REPORT

Of the Review Panel Concerning

INDICATORS FOR RESTORATION

Report to the South Florida Ecosystem Restoration Task Force

Review Panel:
Jeffrey L. Jordan, Chair, University of Georgia
Joanna Burger, Rutgers University
JoAnn Burkholder, North Carolina State University
Robert Ward, Colorado State University
Donald Kent, Community Watershed Fund

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EXECUTIVE SUMMARY
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A set of 'system-wide' indicators has been requested to track significant ecological changes in South Florida coincident with activities associated with implementation of Comprehensive Everglades Restoration Plan (CERP) activities. A report, presenting 14 system-wide indicators for South Florida, has been prepared by the Science Coordination Group (SCG). The SCG report briefly introduces the reader to the concept of system-wide indicators, provides background on the need for indicators in South Florida, notes that the purpose of the proposed suite of indicators is to track restoration success and associated performance measures, outlines the tasks employed to develop the indicators, and presents a rationale for each of the selected 14 indicators.

The review panel recognizes that ecological systems are complex and efforts to select and implement easily understood indicators of change are extremely difficult. In seeking indicators of significant ecological change for management information purposes, there is a need to consider the many steps involved in producing and conveying a scientifically sound report to policy makers. For example, producing 'top-of-the-mountain' ecological information requires such tasks as identifying and quantifying information objectives, designing a sampling network, selecting methods to perform the sampling, establishing a transparent and documented data management system, detailing how data will be analyzed and interpreted, and designing reports to convey the resulting information. The Science Coordination Group (SCG) report focuses primarily on one dimension of network design – identification of variables to be measured.

In October 2005, responding to a Congressional request regarding the Chesapeake Bay Program, the GAO was asked to examine the extent to which appropriate measures for assessing restoration progress have been established and the extent to which current reporting mechanisms accurately describe the overall health of the Chesapeake Bay. The GAO report noted that the Bay Program has over 100 measures to asses progress toward meeting restoration goals and providing information to guide management decisions. The GAO concludes however that the program has yet to develop an integrated approach that would allow it to translate individual measures into assessment tools. In short, they are measuring many indicators not connected to the five broad restoration goals of the Bay Program. The reports out of the Bay Program focus on these individual indicators instead of providing information on a core set of ecosystem characteristics. The GAO found that the Bay Program does not have a comprehensive, coordinated strategy to enable it to achieve its goals. The SCG report has tried to avoid these problems in two ways. First it has selected a set of fewer indicators that were chosen for their ability to not only be measured, but to be communicated to decision-makers and the public. Second the indicators were selected based upon their sensitivity to CERP actions intended to restore the south Florida ecosystem. The purpose of the indicators is to provide an integrated approach to determine the progress of restoration efforts. The panel

emphasizes however that the problem of integration of all the indicators should remain a top issue for the SCG. We also note that while the report is focused heavily on South Florida, other regions require attention as well.

In the following report, the Review Panel has responded to the seven questions that were the main part of our scope of work. We have also provided recommendations and suggestions regarding the 14 indicators proposed in the SCG report. The main conclusions of the review include:

1. The set of indicators proposed could be reduced to a set of nine (or 10) that provide sufficient a "top-of-the-mountain" view of restoration progress tied to the CERP program. These indicators include: water storage, flooding, Lake Okeechobee littoral zone, oysters, SAV, invasive exotic plants, fish, wading birds, cattail, and perhaps shrimp.
2. The red, yellow, green light communication process requires further consideration. The review panel suggests a simpler system in the report.
3. The panel recommends that an integrated index of ecological health be produced. The creation of a Bureau of Ecological Information for South Florida would enable the goals and results of the restoration program to be more systematically addressed.

In short, the SCG report, while limited in scope, addresses a critical need in any modern ecosystem management effort – scientifically sound information regarding changes in ecosystem health as a result of management actions and/or, in the case of South Florida, major restoration programs.

INTRODUCTION

The responsibility of this Panel was to review the draft report from the Science Coordination Group (SCG) entitled *Indicators for Restoration: South Florida Ecosystem Restoration*, dated March 2006. The draft report was submitted to the South Florida Ecosystem Restoration Task Force. This Report summarizes the Panel's findings and recommendations regarding the report. Constructive criticism of the report was sought from the Panel. However, this review by its very nature and constraints is not designed to evaluate detailed aspects of research.

In reviewing the draft report, the general questions that the Panel was asked to address included:

1. Are there enough, too few or too many indicators for this integrative suite to be useful?
2. Is the approach (the four steps), including the guidelines and methods used to evaluate and develop the suite of system-wide indicators, reasonable and appropriate?
3. How might the indicators best be used or interpreted to integrate across geographical and ecological lines? Does reporting the indicators at three levels (individually, aggregating results into modules, and aggregating results ecosystem wide) produce a reasonable approach to integration?
4. Are the suite of indicators representative enough of the different ecological and biological dimensions of the Everglades' system so that they are also likely to be representative of components and conditions of the system that are not or can not be measured.
5. If used, will this suite of system-wide ecological indicators provide a reasonable and useful way to signal whether ecological restoration goals and targets are being met?
6. Will the suite of system-wide indicators provide a means for indicating progress (or lack thereof) over time?
7. Does the communication tool (red light, yellow light, green light) developed for the invasive exotic plant indicator provide a good method for simplifying and communicating complex data from many disparate sources? How might this approach be improved for use with the entire suite of indicators?

General Panel Response to the Draft Report

This Report described a suite of indicators for ecological conditions and restoration compatibility, applicable to one or more of eight "eco-regions" (regional modules) within South Florida. Indicators provide discrete information about one (or a limited group of) constituents of an ecosystem, intended to "reflect" the status of

the larger system (from Schiller 2002, cited in the Report). The "reflection" needs to be integrative but simple and unambiguous, without compromising the integrity of the individual findings.

The report consisted of three major parts. In Part I, background explanatory information was provided, including a four-step approach used in the selection of Ecological Indicators and Restoration Compatibility Indicators. The SCG appropriately noted that effective communication to resource managers, policy makers, and the general public about the information gained from these indicators can be equally as important as the information itself. Although an overall communication tool for conveying the concepts and information from use of the indicators has not yet been developed, a prototype example was proposed. Parts II and III described each Ecological Indicator and Restoration Indicator in more detail, including interesting, reader-friendly subtitles explaining each indicator, its applicability across the eco-regions, clear performance measures, and additional scientific information that will be needed to strengthen the utility of the indicator over the long term.

Indicators can and should fill multiple functions, both for understanding the ecosystem, and communicating to a wide range of stakeholders, including the biologists themselves, as well as public policy makers. Communicating an understanding of the status of the system, and trends that indicate both past effects and possible future effects, is an essential feature of a suite of indicators such as those proposed for South Florida Ecosystem Restoration.

The SCG report addresses a critical need in any modern ecosystem management effort – scientifically sound information regarding changes in ecosystem health as a result of management actions and/or, in the case of South Florida, major restoration programs. Unfortunately, the state-of-the-art in designing management-oriented ecological information systems is not well developed nor are there highly successful examples that the SCG report author's could readily draw upon.

The SCG report, in particular, describes how indicators and restoration performance measures were selected for South Florida and provides justification for each individual indicator being included. The overall thinking behind each individual indicator, as well as the overall collection of indicators, appears to be well founded in currently available science. There is no guarantee, however, that another group of scientists, operating under the exact same conditions, would not arrive at a different, well justified, set of indicators. The major reason for this observation is that the design of ecological monitoring systems, for management decision-making purposes, is not standardized. The state-of-the-art is simply not available at this time. Having said this, the review panel makes some recommendations regarding the combination or elimination of some of the 14 indicators.

The process employed to review the range of available indicators and to ultimately arrive at the selected ones needs further definition. The 14 selected indicators are justified, but there is not indication if other indicators were considered and why they were not included. For example, water flows, storm water releases, and phosphorus concentrations

considered appear more directly connected to restoration activities that are designed to restore hydrologic function and water quality to more natural cycles. Were these considered and, if so, why were they not selected?

Many monitoring system design/planning details are not provided in the SCG report. For example, data management, data analysis and interpretation, and reporting are not spelled- out for the individual indicators or for the collection of information that will eventually be produced. It is not clear if the purpose of the report was to provide such details, but if this were the case, a 'scope' section added to the report would clarify the limited purpose of the SCG report – limited to indicator selection only with the other details available elsewhere.

Finally, production of information about restoration performance, outlined in very broad terms in the SCG report, will require considerable effort. There is no discussion of implementation mechanisms, agencies, timelines or staffing. Again, this may have been beyond the scope of the SCG report, but some reference to this aspect of developing a successful performance measure system would help insure the reader that all facets for successful implementation have been considered.

GENERAL RECOMMENDATIONS

1. The review panel suggests that nine (or ten) indicators are sufficient (page 6) to provide coverage for South Florida and key regions.

2. The red, yellow, green light communication process needs further conceptual work. The panel detects inconsistencies in the evaluation ranking system, and bias toward a favorable ranking.

3. Discussion of a performance measurement system should be included in the SCG report.

4. A "scope" section should be added to the report to better clarify its purpose.

5. The selection process in step 4 of the four-step procedure needs more discussion to provide transparency for managers, policy makers, and the public.

6. If other indicators are to be added, the panel recommends including ones for Mercury (although a difficult issue), chemical contamination (if and when appropriate), and exotic species.

7. An appendix should be added that includes a list of all the indicators considered but not included in the final suite.

8. The panel recommends that an integrated index of ecological health be produced and consider the creation of a Bureau of Ecological Information for South Florida.

The balance of this review will be as follows: A discussion of the seven questions posed above to the panel; a set of specific comments and questions about the individual indicators, and; some additional comments on the report in two appendices.

PANEL RESPONES TO THE QUESTIONS POSED

1. Are there enough, too few or too many indicators for this integrative suite to be useful?

The suite of indicators does provide a good mix of 'top-of-the-mountain' coverage for South Florida and key regions. The number of indicators seems appropriate, especially since different subsets can be used for different purposes for different stakeholder groups. However, we do suggest in the following another way to group indicators that reduces the number to nine (or ten including shrimp). Indicators could be grouped for the purposes of communication into different trophic levels, or biological levels of understanding. Further, there are water regime indicators and biological indicators, which will allow an appropriate presentation to the public and others. However, with the information provided in the SCG report, it is difficult to know if the selected indicators are duplicative of each other. Has the correlation among the indicators been statistically tested? This would help determine if there is duplication in the selected indicators.

The restoration efforts, as indicated, appear to be primarily addressing hydrological flow patterns and quantities. The water volume indicator has rather specific targets, associated with well defined target accomplishment dates; however, the remaining indicator targets are not as well defined. The report does not spell out whose performance is being judged and what criteria are being used to measure success. For example, is the ecological restoration of South Florida being entirely undertaken by CERP? Is the suite of 14 indicators measuring CERP performance? These questions, in turn, raise questions about how the data for each indicator will be analyzed, interpreted, and reported.

Communicating the CERP's progress toward a healthy EPA is far more complex task than water supply or flood protection. What constitutes a healthy EPA is ambiguous, and the list of potential indicators is extensive. It appears that at least eight indicator categories are required to evaluate the CERP's effect:

- Lake Okeechobee trophic status.
- Lake Okeechobee hydrology/hydroperiod.
- Northern EPA trophic status.
- Northern estuaries salinity.
- Water Conservation Areas hydrology/hydroperiod.
- Everglades National Park hydrology/hydroperiod.
- Southern estuaries salinity.

- Invasive exotic plants.

What indicators might be readily accepted as representative of healthy conditions? Some of the indicators recommended by the Science Coordination Group (SCG) address the aforementioned indicator categories, and are likely acceptable to the target audiences as representative of healthy conditions. A littoral zone indicator integrates two categories - trophic status and hydrology/hydroperiod - affecting Lake Okeechobee. Salinity impacts to the estuaries are addressed by an oyster indicator (northern estuaries) and submerged aquatic vegetation (SAV, southern estuaries). An invasive exotic plant indicator is representative of native flora health. Fish and wading birds are readily acceptable indicators of WCA and ENP health in response to hydrology/hydroperiod.

Periphyton was recommended by the SCG as an indicator of trophic status in the northern EPA and elsewhere. Substantial research has been conducted on periphyton, and certainly calcareous taxa are more abundant in non-enriched areas than enriched areas. The importance of tissue phosphorus concentration, and the relationship between calcareous periphyton and other components of the community is less clear. Moreover, periphyton is not an ecological component that some members of the target audiences intuitively accept or understand as representative of healthy conditions. Shifts in taxa of microscopic algae, or changes in tissue phosphorus concentrations, are difficult metrics around which to rally enthusiasm. Cattail is an alternative indicator of northern EPA health that the SCG should consider. Recovery of impacted areas, i.e., replacement of cattail by sawgrass and sloughs, is a primary, and highly visible, aspect of the CERP. Moreover, eliminating cattail and restoring sawgrass and slough is intuitively evidence of progress.

Thus we suggest at a minimum of nine indicators is required to represent the CERP progress on broad issues needing redress:

- Water Shortage
- Flooding
- Lake Okeechobee Littoral Zone
- Oyster
- SAV
- Invasive Exotic Plants
- Fish
- Wading Birds
- Cattail

Aggregating the indicators will help tell a better story about each issue being addressed by the CERP (Table 1). More than one indicator, with the exception of invasion by exotic plants, represents each issue. Fish and wading bird monitoring is ubiquitous, and serves to spatially bind the indicator process. The outcome of this approach is a relatively straightforward response to queries about the CERP progress (Table 2). The responses would be accompanied by simple graphics (see discussion of question 7) depicting the response of the indicator to changes imparted by the CERP.

Table 1. Relationship between CERP issues, recommended indicators, and ecological regions.

Issue	Indicators	Ecological Region
Lake Okeechobee trophic status and hydrology/hydroperiod	Littoral Zone, Invasive Exotic Plants, Fish, Wading Birds	Lake Okeechobee
Northern EPA trophic status	Cattail, Fish, Wading Birds	Greater Everglades
Northern estuaries salinity	Oyster, Fish, Wading Birds	Northern Estuaries
WCA hydrology/hydroperiod	Fish, Wading Birds	All
ENP hydrology/hydroperiod	Fish, Wading Birds	All
Southern estuaries salinity	SAV, Fish, Wading Birds	Southern Estuaries
Invasion by exotic plants	Invasive exotic plants	All
Water Supply	Water restrictions	Built Environment
Flood Protection	Flooding	Built Environment

Table 2. Example queries and responses about the CERP progress.

Query	Response
How are water supplies in south Florida?	Neither the urban nor the agricultural areas have experienced any water shortages since É
Have we had any flooding problems?	No flooding of populated areas has occurred since we instituted É
Is Lake Okeechobee getting any better?	We have a long way to go, but the littoral zone is expanding, invasive exotic species have decreased, and the number of fish and wading birds have increased.
Are those cattails gone yet?	We've developed a method for accelerating recovery of the impacted areas and cattails have been reduced by 50 percent.
How are the estuaries doing?	The estuaries are improving. Since we modified the timing and amount of flows to the estuaries we've observed an increase in oyster beds in the northern estuaries, and an increase in SAV in the southern estuaries. Fish and wading birds numbers have increased in all of the estuaries.
Has the health of the WCAs and ENP improved?	Yes, the number of fish and birds has increased throughout the region.
Are invasive exotic plants still expanding in the EPA?	Our aggressive control has reduced invasive exotic plant coverage by 50 percent, and we have developed biocontrol the worst species.

The following are reasons for our suggestion:

- We suggest eliminating the fish and macroinvertebrates indicator. Fish and wading bird abundances integrate macroinvertebrate organism abundance, are easier and more reliably measured, and more comprehensible to the target audiences.

- The wading birds indicator was modified to include roseate spoonbill. The latter offers valuable information, but not enough to warrant its own indicator.

- We suggest the Florida Bay algal bloom indicator be eliminated; it largely duplicated the function of the SAV indicator. The SAV indicator is more understandable to the target audiences, and more easily related to faunal components of the community than algal blooms.

- Crocodilians could be eliminated. SAV is a more effective indicator of hydrology and water quality, fish a more effective indicator of hydrology, and wading birds a better indicator of predator response. Crocodiles are too narrow an indicator for the intended use of the *Indicators for Restoration* document; alligators are too ubiquitous and adaptable to be a sensitive indicator.

- Periphyton could be eliminated for reasons already discussed. Moreover, the suggested links between periphyton and macroinvertebrate organism, fish, and wading bird abundances are unclear. Everglades' periphyton is a fascinating and complex topic, but it does not suit the intended purpose of the *Indicators for Restoration* document.

- Pink shrimp may be eliminated. The economic importance of pink shrimp argues for its inclusion. Thus, this could reasonably be a tenth indicator. That said, SAV and wading birds serve the same ecological indicator function as pink shrimp.

- Water volume was transformed into water shortage. Having adequate water volume does not guarantee adequate water distribution.

- Biscayne Aquifer Saltwater Intrusion could be eliminated. Water shortage encompasses supply from the aquifer.

Although we make these suggestions, the panel believes the original 14 indicators are also adequate.

2. Is the approach (the four steps), including the guidelines and methods used to evaluate and develop the suite of system-wide indicators, reasonable and appropriate?

The four-step approach to system-wide indicator development is reasonable and appropriate, although a fuller documentation of the process would be helpful.

Step 1: Evaluation of existing restoration efforts. Various sources were considered by the SCG in selecting the targeted indices, especially information from the Restoration Coordination and Verification (RECOVER) team's Interim Goals and Interim Targets for CERP (described to include 31 indicators) and the RECOVER Monitoring and Assessment Plan (MAP, described to include more than 90 parameters used as indicators for restoration). Upon consulting the various web sites listed, however, it seemed that some of these sources are only in the process of developing indicators (e.g. CALFED and the Chesapeake Bay Program Integrators Workshop), or include only a brief list of general indicators (e.g. the Ecological Indicators for the Nation). It was unclear as to why some sources (e.g. the Fort Benning Military Reservation, Georgia) were not further considered. We assume that the indicators described in the several SFWMD Consolidated reports were considered, but this should be made clearer.

Step 2: Selection of candidate indicators. Targeted indicators met the following criteria: they were relevant to (at least a large portion of) the ecosystem and sensitive/responsive to variations in environmental conditions and management actions; feasible to implement based on availability of substantial data; interpretable for the general citizenry in a "common language", and; scientifically defensible with clear, measurable performance criteria. Restoration Compatibility Indicators are also needed to provide a measure of compatibility of built systems (canals, storage units, etc.) with ecological restoration. The selected candidate indicators were not identified.

To the ecological indicator guidelines we suggest adding the following:

- Does the indicator have specificity? Does it indicate a feature specific enough to result in management action or corrective action?

- What level of ecosystem process or structure does it address? This might help the public understand how all the levels of ecosystem structure and function are included in the suite selected.

- The list of "features" is laudable, and fairly inclusive. Features that are missing include patchiness, trophic balance, and habitat balance. Patchiness refers to the spatial relationship among different habitat (or subhabitat) types. Trophic balance refers to the relationship between the numbers (both species and individuals) within different trophic levels (e.g. are there too many top level predators). Habitat balance refers to the appropriate relationship among the different habitat types. That is, the present habitats may be appropriate to the Everglades system, but not be correctly balanced (too many or too few of specific habitats).

- Under nutrients, we suggest adding sulphur.

Step 3: Consideration of "indicator gaps". Beyond the indicators selected in Step 2 (and our suggested rearrangement), a need was identified for indicators to describe three additional important features of the ecoregions, including contaminants (toxic substances, medical wastes), exotic species (occurrence and changes in distribution over time) and vegetation pattern/integrity. The SCG did not consider it feasible to develop indicators for these three important ecological features for inclusion in the 2006 report, except that an indicator was added for exotic plant species. A need for additional Restoration Compatibility Indicators was identified, to be completed by 2008 pending consensus of the SCG. Mercury and other metals need to be added to bullet one. The development of a mercury indicator should not be difficult since the SFWMD Consolidated reports have many years of data on mercury levels in Bass, for example, which could form one of the metrics of such an indicator. The lack of an indicator for chemical contamination of the water is serious. Also, the lack of an indicator of mosaic is a serious gap that needs filling since many animals respond to this pattern. Finally, one major gap is a systems wide indicator for sea level rise, and associated effects.

Step 4: Final indicator selection. Eleven Ecological Indicators (E) and three Restoration Compatibility Indicators (R) were selected and listed in this section. All but one are existing RECOVER indicators. Some indicator gaps were identified, to be filled by 2008 "or beyond" (meaning unclear); and a proposal was developed for indicator documentation/communication. Importantly, limitations to the selected indicators were recognized: some are specific to certain eco-regions only; certain eco-regions are not included in the monitoring area for some indicators; and data gaps for a given indicator was identified as a serious deficit in its utility for evaluating restoration success. The selection process itself was not described, and it should be to provide transparency for managers and public policy makers, as well as the general public. It might also help to include an appendix that lists the indicators considered. Also needed is information on exactly how they were selected, who selected them, and what the process was. Was there public input?

The report clearly notes some of the limitations of the present suite of indicators. There is an overall emphasis on South Florida as opposed to the entire system. There may also need to be some human dimension indicators. That is, the indicators selected mainly relate to ecological conditions, and the South Florida ecosystem is entirely human-dominated.

As suggestions to improve the draft report we offer the following:

- A brief appendix supporting Step 1 should be included to provide the list of 31 indicators from the RECOVER team's Interim Goals and Interim Targets for the Comprehensive Everglades Restoration Plan, and the parameters used as "indicators" in the RECOVER MAP.

- The candidate indicators compiled in Step 2 should be listed before identifying indicator gaps in Step 3.

- Under Guidelines for Ecological Indicators was the question, "Are there situations where an "optimistic" trend might suggest a "pessimistic" restoration trend?" A brief additional explanation and an example should be provided for clarification.

- An additional step should be added; to plan in advance and clearly convey how the indicators will be used/interpreted to integrate across ecological and geographic boundaries.

3. How might the indicators best be used or interpreted to integrate across geographical and ecological lines? Does reporting the indicators at three levels (individually, aggregating results into modules, and aggregating results ecosystem wide) produce a reasonable approach to integration?

The indicators should be used to tell a story about the response of the ecosystem to CERP actions, which are in turn designed to address specific issues. Consequently, the indicators should provide information about the CERP's progress in addressing issues, regardless of geographical and ecological lines.

The response of individual indicators should be used to illustrate progress toward CERP goals. Regional modules should not be used to communicate CERP progress, unless the module overlaps with a specific issue. Indicator responses should be aggregated to tell a story about a specific issue, and progress on issues should be aggregated system-wide. For example, Florida Bay salinity is improving as evidenced by increasing SAV, fish, and wading birds. The CERP is succeeding as evidenced by improved salinities in the estuaries, fewer cattails in WCA-2A, and improved hydroperiods in the WCAs and ENP, and a decrease in invasive exotic plants.

Ideally, an integrated 'index' of ecological health could be produced for South Florida, in much the same way the Dow Jones Index is used to indicate the health of the stock market. This index could then be widely distributed to the public to provide regular public accounting for the health of the ecosystem. The Bureau of Economic Analysis (BEA) maintains a webpage (http://www.bea.gov) with a number of articles explaining its strategy and methods for producing economic indicators, including how it develops integrated economic information across not only different U.S. economic sectors, but across international economies.

If an *index* of indicators is of interest, it should be constructed in a way that it can easily be deconstructed when the index stimulates questions about its behavior. Such deconstruction will involve closely examining a list of indicators employed to produce

the overall index and each indicator having its own behavior that can be examined for more in depth study of ecosystem health.

Another option would be to avoid the highly integrated, overall index, and present the behavior of the 14 indicators in an integrated, graphic fashion. For example, the indicators could be presented as bars on a map of South Florida via a system of color codes, or the indicators could be presented as an AMOEBA where the shape of the graphic reveals both changes in indicator relationships and accomplishment of targets (Noordhuis, et. al, 1994).

Given that a number of the indicators have long term records available, it would be useful to have various data analysis, interpretation, and presentation formats tested with real data. In this way, it would be possible to 'test' the indicator presentation of information against the current knowledge of a group of scientists to check each indicator's ability to match scientific understanding about past changes and trends. This can be a powerful line of evidence indicating an indicator's future ability to measure restoration performance.

4. Are the suite of indicators representative enough of the different ecological and biological dimensions of the Everglades' system so that they are also likely to be representative of components and conditions of the system that are not or can not be measured.

The suite of indicators (proposed and recommended) will represent the response of the south Florida ecosystem to CERP actions. One or more of the indicators will detect the anticipated responses to each of the major issues motivating the CERP.

5. If used, will this suite of system-wide ecological indicators provide a reasonable and useful way to signal whether ecological restoration goals and targets are being met?

The response of the suite of indicators (proposed and recommended) will be sufficient to determine if the CERP is achieving its goals. Whether the suite of system-wide ecological indicators provides a reasonable and useful way to signal CERP progress is dependent on how the indicator responses are communicated.

6. Will the suite of system-wide indicators provide a means for indicating progress (or lack thereof) over time?

The 14 indicators, if analyzed, interpreted, and reported in a consistent, transparent, and reproducible manner, will provide 'a' means of indicating restoration progress. Of course, it would be possible for another group, carefully selecting indicators AFTER data are collected, to portray a different finding. The only way to insure that the SCG selection represents the best science can offer is to document all aspects of the

information system, as noted above, before the data are collected. The SCG report is taking a big step in this direction, but there are still many details needing to be defined.

Further, without defined restoration goals, there will be arguments that the selected indicators are not indicating improvement if the rate of change is not deemed adequate. How can a desired rate of change be established as a restoration target for each indicator when dealing with complex biological organisms which respond to many other pressures besides the main hydrologic attributes being addressed in the restoration program (e.g. such as the extreme event of multiple hurricanes crossing Florida in one season)?

7. Does the communication tool (red light, yellow light, green light) developed for the invasive exotic plant indicator provide a good method for simplifying and communicating complex data from many disparate sources? How might this approach be improved for use with the entire suite of indicators?

We believe that there are some conceptual flaws in the example provided which, if adopted for this or analogously for other indicators, could defeat the purpose of the communication tool by providing misleading information to policy makers and the public. The following examples illustrate inconsistencies in the evaluation ranking system, and bias toward a favorable ranking.

Within the Module Level, (Question 1) if the number of species identified as high priority for control have not been documented to occur within a given eco-region, the assigned ranking is –2 points. In Question 2, if the number of previously undetected species within a given eco-region in the last survey period cannot be determined, the assigned ranking is 0 points. This seems inconsistent. Moreover, a pattern of “rewarding optimism” was detected as follows: Negative information in question 1 must be extreme (more than 10 new exotic species found) to be ranked as –4 points. Yet in question 3, if there has been no new location detected for the exotic species in question, the ranking is +4 points.

Similar conceptual flaws were detected within the Species-Level questions, as well as an additional serious limitation. In question 1, if an invasive plant infests up to 100,000 acres, the ranking is –5 points; infestations covering >100,000 acres are assigned –6 points. In contrast, in question 3, if an exotic invasive plant population is static and the lack of change can be related to a (any) management program, the assigned ranking is +4 points. In question 4, if both biological control and chemical and/or mechanical control were used to help achieve the static condition, the points are “additive” – that is, double the number of positive points are assigned (+8). Yet, part of the ecological impacts from exotic invasive plant species involve not only the occurrence and coverage of a given species, but also the impacts of efforts to reduce or contain it. Although resource managers should be commended for doing their best when combating exotic invasive aquatic plants – which are formidable adversaries – this ranking system clearly gives much more positive weight even to maintaining “status quo” than to major infestations or major increases in exotic

plant species richness. Moreover, the ranking system as presented fails to consider the serious impacts to an ecosystem that may result, and have sometimes resulted, from biological control gone awry, or from high quantities of herbicides applied routinely, year after year. This flawed approach is also apparent in the most favorable color-coded “Green” ranking, form the final tally of the assigned points. Assignment of the green color code is described as follows (p.16): “where chemical maintenance control is in place, continuation of control efforts is essential to maintain Green status.” It would seem that the translation is that “Green” status does not need to take into account the potential detriment to the ecosystem from a continuous program of herbicide application.

We have concerns about this communication tool since it appears neither simple nor unambiguous, two SCG criteria for communicating to the target audiences. The numerical ratings and ranking system is needlessly complicated and conflicts with the SCG’s goal to develop and use simple, understandable indicators.

The red/yellow/green light obscures the basis for decisions leading to the conclusions about the CERP progress. Independent evaluation of the conclusions by the reader is precluded, resulting in a “take my word for it approach”. The net effect is the decision-makers have no ownership of the issue for which they are making decisions.

Alternatively, representative performance measures that are simple and understandable are listed below.

Indicator	Performance Measure	Presentation
Fish	Abundance (species-specific)	Stacked column chart abundance over time
Wading Birds	Abundance (species-specific)	Stacked column chart abundance over time
S. Estuary SAV	Cover (species-specific)	Stacked column chart abundance over time
N. Estuaries Oysters	Cover	Line chart over time (one line for each estuary)
L.O. Littoral Zone	Cover (emergent and SAV)	Stacked column chart over time
Invasive Exotic Plants	Cover (Species-specific)	Stacked column chart over time
Water Shortage	Duration of water restrictions (by water supply district)	Stacked column chart over time
Flood Control	Area Flooded	Line chart over time (option - stacked column chart parsed by county)

Finally, all indicators/performance measures should have a quantifiable goal so that progress can be measured. The basis for each goal must be fully explained. We recommend that goal setting involve all stakeholders.

COMMENTS ON INDIVIDUAL INDICATORS

The following comments both reflect some of the rearrangement of the id=indicators we suggest as well as comments if all14 remain in the suite.

Fish and Macroinvertebrates

- The suite of native fishes and crustaceans to be included in this indicator should be listed.

- Species diversity indices should be developed along with consideration of species numbers.

- Water quality parameters should be included along with hydrological factors and salinity to strengthen modeling efforts to simulate fish population densities. Similar models should be developed for crustaceans, if not yet available.

- An identified longer-term science need, to improve monitoring techniques for rocky glade-like habitats, should be addressed in order to strengthen the accuracy and utility of this indicator.

- Fish is an excellent mid-level ecosystem indicator. Reliably measured, integrative of a number of environmental conditions, important to stakeholders, and understandable to the layperson.

- Eliminate macroinvertebrate organisms from the indicator; fish communities reflect macroinvertebrate community condition and are easier to measure.

- Define appropriate density, community characteristics, size structure, and taxonomic composition of marsh fishes.

- Define sustainable breeding populations of higher vertebrates.

- Shifting the distribution of high-density populations of fishes and other aquatic fauna from artificially pooled areas to restored wetlands in the southern Everglades will likely decrease predators in artificially pooled areas. Has this outcome been factored into this and other indicators?

- Extend this indicator to the northern estuaries.

- Performance measures should include abundance and community composition. The latter is important to track exotic species.

- The primary communication device might include a stacked column chart of abundance by species over time with a goal overlay.

- Interpretation will likely be necessary on a regional basis.

- Sampling methods will likely vary with habitat. In the STAs and WCAs, fyke nets set for a standardized time effectively sampled the fish communities.

Wading Birds (white ibis and wood stork)

- Supercolony needs to be defined, with an explanation of when they have occurred (recently).

- A citation should be added to page 29

- Some indication of the number of years trends data are available should be given

- How will other species of wading birds be integrated (page 31).

- What about adding number of birds, reproductive success to the metrics?

- Wading birds are an excellent end-user ecosystem indicator. Reliably measured, integrative of a number of environmental conditions, important to stakeholders, and understandable to the layperson.

- Why is the indicator limited to white ibis and wood stork? Can it be expanded to include heron, egret, and spoonbill? If the white ibis and wood stork are representative of these other species please include a statement to that effect in the document.

- For the purpose of this document, number of birds of each species should be the primary performance measure.

- The primary communication device might include a stacked column chart over time with a goal overlay.

- The Report should clarify why the initial numerical goal for white ibis is set at recovering and/or sustaining 50,000 birds, when populations historically (1930s-1940s) were at 100,000-200,000 birds.

- The Report should clarify when long-term numerical goals for nesting populations are planned.

- Identified longer-term science needs, such as a comprehensive, system-wide program to monitor nesting colonies, and research to examine factors controlling population dynamics of two key prey species of crayfish for the ibis, should be addressed in order to strengthen the accuracy and utility of this indicator.

Roseate Spoonbill

- Combine the roseate spoonbill indicator with the wading bird (white ibis and wood stork) indicator.

- Define a species-specific restoration goal.

- Need to give the citation for correlations (page 34).

- Justify why tactile is more sensitive that visual foraging (page 27).

- Why isn't there consistency in the metrics used for spoonbills and wading birds?

Florida Bay Submerged Aquatic Vegetation (SAV)

- SAV is an excellent end-of-the-pipe indicator of efforts to restore Everglades' hydrology.

- Can the SAV indicator be extended to the northern estuaries?

- An effective performance measure for this document is species-specific cover.

- A specific cover goal must be defined, if possible for each species.

- The primary communication device might include a stacked column chart over time with a goal overlay.

- Development of Indicator E4 should consider seagrass responses to not only salinity, but also nutrients, given that increased freshwater inputs containing elevated nutrient concentrations (as described elsewhere in this Report) would be expected to exacerbate conditions for the valuable habitat species, *Thalassia testudinum* in particular, and (less so) for *Ruppia maritima* and *Halodule wrightii.*

- The Report should clarify whether aerial photography to assess SAV cover distribution can accurately detect mixed beds.

- Regarding assessment of SAV cover, species composition, and epiphyte biomass, the Report should clarify which indicator regions will be the focus. In addition, macroalgal cover/ biomass should also be assessed; and dominant species of epiphytes and macroalgae should be tracked. Such data will provide important information about the role of salinity versus other water quality conditions in controlling SAV in Florida Bay.

- An identified longer-term science need, to experimentally examine and quantify the importance of nutrient-salinity interactions in controlling SAV in Florida Bay,

should be addressed to strengthen the reliability of modeled predictions about SAV dynamics.

Florida Bay Algal Blooms

- The algal bloom indicator could be eliminated.

- This indicator, to a large extent, duplicates the SAV indicator.

- The SAV indicator is likely more comprehensible to the target audiences than the algal bloom indicator.

- The SAV indicator is more easily related to faunal community components.

- Indicator E5, as presently conceived, focuses only on one parameter to describe phytoplankton blooms – chlorophyll *a* as an estimator of overall phytoplankton biomass. This indicator should be expanded to include data for the dominant phytoplankton species. Such data will substantially improve model development and predictive capability.

- Performance measures should include more frequent sampling than the ongoing monthly efforts during bloom events.

- An identified longer-term research goal, to examine the forms, fates, and effects of dissolved organic nitrogen inputs on phytoplankton abundance (and species dominance), should be addressed. The fact that organic N forms predominate (p.50) may be stimulatory to some harmful algae (e.g. see Glibert et al., 2005, Oceanography 18:198-209).

Crocodilians

- The crocodilian indicator could be eliminated.

- SAV is an effective indicator of hydrology and water quality (including salinity).

- Fish are an effective indicator of hydrology.

- Wading birds are a top predator and a better integrator of ecosystem function than crocodilians.

- Crocodiles are too narrow an indicator by which to judge CERP progress.

- Alligators are too ubiquitous and adaptable to judge CERP progress.

- Longer-term identified science needs should be addressed, including development of improved survey techniques for alligator nests in other areas of the Greater

Everglades System beyond the marshes of the Everglades National Park, and assessment of impacts on alligator populations from non-indigenous pythons.

- What data bases are available for what years.

- Why isn't reproductive success a metric?

- Although the creation of runs and holes is given as an important aspect of alligator ecology, there is no metric to examine this aspect.

American Oysters

- Performance measures should also include measurement of suspended sediment concentrations and bottom-water dissolved oxygen concentrations near oyster reefs.

- Identified longer-term science needs including the development of antibody-based techniques to aid in assessment of reproductive stage/potential, and maps of oyster occurrence, density, and health, should be addressed to strengthen the utility of this indicator.

- Oysters are a reasonable scientific indicator of CERP efforts to restore hydrology and water quality (especially salinity) in the northern estuaries.

- The indicator may be less intuitive to the target audiences, necessitating more detailed explanation.

- Oysters are a redundant indicator in the southern estuaries, serving much the same function as SAV.

- Oyster reef cover is the simplest performance measure, with number of live oysters/m^2 a possible secondary measure.

- A specific cover goal should be defined.

- The primary communication device might include a line chart over time with a goal overlay.

Periphyton and Epiphyton

- Periphyton may be too obscure, and too complicated, a community component to be useful as an indicator for the target audience.

- Periphyton is most applicable to the Greater Everglades.

- In the northern Greater Everglades, periphyton is affected by hydrology and nutrient levels.

- In the southern Greater Everglades, periphyton is affect primarily by hydrology.

- Fish abundance is an effective indicator of hydrology throughout the Greater Everglades.

- Cattail cover is an effective indicator of hydrology and nutrient levels in the northern Greater Everglades. Cattail is easier to measure, and easier for the target audiences to understand within the context of CERP.

- In the northern Greater Everglades, periphyton taxa indicative of a balanced ecosystem occur at surface water total phosphorus concentrations greater than 10 μg/L (e.g., see SFWMD STA-2 Discharge Monitoring Program data).

- Hydrology likely has as significant an effect on macroinvertebrate, fish, and wading bird abundance as periphyton, at least in the northern Greater Everglades.

- The Williams et al. (and other) reference is missing from the Literature Cited section.

- Identified longer-term science needs – to examine how hydrology and water quality interact to control periphyton assemblages, and to assess associated impacts on higher trophic levels over short- and long time scales – should be addressed to strengthen the utility of this indicator.

Pink Shrimp

- Pink shrimp indicate hydrology and water quality (i.e. salinity).

- SAV and wading birds negate the necessity of pink shrimp as an indicator.

- Nevertheless, pink shrimp is an intriguing indicator for the Southern Estuaries because of its potential economic importance and relationship to extra-Everglades areas.

- The document should indicate the economic importance of the pink shrimp fishery.

- If pink shrimp is sufficiently important economically, a specific goal needs to be defined.

- Shrimp density would be a potentially reasonable performance measure.

- The primary communication device might include a line chart over time with a goal overlay.

- Are trends data available?

- What about seasonal, yearly variations?

- A longer-term science need, to quantify the relationship between salinity and spatial/temporal patterns of juvenile pink shrimp densities, should be addressed.

Lake Okeechobee Littoral Zone

- The littoral zone is an important component of Lake Okeechobee.

- The littoral zone is an easily understandable indicator of lake condition, integrating hydrology, water quality, and exotic species.

- Specific goals for emergent and SAV should be defined.

- Plant cover is a reasonable performance measure

- A stacked column chart over time, one for emergent and one for SAV, with a goal overlay would be effective communication tools.

- Several identified longer-term science needs should be addressed: to develop food web models for the major plant communities in Lake Okeechobee; to examine whether hydroperiod influences water lily expansion; to identify the yearly range of water levels ("lake stage window") required to support healthy bulrush populations and SAV; and to modify the existing lake model for fine-spatial-scale prediction of SAV cover under different lake stage management strategies.

Invasive Exotic Plants

- Invasive exotic plants are a serious threat to Everglades' recovery and should be monitored and communicated to decision-makers.

- The ideal specific goal for invasive exotic plants should be zero; the pragmatic goal should be quantified and explained.

- Invasive exotic plant cover is a simple and understandable metric.

- A stacked column chart over time would be an effective communication tool.

- As the authors point out, not all exotic plants are equally bad in terms of competitive and ecosystem effects. How this will be integrated is unclear (even with the communication example).

- Competition and replacement of natives by exotics seems only to be covered by decreased recruitment.

- The metrics seem general, which makes them hard to measure (e.g. occurrence of faunal shifts, potential hydrologic impacts).

- The Report should clarify which species are targeted for inclusion in this Indicator.

- The four monitoring and assessment programs used to obtain performance measures for Indicator E11 should be coordinated and standardized insofar as possible.

- Identified additional science needs should be addressed, including improved techniques for detection/assessment of invasive exotic plant species; research to understand their basic biology to strengthen control strategies; and for newly discovered exotics, assessment of risk for invasive potential.

Water Volume

- Managing the water supply is a critical aspect of CERP.

- Some type of water supply indicator is essential, and complements other indicators.

- Ideally, the water supply indicator would be more direct than water volume; water volume does not speak to distribution.

- The SCG might consider using water shortage(s) as an indicator.

- A water shortage indicator could consider all users: urban, agricultural, natural areas. Alternatively, water shortage could be restricted to human use, and fish and birds used to indicated hydrology/hydroperiod in natural areas.

- The water shortage indicator performance measure could be as simple as an adequate/inadequate decision for each user.

- An alternative water shortage indicator performance measure would be achievement of desired volumes, flows, and depths expressed as percent shortfall.

- The Water Volume indicator has defined specific goals.

- If the SCG retains the Water Volume indicator, a line chart of total water volume over time with a goal volume overlay would be an effective communication device.

- Improved water quality was mentioned as a restoration goal to be evaluated, in part, by Indicator R1. The Report should clarify whether this pertains only to salinity, or includes other factors.

- The Report should clarify plans water volume-related plans for the Northern Basins and Big Cypress Basin, which apparently will not receive "new" water in the near future (Table 7).

- Identified long-term science needs - continued model refinement and determination of potential impacts from global climate change – should be addressed to strengthen the utility of this indicator.

Biscayne Aquifer Saltwater Intrusion

- The Biscayne Aquifer Saltwater Intrusion could be combined with the Water Shortage indicator to form a Water Supply indicator.

- An identified science need, to develop one integrated network that can provide real-time stage data across the greater Everglades area, should be addressed to strengthen the utility of this Indicator, and to enable realistic integration of hydrologic and biologic responses.

Flood Control

- Flood Control is an essential indicator.

- The proposed performance measures are too complicated for this document's intended use.

- The indicator could apply to all regions and consider flooding of urban, agricultural, and natural areas. Alternatively, flooding could be applied to built areas and fish/wading birds to natural areas.

- The simplest metric is flooded/not flooded.

- The performance measure might reflect desired water depths – zero in urban and agricultural areas, and based upon Minimum Flows and Levels for natural areas.

- Two identified longer-term science needs – continued model refinement, and assessment of potential impacts from sea level rise associated with global climate change – should be addressed to enhance the utility of this indicator.

ADDITIONAL COMMENTS

One concern that surfaced in the review is a lack of indicators of overall landscape processes. There needs to be some indicator of landscape relationships, especially in the types and interspersion of habitats. Are there enough tree islands, are they appropriately placed, is there enough prairie? and so on.

Other indicators (mentioned earlier) include:

- *Toxic substances in sediments and sentinel species* (e.g. mercury, arsenic, atrazine or other candidate pesticide):

  The need for this indicator was reflected in many areas throughout the Report. For example, in the C-111 Basin, the Report mentioned that high concentrations of copper were detected in water samples from canals, ditches and wells. It was suggested that the source may have been agricultural areas and/or mobilization from past residues. Some samples also had high concentrations of arsenic, cadmium, cobalt, chromium, nickel, lead and selenium. That high levels of toxic substances were detected in water samples is a signal of a potentially serious problem. Most toxic substances accumulate in sediments, and also in sentinel species such as shellfish. They compromise the health of natural flora and fauna and could significantly impede restoration efforts. Representative toxic substances should be tracked using a systematic, long-term approach so that impacts on the south Florida ecoregions can be assessed.

- *Invasive exotic animal species*: This need was identified within the Report (see Invasive Exotic Plant Species Ecological Indicator section), and supporting rationale is similar to that for invasive exotic plant species.

- *Phytoplankton in Lake Okeechobee:* Inclusion of this Ecological Indicator is based on many ongoing and previous studies. Phytoplankton assemblages should be tracked in terms of abundance, dominant species, and ratios of important groups (e.g. cyanobacteria, diatoms, flagellates), both in routine monitoring and more frequently during blooms. Toxin levels (e.g. total microcystins, anatoxin-a) should be assessed during cyanobacteria blooms. Environmental conditions (inorganic N, total dissolved organic N, urea, total P, SRP, suspended solids, turbidity, pH, dissolved oxygen) should be monitored in concert.

- Additional Restoration Compatibility Indicators are needed that can be used to assess and integrate over larger areas. At present, only one of the three selected Indicators (R1 – Water Volume) covers large areas (i.e. several eco-regions)

within the Everglades system; the two other indicators included in the indicator suite thus far are specific to southeastern Florida.

- The models (including major assumptions) that are planned for use in integrating individual Indicators to characterize restoration progress at an ecosystem- or eco-region scale should be more clearly summarized, with utility and limitations at least briefly explained. Major data gaps for important parameters in the models should be identified and targeted for sampling emphasis.

Finally we add two appendices that were suggested by one of the panelist as helpful in thinking through the issues presented in the report.

Appendix A: ***Designing and Documenting a Total Environmental Information System***

Context for producing 'top-of-the-mountain' information involves much more than selecting indicators. In fact, there are those that argue that we seldom get beyond selecting indicators in producing policy-relevant environmental management information. The reason for this argument is that producing such information, as described by the National Water Quality Monitoring Council (NWQMC) in an entire issue of Water Resources Impact (Peters and Ward, 2003), involves a series of steps in order to insure that information is produced in support of management actions and policy. The NWQMC framework includes the following, slightly modified, steps:

1. Developing information objectives;
2. Designing a monitoring program (the where, what, and when of sampling);
3. Collecting field and laboratory data;
4. Compiling and managing the data;
5. Assessing and interpreting the data; and
6. Conveying results and findings to targeted audience.

There are many critical aspects of designing an 'effective, credible, and persuasive' ecological information system for South Florida that are not addressed in the report. For example, consider the following questions regarding the total design of a complete ecological information system. Will the data be collected with consistent protocols across the entire area? What methods will be used to collect the data? Who will insure that the methods don't change if long-term trends are to be assessed (trends in environmental data are the result of either changes in the population being measured or changes in the monitoring system itself)? Who insures that a strong and consistent QA/AC program is in place for all data collected? Will they have the authority to insist upon consistent sampling methods over a long period of time? If changes are to be made in sample collection methods, will it be possible to collect data with both the old and new methods for a year, for example, so the old method and new method data can be scientifically correlated? How will the data be stored electronically? Will the meta-data be stored along with the observations? Will there be consistent data management protocols followed? Who will assemble the data to produce the 'top-of-the-mountain' view? What methods will they use to assess and interpret the data? How will these methods be selected? Will they be peer reviewed before the data are collected? How

will the resulting information be conveyed to the intended audience? What will a report look like? What information transmission strategies will be employed, in addition to a formal, scientifically sound, report? Will the information be evaluated, by the audience, to determine if it is useful and relevant? How will changes be made in the monitoring system? Will changes be formally evaluated and reviewed before changes are made in the field and assessment protocols?

Given the fact that the SCG report addresses only indicator selection, it is assumed that the questions above are being addressed by other work groups and that the SCG report is part of a much larger ecosystem information system

Appendix B*: Review of Existing Restoration Indicator Developments*

Step 1 of the tasks involved in developing system-wide indicators was very briefly summarized (one page) with most of the substance presented in Table 1 – which consists of a list of six URL's. A summary of key findings that the report author's took from the six URL's would have been helpful in understanding how task one informed their decisions in the remaining three tasks.

The task assigned the SCG, to develop a suite of indicators to support informed programmatic and policy level decisions, has confronted many natural resource and ecosystem managers for many years (National Research Council, 2000). It is not an easy task as there are a great variety and number of physical, chemical, and biological approaches that have been developed to measure environmental conditions and ecosystem health (e.g. in the 1970s the issue was being debated extensively by such authors as Ott, 1978; and Thomas, et. al, 1976). A title of an article during this time captures the essence of the difficulty: *A water quality index: Do we dare?*

Making the situation more difficult is the lack of a good model to follow. Table 1, on page 5 of the report, presents a set of WebPages where such efforts are underway. The RECOVER webpage (http://www.evergladesplan.org/pm/recover/recover_map.cfm) describes the performance measure scope, development, application, and associated uncertainty, but it does not describe implementation of the monitoring program to obtain restoration performance information. When the section entitled 'Next Steps' is referenced, the following statement is provided:

> "RECOVER has identified needs to improve performance measure development and application. Each section below gives a brief overview of identified needs and general information about how RECOVER expects to address them. Development and refinement of performance measures is a dynamic process and actions identified below are the first in a series of steps to continually approve upon the ecological meaningfulness of performance measures."

On page 4-10 of the report, provided on the webpage, there is the following statement about how information will be reported:

> "Data evaluation is an essential prerequisite to the task of interpreting system responses. Through the data evaluation process, data generated by the monitoring and assessment program will provide baseline data and status and trends for each measure in a system-wide context, as well as information on the causal relationships that underlie these trends. The monitoring and assessment results will also be used to revise performance measures and restoration goals where needed (i.e., re-evaluate working hypotheses and the organization of the conceptual ecological models [see Appendix A]).
>
> For this to happen, the data for each monitoring component must be carefully reviewed and analyzed according to protocols and methods that are consistent with the guiding hypotheses and the restoration targets. These data must be amenable (in terms of frequency, replication, etc.) to the types of statistical and other analyses envisioned to be employed for documenting changes in biota, water quality, and hydrology within acceptable limits of certainty. Data evaluation tools and methods will be determined, as will the resources, approaches (i.e., statistical), and time frames needed to compile and analyze large amounts of data and feed those assessments into the adaptive management process. Monitoring data will be presented in specified reporting formats that best illustrate the status and trends, patterns of variability, and probable responses to the effects of the CERP for each of the performance measures.
>
> A detailed technical report will be submitted every three to five years as required under the Programmatic Regulations. The process for assessing the performance of the CERP for this report is described in Section 2.4. RECOVER will work with CERP Public Outreach to convert these technical assessment reports into formats effective for public consumption, selecting a subset of the indicators that are defined in the Performance Measure Documentation Report (RECOVER In prep) and that will be monitored and assessed through the MAP to create an annual CERP report card. Also, using a subset of indicators from the Performance Measure Documentation Report (RECOVER In prep), a CERP Interim Goals Report will be developed, as required under the Programmatic Regulations (DOD 2003)."

What data analysis procedures will be used? What would the report contain? Can management work with reports issued every 3-5 years? Thus, this reference is not providing the performance measure monitoring implementation detail sought by this reviewer.

The Corps of Engineers, South Florida Water Management District and Everglades National Park webpage (http://www.sfwmd.gov/org/pld/hsm/reg_app/mwd/), addressing water flows to the Park, under performance measures, presents plots and graphs representing a variety of measurements, such as stage hydrographs and bar graphs representing the percentage of time the stage is below a criterion. This particular webpage provides insight into the physical hydrology of the South Florida system and how well that hydrology satisfies ecosystem flow goals. The information, however, is not synthesized into a 'top-of-the-mountain' view.

The Southwest Florida Feasibility Study webpage (http://www.evergladesplan.org/pm/studies/swfl.cfm) and the Florida Bay/Florida Keys Feasibility Study webpage (http://www.evergladesplan.org/pm/studies/fl_bay.cfm) are not organized to readily identify performance measures, indicators, or monitoring programs. A power point presentation on performance measures was found on the Florida Bay/Florida Keys webpage, but there was no indication that a formal monitoring plan has been documented or implemented. Indicators are listed without justification.

The Chesapeake Bay Program Indicators Workgroup webpage (http://www.chesapeakebay.net/irw.htm) describes a long-term monitoring program and a current Indicators Redesign Workgroup striving to develop indicators, but presents no results of restoration trends or performance measure results.

The Ecological Indicators for the Nation webpage (http://www.nap.edu/catalog/9720.html contains the National Academy of Sciences 2000 report on indicators. The report provides guidance on how to select useful ecological indicators, but does not provide case studies of successful applications of scientifically sound indicator designs.

The California Bay-Delta Authority Restoration and Adaptive Management Program of the San Francisco Bay and Sacramento-San Joaquin Delta (CALFED) webpage (http://science.calwater.ca.gov/sci_tools/performance_measures.shtml) presents an overview of the science involved in developing indicators, but does not present the result of a monitoring system reporting on restoration indicators and/or performance measures. For CALFED the following overall information strategy is presented:

> "The immense scale of the CALFED Bay-Delta Program requires that a *consistent protocol* and a series of methodologies be developed to analyze the cumulative effects of the restoration projects and water management actions. It is expected that the system of indicators and performance measures *will evolve* as knowledge of the Bay-Delta responses to CALFED actions grows. But the indicators must also be sufficiently robust in the early stages to allow managers to assess progress and refine their actions as the plan proceeds. Thus, developing a system of indicators in the Bay-Delta Program will be an *iterative process*, whereby the initial indicators are constantly evaluated for effectiveness and new indicators are added as knowledge of change continues." (italics added)

The existing restoration programs evaluated by the SCG, those listed above, have some common characteristics:

1. Several of the WebPages report current development of indicators to portray ecosystem health while, in some cases, reporting the results of flow monitoring. None of the restoration indicators seem to have been implemented even though several indicate related data have been collected for a number of years (as is the case with the SCG report). A quick review of the WebPages indicates that the

Science Coordination Group (SCG) has little direction from the current state-of-the-art as practiced by large ecosystem restoration programs.

2. The URL's for all the WebPages indicate that performance measures and indicators are not up front where the public and policy makers can readily access "top-of-the-mountain" information. In other words, the WebPages do not provide performance measures up front, but rather deep into the webpage structure where the focus is more on development and adaptability.

3. It does not appear that monitoring has been initiated to implement the indicators/performance measures described. We could not find reports/updates on the status of restoration on the WebPages.

4. The WebPages appear to 'mix' the science of developing indicators with the actual monitoring/reporting of performance of ecosystem restoration (or are the results provided on different WebPages?). This could be an artifact of the state-of-the-art being in an early development phase. If this is the case, it would be helpful to so state.

More generally, there seems to be a tension between (1) developing and implementing a consistent protocol so trends and changes in ecosystem health can be carefully measured in a scientifically sound manner and (2) the need to evolve performance measures through an iterative process seeking new indicators. In some ways, the CALFED paragraph, quoted above, is blending the consistency needed for performance measure monitoring with the flexibility to conduct research into ecosystem function and reaction to changes taking place. This tension may result in a constant search for performance measure indicators with no consistency over time and space in the measurements themselves. Where there is consistency, it is often done for scientific purposes, not for performance measure purposes, such as reported in the long records of spoonbill nesting activity in the SCG report.

To further elaborate on this last point, the CALFED website indicates that:

> "Although there has been progress over the past five years to develop performance measures and indicators to assess the progress, performance and effectiveness of program actions, it is recognized that a more complete, robust and accessible set of indicators and performance measures is needed. A new effort has begun to make the framework more flexible and useful to program elements and agencies in their effort to develop and utilize indicators."

To avoid the need to constantly develop indicators while they are being measured (a problem the National Research Council, 2000, refers to as reliability and robustness), would it be possible for South Florida indicator program managers to separate the need to perform research into the physical, chemical and biological complexities of its ecosystem from the need to measure performance of restoration programs? This would require the design, documentation, and implementation of a performance indicator information

system for a given time period, without change. At a set point in the future (e.g. five years), the design of the performance measurement system would be evaluated using the new scientific understanding obtained from a research program that is parallel to the performance measure monitoring, but totally separated so the focus of the monitoring can be on consistently and regularly reporting and communicating trends and progress in restoration, unencumbered by the constant changes occurring in the research program. The performance measurement system would then be 'updated' with the new science in a way that permitted a continuous comparison of indicators over the entire record of performance monitoring (in a manner similar to the Bureau of Economic Analysis periodic evaluation of its economic indicators).

Related Ecosystem Indicator Communications

The SCG report does not review public interest group efforts to inform the public and policy makers regarding the health of large aquatic ecosystems. For example, the Chesapeake Bay Foundation issues a State of the Bay report that includes a number of elements similar to that proposed in the SCG report (http://www.cbf.org/site/PageServer?pagename=sotb_2002_index). Likewise, there is a Pulse of the Estuary issued by the San Francisco Estuary Institute (http://www.sfei.org/rmp/pulse/2005/index.html). Comments on the value of these efforts, and how they might or might not inform the SCG effort, would be useful in the SCG report. Absence of reference, in any manner, to these efforts is of concern, especially since they seem to be the type of 'top-of-the-mountain' assessment sought in the SCG report.