

Aquatic Fauna as Indicators for Everglades Restoration: Applying Dynamic Targets in Assessments for CERP-MAP

Joel Trexler and Charles Goss

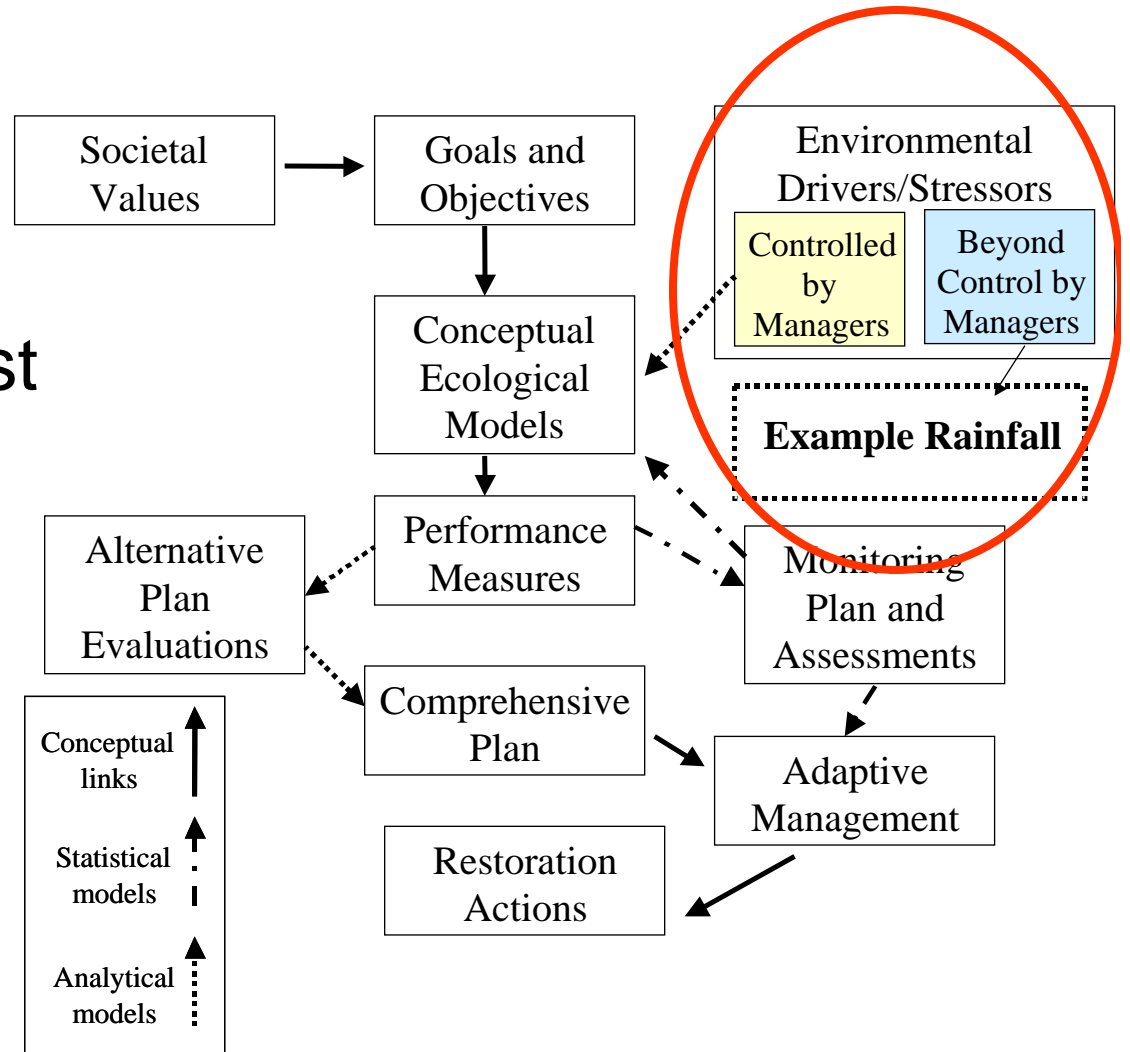
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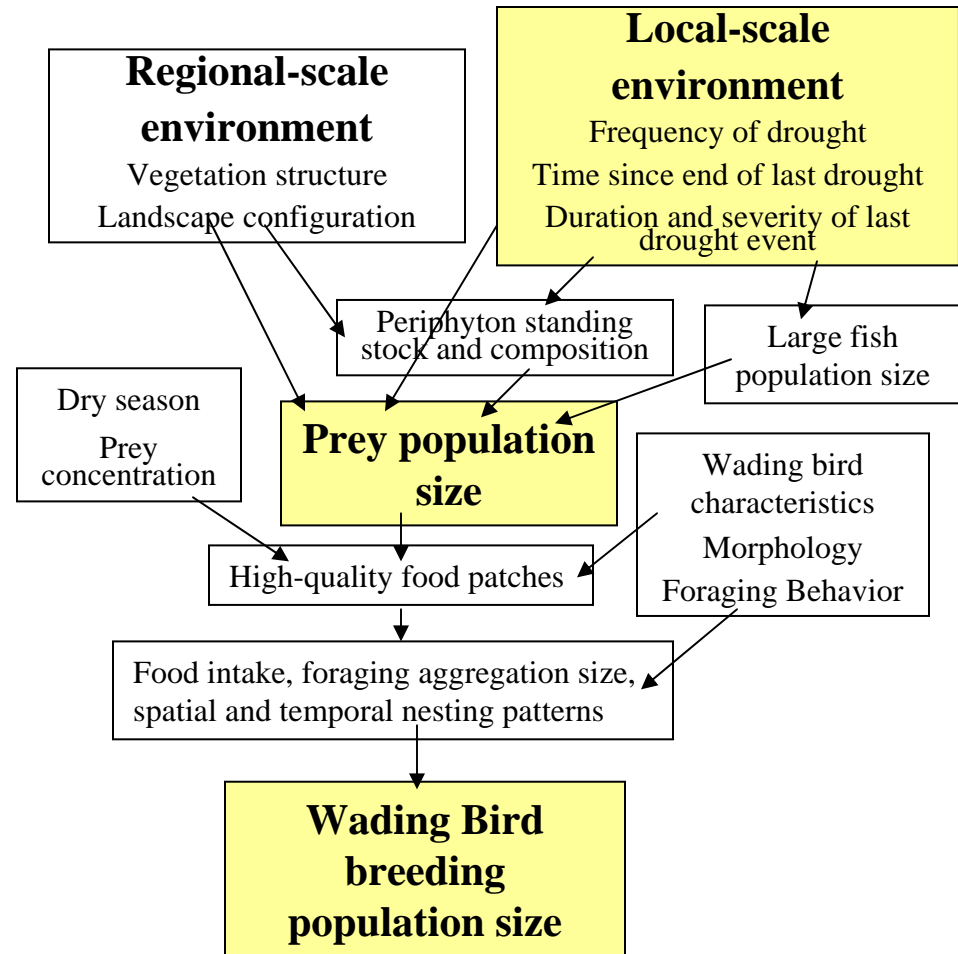
Everglades Restoration Science Strategy and Dynamic Targets

- Assessment requires a target
- Targets need to adjust for factors affecting performance measures but out of the control of managers
 - Example: Inter-annual variation in rainfall



Monitoring Aquatic Fauna

- Aquatic fauna are monitored because of their role linking environmental drivers controlled by management and wading birds
- Annual or semi-annual life cycles yield real-time responses to management



Data for Assessment

Six Performance Measures

- Four species selected as Performance Measures to represent different life histories related to effects of marsh drying
- Total fish as a measure of fish availability for higher trophic levels
- Frequency of non-native fish species



Hydrological PMs

- Recover slowly (years), effected by local drying - bluefin killifish
- Recover quickly (months), decline as site remains flooded – flagfish
- Recover quickly (months), effected by local and regional drying – eastern mosquitofish
- Not effected by short drying events, average depth past 6 months, regional drying – Everglades crayfish



(c) 1998 Keith A. Crandall

Assessing Impacts of Hydrological Management

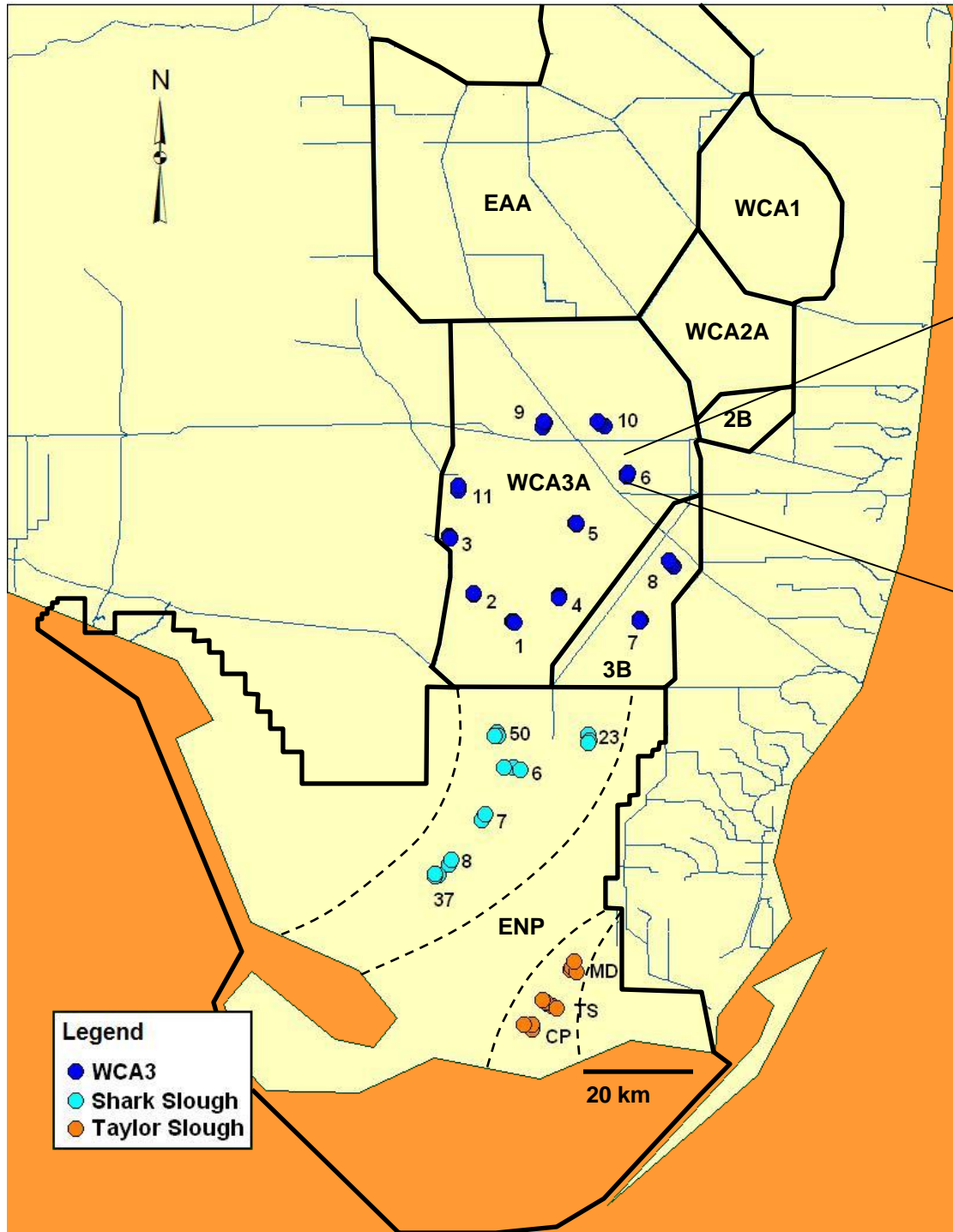
models to predict fish density

- Identify goals for hydrological management
 - Baseline period: Jan 1993 – Nov 1999
- Assessment period: Dec 1999 – 2006
- Can we detect an effect of hydrological operations on biological indicators beyond rainfall-driven hydrological variation?
 - > **Residual effects = (Old operating + rainfall) – (New operating + rainfall)**

Steps for Assessment

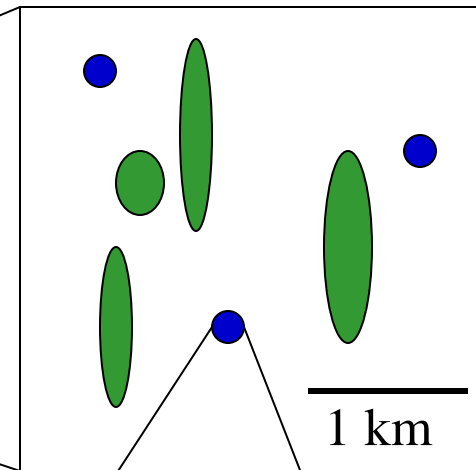
- Select Performance Measures and report temporal pattern 1995 – 2006
- Model water depth from rainfall during baseline period (1993 – 1999)
- Project water depths for assessment period (late 99 - 2006) under old operating rules
- Model PM from hydrology
- Project PM during assessment period from for projected hydrology
- Compare projected PM values to observed





Sampled by throw trap

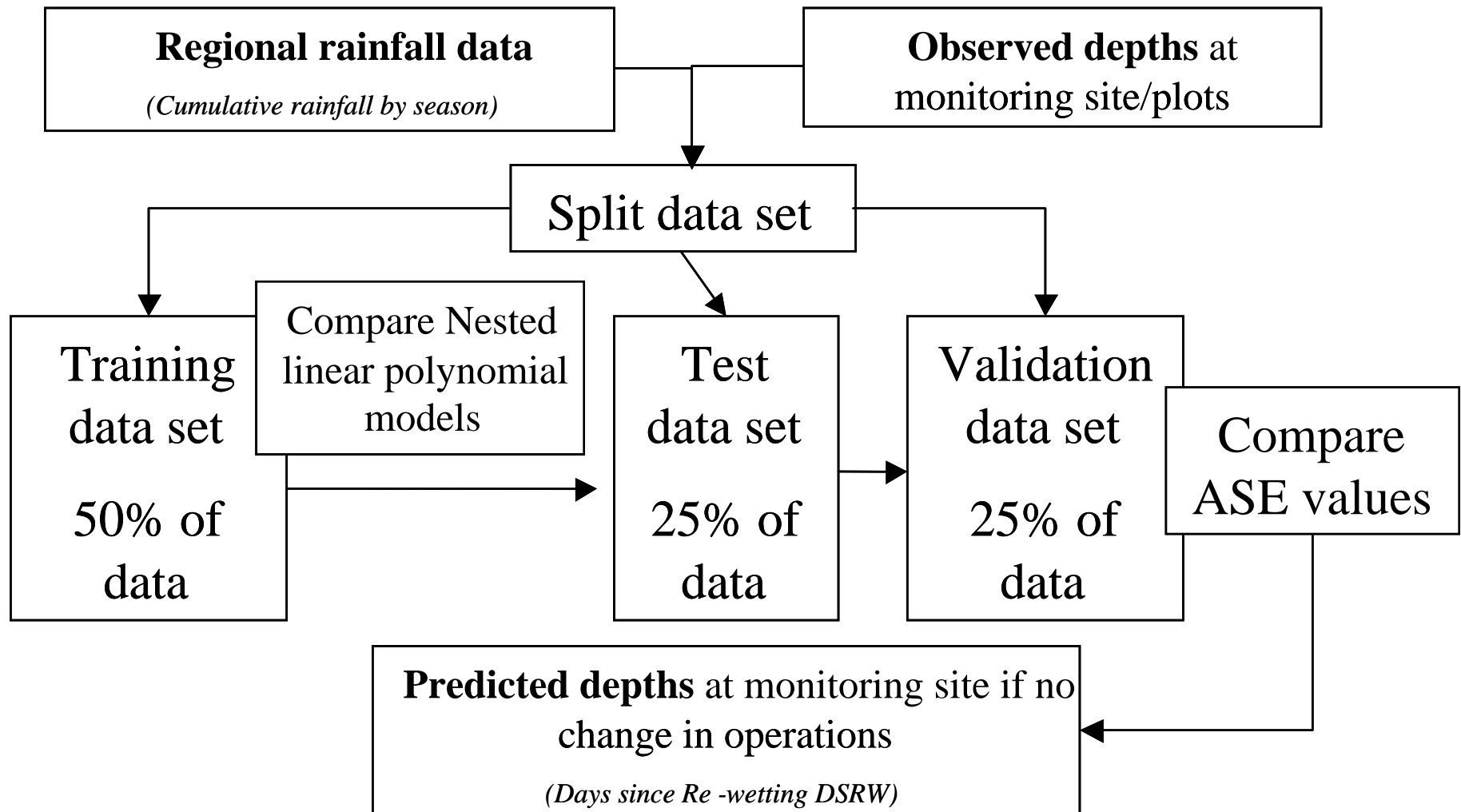
Plots A-C



Plots approx
100m x 100m

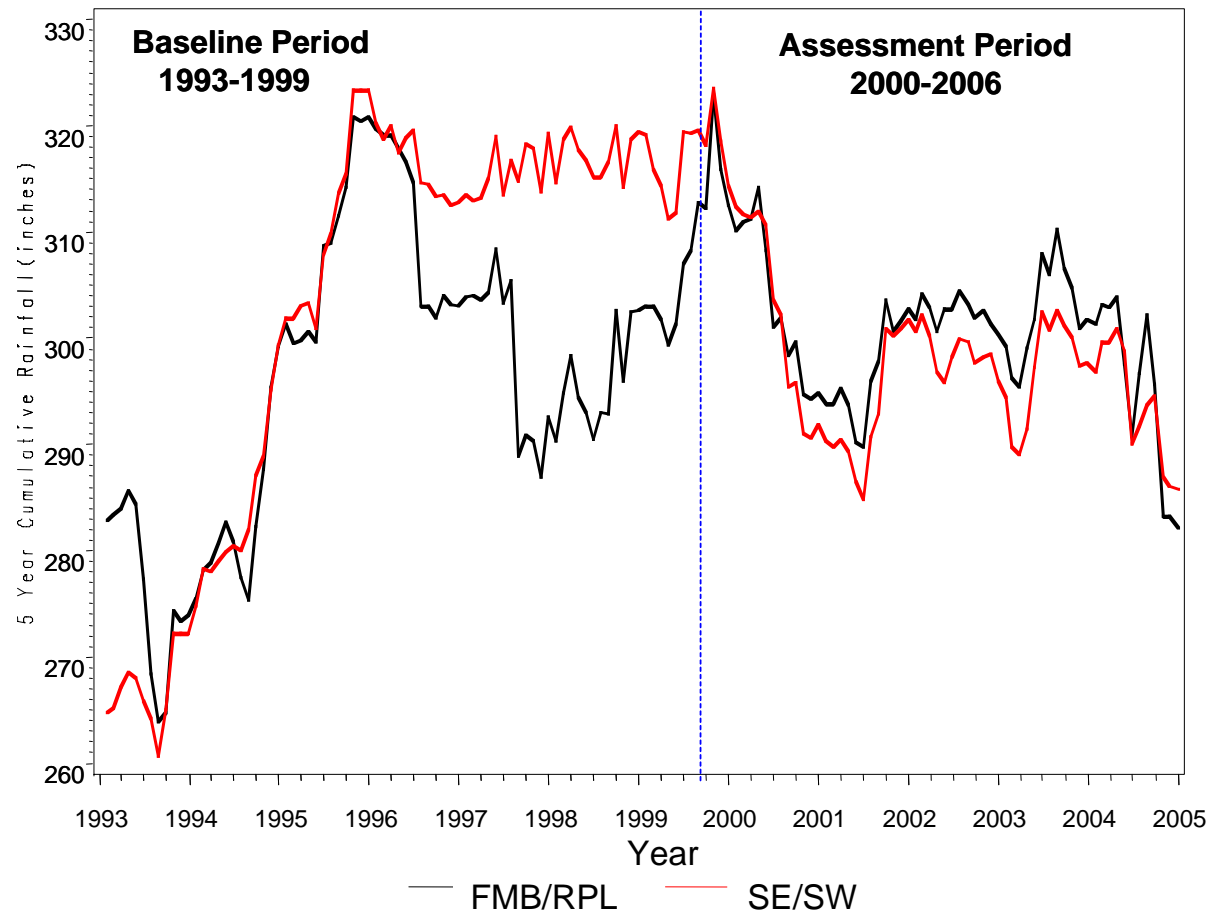
5-7 throws

Hydrological Forecasting Model



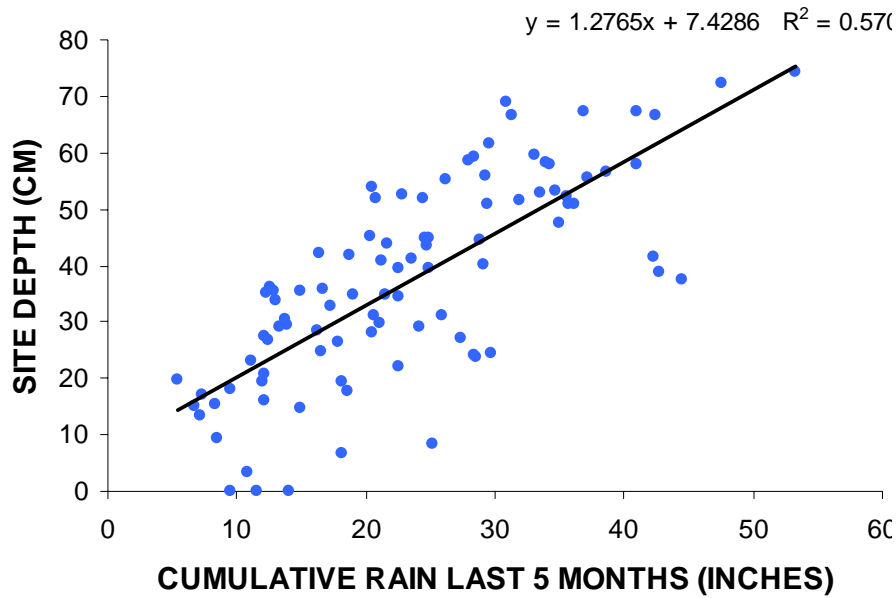
Data for Assessment

- Inter-annual variability in ‘baseline period’ needs to span range in assessment
- If not, predictions (targets) will be extrapolations beyond observed conditions

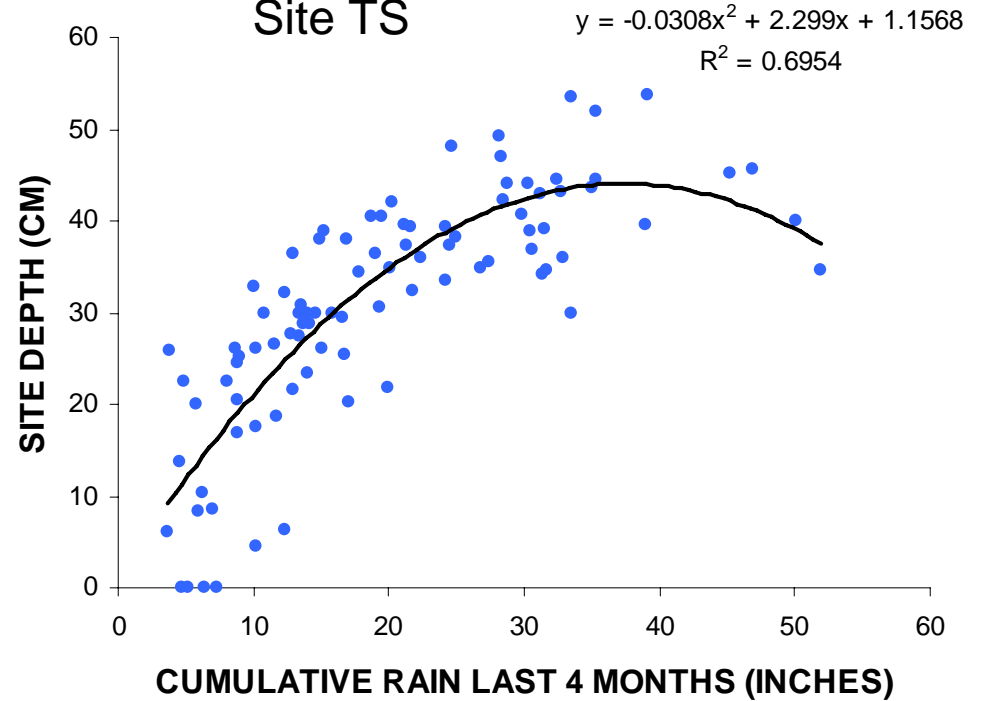


Depth vs. Cumulative Rain (Before Period)

Shark River Slough
Site 7



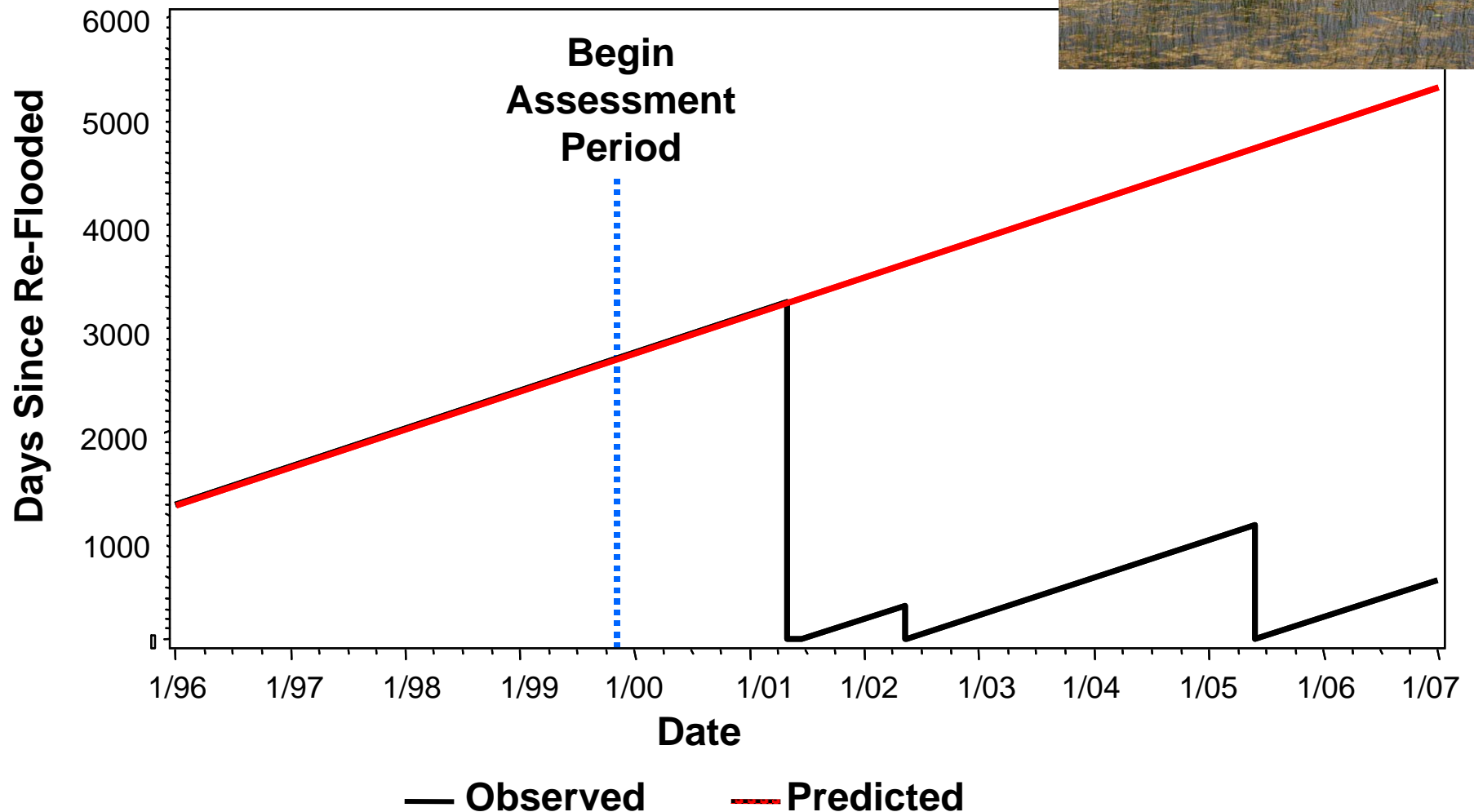
Taylor Slough
Site TS



Observed and Predicted Hydrology



Shark River Slough Plot 6C



Ecological Model

Observed PM values

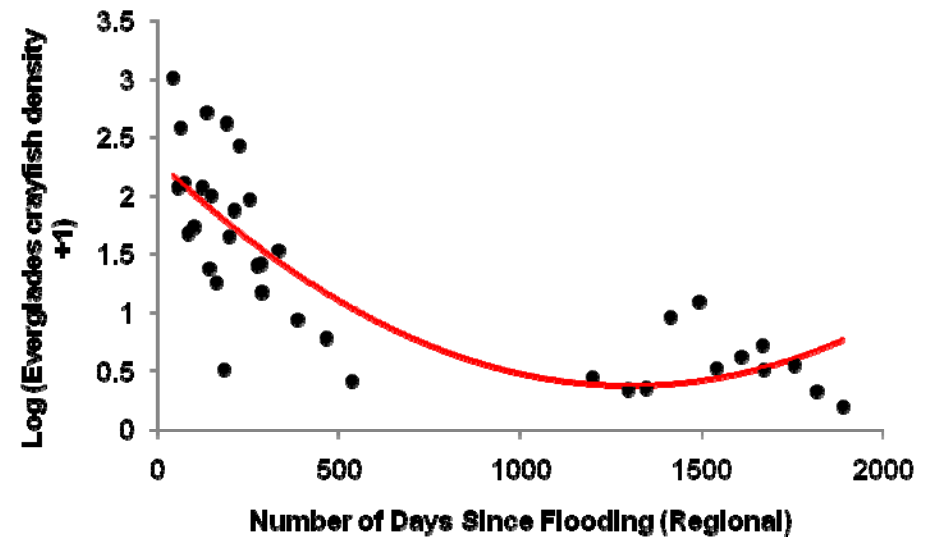
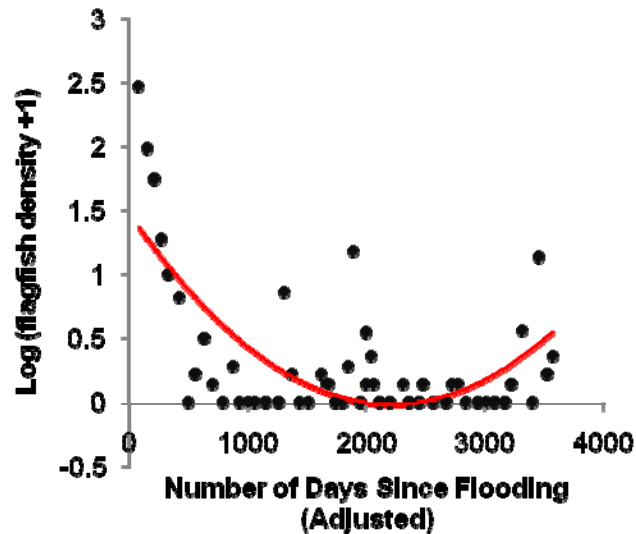
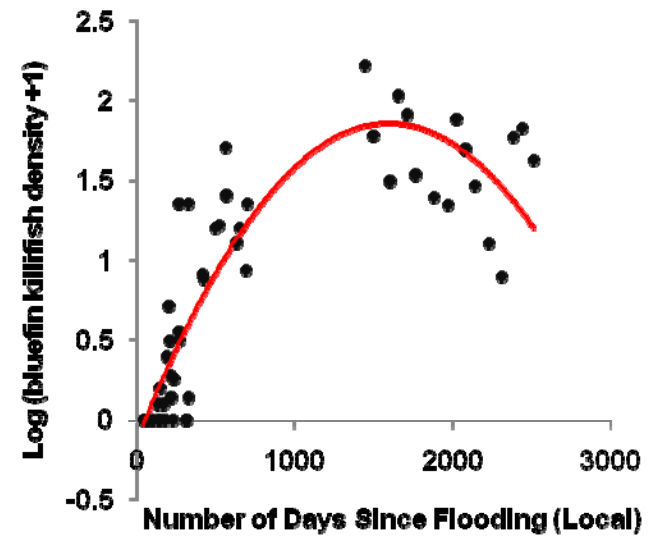
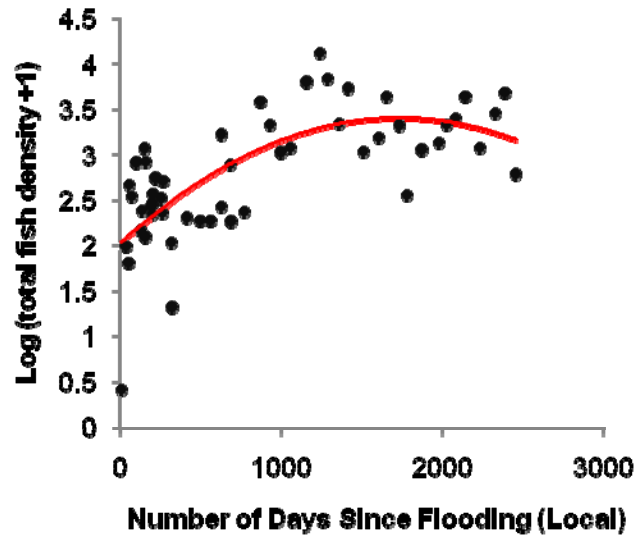
Observed Hydrology
(Local and Regional)

Nested linear polynomial and non linear
models
Select error structure and link

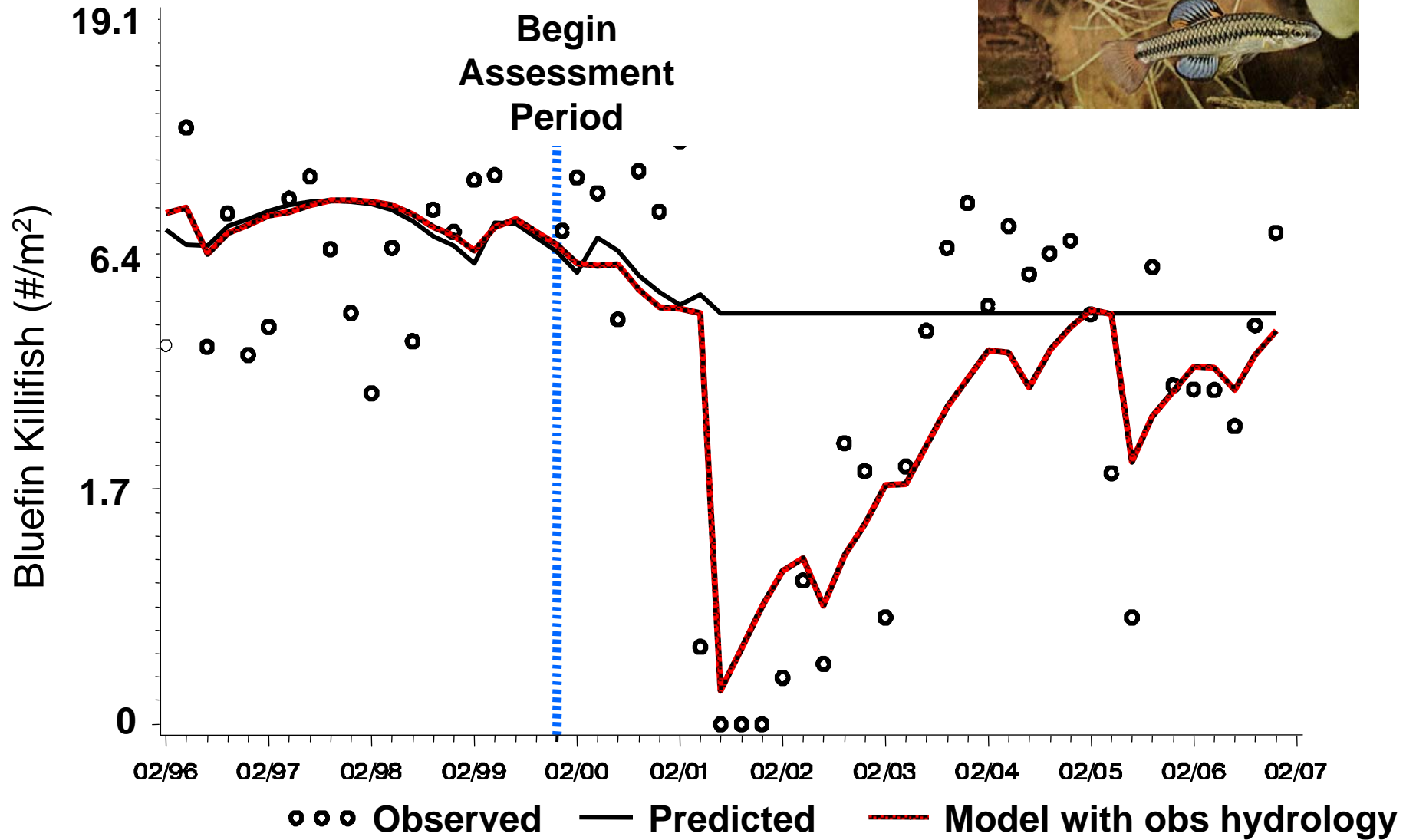
Compare AIC and choose

Please see the poster by Goss and Trexler for more details on
these models

Examples of PMs



Shark River Slough Plot 6C



Assessment

Forecast PM values using ecological model and hydrological forecast if no change in operations

Observed PM values

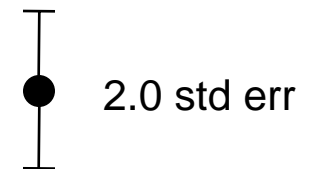
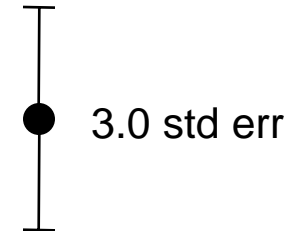
Compare PM values: Observed and predicted if no change in operations



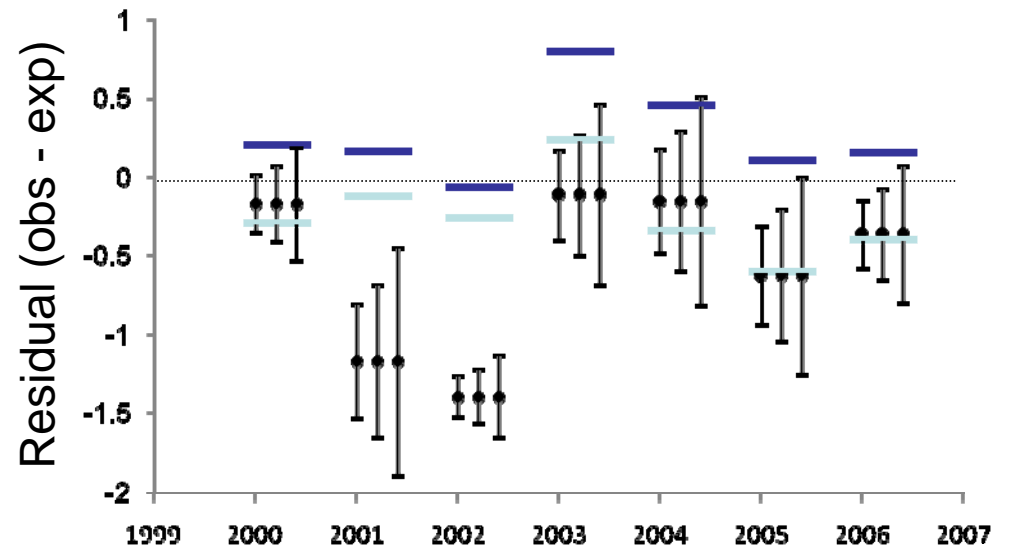
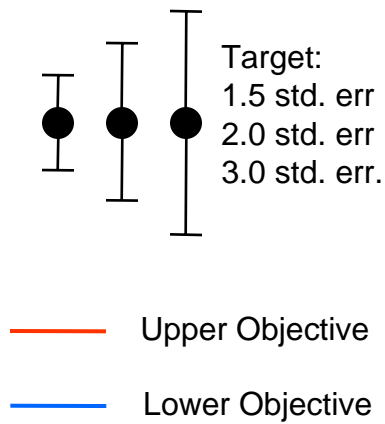
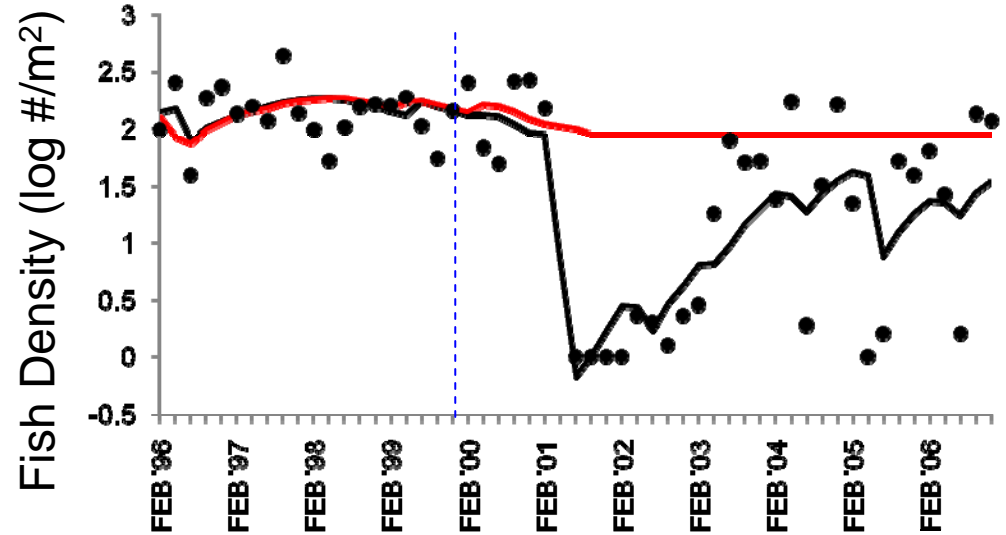
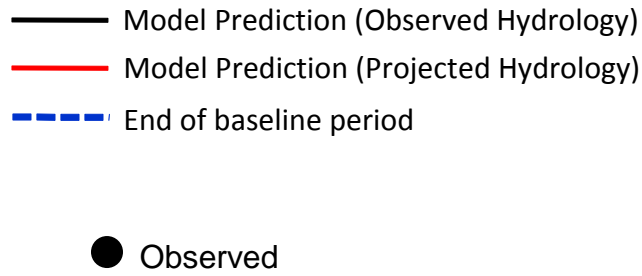
Criteria for Red Stoplights

Deviation from Target

- Type A: one year at least three standard errors above/below limits of objective interval
- Type B: two out of three consecutive years at least two standard errors above/below limits of objective interval
- Type C: four out of five consecutive years with at least 1.5 standard errors above/below limits of objective interval



Bluefish Killifish Fish



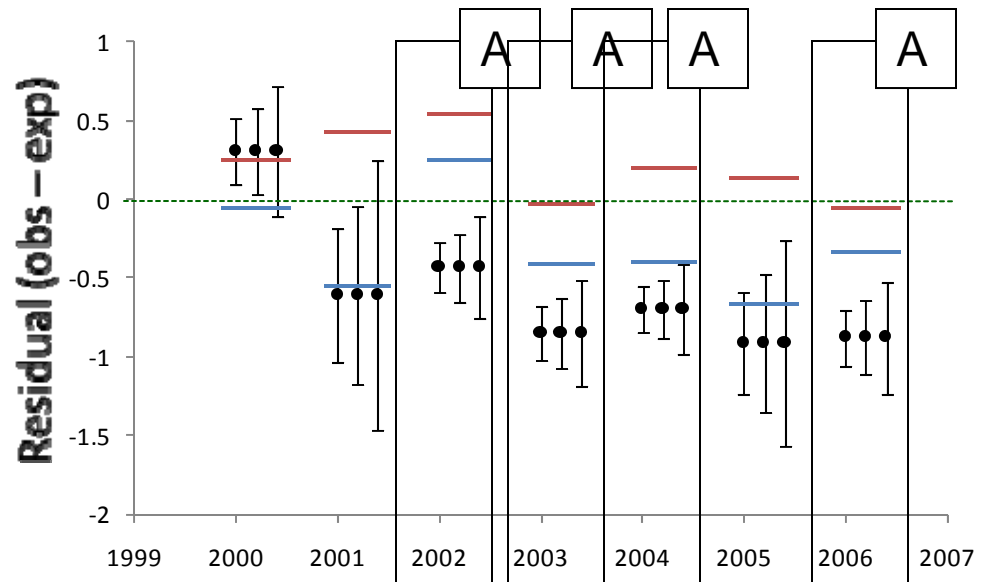
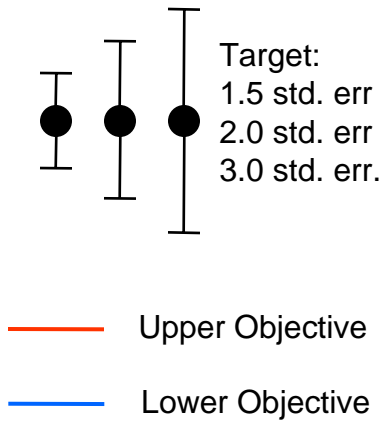
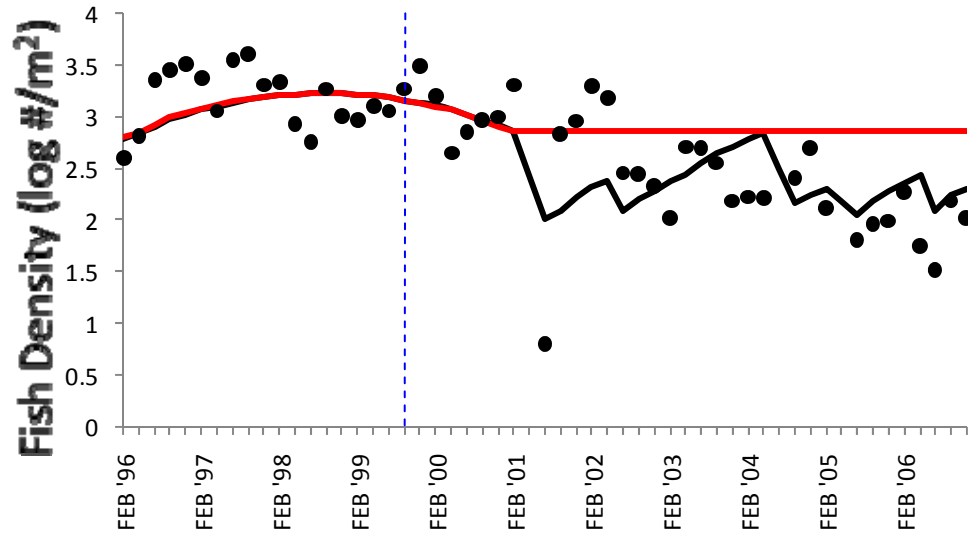
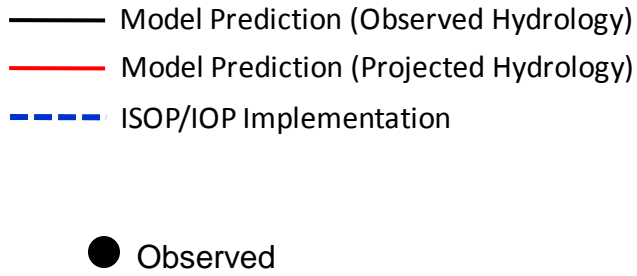
Stoplight Annual Assessments

Performance Measure	2000	2001	2002	2003	2004	2005	Current status
Shark River Slough							
eastern mosquitofish	●	●	●	●	●	●	●
flagfish	●	●	●	●	●	●	●
bluefin killifish	●	●	●	●	●	●	●
total fish	●	●	●	●	●	●	●
Everglades crayfish	●	●	●	●	●	●	●
Non-native fishes	●	●	●	●	●	●	●
Taylor Slough							
eastern mosquitofish	●	●	●	●	●	●	●
flagfish	○	○	○	○	○	○	○
bluefin killifish	●	●	●	●	●	●	●
total fish	●	●	●	●	●	●	●
Everglades crayfish	●	●	●	●	●	●	●
Non-native fishes	●	●	●	●	●	●	●

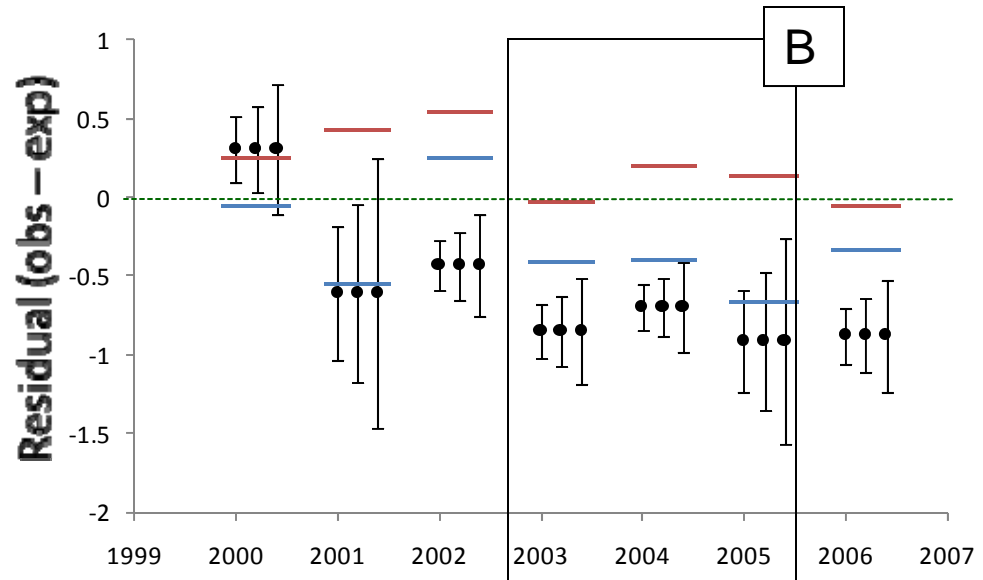
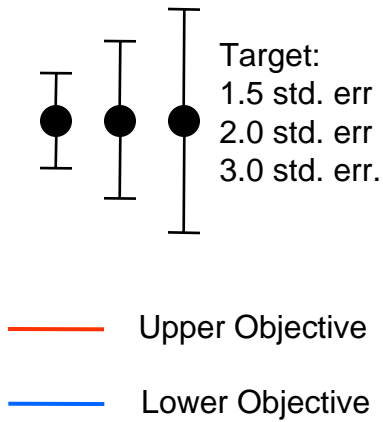
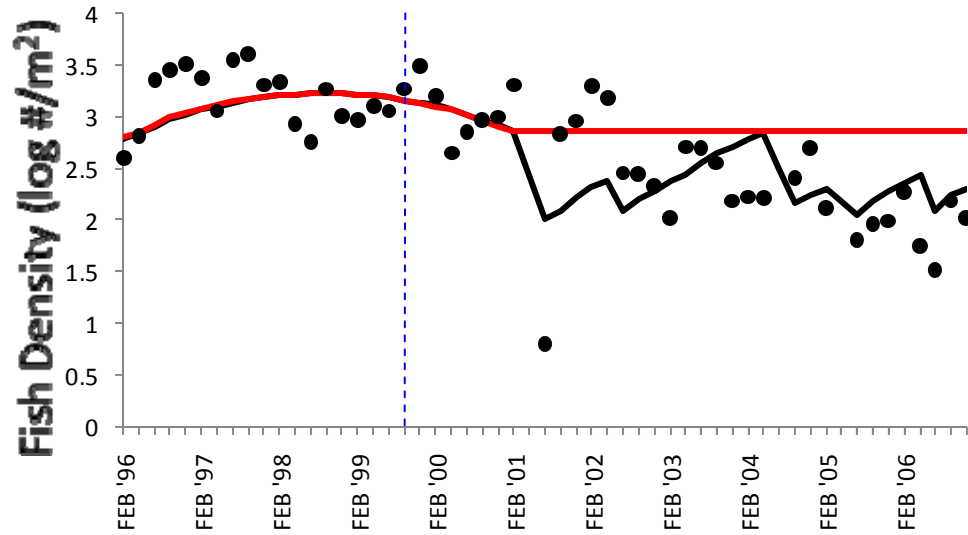
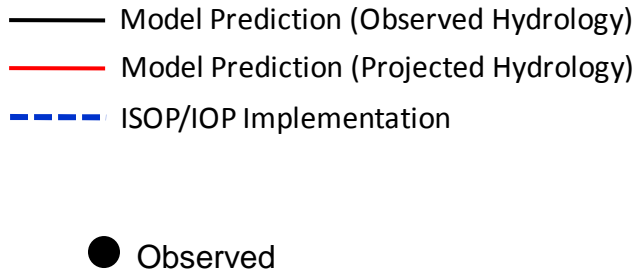
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bluefin killifish	●	●	●	●	●	●	●
total fish	●	●	●	●	●	●	●
Everglades crayfish	●	●	●	●	●	●	●
Non-native fishes	●	●	●	●	●	●	●
Taylor Slough							
eastern mosquitofish	●	●	●	●	●	●	●
flagfish	○	○	○	○	○	○	○
bluefin killifish	●	●	●	●	●	●	●
total fish	●	●	●	●	●	●	●
Everglades crayfish	●	●	●	●	●	●	●
Non-native fishes	●	●	●	●	●	●	●

Total Fish



Total Fish



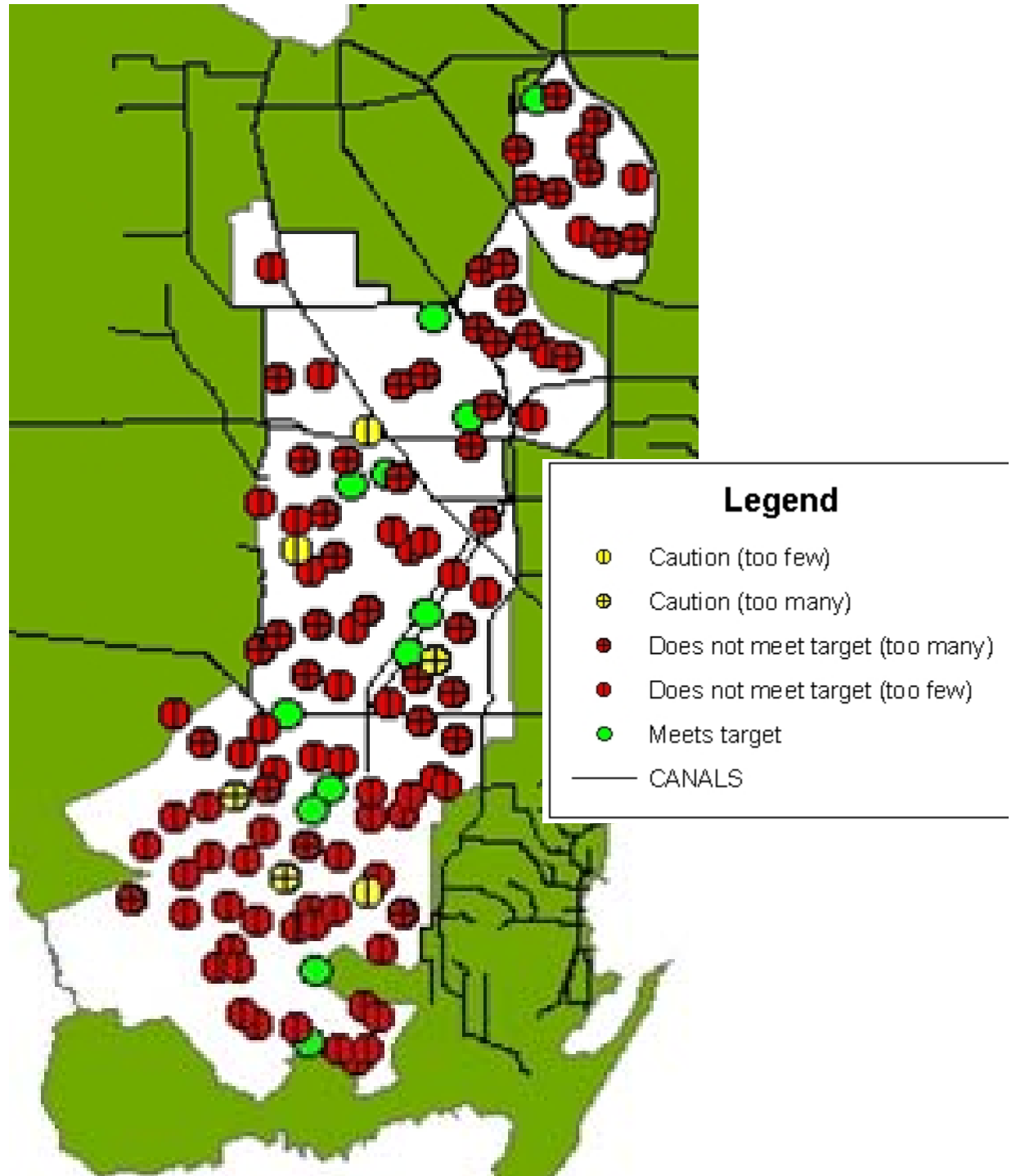
Future Assessments Using CERP MAP

Illustration

PM: Total Fish 2005

Goal: Experimental
NSM for 2005 rainfall

Target: Shark River
Slough ecological
model



Summary and Conclusions

- Assessment involves comparing monitoring data for performance measures to targets
- We recommend use of ‘dynamic targets’ for assessments in CERP when possible
 - Dynamic targets are adjusted for environmental variation outside the controls of managers
- Rainfall is a key environmental driver outside of the control of managers that effects hydrological conditions critical to aquatic fauna
- Hydrological Models for assessment (those routinely updated with contemporary rainfall) are currently lacking
- ‘*Getting the water right*’ should be captured in one or more hydrological models that can be used as standards for assessments

Acknowledgments

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- Thanks to Bob Doren for including us in the Restoration Indicator Program



<http://www.fiu.edu/~trexlerj/publications.htm>