An Integrated Framework for Linking Ecosystem Services Valuation with Freshwater Flow in the Florida Everglades

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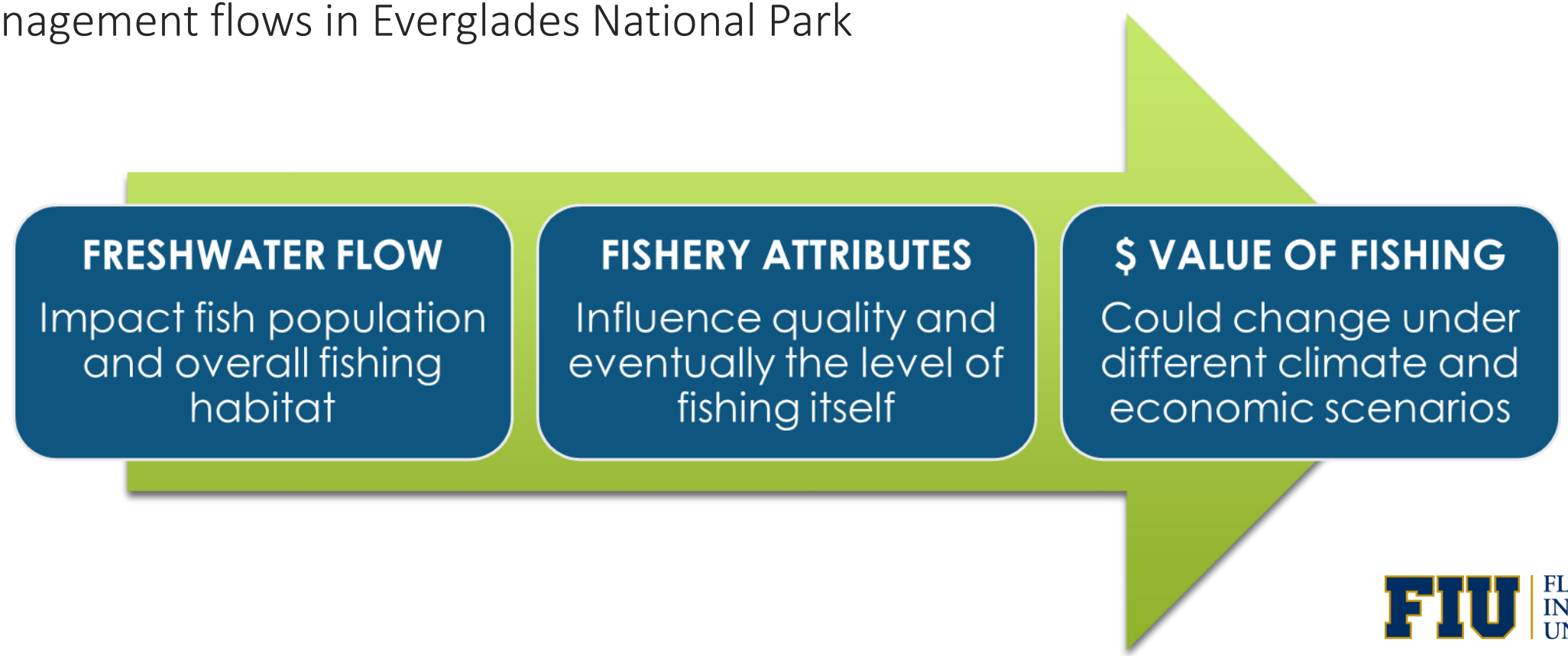
Outline

- Background
- Conceptual Model
- Flow-Fisheries Relationship
- Willingness to Pay
- Penalty Function

Linking Flow and Ecosystem Services

Recreational fisheries context: Estimate economic value in response to changes in various fishery attributes, which could occur as a result of changes in freshwater management flows in Everglades National Park



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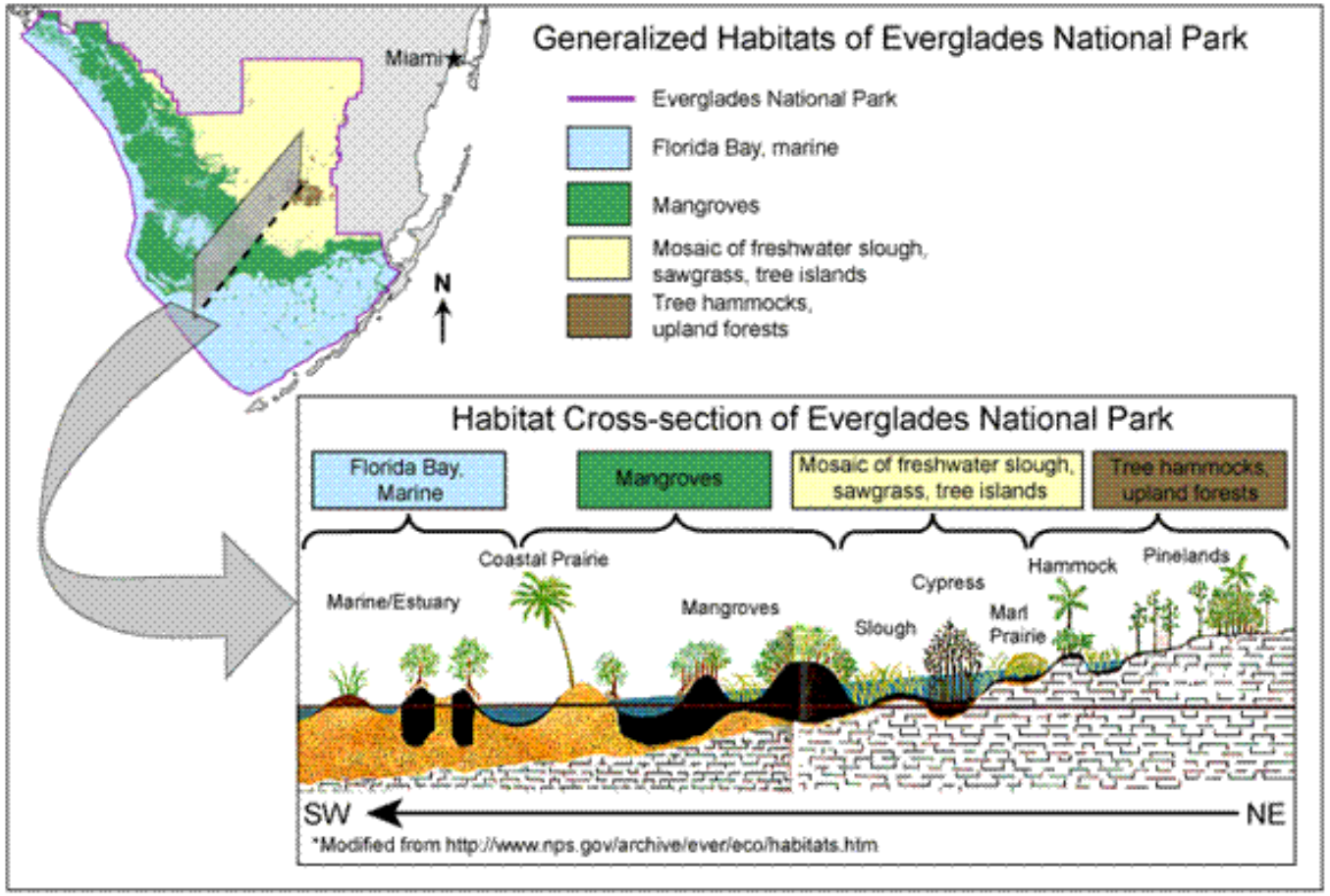
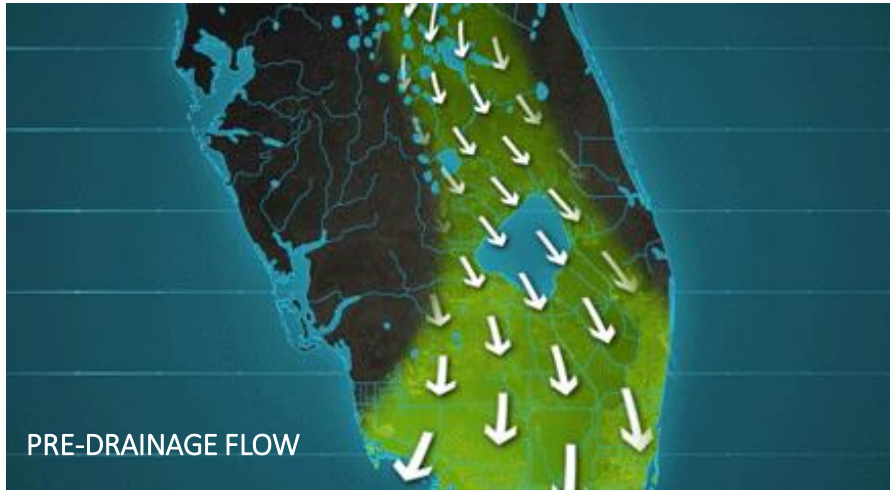
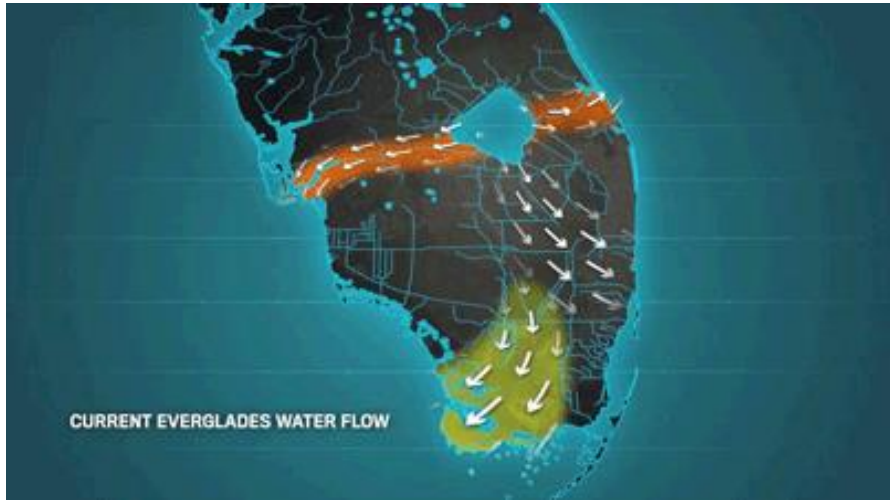
Florida Everglades







Source: Everglades Foundation

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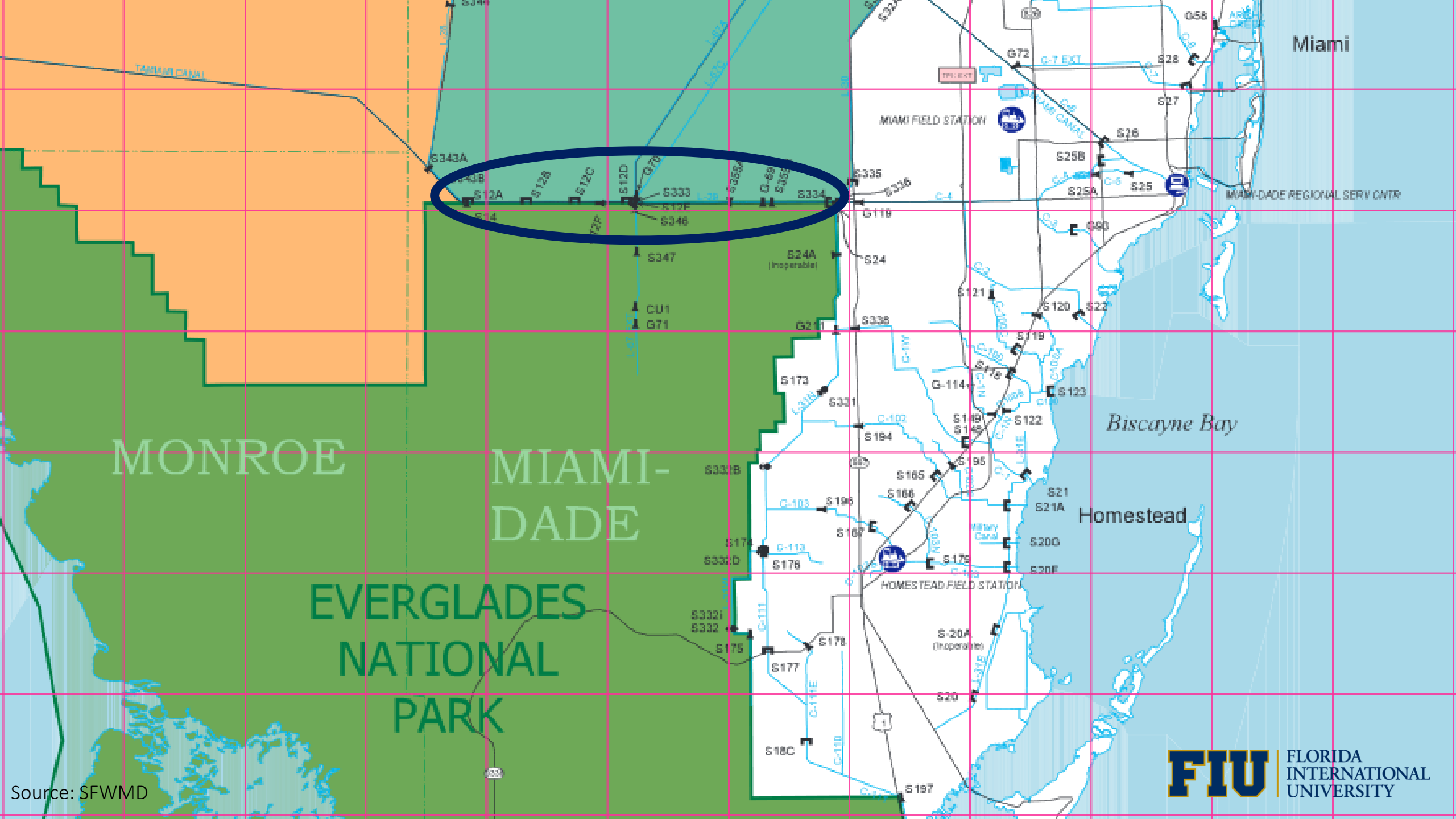

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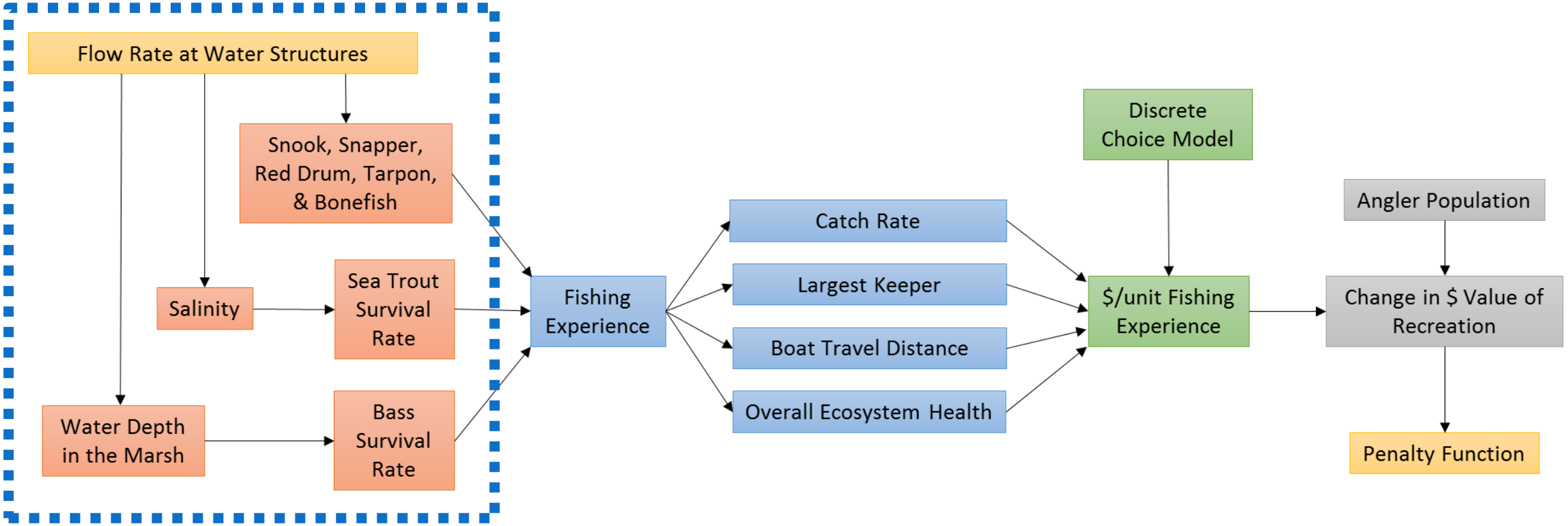
Conceptual Model



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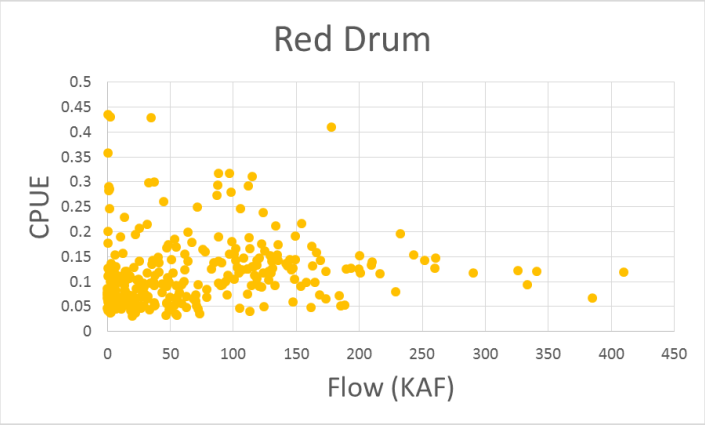
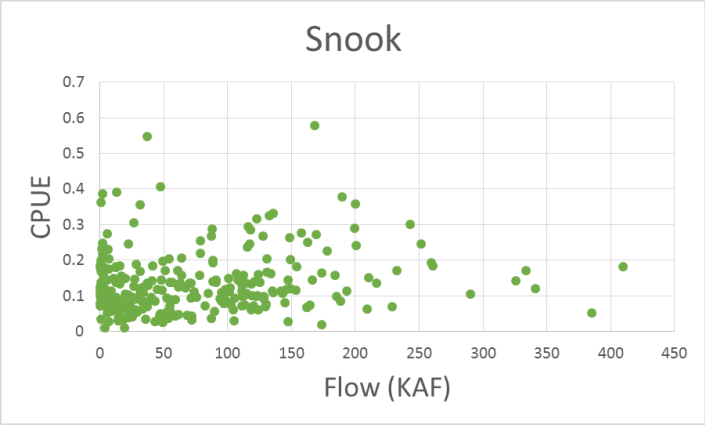
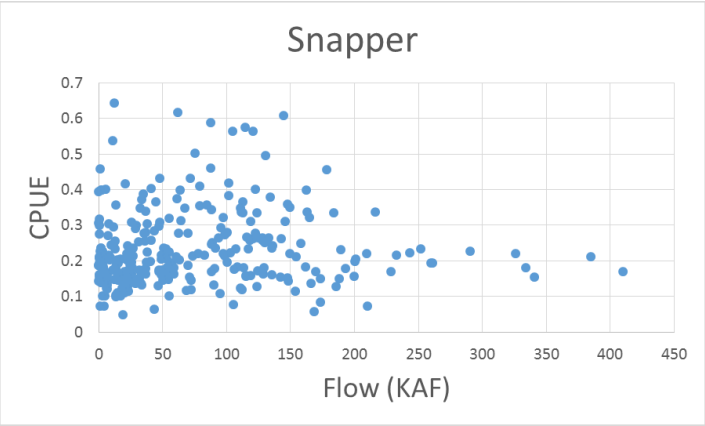
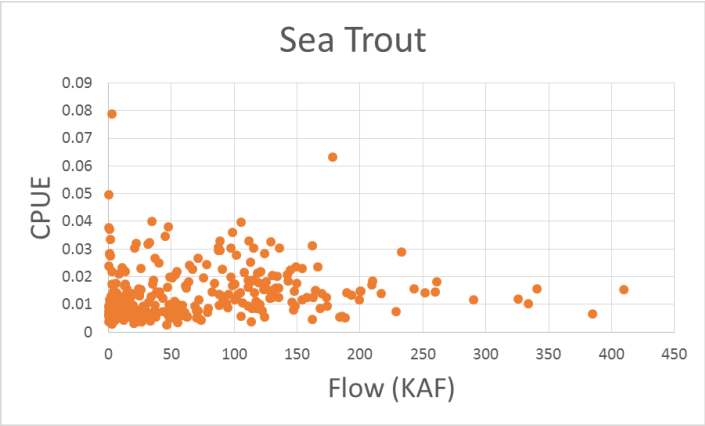
Flow-Fisheries Relationship









Estimating a seasonal catch-flow function for each species:

$$C = \beta_0 + \beta_1 F + \beta_2 lnR + \beta_3 Month_1 + \beta_4 Month_2$$

C = CPUE
F = Flow at structures
R = Rainfall
Monthly dummy variables

Winter (Dec, Jan, Feb)
Spring (Mar, Apr, May)
Summer (Jun, Jul, Aug)
Fall (Sept, Oct, Nov)

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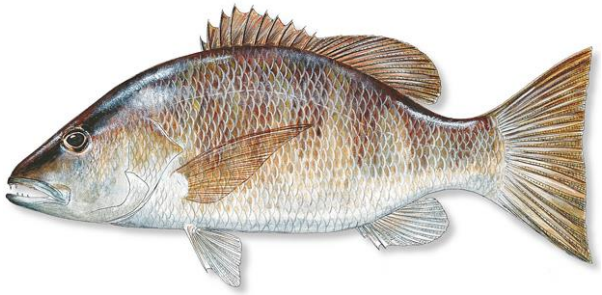
Flow-Fisheries Relationship



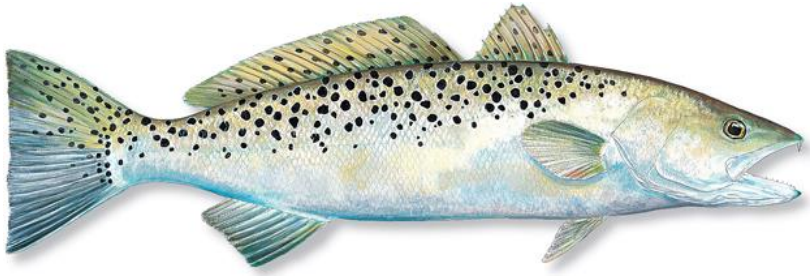
The relationship between water delivery and fishery habitat quality is modeled based on existing data sets

Fisheries

- Creel surveys
- Species survival
- Habitat productivity

Water delivery

- S12, S333, S334, and other structures
- Seasonal dummy variables (reflecting stage and temperature)
- Precipitation



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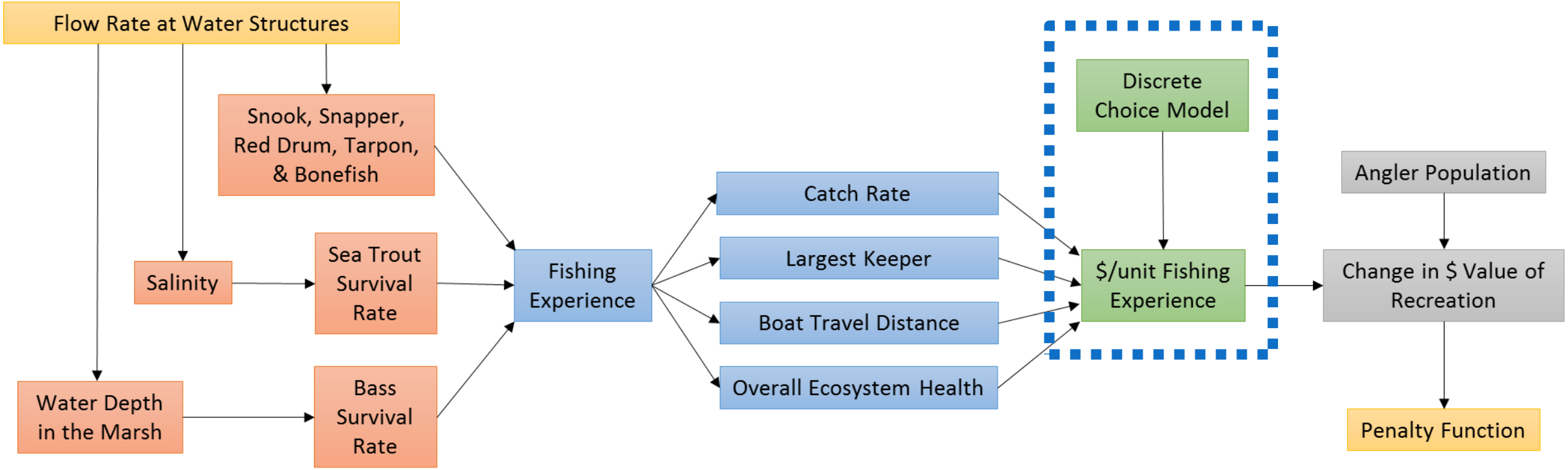

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Willingness to Pay

Discrete Choice Experiment

We asked anglers to value a **percent change** in various attributes from the **current level**.

Scenario I

- "Status quo"
- Low/no additional per-trip cost

Scenarios II & III

- Maintain or improve current levels
- Increased per-trip cost

Effects of Future Scenarios on Recreational Fishing Experience	Do Nothing or Do the Bare Minimum Scenario I	Protect or Improve the Current Status Scenario II	Protect or Improve the Current Status Scenario III
Catch rate 	20% lower than your current catch rate	20% higher than your current catch rate	10% higher than your current catch rate
Size of the largest keeper 	10% smaller than the largest fish you catch now	10% bigger than the largest fish you catch now	20% bigger than the largest fish you catch now
Boat travel distance for fishing 	10% increase in the distance you currently travel by boat	10% increase in the distance you currently travel by boat	10% increase in the distance you currently travel by boat
Overall ecological health of the Everglades ecosystem 	40% worse natural health than the current level	40% better natural health than the current level	40% better natural health than the current level
Additional cost paid by you on each trip ($) in terms of either higher boat launching fee, boat registration fee or tour guide fee	No additional cost per trip	$30 more per trip	$10 more per trip

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Willingness to Pay

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Let's say $\boldsymbol{C^k}$ for current catch

Any given flow-related catch can be expressed as % change from the current catch

$$\Delta C = 100\left[\frac{C - C^k}{C^k}\right] = 100\left[\frac{C(F) - C^k}{C^k}\right]$$

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Mixed logit WTP estimates

Catch	$1.28
Largest keeper	$1.64
Travel distance	$1.58
Ecosystem health	$3.44

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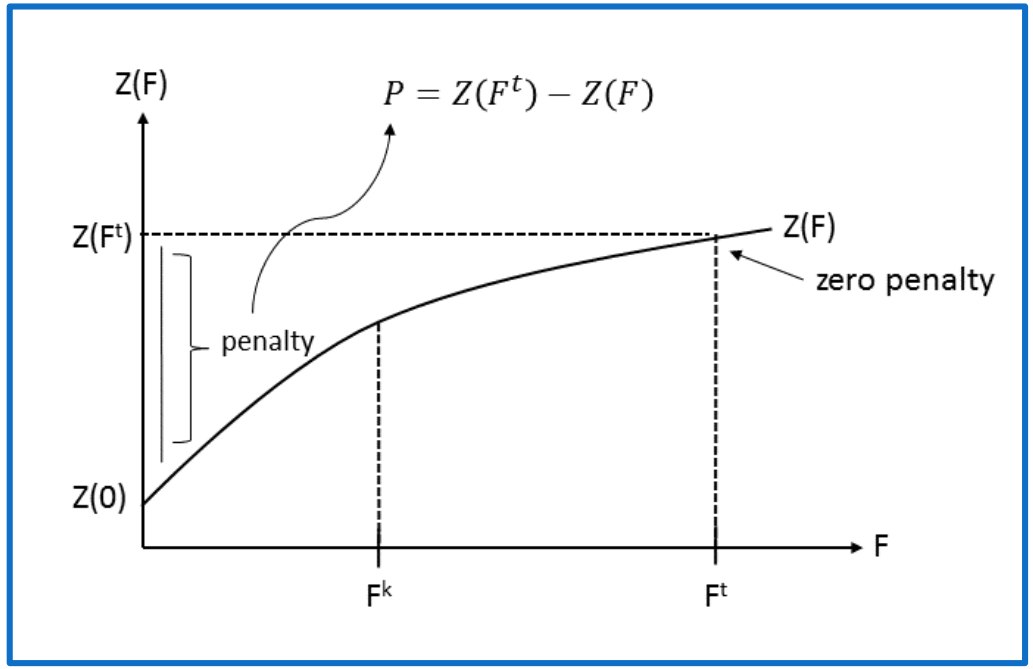
Penalty Function

Penalty = loss of $ value in catch for not meeting target flow, F^t

For example, the penalty for not meeting the target catch is expressed as

$$P_c(F) = 100AW_c\left[\frac{C(F^t) - C(F)}{C^k}\right]$$

The proportionate loss in catch in relation to the current catch as a reference, monetized at the WTP estimate of a percent change in catch (W_c)



Total economic recreational catch value in relation to flow

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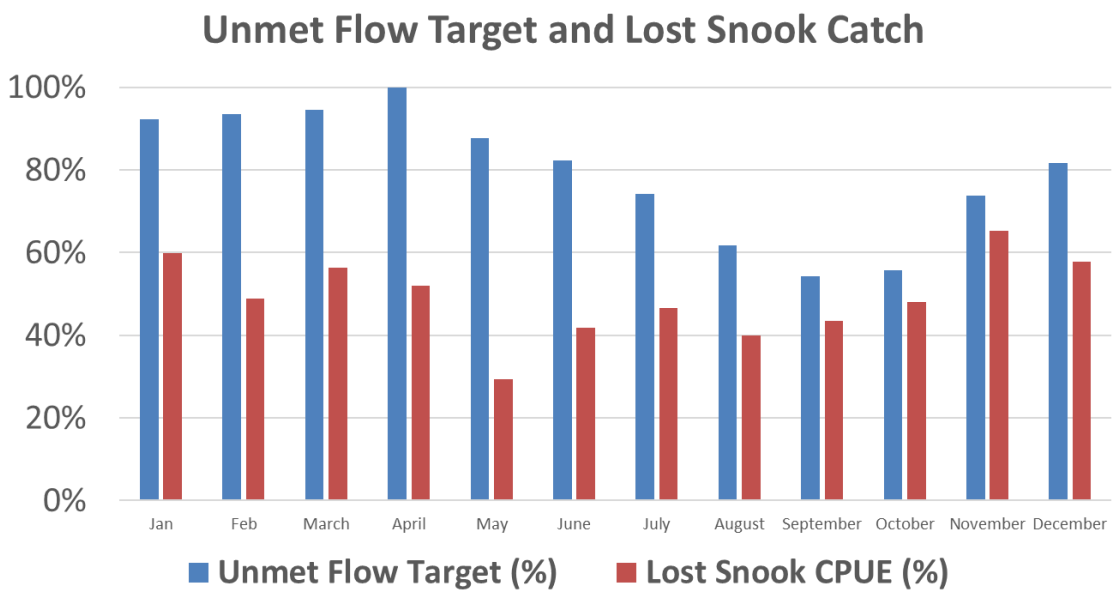

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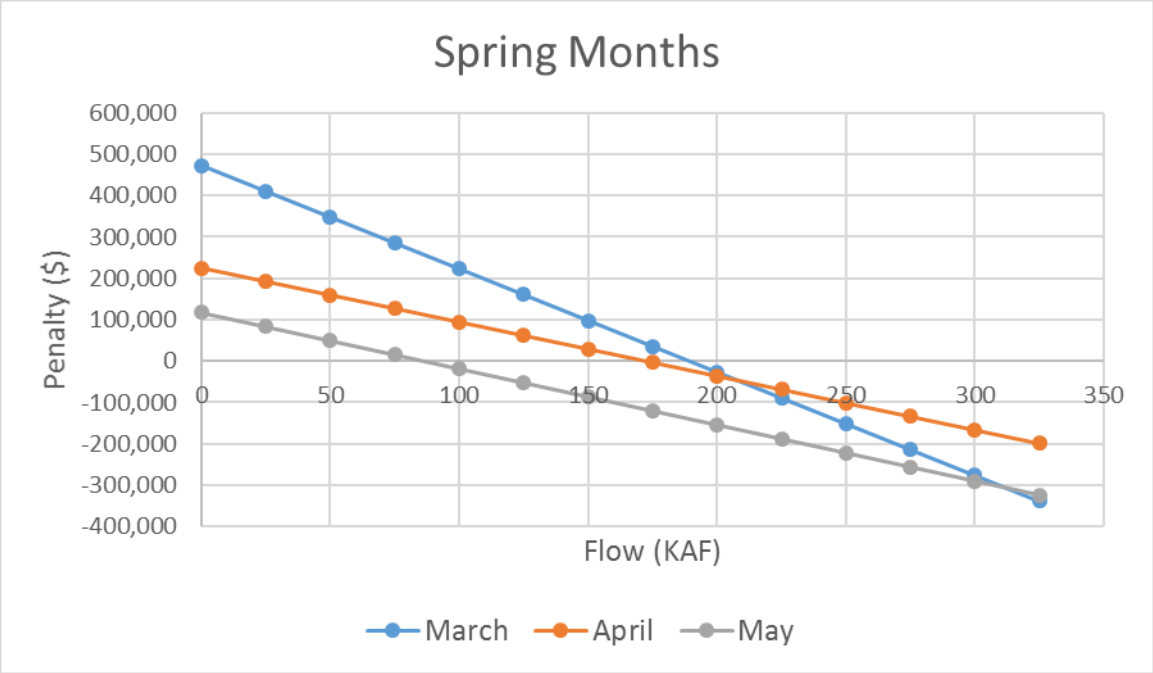
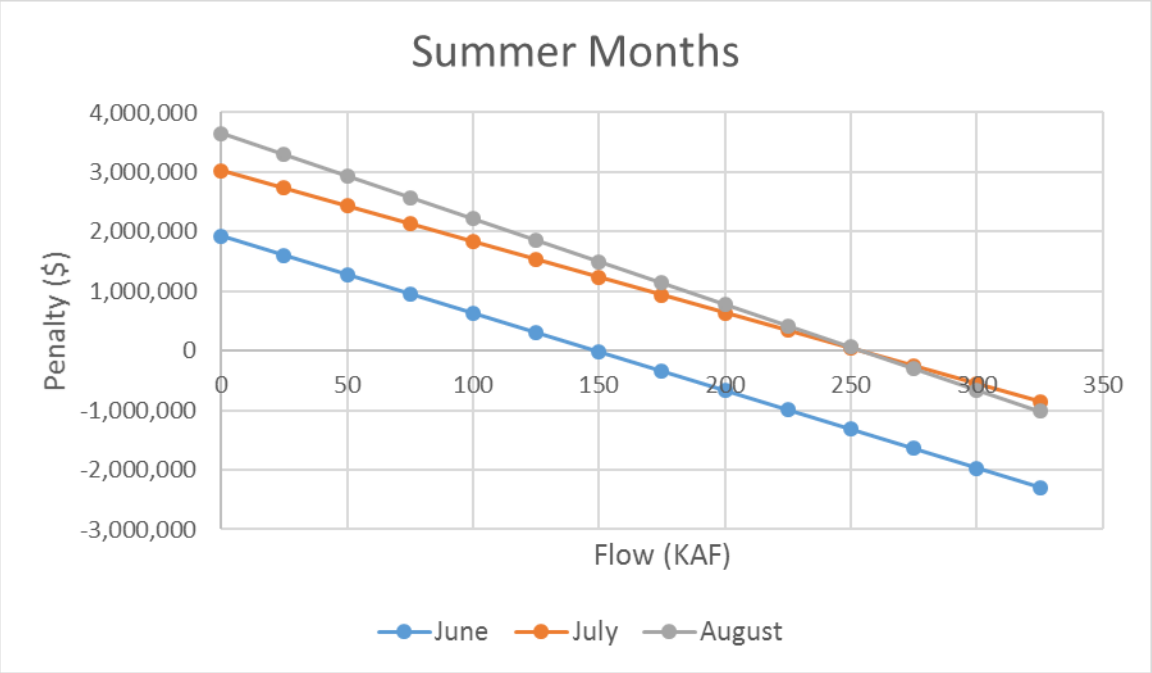
Penalty Function

Weighted catch penalty function

$$P_a = \sum_{i=1}^{N} \omega_i \left\{ TW_c 100 \left[\frac{C_i(F^t) - C_i(F)}{C_i^k} \right] \right\}$$





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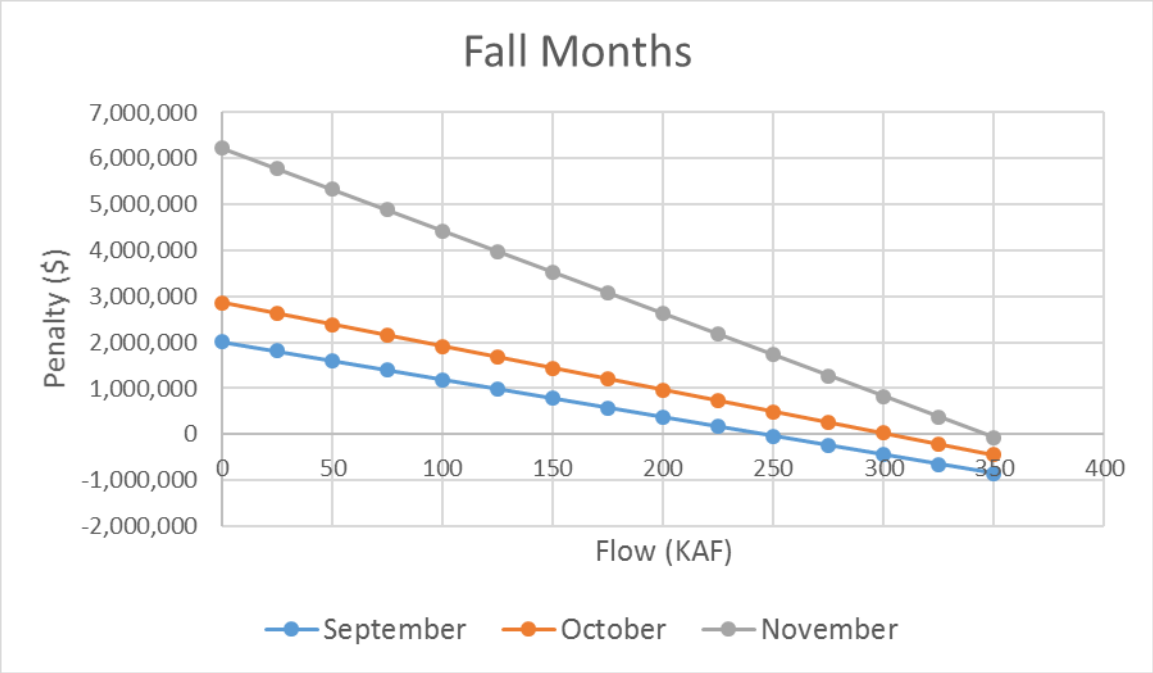

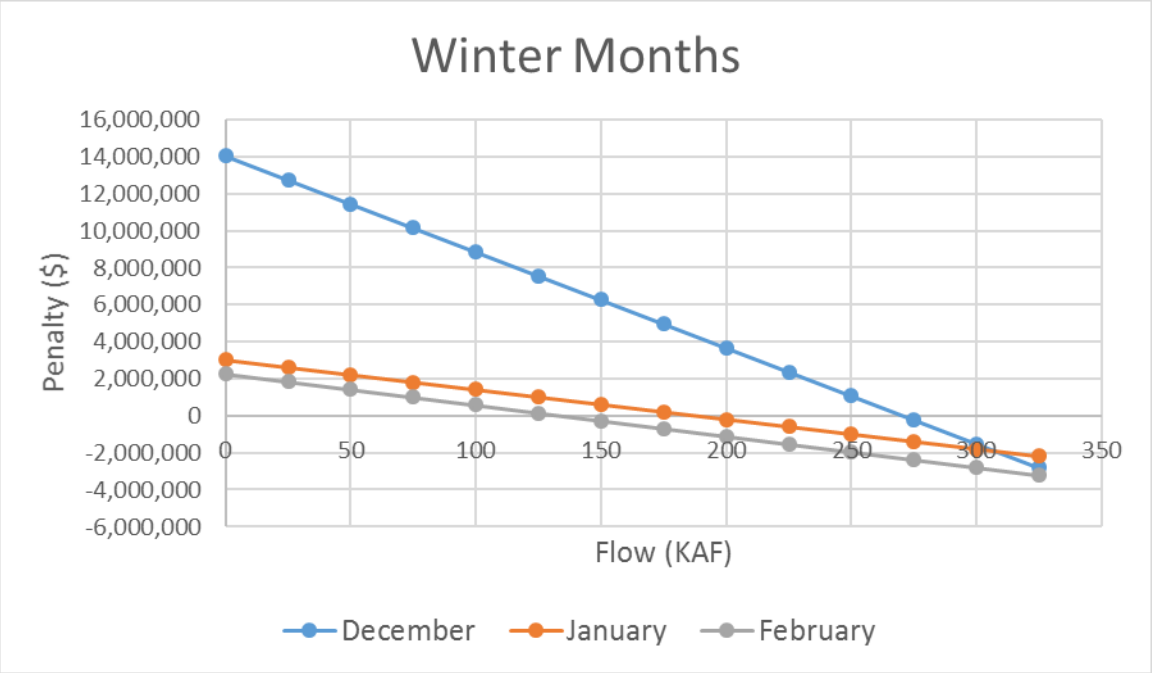

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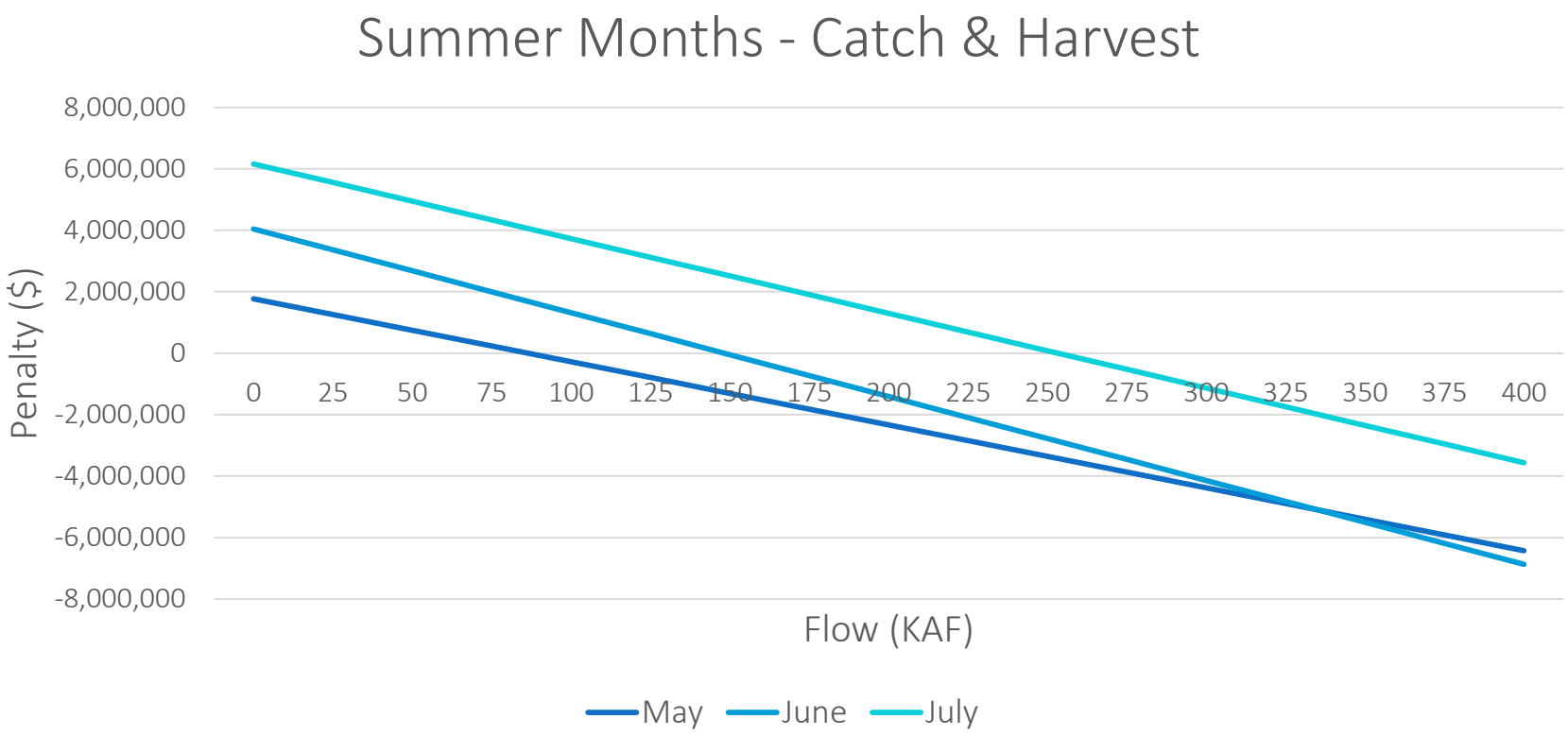
Penalty Function

Combined penalty function



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Applications & Future Work

- Contribute to broad-sector hydro-economic optimization model for south Florida as part of the South Florida Water, Sustainability, and Climate Project
- Scenario analysis for both past and future water management decisions
- Framework to estimate loss of benefits in other ecosystem services (carbon storage) and/or regions (Caloosahatchee and St. Lucie River Estuaries)

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