

Decision Modeling For Ecosystem Management In The Georgia Coastal Plain Affected By Irrigation Pumping



James Peterson

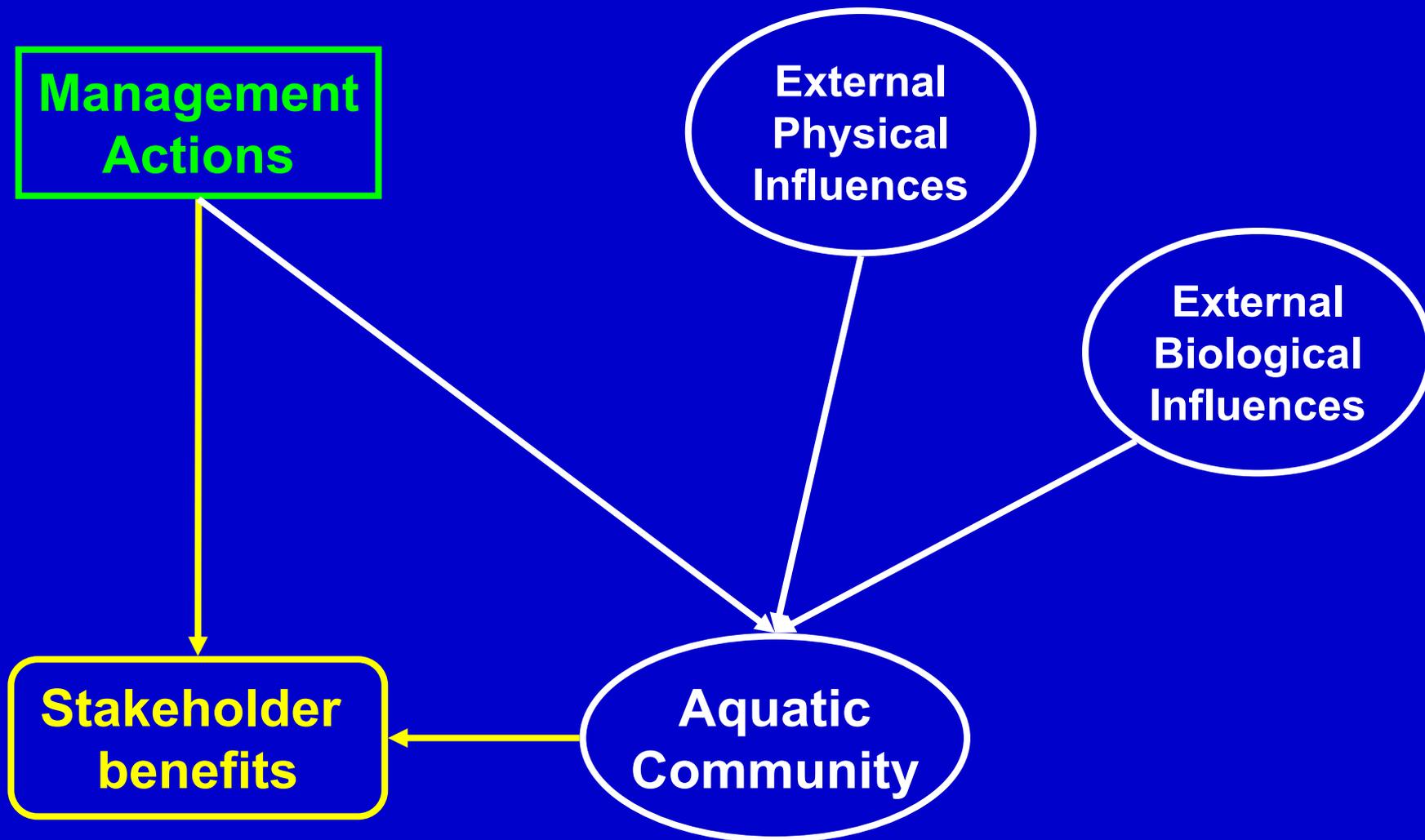
**USGS, Georgia Cooperative Fish & Wildlife Research Unit
Warnell School of Forest Resources**



Aquatic Resource Decision-Making: Current Approaches

- **In many instances not explicit unidentified assumptions**
- **Little consideration of space or large scale processes**
- **Little recognition or incorporation of uncertainty**
- **Generally no formal “learning” component**

Quantitative Decision Modeling



Explicitly incorporates uncertainty

Types of Uncertainty

System uncertainty

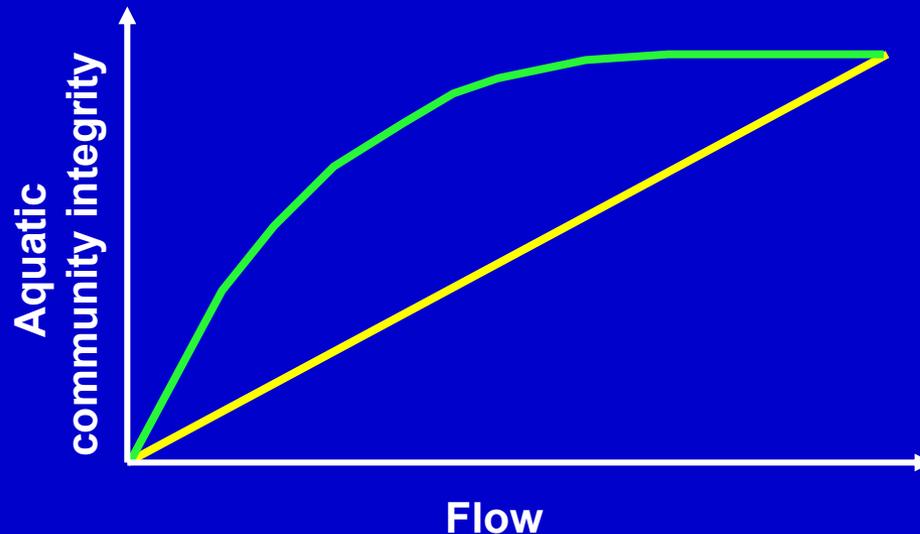
due to environmental and demographic variation

Statistical uncertainty

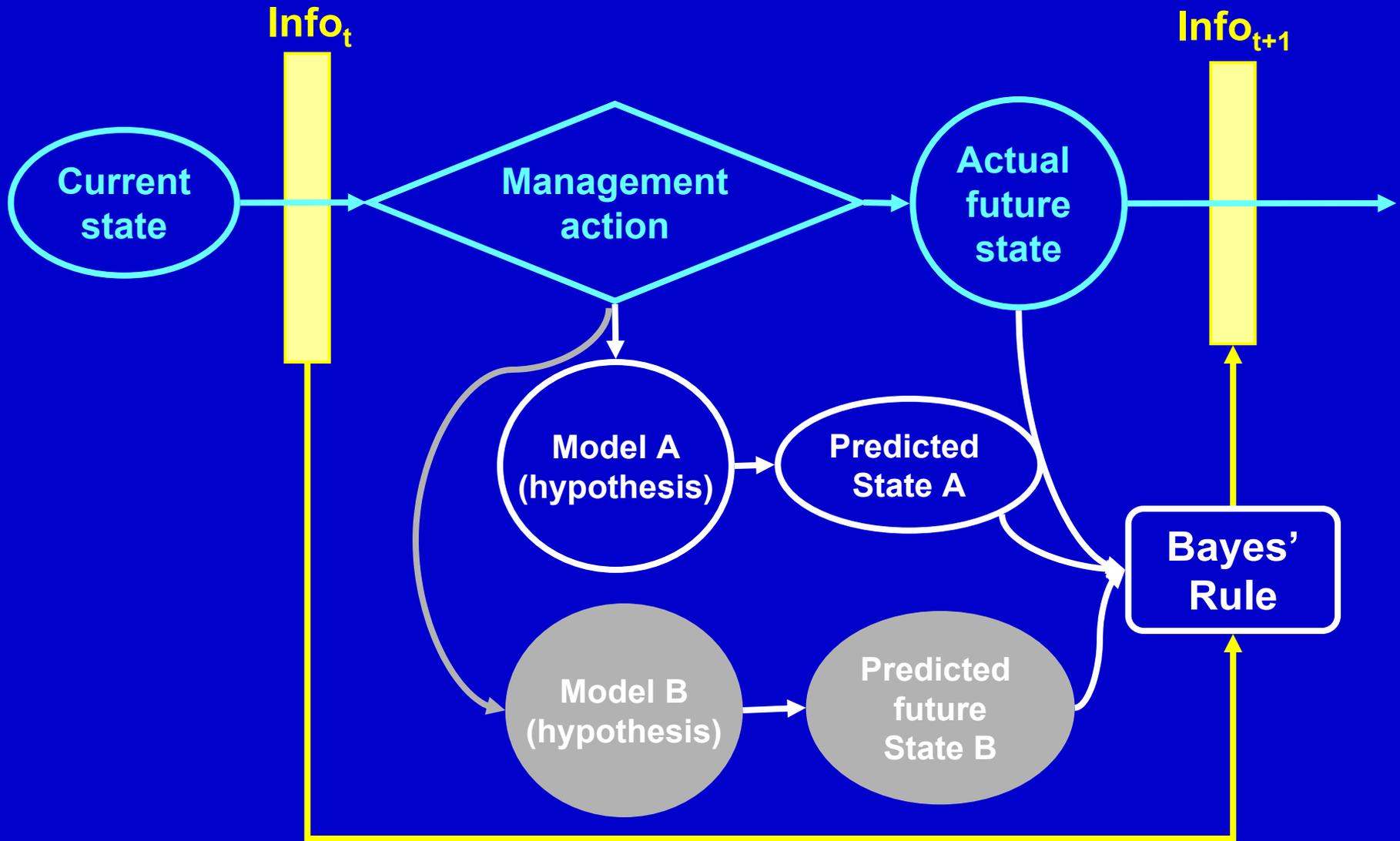
due to the use of sample data to estimate parameters

Process uncertainty

due to incomplete understanding of system dynamics

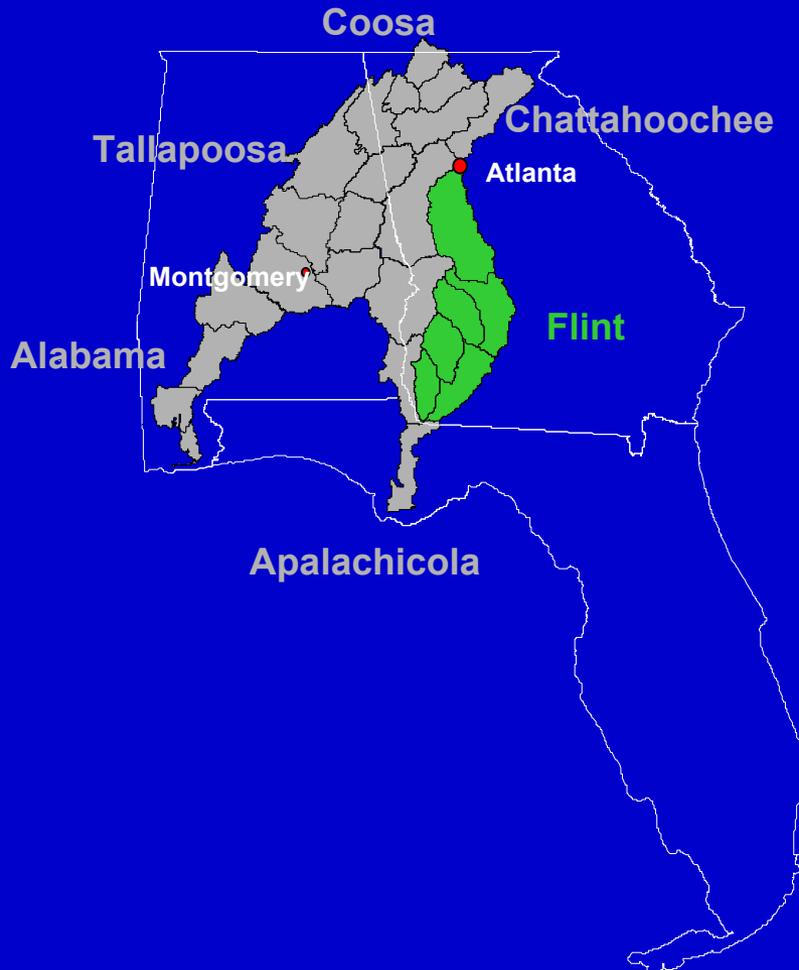


Learning How a System Works (Adaptation)



Application Flint River Basin: Regional Water Issues

Alabama-Coosa-Tallapoosa (ACT) and
Apalachicola-Chattahoochee-Flint (ACF)

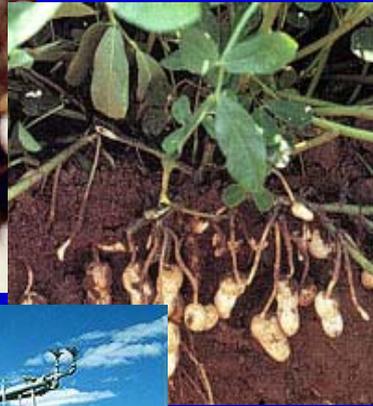


- Broad physiography
- Diversity and endemism

Issues

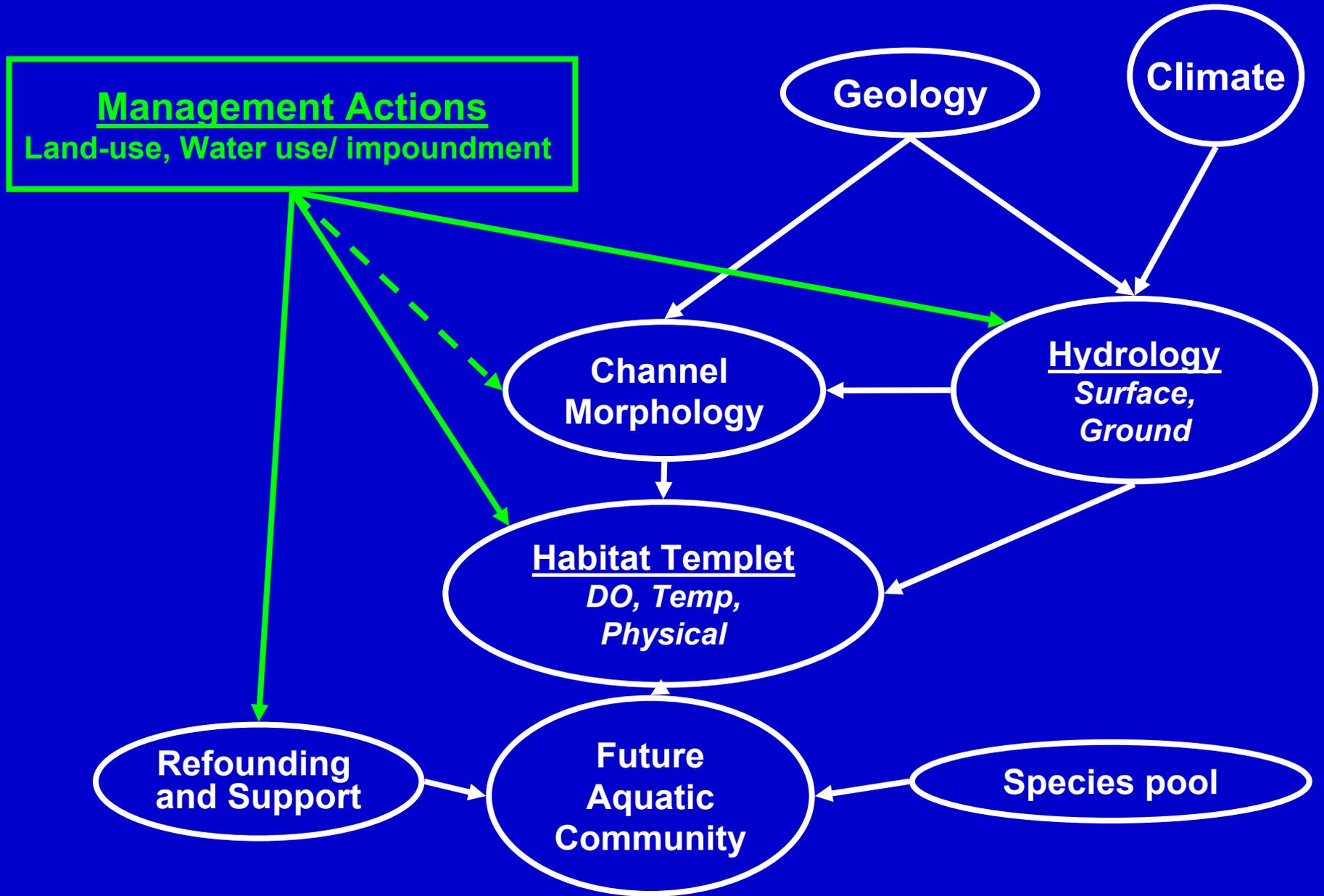
- Tri-State “Water Wars”
- Extensive development
- Water allocation

Issues in the Lower Flint River Basin (the decision context)



- Intensive agricultural irrigation
- Flow standards
- Water allocation
- Flow “augmentation” reservoirs
- Drought protection act

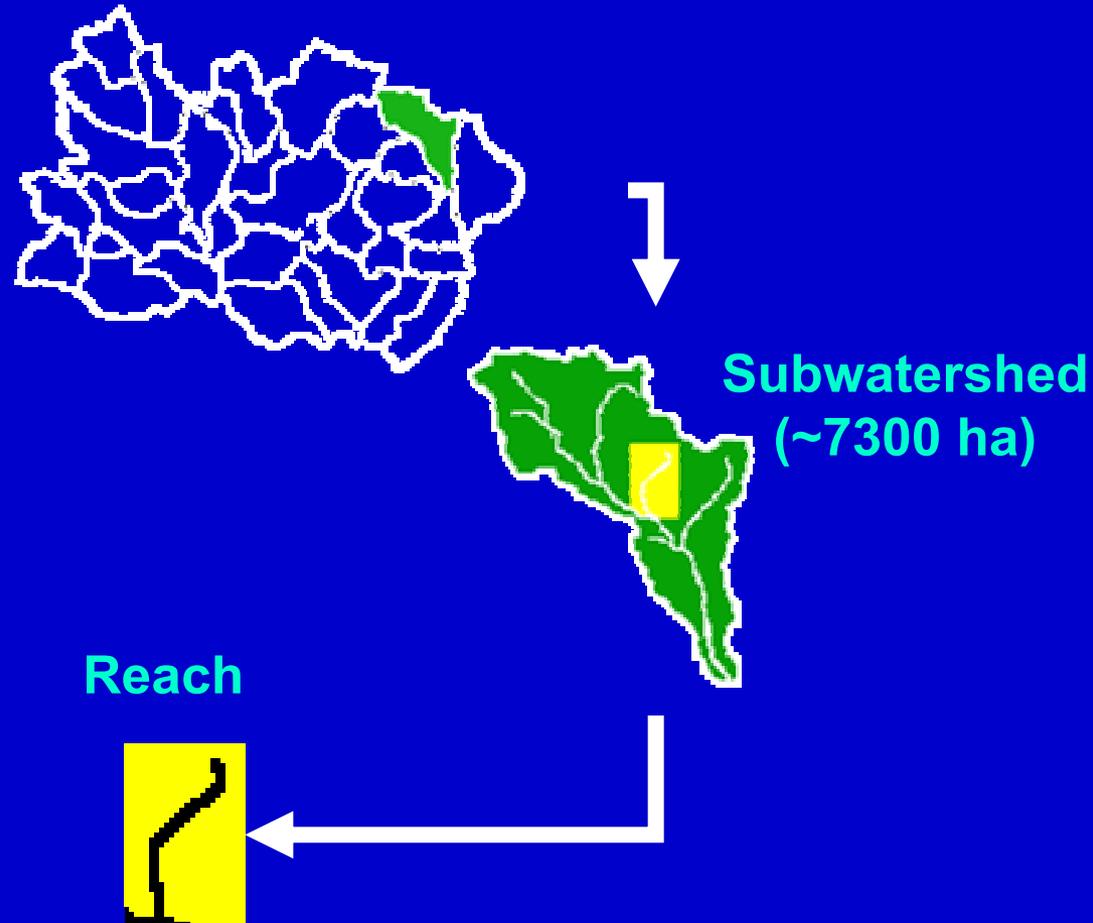
FRB Conceptual Model



Species pool components

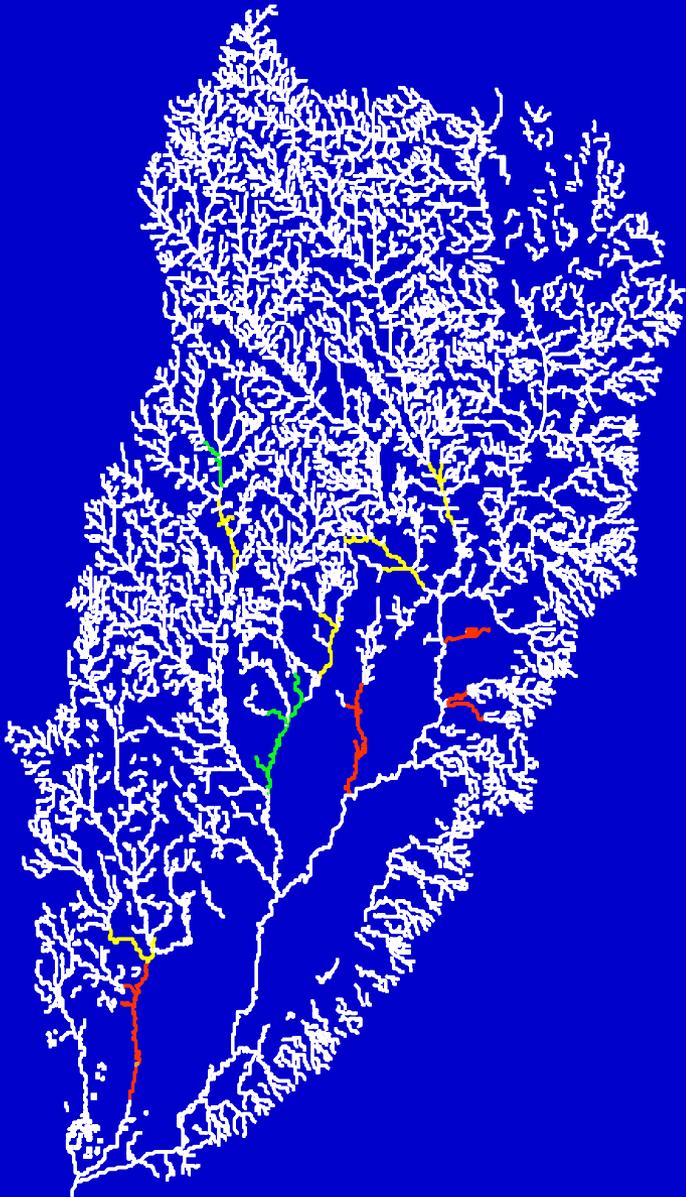
Species distribution models

Hierarchical models
Reaches nested
within subwatersheds



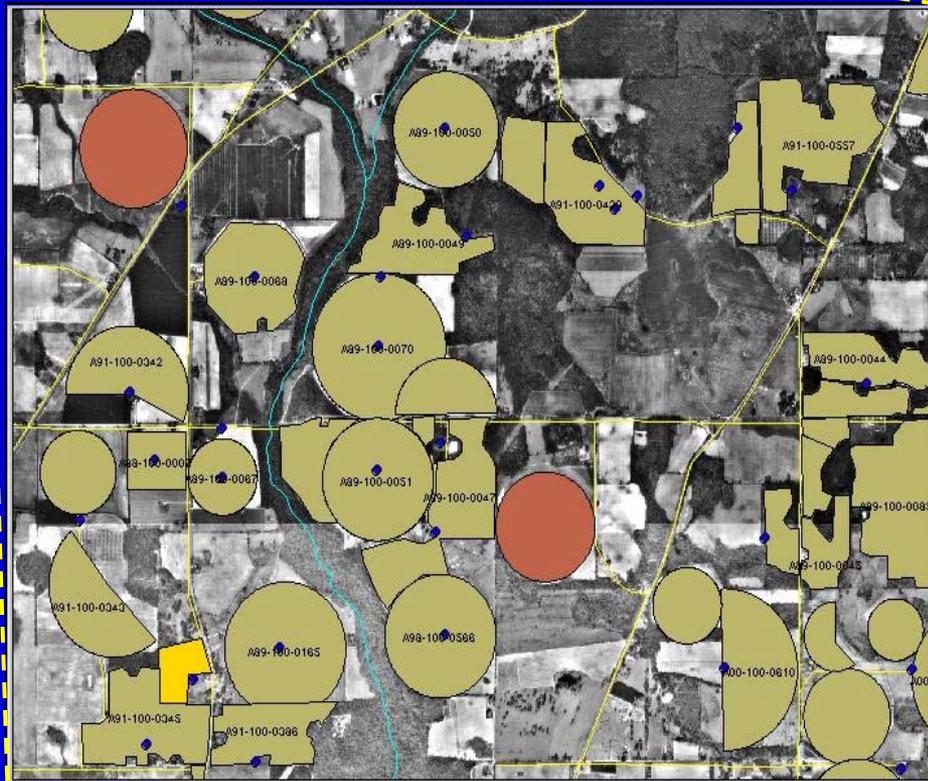
Predictions at
subwatershed scale

Basin Climate and Hydrology Components



- **Concurrent USGS / EPD studies**
- **Developed climate-water use-streamflow- models**
- **Developing flow simulation models (Jones and Torak, USGS)**

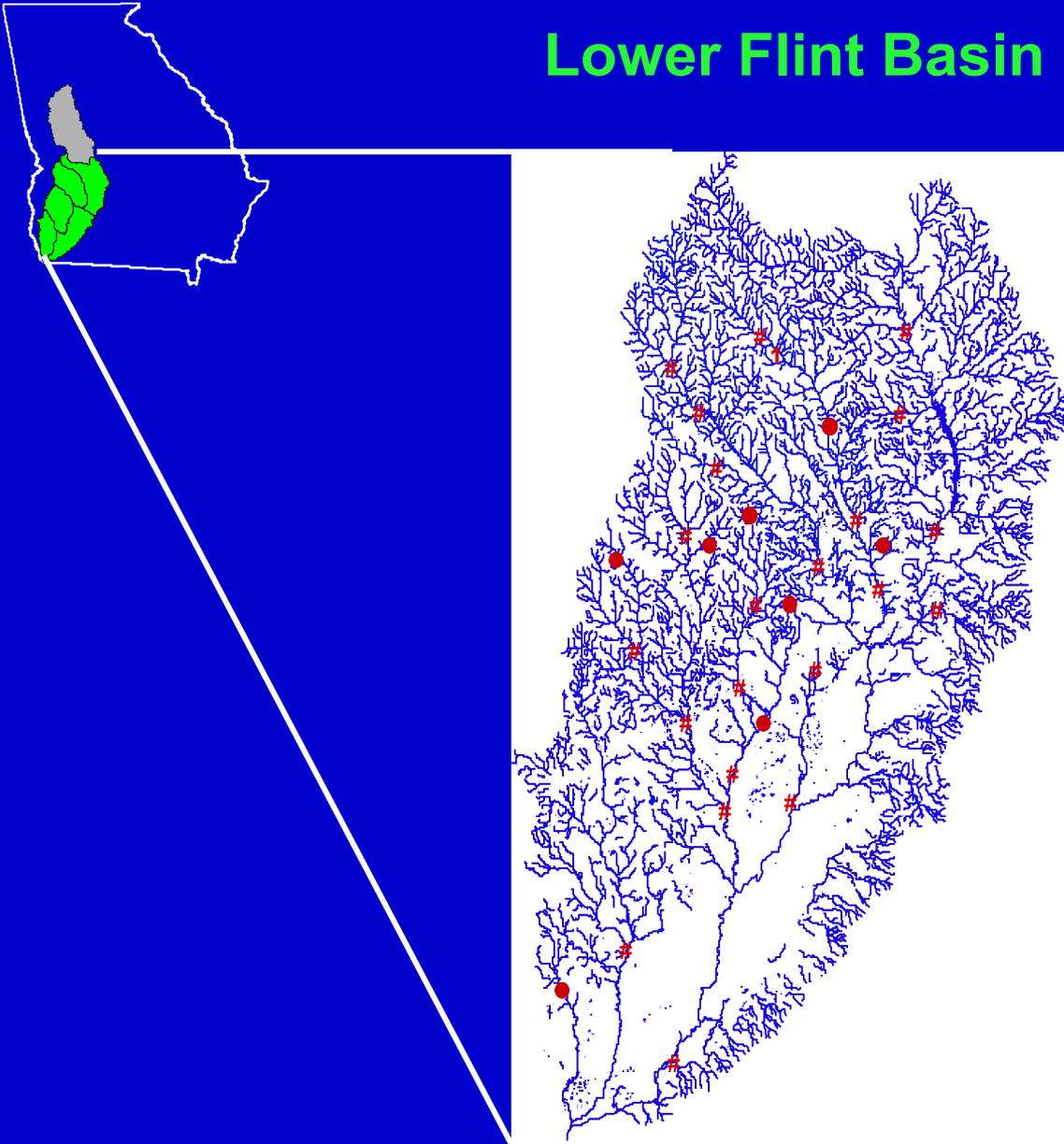
Water Withdrawal and Use Components



- Concurrent EPD study
- Identified and spatially referenced permitted withdrawals
- Monitoring a subset of permitted withdrawals

Evaluating Flow-Habitat-Fish Relationships

Lower Flint Basin



36 Study sites

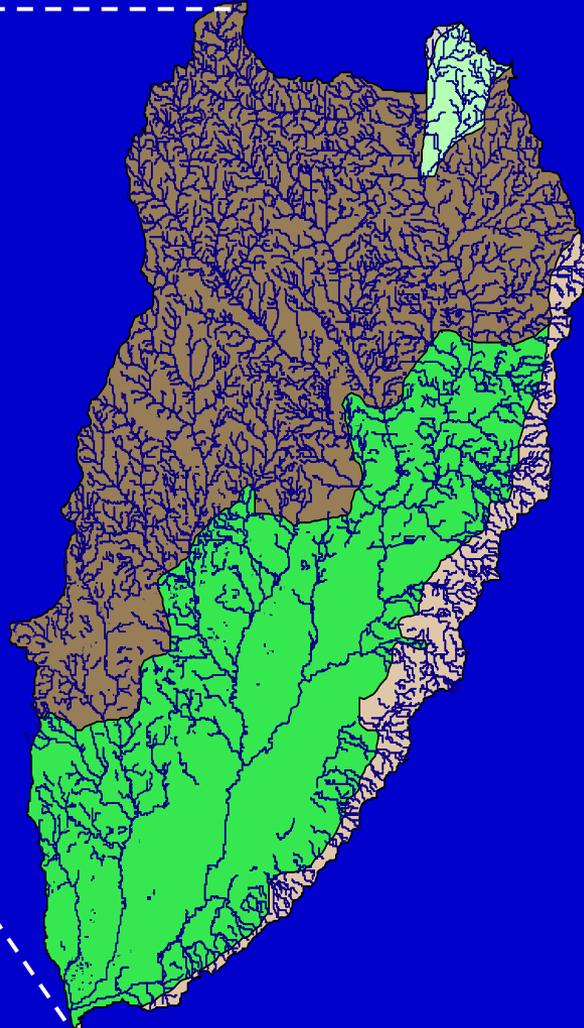
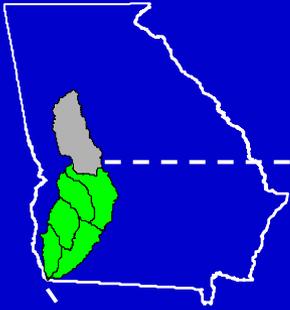
3 Floodplain/wetland

2 mainstem Flint

4 on mainstem tribs.

**~50% groundwater
influenced**

Dominant Geologic Classes



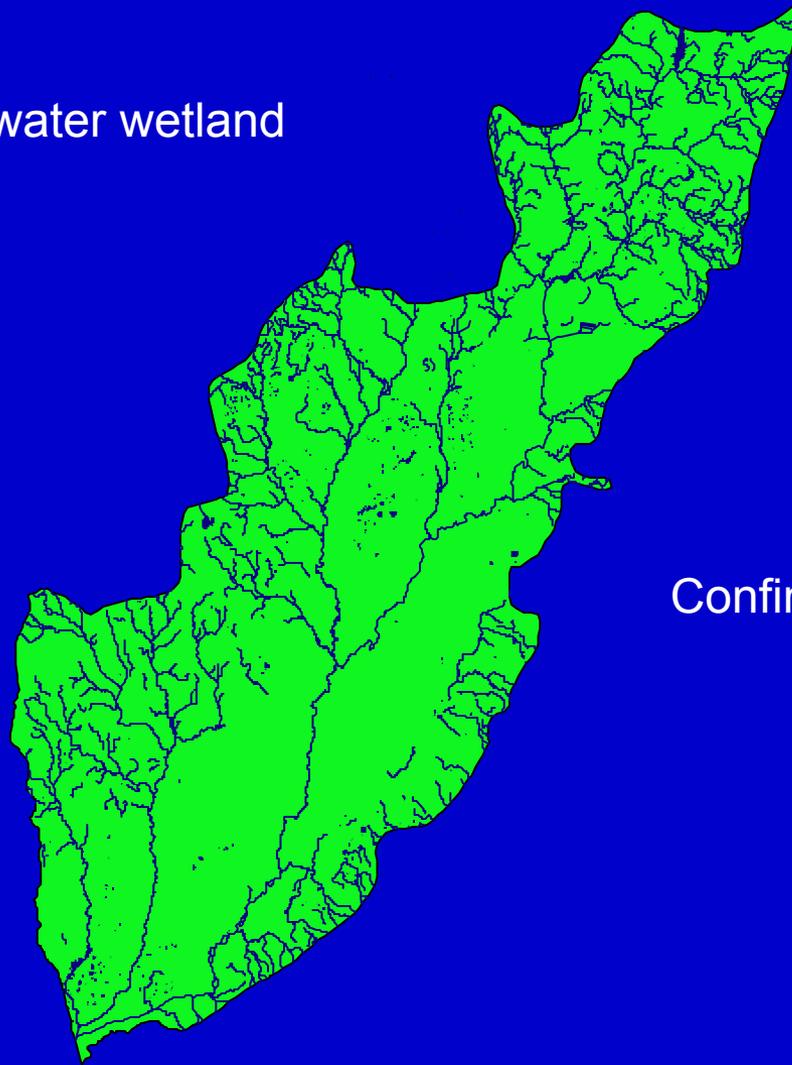
-  Upland Residuum
-  Ocala Limestone
-  Pelham Escarpment
-  Fort Valley Plateau

Geomorphic Channel Types (Ocala Limestone)

Headwater wetland

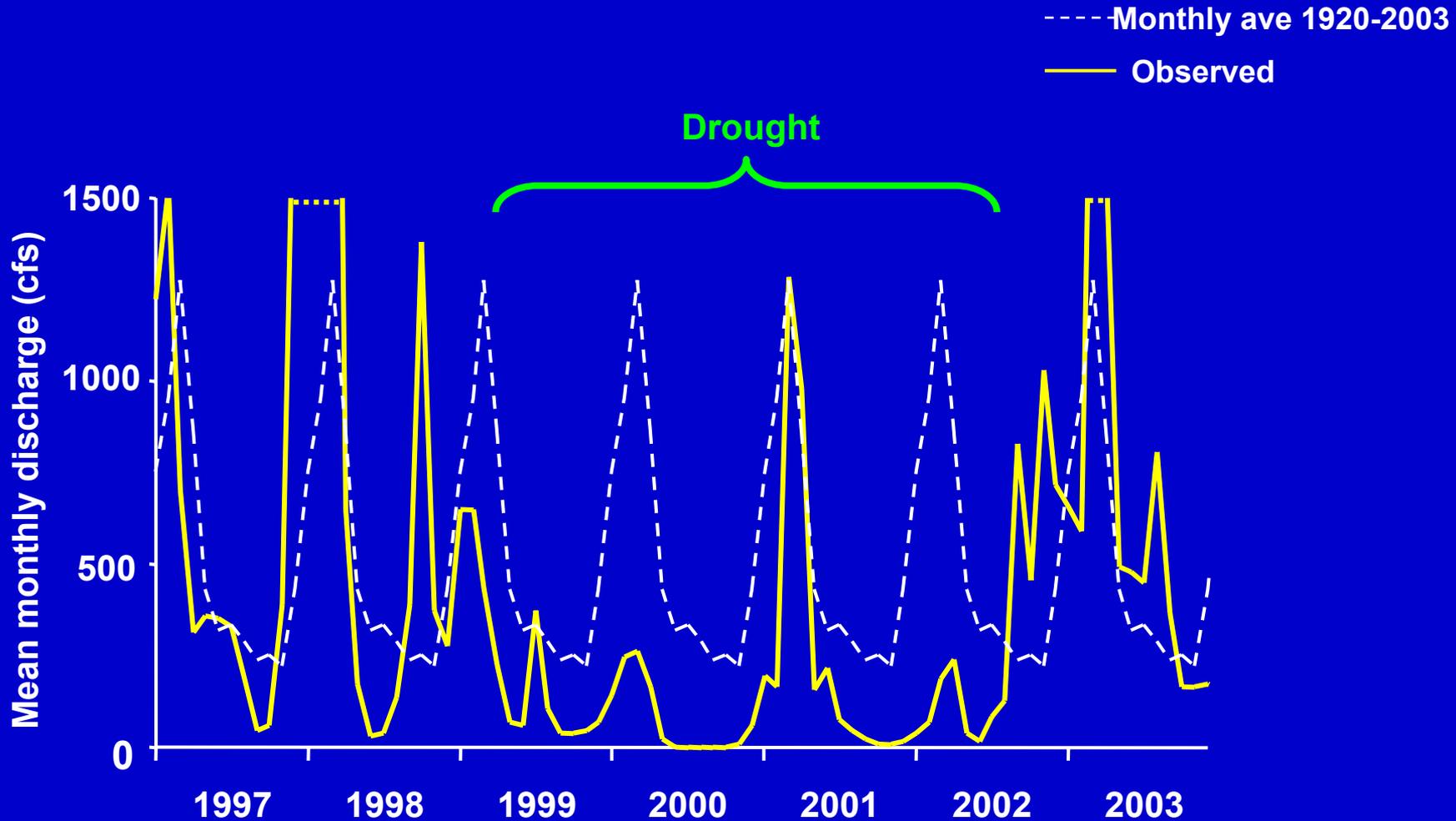
Confined
headwater
streams

Confined Mainstem

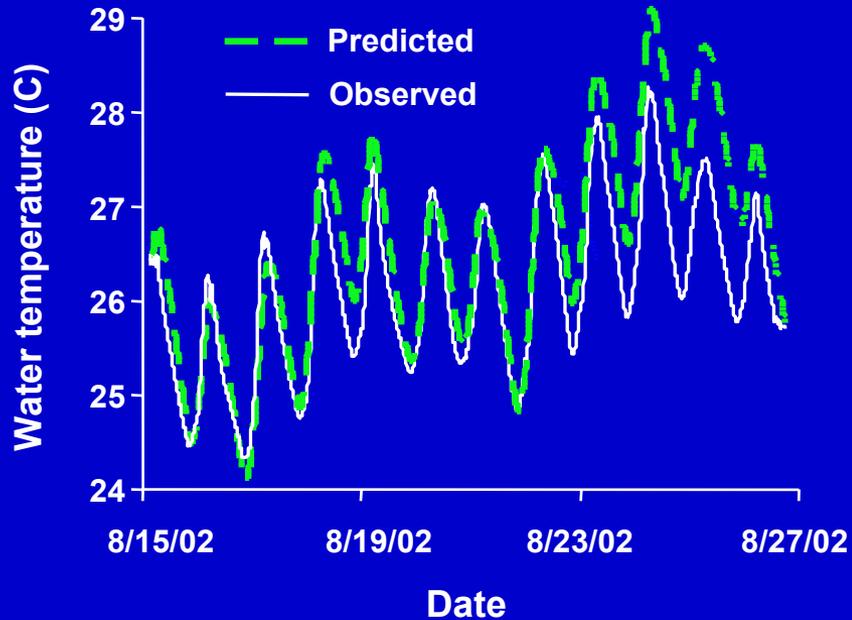


Severe drought in Flint Basin, 1999- 2002

Mean monthly discharge at Spring Creek, GA

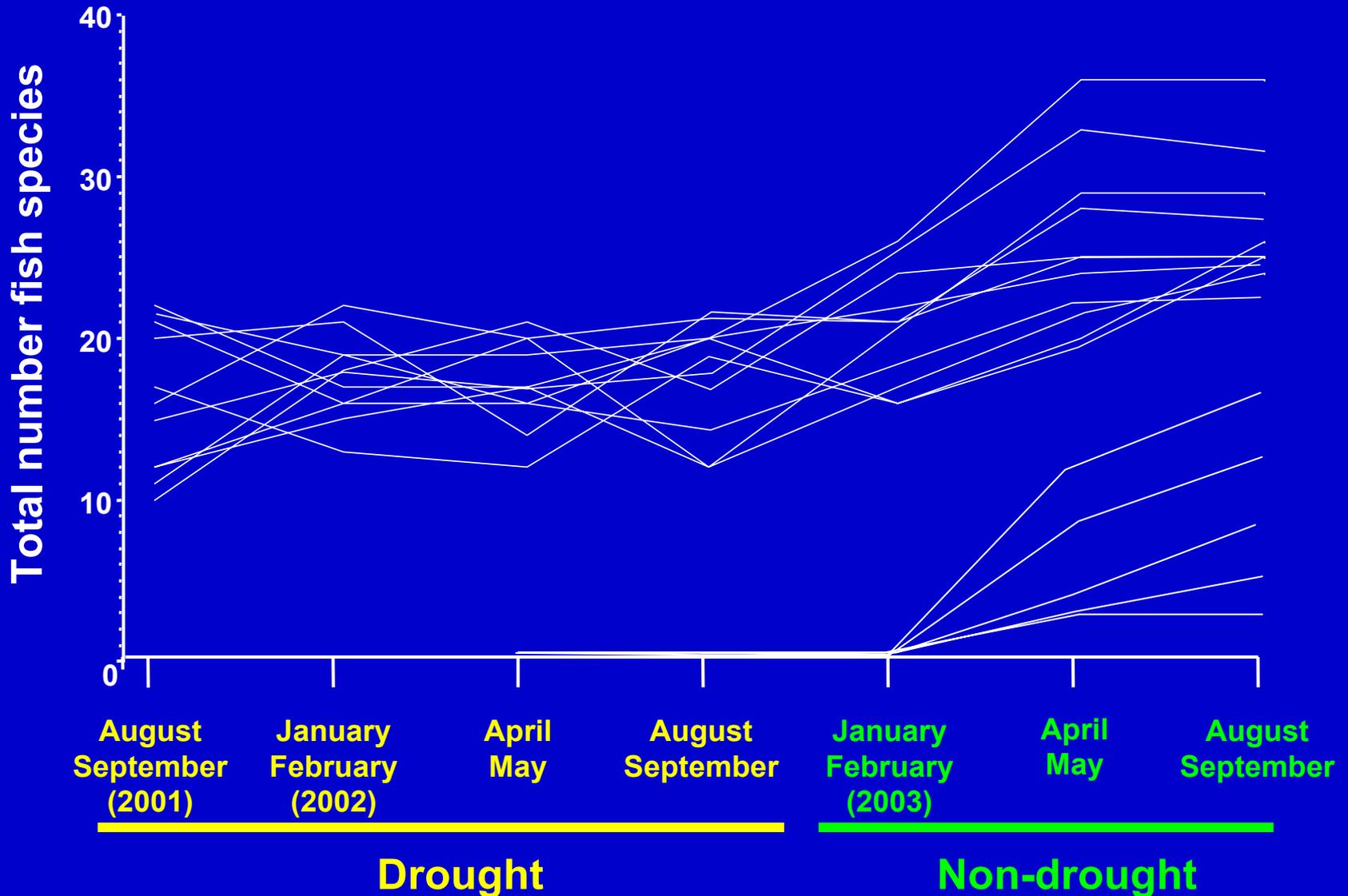


Flow-Habitat Relations

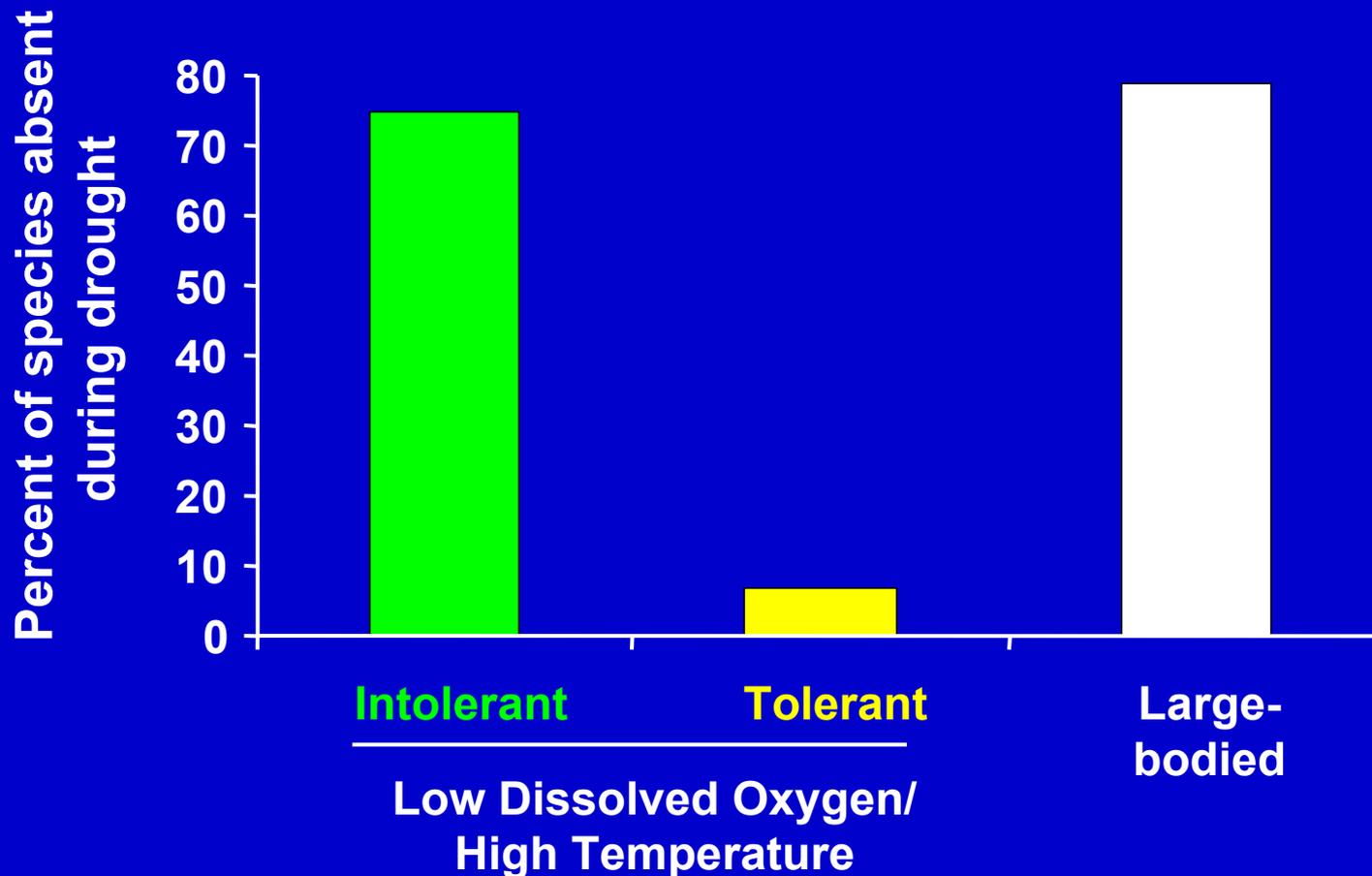


- Temperature
 - Dissolved oxygen
 - Instream habitat availability
- (Jackson and Li, UGA)

Effects of flow depletion and recovery in small streams



“Missing” species (models relating species traits to persistence)



Modeling Issues: Aquatic Community Response

What to model??

Individual species

special concern species, sportfish

Community indices

Index of Biotic Integrity, species richness

Species groups or guilds

species tolerance

Life cycle, abundance, presence

Practical considerations

Spatially explicit ~ model size, complexity

Monitoring → Feedback

Index of Biotic Integrity

legal and institutional recognition

GA DNR stream team monitoring efforts

But...sampling problems

sample design

detectability

underestimate “true” IBI

biases related to stream size, habitat, etc.

all inferences based on single sample

Solution

Focus on reach *occupancy*

Develop community integrity “index” (if necessary)

Species richness

Richness of species groups

Require small modifications to existing protocols

Quadrat sampling

Capture-recapture (multi-species occupancy) models

Modeling

Empirical multi-species occupancy

2 states: occupied, unoccupied

Multi-species occupancy

Mainland-island metapopulation model

Spatially explicit

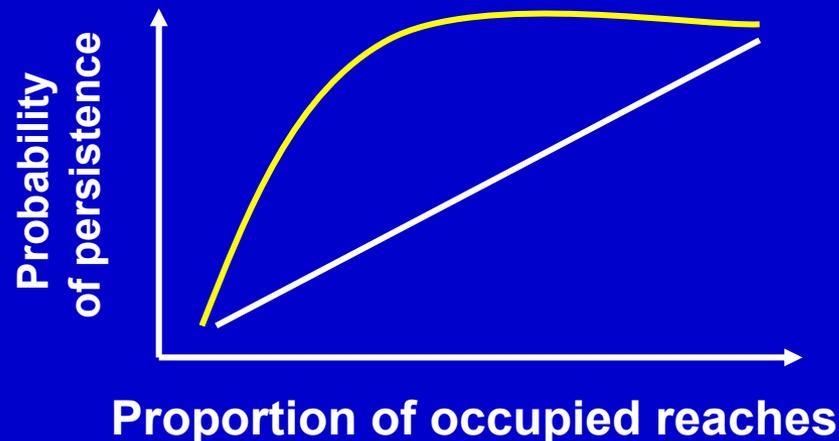
Reach occupancy $_i = f(\text{reach quality, colonization})$

reach quality \sim habitat volume, DO, temperature, size

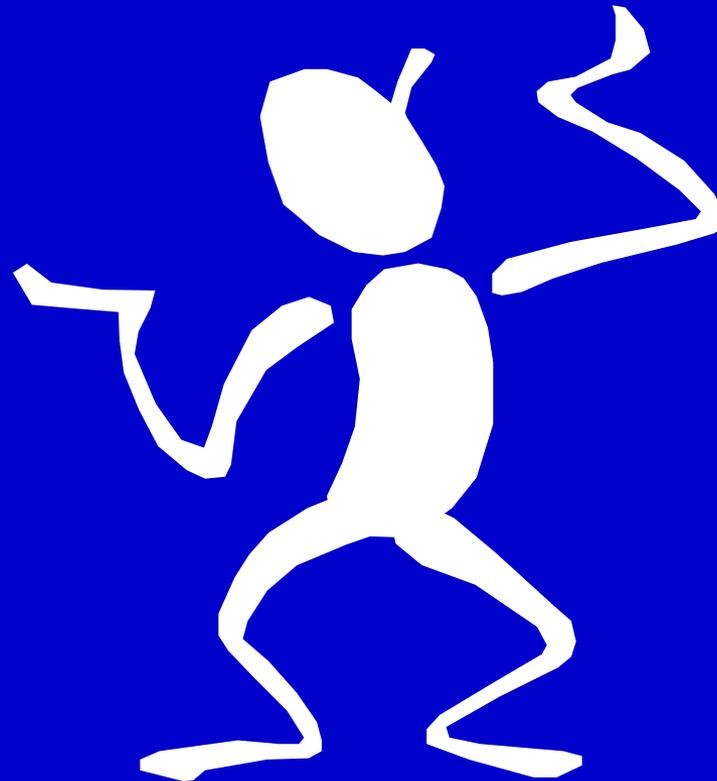
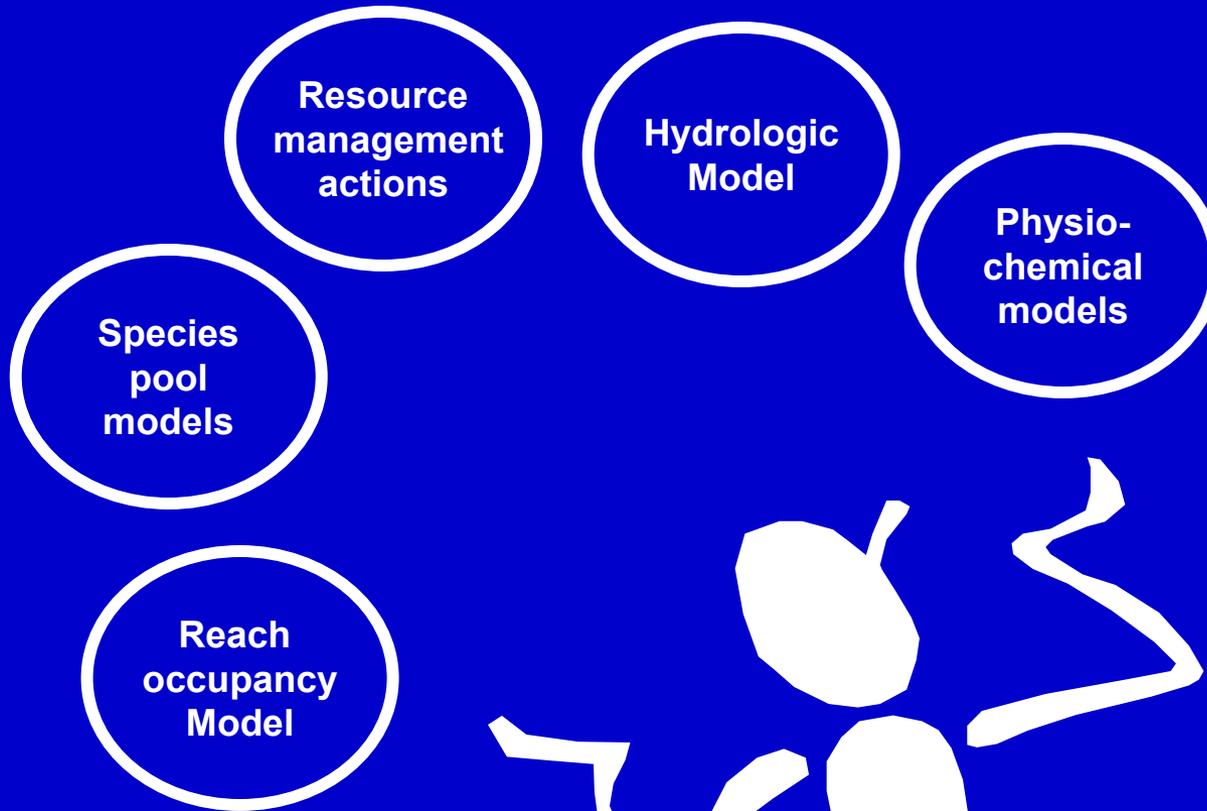
colonization \sim isolation, location, streamflows during spring

(represent 4 hypotheses, weights based on AIC)

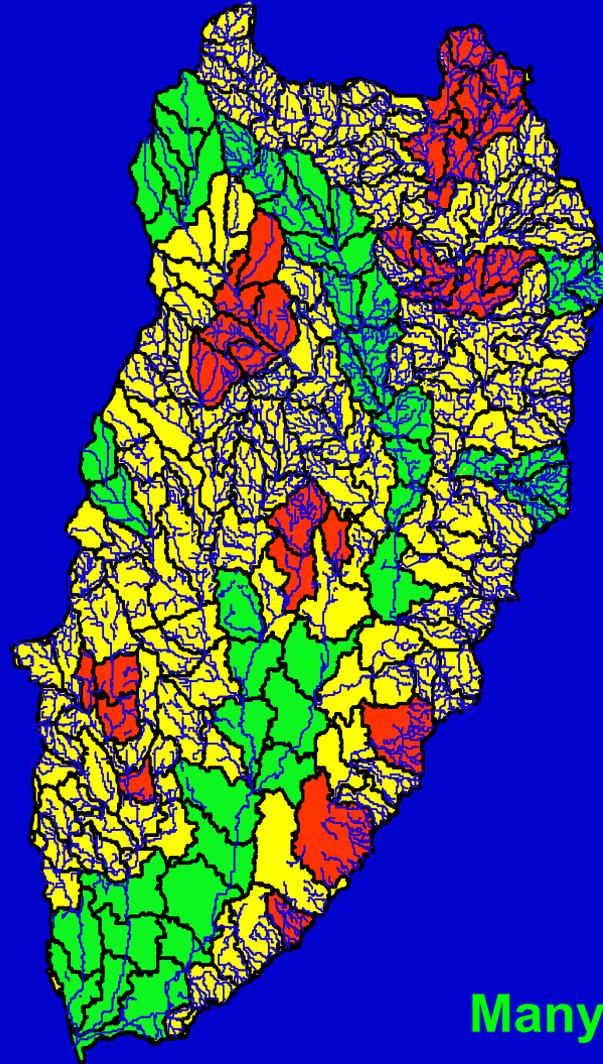
Mainland component ??



Next steps: Putting the Pieces Together



Anticipated Outputs



Proportion streams:
occupied by ...
with “high” biotic Integrity

Many, Few, None

A Big Thanks to:

John Ruiz

Shane Hawthorne

Jeremy McCargo

Nolan Banish

Dale McPherson

Brent Henry

Colin Shea

Drew Taylor

Mary Freeman

Scott Cravin

Bud Freeman

Patrick O'Rourke