Where should we act and at what scale?

Defining the meaning of restoration from an ecological perspective

Jed Redwine[1], Matt Harwell[2], Shawn Komlos [3], Leonard Pearlstine[4], and Erik Powers[5]
[1] Atkins, Jacksonville, FL, USA
[2] U.S. Fish and Wildlife Service, Vero Beach, FL, USA
[3] U.S. Army Corps of Engineers, Institute for Water Resources, Washington, D.C., USA
[4] U.S. Fish and Wildlife Service, Vero Beach, FL, USA
[5] Parsons Corporation, Austin, TX, USA

Ecosystem Valuation: http://www.ecosystemvaluation.org

Ecological functions

- Groundwater recharge
- Reproductive success of duck/fish/deer populations
- Stand-level forest productivity
- Pollination
- Carbon/Nitrogen/Phosphorus cycling

Ecological Services

- Clean water availability
- Fishing/hunting recreation opportunities
- Lumber production
- Crop harvest success
- Pollutant processing capacity

Ecological/evolutionary functions

- Species diversity
- Rate of endemism
- Physical size
- Uniqueness
- Spatial arrangement
- Resilience

Ecological/evolutionary services

- Marketplace quality/scale
- Marketplace uniqueness
- Market size
- Regional network of markets (migration corridors, diversity generating regional configurations)

Decision critical criteria at three scales

- Global scale:
  - Support species diversity patterns
    - nested within this is reducing extinction risks.
- Regional scale:
  - Restoration programs that address regions with high diversity are a priority over those that don’t.
  - How we address each region is unique.
- Local scale:
  - supporting basin functions to ensure
    - Natural system level hydrology
    - Reference water quality (particularly TP)

Result

- A patchwork of preserved natural systems (national preserves) buffered by healthy landscape that expresses a mosaic of land uses which deliver desirable ecological services because they exhibit coherent ecological functions.

It is just that easy

National/Regional scale Restoration Programs

- National Ocean Council: Restoration of Ocean, Coastal, and Great Lakes Ecosystems.
http://www.whitehouse.gov/sites/default/files/microsites/ceq/sap_6_repr_full_content_outline_06-02-11_clean.pdf

- River/Watershed Restoration:
  - Chesapeake Bay
  - Gulf Coast/Coastal Louisiana
  - Upper Mississippi River
  - Missouri River
  - **Everglades Ecosystem**
  - Platte River
  - Rio Grande River
  - Colorado River/Glen Canyon Dam
  - Klamath River/Watershed
  - Puget Sound
  - Columbia River

Preventing extinction

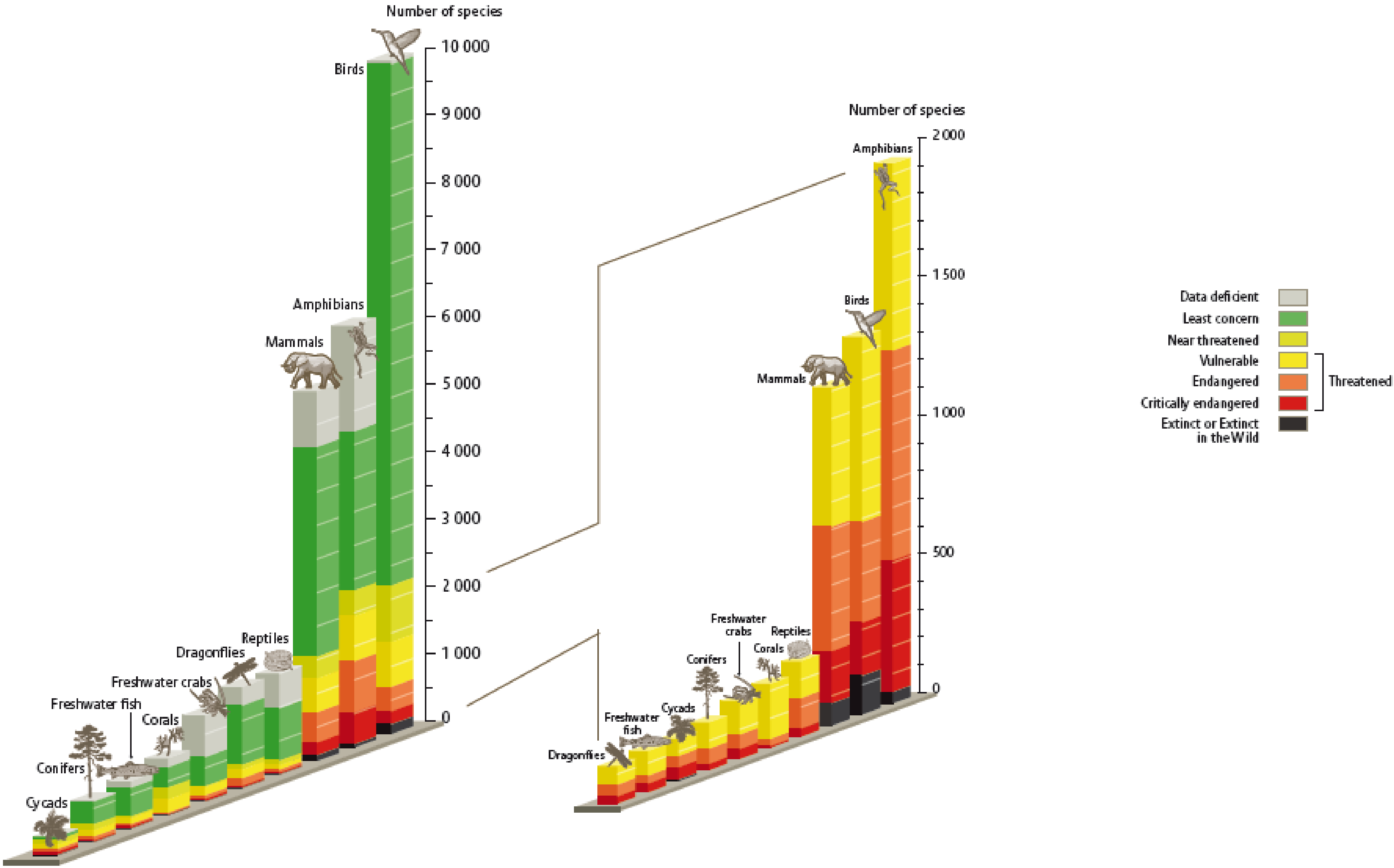
A RATIONAL GLOBAL APPROACH

Animals under threat

- Ten percent of all bird species are likely to disappear by the year 2100, and another 15 percent could be on the brink of extinction, according to a new study by Stanford University biologists. This dramatic loss is expected to have a negative impact on forest ecosystems and agriculture worldwide and may even encourage the spread of human diseases, according to the study published in the Online Early Edition of the Proceedings of the National Academy of Sciences (PNAS) in December.

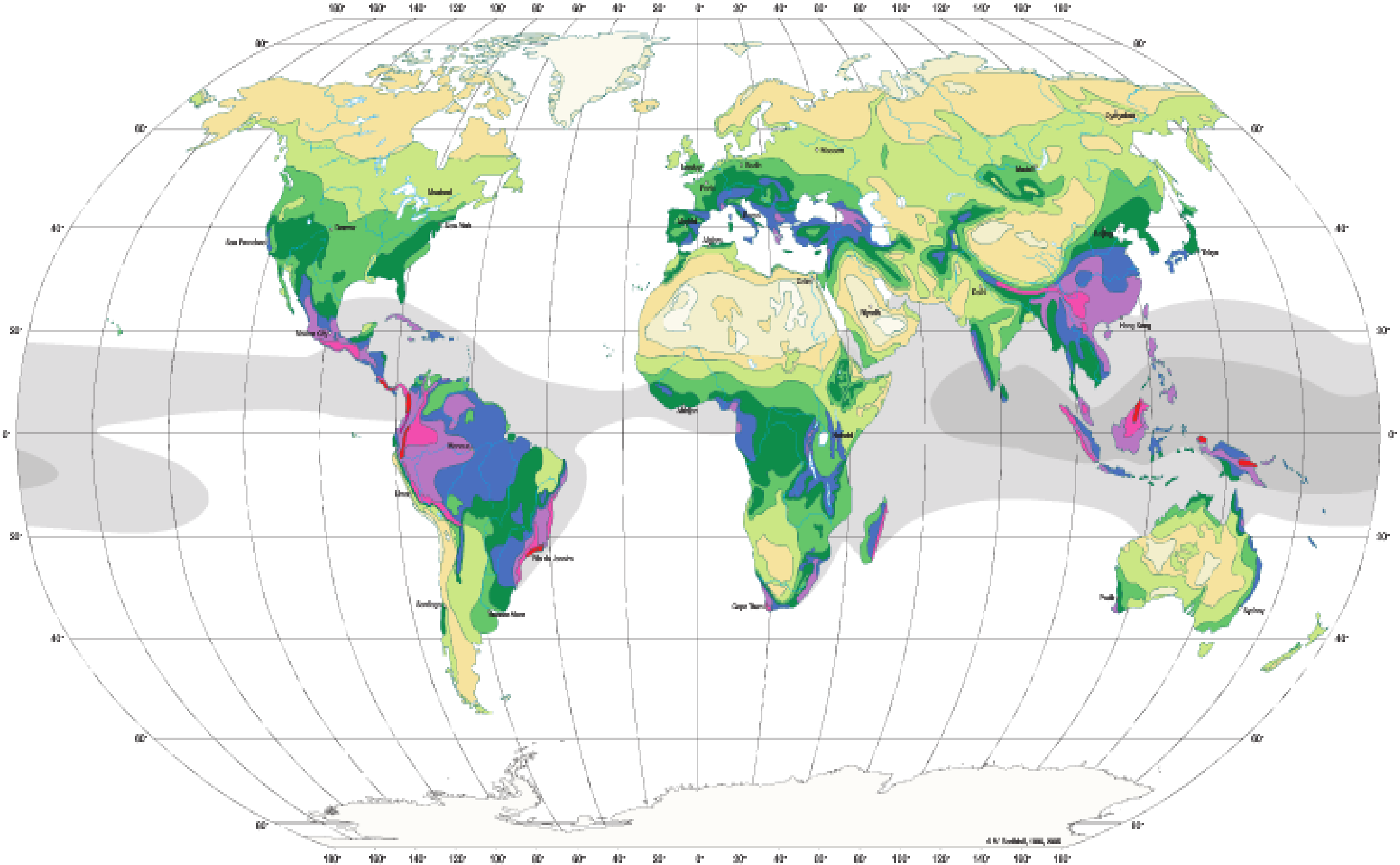
- Stanford University (2004, December 20). Global Bird Populations Face Dramatic Decline In Coming Decades, Study Predicts. *ScienceDaily*. Retrieved July 18, 2011, from http://www.sciencedaily.com-/releases/2004/12/041220023334.htm

- "Disconcertingly, avian declines may in fact portray a best-case scenario, since fish, amphibians, reptiles and mammals are 1.7 to 2.5 times more threatened [than birds]."



Source: IUCN, obtained from: http://gbo3.cbd.int/the-outlook/gbo3/biodiversity-in-2010/species-populations-and-extinction-risks.aspx

GLOBAL BIODIVERSITY: SPECIES NUMBER OF VASCULAR PLANTS



Diversity Zones (DZ): Number of species per 10 000 km ^{2}

DZ 1 (<100)
DZ 2 (100 - 200)
DZ 3 (200 - 500)
DZ 5 (1000 - 1500)
DZ 6 (1500 - 2000)
DZ 7 (2000 - 3000)
DZ 9 (4000 - 5000)
DZ 10 (>5000)

sea surface temperature

> 27°C

> 29°C

Robinson Projection
Standard Lines 38°N and 38°S

W. Barthlott, G. Kier, H. Kreft, W. Küper,
D. Rafiqpoor & J. Mutke 2005
modified after
W. Barthlott, W. Lauer & A. Placke 1996
Nees Institute for Biodiversity of Plants

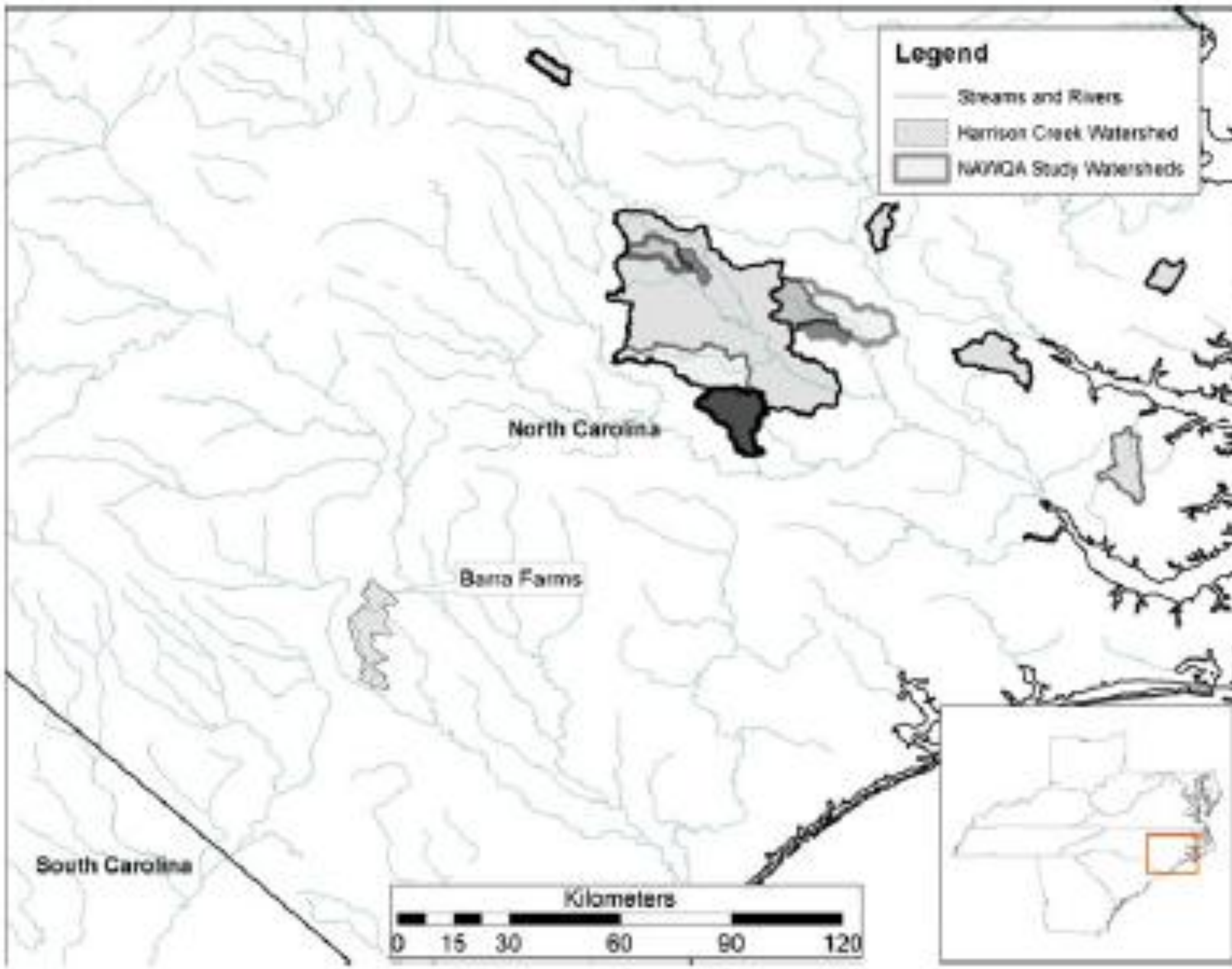
Delivering quality water

A RATIONAL LOCAL APPROACH

A rational local approach

Flanagan and Richardson 2010

Fig. 1 Location of study watersheds in eastern North Carolina, USA



Candidate variables

Results

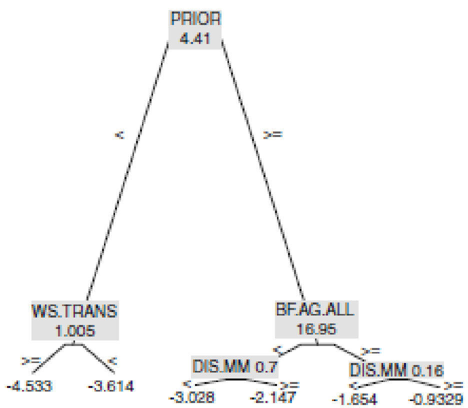


Fig. 3 Regional regression tree of log natural transformed ortho phosphorus concentration. The text above each split shows the variable that is being split and the test below indicates the threshold value identified by the model (% of watershed or buffer area). The text below the terminal nodes shows the natural log of the predicted constituent concentration. See Table 1 for abbreviations

Table 1 Description of predictor variable codes used in the classification tree models

Type	Prefix	Numerical code[a]	Abbreviation	Description
Land-use/ land-cover	WS, BF	21	RES.LI	Low intensity residential
		22	RES.HI	High intensity residential
		23	COM	Commercial/industrial/transport
		33	TRANS	Transitional
		41	FOR.DEC	Deciduous forest
		42	FOR.EVG	Evergreen forest
		43	FOR.MXD	Mixed forest
		81	AG.PAST	Pasture/hay
		82	AG.ROW	Row crops
		91	WET.WDY	Woody wetlands
		92	WET.EMG	Emergent herbaceous wetlands
Summations	WS, BF	NA	UNDEV	Portion of watershed or 90 m stream buffer in undeveloped land-uses sum(41, 42, 43, 91, 92)
			FOR.ALL	Portion of watershed or 90 m stream buffer in forest land-cover sum(41, 42, 43)
			AG.ALL	Portion of watershed or 90 m stream buffer in agricultural land-use sum(81, 82)
			WET.ALL	Portion of watershed or 90 m stream buffer in wetland land-cover sum(91, 92)
Other	NA	NA	NWI[b]	Portion of watershed or 90 m stream buffer NWI polygons
			WT.Peri.Area	Average ratio of perimeter to area of NWI wetland polygons (fragmentation)
			DIS.MM	Instantaneous discharge measurements standardized as millimeters per day.
			HYDRIC[c]	Portion of watershed or 90 m stream buffer as hydric soil series
			ANIMAL	Number of confined animal operations within watershed
			PRIOR	% watershed area as prior converted agricultural lands (see text).
			PT.SRC	Number of permitted point source discharge
			PT.DIST	Upstream distance to nearest point source (km)

Predictors with numeric codes have prefix of WS for those characterizing the entire watershed or BF for those characterizing areas with a 90 m riparian buffer

[a] National Land Cover Data Set numerical codes

[b] USFWS National Wetland Inventory

[c] SSURGO database

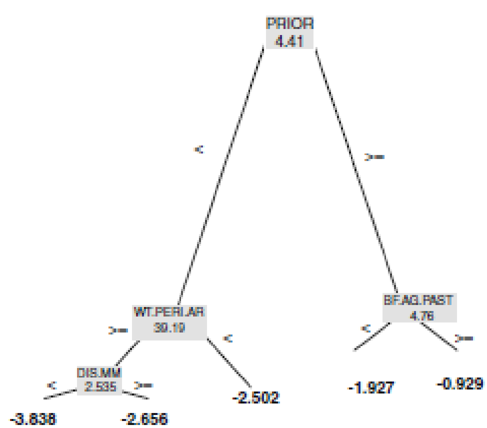
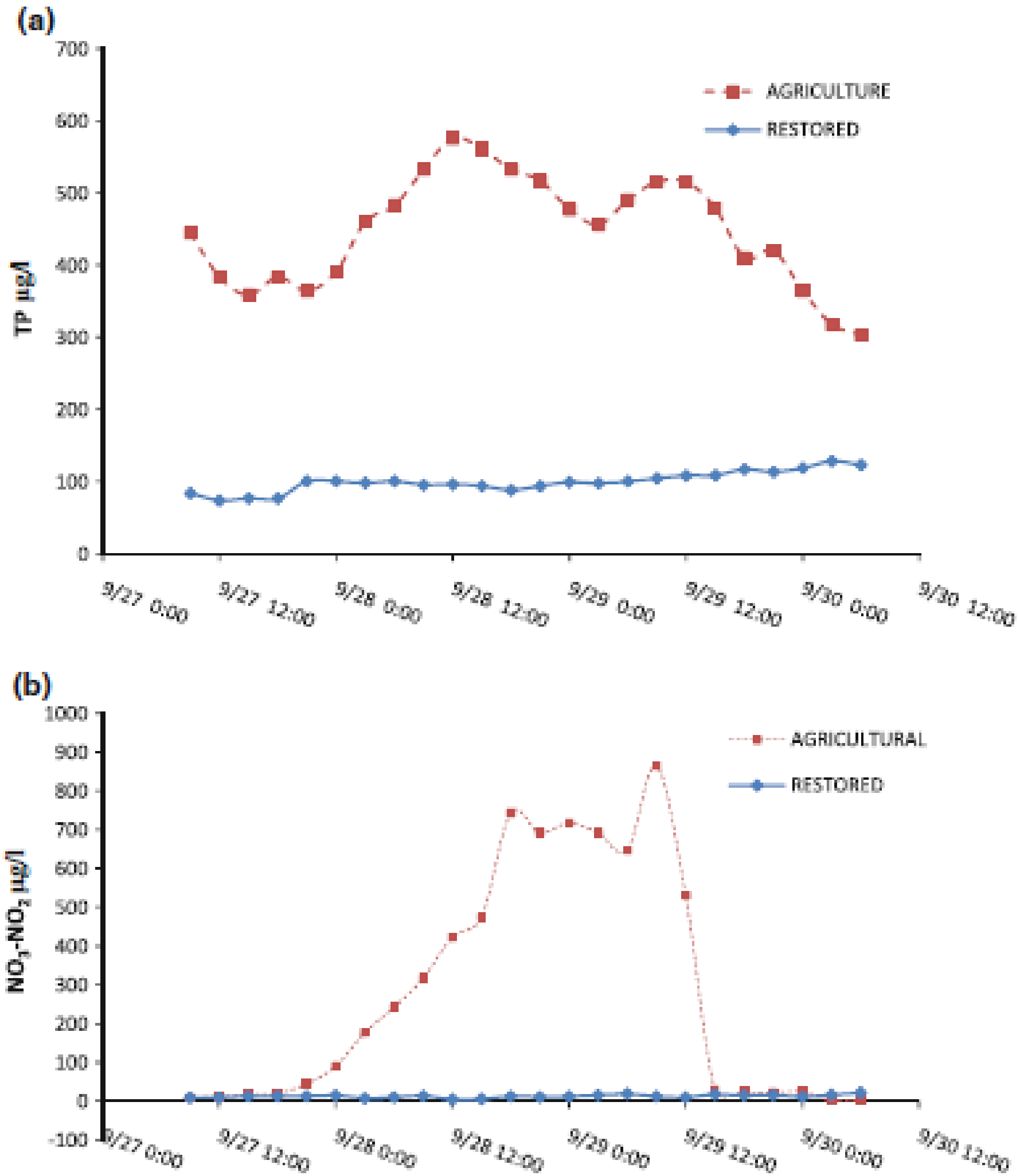


Fig. 4 Regional regression tree model of log natural transformed total phosphorus concentration. See Fig. 3 caption for further explanation

Conclusions: Proportion of watershed in agriculture, prior land use, ratio of perimeter to area (edge/area ratio) of wetlands in basin determine water quality in NC basins

Land uses and water quality



Conclusions: Proportion of watershed in agriculture, prior land use, ratio of perimeter to area (edge/area ratio) of wetlands in basin determine water quality in NC basins

Fig. 7 Nitrate-nitrite nitrogen and total phosphorus concentrations in storm samples from taken between 9/24/99 and 9/27/99. Stations are located in the reference (REF), restored (REST) and agricultural (AG) areas of the Barra Farms site. See Fig. 1

Basin Scale Conclusions:

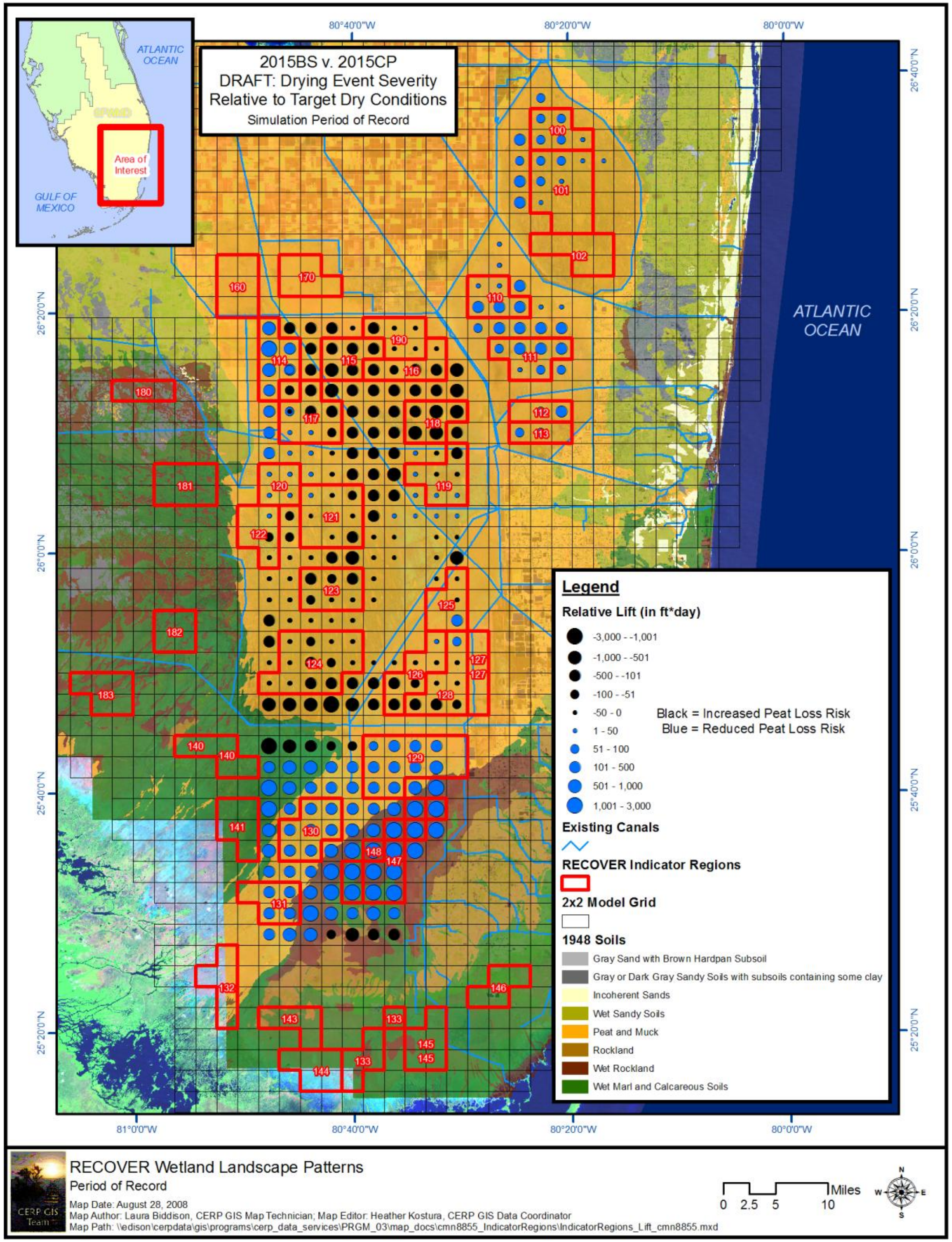
- >20% natural function per basin necessary for appropriate WQ (consider this a minimum threshold that should be applied even to cities….).

- Spatial substructuring can be design-oriented (e.g. area sensitive bird species in FL. Keys, butterfly migration corridors in California, shallow lake function support in Central FL., Maximize agricultural production, high density urban system, etc….)

Decompartmentalization of the Everglades

How we are acting on what we've learned

A RATIONAL REGIONAL APPROACH



Dan Nehler, Alicia LoGalbo, Gregg Reynolds, Doug Donalson, Agnes Mclean, Andy Gottlieb, and Jed Redwine. 2008 (Released to public 2010). Analysis of 2015 Band 1 Scenarios Greater Everglades Wetlands. www.evergladesplan.org/pm/recover/recover_docs/band_1_report/012810_band1_app_3.pdf

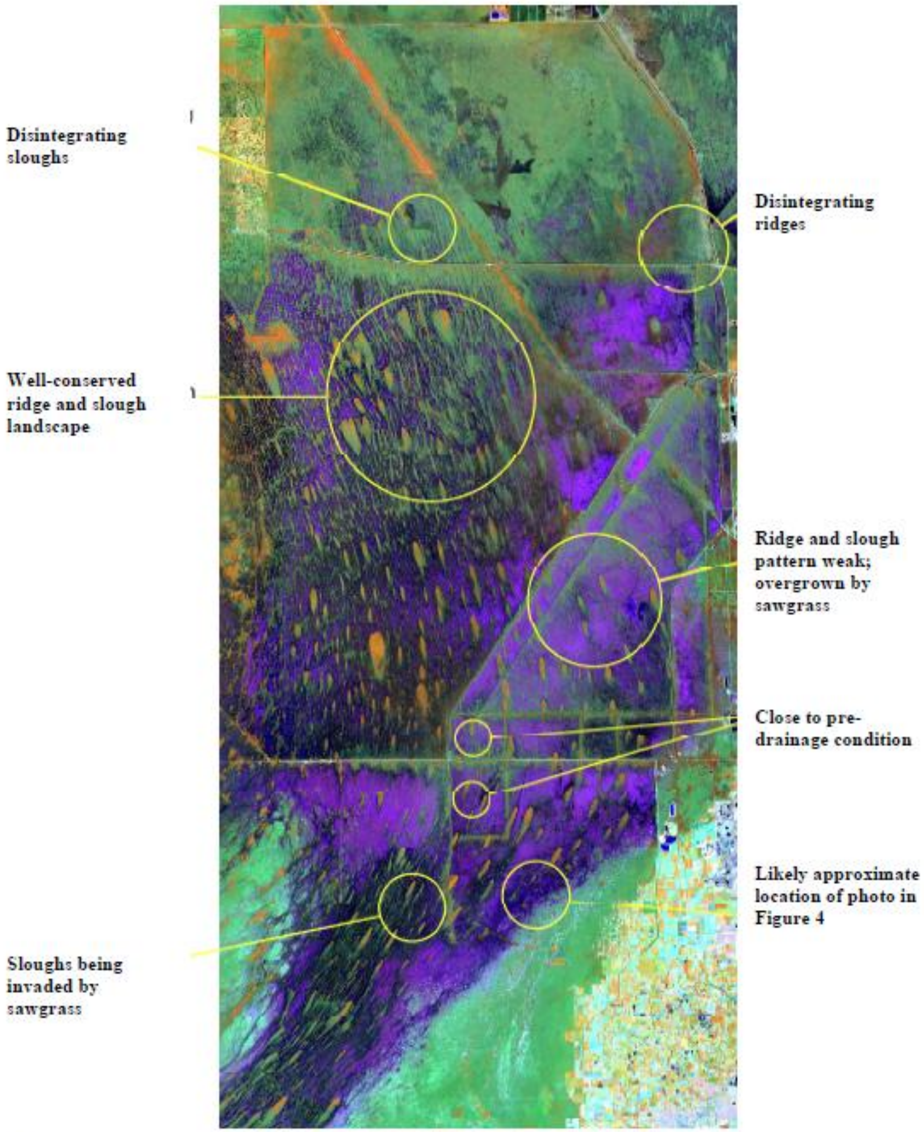
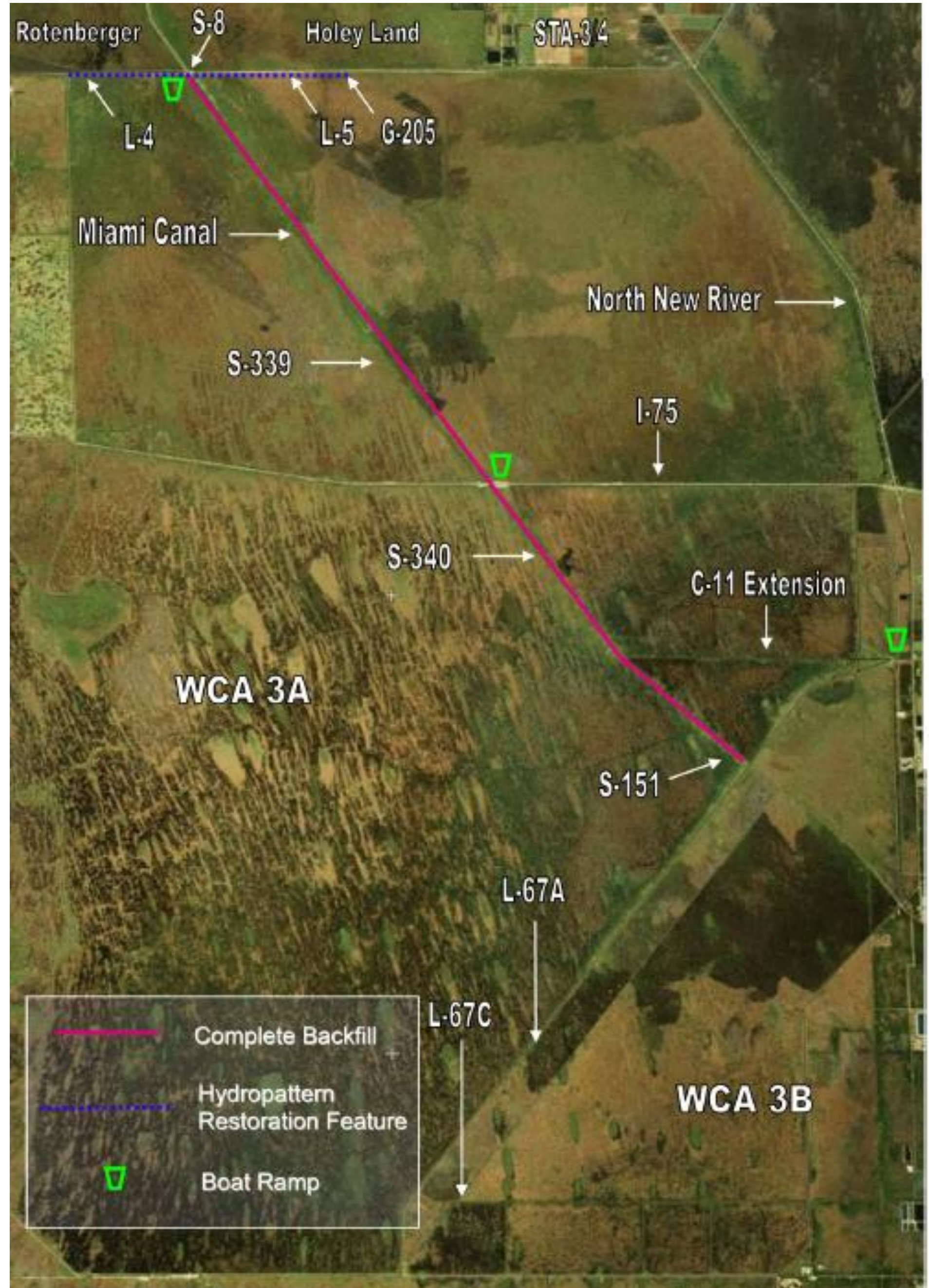


Figure 16. Satellite image of the western ridge and slough landscape, including Water Conservation Areas 3A and 3B, and the Shark Slough/Northeast Shark Slough portions of Everglades National Park. Largest circle indicates portion of landscape which most closely resembles original pattern of ridges and sloughs. Smallest circles show location of 1917 photographs that closely resemble pre-drainage descriptions. Other circles indicate various degraded conditions of present day ridge and slough landscape.

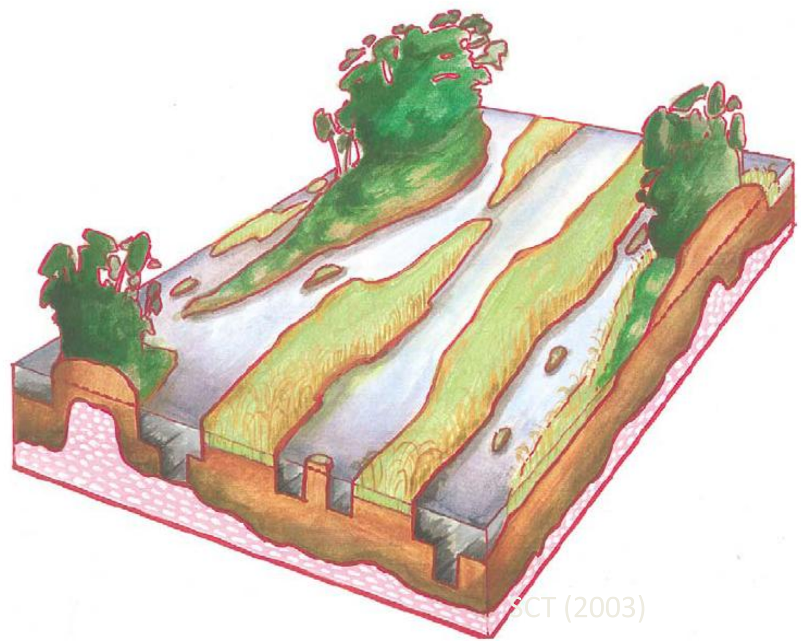
Science Coordination Team 2003



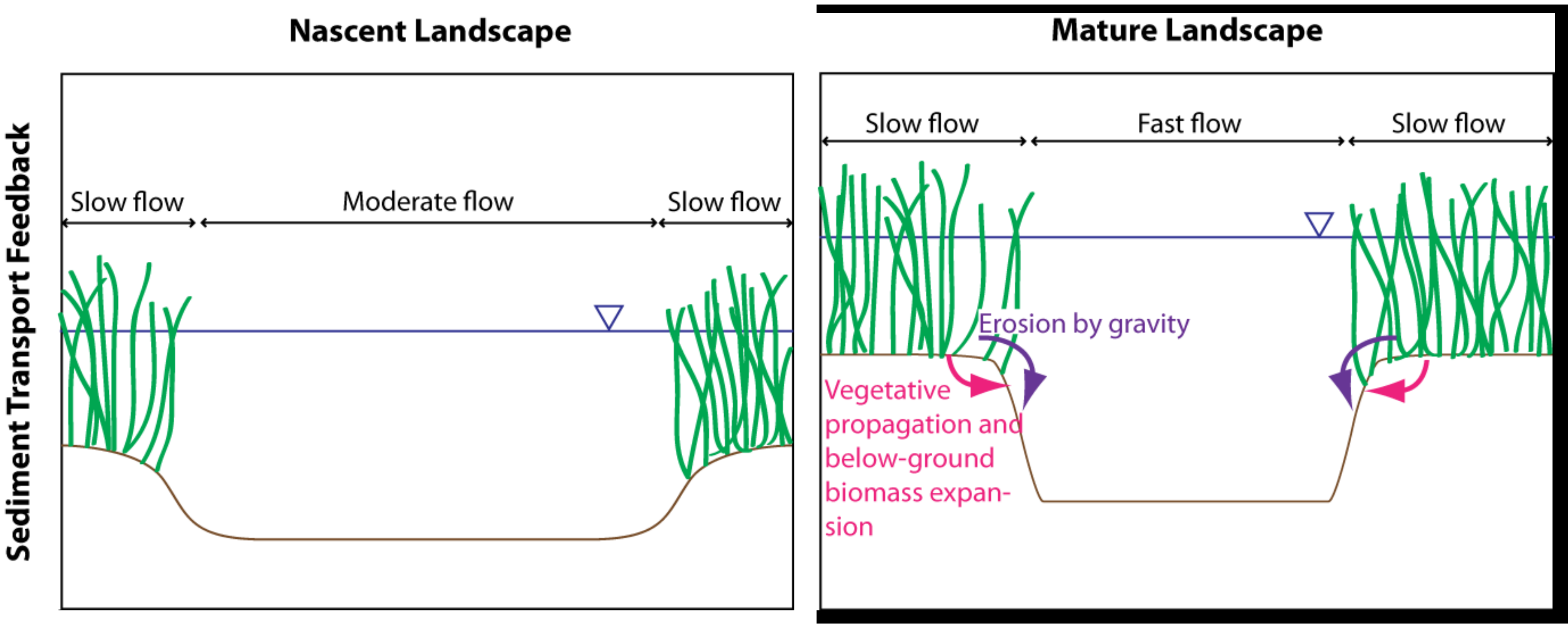
Courtesy of Dana Gentry (USACE)

Central Question

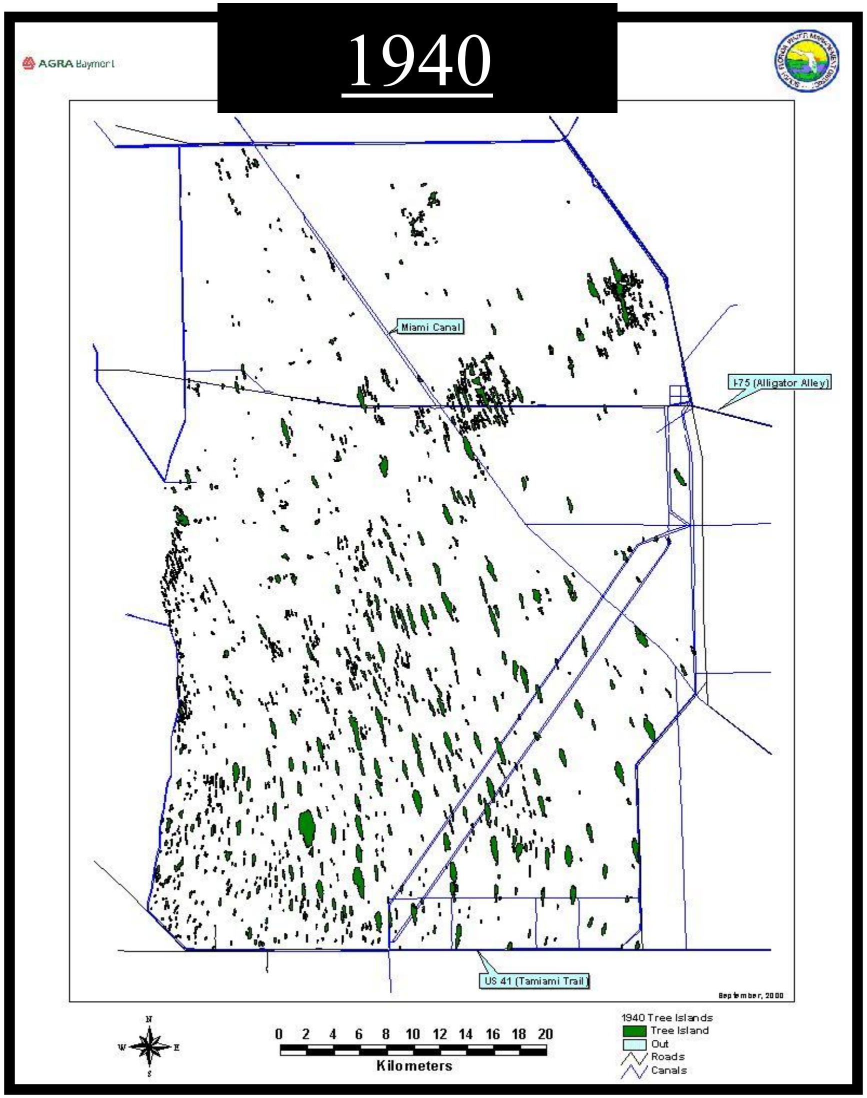
- What mechanisms create and maintain the ridge-slough landscape?
  - Corrugation (vertical dimension)
  - Anisotropy (longitudinal dimension)
  - Wavelength (lateral dimension)

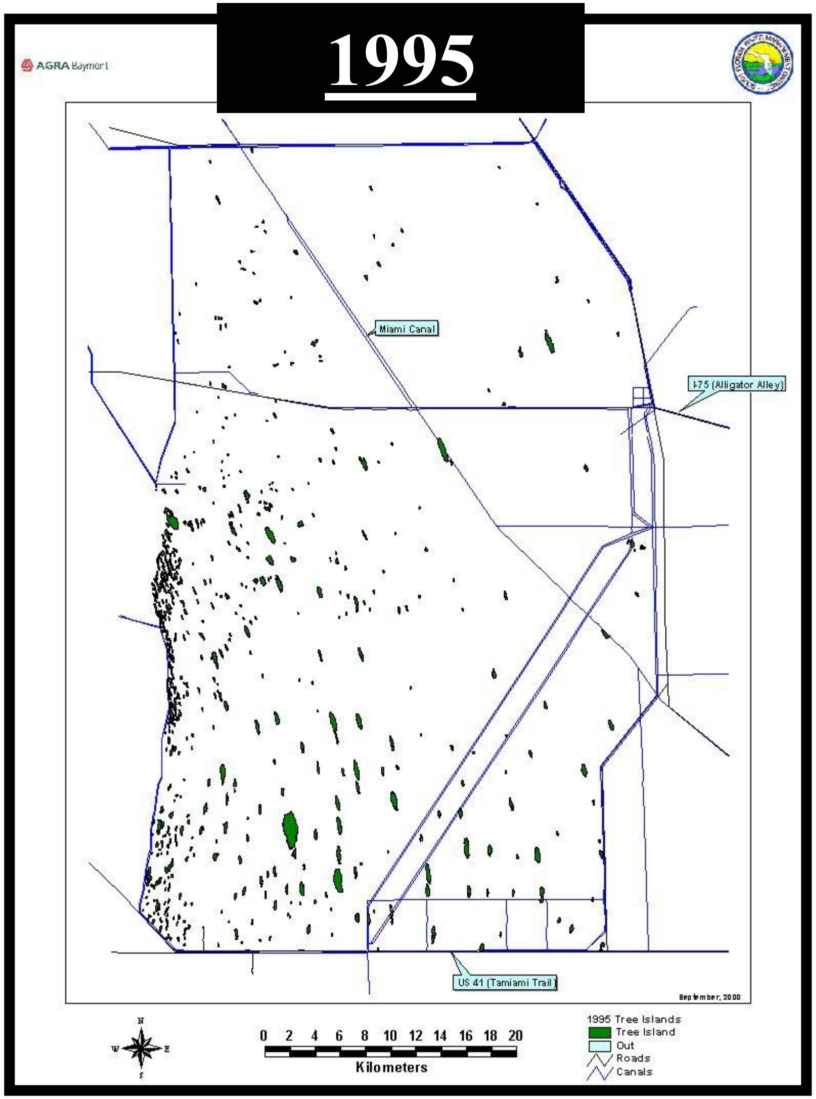


Sediment redistribution can promote cross-sectional landscape stability



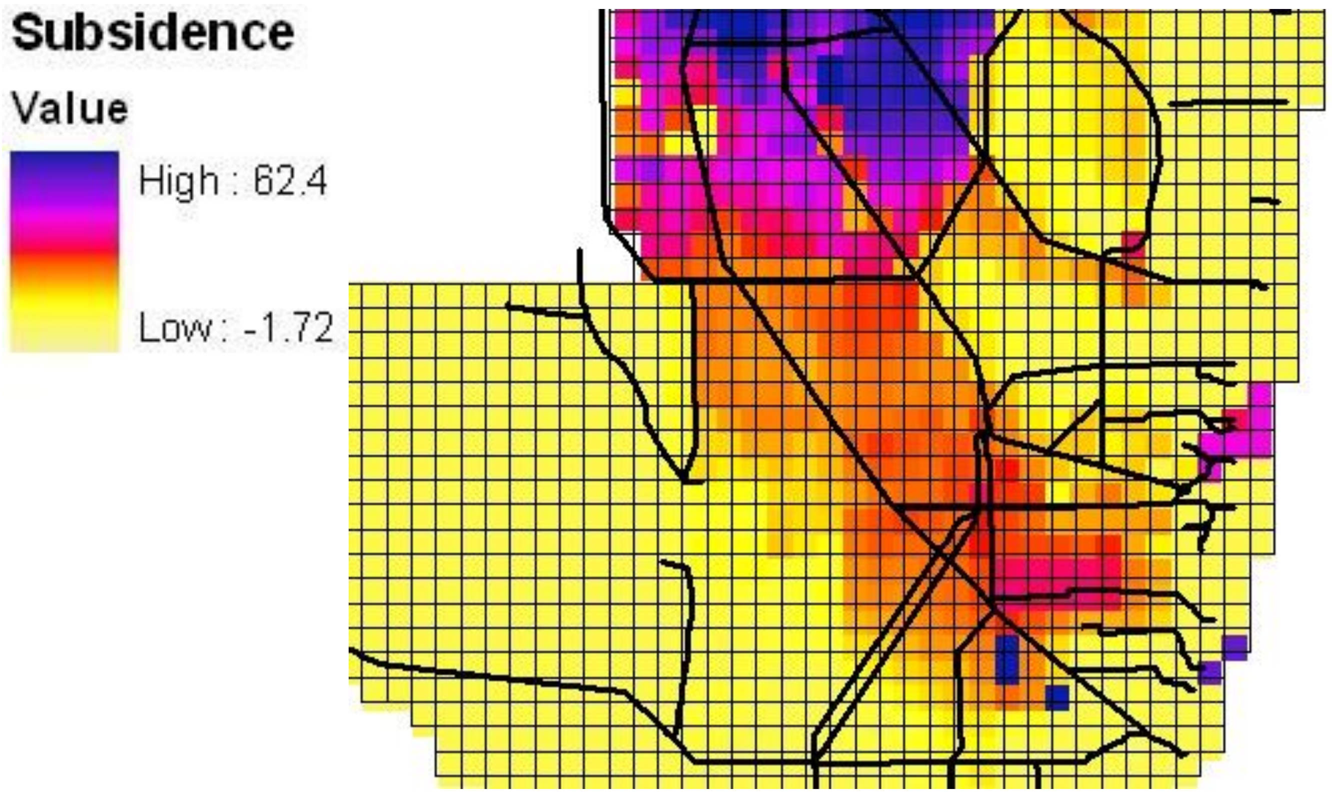
Larsen, Harvey, and Crimaldi, Ecological Monographs 2007
Larsen and Harvey, The American Naturalist, 2010





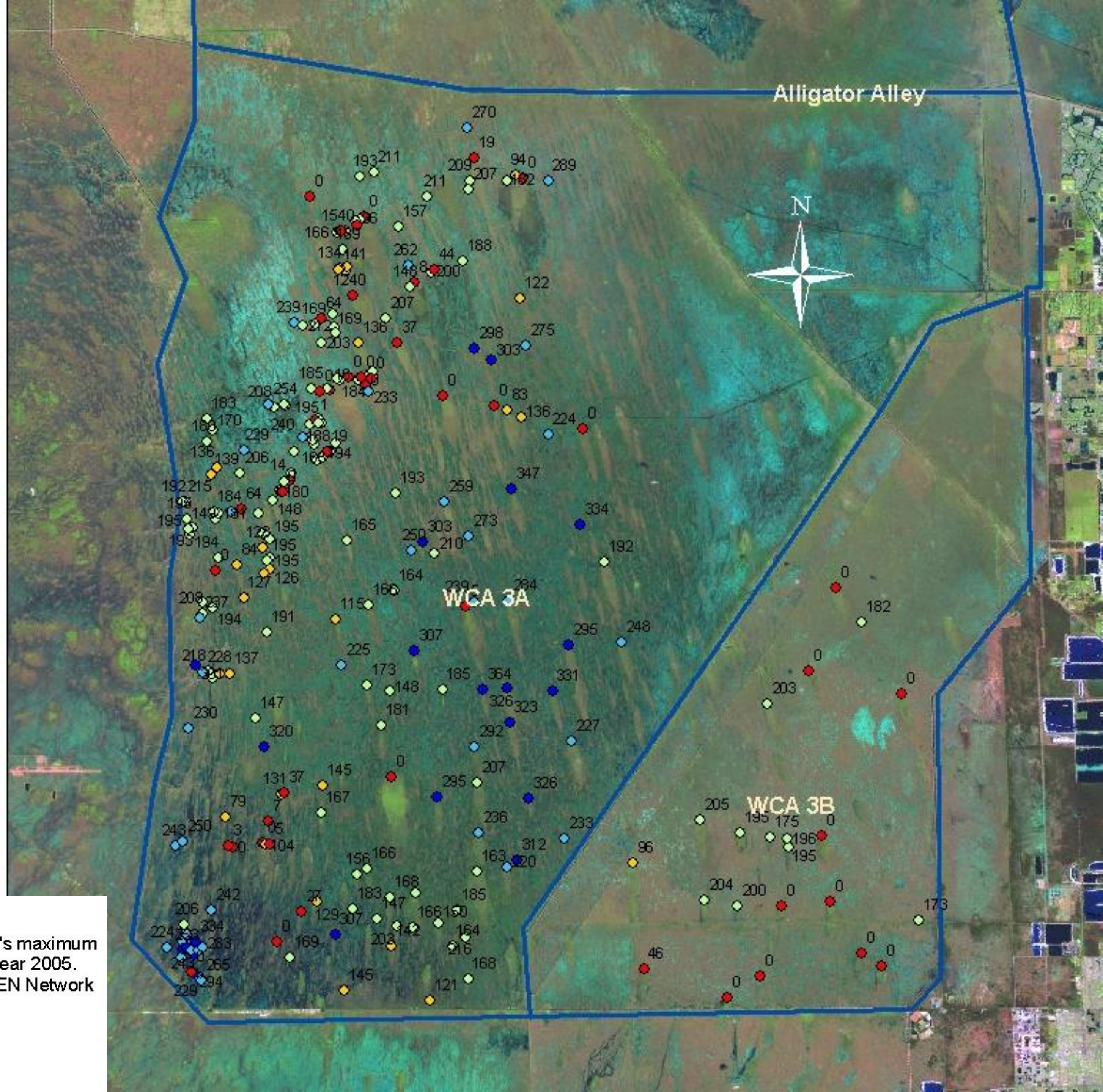
1995 aerial photos were used to identify tree islands (green) in WCA3; 60% of the 1940 islands have been lost.

Subsidence
(NSM v4.6.2 – HAED)



Tree Island inundation duration in 2005 - An average year

Elevation surveys by C. Coronado SFWMD



Number of Days Inundated

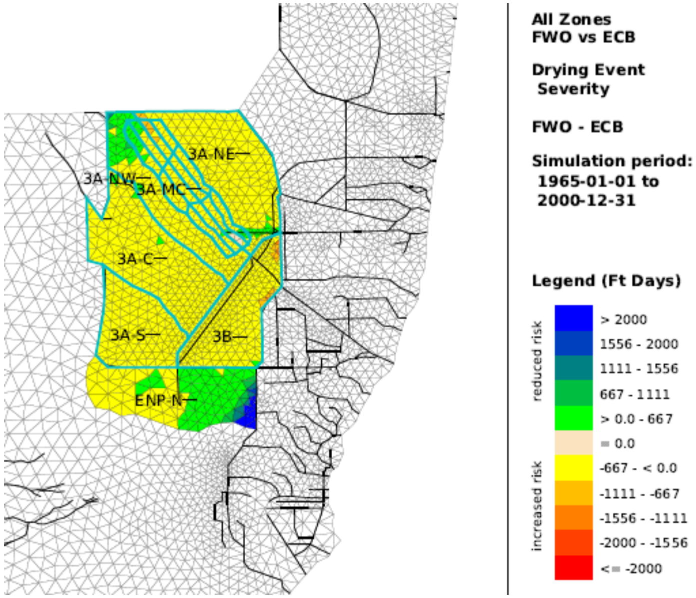
YR2005

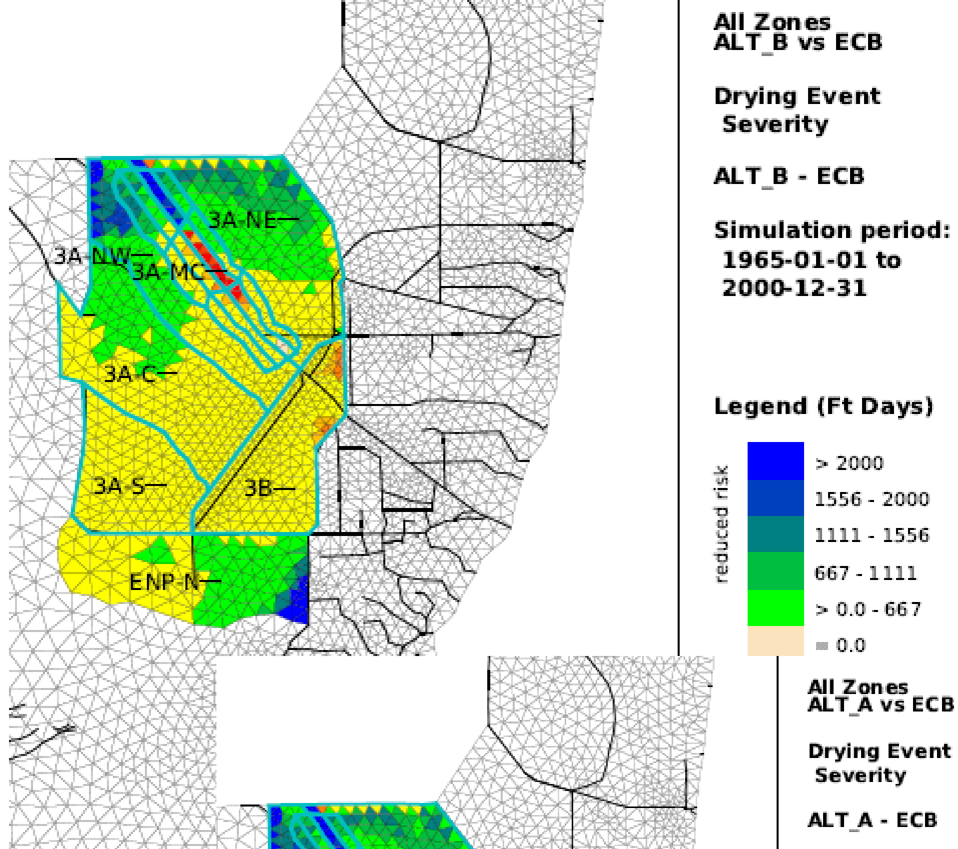
● (red)	0 - 73
● (orange)	74 - 146
● (light green)	147 - 219
● (light blue)	220 - 292
● (dark blue)	293 - 365

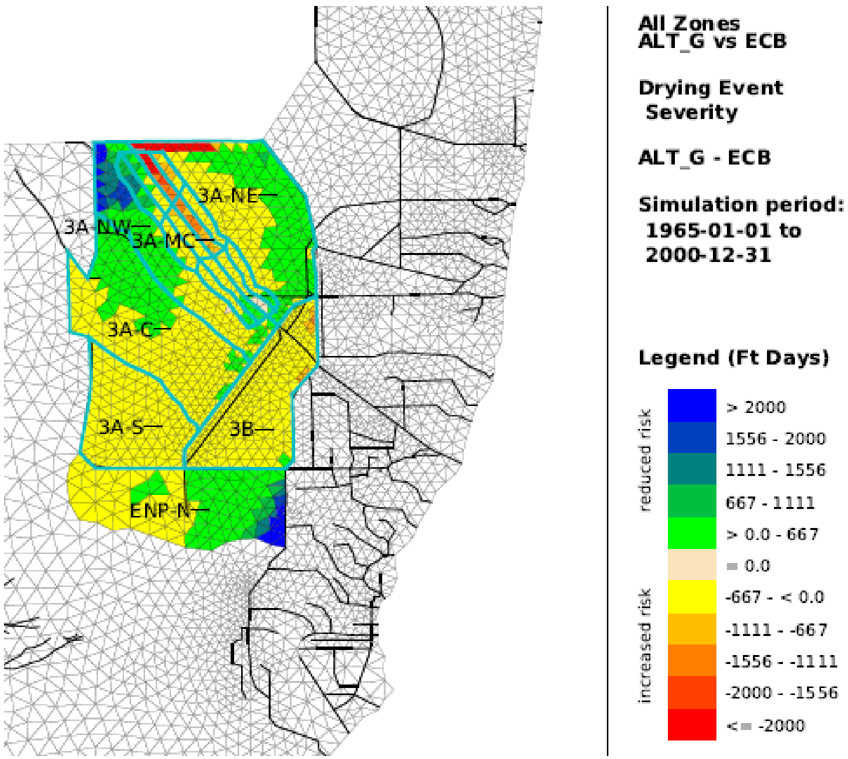
Each island displays the number of days it's maximum elevation point was inundated during the year 2005. Water level data was aquired from the EDEN Network online database for each island.

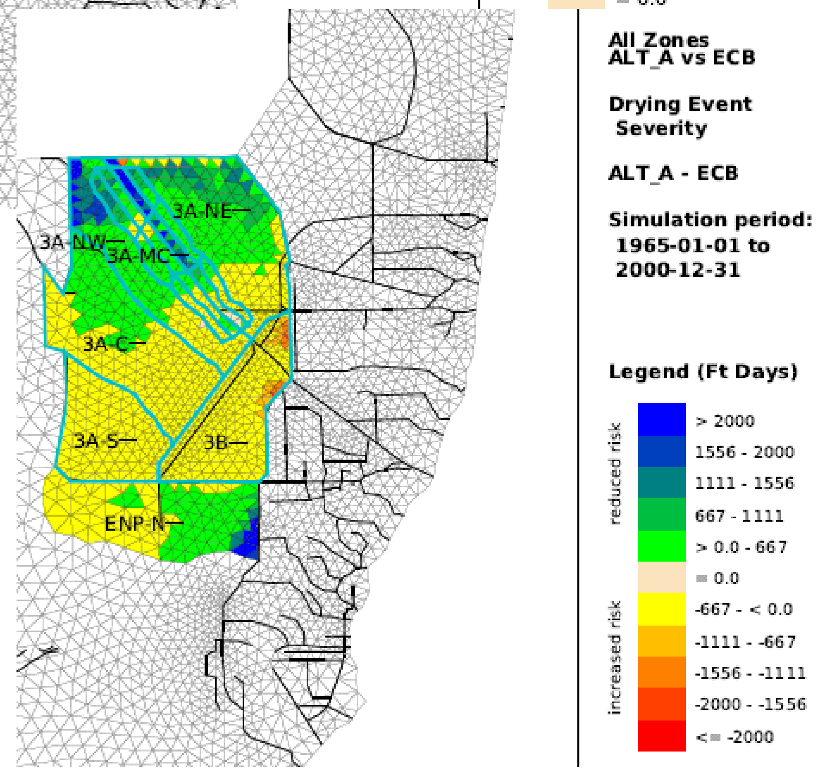
Kilometers

0 1.5 3 6 9 12


All Zones
FWO vs ECB
Drying Event Severity
FWO - ECB
Simulation period: 1965-01-01 to 2000-12-31
Legend (Ft Days)
reduced risk
increased risk
> 2000
1556 - 2000
1111 - 1556
667 - 1111
> 0.0 - 667
= 0.0
-667 - < 0.0
-1111 - -667
-1556 - -1111
-2000 - -1556
<= -2000
3A-NE
3A-NW
3A-MC
3A-C
3A-S
3B
ENP-N


All Zones
ALT_B vs ECB
Drying Event Severity
ALT_B - ECB
Simulation period: 1965-01-01 to 2000-12-31
Legend (Ft Days)
reduced risk
> 2000
1556 - 2000
1111 - 1556
667 - 1111
> 0.0 - 667
= 0.0
3A-NE
3A-NW
3A-MC
3A-C
3A-S
3B
ENP-N


All Zones
ALT_G vs ECB
Drying Event Severity
ALT_G - ECB
Simulation period: 1965-01-01 to 2000-12-31
Legend (Ft Days)
reduced risk
increased risk
> 2000
1556 - 2000
1111 - 1556
667 - 1111
> 0.0 - 667
= 0.0
-667 - < 0.0
-1111 - -667
-1556 - -1111
-2000 - -1556
<= -2000
3A-NE
3A-NW
3A-MC
3A-C
3A-S
3B
ENP-N


All Zones
ALT_A vs ECB
Drying Event Severity
ALT_A - ECB
Simulation period: 1965-01-01 to 2000-12-31
Legend (Ft Days)
reduced risk
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3A-NE
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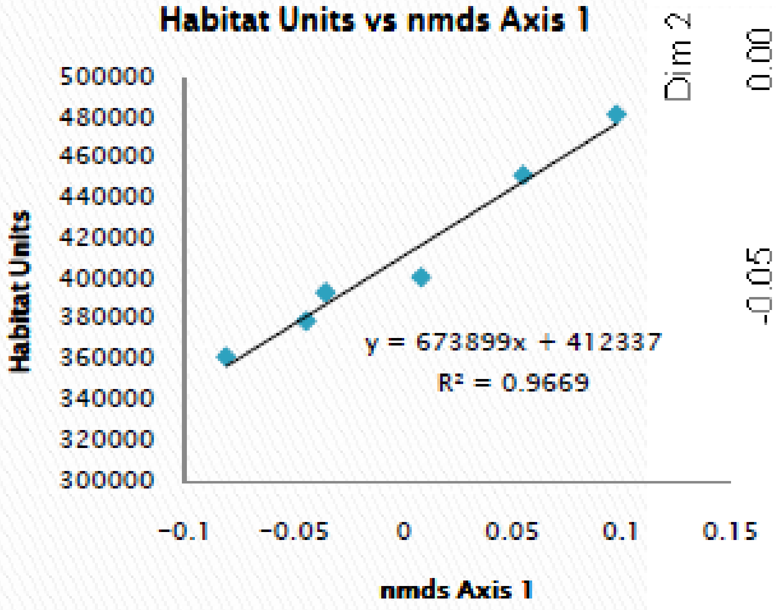
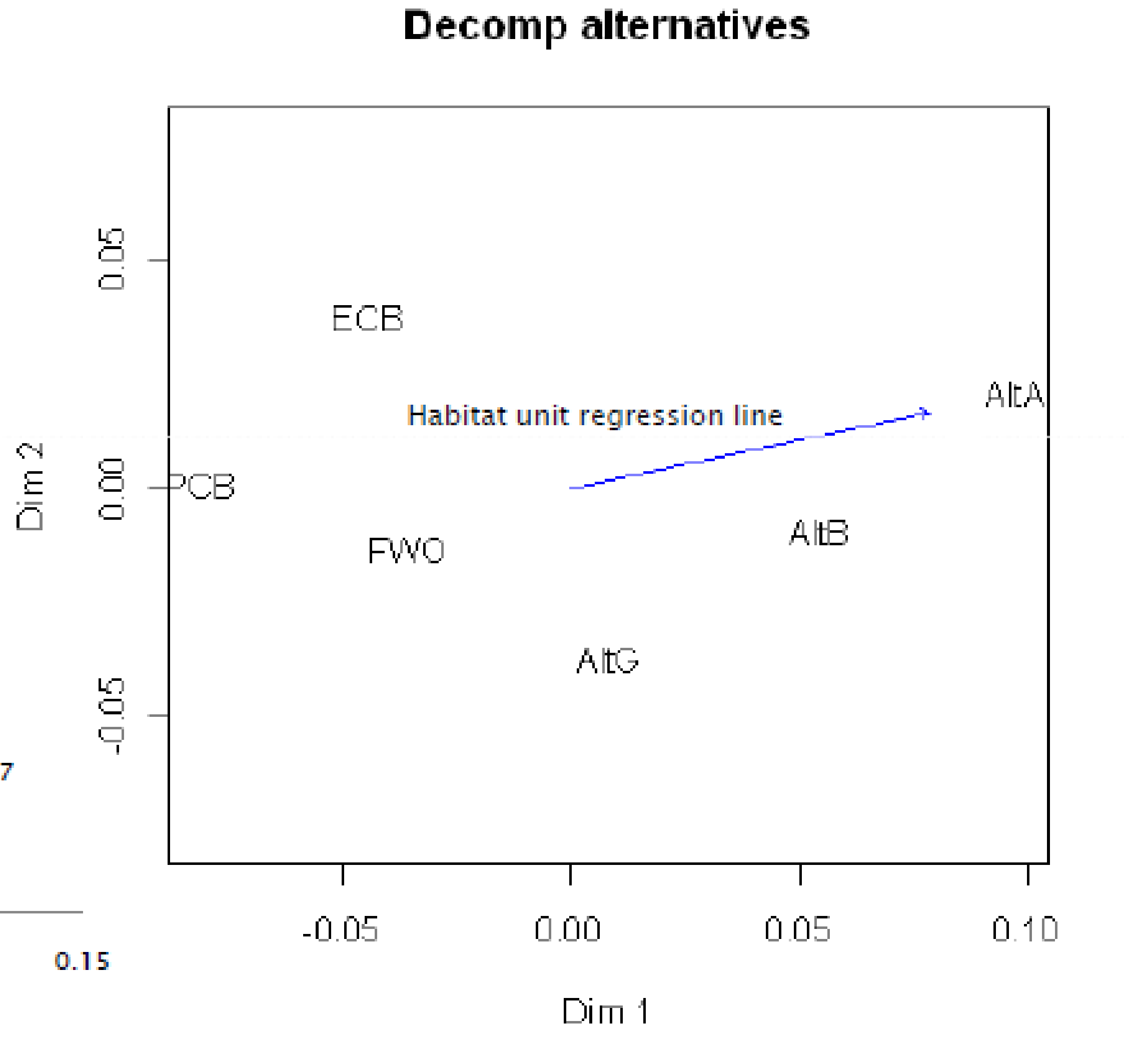
Results from initial Decomp simulations

Entirely consistent with DBQ and other scoring processes





THANKS SO MUCH!