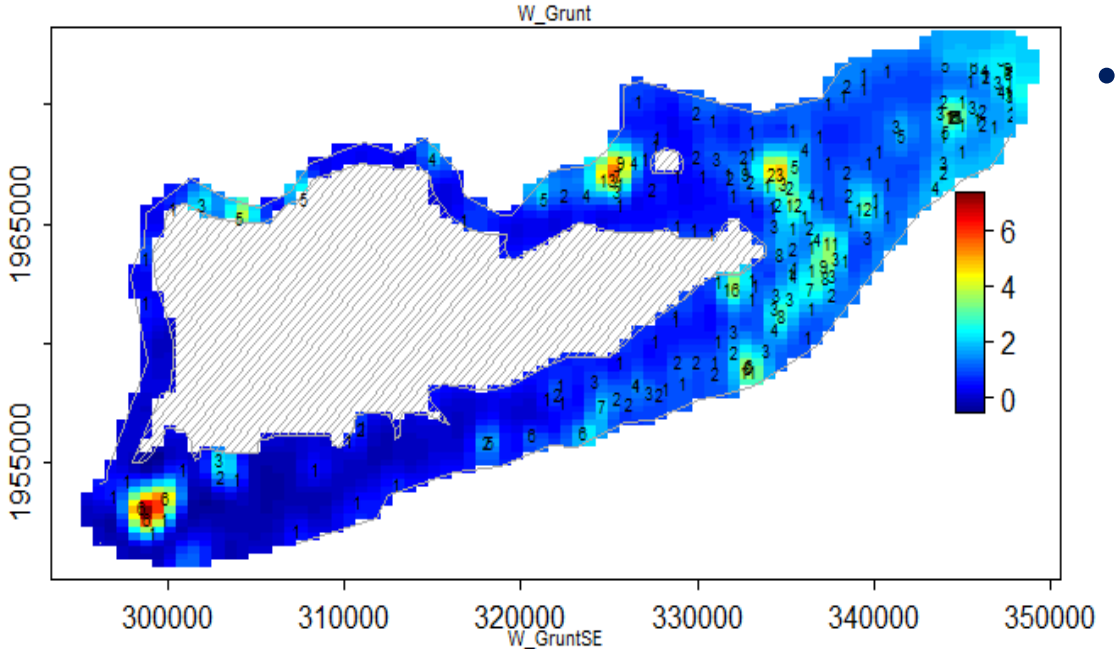


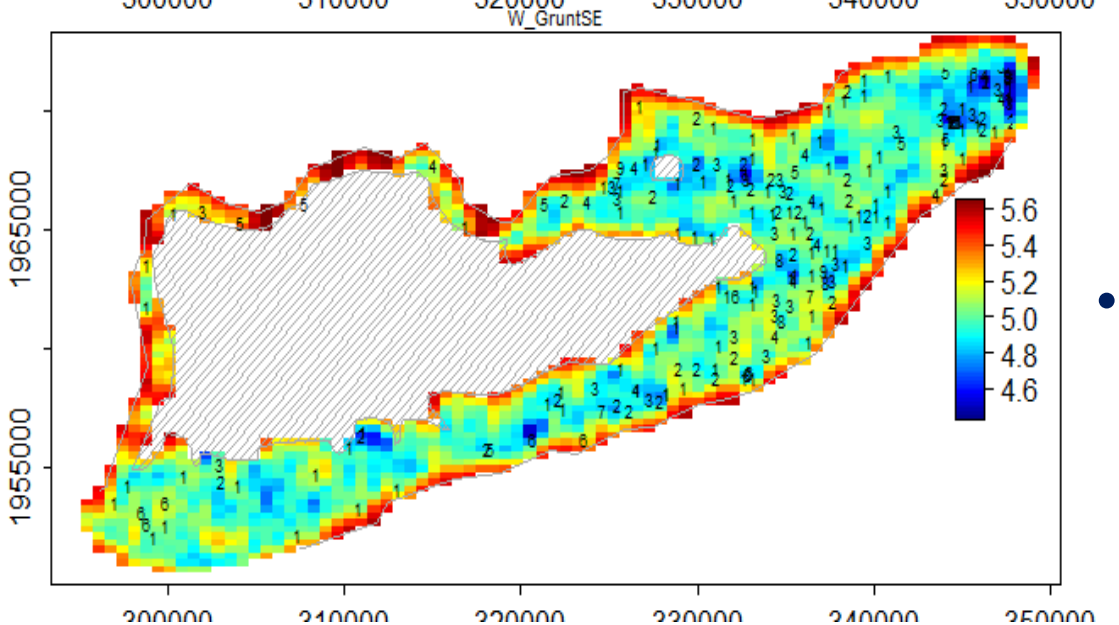


Scale of autocorrelation

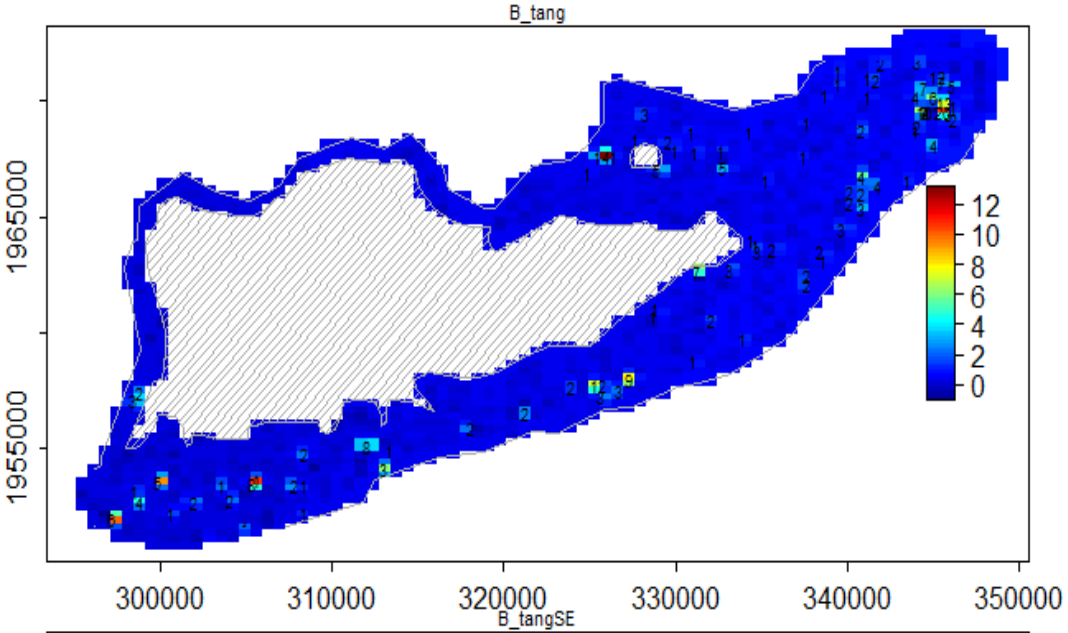


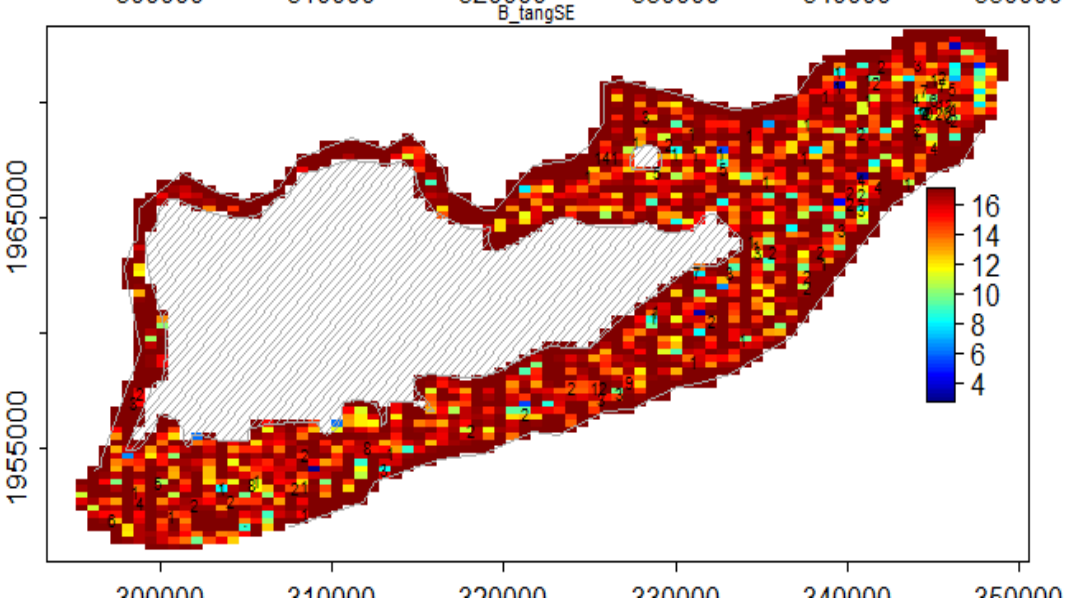
- Range of autocorrelation differs among the species
- Important to consider the range of autocorrelation for future surveys
  - If we were to assume a range similar to yellowtail snapper for future design, we could miss patches of species with a smaller range and could bias estimates of relative abundance





- White grunt catch rates were generally lower on the western side of the island than to the east
  - One dominant hot spot at the southwest end
  - A few clouds of higher catch rates at the eastern side in nearshore waters
- Catch were quite variable, with highest variability in areas of low sample size and along the shelf





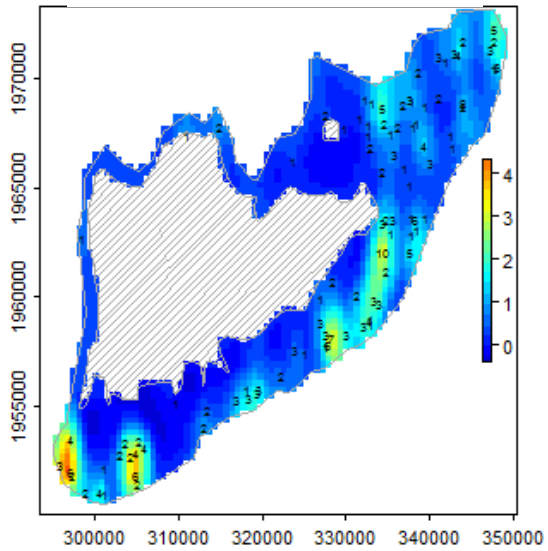
- Blue tang catch rates were relatively homogenous, between 0 and 2 per trap
  - A few small hotspots
- Blue tang catch rates were highly variable, indicating that species with a patch size less than 1km are essentially random processes
  - Variable catch rates may be explained by Blue tang's ability to swim in and out of the traps freely

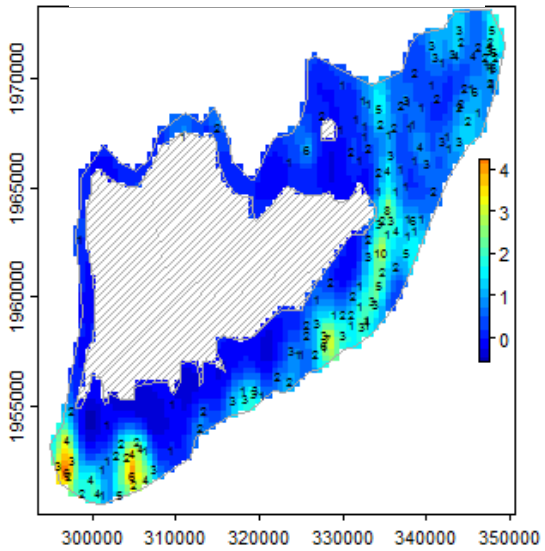
Stratified random samples only

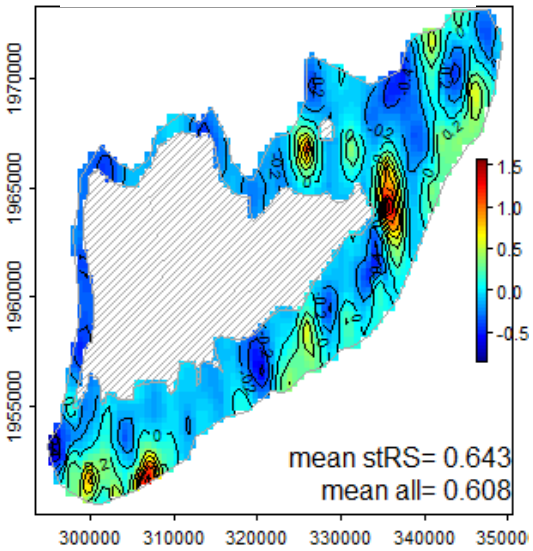
All samples

Difference

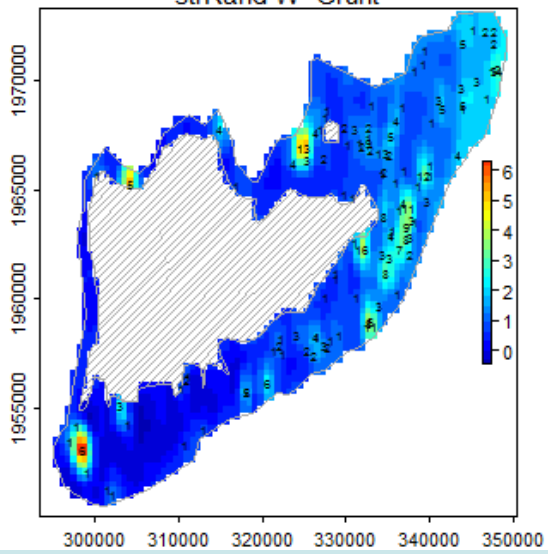
Queen triggerfish

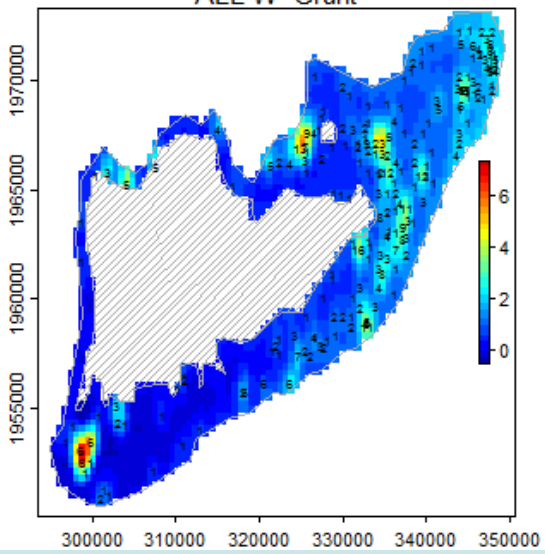


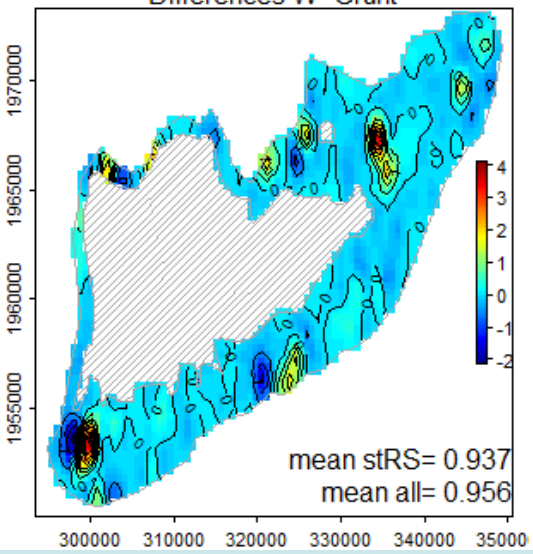




White grunt







Conclusions and next steps

- How well did we predict the underlying model?
  - Reasonable job
- What additional information did we obtain from the spatially optimal model?
  - Identified some potential hotspots missed by the stratified random sampling design (SRS)
  - Exceptional sample size relative to SRS
  - Would expect with lower sample sizes associated SRS we would see greater information gains
- Did we adequately map the distribution of biomass?
  - The next step is to bring the maps to the fishermen to determine whether they match their understanding
- Repeat the survey

Acknowledgements

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