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

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Everglades Restoration

Pre-drainage Flows

Current Flows

Restored Flows

HISTORIC FLOW

CURRENT FLOW

RESTORED FLOW
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 m² 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)
ENP adding about 1 new spp per 2.5 years since 1965
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
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
Jewelfish Invasion

- 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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Non-native Fish Species CERP-MAP 2012

Relative Abundance of Non-native Species

- 0
- 0.01 - 0.05: Pike Killifish
- 0.06 - 0.10: African Jewel Fish
- 0.11 - 0.15: Mayan Cichlid
- >0.15: other non-native fishes

- No Exotic Species Observed
- Unsampled PSUs
- Everglades National Park
- Water Conservation Areas
- Canals

Total Fish Counts CERP-MAP 2012

Total Fish Counts 2012

- 0.00-7.00
- 7.01-14.00
- 14.01-28.00
- 28.01-56.00
- >56.00
- Unsampled PSUs
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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.
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- 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

Total fish collected from electrofishing marshes in Taylor Slough

- Non-native
- Native

Water-year (wet season through following dry season)
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 from 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
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