Non-native Fish and Everglades Restoration: An Unexpected Challenge to Restoring an Iconic Ecosystem

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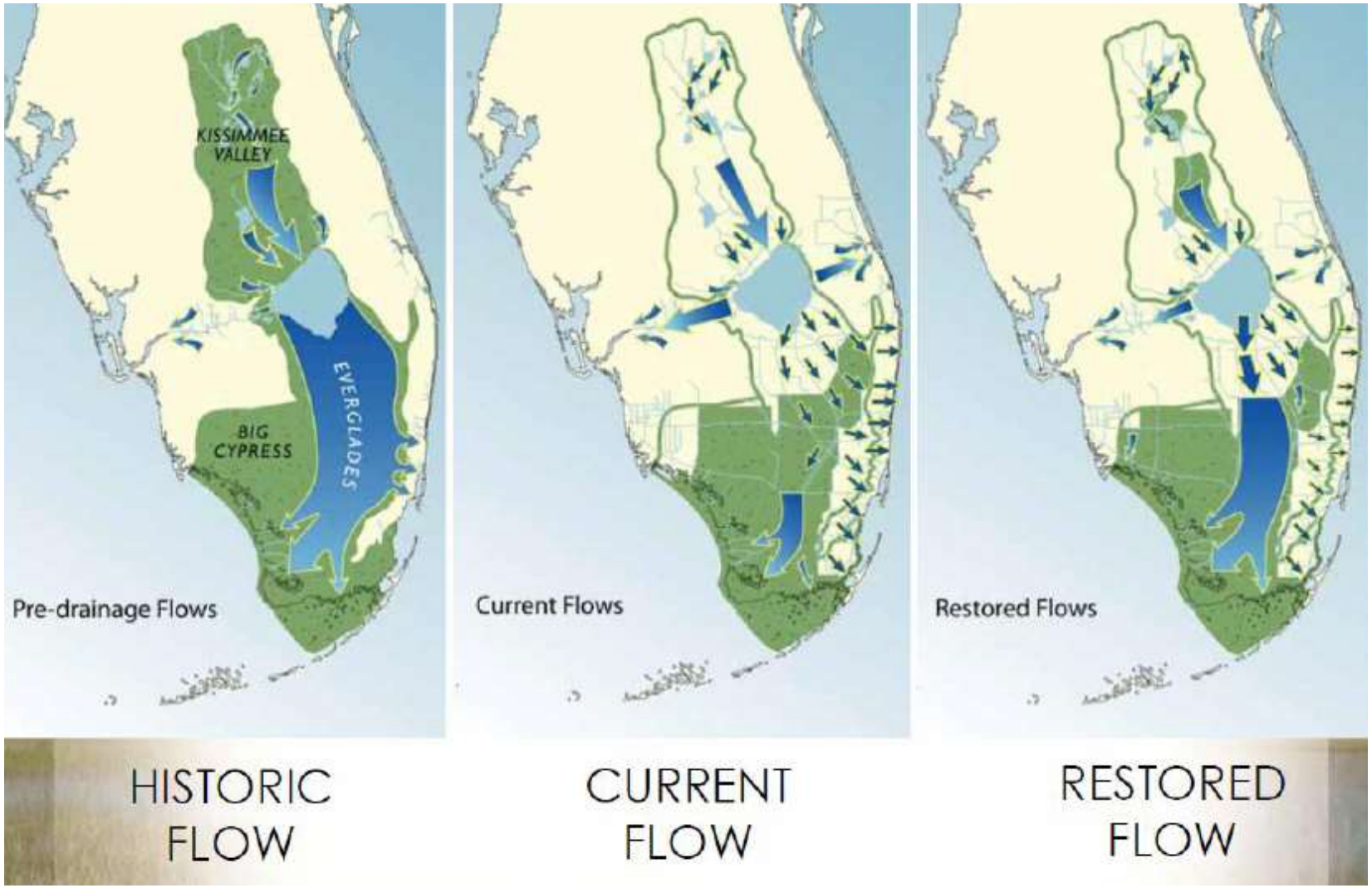
Everglades Restoration



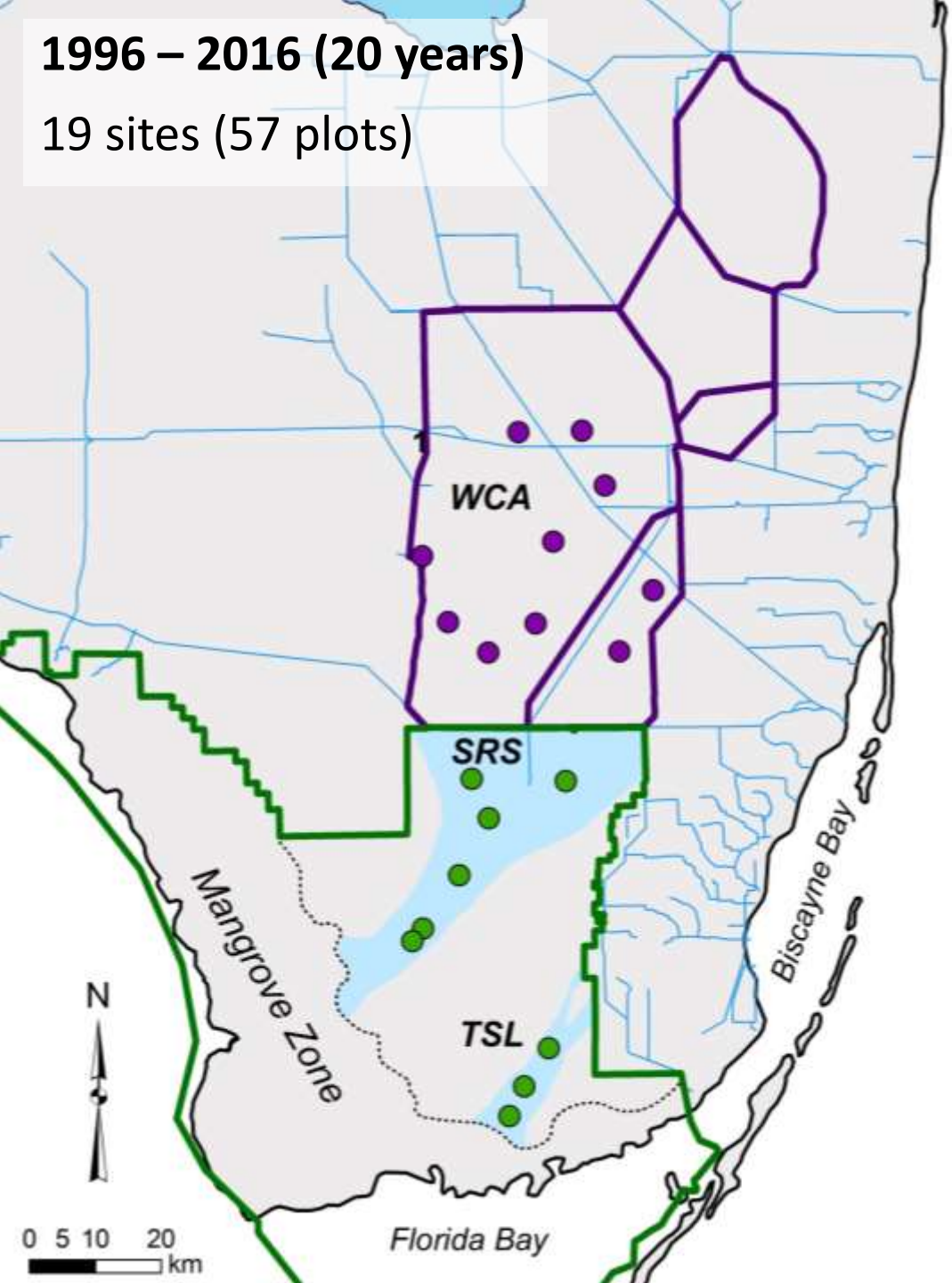
Overview

1. Long-term trends in fish community structure and turnover rate
   - Abrupt vs. gradual change
   - Directionally or non-directionally?

2. Invasive species changing biomass trends
   - Decomparmentalization (DECOMP) and invasion
   - Changing controls of ecosystem resilience?

1996 – 2016 (20 years)

19 sites (57 plots)

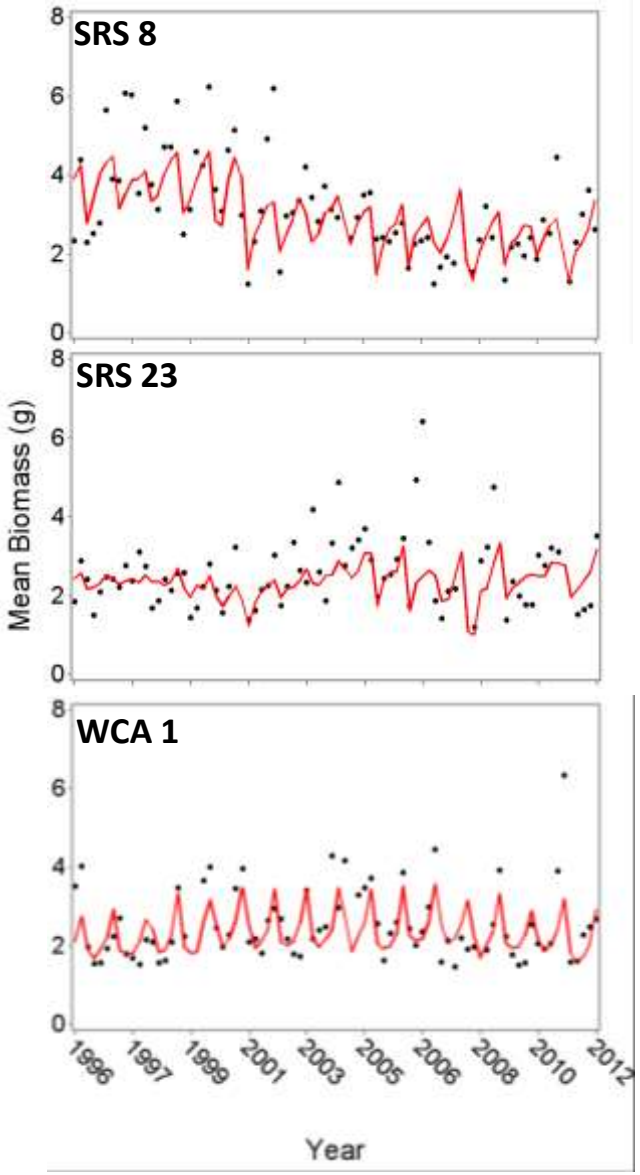


Sampling Methodology

- Sampling method
  - Small fish: 1 m^2 throw trap
  - 5 or 7 samples /plot
  - July, Oct, Dec, Feb, April
  - 40,169 samples total

Long-Term Trends in Biomass

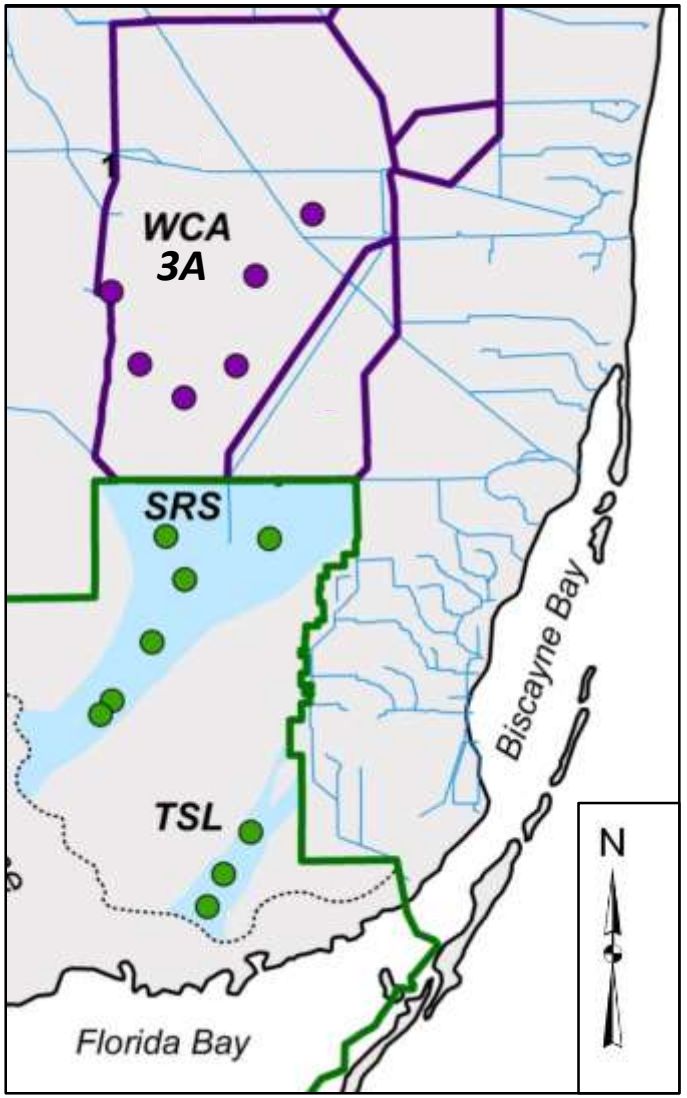
- Generalized Linear Mixed Model (GLMM)
- Generalize logistic model
- Parameters: DSD, Depth, Expansion/Recession Rate, Season



Biomass Summary (1996-2012)

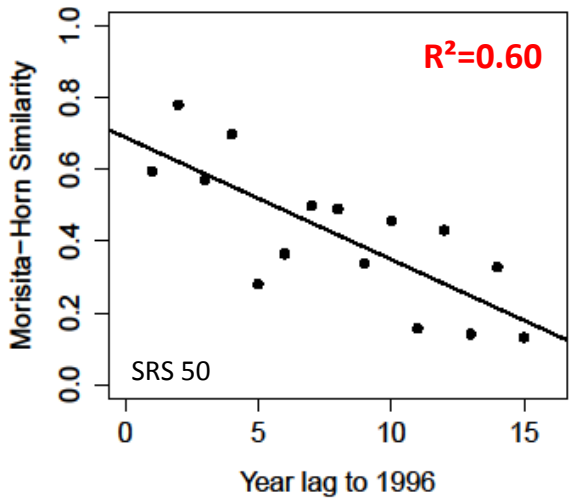
- After accounting for local hydrology, fish biomass declined significantly at:
  - 4 of 6 (67%) sites in SRS
  - 2 of 3 (67%) sites in TSL
  - 2 of 6 (33%) sites in WCA 3A

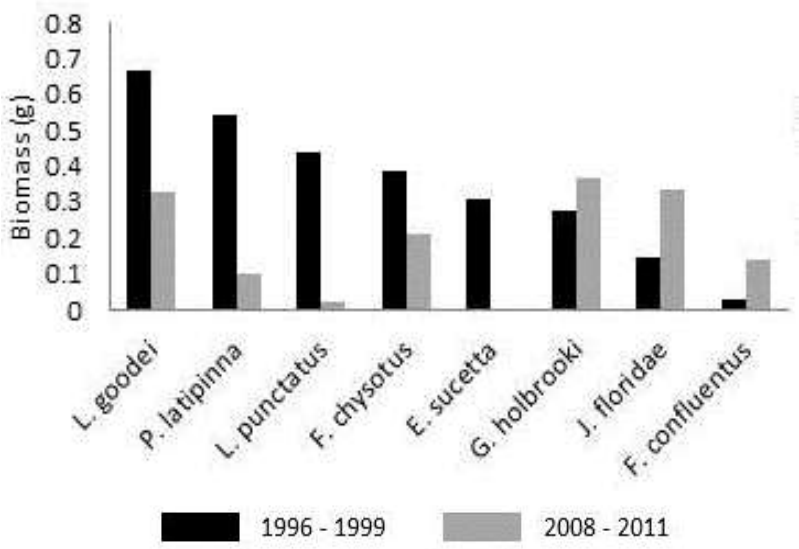
- Average regional decline:
  - -11.2% in TSL (r=-0.007)
  - -9.50% in SRS (r=-0.006)
  - -3.77% in WCA 3A (r=-0.002)



Long-Term Trends in Community Composition

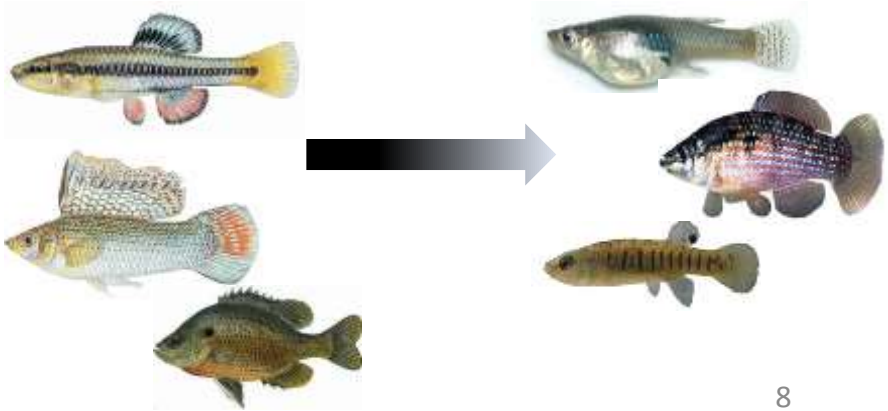
Shark River Slough & Taylor Slough





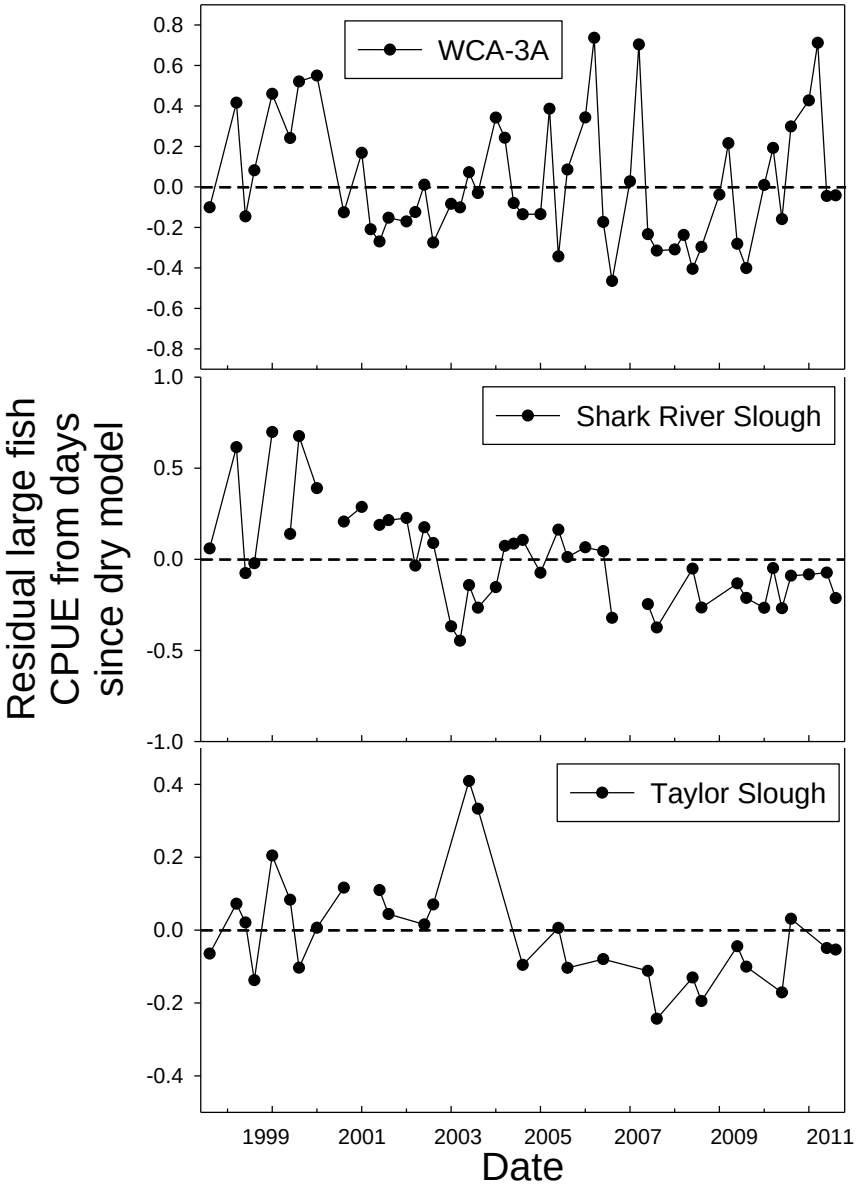
Significant directional change at:

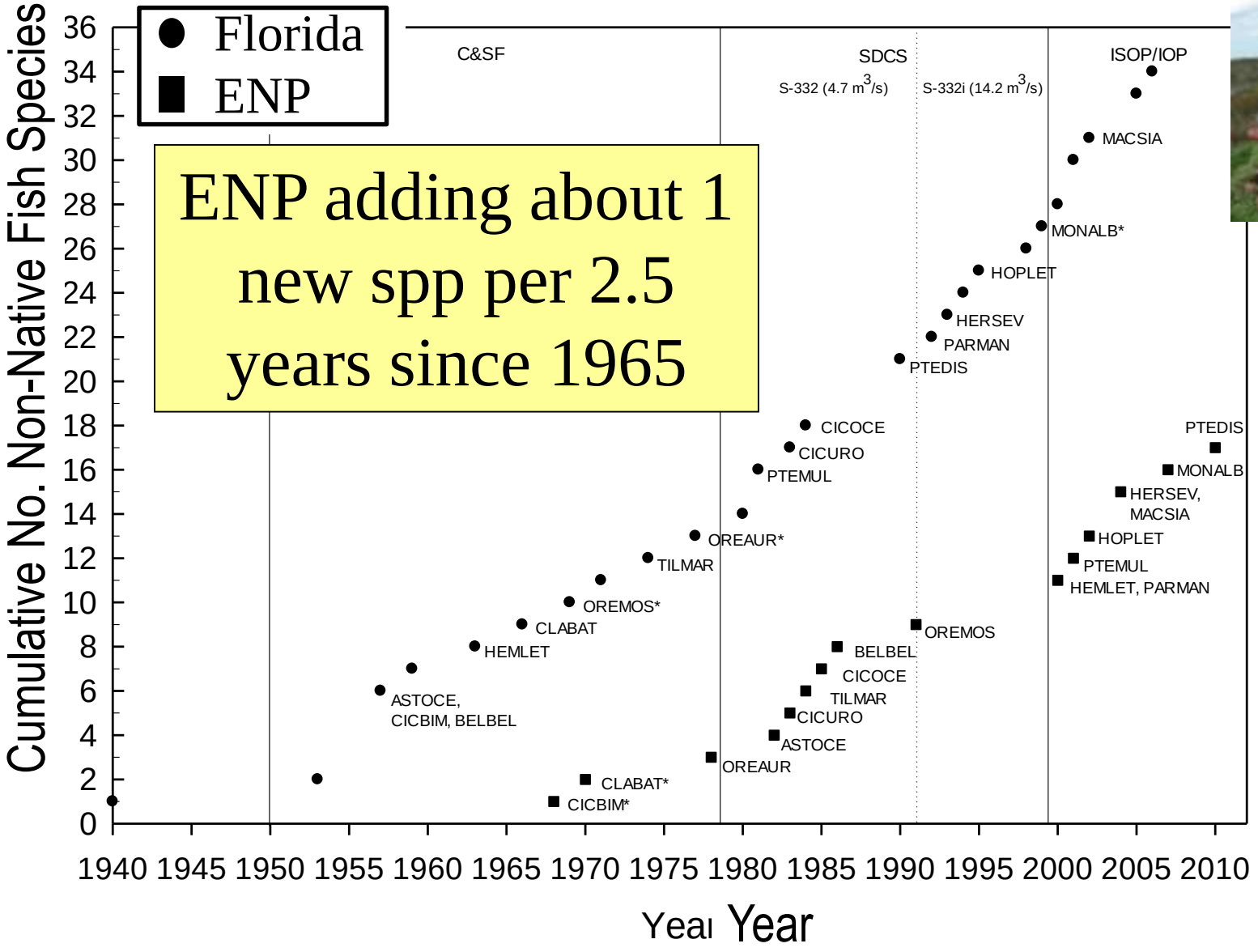
- 3 (50%) sites in SRS
- 2 (67%) sites in TSL
- 3 (50%) sites in WCA



Large fish collected by marsh electrofishing

- All species summed. Mostly Florida gar, warmouth, largemouth bass, lake chubsuckers
- Residuals from grand mean (highest CPU in WCA, lowest in TS)

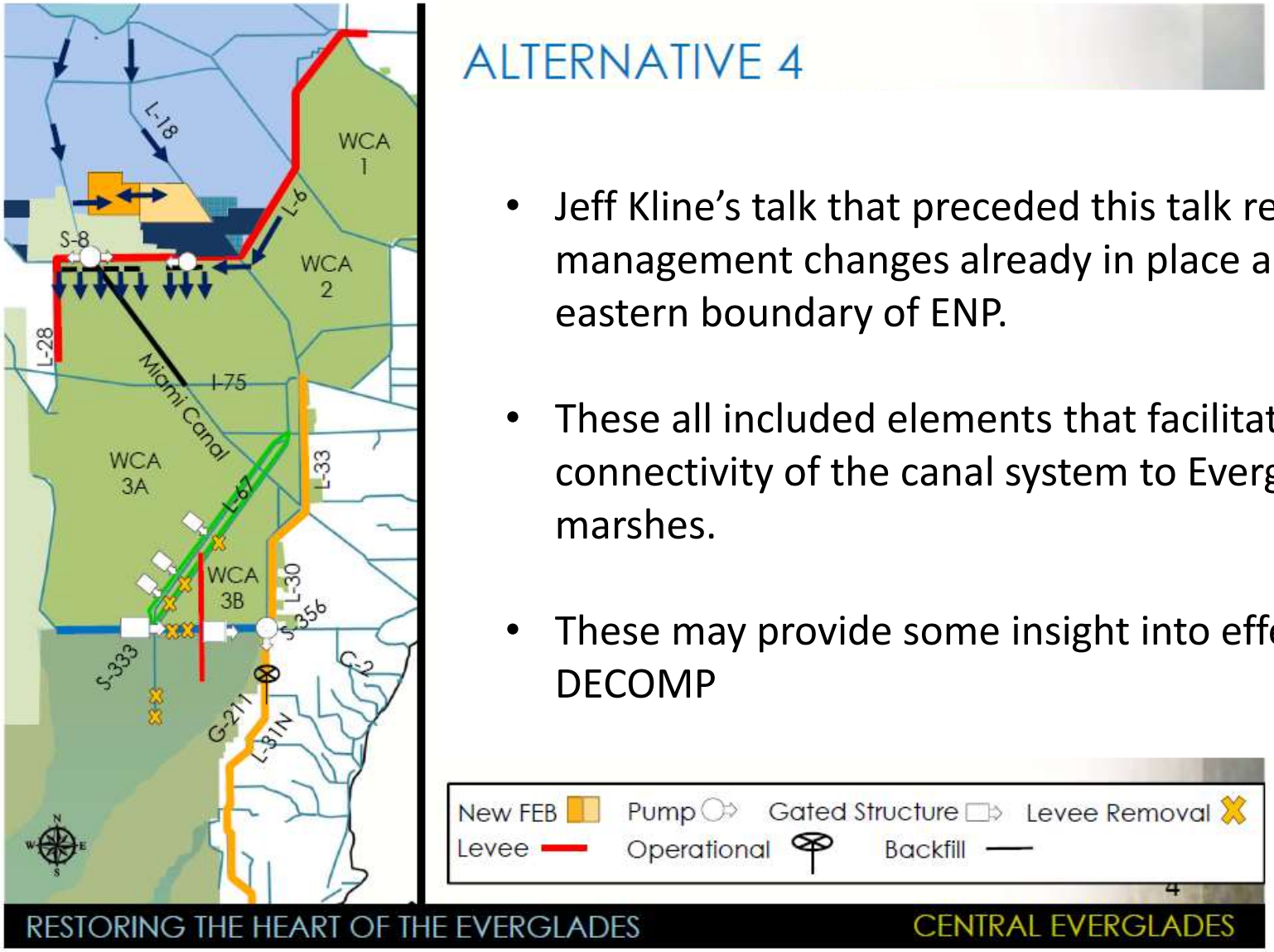



Florida
ENP
C&SF
SDCS
S-332 (4.7 m3/s)
S-332i (14.2 m3/s)
ISOP/IOP
ENP adding about 1 new spp per 2.5 years since 1965
Cumulative No. Non-Native Fish Species
Year
1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
MACSIA
MONALB*
HOPLET
HERSEV
PARMAN
PTEDIS
CICOCE
CICURO
PTEMUL
OREAUR*
TILMAR
OREMOS*
CLABAT
HEMLET
ASTOCE, CICBIM, BELBEL
CLABAT*
CICBIM*
OREAUR
ASTOCE
CICURO
TILMAR
CICOCE
BELBEL
OREMOS
PTEDIS
MONALB
HERSEV, MACSIA
HOPLET
PTEMUL
HEMLET, PARMAN

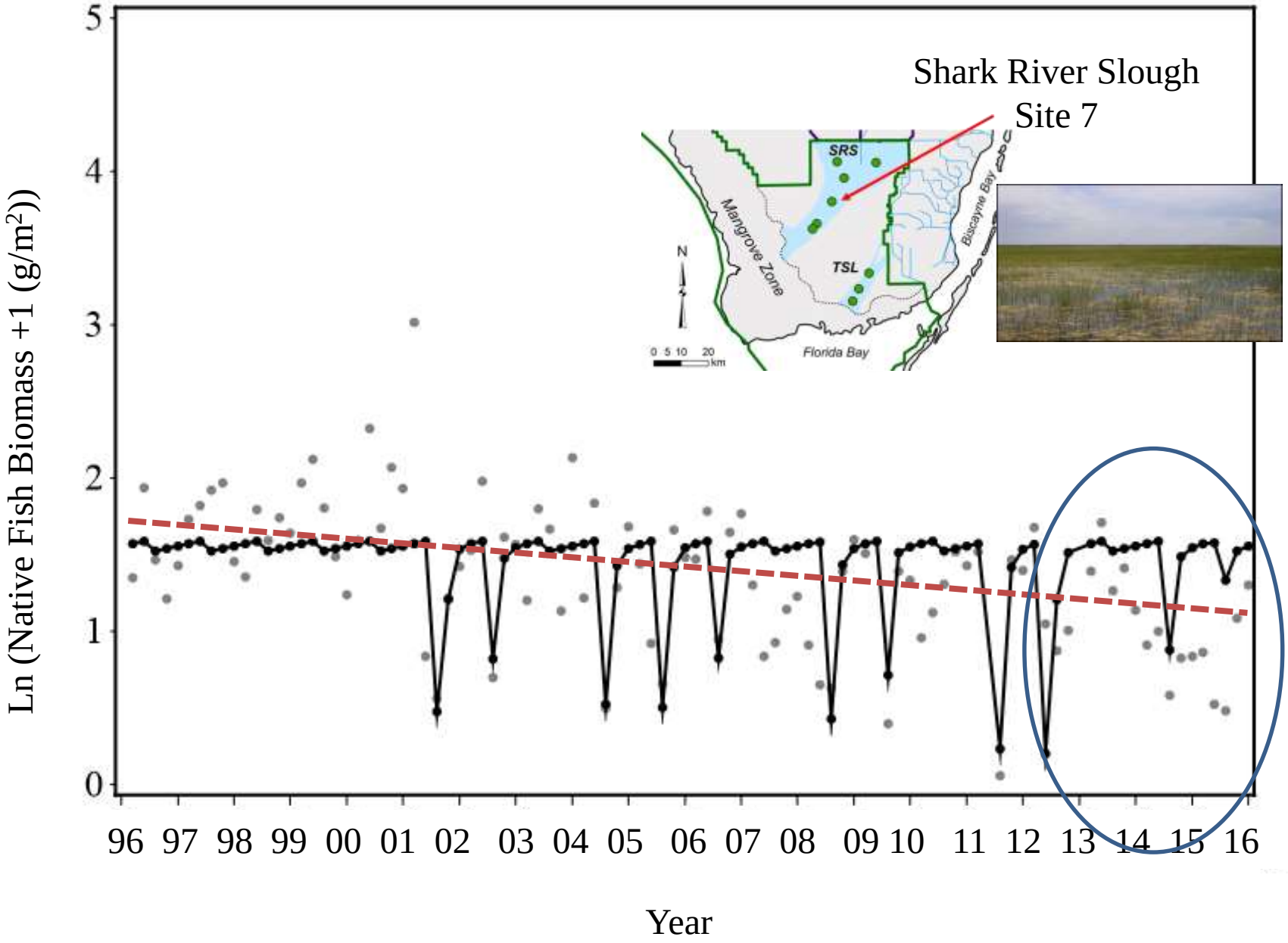
De-Compartmentalize
DECOMP

- Benefits
  - Re-creates sheetflow and physical processes of flow with potential to maintain landscape topographic features (ridge and slough)
  - Flow affects biogeochemical processes (nutrient loading and nutrient spiraling phenomena)
  - Permits movement of aquatic animals at landscape scale
- Concerns
  - Permits spread of non-native plants and animals

Central Everglades Planning Process and DECOMP

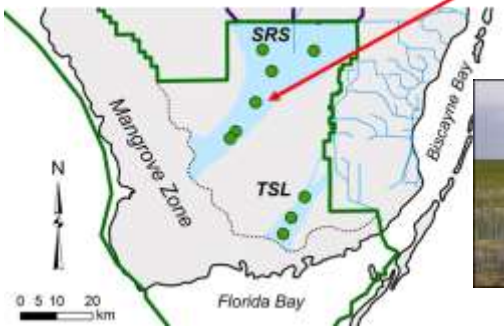


- Jeff Kline's talk that preceded this talk reviewed management changes already in place along the eastern boundary of ENP.
- These all included elements that facilitate connectivity of the canal system to Everglades marshes.
- These may provide some insight into effects of DECOMP

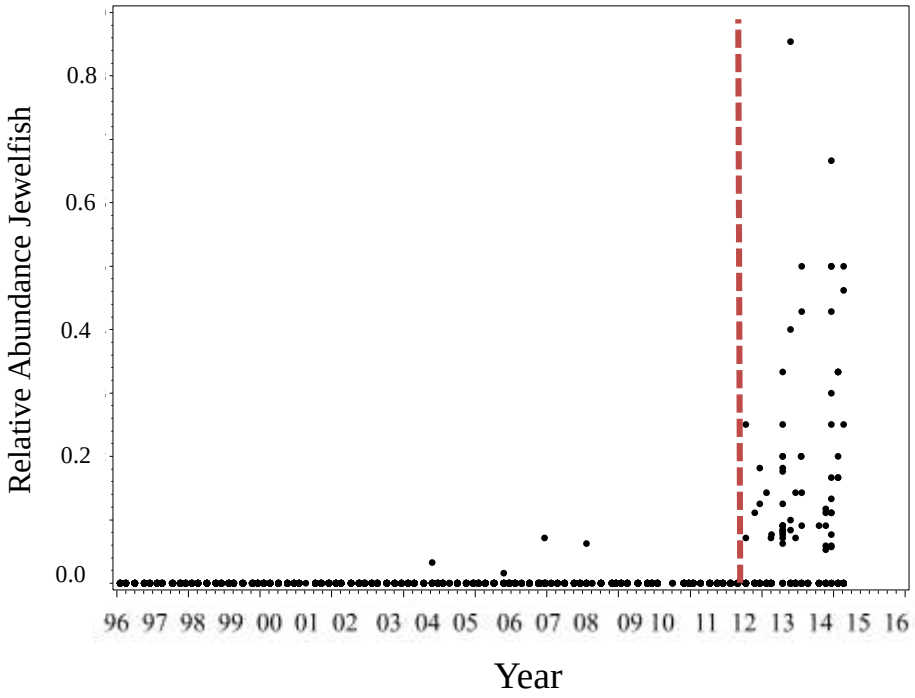

Shark River Slough
Site 7
SRS
TSL
Mangrove Zone
Biscayne Bay
Florida Bay
N
0 5 10 20
km
Ln (Native Fish Biomass +1 (g/m2))
0
1
2
3
4
5
96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16
Year

Jewelfish Invasion

Shark River Slough
Site 7



- Example site in Shark River Slough
- First appeared in 2004 at low density
- Serve cold event in 2010
- Reappeared in 2012



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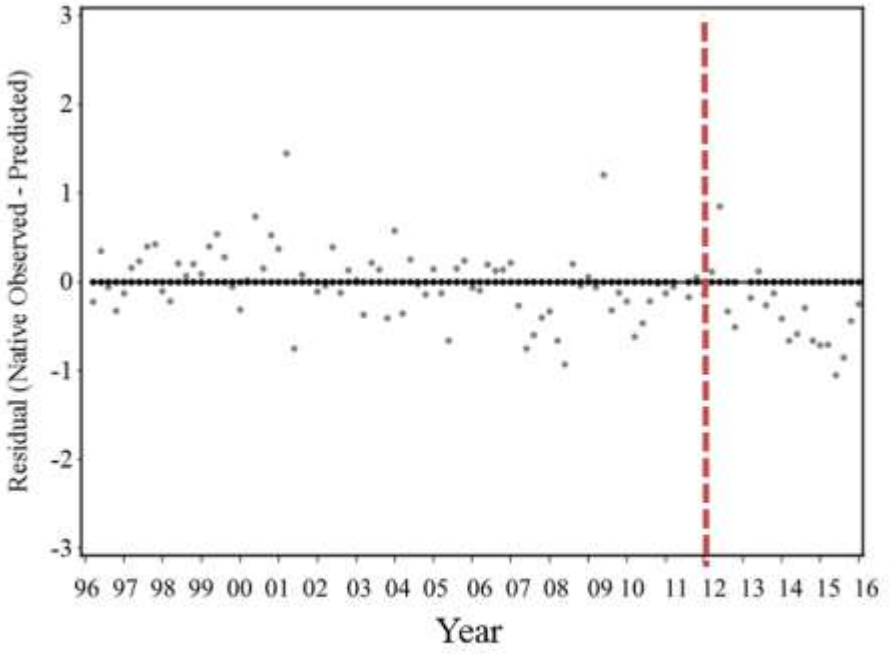

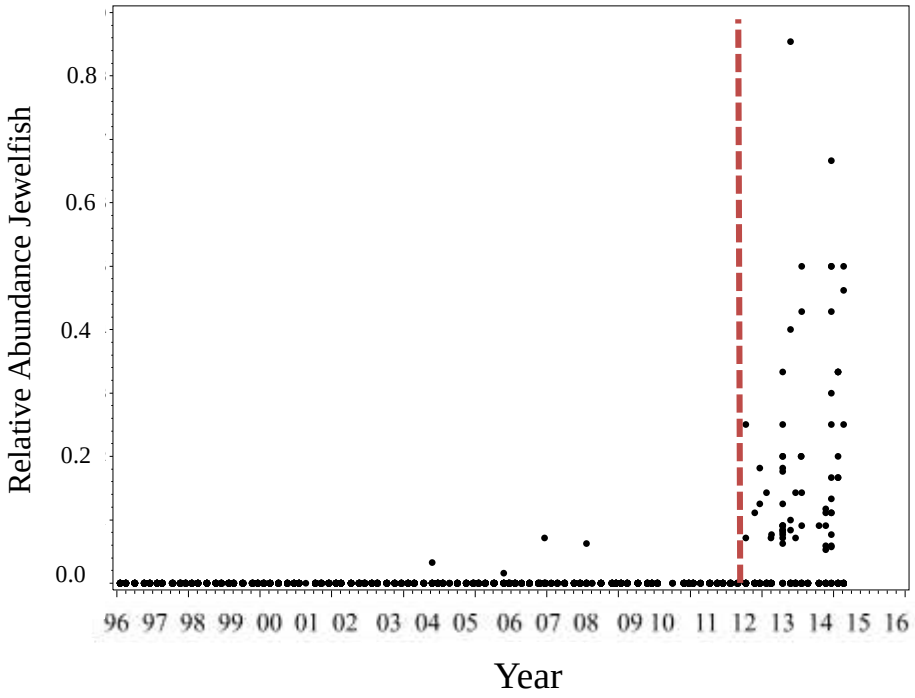

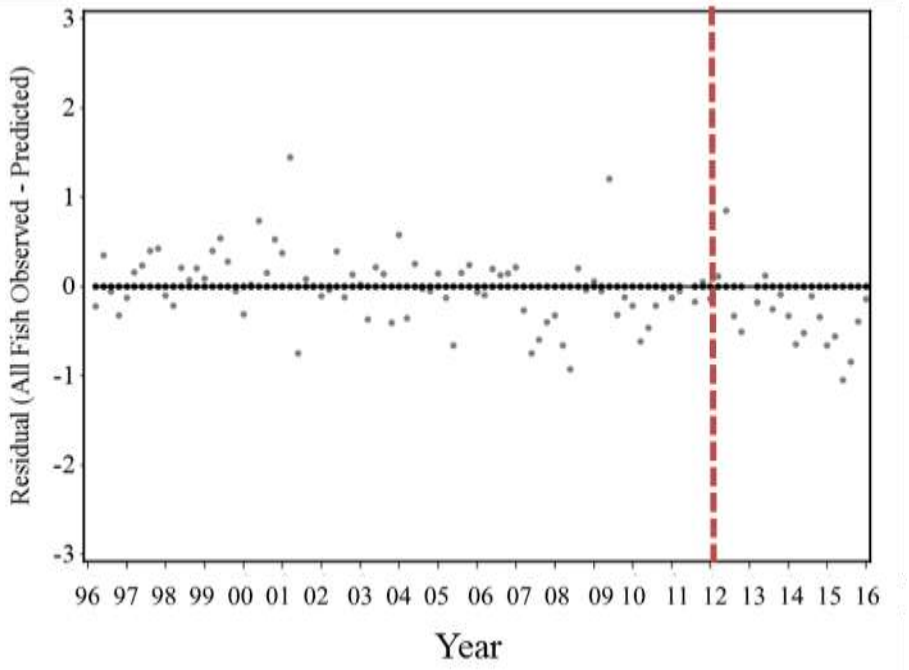

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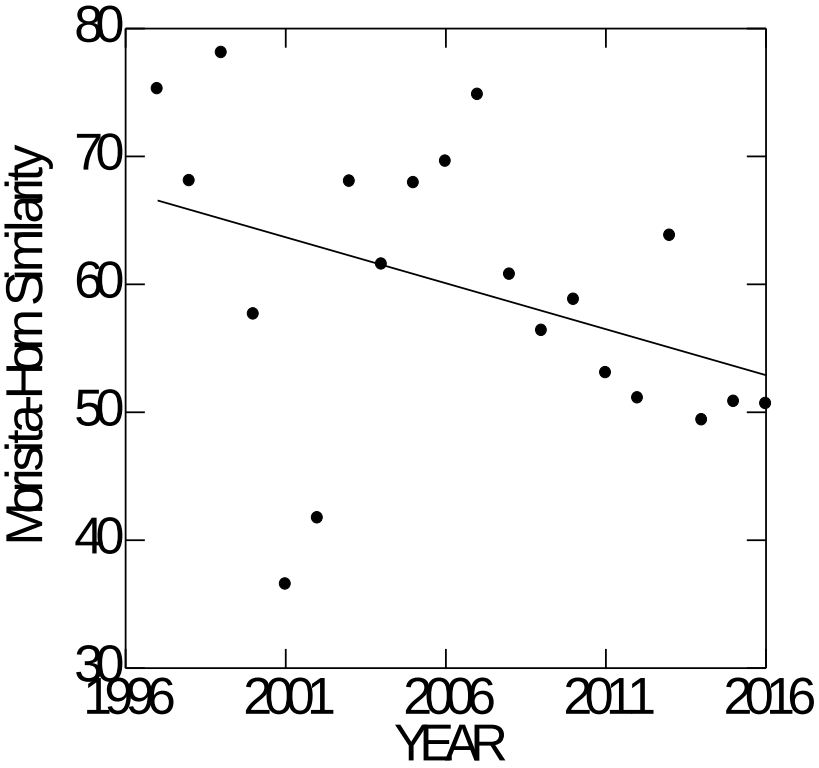
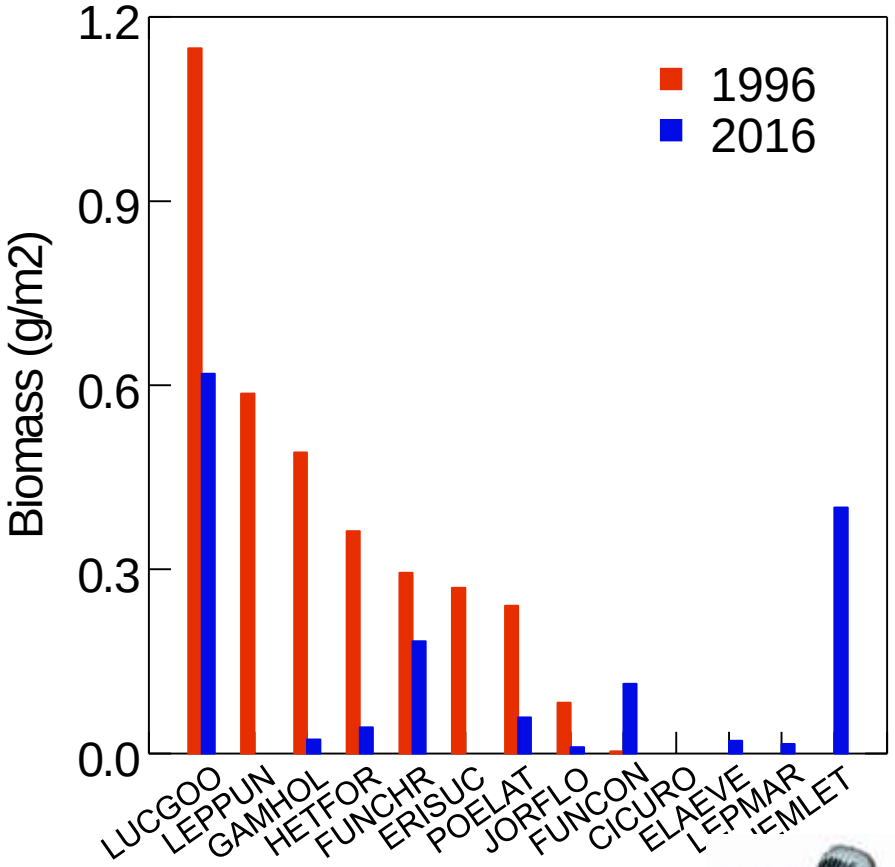
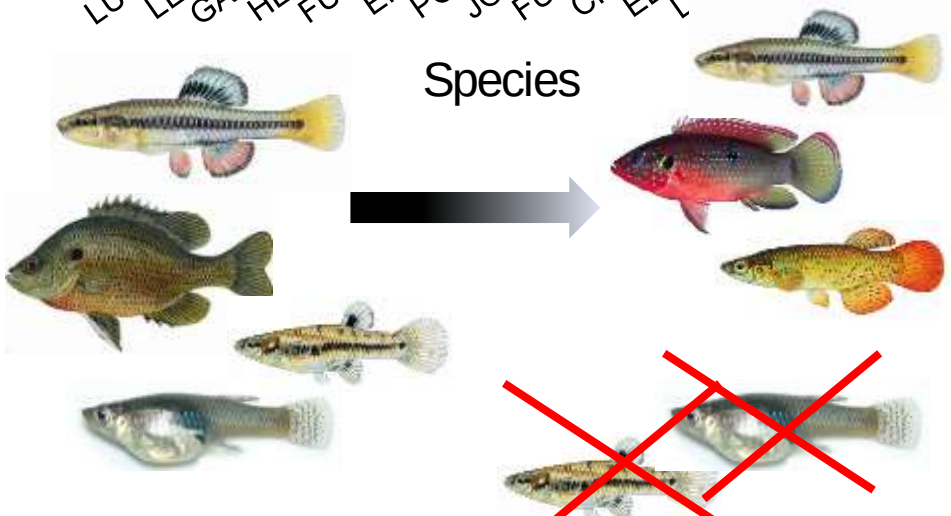
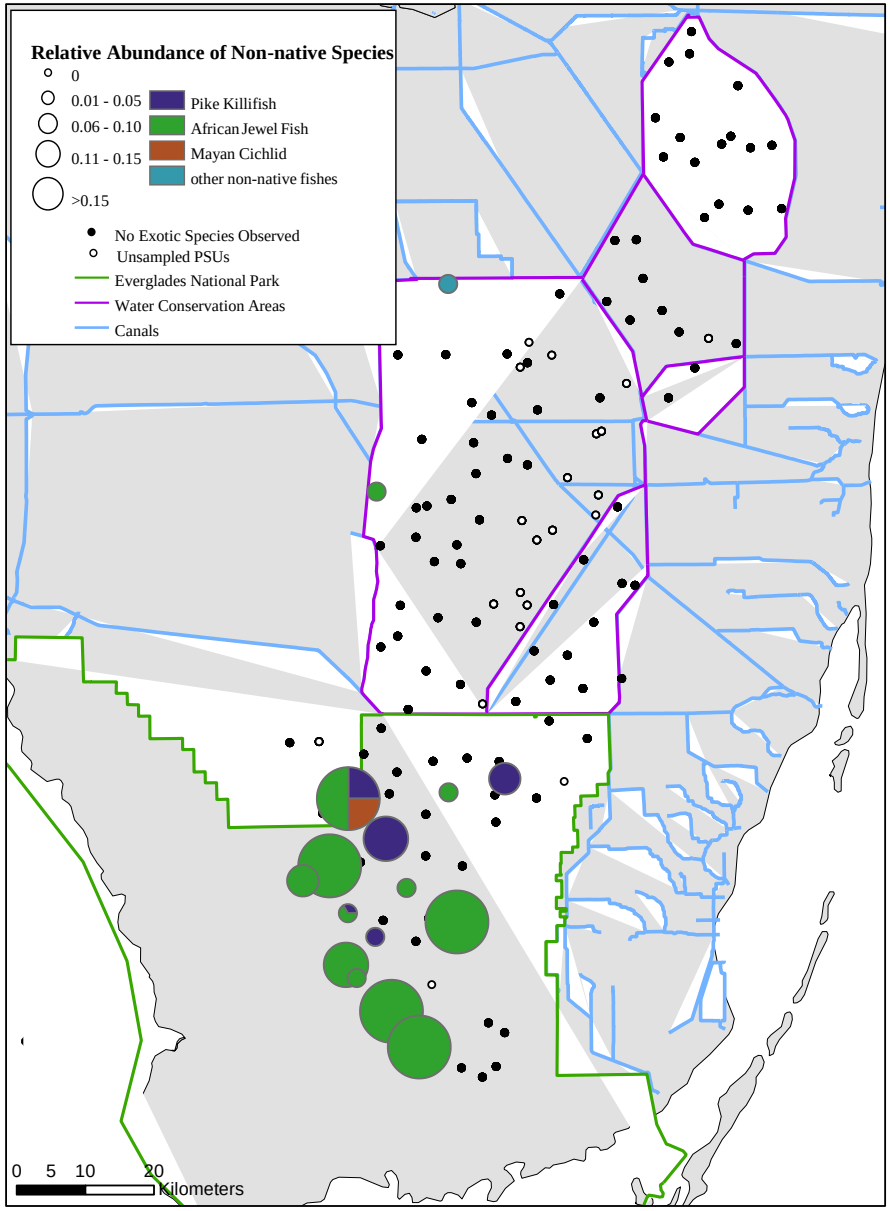


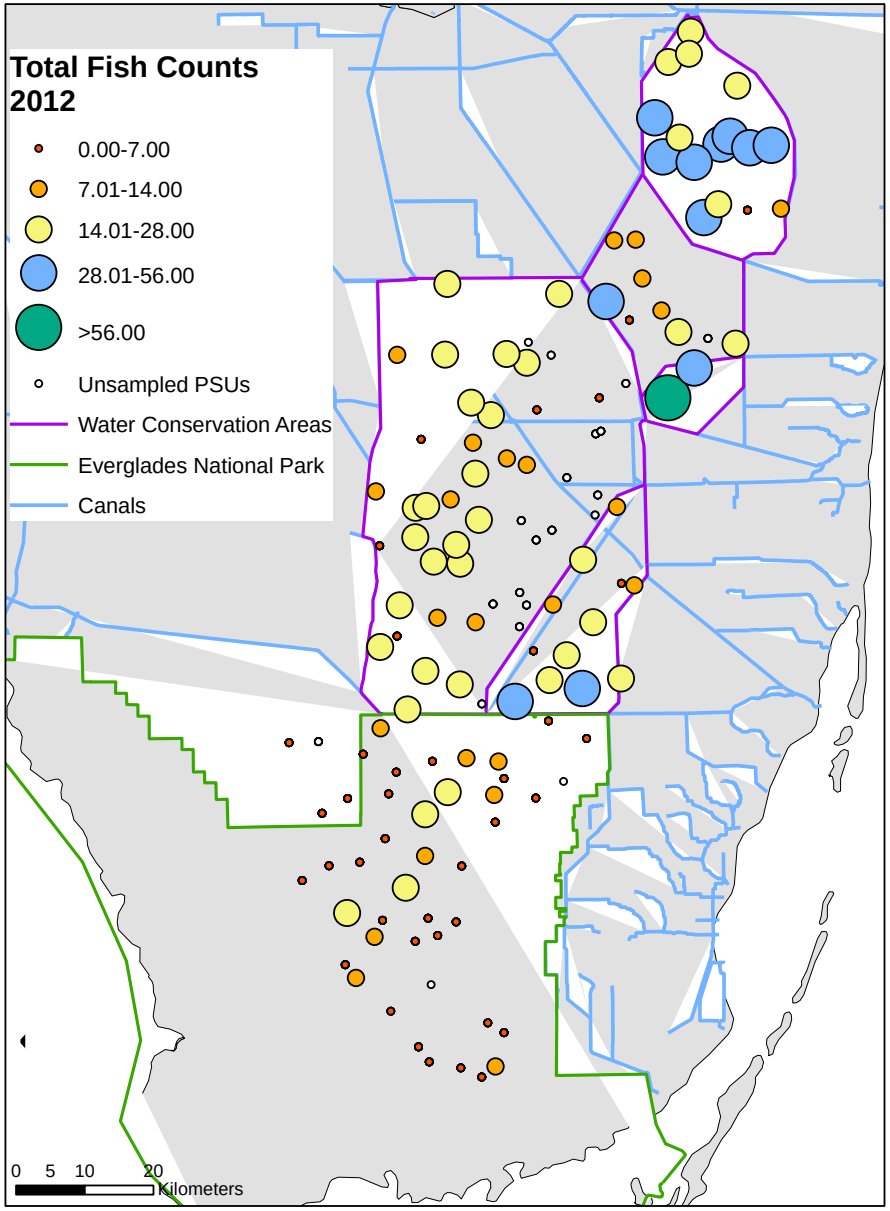




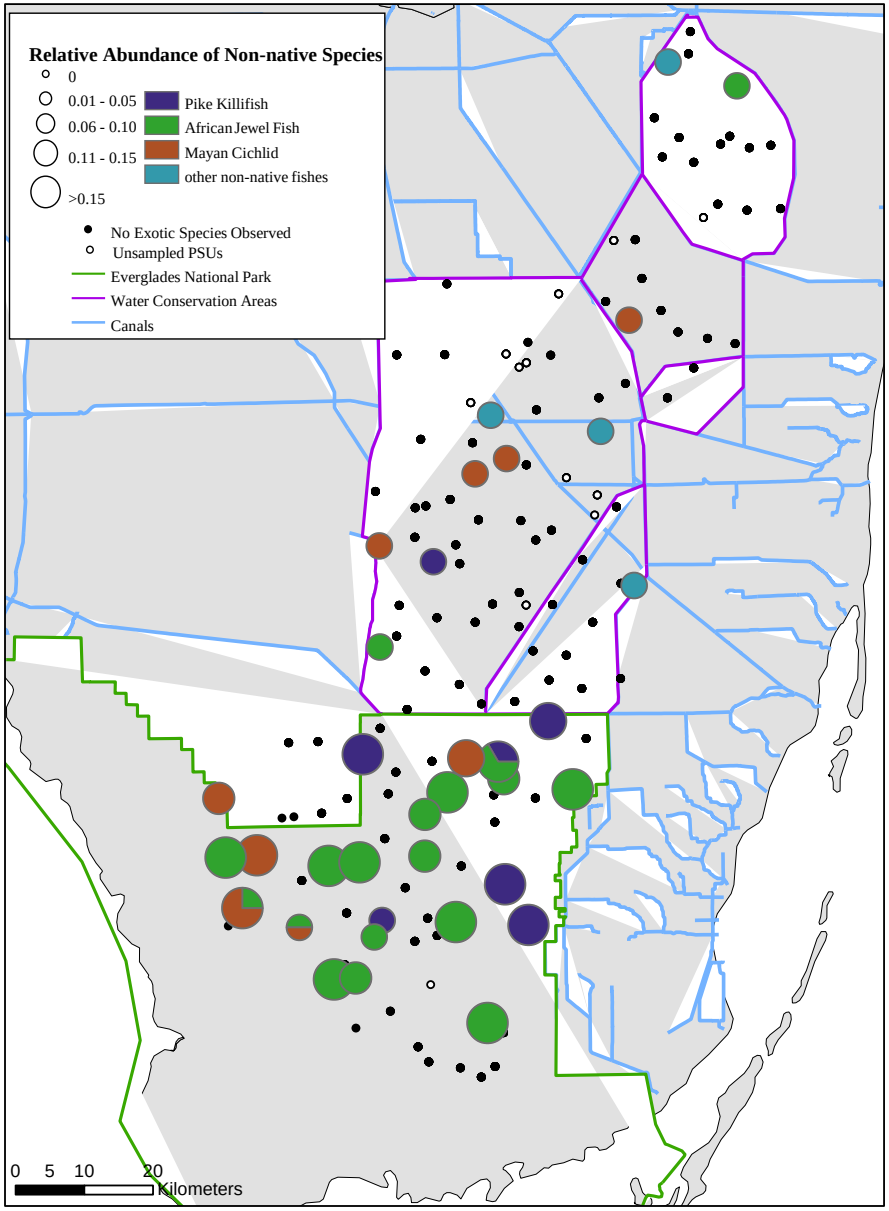
Non-native Fish Species CERP-MAP 2012



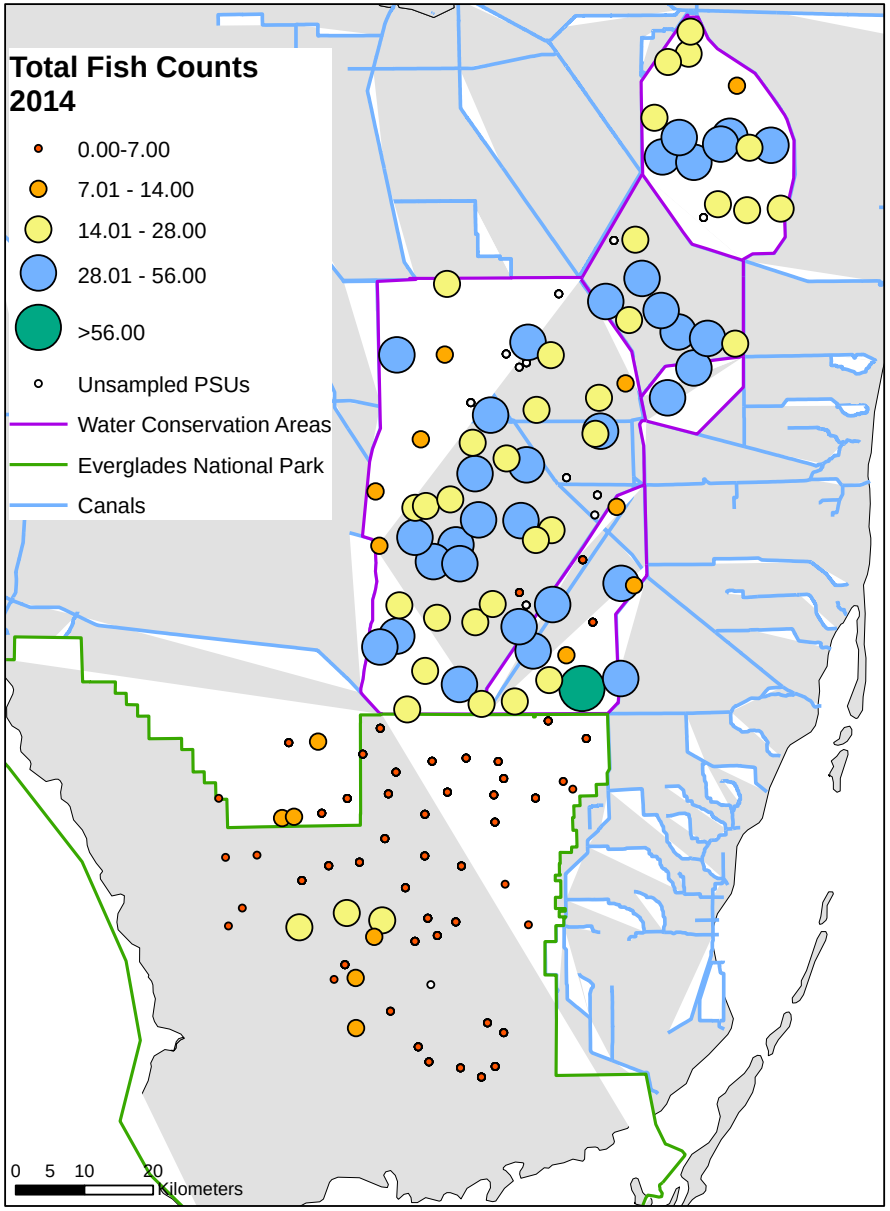
Total Fish Counts CERP-MAP 2012



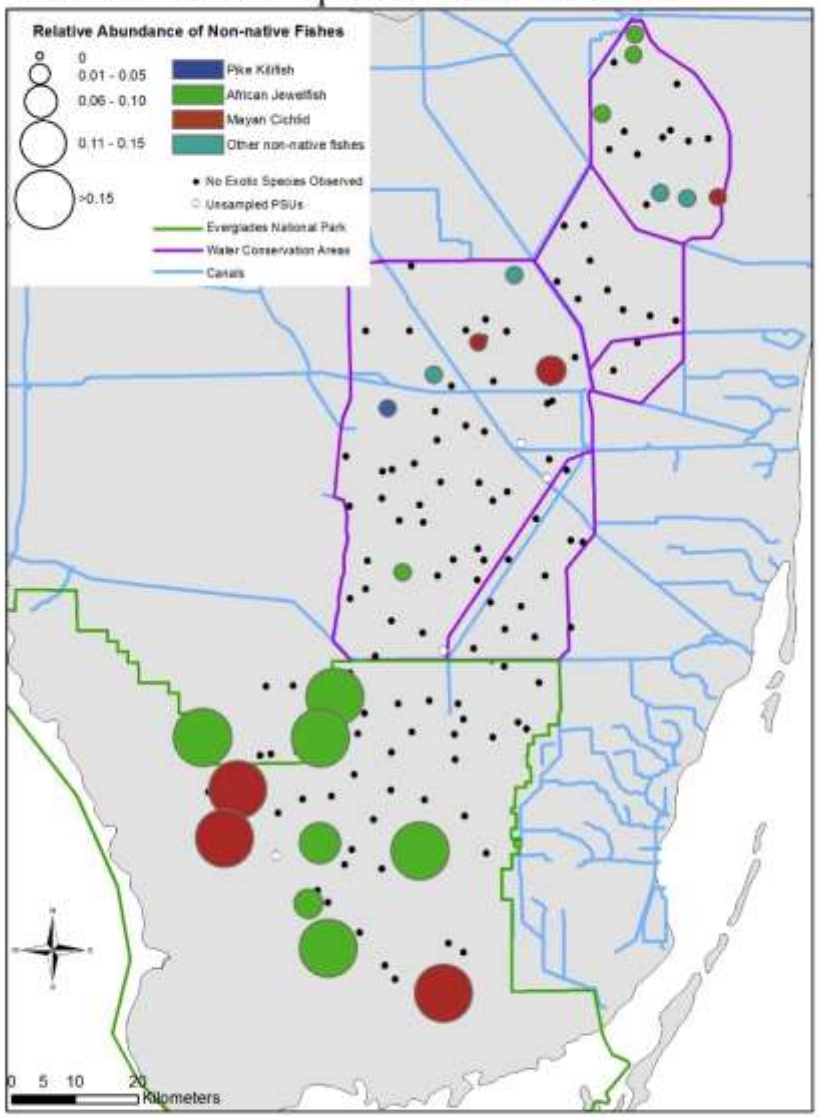
Non-native Fish Species CERP-MAP 2014



Total Fish Counts CERP-MAP 2014



Non-native Fish Species CERP-MAP 2015



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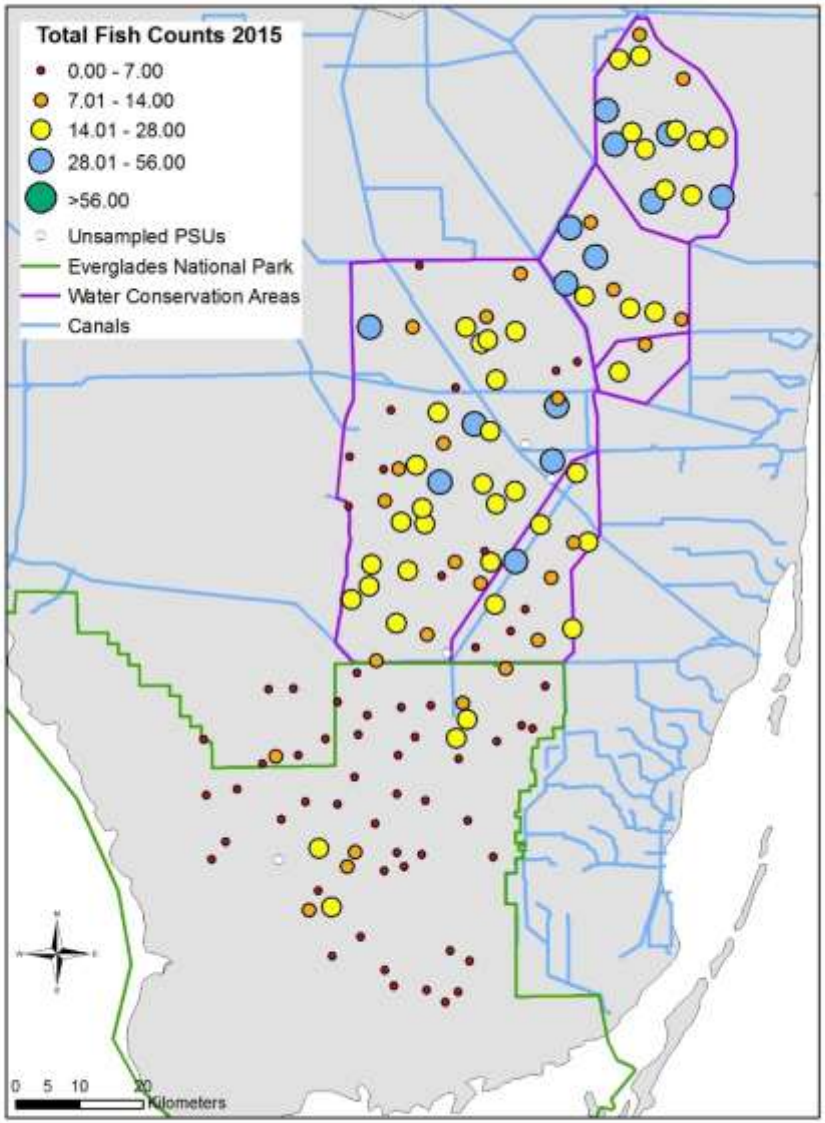
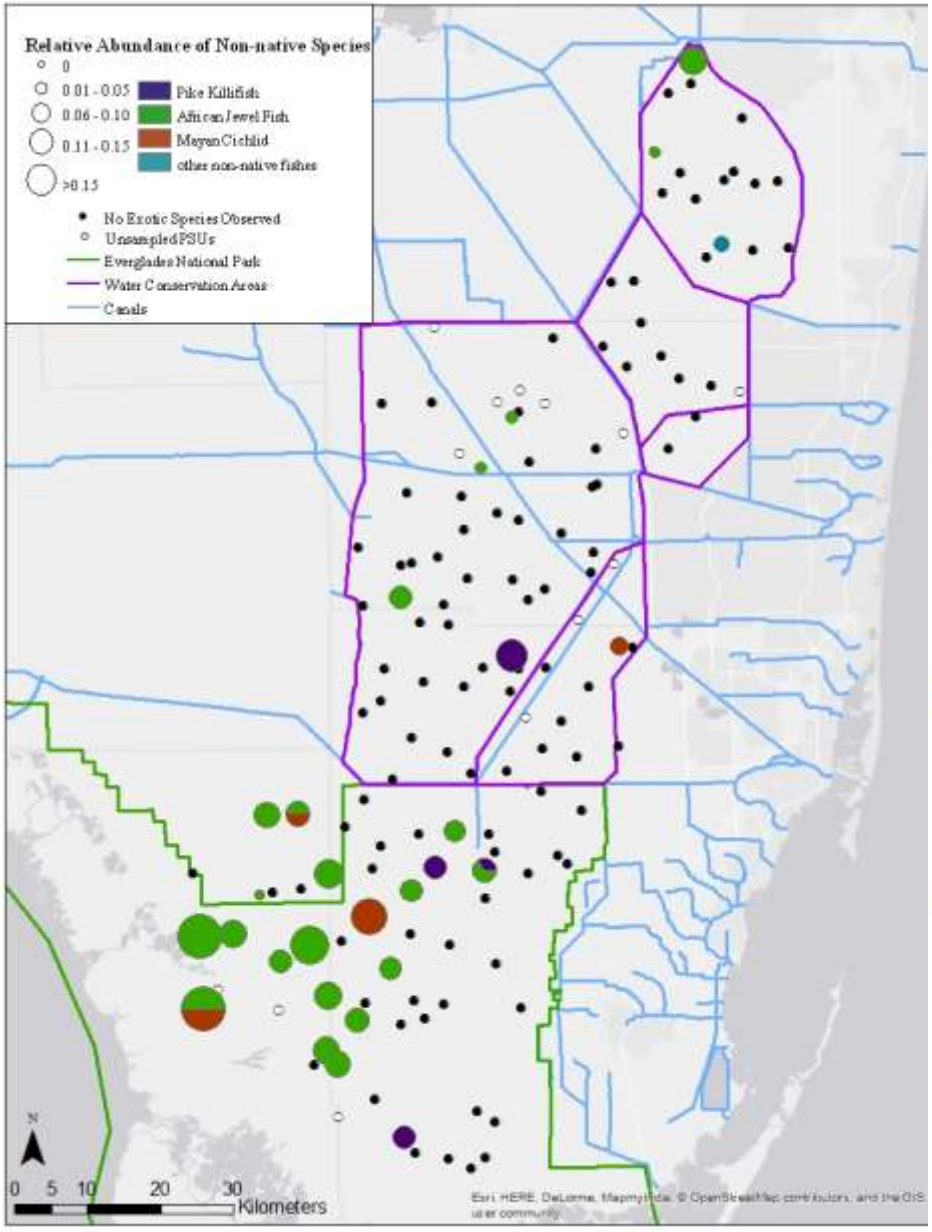
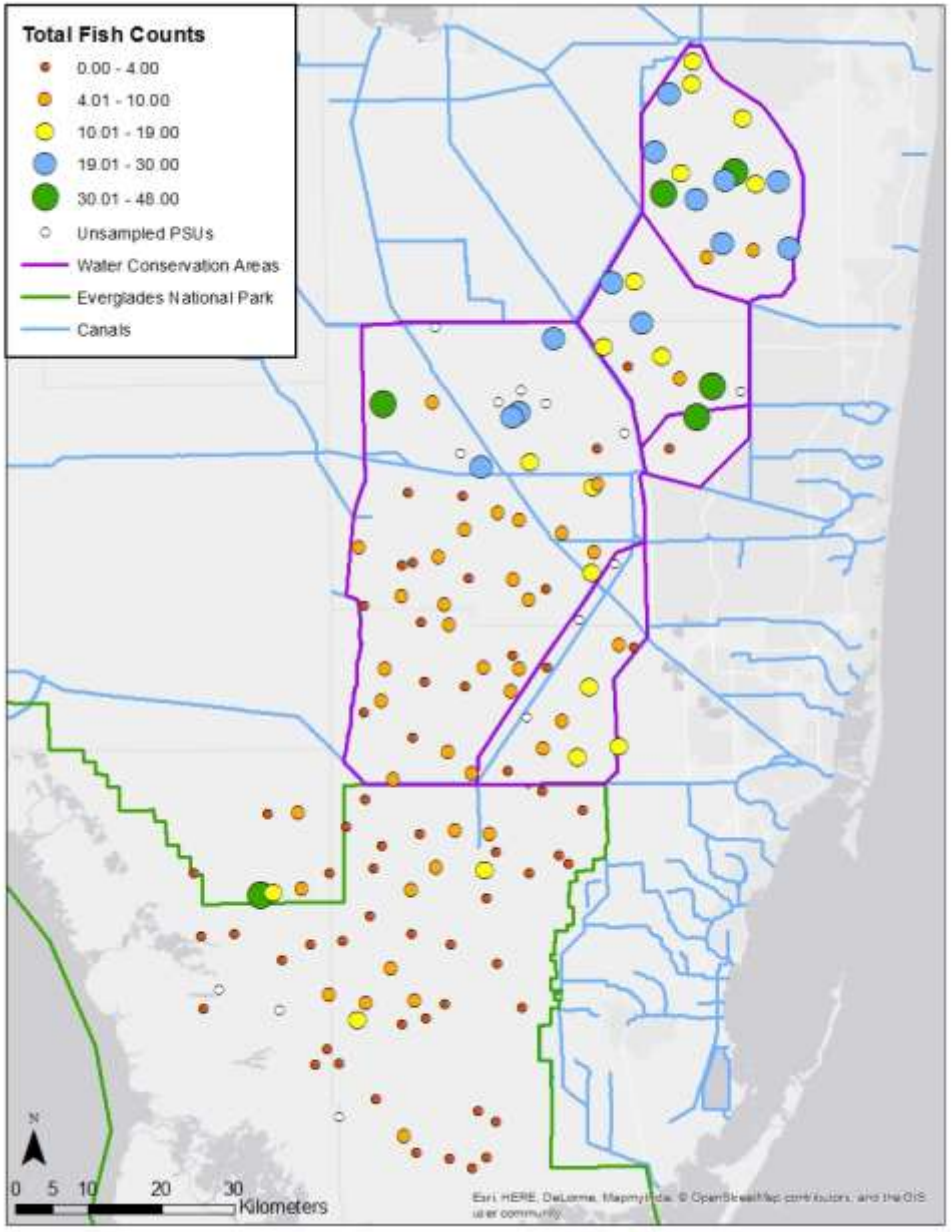


Non-native Fish Species CERP-MAP 2016

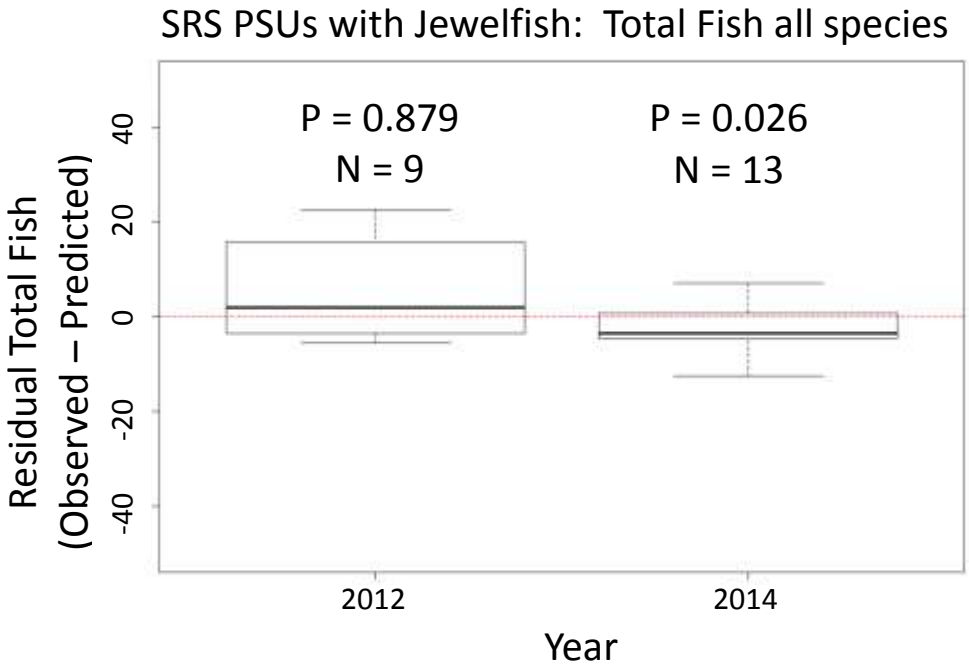


Total Fish Counts CERP-MAP 2016



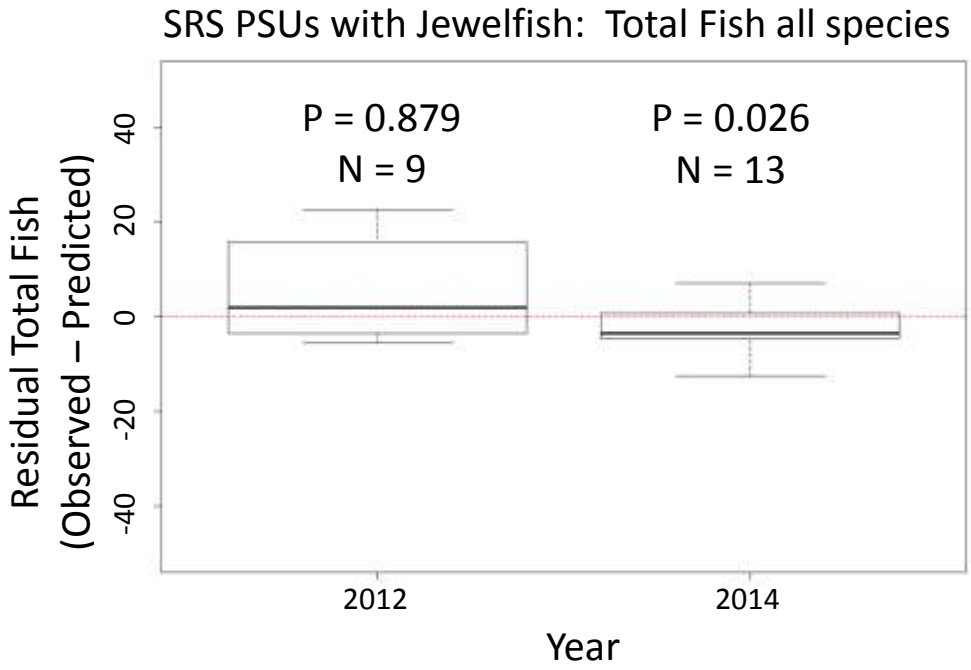
Jewelfish in Shark River Slough

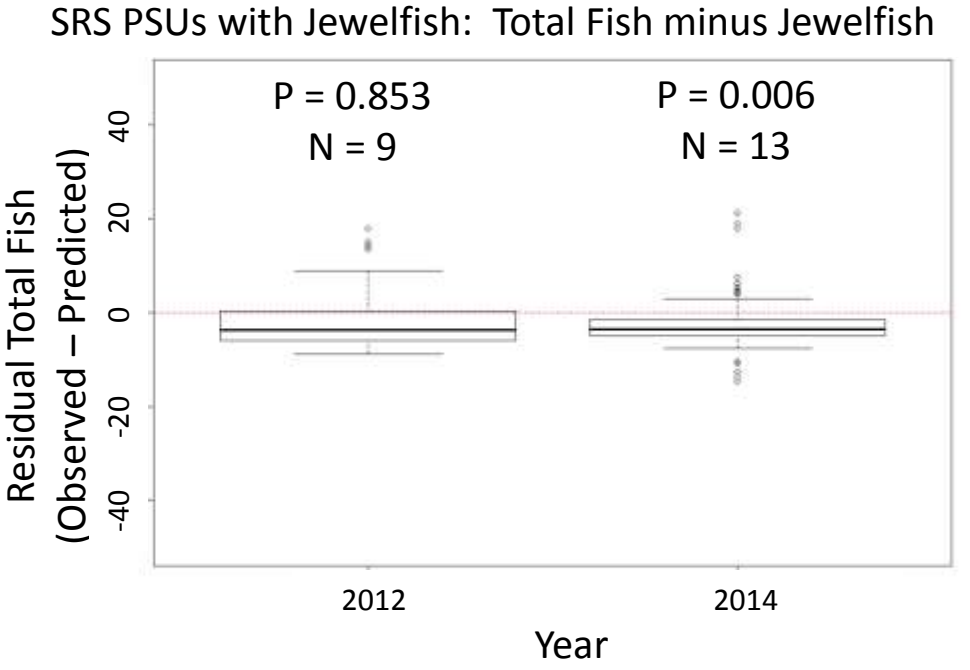
- Predicted fish density given Days Since Dry based on data from 1996-2010.
- Fish density (all species) not different from expected in 2012, but less in 2014.



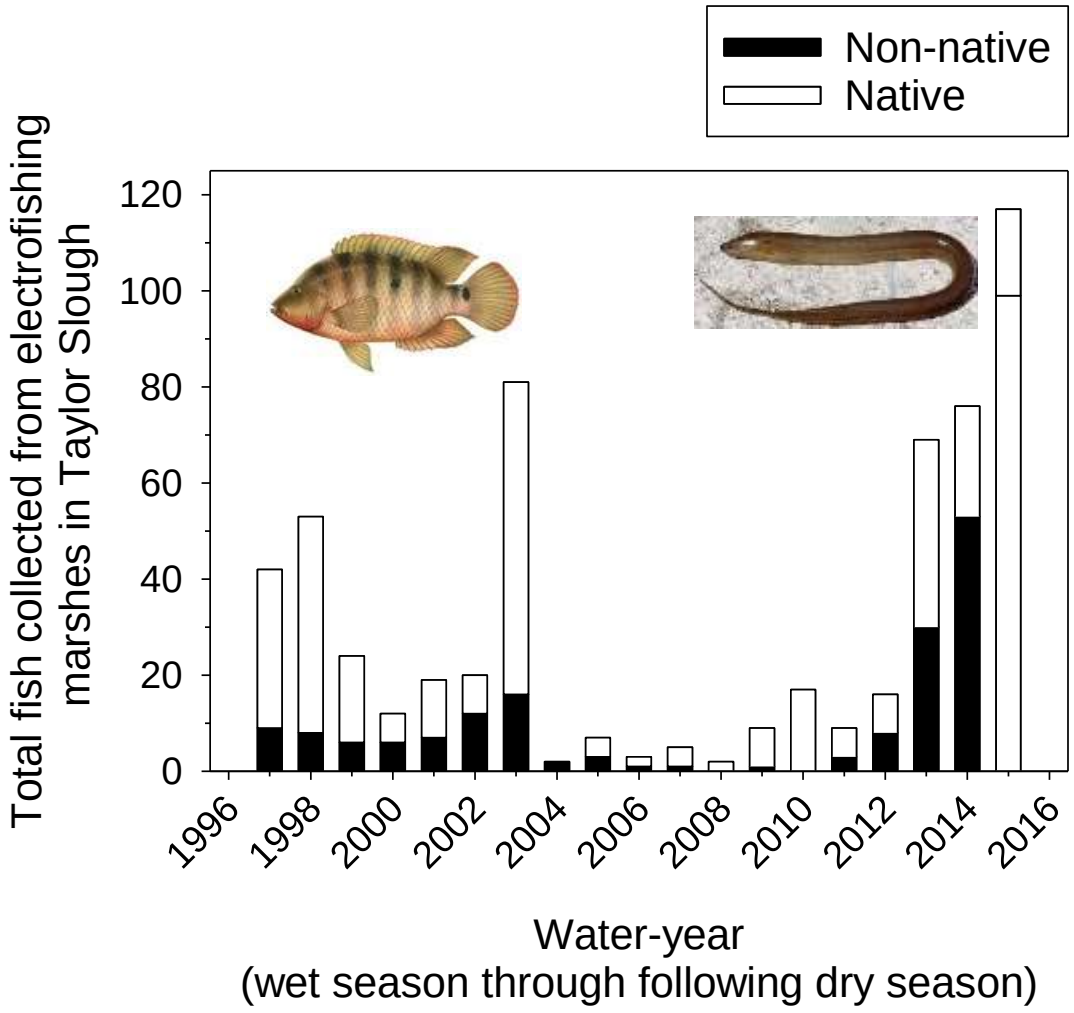
Jewelfish in Shark River Slough

- Predicted fish density given Days Since Dry based on data from 1996-2010.
- Fish density (all species) not different from expected in 2012, but less in 2014.
- Removing jewelfish has no effect in 2012, effect increased in 2014.
- Suggests jewelfish replaced native fish in Shark River Slough in 2014, but not completely; community with jewelfish may be less efficient.





Asian Swamp Eels in Taylor Slough



Conclusions

Long-term trends:

1. Biologically important reductions in fish and crayfish (not shown) biomass

2. Gradual, directional composition change
   - Greater increase in disturbance frequency -> Greater turnover rate
   - Resilient to hydrological disturbance within historical range

Conclusions

Small-scale DECOMP has demonstrated:

3. New invasive species impacting aquatic community productivity, particularly on top of ongoing hydrological drivers
   - African Jewelfish expansion form eastern ENP
   - New connectivity has facilitated invasion by Asian Swamp Eel at C-111

4. Trade-offs for restoration and DECOMP
   - Ecosystem function and structure changes

Acknowledgements

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FLORIDA COASTAL EVERGLADES
LONG TERM ECOLOGICAL RESEARCH