



- **Ecology and Biodiversity**
 - Vulnerability assessments and adaptation strategies based on a watershed approach.

Coordinator: Dr. Lisamarie Carrubba



Freshwater Ecosystem

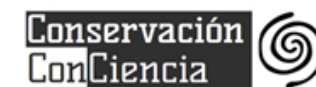
Forests (Montane to Coastal)

Brackish, Estuarine and Lagoon Systems

Karst

Beaches and Rocky Shorelines

Marine Systems (Coral Reefs and Other Coral Habitats, Submerged Aquatic Vegetation, Bioluminescent Bays, Cays and Islets, Fishery Resources, Marine Mammals)



WG2: Ecology and Biodiversity Freshwater Ecosystems

SOFIA BURGOS CARABALLO, PhD

COMPREHENSIVE WATER PLAN MONITORING DIVISION

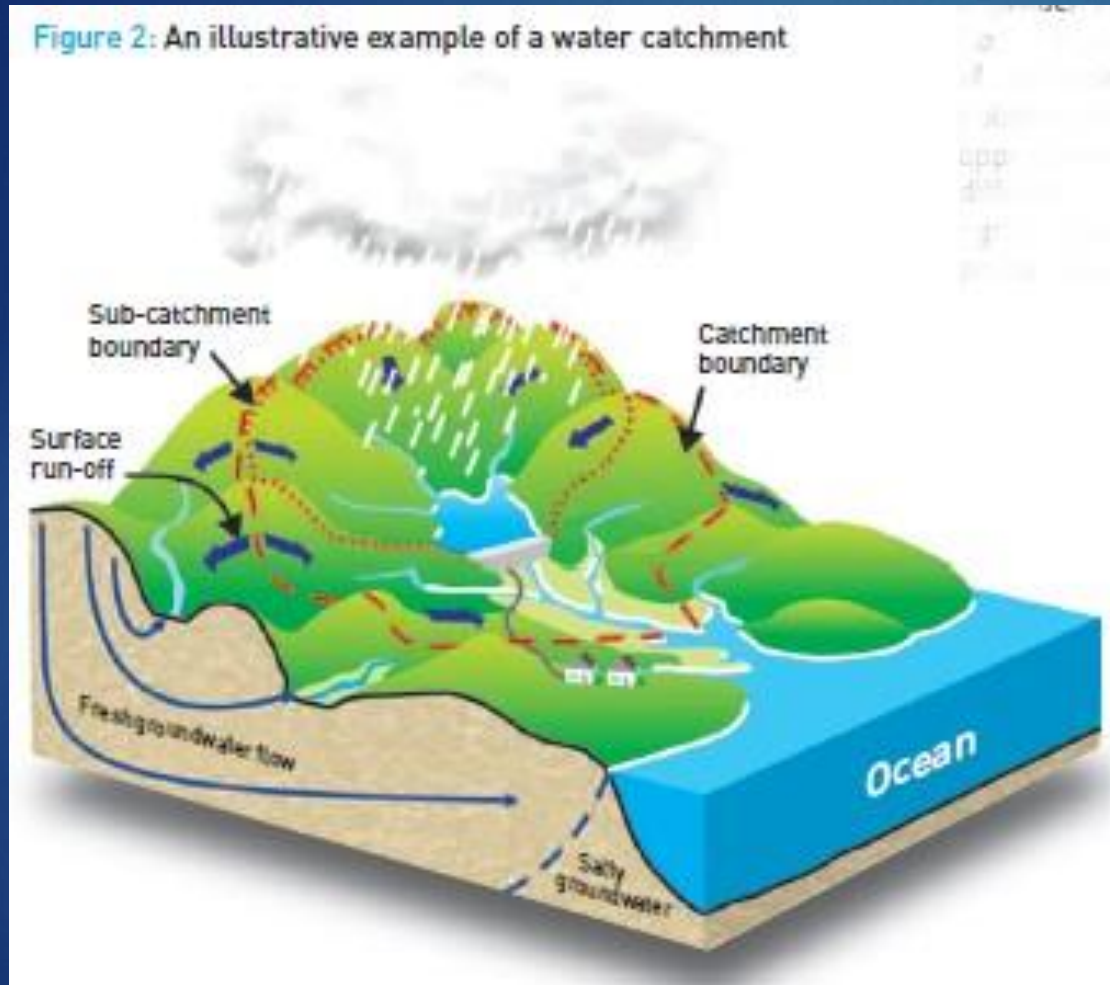
DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES



OUTLINE

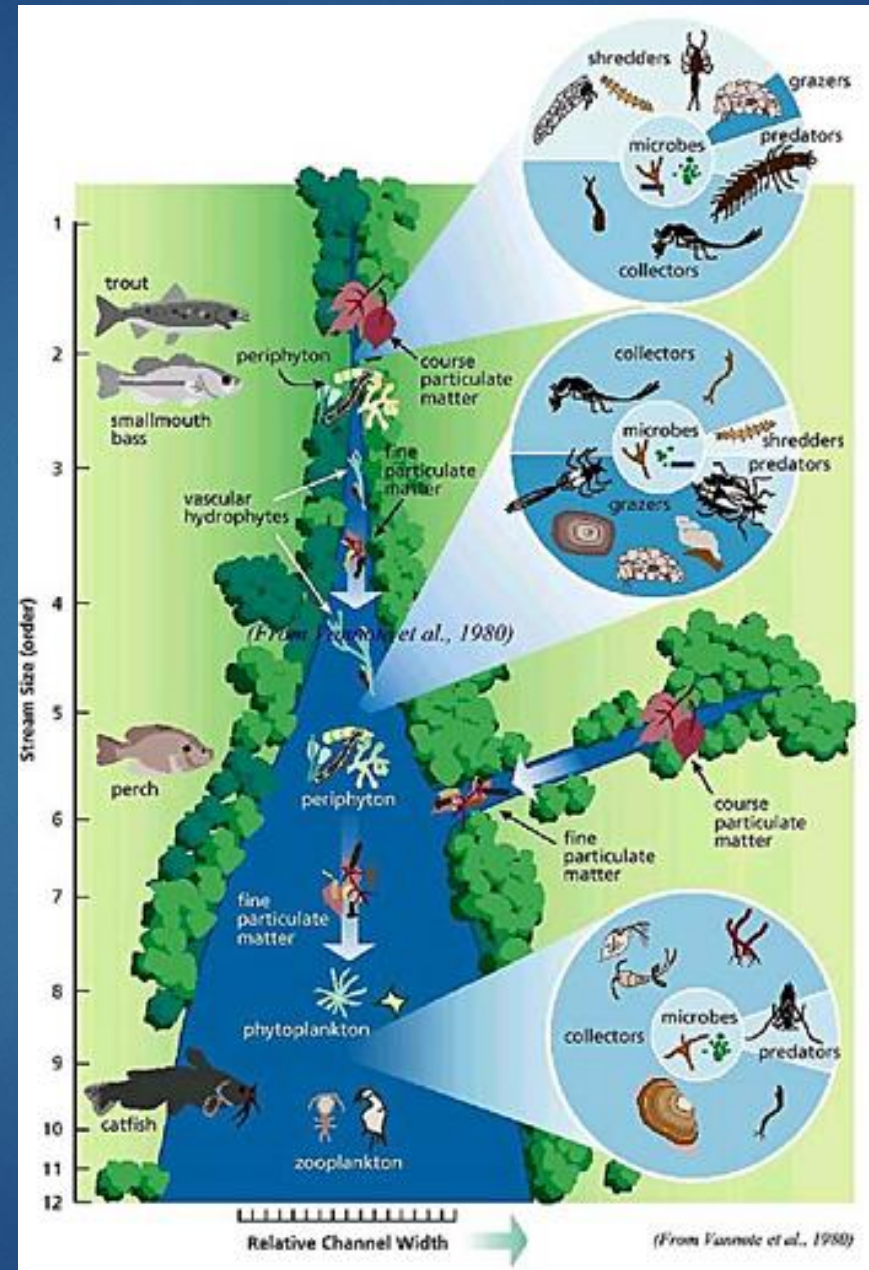
- ▶ Approach used for the freshwater section
- ▶ The River Continuum Concept
- ▶ Stressors

Watershed Approach



- ▶ Landscape modification
 - ▶ Urbanization and agriculture
 - ▶ Elimination of riparian areas
- ▶ Instream modifications
 - ▶ Obstructions in the main channel
 - ▶ Degradation in water quality
 - ▶ Introduction of exotic species

The River Continuum Concept

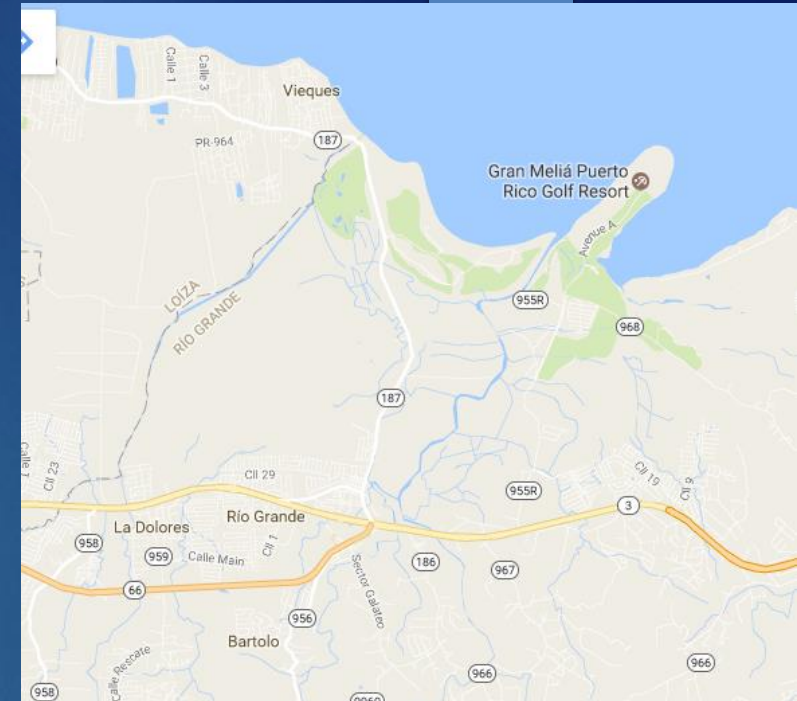


Does the river continuum concept apply on a tropical island? Longitudinal variation in a Puerto Rican stream

Effie A. Greathouse and Catherine M. Pringle

Stressor: Sea Level Rise and Salt Water Intrusion

- ▶ During low flow periods there is more salt water intrusion
 - ▶ Establishment of saline tolerant species that can increase in abundance and outcompete freshwater species.
- ▶ Gaps:
 - ▶ How far can it moves upstream?
 - ▶ What are the implications?



Stressor: Temperature

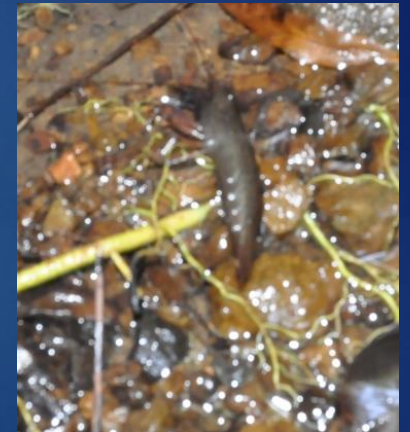
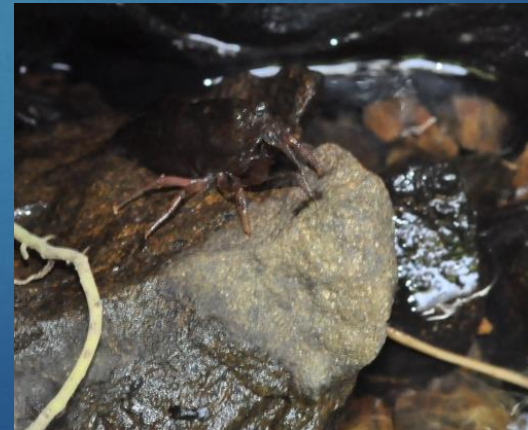
- ▶ Reduce the water capacity to retain dissolved oxygen.
- ▶ Affect the growth rate and distribution of species.
 - ▶ Reductions in the size of adults.
 - ▶ Increases in metabolic rates and nutrient cycling.
- ▶ Gap:
 - ▶ What is thermal threshold for freshwater aquatic organisms?

Stressor: Storms and hurricanes

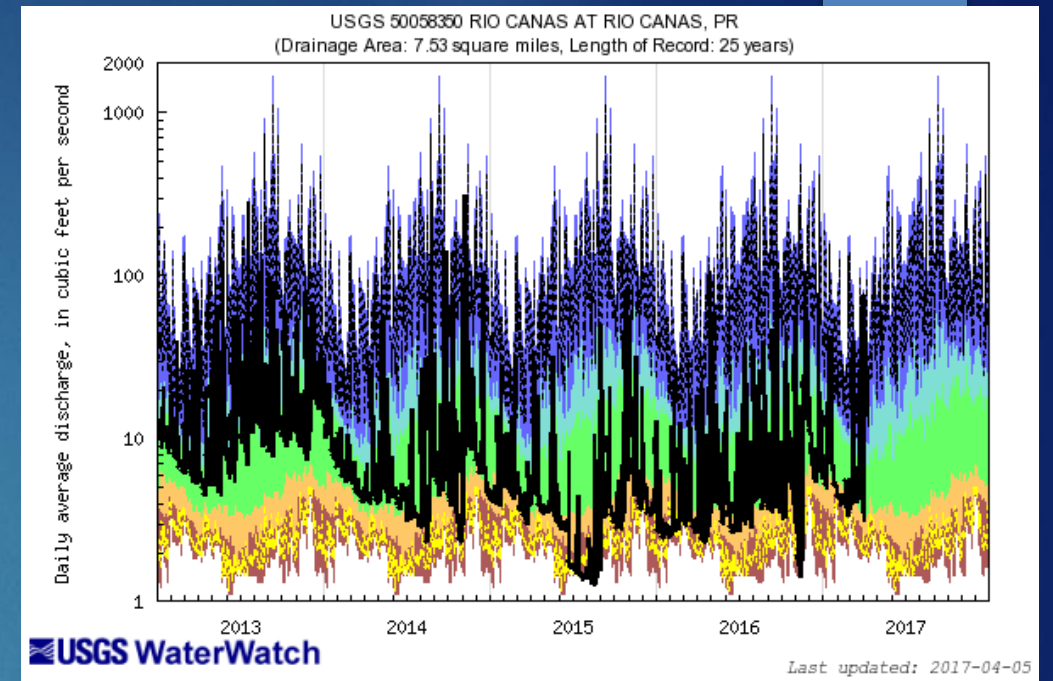
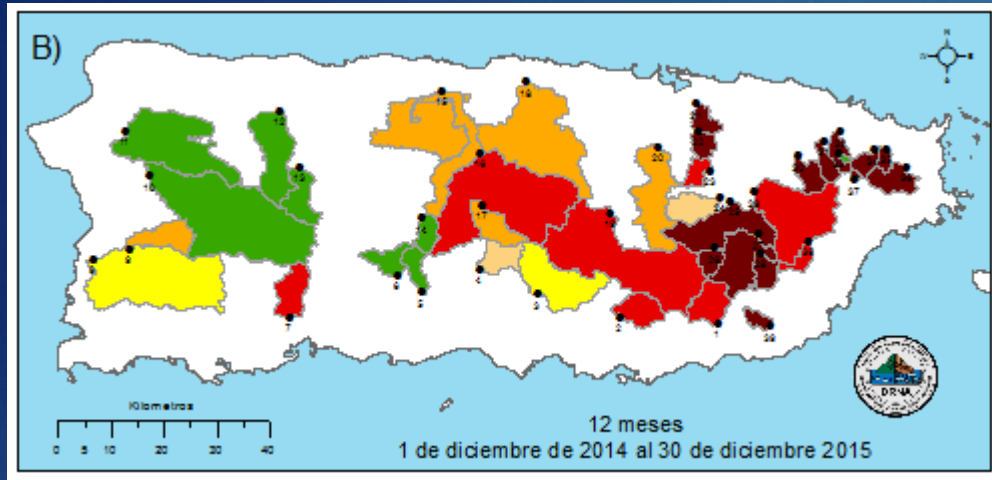
- ▶ Erosion and sedimentation
 - ▶ Increase downstream transport of dissolved and particulate material.
 - ▶ Hurricane-related flooding cause mortality and displacement of fauna (fishes, shrimps, crabs).
- ▶ Gaps:
 - ▶ Even when these species can be resilient through the mechanisms of recruitment and recolonization, are these mechanisms sufficient for species subsistence in the face of more frequent and intense storm events?

Stressor: CO₂

- ▶ Indirect CO₂ input
- ▶ Experimental addition of CO₂ has shown a reduction in stream pH and a negative effect on macroinvertebrates.



Stressor: Drought



▶ Concentration of pollutants:

- ▶ pharmaceutical products (such as antibiotics, analgesics, anti-inflammatory)
- ▶ personal care products
- ▶ endocrine disruptors (caffeine, aspirin, steroids, hormones, among others).

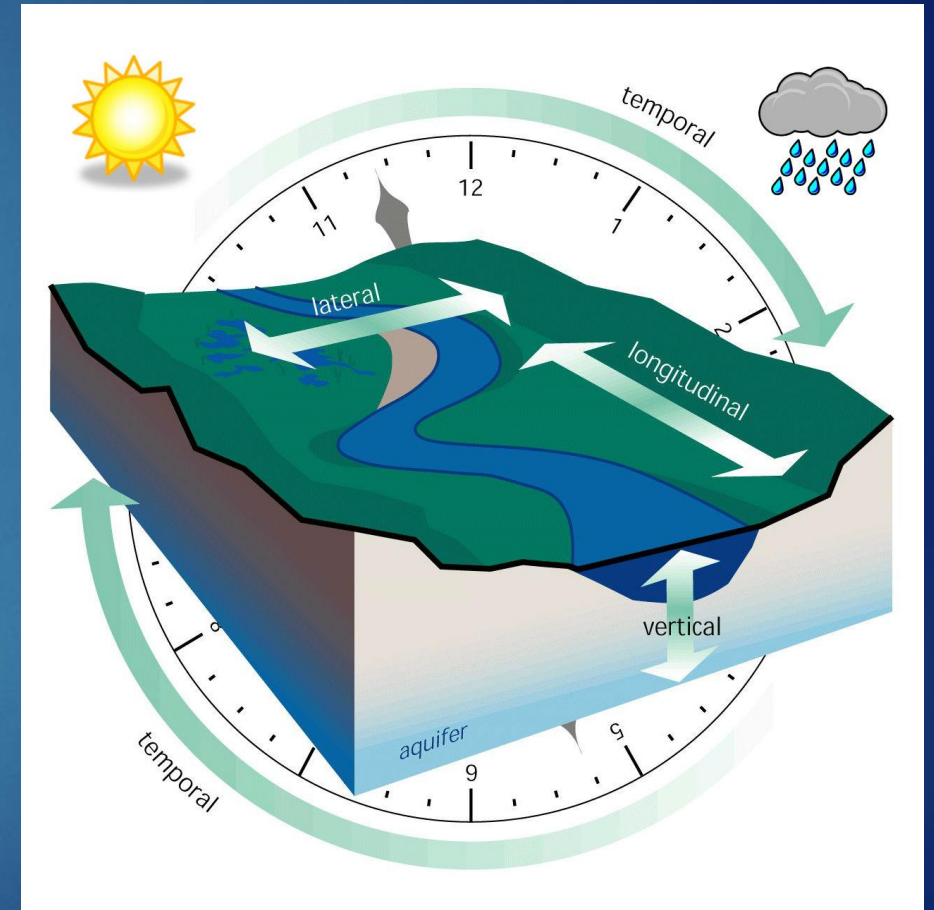
▶ Persist even after water treatment!

▶ Gap:

- ▶ How long it takes to the river to recover the deficit in flow?

Stressor: Drought

- ▶ Abundance of exotic fish species
- ▶ Enhance the effect of barriers
- ▶ Reduction in connectivity



Stressor: Drought

- ▶ Accumulation of sediments in river mouth
 - ▶ Restrict the entrance of migratory fauna.
 - ▶ Nutrients from marine origin will be eliminated.

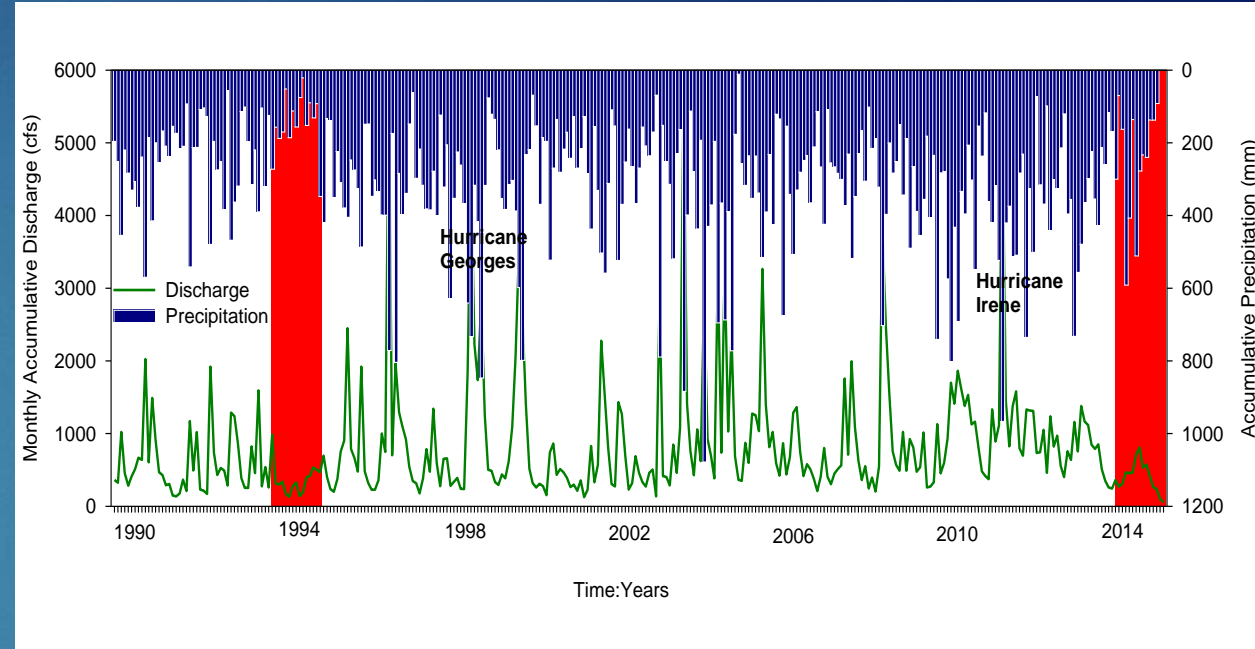
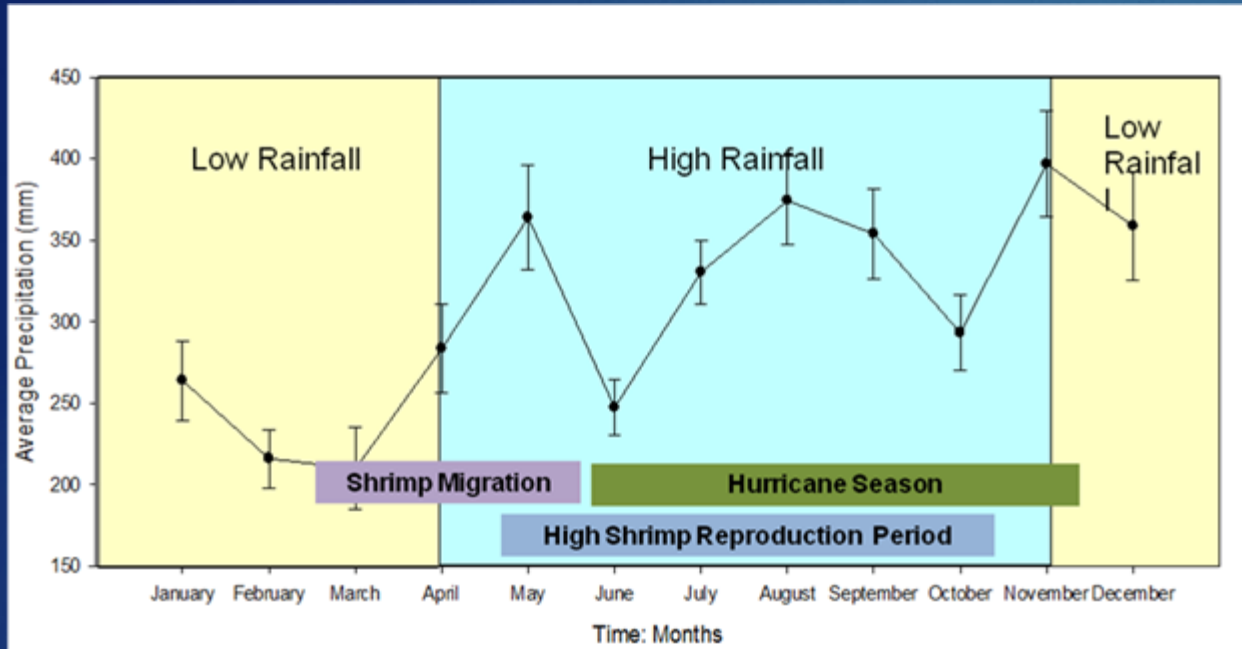


River mouth of río Sabana, without sand berm (picture taken on May 24, 2014).



River mouth of río Sabana with sand berm formed (picture taken on July 17, 2014).

Stressor: Drought



High flow- Reproduction and egg release
Low flow- Migration

➤ Gap:

- What are the effects of prolonged drought events on the migration patterns?

➤ Effects of the past two droughts:

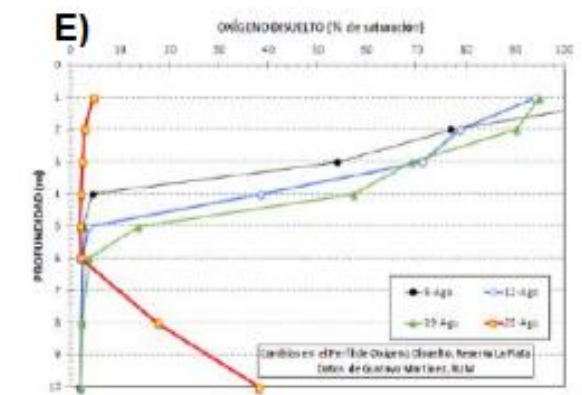
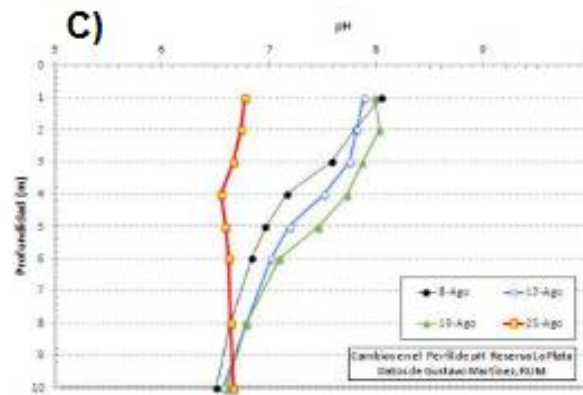
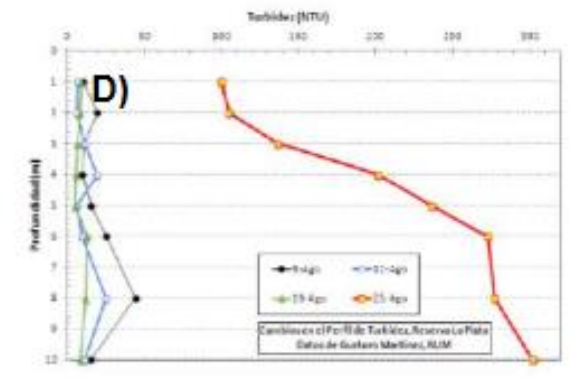
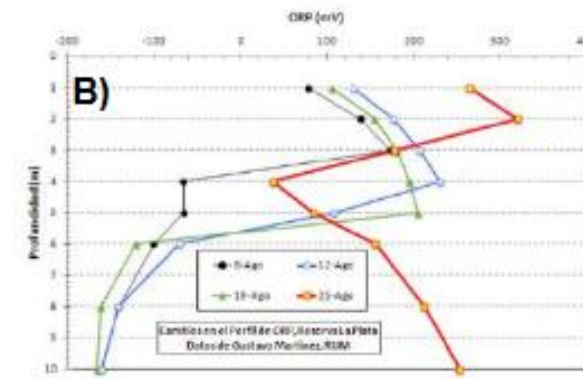
- an increased in densities of macroinvertebrates
- downstream migration of filter feeders and shredders;
- an increased in the number of predators (e.g. *Macrobrachium*) in the headwater pools

Stressor: Drought



2014

Embalse La Plata
2 de julio 2014



- ▶ Gaps:
 - ▶ How long it takes to recover?
 - ▶ What is the best way to manage reservoirs to prevent future massive death events?

Questions? Suggestions?