Application of the MIKE Marsh Model of Everglades National Park to Evaluate Restoration Alternatives

Kiren Bahm[1] and Amy M. Cook[2]

Robert J. Fennema[1], Georgio I. Tachiev[2], Kevin Kotun[1]

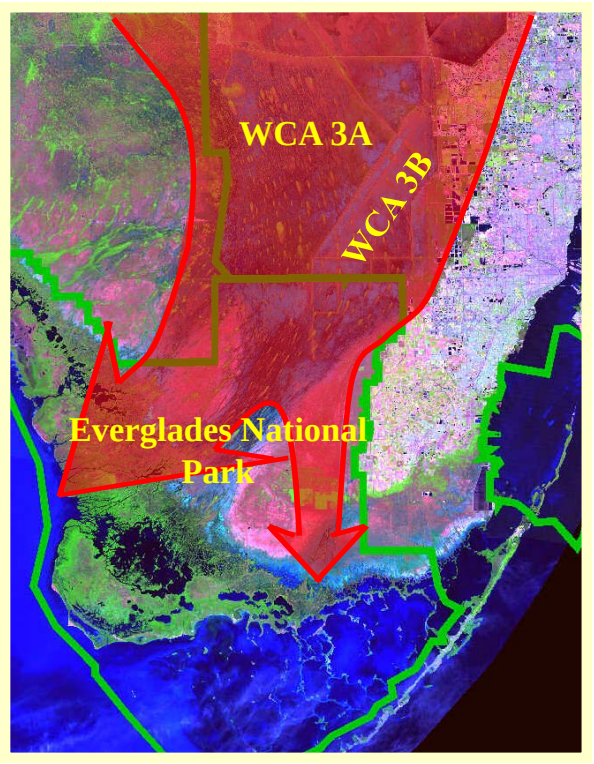
[1]National Park Service, Homestead, FL, USA

[2]GIT Consulting, Coral Gables, FL, USA

2016 National Conference on Ecosystem Restoration

Flow Patterns of the Everglades

Historical



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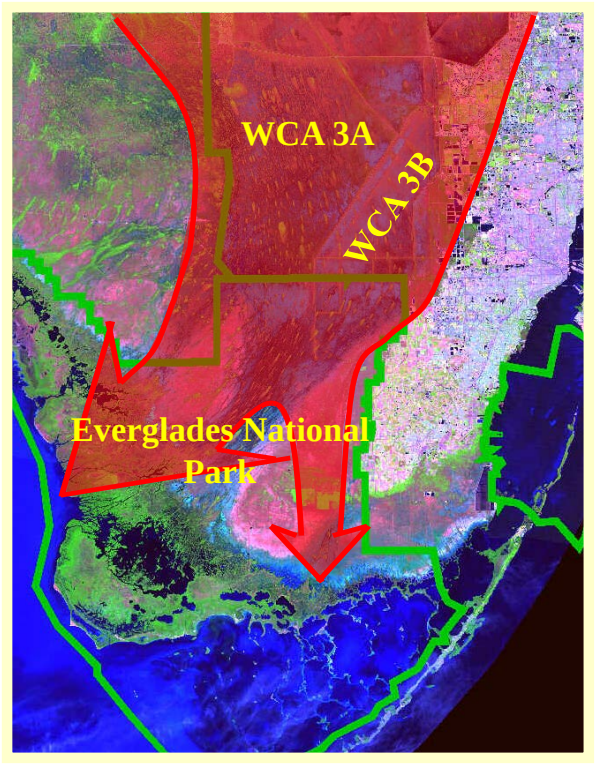
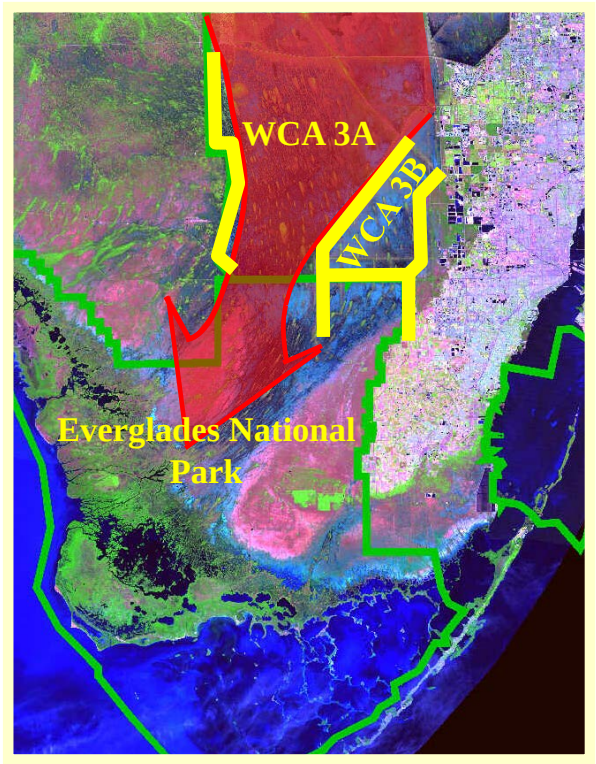


Current



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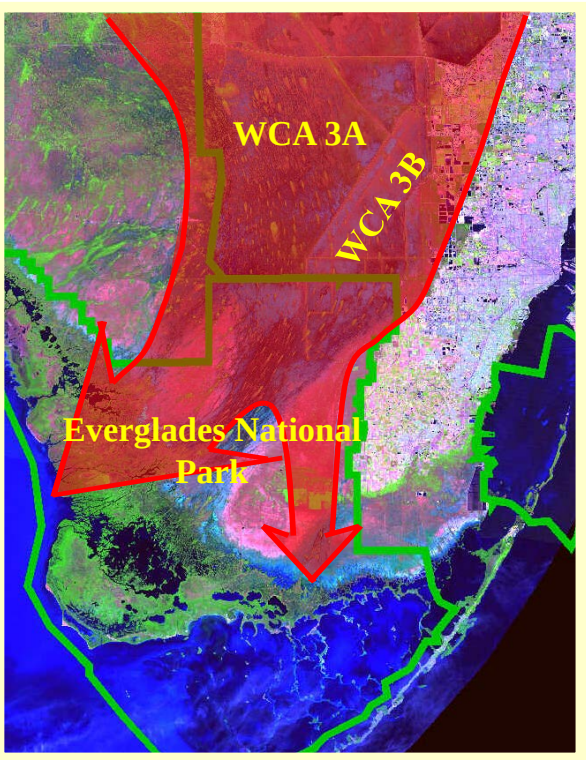

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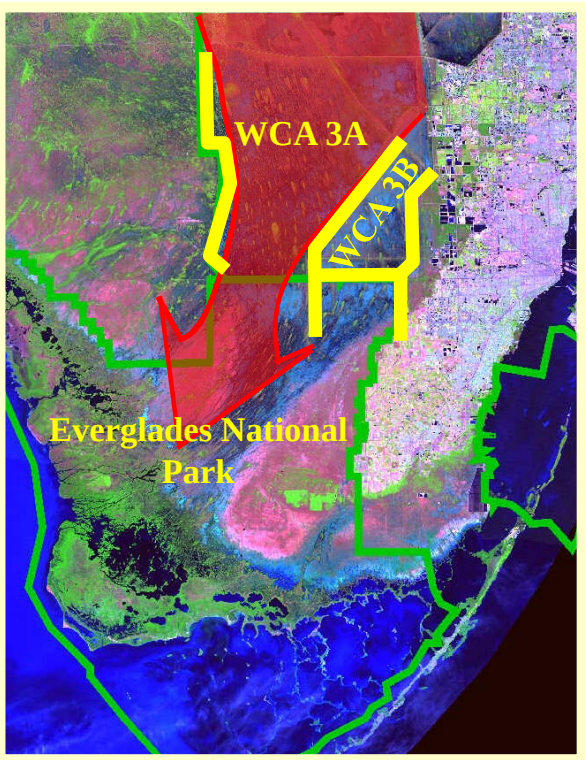
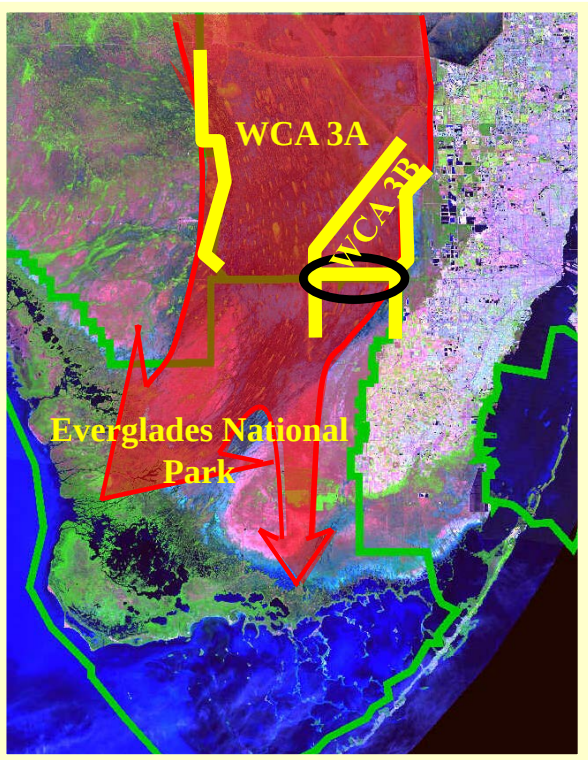


Future



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Flow Patterns of the Everglades

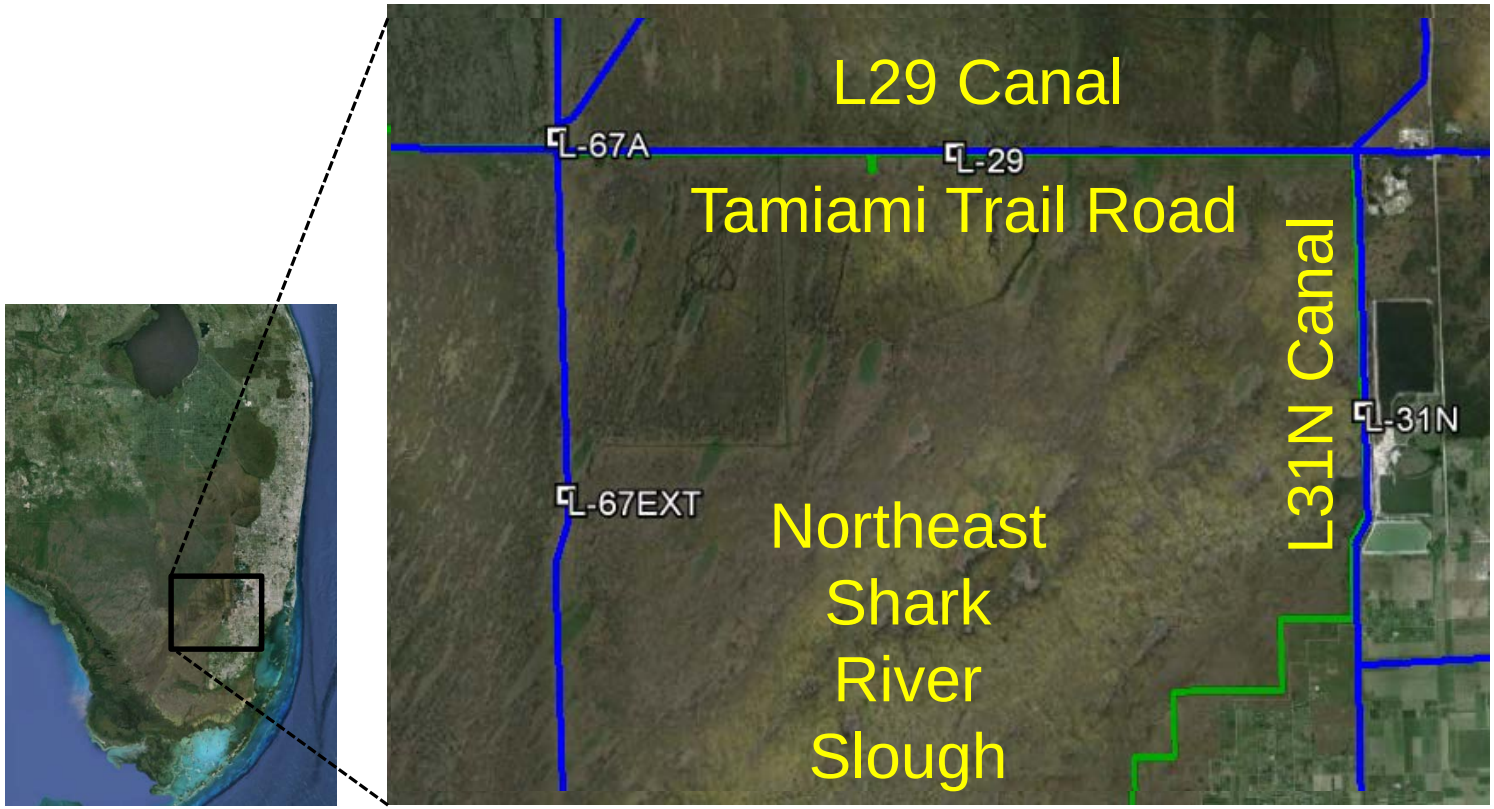
Desired state of conservation:

*"On average, a total annual volume of water should be delivered to NESRS of **550 thousand acre-feet** (acre-feet) with a range of 200 to 900 thousand acre-ft during years of below- and above-average rainfall, respectively."*

Everglades National Park: 2015 State of Conservation, Report to the World Heritage Committee, UNESCO

Problem statement

How can we **increase flow** into Northeast Shark River Slough (NESRS)?



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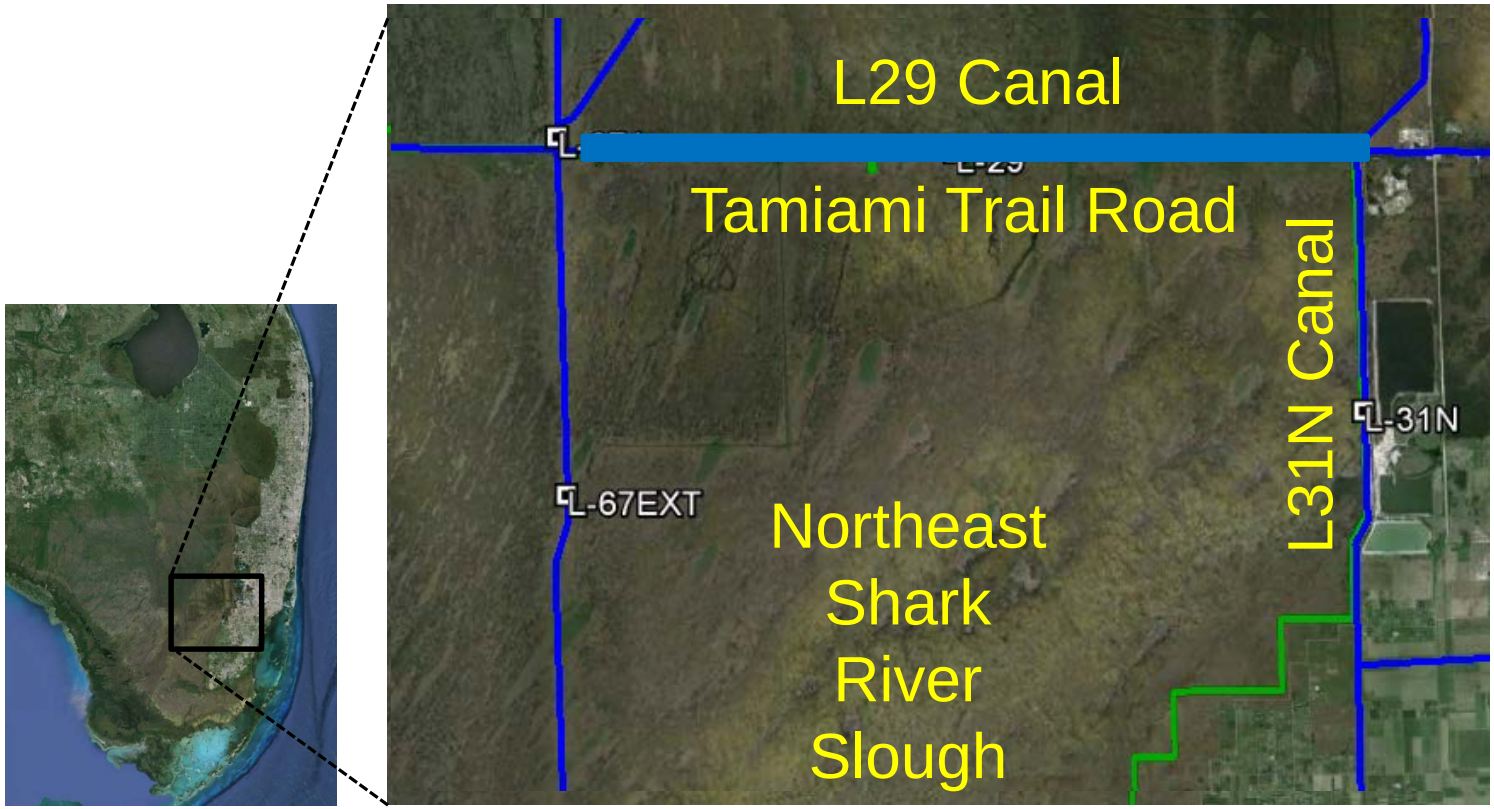

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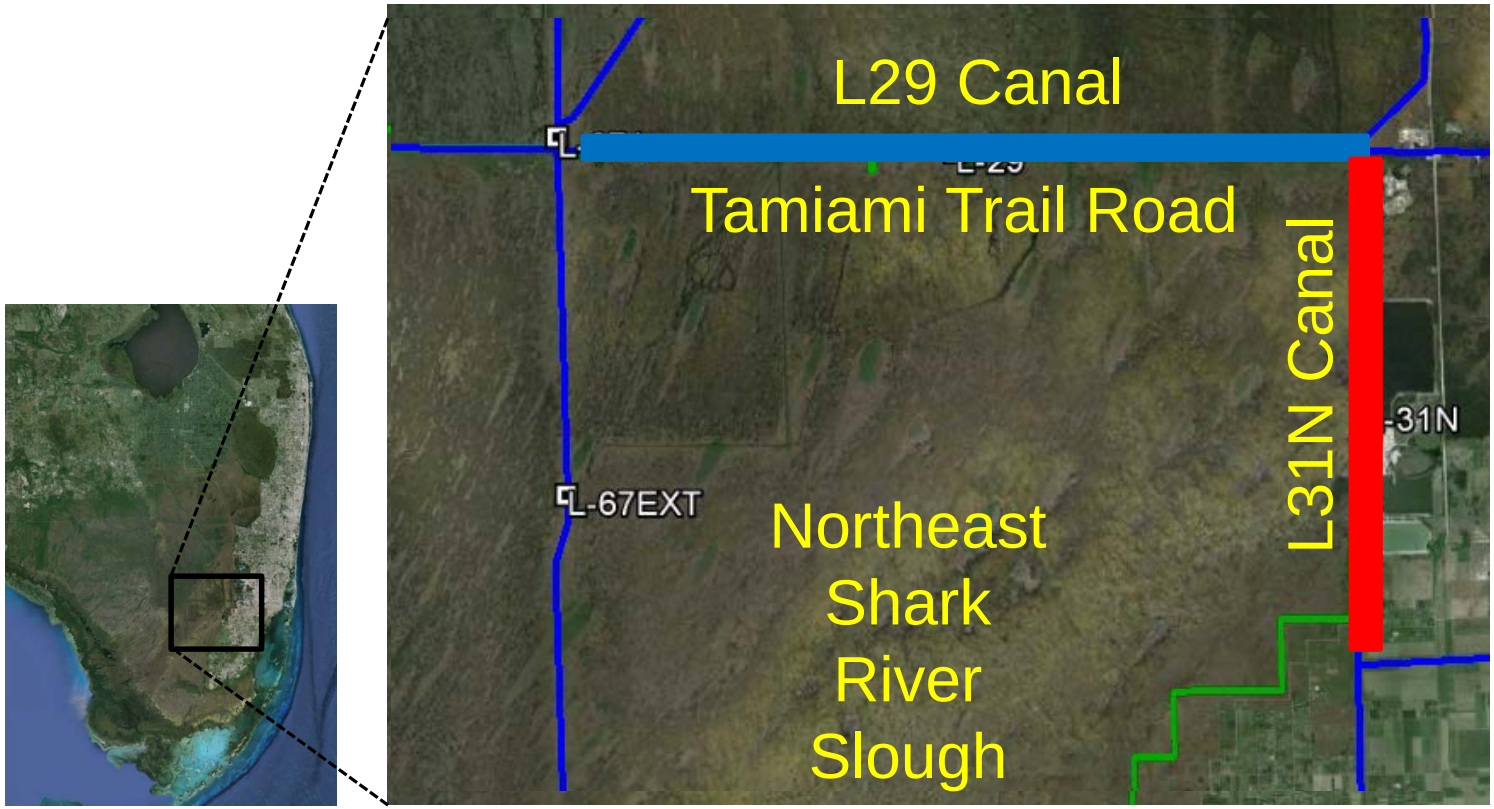

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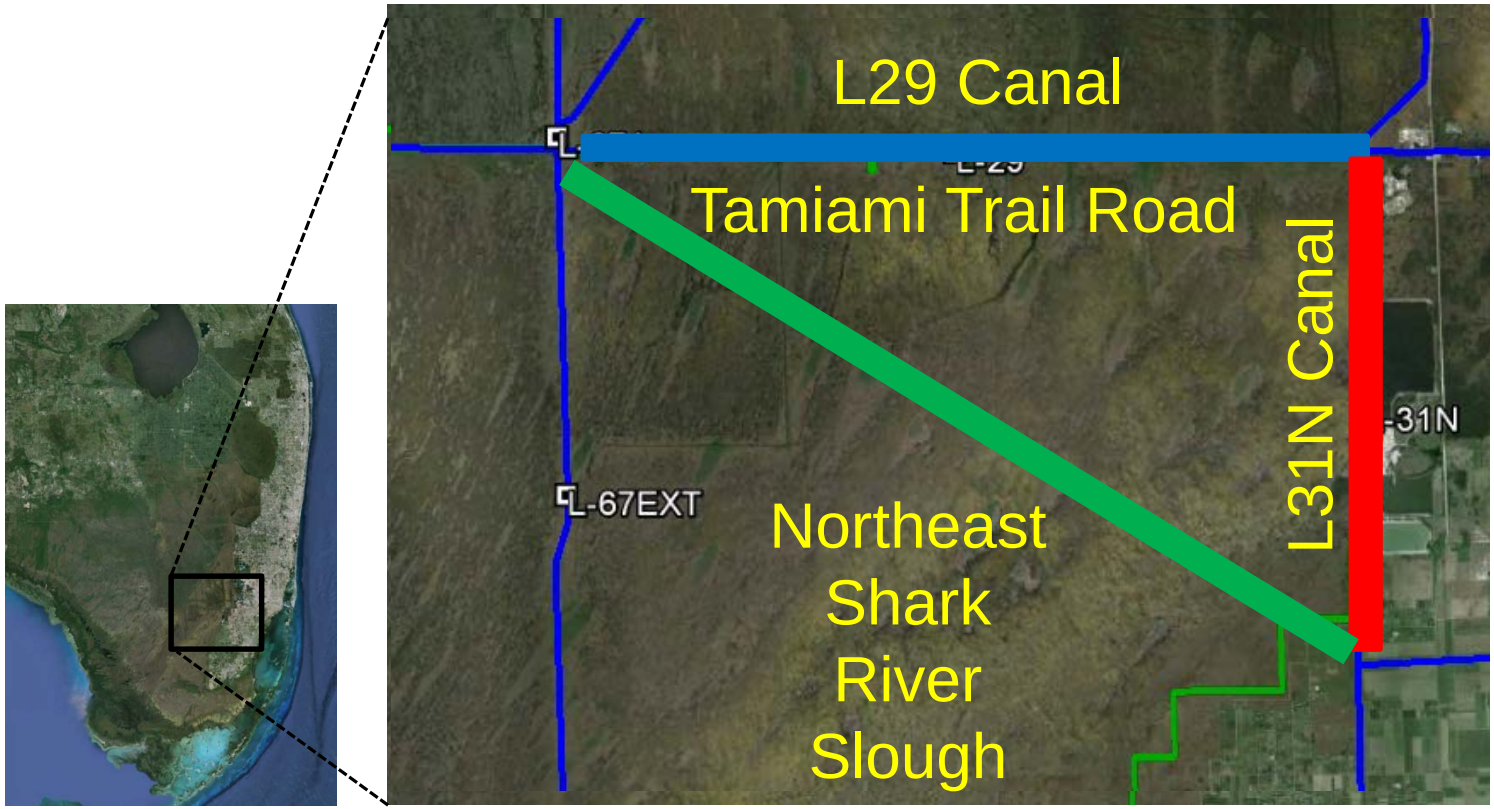
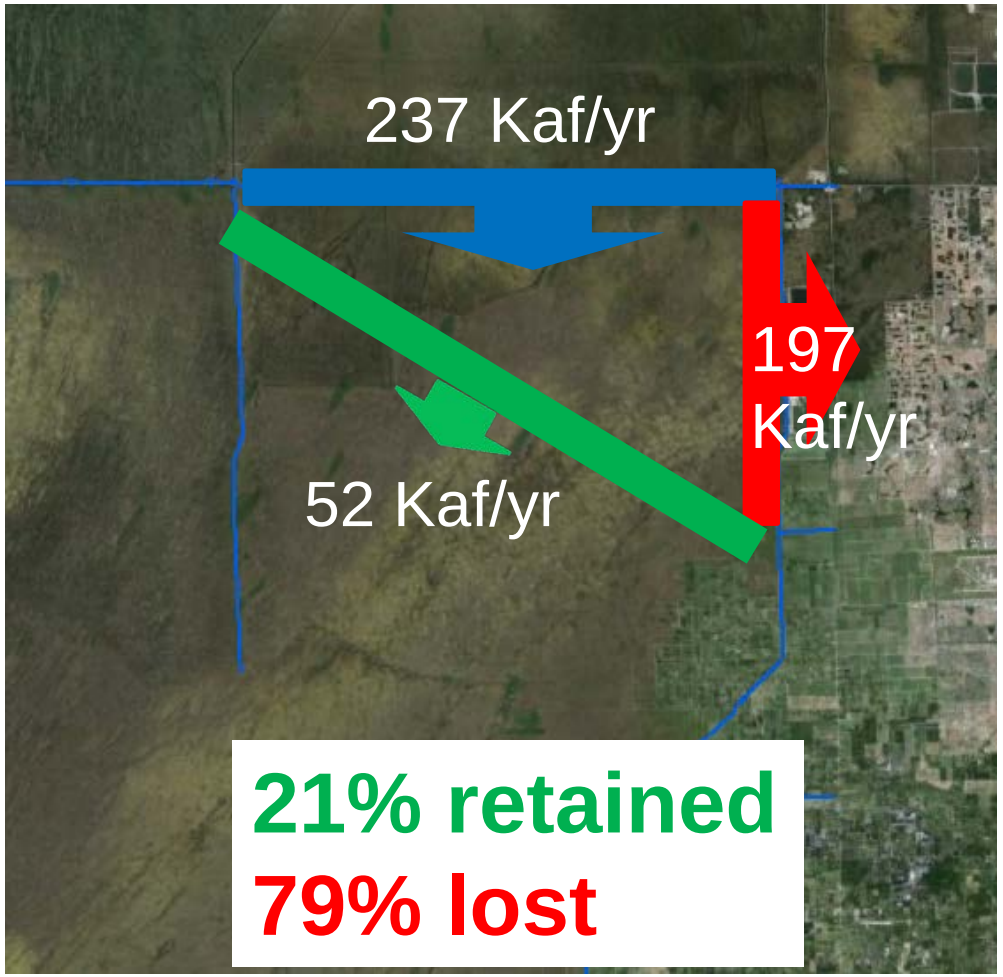


Problem statement

Water budget calculations for transects in NESRS show:

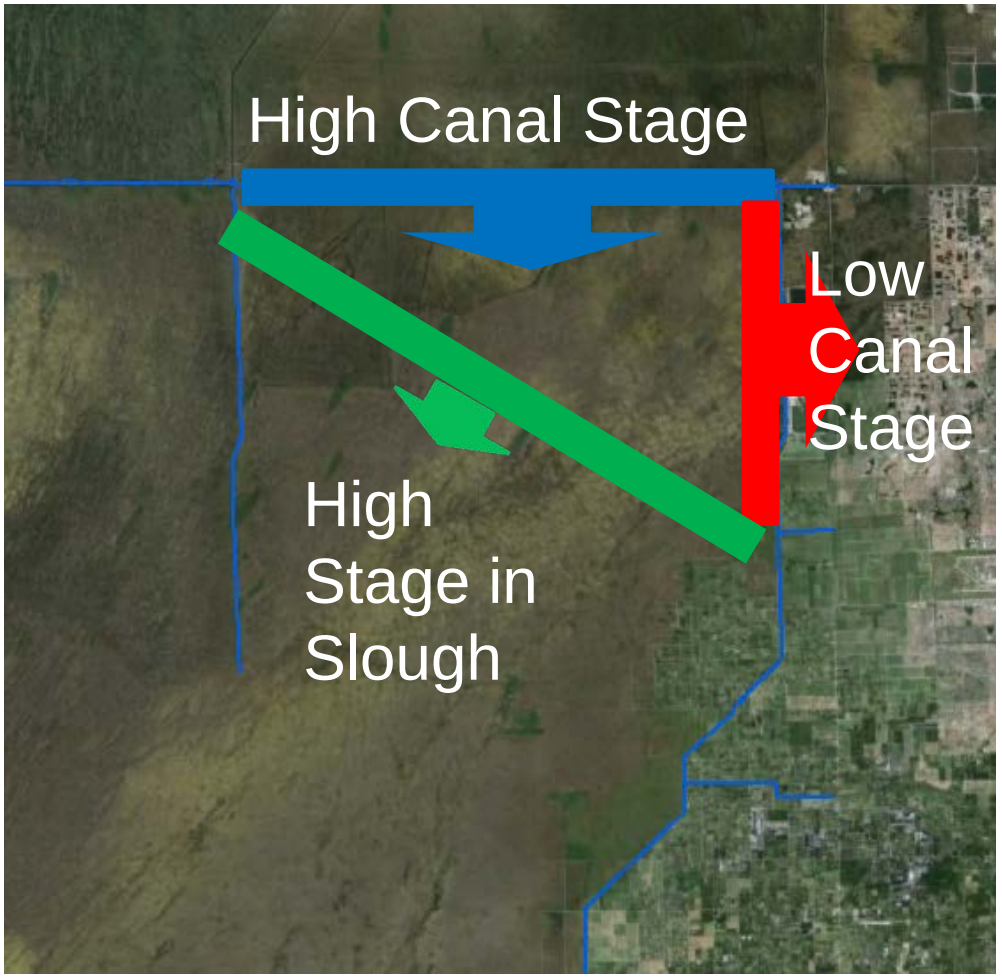
- **237** Kaf/yr flows into ENP at Tamiami Trail
- **52** Kaf/yr flows further into NESRS
- **197** Kaf/yr is immediately lost out of the Park to the east.
- Remainder accounted for by rainfall and ET



Problem statement

Why is this happening?

- Maintaining low canal stages to the east, which draws water out of the park where stages are higher
- Not enough north-to south gradient to drive higher flow volumes down the slough



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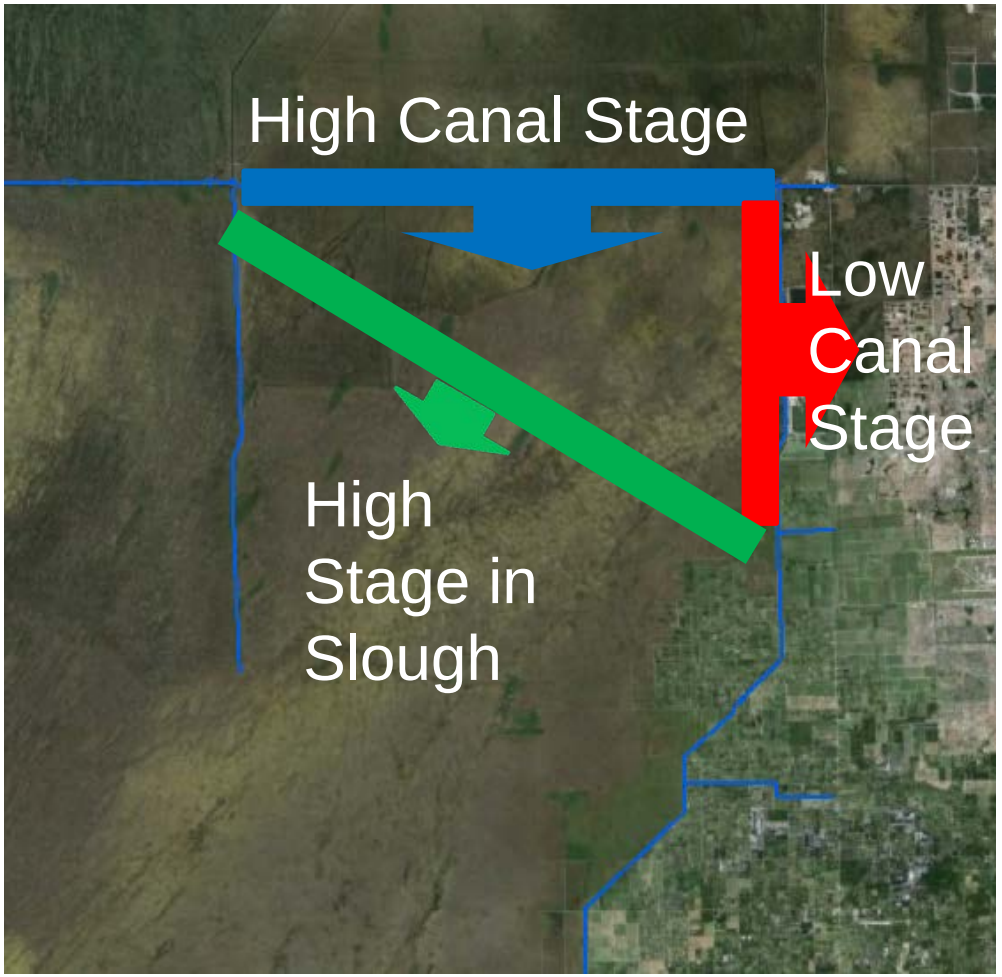
Restoration components modeled are:



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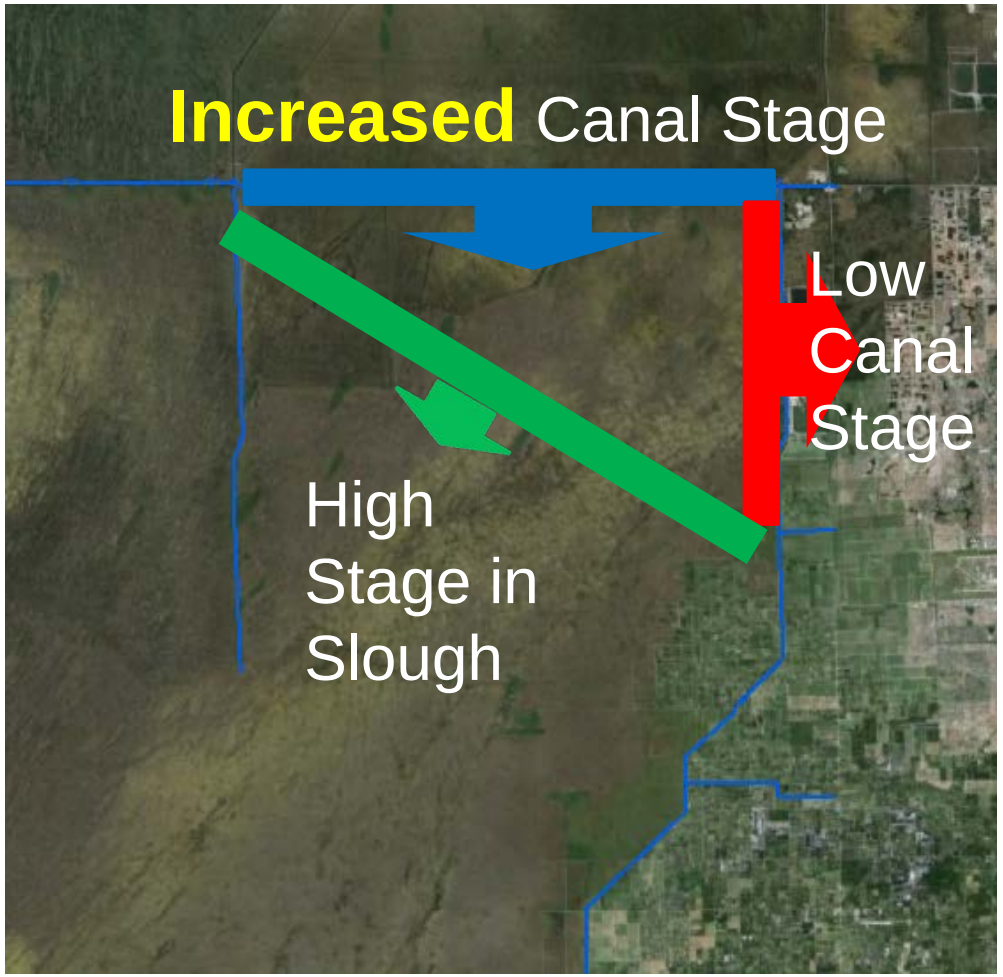
Restoration components modeled are:

- **Increased canal stage** in L29 to provide a greater gradient for flow



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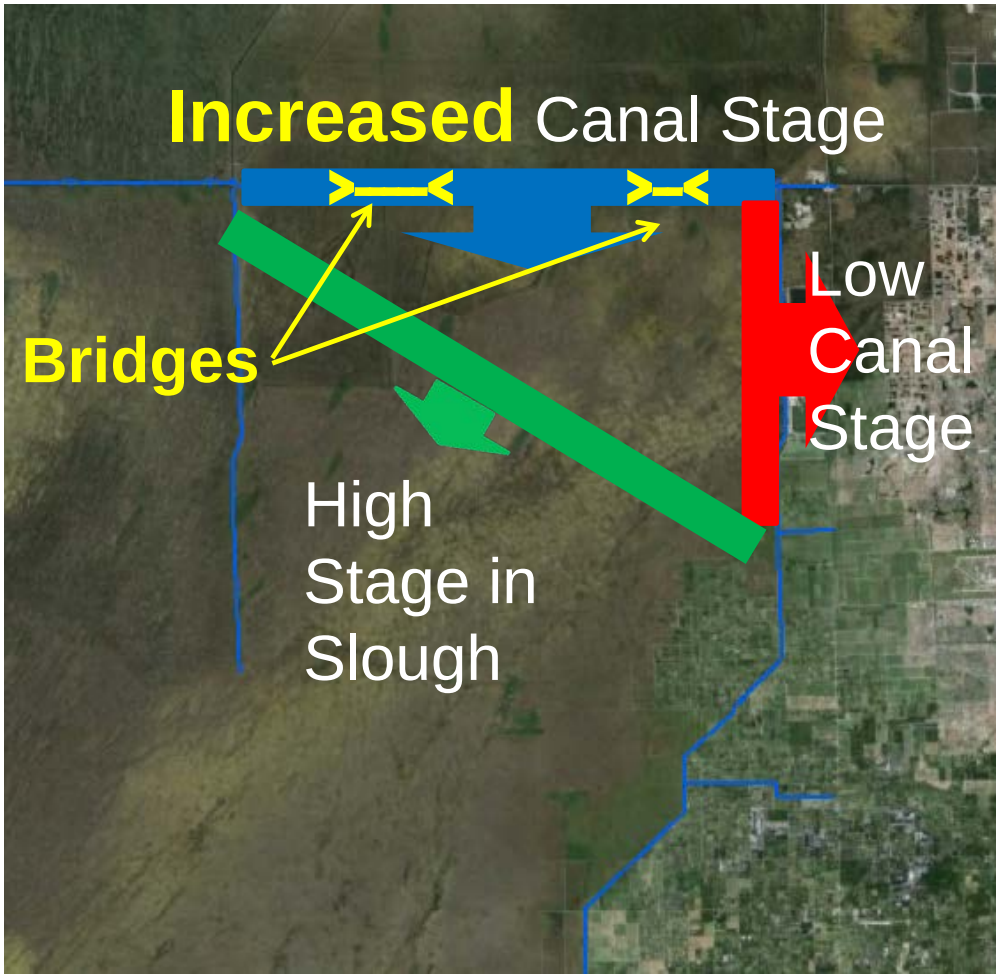
Restoration components modeled are:

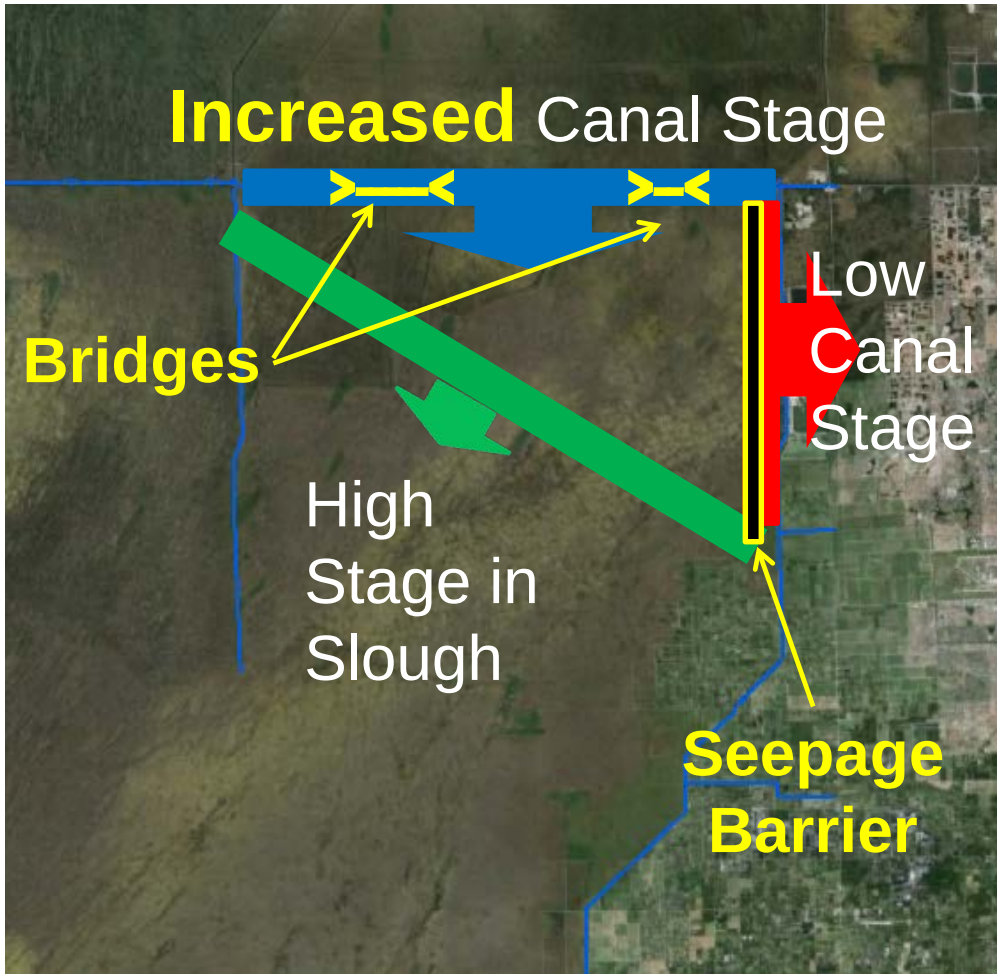
- **Increased canal stage** in L29 to provide a greater gradient for flow
  - requires construction of **bridges** along roadway and removal of roadbed



Problem statement

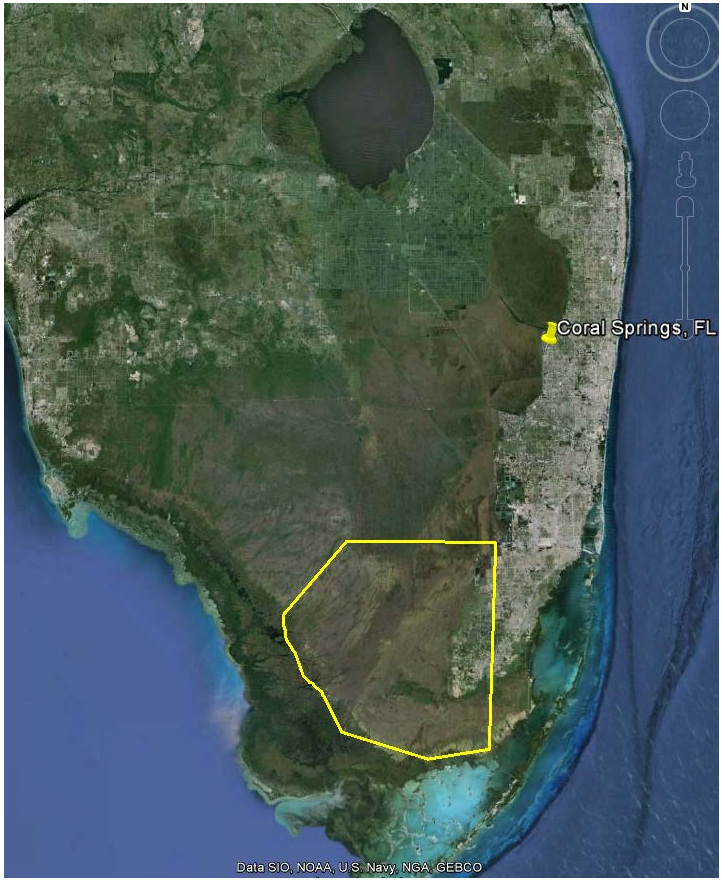
Restoration components modeled are:

- **Increased canal stage** in L29 to provide a greater gradient for flow
  - requires construction of **bridges** along roadway and removal of roadbed
- Installation of a seepage **barrier** to reduce losses to the East

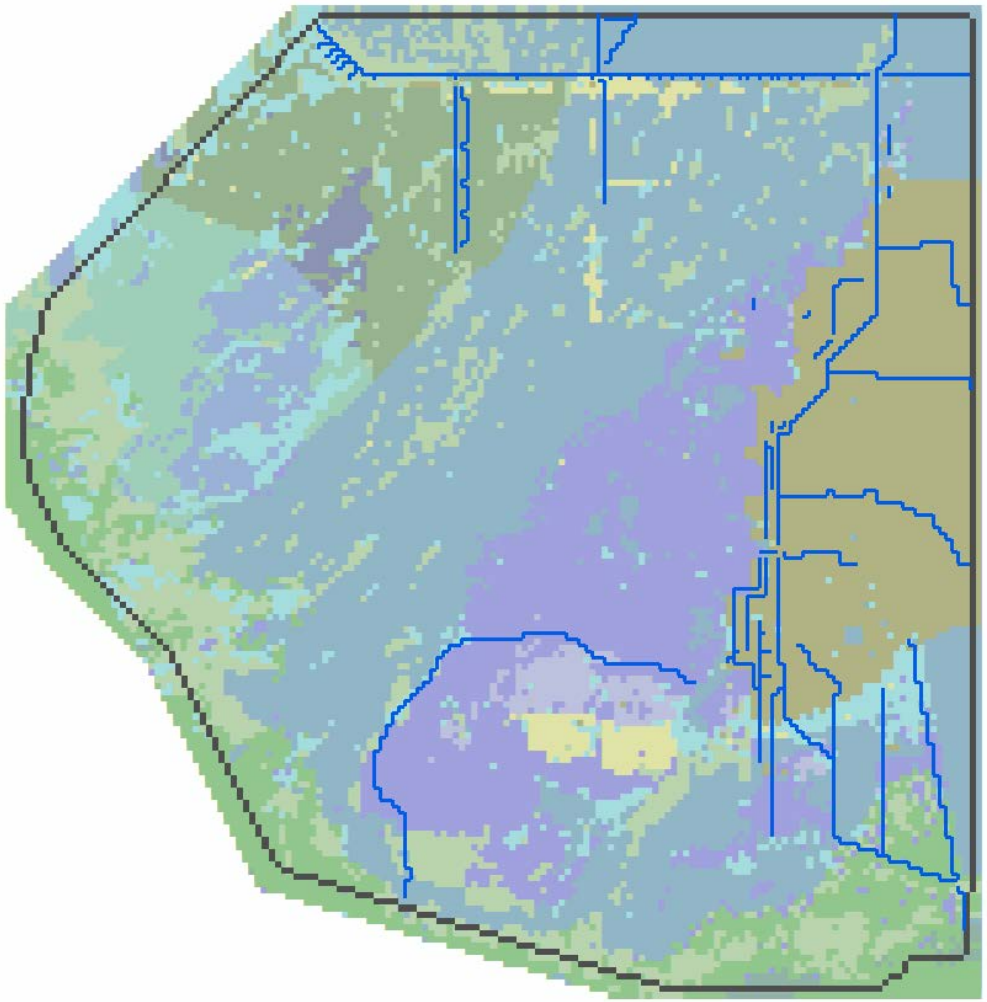


MIKE **M**arsh **M**odel of **E**verglades **N**ational **P**ark (M3ENP)

- 400 meter finite difference, square grid
- 1250 mi^2 domain, 120 mi canals
- 2D Overland/Sheet Flow
- 1D Unsaturated Zone Flow
- 3D Saturated Zone flow
- 1D channel flow

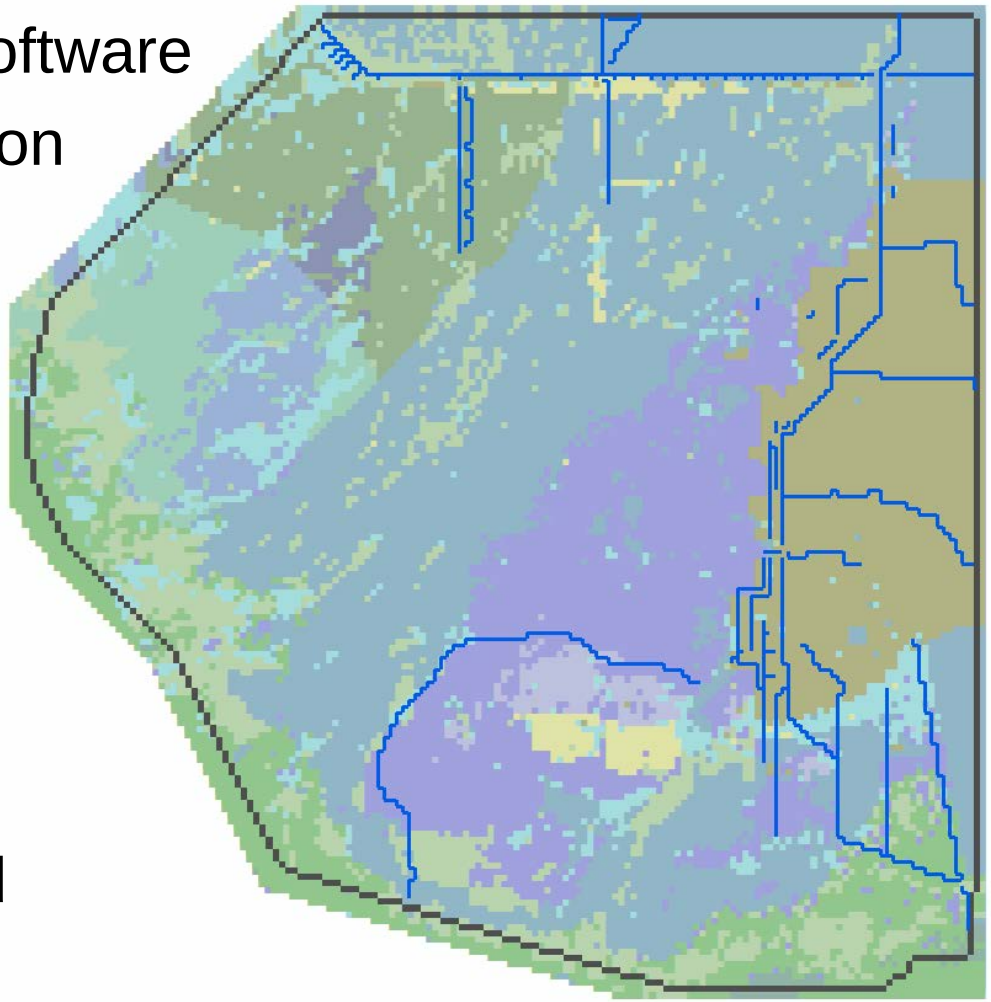


What makes M3ENP unique?



What makes M3ENP unique?

- Uses MIKE SHE/MIKE11 software
- 400x400 meter grid resolution
- 3 saturated zone layers
- 27 unsaturated zone layers
- Ability to simulate **highly localized effects**
  - detention areas
  - bridges
  - seepage barriers
  - groundwater flow around structures



M3ENP Scenarios

- **Tamiami Trail bridges** and roadbed removal
  - No bridges / Two bridges

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  - 7.5 ft / 8.5 ft NGVD maximum stage

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- **Combined effects** of all above components
  - Base / Two bridges, 8.5 maximum stage, and 5-mile seepage barrier

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Coming up at 11:40 Fahmida Khatun will discuss more details!

Why do we need bridges?

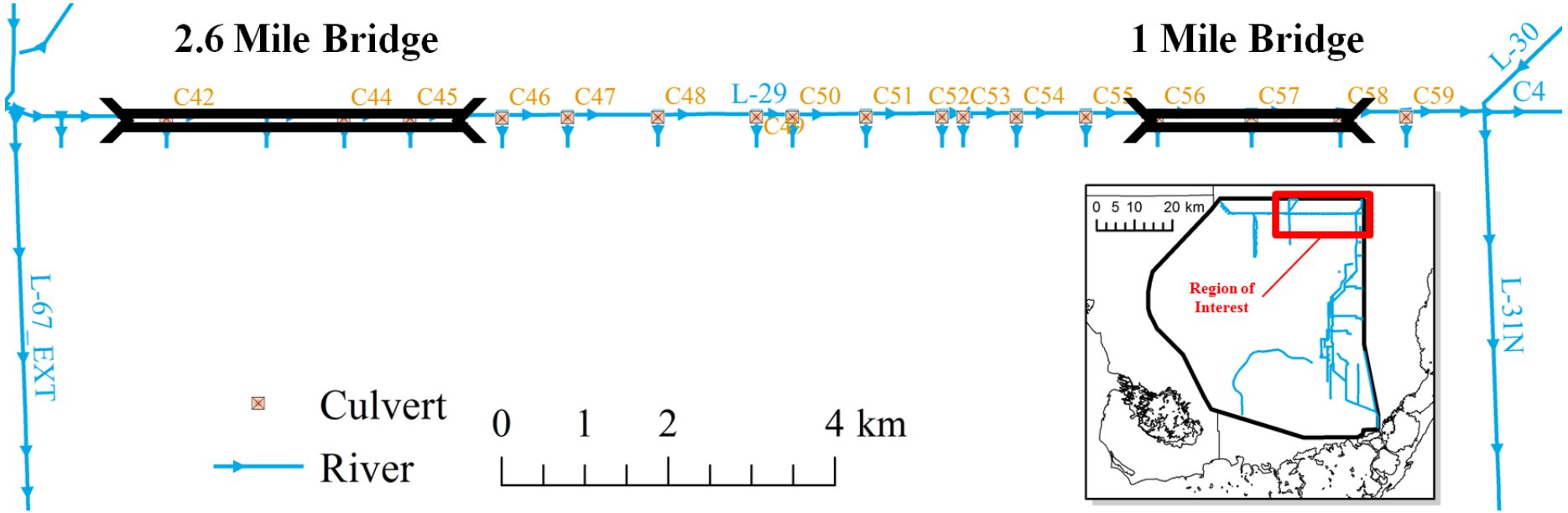
- To allow us to raise canal stages in L29
- To allow more sheet flow, less point-source flow

- *Common perception: the bridges are being built because Tamiami Trail is blocking flow to the park*
- *In reality the canal level cannot be raised without risking damage to the existing roadbed*

Why do we need bridges?

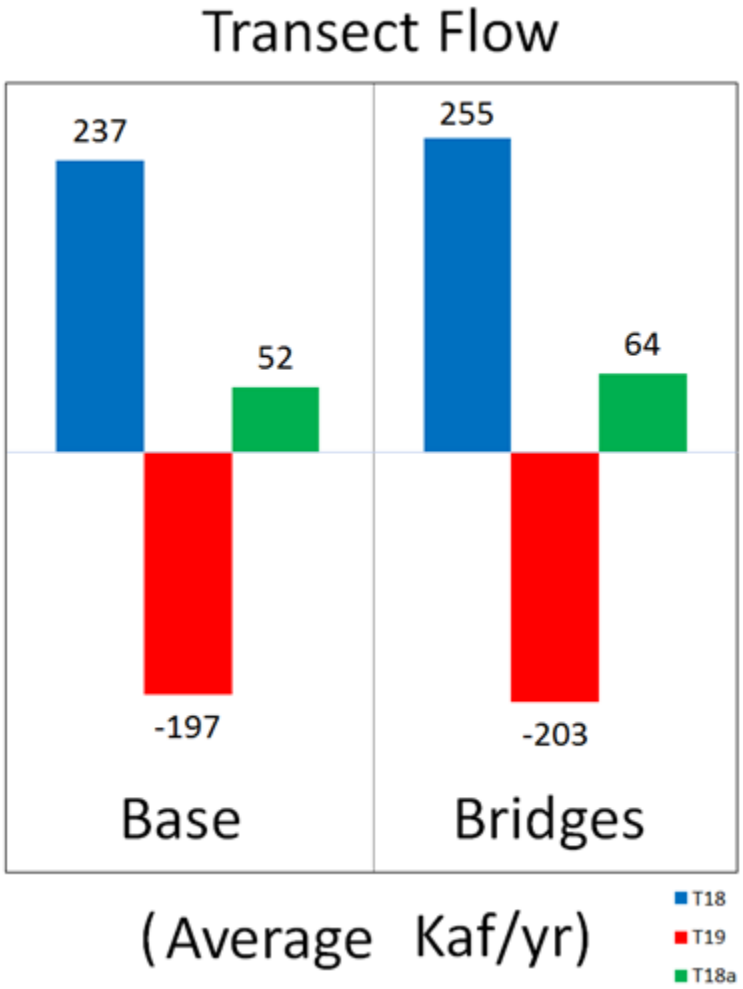
Groundbreaking in 2016

Completed in 2013



Culverts remain under the roadway at non-bridged locations

Why do we need bridges?



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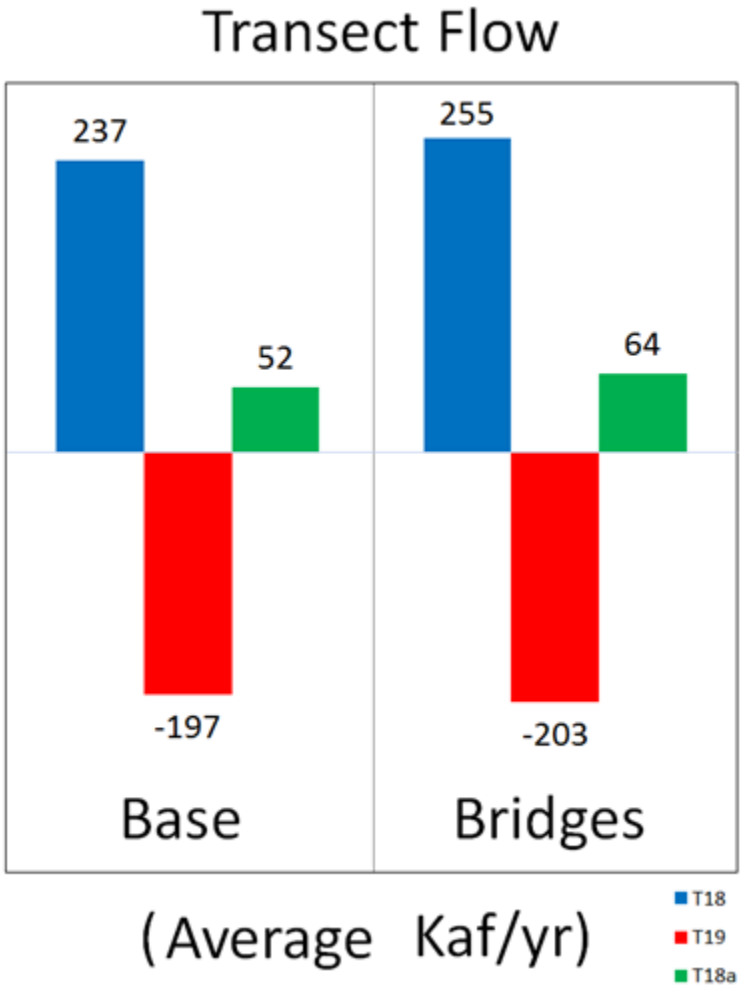

Effects of adding Tamiami Trail bridges:

- Available flow into the Park increases 8%
- Losses out of the Park increase 3%
- Flow to NESRS increases 22%

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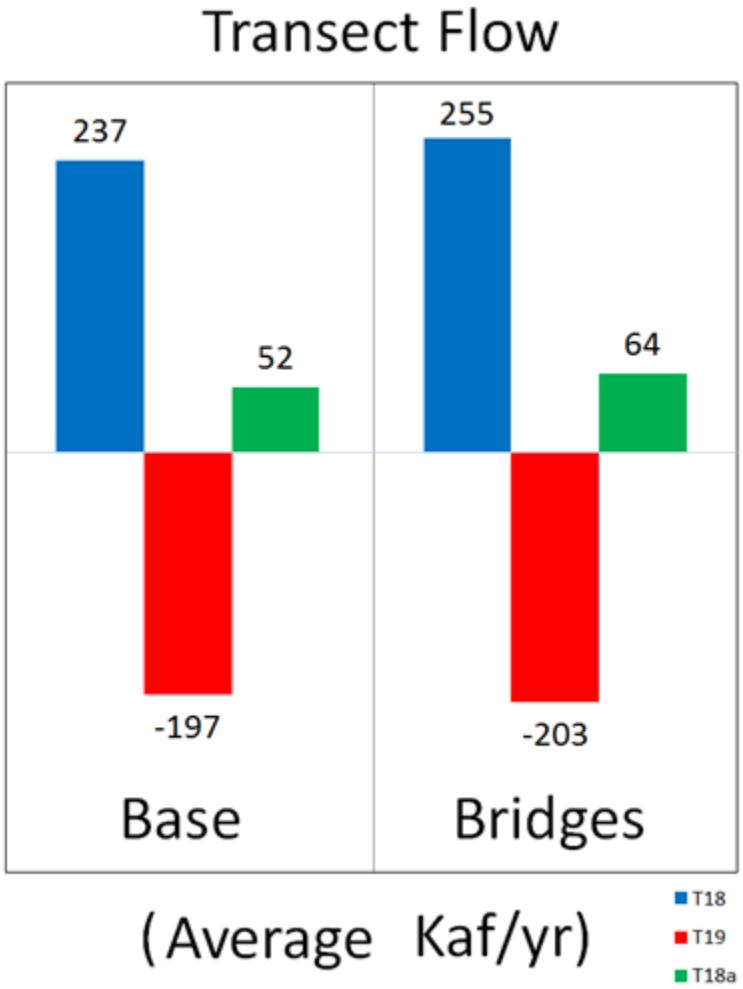

Effects of adding Tamiami Trail bridges:

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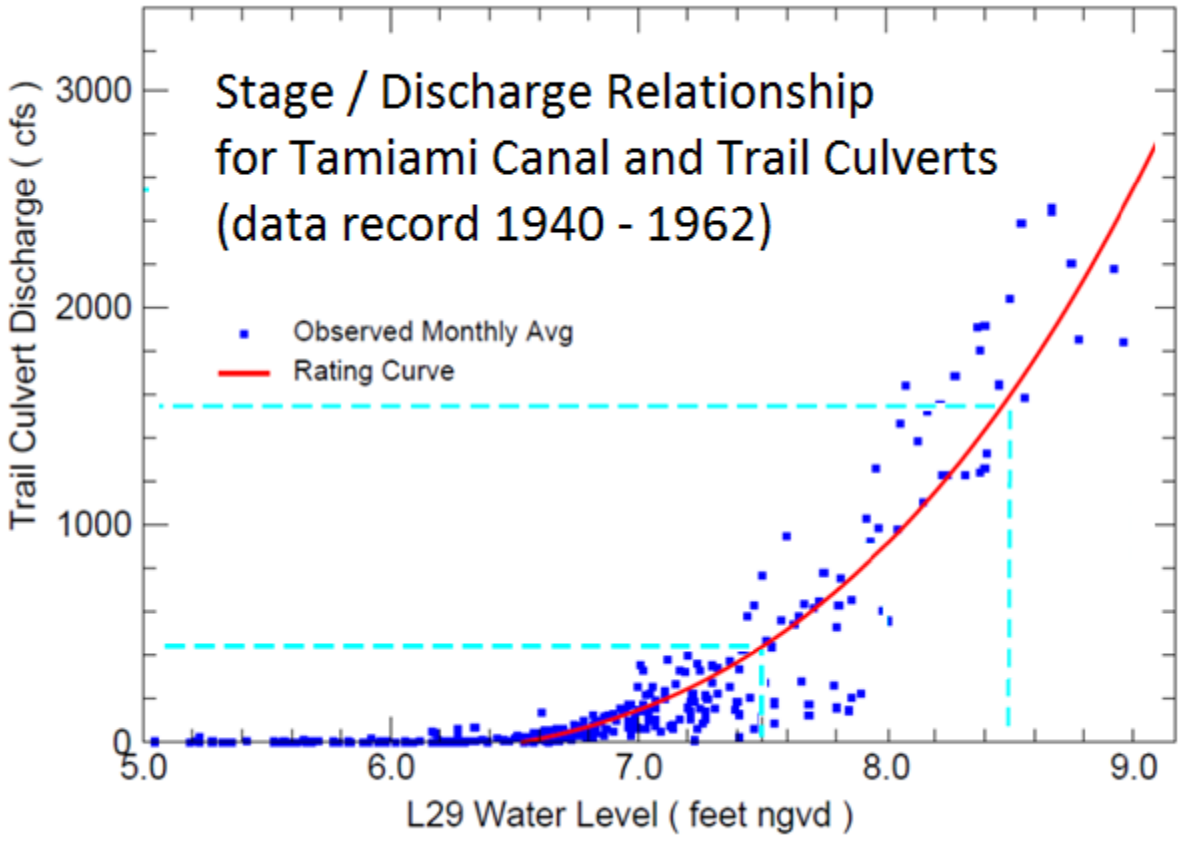
- Losses out of the Park increase 3%
- Flow to NESRS increases 22%

24% retained
76% lost

Why raise canal stage?

- To produce a steeper gradient to move more water into the park
- To increase cross-sectional flow area



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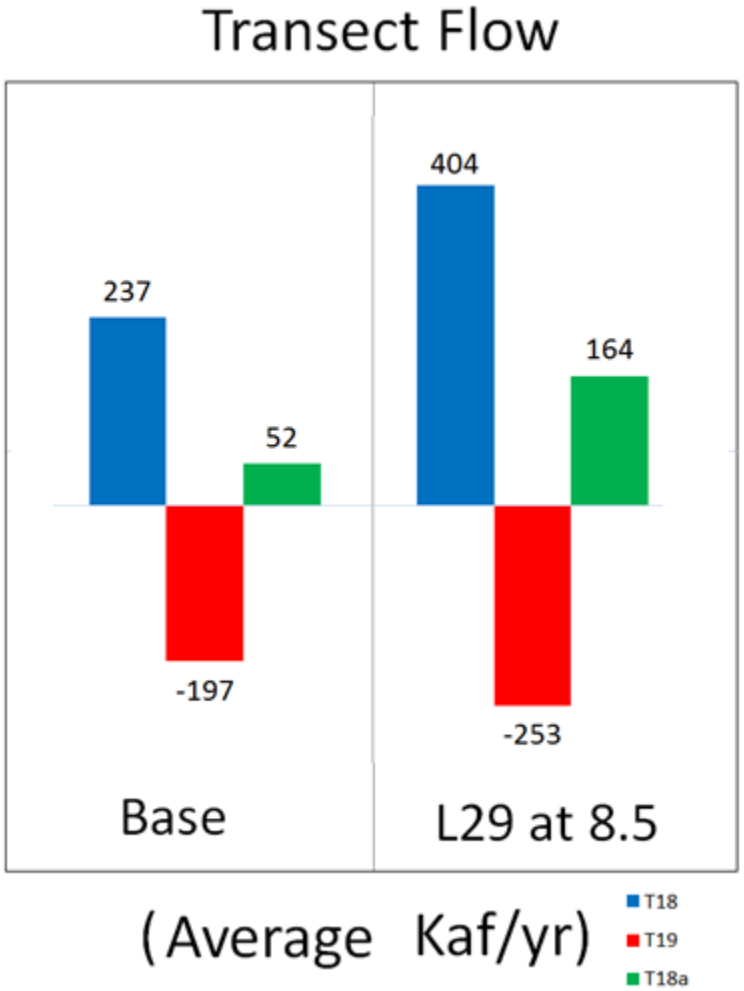


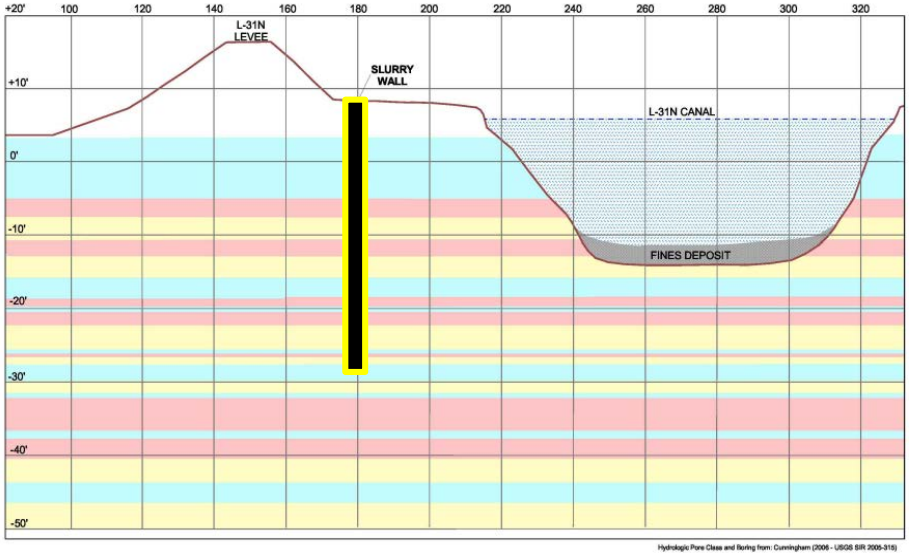
Increasing L29 canal stage to a maximum of 8.5 ft:

- Increases inflows to the Park by 71%
- Increases seepage out of the Park by 29%
- Increases flow to NESRS by 212%

39% retained
61% lost

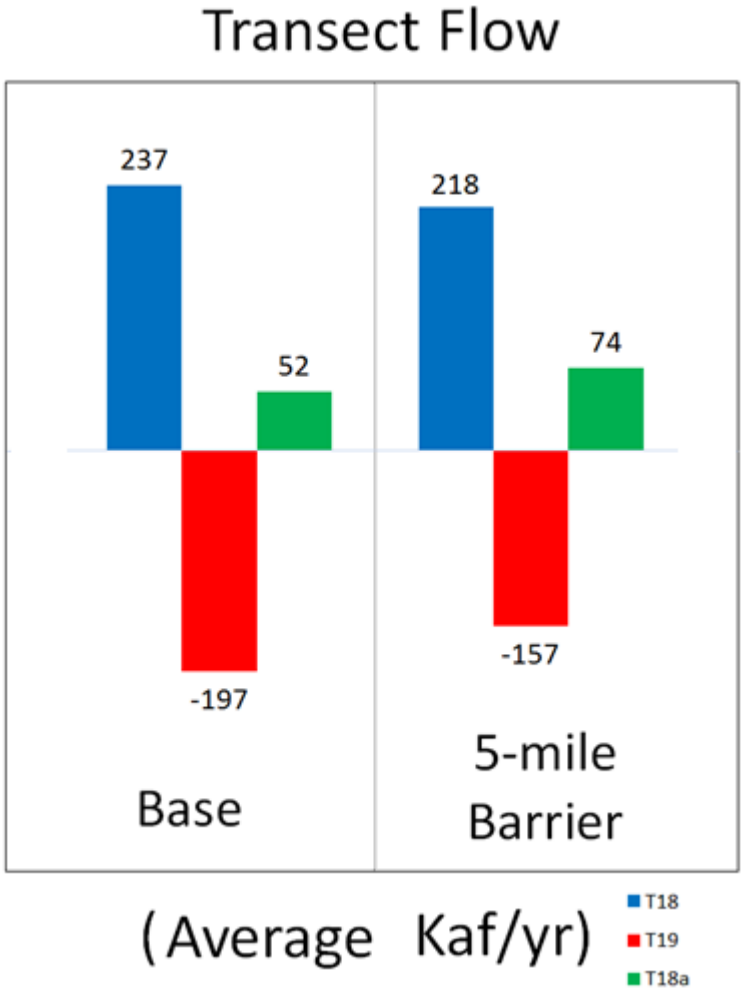
Why Add a Seepage Barrier?

- To mitigate for groundwater losses into the L31N canal.
- Increasing stages in NESRS also increases losses



- 35 feet deep
- 2 miles built
- 3 miles under construction

Why Add a Seepage Barrier?

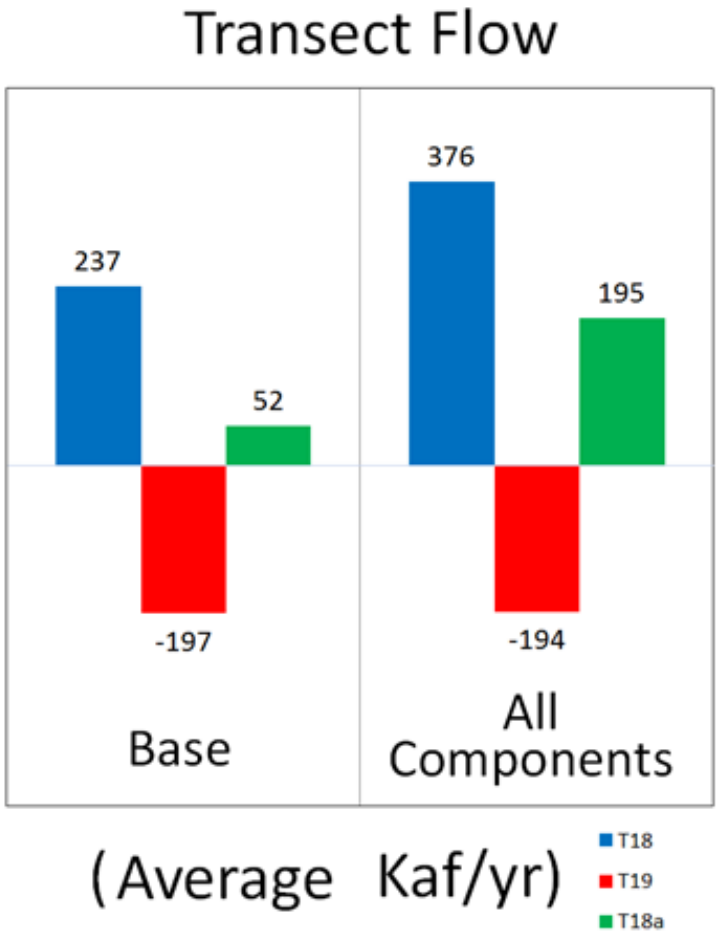


Adding the 5-mile L31N Seepage Barrier:

- Decreases available flow to the Park by 9%
- Decreases seepage out of the Park by 22%
- Increases flow to NESRS by 40%

32% retained
68% lost

Combined Effects of Components



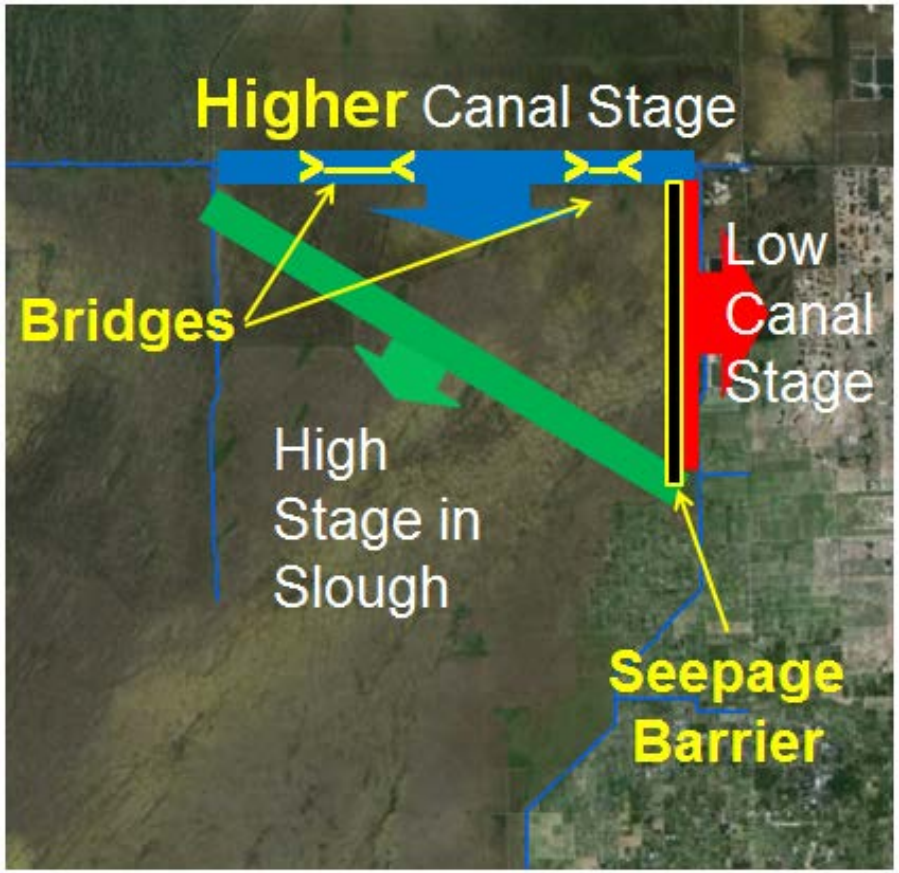
Adding the bridges, seepage barrier, and raising canal stages:

- Increases available flow to the Park by 59%
- Decreases seepage out of the Park by 2%
- Increases flow to NESRS by 270%

50% retained
50% lost

Summary

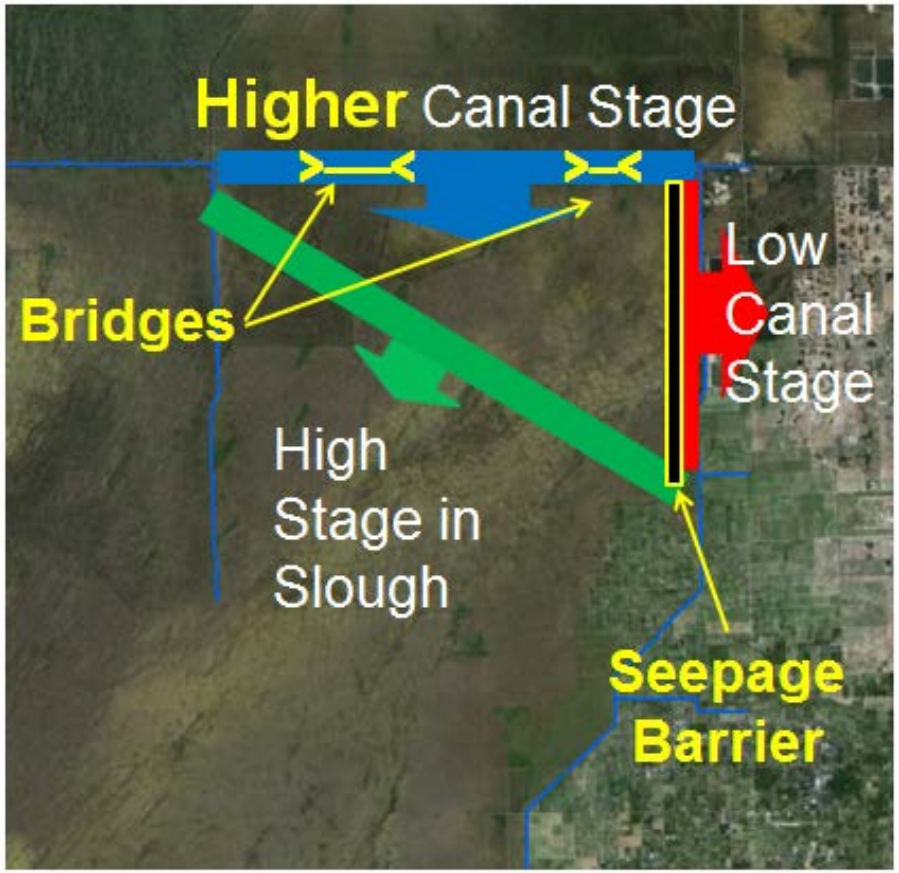
- The **independent** effects of the components provided benefits to the Park, most notably **increasing stages** in the L29 canal



Summary

- The **independent** effects of the components provided benefits to the Park, most notably **increasing stages** in the L29 canal

- The **combined** effects of these three components will result in significantly **higher flows** into the park, while mitigating for seepage losses



The Takeaway

- The **target** for restoration of flows to NESRS is **550 Kaf/yr**
- Implementation of all three components will increase flows along the northeastern boundary of ENP to **370 Kaf/yr**
- **195 Kaf/yr** will be retained in Shark River Slough
- This represents a **significant step** towards achieving our restoration goals

Acknowledgements

Robert J. Fennema, PhD (ENP)
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Janice Parsons (ENP)


Thank You