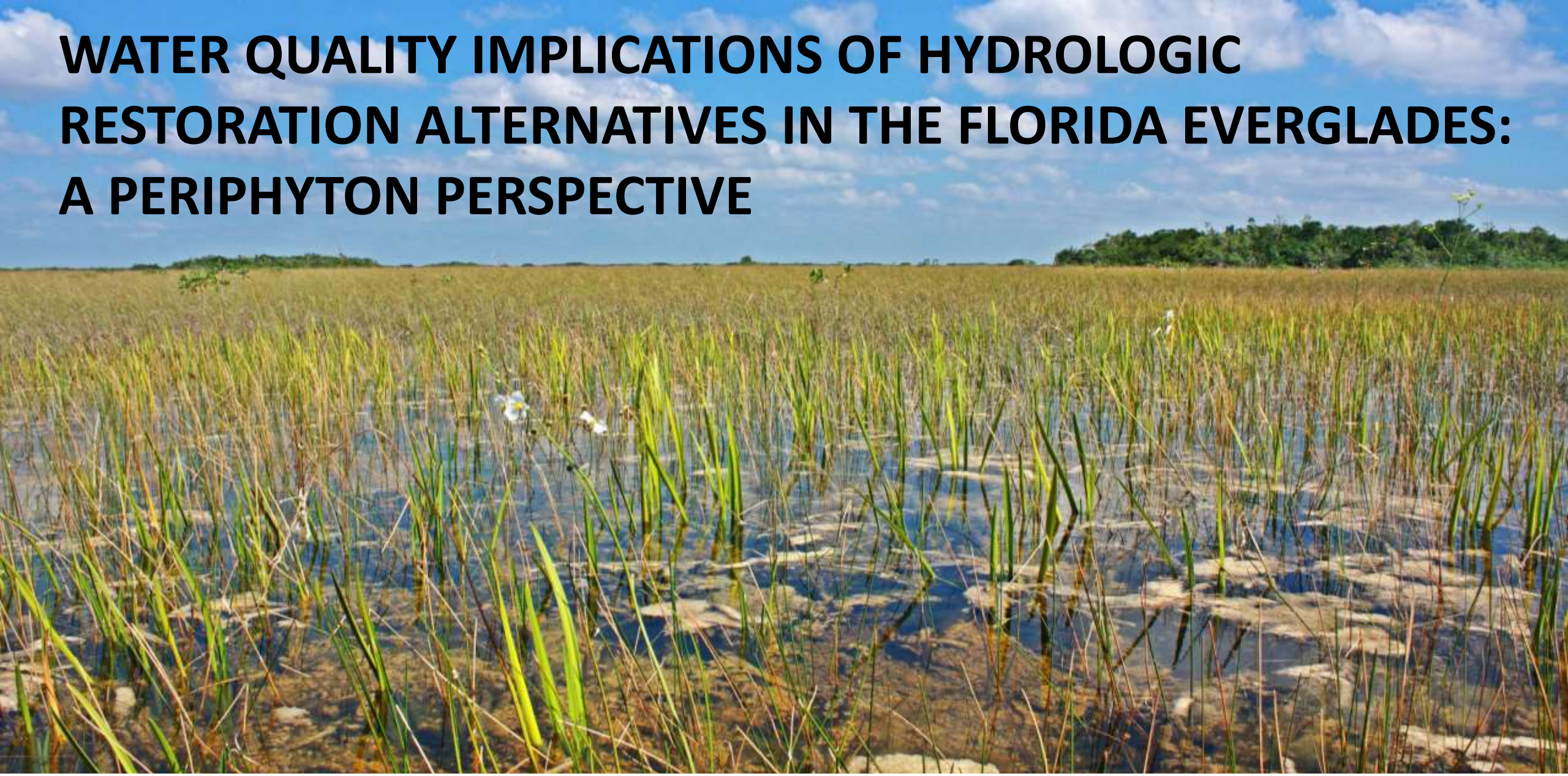
WATER QUALITY IMPLICATIONS OF HYDROLOGIC RESTORATION ALTERNATIVES IN THE FLORIDA EVERGLADES: A PERIPHYTON PERSPECTIVE



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THE SERES PROJECT

Synthesis of Everglades Research and Ecosystem Services

Management-Driven Science Synthesis: An Evaluation of Everglades Restoration Trajectories

SERES Restoration Options

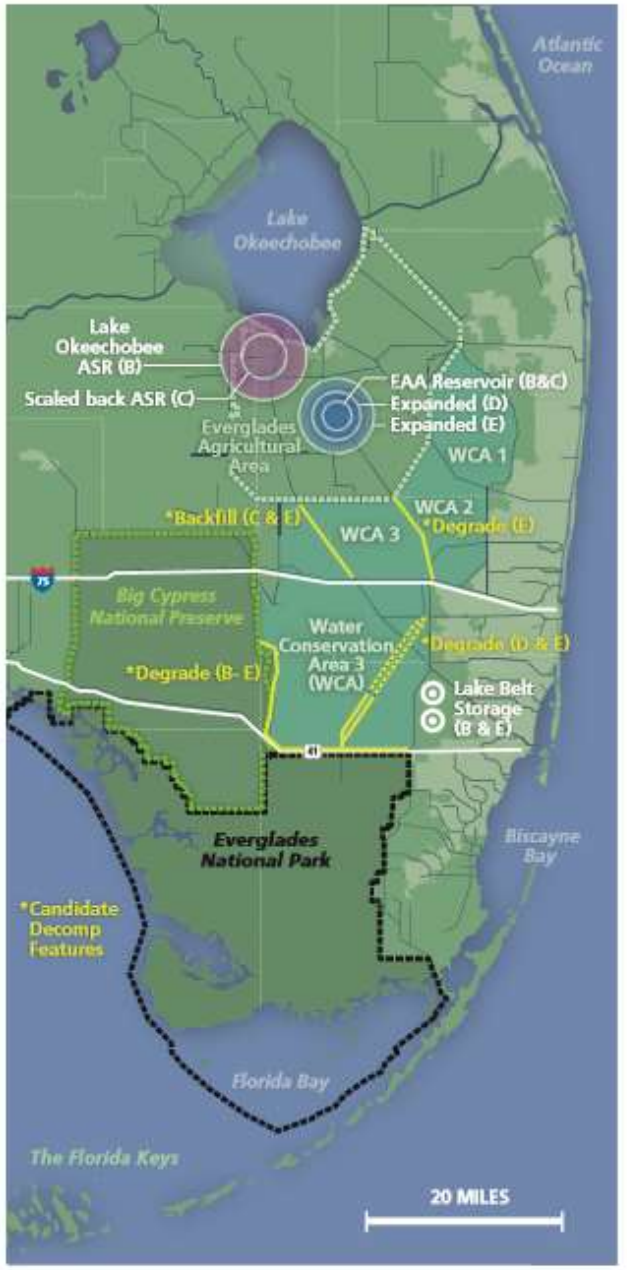
OPTION A Existing Condition ("do nothing" or a future without restoration)

OPTION B Full implementation of the Comprehensive Everglades Restoration Plan (CERP), including 1000 MGD capacity for aquifer storage and recovery (ASR), Northern and Central Lake Belt storage, Everglades Agricultural Area (EAA) reservoir, Bird Drive Basin storage, and partial decompartmentalization.

OPTION C Scaled-back CERP, featuring 250 MGD ASR, no Lake Belt storage, no Bird Drive Basin storage, and partial decompartmentalization (as in Option B).

OPTION D Expanded storage and decompartmentalization, featuring an expanded EAA reservoir (from 360,000 acre-ft to 1.3 million acre-ft) due to feasibility questions related to ASR and Lake Belt storage (both not included in Option D), increased decompartmentalization between WCA-3A and 3B.

OPTION E Maximum decompartmentalization, featuring an expanded EAA reservoir (2.5 million acre-ft) to replace loss of ASR, direct connections between WCA-2A and 3A and between WCA-3A and 3B. Option E also includes Lake Belt Storage as conceived in CERP (Option B).



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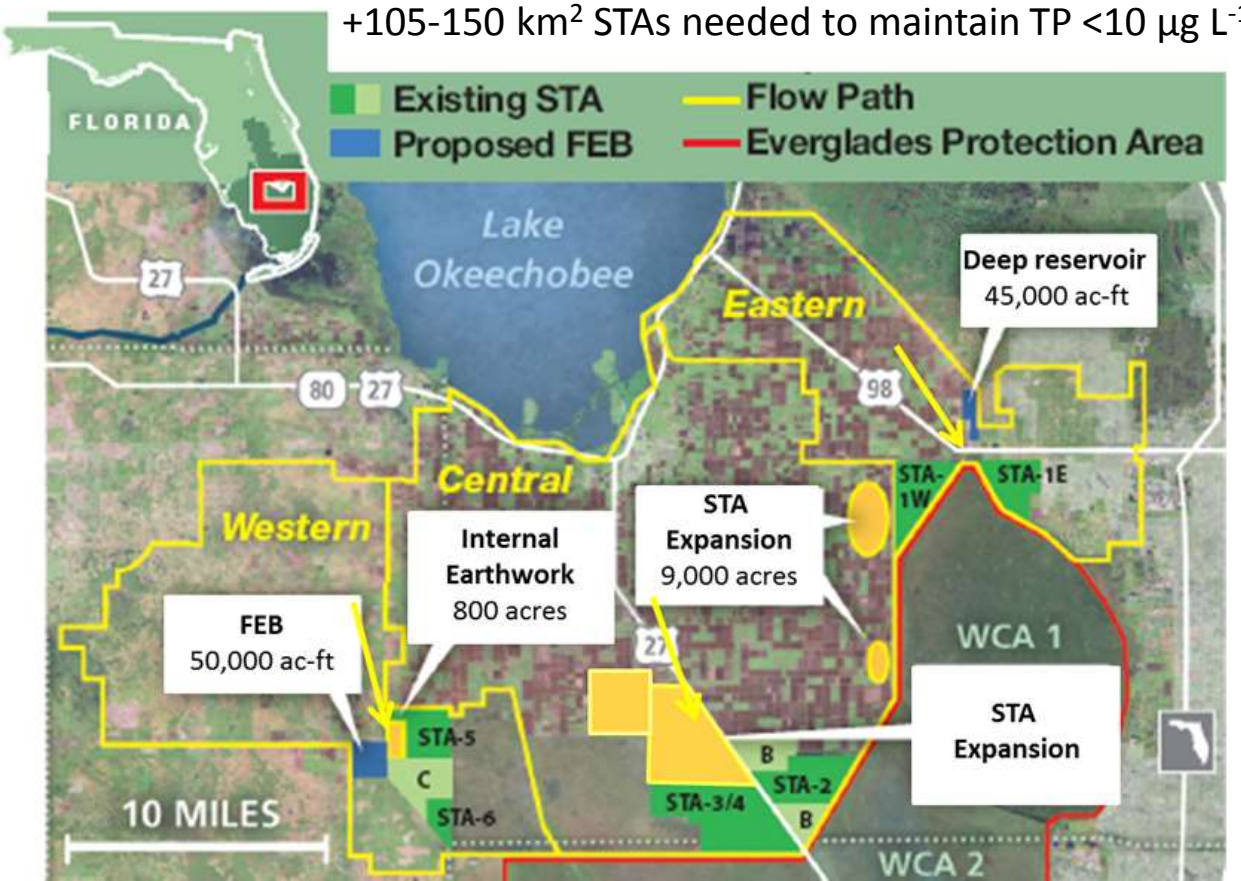
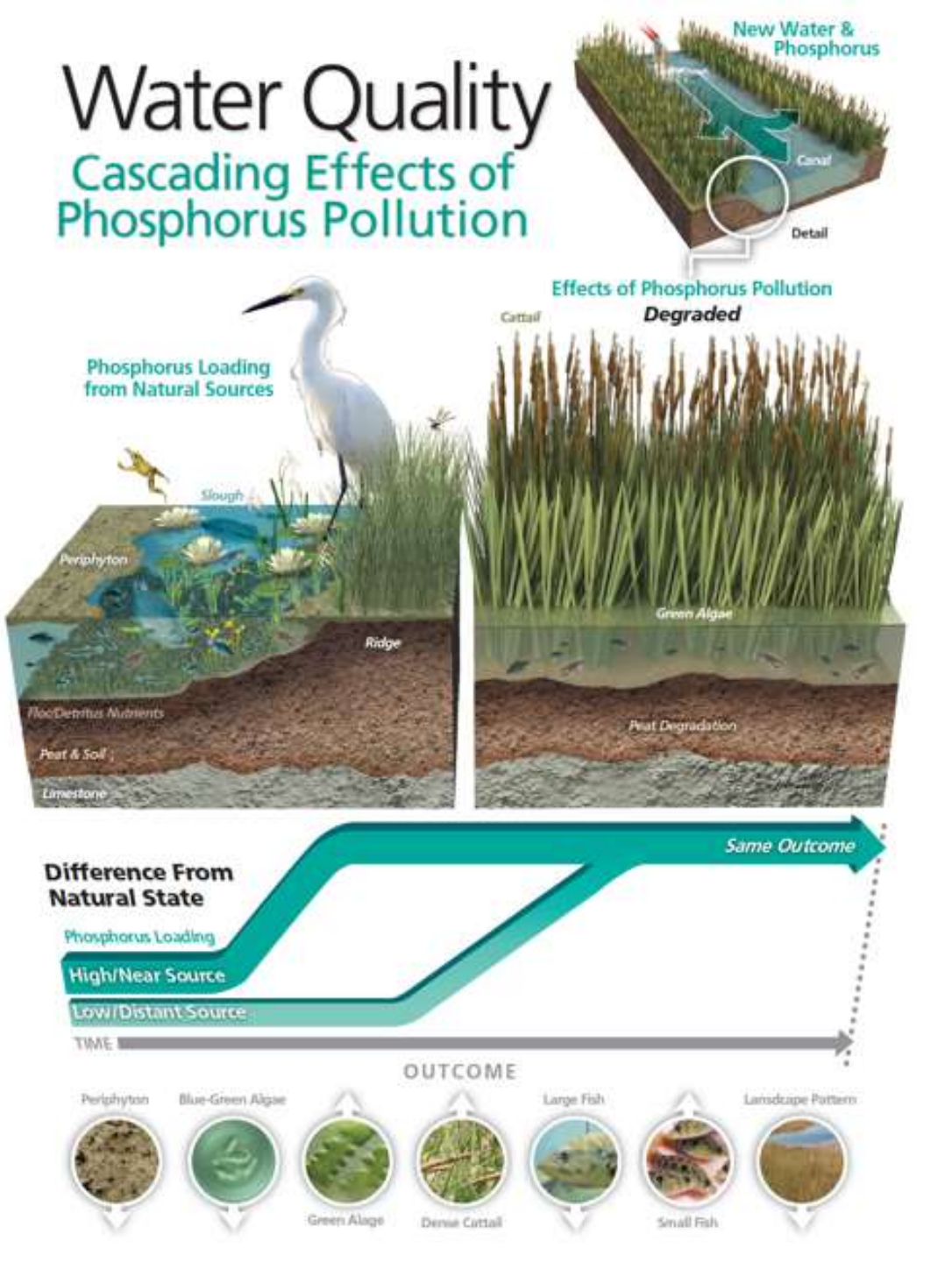
WATER QUALITY

Synthesis of Everglades Research and Ecosystem Services

Everglades Water Quality: There is no compromise

+105-150 km^2 STAs needed to maintain TP <10 µg L^{-1}





PERIPHYTON THE BASE OF THE EVERGLADES FOOD WEB

Periphyton is created by microorganisms including algae, fungi and bacteria. It is found widely across the Everglades landscape growing as a mat on the surface of the soil, water and plants.

Top Predators

LANDSCAPE

Periphyton

Small Invertebrates

TRANSFER OF ENERGY WEB

Periphyton is the base of the Everglades food web. Small organisms that feed on the periphyton mat provide the food base for fish and top predators.

Large Fish

Small Fish

MICROSCOPIC
2,300X SIZE

MARSH

MICROSCOPIC
10X SIZE

CLOSE-UP

PERIPHYTON AND PHOSPHORUS POLLUTION

Periphyton is extremely sensitive to changes in water quality. Scientists have shown that when phosphorus concentrations get above 10 parts per billion, periphyton disappears, resulting in changes to the Everglades food web.

CHANGE IN LANDSCAPE OVER TIME

Natural marsh with periphyton

Loss of periphyton mat

Replacement by green algae

Open water, low oxygen phase

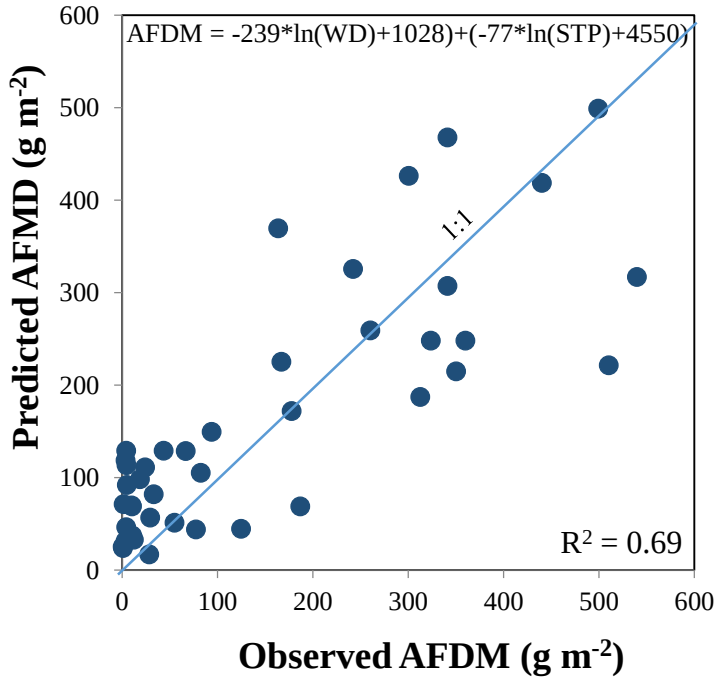
Invasion by cattail

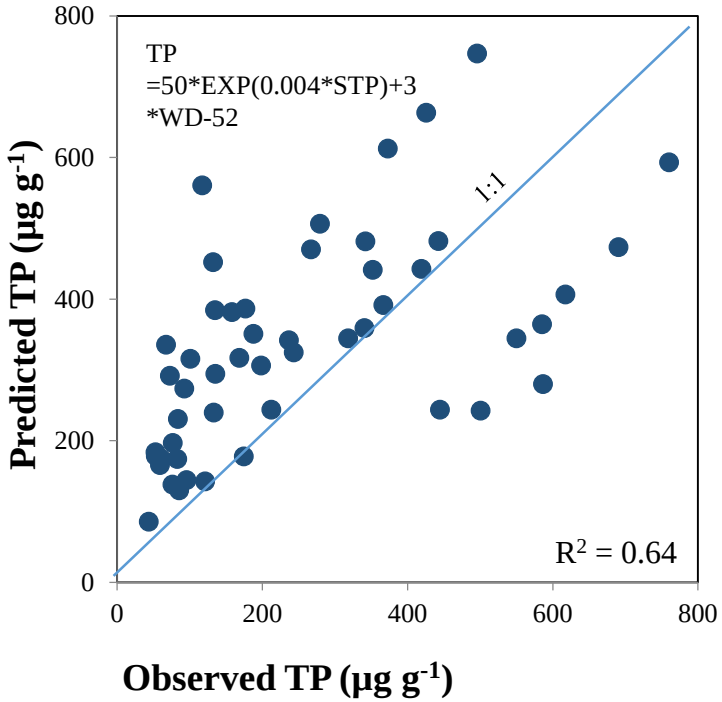
Periphyton Indicators

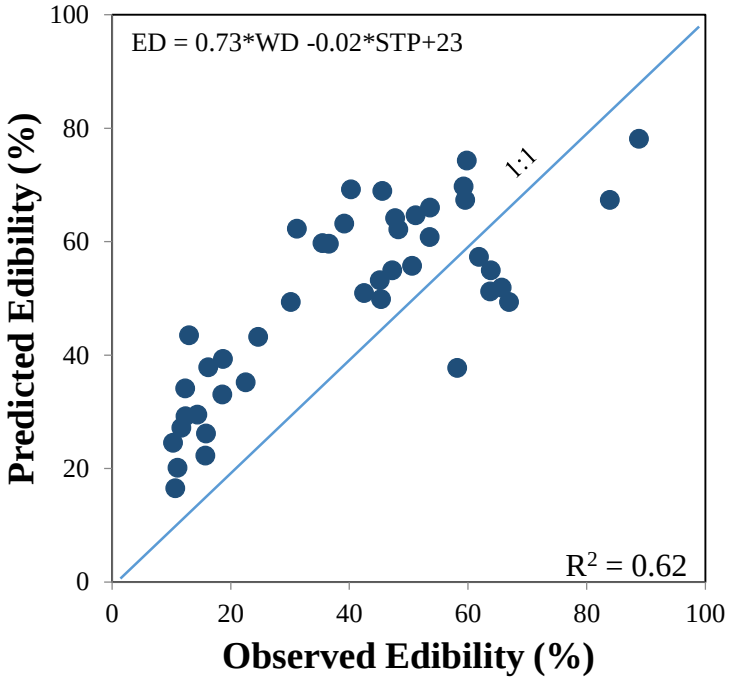
1. Nutrient Content
2. Mass
3. Edibility

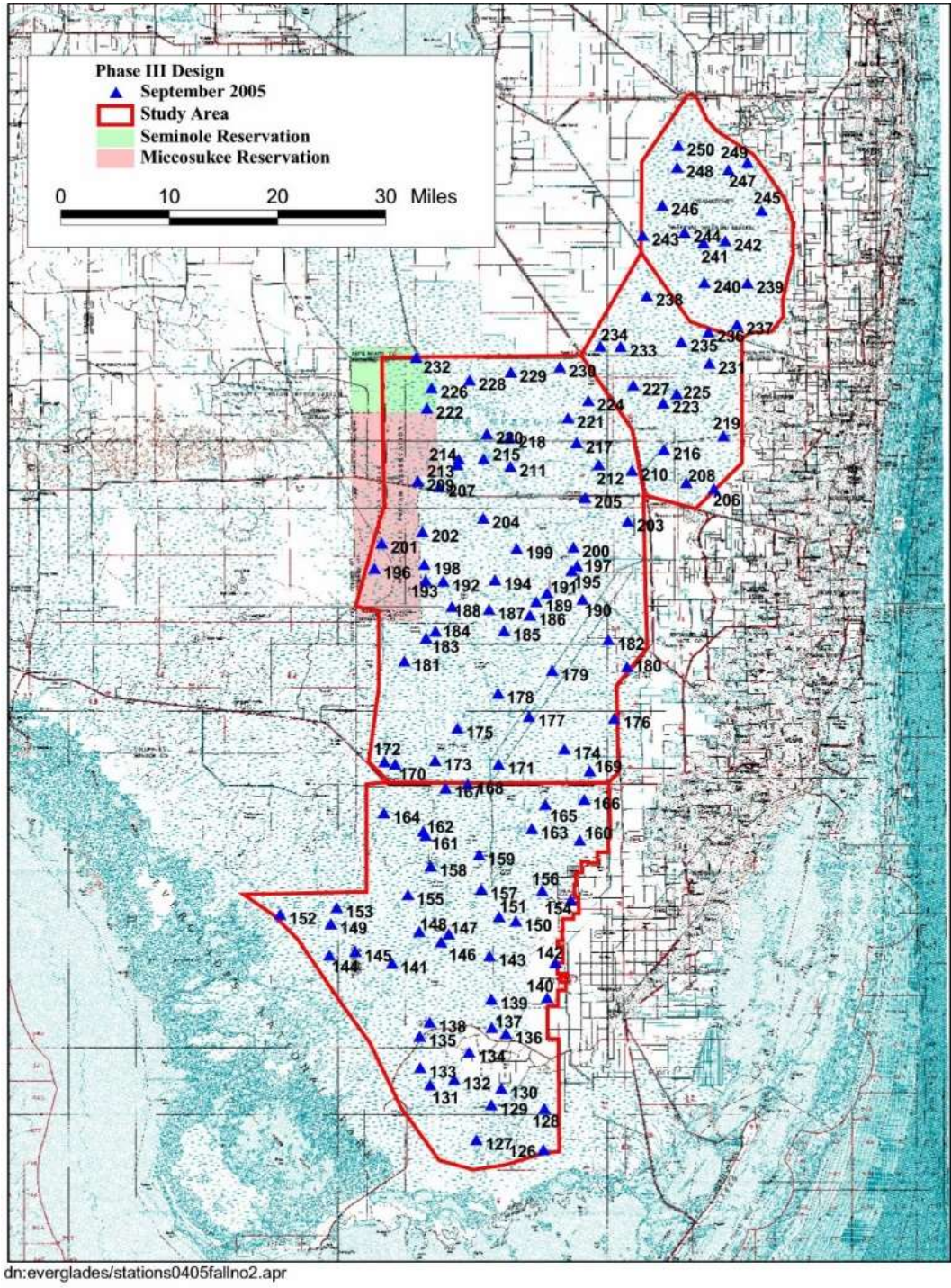
Periphyton Model (PERIMOD)

- Functions for predicting periphyton attributes from ELM output [water depth and soil TP] based on EPA REMAP 2005

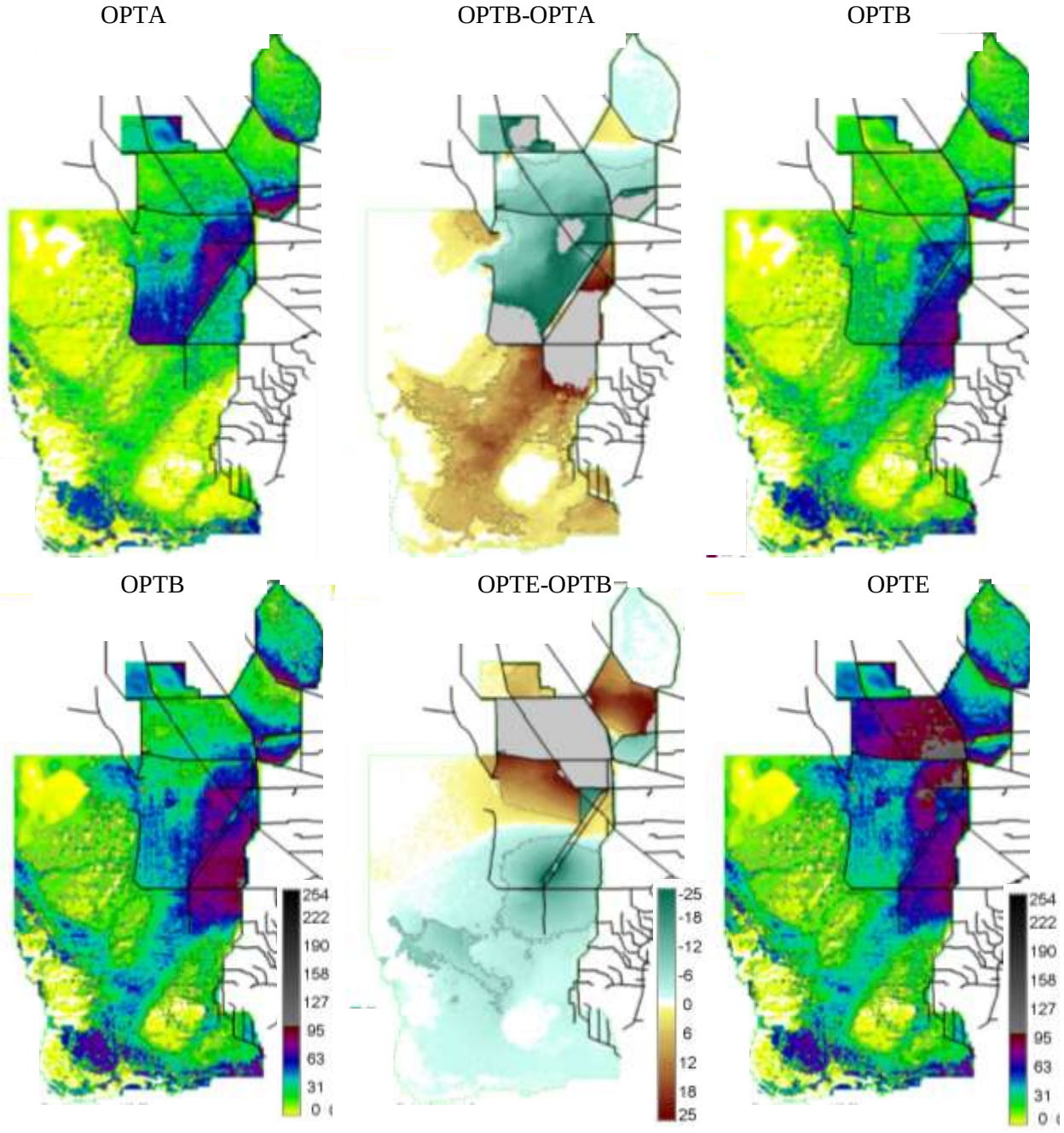








Water Level



Everglades Landscape Model Output

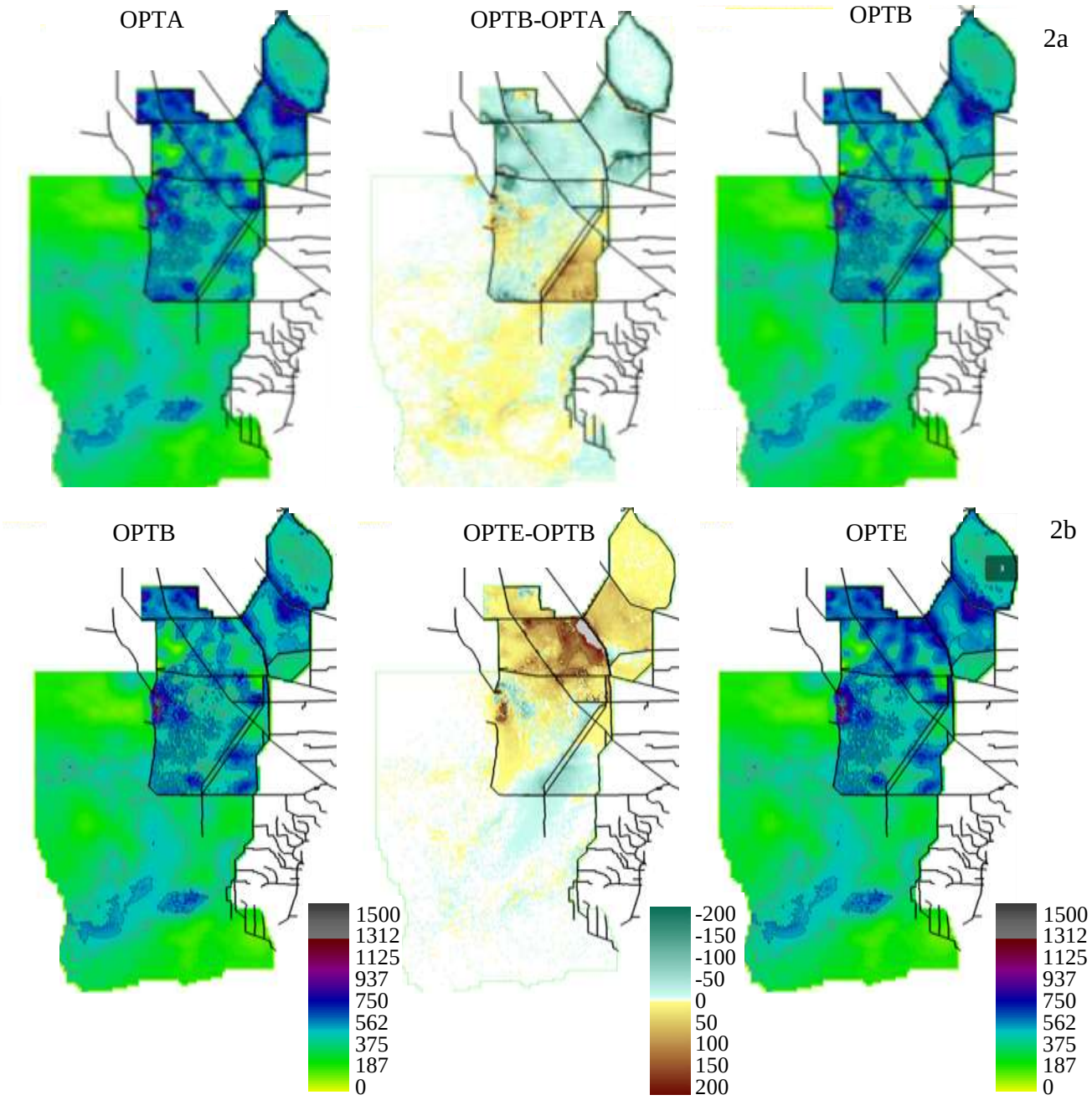
Scenarios	Descriptor
Option A	Existing Condition
Option B	CERP
Option C	Partial CERP
Option D	Expanded Storage and Decomp
Option E	Maximum Storage and Decomp

Table 6. Approximate water depths equaled or exceeded 50% of the time.

Scenarios	WCA-3A north	WCA-3A central	WCA-3A south	WCA-3B south	NESRS	WSRS	Rocky Glades
Natural System	0.8	0.9	1	1.6	2	1.5	0.9
Option A	1.2	1.6	2	1.5	1.2	0.9	0.1
Option B	1	0.9	1	1.9	1.9	1.5	0.8
Option C	1	1	1	1.8	1.8	1.4	0.7
Option D	1	0.7	1	2	2	1.5	0.8
Option E	2	0.8	0.9	2	2	1.5	0.8

- **Water depth approximates NSM once levees and canals are removed**
- **Ponding in northern WCA-3A under OPT E**
- **Ponding in WCA-3B under all options**

Soil Total Phosphorus



Everglades Landscape Model Output

Scenarios	Descriptor
Option A	Existing Condition
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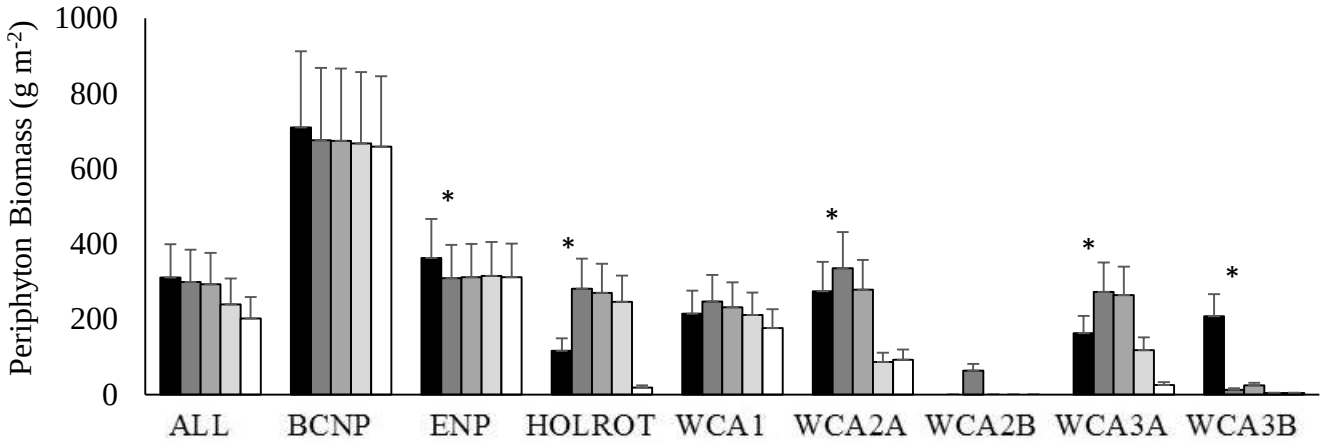
Table 11. Area of Everglades (in hectares) exhibiting soil phosphorus uptake beyond two thresholds (50 mg P m^{-2} $year^{-1}$ and 100 mg P m^{-2} $year^{-1}$).

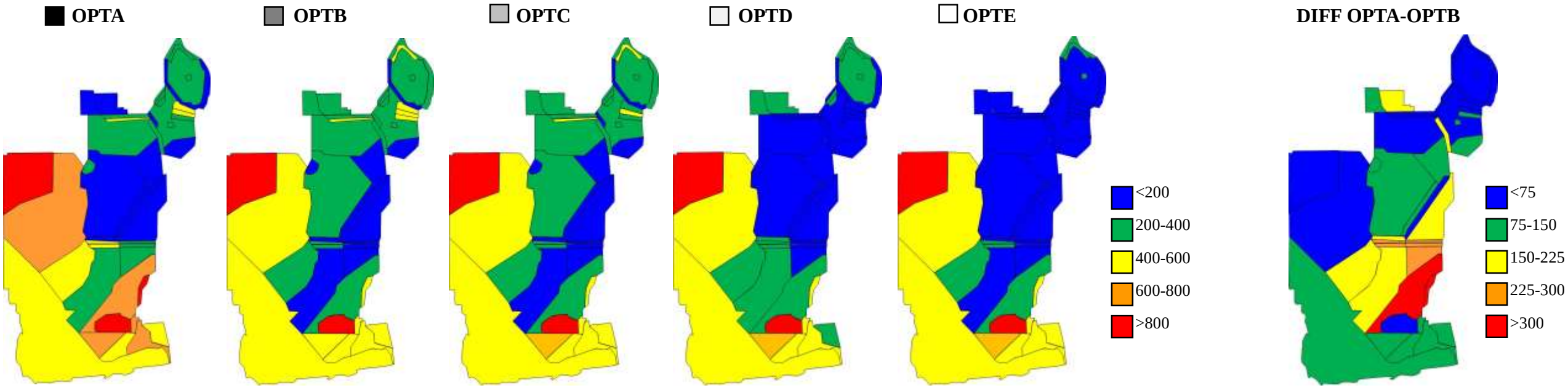
Scenario	Soil P uptake: low threshold (≥50 mg P/m2/yr)	Soil P uptake: high threshold (≥100 mg P/m2/yr)
Option A	142,000	25,300
Option B	85,975	8,775
Option C	84,650	8,750
Option D	90,250	9,700
Option E	105,550	9,800

- **TP loads dramatically reduced in OPTB-E**
- **Highest P uptake in OPT E due to higher loads**

Periphyton Biomass

Scenarios	Descriptor
Option A	Existing Condition
Option B	CERP
Option C	Partial CERP
Option D	Expanded Storage and Decomp
Option E	Maximum Storage and Decomp

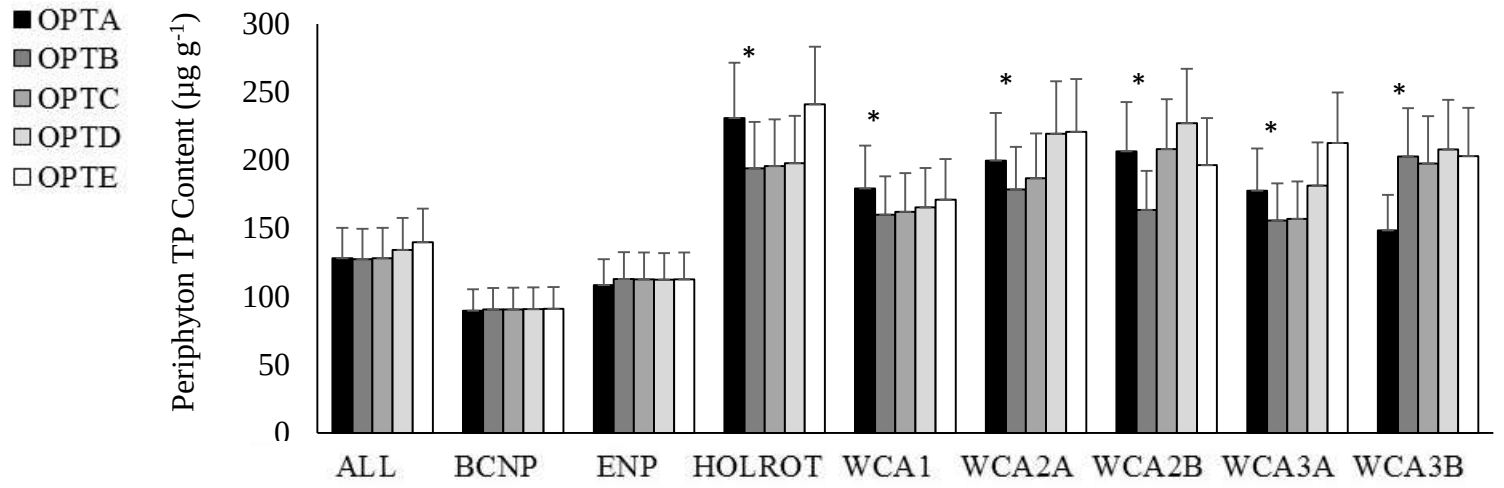


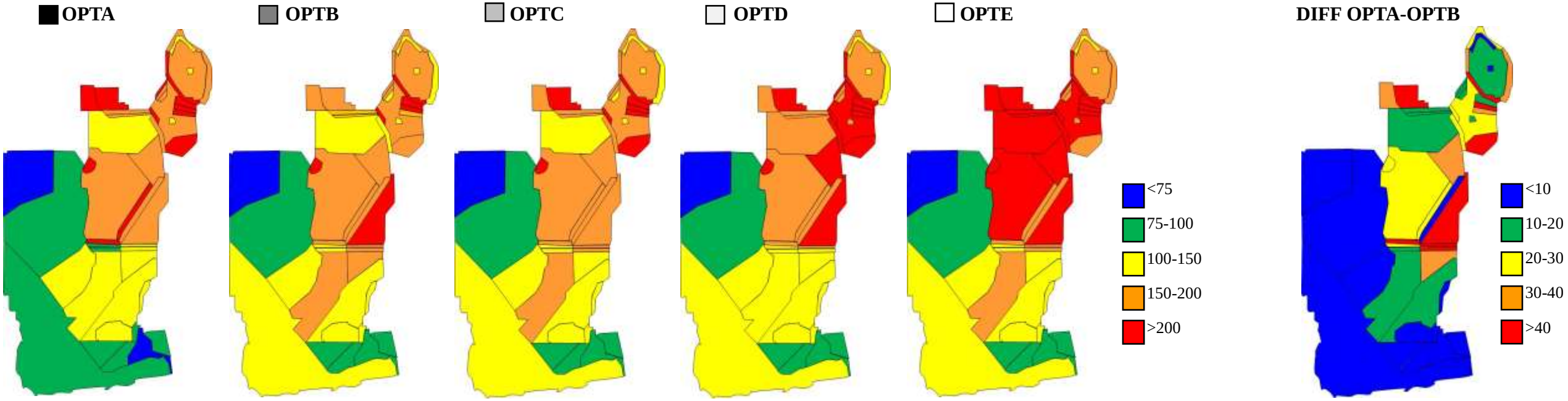


All options reduce periphyton biomass, especially in SRS (marl prairie) and WCA2, northern WCA3A

Periphyton TP

Scenarios	Descriptor
Option A	Existing Condition
Option B	CERP
Option C	Partial CERP
Option D	Expanded Storage and Decomp
Option E	Maximum Storage and Decomp

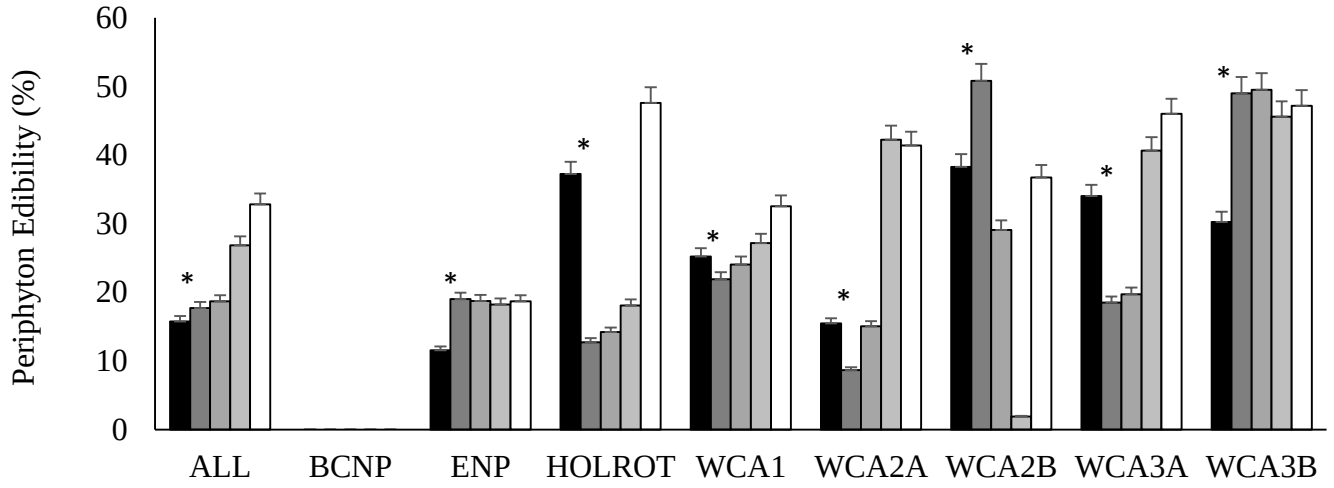


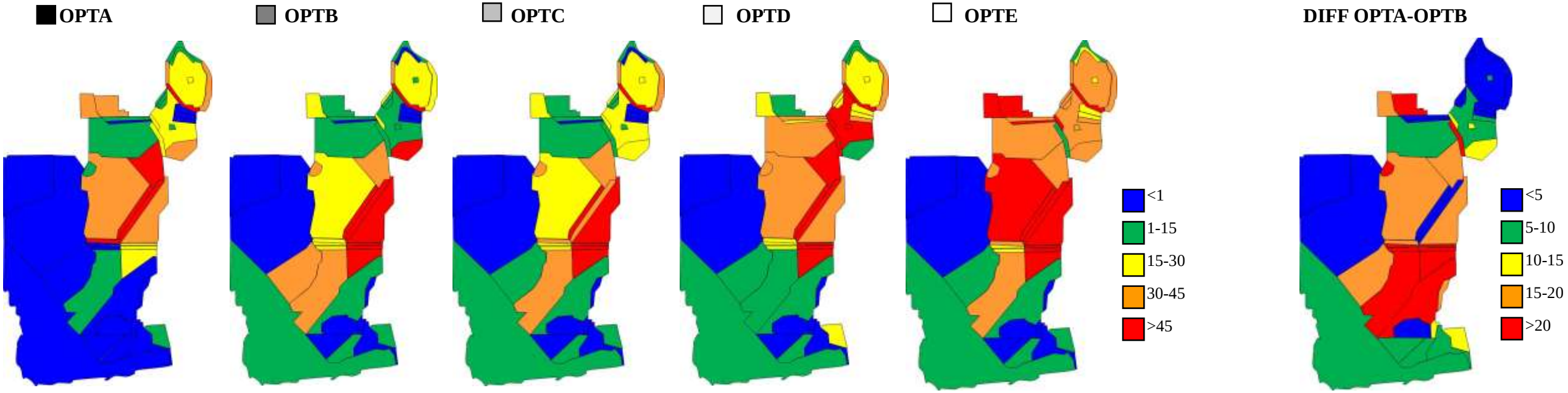


All options increase periphyton TP in Shark River Slough and WCAs, but >90% values within acceptable limits

Periphyton Edibility

Scenarios	Descriptor
Option A	Existing Condition
Option B	CERP
Option C	Partial CERP
Option D	Expanded Storage and Decomp
Option E	Maximum Storage and Decomp





All options increase periphyton edibility (particularly throughout SRS, northern WCAs), especially Option E

Interpretation

All options caused the same direction of change in the three periphyton variables. Magnitude of change depends on water delivery scenarios and their effect on legacy P.

Biomass: Greatest impact → increased stage reduces calcareous periphyton

- Reduction greatest on edges of SRS (50% of baseline)

Quality: No significant changes at whole system scale, notable decreases in WCAs

- Some increases due to increased load (but mostly <200 µg g^{-1} ~ baseline)

Edibility: Increases significantly in all scenarios

- Edible species of green algae and diatoms increase with water depth and P load
- Greatest increases greatest in SRS, WCA-3A and 2-A (up to 20% increase)

Option D maximizes biomass while minimizing quality (TP) impacts. Improved edibility will increase trophic transfer and cascade through the food web from small aquatic consumers to wading birds. In ENP, impacts are strongest in the marl prairie.

Next steps

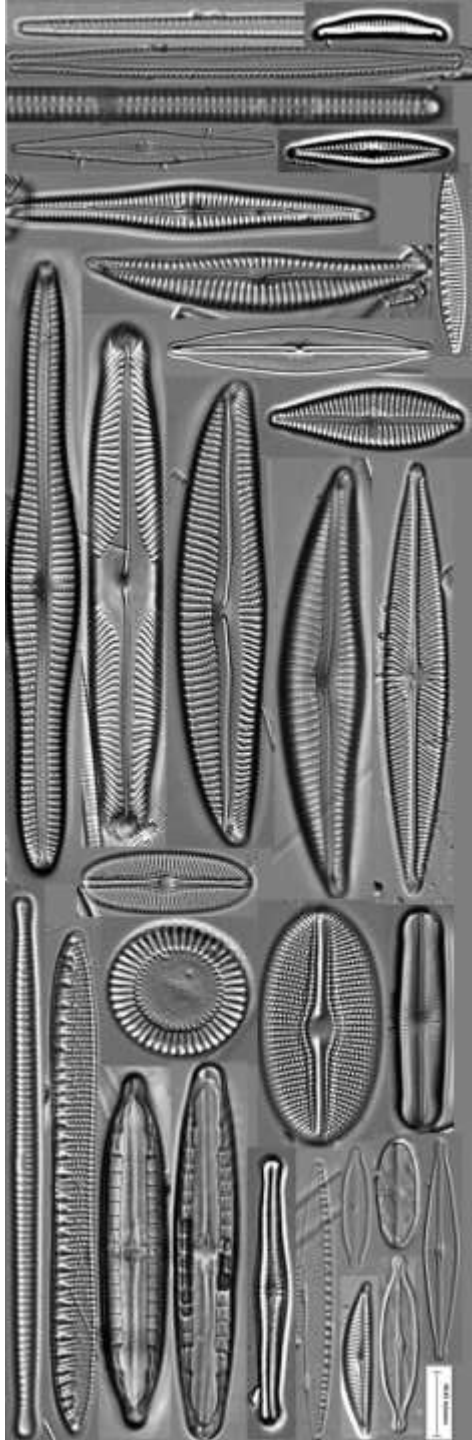
- Mechanistic experiments to improve functions and feedbacks of periphyton responses to TP, hydrology and salinity

- What are the consequences of changing periphyton quantity on vegetation structure, fire probability and CSSS habitat in the marl prairie?

- What are the boundaries of “safe” periphyton function for the Everglades?

- What are the spatio-temporal scales of disturbance-response cascades?

Updated diatom identification monograph coming soon! →



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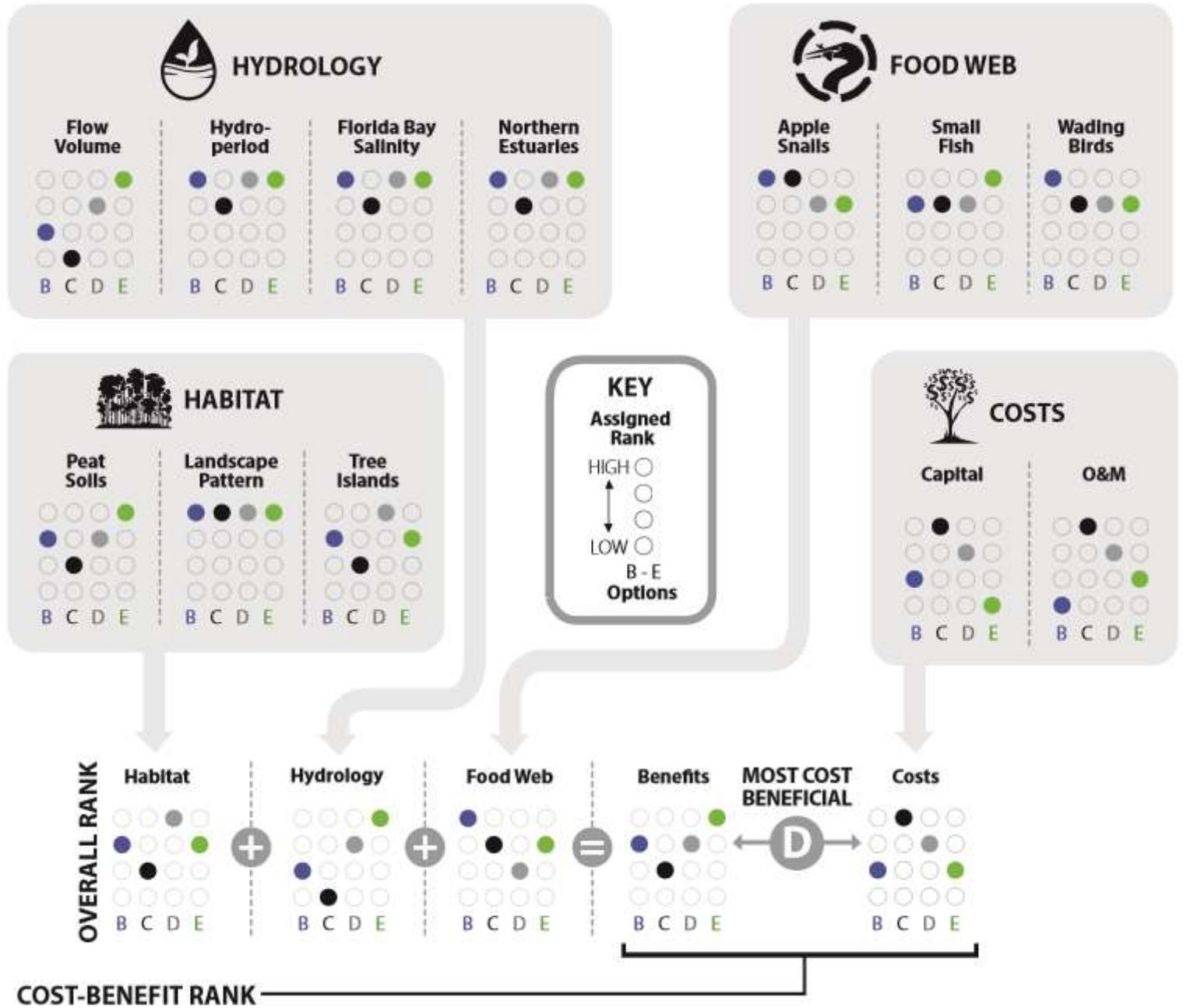
Option E exhibited best overall ecological performance, followed by Options B and D. Option D was the most cost beneficial option.



Management-Driven Science Synthesis: An Evaluation of Everglades Restoration Trajectories

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Synthesis of Everglades Research and Ecosystem Services

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