WHY ARE WE SO BAD AT TALKING SCIENCE WITH NON-SCIENTISTS: ESPECIALLY MANAGERS AND POLICY MAKERS?

Ecological Indicators for System-wide Assessment of the Greater Everglades Ecosystem Restoration Program

a modest proposal

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"With the exception of a few people. . .we [*scientists*] don't know how to communicate with the public *[or managers and policy-makers*]. We don't understand our audience well enough... to understand why it's difficult for them to hear us speak. We don't know the language and we haven't practiced it enough."

Dr. Neal Lane, Former Head of the National Science Foundation (source Weigold 2001)

Large numbers of American adults appear to be scientifically illiterate (Maienschein 1999), **leaving many to conclude there is a problem in science communication** (Dornan 1988, 1990, Hartz and Chappell 1997)

In the 1920s the language of science would have been indistinguishable from other forms of literature, but today the language of science has "diverged from the mainstream of literary language and divided into a large number of small, winding tributaries" (Shortland and Gregory 1991)

Some thoughts I've heard

It's just "pointy-headed scientist's" stuff people express at meetings

Former deputy to a former secretary of interior

(and I'll bet you have too)

All they (*i.e., scientists*) do is "make long lists of research we don't need" but that they want to do to "keep themselves employed"

Former member of the South Florida Ecosystem Restoration Task Force

"It's either a 'wicked major priority' [*referring to Everglades Restoration science projects*] or it's not a priority at all . . . and it won't get funded."

Carol Wehle

Executive Director SFWMD, Feb. 2008 Task Force Meeting

On the other hand . . .

"…. what goes on down here [i.e. *South Florida*] is an amazing connection between scientists who want to do science, and what's happening at Carol's [*i.e. Carol Wehle*] level."

Dr. Jeff Jordan
University of Georgia, Feb. 2008 Task Force Meeting

So if people like Jeff Jordan (and even Lynn Scarlet) seem to think we're doing a pretty good job with science, how can we do a better job of communicating the results of our science to managers and policy makers?

the modest proposal

A small set of System-wide Ecological Indicators with which to assess the "big-picture" of restoration and a means to synthesize and communicate summary results using an easy to understand format

This work involves too many people to name here but it is a joint effort between

The Task Force Science Coordination Group

and

RECOVER

and

The many scientists who are working on the indicators

Why?

- The Task Force and RECOVER are required to report to Congress on the status of Everglades restoration
- In 2004 the Task Force requested a small set of System-wide Indicators to assess Everglades restoration
- Developed criteria and a selection process to identify a small set of system-wide indicators
- Developed a “report card system”
- Included peer review and public comment
- System-wide indicators and reports cards will be included in the Task Force 2008 Biennial Report and will be incorporated in the RECOVER System Status Report for 2009 and RECOVER 5-year report to Congress

Four Step Process

1. Reviewed the scientific literature on indicators
2. Developed criteria to evaluate relevant concepts and indicators for Everglades Ecosystem
3. Used those to select system-wide indicators, and develop appropriate concepts and formats
4. Developed final suite of indicators to assess System-wide restoration

Selection Criteria

1. Is the indicator relevant to the ecosystem?
2. Is the indicator feasible to implement (i.e. is someone already doing it?)
3. Is the indicator sensitive to system drivers?
4. Is the indicator interpretable in a “common” language?
5. Are there situations where an “optimistic” trend in the indicator might suggest a “pessimistic” restoration trend?
6. Are there situations where a “pessimistic” trend in the indicator may be unrelated to restoration?
7. Is the indicator scientifically defensible?
8. Can clear measurable targets be set?
9. Does the indicator have enough specificity to be able to be used to correct or redirect restoration actions?
10. Is the indicator integrative?
11. Does the suite of indicators cover the critical range of ecosystem “features” including processes and structures?

Everglades Ecosystem "Features"

- **Landscape Characteristics**
  - Hydro-patterns
  - Vegetation Pattern/Patchiness
  - Productivity
  - Native Biodiversity
  - Oligotrophy
  - "Prinstineness"
  - "Intactness"
  - Trophic Balance
  - Habitat Balance
- **Trophic Constituents – Biodiversity**
  - Primary Producers
  - Primary Consumers
  - Secondary & Tertiary Consumers
- **Physical Properties**
  - Water Quality, Depth, Duration, Timing
  - Water Management
  - Exotics
  - Salinity
  - Nutrients
  - Contaminants
- **Ecological Regions**
  - Estuaries, Short-hydroperiod marshes, etc.
- **Temporal Scales**
  - Indicators that respond rapidly to environmental changes
  - Indicators that respond more slowly to environmental changes

Principal Principle

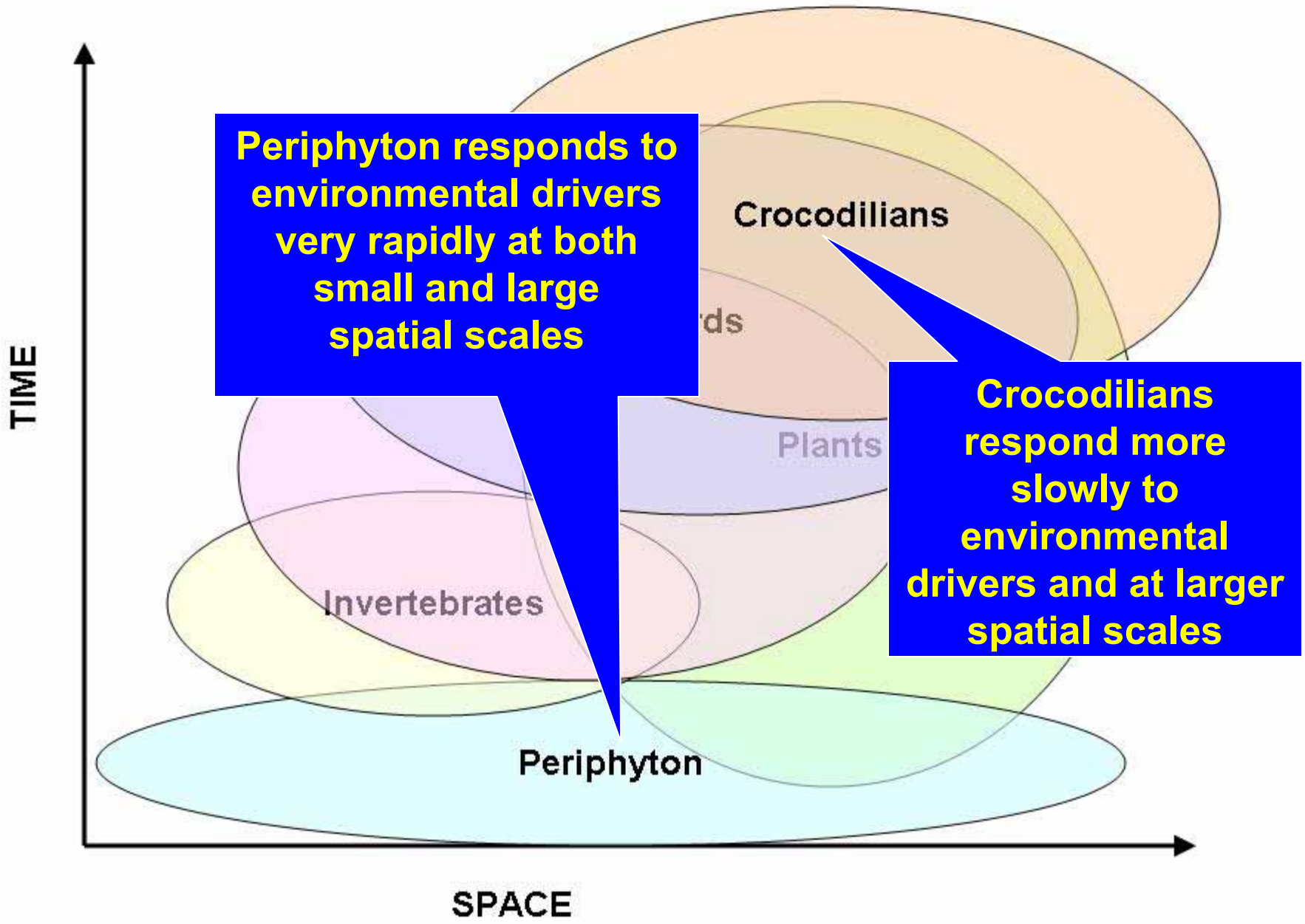
The Indicators individually and collectively integrate a vast number of ecological functions **(that can not or will not be monitored)** in their life stages and processes **(and their life processes interrelate spatially and temporally)**

System-wide Ecological Indicators

1. **Periphyton-Epiphyton**
2. **Fish**
3. **Roseate Spoonbills**
4. **Wood stork—White Ibis—Great Egret**
5. **Oysters**
6. **Juvenile Pink Shrimp**
7. **Florida Bay Algal Blooms**
8. **Florida Bay Submerged Aquatic Vegetation (SAV)**
9. **Lake Okeechobee Littoral Zone (SAV)**
10. **Crocodilians (Alligators & Crocodiles)**
11. **Exotic Plants**

How Indicators Apply System-wide

- The System-wide Ecological Indicators are populations or communities of organisms
- Indicators need to “cover” as many Everglades “Features” as possible to be considered System-wide
- This includes spatial and temporal aspects of the Everglades
- The indicators need to be integrative


Periphyton responds to environmental drivers very rapidly at both small and large spatial scales
Crocodilians respond more slowly to environmental drivers and at larger spatial scales
Crocodilians
Plants
Invertebrates
Periphyton
TIME
SPACE

Assessing and Communicating System-wide Indicators

8 Essentials

1. **Scientific Consensus** on Ecosystem Structure & Function – and on what makes a good indicator – CEMS
2. **Indicators** (e.g. fish) with ***metrics*** for Ecosystem Structure or Function (Environmental Conditions)
    1. Species that integrate numerous ecological processes
    2. Species whose status reflects status of key habitats
    3. Species that serve as an "early warning sign" of anticipated stressors
3. **Baselines** (reference periods) to establish points of comparison
4. **Monitoring Programs** to collect the data for assessments
5. **Performance Measures** (e.g. bluefin kilifish per unit area) using ***metrics*** *to* compare interim and end point results with desired outcomes
6. **Targets** for indicators (e.g. bluefin kilifish per unit area relative to water depth) to set interim or end points against which to measure trends
7. **Assessments** to analyze the data and evaluate the progress and results
8. **Communication Tools** to inform, advise and educate the restoration community

Communicating the Status of the System-wide Indicators

Linking Complex Data Analyses to the Stoplights

3 Tiers of Information

Florida Bay Algal Blooms

Chlorophyll *a*

Tier One

Restoration Stoplight Report Card

Restoration Stoplight Report Card
Florida Bay Algal Blooms

KEY FINDINGS – SOUTHERN ESTUARIES

SUMMARY FINDING: Re-suspension of nutrients from the 2005 hurricane season resulted in algal blooms in many regions of the southern estuaries and may cause continued algal blooms in the bay for some time. However, this is expected to subside within a few additional years in lieu of further significant hurricane activity and should return to predominantly green for all regions with the possible exception of BMB.

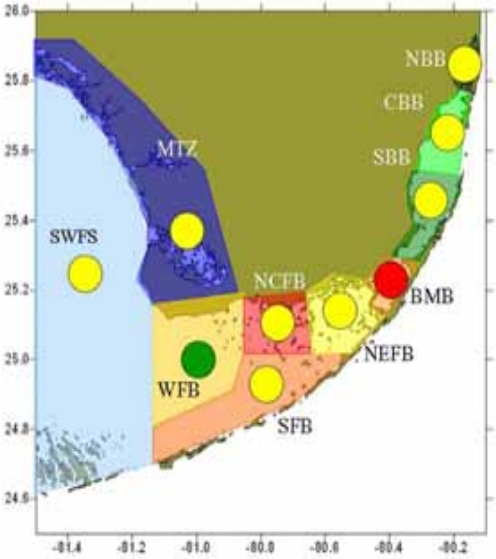


Figure 1. Map of Florida Bay regions with stoplight ratings by region

KEY FINDINGS:

1. The majority of regions assessed had significant algal bloom activity that appears to have been predominantly influenced by the heavy 2005 hurricane season aggravated for the eastern bay by road construction on US 1.
2. The majority of regions assessed had chlorophyll-*a* and algal blooms rated as moderate (yellow).
3. The majority of regions assessed where the chlorophyll-*a* was higher than the median do not appear to be indicative of long-term negative trends.
4. The most commonly occurring condition was large spatial coverage of algal blooms and elevated chlorophyll-*a* concentrations.
5. Overall eutrophic symptom expressions were geographically variable and appear to be explainable from existing phenomenological conditions of hurricane activity overall exacerbated by road construction along US 1 in the eastern areas of the bay.
6. Continue monitoring water quality throughout the bay and the SW coastal shelf particularly as a result of the post 2005 hurricane season.
7. Monitoring of Barnes, Manatee and Blackwater Sounds is critical while road construction along US 1 continues.
8. Monitoring long term consequences of nutrient releases into the bay from both natural (e.g. hurricanes) and human causes (e.g. road construction) and the interactions of hydrological restoration (e.g. more fresh water flow into Florida Bay) is critical to evaluating Florida Bay restoration.

ALGAL BLOOMS – SOUTHERN ESTUARIES

PERFOMANCE MEASURE	LAST STATUS	CURRENT STATUS[a]	2-YEAR PROSPECTS[b]	CURRENT STATUS[a]	2-YEAR PROSPECTS[b]
Chlorophyll a BARNES, MANATEE & BLACKWATER SOUNDS (BMB)				This region of the bay experienced an unusual cyanobacterial bloom in 2006. The bloom was initiated by a large spike in phosphorus from a combination of canal releases and highway construction in response to the active hurricane season. The bloom has abated somewhat but chlorophyll concentrations have not returned to previous levels.	When road construction is completed, we expect that this area will return to its green condition that existed from 1995 until 2006.
Chlorophyll a NORTHEAST FLORIDA BAY (NEFB)				The current status is due to influence of the cyanobacterial bloom from Barnes, Manatee and Blackwater Sounds periodic expansion into this region.	The return to a green condition for this region of the bay depends on water management activities improving flows into the C-111 basin and Taylor Slough.
Chlorophyll a NORTH-CENTRAL FLORIDA BAY (NCFB)				The current status is due to the presence of a seasonal cyanobacterial bloom in both early and late 2006. These blooms do not appear every year, but have occurred intermittently over the past 15 years.	Without improvements in freshwater flows to Florida Bay the area will probably remain yellow.
Chlorophyll a SOUTH FLORIDA BAY (SFB)				The current status is due to the extension of the cyanobacterial bloom from the north-central region of the bay during both years. This has occurred intermittently over the past 15 years and it is unlikely that this signifies a long-term negative trend.	Since blooms in this area are driven by external forces, it is expected that such periodic events may occur.
Chlorophyll a WEST FLORIDA BAY (WFB)				The seasonal diatom blooms in this region for both 2006 and current were not as dense or widespread as in the past.	This region is influenced primarily by Shark Slough outputs and southerly transport of Gulf of Mexico water along the SW Florida Shelf. Conditions are therefore dependent on external forcing.
Chlorophyll a MANGROVE TRANSITION ZONE (MTZ)				The chlorophyll concentrations were slightly higher in this region for 2006. This may have been due to the active 2005 hurricane season and is unlikely to indicate a negative long-term trend.	The return to a green condition for this region of the bay depends on water management activities improving flows into the C-111 basin and Taylor Slough.
Chlorophyll a SOUTHWEST FLORIDA SHELF (SWFS)				The chlorophyll concentrations were slightly higher in this region for both 2006 & 2007. This may have been due to the active 2005 hurricane season and is unlikely to indicate a negative long-term trend.	This region is influenced primarily by Shark Slough outputs and southerly transport of Gulf of Mexico water. Conditions are therefore dependent on external forcing.
Chlorophyll a NORTH BISCAYNE BAY (NBB)				The chlorophyll concentrations were higher than the baseline for the past four years.	Without any major hurricanes or changes in water flows to this region it is expected that this region will remain yellow. Significant inputs from canals will continue to affect this area until sheet flow is restored.
Chlorophyll a CENTRAL BISCAYNE BAY (CBB)				The chlorophyll concentrations were higher than the baseline for the past four years.	Without any major hurricanes or changes in water flows to this region it is expected that this region will remain yellow.
Chlorophyll a SOUTH BISCAYNE BAY (SBB)				The chlorophyll concentrations were higher in this region for 2006. This area was also influenced by periodic expansion of the cyanobacterial bloom from Barnes, Manatee and Blackwater Sounds into this region.	Without any major hurricanes or changes in water flows to this region it is expected that this region will remain yellow.

[a] Data in the Current Status column for the algal bloom indicator reflect data inclusive of calendar year 2006.

[b] The assumption being used for the 2-Year Prospects Column is: *There will be no changes in water management from the date of the current status assessment.*

Tier Two Examples

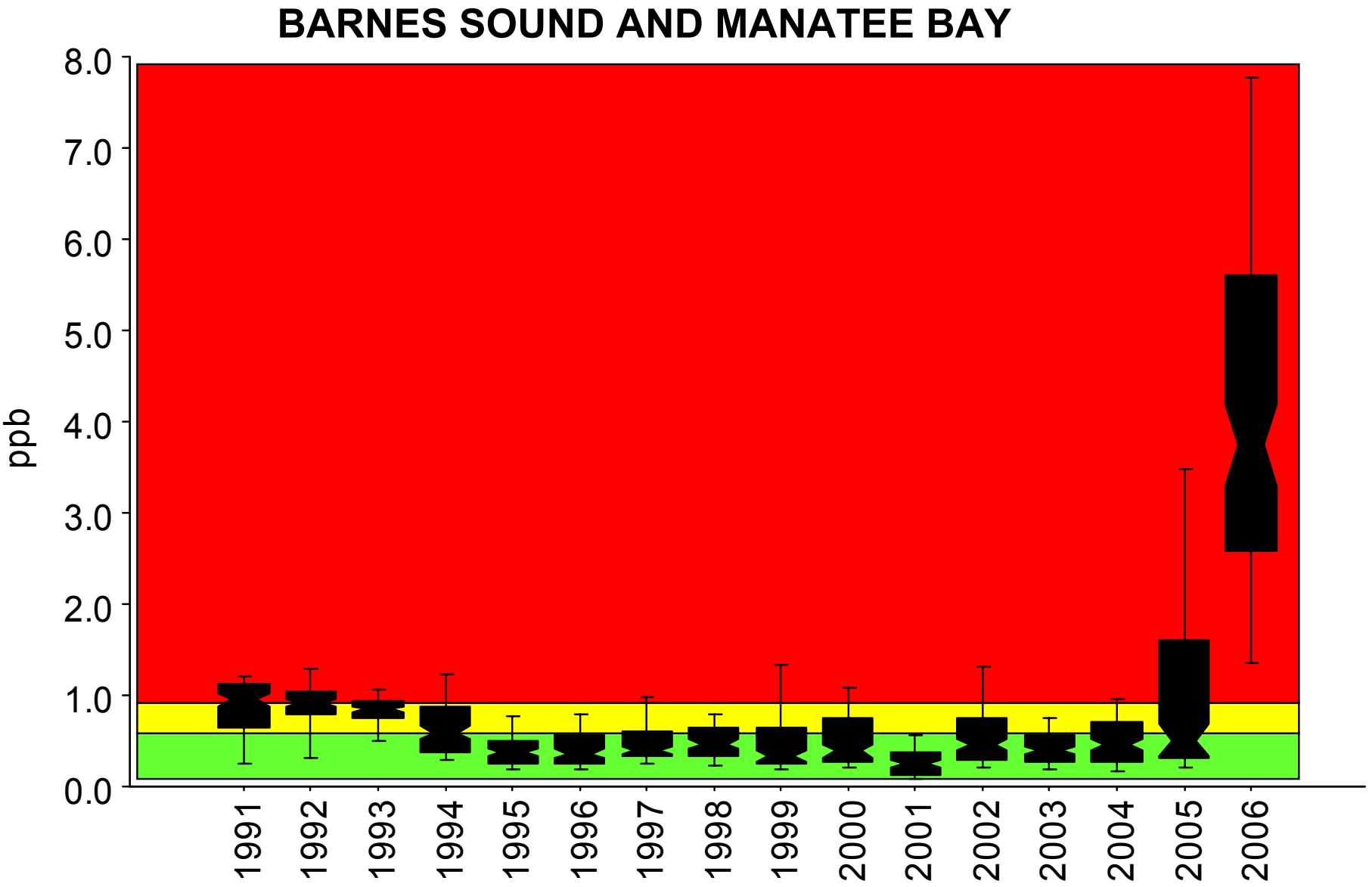
Florida Bay Algal Blooms

SUMMARIZED DATA & GRAPHICS

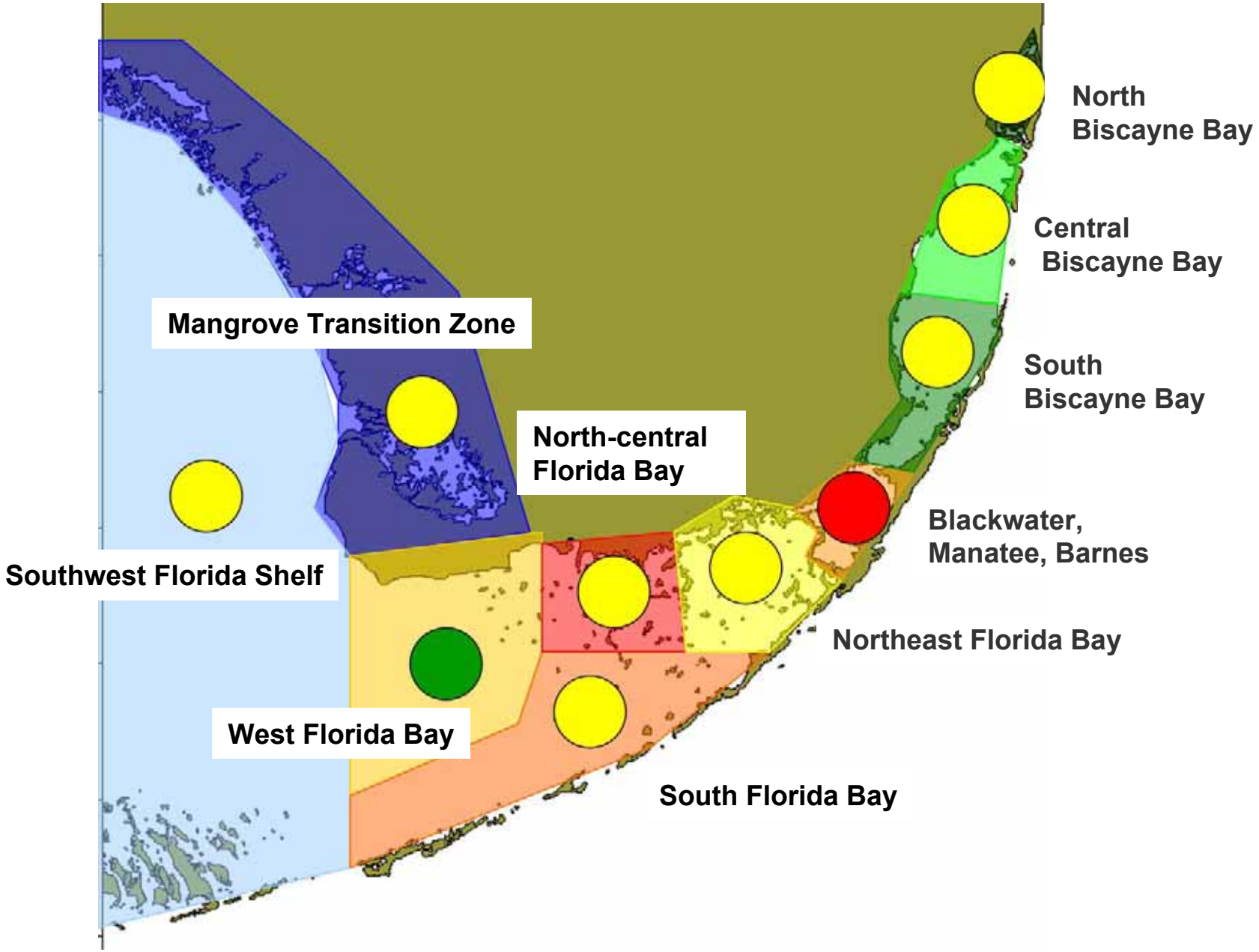
Stoplight "Color - Coded" Maps
Simplified Stoplight "Color- Coded" Graphics
Performance Measure Thresholds

Target thresholds for evaluating chlorophyll *a* (ppb) Performance Measure to determine color code

Sub-region		Valid N	25th Percentile	Median	75th Percentile
Blackwater, Manatee, Barnes	BMB	1704	0.306	0.526	0.910
Central Biscayne Bay	CBB	1673	0.200	0.313	0.566
Mangrove Transition Zone	MTZ	3803	1.690	2.863	4.903
North Biscayne Bay	NBB	635	0.670	1.048	1.648
North-central Florida Bay	NCFB	1399	0.585	1.216	3.710
Northeast Florida Bay	NEFB	1979	0.254	0.417	0.790
South Biscayne Bay	SBB	2257	0.181	0.264	0.426
South Florida Bay	SFB	1695	0.327	0.533	1.059
Southwest Florida Shelf	SWFS	1297	0.739	1.180	1.976
West Florida Bay	WFB	2304	0.653	1.345	2.845



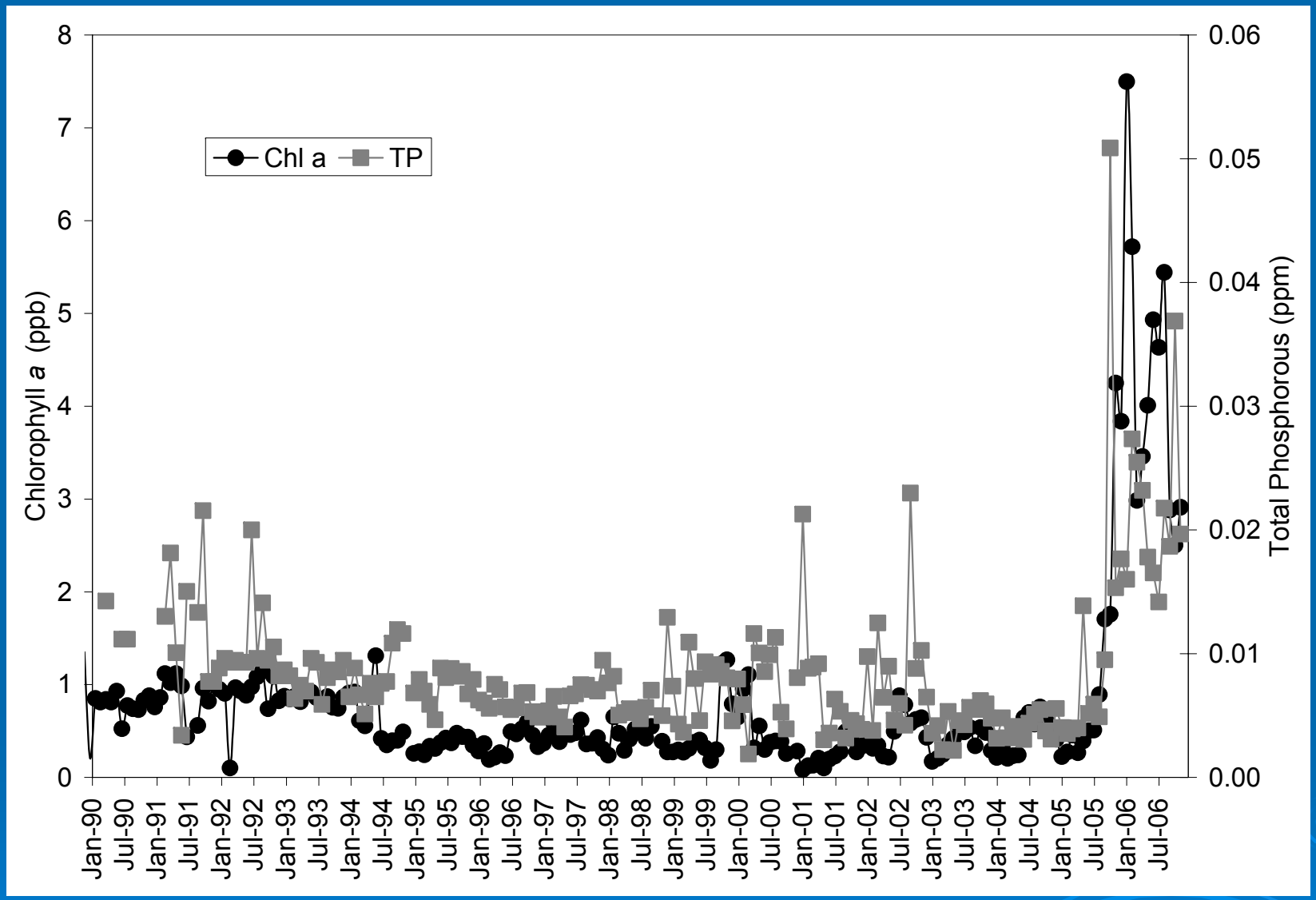
GRAPHIC DATA SUMMARIES
IN STOPLIGHT COLOR-CODED FORMAT


North
Biscayne Bay
Central
Biscayne Bay
South
Biscayne Bay
Mangrove Transition Zone
North-central
Florida Bay
Blackwater,
Manatee, Barnes
Southwest Florida Shelf
Northeast Florida Bay
West Florida Bay
South Florida Bay

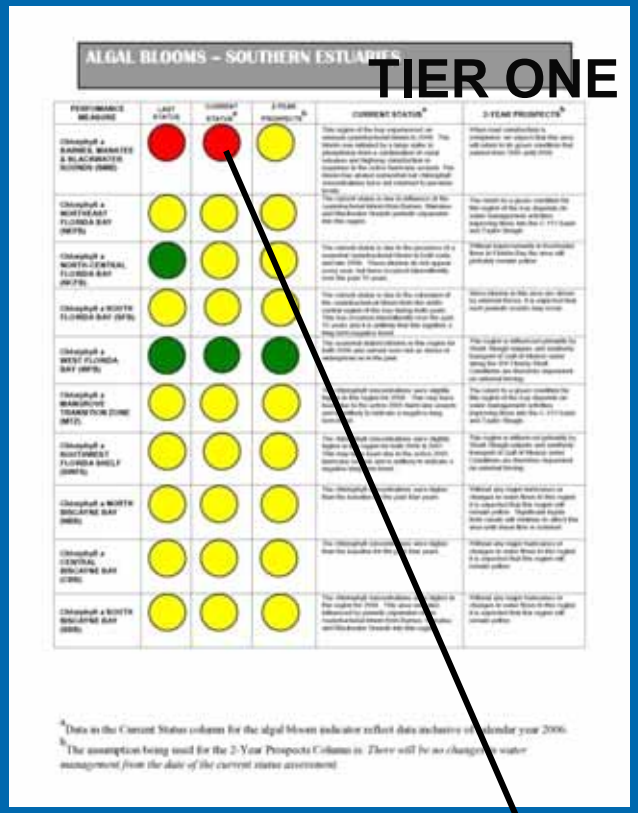
Tier Three Examples

Florida Bay Algal Blooms

Data Analyses, Theory,
Modeling, Performance Measures,
Metrics, Thresholds,
Targets, Assessments



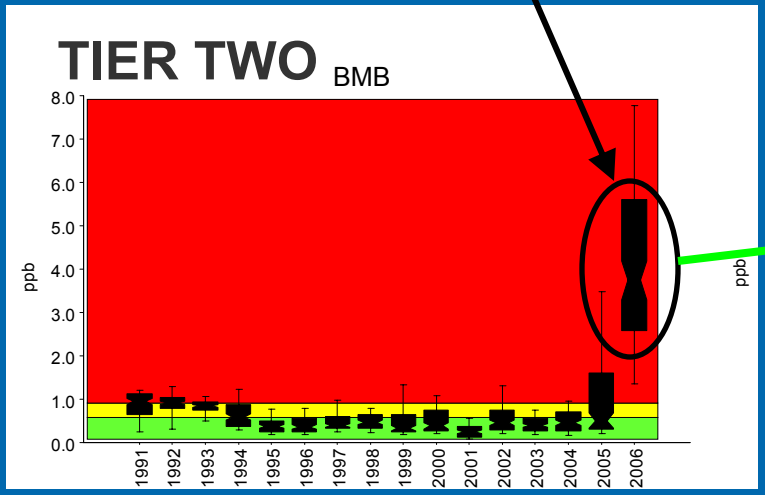
Time series of median chlorophyll *a* (ppb) and total phosphorous (ppm) in the Barnes Sound Manatee Bay sub-region.

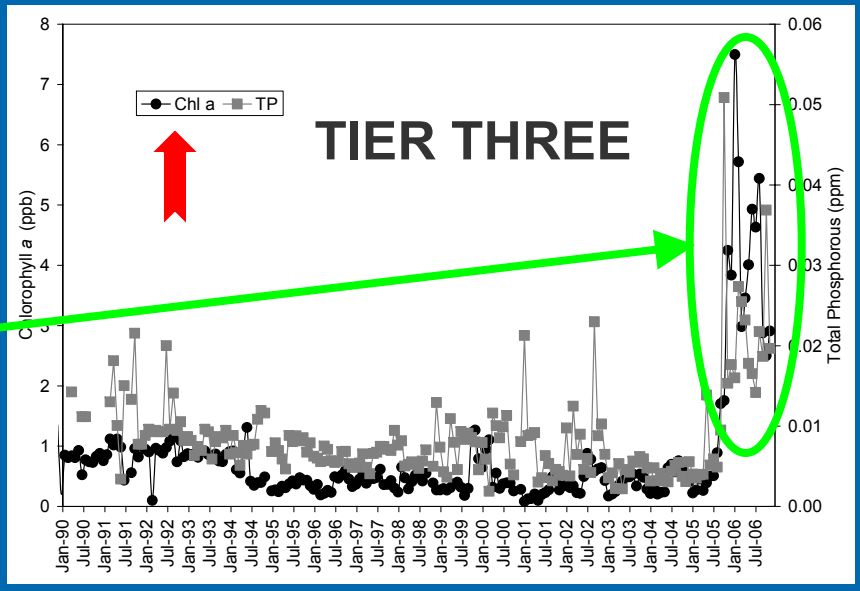


The assessments and stoplight report cards provides direct and transparent links from the data to the stoplights

OUR GOAL IS TO:

- Develop Stoplights that are empirically based
- Develop performance measures and targets that are dynamic & reflect natural variation
- Distinguish between natural and management effects on performance measures and targets where possible

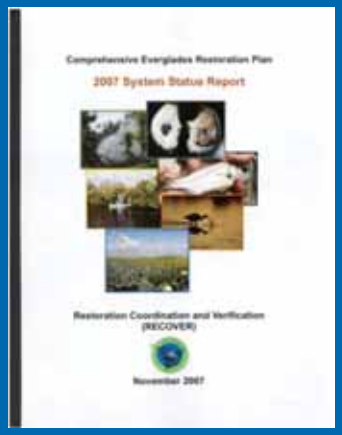




Agency Reports are all using the same science

Task Force
Biennial Report

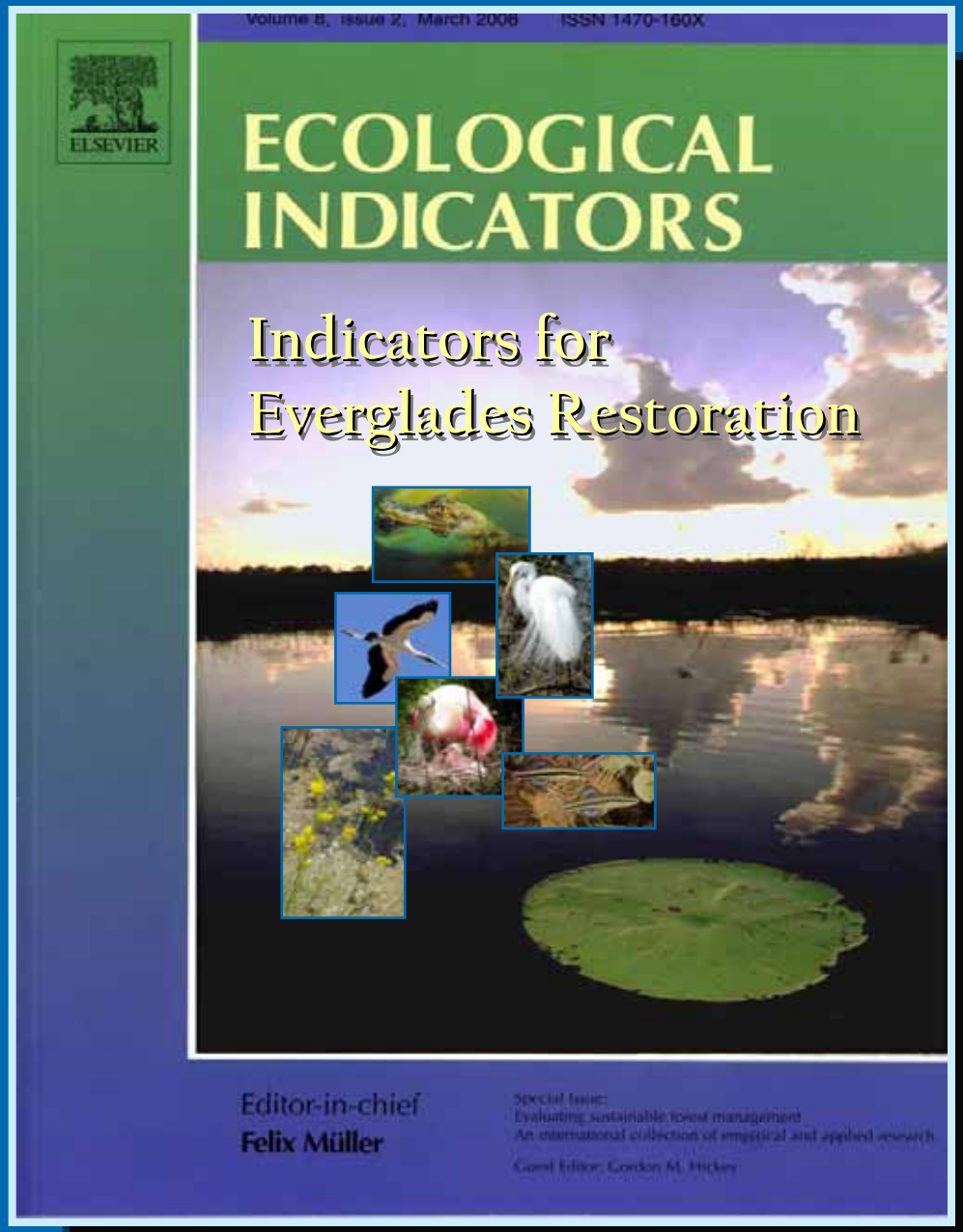
Partnerships
CERP System Status Report



Agencies
South Florida Environmental Report

HARMONIZED SCIENCE REPORT & REPORT CARD FORMATS

- Part 1. Develop a reporting format that will provide scientists an internally consistent template by which to construct their ecological indicator assessments
- Part 2. With a standardized reporting format reduce the number of reports scientists need to write (hopefully to one)
- Part 3. Stoplight Restoration Report Cards as Summary reports to Agencies, the Task Force and Congress
- Part 4. Synthesis of Assessments



ECOLOGICAL INDICATORS JOURNAL

SPECIAL EVERGLADES INDICATOR ISSUE

- **Publication date Sept-Oct 2008**
- **Guest Editors:**
  - **Robert F. Doren**
  - **Joel C. Trexler**
  - **Matt C. Harwell**
  - **G. Ronnie Best**


The End
Photograph by Bill Perry