Experimental Assessment of Functional Redundancy and Resilience of Benthic Algal Metacommunities

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Theory

As seawater intrusion accelerates in the coastal Everglades, freshwater algal communities will give way to seawater-tolerant communities. It is known that fresh and brackish benthic algal communities (periphyton) are capable of providing similar functions and ecosystem services (**functional redundancy**), but the extent of this redundancy is unknown, as is the capacity for redundant species to provide functional resilience to seawater intrusion for the algal metacommunity spanning the coastal ecotone.

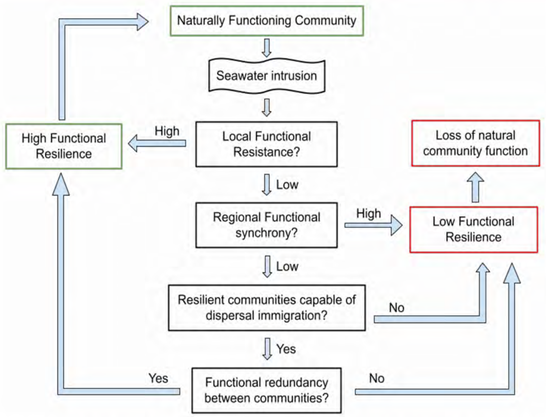

Fig. 1: Flow-chart diagram outlining the processes by which a community patch may maintain functional resilience during a disturbance, or lose its previous functional attributes.

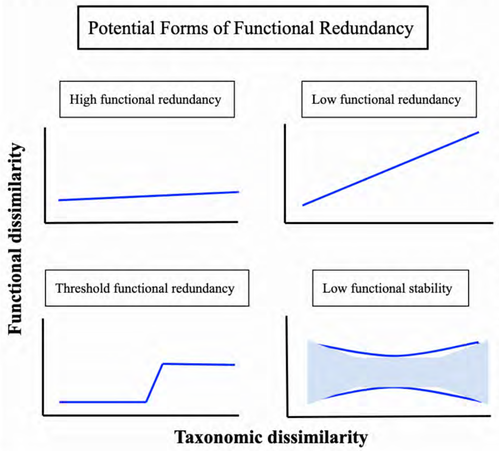

Fig. 2: Potential degrees and forms of functional redundancy the benthic algal metacommunity may exhibit, based on how dissimilar the aggregate functions of its constituent community patches become as the species within a community turn over and the community becomes more taxonomically dissimilar, relative to its original composition.

Experimental Design

• Solute-diffusing tiles mimic the components of groundwater-derived seawater intrusion: salt, phosphorus, and both.

• Tiles have been deployed across the existing fresh-brackish ecotone in a replicated, spatially distributed manner. Algae which grow on tiles will be collected for analysis of **composition** (diatom assemblage) and **functional attributes** (accumulation rates of biomass, chlorophyll-*a*, and inorganic carbon production).

Fig. 3 (above): Landscape-scale satellite image of the coastal Everglades salinity ecotone. Red box represents the experimental area (as in Fig. 6).

Fig 4 (left): Solute-diffusing tile (orange) connected to its IV-drip-style reservoir, being tested in the field. Benthic algae (tan) surrounds it.

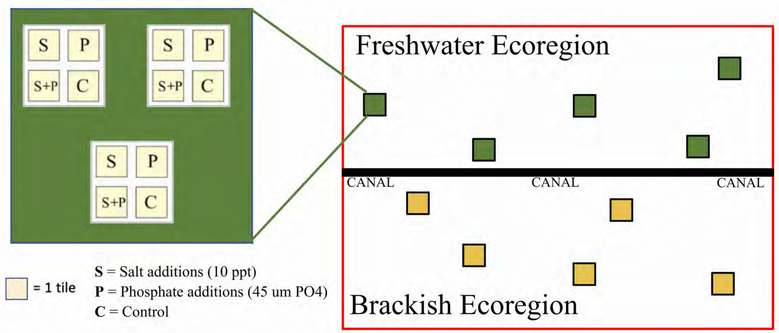

Fig. 5 (left): Experimental design for one treatment site. Each site has triplicate suites of solute-diffusing tiles of each treatment type: salt (S), phosphorus (P), both (S+P), and a control tile (C).

Fig. 6 (right): Conceptual diagram of the spatial distribution of treatment sites. Treatment sites span a haline ecotone across the canal seen on the map in Fig. 3. Green = freshwater treatment sites. Yellow = brackish treatment sites.

Analyses and Expected Results

• **Dissimilarity** is measured as the difference between a treatment and its control. **Taxonomic dissimilarity** is Bray-Curtis dissimilarity of the sample's diatom assemblage. **Functional dissimilarity** is Gower's dissimilarity index for accumulation rates of periphyton functional attributes.

• Influence of functional redundancy on the metacommunity's functional resilience will be assessed via MANOVAs.
  • Resilience = nonsignificant difference between treatment and control.
  • *Functional resilience is expected to be more prevalent for communities with greater functional redundancy.*

• Spatial scales at which salinity and dispersal are most influential on functional resilience to P will be assessed via db-RDA.
  • *Salt exposure is expected to promote P resilience at the ecoregional spatial scale. Dispersal is expected to still be limiting to composition at large spatial scales, and be positively correlated with P resilience.*

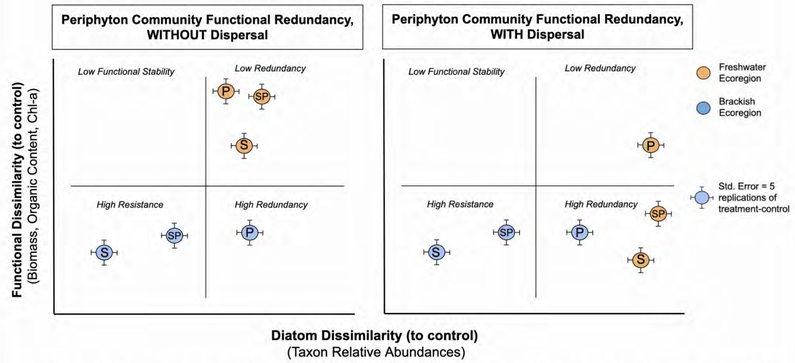

Fig. 7: Functional redundancy diagram illustrating the expected responses of coastal periphyton to seawater intrusion. Freshwater communities are expected to be more resilient if brackish, seawater-resistant species with similar functional attributes are capable of dispersing to the intruded areas.

Next Steps

I would like to apply this experimental setup and analytical framework in a distributed way to other freshwater systems, inland and coastal, which are threatened by saltwater intrusion.

If you are interested in participating in this globally distributed endeavor, please contact Tommy Shannon at tshan018@fiu.edu

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