Appendix 1A-6: Final Report of the Peer-Review Panel for the Draft *2008 South Florida Environmental Report –Volume I*

This final report, dated October 26, 2007, was prepared by the *2008 South Florida Environmental Report* Peer-Review Panel under purchase order to the South Florida Water Management District. This appendix was not edited or spellchecked by the SFER production staff and appears verbatim as posted on the District's WebBoard (http://www.sfwmd.gov/sfer).

FINAL REPORT

of the Peer Review Panel Concerning the

2008 South Florida Environmental Report

Review panel:

- Jeffrey L. Jordan, Chair, University of Georgia
- Neal E. Armstrong, The University of Texas at Austin
- Joanna Burger, Rutgers University
- JoAnn Burkholder, North Carolina State University
- Richard Meganck, United Nations University for Water Education
- Otto R. Stein, Montana State University
- Ellen van Donk, NIOO-Center for Limnology
- Robert Ward, Colorado State University (emeritus)

Submitted October 26, 2007

INTRODUCTION

The responsibility of this panel was to review and prepare questions on the draft of the *2008 South Florida Environmental Report* (SFER), dated September 2007. In addition, the panel's responsibilities included the consideration and inclusion of input from the public workshop conducted October 2-4, 2007, where relevant. This Report summarizes the panel's findings regarding the key facts presented during the workshop and conclusions and recommendations on the subjects raised by the report authors and public participants.

The Report and this peer review are part of an open panel review and public hearing to ensure that all involved are given an opportunity to be part of an open deliberation before a panel of objective experts.

The 2008 SFER review was conducted using a tri-level process:

Accountability: Does the draft document present a defensible scientific account of data and findings for the areas being addressed? Is the synthesis of this information presented in a logical and complete manner, consistent with earlier versions of the Report? Are findings linked to management goals and objectives? The chapters that were primarily reviewed for accountability were: **1A, 2, 3A, 3C, 4, 5, 7A, 7B, 8, 9, 11, and 12**.

Technical: Are the findings and conclusions supported by "best available information" or are there gaps or flaws in the information presented in the main body of the document? What additions, deletions or changes are recommended by the panel to enhance the validity and utility of the document? Are there other interpretations of the data and findings that should be considered and presented to decision makers? Is there available information that has not been considered by the authors? If so, the panel shall identify specific studies that should be addressed or available data to support alternative findings. The chapters and special review appendices that were primarily subject to a technical review were: **1B**, **3B, 6, 10, and Appendices 2-1 and 3B-2.**

Integrative: Are large programs presented so that the overall goals are clear and linked systematically to descriptions in the Report? Are chapters cross referenced in a thorough and consistent manner? Are there integrative data summaries and analyses bridging programs and projects that should be included in future, annual peer reviewed reports to the Governor and Legislature? The panel shall also provide constructive criticism of the District's programs and projects, as appropriate. The special review appendices that were primarily the subject of this integrative review were: **Appendices 6-1 and 12-1**.

General Panel Response to the Draft Report

After reviewing the 2008 South Florida Environmental Report, the panel continues to be impressed by the thorough and informative report describing a comprehensive water management program for the complex South Florida environment. The authors are to be complimented for their efforts and success.

Reporting on South Florida's environment has evolved from an almost totally research-findings orientation to a blend of research findings, management reporting (on subjects where the science behind the reporting is well understood and supportive), and integration across regions and projects. Thus, along with the report's authors, the panel's review of the 2008 report continues to search for areas of the report where the science is reaching maturity, for management purposes, and where information can be organized and presented in a more efficient and effective manner, with references to the scientific details for interested readers.

Public Workshop

The panel remains impressed with the commitment of the District Board and management to the public workshop process. This is a unique endeavor and continues to provide an open, transparent review process. The panel thanks the authors of the chapters for their attention to our comments.

Although it may compress the timing of the review of the 2009 SFER, the panel recommends some changes to the format of the public workshop. After the release of the 2009 SFER, the "A" and "B" reviewers of each chapter will submit any comments to the "AA" reviewer who will then post one set of questions and comments on the webboard. Questions and comments will be numbered. The chapter authors will post responses to the comments no later than six days before the start of the public workshop. At the workshop itself, each chapter author (or editor) will have up to 15 minutes (less if needed) to present chapter highlights, followed by at least 15 minutes of panel-led discussion. The authors should have responses to the posted comments on slides as is now the case, to be used if requested by the panel. Presentations of "special reviews" will have more time on the agenda.

Agency-wide Recommendations on Programmatic and Integrative Issues

These recommendations represent those that the panel believes are not only most important but will require a longer time frame to implement. These recommendations will require yearly updates as they are implemented.

1. The panel supports and encourages the efforts to redesign and reengineer the monitoring network by which information is acquired for the management of water quality in South Florida. The panel suggests that the District work collaboratively with an internal group to develop proposals for reengineering that are reviewed, on a regular basis, by an interagency working group with appropriate expertise.

2. Understanding the relationship between mercury, sulfur (in all of its forms), and methylmercury in sediment, water, and biota (especially fish at different trophic levels and birds) is critical to “getting the water right” (water quality and quantity).The panel recommends a two-pronged approach (hotspots, mass balance) toward delineating the extent, severity and root causes of sulfur loading and associated mercury methylation since the linkage appears to be more acute than the linkage between sulfur loading and either internal eutrophication or sulfide toxicity. The panel supports several high-priority projects that were recommended in the SFER, and supports critical re-evaluation of the existing data for methodological consistency and concomitant sampling before attempting data comparisons and inferences.

3. Efforts should be initiated to develop voluntary BMPs for sulfur reduction in likely contributing areas. To this end, the IFAS should be encouraged better refine sulfur requirements for specific crop, ornamental, and residential plant species growth in an effort to limit the amount of sulfur applied to contributing areas. The panel strongly supports the directions for sulfur BMP’s noted in the SFER.

4. Science plans do not appear to be connected (integrated) across South Florida. Rather it appears that each area’s science plan is developed and reviewed independently of other areas’ science plans. Moreover, science plans were not presented for the coastal ecosystems; instead, a sound approach to develop plans was presented, but plans remain to be developed. Integrated science planning across South Florida could be further enhanced by combined peer review of all South Florida science plans. The panel recommends the implementation of integrated science plans to enhance the connection of research with management information, needs and with development and refinement of performance measures.

5. The panel recommends the integration of performance measures across South Florida that will further enhance accountability and reporting to the District’s Board and the public.

6. Implementation of TMDLs in South Florida will have a large impact on environmental accountability in across South Florida. The panel recommends an evaluation of this impact. For example, there is a need to assess: What is the impact of TMDLs on monitoring design and operation; standard setting and compliance assessments; and reporting of standard compliance? Is the TMDL program another ‘project’ that continues to pull District staff away from an integrated approach to water management? Can TMDLs be integrated into an efficient water management strategy?

7. To assist in connecting hydrological monitoring to management information needs, the panel recommends that a District-wide assessment of hydrologic information should be undertaken. Much of the information needed for this recommendation already exists, in separate programs. There is a need to assemble it in one place and for the purpose of guiding development of an integrated hydrologic “information system”.

8. Increased phosphorus levels at the southern end of Lake Kissimmee are as yet unexplained, and could confound management goals. The sustained drought impeded work to resolve the

sources. This important work should be emphasized as soon as climatic conditions permit, with progress assessed in the 2009 SFER.

9. The panel supports the continued need to connect the rich research program of the District to its strategic goals and yearly work plans. However, the panel notes that across the eleven program strategies of the District there are 83 strategies. Of those 83, only three (one in coastal wetlands and two for the Everglades) specifically mention research. The panel recommends that research programs be more fully and clearly integrated into the strategic plan of the District.

10. The panel recognizes that CERP planning has changed with the passage of the Northern Everglades and Estuaries Protection program in 2007. The panel has often referred to the link between what goes into Lake Okeechobee in the North to what comes out in the South that affects the EAA. Nevertheless, the panel is concerned that the creation of separate Northern and Southern Everglades planning areas will lead to a bifurcation of the District. The panel recommends that careful attention be paid to strengthen the links between the two areas rather than create what could turn out to be "two Districts."

11. There is still a need for an examination of the conditions adjacent to the Everglades (particularly urbanization) that have an impact on the system.

Recommendations on the 2009 SFER

These recommendations are of a shorter time scale and should be implemented in the 2009 SFER.

1. There is less consistency both across and within chapters with respect to the initial paragraphs of any project. Such initial paragraph(s) should include objectives, hypotheses, project period, project initiation date, relevance to management and recovery goals.

2. The cross-cutting appendices, such as 3B-2, are a very useful stakeholder tool, and provide an easy and quick look at a particular problem. This type of chapter would be even more useful if there was a table at the end that directed the reader to the appropriate chapter in the entire document that discussed further the aspects highlighted in this chapter.

3. New projects (e.g. the macroinvertebrate index and application of periphyton signature pigments) should be described in detail to enable evaluation of technical merit. Sufficient information about ongoing or recently completed projects and experiments, needed for context, should also be presented consistently within each major ecological area of focus.

4. In terms of both accountability and transparency, the panel strongly recommends that the District continue to work to clarify the listing of authors for each chapter. Authorship/chapter responsibilities the 2007 SFER are often not clear, given the range of authorship designation employed by the chapters. Long list of authors, or authorship assigned alphabetically, is not sufficient. The Panel suggests that guidelines for authorship designation be developed for use in preparing the 2009 SFER. All "lead authors" should be able to answer questions about all facets

of chapter. “Other Authors” should be intimate with specific sections and familiar with the entire document. “Contributors” should be able to answer questions about their portions of the chapter. The SFER should designate overall chapter editorial responsibility and section authorship. A “corresponding author” should also be identified.

5. The panel strongly supports the Districts new data disclosure policies and trusts that all data used to support work in the 2008 (and previous SFER’s) will be made publicly available in a timely manner.

Thoughts on the 2009 Cross-Cutting Theme: Performance Measures

Performance measures should be considered as a theme for Chapter 1-B in the 2009 SFER. Performance measures can be an environmental accountability integration factor across South Florida as well as a focus for research planning. To enhance insight into the nature of each chapter’s contribution to the SFER mission, each future chapter, in the introduction, should connect its performance measures to strategic missions and work plans.

Many of the chapters in the South Florida Environmental Report deal with performance measures of water quantity and quality, ecosystem structure and function, and health and well-being of specific species. Performance measures can be an environmental accountability integration factor across South Florida as well as a focus for research planning. The chapter should synthesize and integrate the linkages between the broader Strategic Planning documents, work plans, and Everglades recovery mandates. The performance measures (e.g. salinity targets, water release schedules in STAs, legal reporting requirements, bioindicators, number of breeding wading birds, reproductive success of wading birds, number of pythons removed/month, oysters, monitoring) are for different levels of the ecosystem, with different complexities and of different temporal and spatial scales. It would be useful to have a chapter (1B) that presents the different performance measures used for all aspects of the recovery plan, describes their purpose, objectives, spatial and temporal components, and laws and regulations they fulfill. The chapter should examine the relationship between specific performance measures and the goals of the Everglades recovery, including how they further our understanding of recovery.

The performance measures were developed to represent the best science at the time. The chapter should evaluate the various factors that are now known to affect the performance measures or bioindicators, using specific examples including (but not limited to) invasive species (both exotic and native), water quality and quantity differences, hurricanes and storms, and drought versus dry conditions. Further the ties to legislation and recovery goals should be delineated. Finally, the chapter needs to explain whether there is an integrated approach to performance measures, and how do the performance measures relate to restoration success? The chapter also needs to examine whether there is a series of performance measures that can serve as a report card of Everglades recovery and health.

Starting with the Strategic Plan, the introduction of each chapter should then enumerate the performance measures that relate to specific projects, as well as management and recovery goals and whether they relate to mission and decision needs. This effort will enhance the current strategic planning.

CHAPTER 1A: INTRODUCTION TO THE 2008 SOUTH FLORIDA ENVIRONMENTAL REPORT-VOLUME 1

This summary chapter is concise and well written. The panel continues to support the need for this chapter and agrees that the information presents "a basic understanding of the governmental, scientific, and legal context behind the 2006 SFER." In the opinion of the panel this chapter is of utmost importance, given the increasing level of public interest and scrutiny regarding the Comprehensive Everglades Restoration Plan (CERP).

Chapter 1A continues to serve as a "stand alone" document for many readers interested in gaining an overview of the area and its principal management issues and results of research for WY2007 without having to have an in-depth understanding scientific principles or the application of the research results in a complex management context. Separating-out the appended documentation and data is valid as the majority of the readers will not need to delve into this level of detail.

Accountability Review

The revisions made to chapter 1A continue to improve its utility to both the general and technical readership of the SFER. The panel noted the refinements to the descriptions provided in table 1A-1. This information together with figure 1A-3 is a great help in orienting the public to the region.

Integrative Review

The summary of the System-Wide Challenges and Initiatives is excellent and clearly indicates the integrative nature of management decisions affecting the South Florida region. The panel also agrees that this chapter helps to satisfy the many monitoring and reporting requirements of federal and state agencies in terms of permits being granted to undertake activities throughout the region. Water is clearly noted as the medium where all impacts of decisions are manifested; an extremely important concept for the general public to understand. In fact this relationship should continue to be stressed wherever possible given the level of investment and continued support required from the public for the decisions taken by the various governmental bodies involved in the restoration effort.

The fact that "two notable events" in 2007 affecting the region were highlighted **–** one of an environmental nature (drought) and one of a policy nature (new legislation) are highlighted is also important and strengthens the basis for building support from the public for the complex decision matrix that faces the District. The public needs to understand the integrative and reflective nature of environmental and policy/management issues which is highlighted in lines 137-139. This is an extremely important and sometimes confusing issue for the public as well as decision makers at both the State and Federal levels to grasp.

The section of chapter 1A on Strategic Plan Reporting and the accompanying table 1A-3 provide an excellent overview of how research/policy and chapter content are cross-referenced in the SFER.

The section of chapter 1A on pubic information, media and outreach activities responds to a long-standing concern on the part of the panel and provides information to the general public that will undoubtedly assist in increased support for the entire restoration program. The panel notes the level of interest, as manifested by the number of web site hits and calls to the Citizen Information Line. The panel fully supports all of the efforts noted in the 2008 SFER and continues to encourage the District management provide funding to ensure that these programs continue and, when justified are expanded to reflect new developments. In this regard, even if Florida residents are more intimately familiar with details of the SFER, this process is one of national significance and interest.

Recommendations

1. The use of explanatory picture, maps, and tables is a useful tool for this introductory chapter and can be expanded.

2. The peer review information can be moved to an appendix (this recommendation was accepted during the peer review process).

3. The panel recommends that the special report section on public information, media and outreach activities be a regular part of the chapter. Such a section could cross-cut District education outreach activities from the headwaters of the Kissimmee to the coastal estuaries. Discussion of tangible progress should be included with examples of positive outcomes extending from the District's education outreach efforts. In addition, a section could be added to provide information of the positive effects of District activities extending well beyond Florida to help other states and nations (this recommendation was accepted during the peer review process).

CHAPTER 1B: STATEGIES FOR REENGINEERING WATER QUALITY MONITORING IN SOUTH FLORIDA

Technical Review

This chapter considers, as a cross-cutting theme, redesign of monitoring networks to enable data compatibility and rigorous comparison. It is a thoughtfully conceived, innovative analysis, from its honest characterization of the present morass of monitoring networks in South Florida, to its suggestions of new ideas and its acknowledgment of traditional resistance to change (lines 868-879). It suggests a logical progression to "reengineer" a new water quality network based on analysis of sampling station locations, data redundancy vs. the need for additional stations, sampling frequency, and parameters to be considered.

The problem of focus in this chapter is well described in the introductory writing: A "loose confederation of programs", initiated by various entities for various reasons within various time frames, presently forms the water quality monitoring networks across South Florida. This enormous, albeit "hodgepodge" effort excludes monitoring for TMDLs or NPDES permits, and thus conservatively includes ~1,000 stations and 35,000 sampling events per year, costs ~$18 million per year, and is expected to increase by ~30% during the restoration project. There has been little by way of previous major concerted efforts to infuse coordination or compatibility in sampling frequencies, analytical techniques/detection limits or data management/archiving. Major efforts have been lacking to address overlaps and gaps left by the various programs in water quality data acquisition – in part because no single monitoring approach can satisfy various diverse needs (lines 81-82), and because it would not be feasible for the District to do all of the essential background study needed for a coordinated set of approaches without substantial input from other agencies (lines 199-201).

Nevertheless, water quality is identified as one of four key areas of District responsibility, linked to 10 major programs in its strategic plan; moreover, more than 160 water bodies within the District are degraded (listed in 303(d) lists). The authors acknowledge that an integrated monitoring strategy is needed for the entire South Florida region; previous review panels have repeatedly recommended that regional water quality monitoring should also be standardized and optimized. As a potential approach, they consider the Basinwide consolidation of water quality networks achieved by the Chesapeake Bay Program, which took advantage of parallel efforts across agencies and used a series of technical workshops to rework programs toward an overarching framework of information needs and questions. This strategy was needed despite the fact that the Bay program had repeatedly been reviewed, and efforts had repeatedly been taken to attempt to optimize regional monitoring networks

While Chapter 1B describes the initiation of an effort to redesign the monitoring by which information is acquired for the management of water quality in South Florida, Appendix 2-1 also presents the current status of the hydrologic monitoring conducted by the South Florida Water Management District (SFWMD). These two portions of the 2008 SFER provide excellent insight into the current status of broader water monitoring efforts conducted by the District.

Chapter 1B and Appendix 2-1 indicate the SFWMD has begun an evaluation of its water monitoring programs. Given the legal and societal changes facing modern water management organizations, this review is very timely. Water resources management in South Florida, originally established in the 20th century for drainage and flood control, is evolving, in the 21st century, into a program to assure human water needs are met while also sustaining the natural aquatic resources of South Florida. The SFWMD, as does many water organizations around the world today, find themselves heavily involved with environmental, recreation, and exotic species management/control associated with the water resources they manage, whether they want to or not. The SFWMD appears to clearly recognize this fact and is embracing the changes required to assume this new function in society. As a result, the SFWMD finds itself operating at the forefront of establishing modern water and water-related information systems in support of meeting human water needs while maintaining a healthy, sustainable, aquatic ecosystem. A private business analogy can be seen in the ‘supply chain’ software developments enhancing the way modern businesses obtain information in support of business decision making. The monitoring framework, presented in Figure 1B-2 portrays water quality monitoring as a series of highly connected activities (i.e. a chain) that, when designed and operated in an integrated manner, produces information for water quality management decision making.

The chapter title refers to ‘reengineering’ water quality monitoring. Another term, often used in Europe to describe the task discussed in Chapter 1B, is ‘rationalizing’ monitoring programs. In other words, there is a desire to ‘give a rational explanation’ of the SFWMD water quality monitoring programs. In the process, monitoring program designs and operations will be carefully examined and revised in a manner that meets legal, scientific, and management needs for an efficient and effective flow of information to decision makers (lines 20-22 on page 1B-2).

The need to rationalize the many individual water quality monitoring programs springs from the wide variety of laws, projects, and initiatives that have been placed on water management organizations during the latter part of the 20th century. Chapter 1B describes this situation with insight and understanding that permits the problem to be well defined. The discussion in Chapter 1B is very well connected to key literature and thinking on the subject of designing water quality information systems in support of 21st century management. The fact that the lead author is a member of the National Water Quality Monitoring Council further connects the SFWMD monitoring evaluation activities to the latest thinking on the subject. Given that water quality monitoring is conducted by many federal, state, and local agencies, Chapter 1B indicates that the SFWMD monitoring evaluation efforts are well connected to the larger state and federal water quality monitoring infrastructure in South Florida.

The redesign of the SFWMD’s water quality monitoring efforts is focused on developing monitoring objectives and designing the monitoring program (lines 125-126), given that there are ongoing efforts to optimize operations of other parts of the monitoring framework, as presented in Figure 1B-2. As the redesign proceeds, there is a need to illustrate and document how all the cogs of the framework, presented in 1B-2, connect in South Florida. The outer ring on the monitoring framework presented in Figure 1B-2 indicates that all the cogs should collaborate and communicate with each other in a coordinated manner – in other words, create an information chain. Chapter 1B is an excellent step to begin the communication and collaboration.

The WCA-2A test case for redesigning the water quality monitoring system is very helpful in understanding the logic and methods employed to date. It is very helpful to explain the reasons why samples are taken, or not taken, for operational purposes (lines 281-293) and present the rationale for change (lines 303-317).

Integrative Review

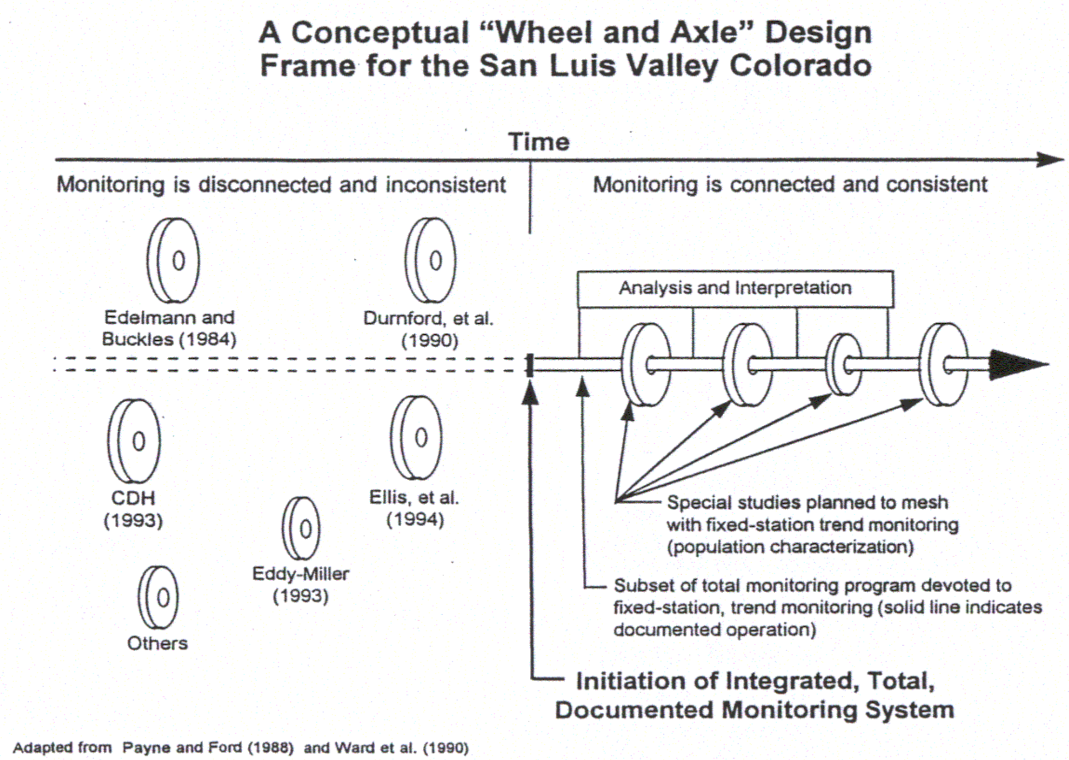
In many ways the SFWMD has pursued rationalization of monitoring and reporting, particularly water quality standard compliance, to great lengths (about as far as is legally permitted). However, by now approaching water quality monitoring from a strategic point-of-view (in Chapter 1B), the SFWMD continues to drill down into the mechanics of monitoring seeking additional ways to rationalize its acquisition of data and reporting of data analysis findings, within legal boundaries. This effort is greatly appreciated by the Panel as it will permit documentation of the entire monitoring system, from sampling strategy, to data storage and retrieval, to data analysis, to interpretation against standards, to, finally, reporting of results.

As the sampling strategy review, described in Chapter 1B, proceeds, there are scientific issues, economic aspects, and operational factors that must be accommodated. These factors can be documented within the larger monitoring strategy documentation. The Panel also wonders if the rationalization of monitoring will reach a point where there is a need to carefully examine how the laws, agreements, and permits, in particular, might be rationalized in support of more efficient management and monitoring of water and ecosystem resources in South Florida? To legally demand water quality information, without considering the economics of its acquisition, places a huge burden on an agency to fund a large-scale water quality monitoring program (the up coming TMDL requirements is a case in point). Once the information from the monitoring redesign described in Chapter 1B (and Appendix 2-1) becomes available, it may become obvious how tweaking of laws, permits, and agreements can greatly improve the economics of monitoring without necessarily diminishing the level of information supporting water quality management decision making.

Along this line, the authors state that the District needs to “wipe the slate clean” and rethink its monitoring from entirely new approaches, rather than attempting to “tinker” with existing networks. The two broad goals identified (page 1B-8) are to (1) determine water quality and quantify changes through time, and (2) assess the effectiveness of management actions and programs. The authors suggest a new, flow-based sampling regime (BWRF, biweekly if recorded flow” schedule), to improve efficiency while meeting monitoring standards: Stations would only be visited if flow had been recorded since the last scheduled visit; all non-flowing samples would be eliminated. The exact nature, and resulting purpose, of the information to be produced by this new sampling strategy is not clear. Is the information focused on pump station permits only? From an integrative perspective, how does the data resulting from this new strategy connect to the standard compliance assessment conducted in Chapter 3, Sections A and C? Data placed in DBHYDRO is used for many management information purposes, not just pumping facility permits, thus an attempt should be made to insure, to the extent possible, that all information needs are supported by the sampling strategies employed.

The Chapter clearly notes the distinction between producing long-term, area-wide, information for management and producing highly site specific, short-term, data for research. Understanding this distinction and incorporating it into the design is very helpful to both managers and researchers. How to evaluate this diverse array of information in order to rationalize the design of a water quality monitoring system is not an easy question to answer. Goetz (1995) proposed one approach as she studied ways to design a ground water quality monitoring network in the San Luis Valley of Colorado where 39 separate laws/regulations addressed ground water quality in the valley. (This same reference is provided to the authors of Appendix 2-1 for the same purpose – searching for common information goals among an array of applicable laws and permits – goals that can then be used to design an integrated water information system.)

Also, there is a way to connect research, short study-oriented measurements/monitoring to routine management-oriented monitoring via concepts presented in the following figure (from Goetz's work).



The axle monitoring consists of a network of sampling sites that are core to management's accountability information needs. The 'wheels' are special studies, projects, research efforts, etc. which have unique, specialized knowledge/technical, information needs. By insuring that each 'wheel' is connected to the 'axle' by common sampling sites, it becomes possible to draw much larger and more complete pictures of water quality conditions in the jurisdiction being managed. Thus, a strong 'axle' monitoring program that is scientifically consistent and comparable over time and space is designed to provide management's key information needs. The 'wheels' represent all other types of monitoring which are connected, by joint sampling, to address emerging knowledge needs, special project needs, etc.

Colorado State University offered an academic course on the design of water quality monitoring systems for many years. The handouts for this course are still available at: http://www.engr.colostate.edu/CE545/Handouts/Topic_List.htm. There may be some information here that would be helpful in the District's efforts to rationalize or redesign water quality monitoring programs in South Florida (e.g. Topic 13: Quantifying Information Goals).

Finally, Chapter 1B (in combination with Appendix 2-1) sets the stage for a new reading of the SFER's – the source of the data (in all its facets) is now being revealed in ways that it has not before. The discussion in Chapter 1B opens much new thinking, such as that offered above, that hopefully, will lead to creating a well documented, rationalized, efficient and effective water quality information system for South Florida.

Recommendations (Technical):

1. Chapter 1B addresses two of the six 'cogs' in the National Water Quality Monitoring Council's monitoring framework – a framework that defines the elements of a total water quality information system that supports water quality management decision making. The two cogs considered in Chapter 1-B are 'Develop monitoring objectives' and 'Design monitoring program'. The authors state that the other four cogs are already addressed by the District. References (including hyperlinks) to the four other cogs would assist the Panel in understanding the broader operational context for the redesign effort described in the Chapter.
2. Regarding developing monitoring objectives (and as noted in the Special Review of Appendix 2-1), is it possible to 'sort out' common water quality information expectations (e.g. average, changing, and extreme conditions) from the laws, mandates, and agreements guiding water quality management in South Florida? If so, it may then be possible to design data collection networks and sampling strategies in parallel with data analysis protocols that convert the data into specific information needs of each law, mandate, and agreement.
3. Chapter 1-B and Appendix 2-1 provides considerable insight into the type and nature of data placed into DEHYDRO. This response to the Panel's 2006 review is much appreciated. We now have a much better understanding of the data behind the District's water quality assessment, presented in Chapter 3A and 3C.
4. Chapter 1-B and Appendix 2-1 are excellent first steps in addressing the need to rationalize the District's many, project-oriented, monitoring networks into a more efficient and effective water information system supporting, in a transparent manner, management decision making. While Chapter 1-B and Appendix 2-1 address the acquisition of water quantity and quality data, Chapter 3 addresses the analysis of that data to produce management relevant information (water quality standard compliance information, in this case). There is considerable integration that should occur across these chapters – or rather between the data acquisition strategies and the data analysis methods employed across South Florida. The Panel looks forward to following the District's progress in rationalizing (i.e. re-engineering) monitoring efforts across South Florida

Recommendation (Integrative):

Chapter 1B and Chapter 3A and 3C address the foundations upon which standard compliance assessment is based (sampling strategy and data analysis, respectively). There is a pressing need for these two features of monitoring design be coordinated (and integrated) during the monitoring redesign described in Chapter 1B. In terms of the NWQMC monitoring framework, such integration connects the 'develop monitoring objectives' and 'design monitoring program' cogs with the 'assess and interpret data' cog. Through such integration, efficiencies in data analysis and interpretation may be obtained through connecting sampling strategies to data analysis during the monitoring redesign.

References:

Adkins. 1993. A Framework for Development of Data Analysis Protocols for Groundwater Quality Monitoring. Technical Report No. 60. 85 pp. plus appendices. Colorado Water Resources Research Institute, Fort Collins, CO. (http://cwrri.colostate.edu/pubs/series/technicalreport/TR60.pdf)

Linenfelser, B. and L Griffith. 2007. **Evaluating Waterbody Assessment and Listing Processes: Integration of Monitoring and Evaluative Techniques**. WERF Stock No. 04WEM4, Water Environment Research Foundation, Alexandria, VA (www.werf.org).

Goetz, L.R. 1995. Data Analysis and Reporting Protocols for Ground Water Quality Monitoring in the San Luis Valley, Colorado. MS Thesis submitted to the Department of Chemical and Bioresource Engineering, Colorado State University, Fort Collins, Colorado. 87 pages. (http://watercenter.colostate.edu/ce545/theses/LGoetz.pdf)

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CHAPTER 2: HYDROLOGY OF THE SOUTH FLORIDA ENVIRONMENT

The mission of the South Florida Water Management District is “to manage and protect water resources of the region by balancing and improving water quality, flood control, natural systems and water supply”, and to fulfill this mission the District operates and maintains the “world’s largest water management system, made up of numerous canals and levees, water storage areas, pump stations, and other water control structures” (from the District’s Strategic Plan 2007-2017). Given this mission and system, it is appropriate to begin the 2008 South Florida Environment Report with a solid understanding of the District’s hydrology and related management goals, operations, and accomplishments (e.g., meeting target water levels and floodwater and water supply flows).

As noted in the Panel’s 2007 SFER Report, the basic template for this chapter includes three categories of contents: (1) a hydrologic/management overview of South Florida and the District; (2) an annual water year update; and (3) an elaboration on emerging issues facing the District in its efforts to balance the hydrology of the system with multiple, often competing, objectives. Further, the chapter continues a key improvement in the 2007 report, i.e., the graphic presentation of water levels for each of the lakes and WCA’s. The 2008 SFER Report contains plots of average daily water levels against the regulation schedule for each lake and WCA as well as the historical average. This change permits the reader to quickly compare District operations to regulation goals (as established by the U.S. Army Corps of Engineers). The narrative provides explanations where there are differences between operations and goals. The appendices to the chapter contain more detailed information about historic daily average water levels, monthly historical average water levels and flows for WY2006 and WY2007, and monthly inflows and outflows to the lakes and WCA’s for WY2007.

Recommendations

1. The hydrologic system is clearly an immensely complex one, and the chapter is replete with facts about those factors that influence water sources, storage, flows, etc. The reader is provided a staggering amount of information and could be helped by the District staff doing the following:

a. Emphasize more at a “20,000 ft” level the descriptions of the hydrologic system, how it operates, how it responds to spatial and temporal amounts of rainfall, how the system has been operated to accommodate the availability of water, and particularly the consequences of having too much, just the right amount, or too little water in terms of meeting management objectives. In response, the staff will add an appendix to the 2008 SFER Report containing such an overview and add a section in the 2009 SFER Draft Report incorporating this material for review next year.

b. Develop a set of “dashboard” metrics that describes how the hydrologic system has been operated and managed in the past water year and in a historical context so the reader has a quick grasp of the “state of the hydrologic system” in space and time. While these metrics could include the extent to which regulation schedules have been met and the circumstances under which they have or have not been met, they should include a sense of how well flood flows and water supply needs have also been met, e.g., how well have the Minimum Flows and Levels to WCA’s and the estuaries been met. While as District staff note the system is monitored at any given time by comparing water surface elevations to regulation schedules, this is a formative (i.e., ongoing) evaluation as compared to a summative (i.e., at the end) evaluation suggested for the water year, and a table such as that contained in Figure 2-1 giving water year flows for not only the lakes and WCA's but also for water supply, estuarine system MFL's, and so forth is more what is envisioned for this dashboard. As noted by District staff, such as analysis is difficult because of the timing of SFER chapter preparation, and this evaluation of operations may have to look backwards a water year while the focus of the current SFER report focuses on the current water year - but such an analysis has significant benefits in an accountability context.

c. Link the discussion of the hydrologic system each year to the emerging topics raised over the past several years, i.e., the hydrologic monitoring system (as is done this year), droughts, hurricanes, long-term climatic change, long-term changes in water demands, and so forth. Clearly the impacts of the current drought were included this year and as the District staff have noted will be the subject of expanded analysis in the 2009 Draft SFER. A desirable part of that analysis will be the impact on the variability of the hydrologic system and particularly how water uses were met (or not met, as the case may be).

2. A significant enhancement to this chapter would be to tie hydrology more strongly to water management goals and objectives. It is noted in a number of places that the two major purposes of water management at the District are flood control and water supply and that water supply releases are made for various beneficial uses that includes water supply for municipal and industrial use, agriculture irrigation, environmental restoration (especially the Everglades National Park), salinity control, estuarine management, and navigation. How water is managed to provide for these uses is described in great detail in this draft and in the hydrology chapter of the 2007 SFER. But what was not noted was how well the management objectives were achieved. While District staff in their response appropriately noted the complexity and variability of the system over space and time, the linkage to the dashboard indicators above, and even the changes in project objectives and how those affect system operation and management, they are encouraged to consider the following points in preparing the next SFER:

a. How does the District measure success in managing flood control and water supply objectives – what are the metrics or indicators, what are the targets, and what are the assessment and evaluation methods? For example, salinity is used as an important indicator in estuaries, and water is released to maintain salinity levels in the estuaries at certain times of the year. Further, pulses of water are released to estuaries as well. How does the District determine it has been successful is maintaining desired conditions in estuaries, how does it measure that success? How well is the District able to respond to adaptive management if eventually salinity requirements are supplemented by nutrient loading and perhaps other requirements?

b. District staff note that risk management is a high priority for water managers and that the Operations and Maintenance Resource area is working to develop a risk management protocol which will be factored into decision trees and future operational criteria as it is developed. With the hydrologic system being so sensitive to spatial and temporal variations in rainfall and the ability to store and move water within the system and the economic, environmental, and social consequences of not meeting water needs being so high, it is encouraging to learn that risk management is being incorporated into system management. It is recommended that these protocols also include the variation in criteria for meeting objectives of the regulation schedules. For example, if a salinity requirement in an estuary is actually some particular level but the uncertainty in that level such that there is a significant error band about that level, how does that uncertainty translate back to the regulatory schedule and what degrees of freedom does that give managers in managing water?

3. The appendices on stage-storage relationships of lakes and impoundments (Appendix 2-2) and regulation schedules (Appendix 2-6) from the 2007 SFER Report contained useful information which needs to be readily available to the readers of the 2008 SFER Report. Therefore, it is recommended that the 2008 SFER Report contain notes to their availability in the 2007 SFER report and/or include references to the appendices in the Literature Cited section of the report and provide hyperlinks to the appendices.

APPENDIX 2-1: HYDROLOGIC MONITORING NETWORK OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

The District network for the acquisition of hydrologic and hydraulic data is impressive in its number of stations, the amount and type of data that are acquired, and the ability of the District to rapidly assimilate data and make management decisions. The District maintains 287 rain gauges and is currently acquiring radar rainfall using NEXRAD. Thus, 287 separate points can be used to calibrate the NEXRAD radar rainfall data over south Florida, providing excellent accuracy in real-time rainfall estimates. A broad suite of other meteorological data are acquired from 45 active weather stations, and daily potential evapotranspiration (PET) data are available from 19 weather stations, giving managers excellent coverage in the event of dry conditions conducive to fires. The data acquired by this network provide excellent calibration/validation opportunities for modelers.

The District also has a network of 1,265 active surface water gauges to provide surface water stage data allowing excellent accuracy in assessing flow and surface water depth in the District area. There are also 446 active flow-monitoring sites to provide instantaneous flow data. The groundwater-monitoring network contains 907 active wells providing excellent coverage. It should be noted that there is a collaborative effort between SFWMD and the USGS to fund and maintain these wells.

All data acquired are rapidly assimilated into two database programs. DCVP (Data collection/validation and pre-processing) is the site where instantaneous data is stored. DBHYDRO is the site where summary data is stored. Users can access data from either site.

Overall, the monitoring SFWMD monitoring network is comprehensive and well conceived. The amount of data acquired provides excellent input for modeling efforts, and the high temporal and spatial coverage provides managers the necessary information for reaction to hydrological events. The continuous time series, in data mined, will provide insights about seasonal and inter-annual trends. Despite this excellent effort, there are still some geographical gaps in data sites and acquisition (below).

While Appendix 2-1 clearly states that ‘the objective of the report is to describe the hydrologic monitoring network of the District’, there are qualifications. Clarification of the report’s purpose includes noting that the …’report provides a status of the hydrologic monitoring network.’ – in other words, the network is constantly under review thus the report captures the status at a specific point in time – April 30, 2007. The report, in many places, notes that the SFWMD’s hydrological monitoring efforts evolved project-by-project until the early years of this decade, with out any effort to design for any single purpose (lines 114-118). In 2002 initiatives were undertaken to explore ways to optimize and design hydrological monitoring programs. A number of specific optimization/design efforts have been completed while others are currently underway or planned for the future.

In spite of the above, the report’s information is viewed as ‘…a prerequisite to expanding and refining the District’s hydrologic network to meet the needs of CERP and non-CERP projects.’ (lines 189-191) Thus, the needs of ‘projects’ continue to influence how the optimization/design initiatives will be conducted.

In response to the four specific questions that the panel was asked to address:

Does the hydrologic monitoring network report provide necessary information on hydrologic monitoring networks of the District?

If the question refers to the physical infrastructure of the current monitoring network, the answer to this question is 'yes'. The report provides extensive information on the sensors employed in measuring South Florida's rainfall, meteorological conditions, surface water stage, surface water flow, and groundwater levels. The documentation regarding sampling equipment and data transmission/storage (with references), in particular, is thorough. Ongoing efforts to identify new measurement technology and incorporate reliable new equipment into the network are described.

It should be noted, however, that the detail provided in Appendix 2-1 is not sufficient for someone to duplicate the described sampling and data processing, using only the information provided in the Appendix. The report references many additional documents that provide much greater detail. Thus, the report is an overview of the hydrological monitoring network's status, in its physical dimensions, with much of the actual design detail presented in cited literature. Given the immense amount of detail associated with a well designed and operated network, this arrangement for presenting the design of a network is necessary. Where sub-network designs are planned, underway, or recently completed, the report notes this fact (e.g. on page App. 2-1-36 where it is noted that an evapotranspiration network design is being planned; and on page App. 3-1-61 where a completed rain gauge network optimization study is summarized).

The 2008 SFER glossary does not define the term 'network'. The report defines a network as a 'collection of sensors that are spatially distributed'. If the word 'information' in the question includes the entire hydrological information system, the report does not provide insight into how the data and information, generated by the network, are used for decision making. The discussion of the 'purpose for hydrologic monitoring' is too brief to fully understand why the SFWMD connects its hydrologic monitoring to management decision making. Without knowing more about why and how data and information are used in the management of water resources in South Florida, it is difficult, if not impossible to determine how the network can be made more efficient and cost effective or to identify what additional information should be collected.

It is obvious that the studies recently completed or underway do examine information needs to justify additional monitoring features. For example, new groundwater monitoring wells are called for, on page 2-1-115, apparently before a study is undertaken to evaluate the need for new wells. Another example is the rainfall network optimization where the study concludes that 154 new rainfall gauges are needed '…to achieve an accuracy of standard error of 0.3 inch, which was determined to be reasonable and acceptable to the District'. Is there a reference for the methods used to determine this level of accuracy and how the new information will improve SFWMD decision making? Such insight would be very helpful in evaluating the rainfall network expansion being proposed. It is very difficult to evaluate the justification for additional monitoring if the logic behind management's need for additional information is not detailed.

Under the brief 'Purposes of Hydrologic Monitoring' on page 2-1-4, five bullets provide why hydrologic monitoring is needed. To continue to examine the information behind justifying monitoring, several questions are posed to illustrate the need for more insight into data/information connections. How does the SFWMD use hydrological monitoring data and information?

1. In the operation of water control structures?
2. To support hydrological and hydraulic analyses and modeling and why are the analyses and models needed?
3. To identify needs for, and design of, new infrastructure;
4. In regulatory and/or permit compliance; and,
5. In the evaluation and assessment of infrastructure structures.

Given the description of sampling strategy for water quality monitoring contained in Chapter 1-B in the 2008 SFER, such descriptions probably exist, but they are not referenced in Appendix 2-1. A similar type of explanation is needed for each of the information questions above to help the reader of Appendix 2-1 determine if the monitoring network is meeting its information goals.

The considerations currently being used in Appendix 2-1 to guide design/optimization of monitoring (provided on page 2-1-4) include:

- Purpose or objective of monitoring
- Total optimal number of monitoring stations (or points) needed
- Locations of the monitoring stations (spatial distribution)
- Sensor(s) needed for the monitoring station
- Frequency of the data sampling needed at the monitoring station (temporal distribution)

These considerations relate well to a network where sampling location, frequency of sampling, and equipment are used to define a network. The fact that 'purpose or objective of monitoring' is also listed (and is discussed in a few places in the report), indicates that this issue will be addressed as the District continues its efforts to optimize and/or design its monitoring programs.

It should be noted again, however, that the authors of Appendix 2-1 may define 'network' in a limited fashion, focusing on the sampling hardware. If this is the case, why is the purpose of monitoring listed?

To answer the questions asked, as well as to describe the totality of the SFWMD hydrological monitoring efforts (as a total hydrological information system), the authors of Appendix 2-1 should consider following the thinking in Chapter 1-B, described for water quality monitoring, and summarized in the Figure 1B-2. It is very difficult to design/optimize a monitoring network without connecting the design to well defined reasons of why the data are being collected, how they are being analyzed, how the resulting information is being reported, and, ultimately, how the information is used to make decisions – the reason for the hydrological network in the first place.

A more specific comment, it appears that additional surface water stage monitoring stations are needed in the most northwestern and southern regions; and the District's surface water flow monitoring network only appears to be in the eastern half of the SFWMD.

How can the existing hydrologic monitoring network be made more efficient and cost effective?

The discussion of monitoring network design/optimization efforts, presented in the report, refers to justifications for new monitoring resources. As with zero-based budgeting, if this has not been done already, it would be helpful to review the justifications for existing monitoring resources along with proposed new monitoring resources. This fits with the above recommendation to review the approach to water quality monitoring presented in Chapter 1B.

However, given the complexity of the water and ecosystem being managed, and the project-by-project approach to meeting legal mandates, permit conditions, and MOA requirements, it is difficult to envision a single manner in which the monitoring programs could be designed/optimized, other than dividing up the hydrologic cycle into parts and addressing each part separately. One thought that comes to mind for addressing the array of legal mandates and permit conditions is a process employed by Lacey Goetz in examining ways to design a ground water quality monitoring network in the San Luis Valley of Colorado where 39 separate laws/regulations addressed ground water quality in the valley. Her MS thesis on the subject can be reviewed at: http://watercenter.colostate.edu/ce545/theses/LGoetz.pdf.

Is it possible to indicate in this report how hydrological monitoring interfaces with water quality monitoring? Are hydrological monitoring staff field activities coordinated with water quality monitoring staff field activities? Are the staffs the same people? It is not clear if there is an opportunity to gain efficiency by better coordinating monitoring staff.

It seems that the District has been working closely with partner agencies toward more efficient and effective monitoring. Such efforts should continue to build in order to minimize overlap and redundancy. The panel realizes that the District plans to integrate the science and monitoring datasets as modeling efforts continue to strengthen, and this will also help to identify areas where the monitoring network can be made more efficient/cost-effective.

What additional information should be included in the hydrologic monitoring network report to improve the utility of work product?

The report's utility could be improved by adding to each section a justification for the existing monitoring. Why are stations located where they are? Why is the sampling frequency at the current levels? How is the data analyzed (e.g. models, statistical methods, data summaries, or just the raw data itself) to produce the data/information utilized by management? How is the accuracy of the various datasets and sub-datasets (where instruments and sampling techniques differed over time) documented?

Such information would help connect the physical attributes of the network, which are well described and documented in the report, with well described and documented reasons for the network to exist. This effort would, in effect, document the current monitoring network designs, from sample collection to utilization of the resulting information for decision making. In the process, sampling strategies would be documented; data transmission, storage, and retrieval processes would be documented; data analysis methods would be described and documented; data analysis results interpretation and reporting described and documented; and, ultimately, use of the information in decision making would be documented. Much of this information is mentioned and referenced in the report, but it is not organized following the flow of information through the monitoring system, from the water body being managed to the mind of the manager.

A table of all the recently completed, currently underway, and planned monitoring system design/optimization efforts would be helpful in understanding the strategic nature of the hydrologic monitoring system improvements. It is obvious that a lot of effort is going into designing/optimizing hydrological monitoring, but the information about the effort is scattered throughout the report.

It would also be helpful to discuss how the various design/optimization activities could possibly be integrated across the sections of the report (i.e. across the parts of the hydrologic cycle). Is it possible to view hydrological monitoring being conducted for a 'single purpose' (lines 115-116)? Can the monitoring optimization be around District needs, overall, or must the optimization remain on a project-by-project basis?

The report indicates that the longest consistent measurement record is from 1995-2005. How can past data be used with current data for longer-term trend analyses? What techniques are used to 'correct' past data to be compatible with values being generated currently?

At the beginning of this review, it was noted that the descriptions of the current sampling equipment are excellent, but the manner in which equipment changes, over time, are handled is not well developed. This aspect of a hydrological monitoring system relates to being able to analyze long-term trends in a consistent and comparable manner – i.e. a scientifically sound manner. If dates of equipment changes have not, historically, been noted in the data record, and if data were not collected with the old and new methods simultaneously for a set time after the change, then it is difficult to correlate the old data with the new date in analyses of long-term trends.

The Panel has several thoughts on how to address the question. An excellent trend analyst (e.g. Dr. David Dickey, NCSU Dept. of Statistics) should be consulted about whether/how to best correct past data for compatibility with present data. For some datasets corrective techniques can be successfully applied, i.e. with statistical viability. In the Panel's opinion it would be helpful to include a table that describes this information, as well as the equipment/accuracy used throughout.

Another approach is to 'research' past equipment changes; learn about the specifications of the equipment over time; obtain any old-new comparison data from other agencies, such as the USGS or equipment companies; compute the bias that may be attributed to equipment change, and then develop a new long-term data record that accounts for the equipment changes. This is a time consuming process but it is the best way to create consistent and comparable hydrological data records from records that do not account for equipment changes.

This situation, hopefully, points up the need for the SFWMD to, in the future, operate old and new sensors together for a set time in order to correlate the data that comes from both pieces of equipment. This way, future efforts to remove the bias of equipment can be accomplished without the need for research described above.

If the above research effort does not produce the information needed to sufficiently understand equipment bias in the data, it is possible to perform the long-term trend analysis with the existing data and note on all information products (time series plots, tables, figures, etc) when the equipment changes took place. In this way, each person can judge the impact of the equipment change bias on the data analysis results.

Technical Review

The following specific comments address the technical content of the report.

<u>Introduction</u> – It would be very helpful to include a figure with flow vectors (e.g. as in Figure 3 of Richards et al., "A multidimensional modeling system for simulating coupled canal, overland and groundwater flow in South Florida" – US Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS). Inclusion of such a figure would provide a nice setup for the many figures with sensor and monitoring sites, and would clarify for readers why there are clusters of sites in specific areas. It would also be helpful if surface flow could be visualized during the "dry" and "wet" seasons to allow readers to examine station sites in reference to water flow.

<u>Section II, Hydrologic Data Management</u> – is will written and clear; it effectively communicates data flow and processing.

<u>Section III, Meteorological Monitoring Network</u> is comprehensive and complete. The specifics on equipment, data acquisition and sensor formulae are valuable inclusions.

One concern involves the pan evaporation sites in Figure 15. The northwestern and southern regions of the District are not covered adequately with this data. It would be helpful to have stations in these areas. Also, in Fig. 17, the PET sites are lacking in the SW. The addition of stations at Rookery Bay could be helpful in modeling and monitoring.

<u>Section IV, Rainfall Monitoring Network</u> – This is an excellent section. With acquisition of NEXRAD data in concert with rain gage data, the assessment of rainfall rates likely are very accurate. It would be helpful to include such a calibration comparison in subsequent reports.

Figure 27, Proposed rain gauge network is a valuable inclusion. This figure effectively addresses any questions concerning rain data coverage.

Section V, Surface Water Stage Monitoring Network – Figure 33, the composite surface water stage monitoring network in the District, shows a lack of gauges in the most northwestern and southern regions. Are none there because of surface flow characteristics, such as the border of a watershed? The surface flow diagram with streamlines would be valuable here to address this question and apparent gap. The fact that the borders of the SFWMD are straight and not irregular (as at the edge of a watershed) leads the reader to think that flow might be significant in those areas.

Section VI, Surface Water Flow Monitoring Network – Figure 50, the District's flow monitoring network, illustrates that the majority of the monitoring sites are located in the eastern half of the SFWMD. The authors should explain why this is the case. Is it because other entities are monitoring the western half? Or because the eastern half is where the majority of the water is now going, to populated areas? If water is to be diverted to the Everglades, shouldn't there be more sites in the western part of the region?

Section VII. Groundwater Monitoring Network – Figure 53 is a nice addition that provides an overview of the extent of aquifers in the southeastern area. The groundwater-monitoring network is comprehensive because of coverage by both SFWMD and USGS. There appears to be excellent coverage for groundwater data.

Recommendation:

Rather than continue to view monitoring information goals in an 'added project' basis (lines 189-191) and to assist in connecting hydrological monitoring to management information needs, the District should consider conducting a District-wide assessment of hydrologic information needs. Approaches for conducting such an assessment, as suggested by Adkins (1993), Goetz (1995), and Linenfelser and Griffith (2007) for water quality monitoring, involve compiling data/information required by projects, mandates, permits, and agreements, SORTED by information category – e.g. determining what information a project needs to operate and be accountable. A similar breakdown of data and information needs for hydrologic monitoring could be undertaken. For example: (1) average conditions, (2) changing conditions, (3) extreme conditions, and (4) real time information at key indicator locations are types of information needed to make water management decisions. With such a compilation, the monitoring network can be optimized around the information categories, with data analysis protocols developed to convert monitoring data into the information required by specific mandates, permits, and agreements. It is suggested that much of the information needed for this recommendation already exists, in separate programs. There is a need to assemble it in one place and for the purpose of guiding development of an integrated hydrologic 'information system'.

References:

Adkins. 1993. A Framework for Development of Data Analysis Protocols for Groundwater Quality Monitoring. Technical Report No. 60. 85 pp. plus appendices. Colorado Water Resources Research Institute, Fort Collins, CO. (http://cwrri.colostate.edu/pubs/series/technicalreport/TR60.pdf)

Linenfelser, B. and L Griffith. 2007. **Evaluating Waterbody Assessment and Listing Processes: Integration of Monitoring and Evaluative Techniques**. WERF Stock No. 04WEM4, Water Environment Research Foundation, Alexandria, VA (www.werf.org).

Goetz, L.R. 1995. Data Analysis and Reporting Protocols for Ground Water Quality Monitoring in the San Luis Valley, Colorado. MS Thesis submitted to the Department of Chemical and Bioresource Engineering, Colorado State University, Fort Collins, Colorado. 87 pages. (http://watercenter.colostate.edu/ce545/theses/LGoetz.pdf)

CHAPTER 3A: STATUS OF WATER QUALTIY IN THE EVERGLADES PROTECTION AREA

CHAPTER 3C: STATUS OF PHOSPHORUS AND NITROGEN IN THE EVERGLADES PROTECTION AREA

Chapter 3 of the South Florida Environmental Report (SFER) comes in three parts: (A) provides a synoptic view of water quality standards compliance for a portion of South Florida – the Everglades Protection Area; (B) assesses mercury and sulfur monitoring and research in South Florida; and (C) presents an overview of the status of phosphorus and nitrogen levels in the surface water within the Everglades Protection Area. Parts A and C are reviewed together since they both address compliance with water quality standards and an update on trends in water quality in the Everglades Protection Area (EPA). Water quality for other South Florida areas is discussed in 2008 SFER chapters devoted to different parts of the hydrologic system (e.g. Lake Okeechobee and the Kissimmee Basin). Much of this division of the picture of water quality for South Florida is driven by the various Acts, permits, research and restoration projects, and MOAs put in place over the past half century. The 2008 SFER, in Chapter 1B, initiates an effort to rationalize the array of disjoint water quality monitoring programs conducted across South Florida and to improve the economics of monitoring while also achieving the information goals associated with each monitoring program. This effort, hopefully, will lead to a larger-scale, and more integrated, view of water quality across South Florida (in the manner in which Chapter 2 views the hydrology of South Florida and which was illustrated for water quality in Chapter 1B of the 2007 SFER)

As Chapter 3 is reviewed, the extent of the climatic and hydrologic variability, in a very flat terrain, housing a unique ecosystem, reveals how daunting it is to measure and describe water conditions in the EPA, not to mention all of South Florida. Water quality management, in particular, with its standards, tends to define compliance as holding water concentrations/loads below set values. Nature, as it has over the past three years in South Florida, exhibits wide swings in climatic and hydrologic conditions, causing variation in water quality data and results, not to mention in the ability to take samples in the first place. The authors of Chapter 3 are adept at developing methods and protocols to handle such variation while insuring that sound science and transparency, are maintained in the production of management-relevant information. They are also adept in addressing short falls in the number of samples needed to support the excursion analysis protocol. Along this line the authors provide the reader with caution when they encounter situations where their protocols cannot be fully implemented (examples are page 3A-13, lines 221-222; page 3C-7, lines 257-259; and page 3C-12, lines 363-365).

Accountability Review

Chapter 3, parts A and C are well written. The conclusions regarding standard compliance and water quality trends are logical and the methods employed are well documented and explained. The data screening and data analysis methods are state-of-the-art. The summaries provided in Chapter 3, parts A and C, are excellent at providing highlights of the findings.

The computed excursions are reported in a manner that permits a good understanding of the context (e.g. units, criteria, number of samples, mean/median, min and max are provided). The excursions are discussed and explained in a rational and logical manner. The comparisons of excursions over time, presented numerically in Table 3A-5 and graphically in the appendices to Chapter 3, with the new time frames for comparing water quality trends since 1978, are especially helpful in evaluating impacts of various initiatives/projects implemented to improve water quality conditions. Improvements in water quality in general are seen amid a large amount of annual variability, as noted above. To see the improvements, within the variability, requires the 'long view' that is presented in Chapter 3 (parts A and C).

While the methods employed for extracting data from DBHYDRO and computing standard exceedences (the excursion analysis protocol) are well defined and documented, the same cannot be said for the sampling strategies that generate water quality data that is placed into DBHYDRO. As has been noted in previous SFER reviews, the data entering DBHYDRO – a database maintained by the SFWMD – is of concern. This concern stems from the fact that the water quality data in DBHYDRO, as is explained in Chapter 1B of the 2008 SFER, is collected in support of pump station permit requirements. The data are not collected to support the excursion analysis protocol. If the sampling was designed to support the protocol, there would be a minimum of 28 samples collected at each sampling site used in the excursion analysis. To overcome this data limitation, the authors of Chapter 3 developed an excursion analysis protocol that utilizes several assessment procedures, based on the number of samples available (or 'found' in DBHYDRO). Chapter 1B in this SFER, addresses this past concern and defines a context in which the water quality data limitations, as applied to excursion analysis protocols, can be discussed and addressed.

To further elaborate, a minimum of 28 samples is needed to support the binominal hypothesis test chosen for use in the excursion analysis protocol. If there are not 28 samples available during the year, alternative data analysis methods are employed. The question arises as to why a data analysis method was chosen to conduct excursion analysis if the minimum number of samples required for its use will not be collected at all stations each year, by definition in the sampling protocol? As is pointed out in Chapter 1B, water quality samples are collected using a number of factors (e.g. water must be flowing) to determine sampling frequency. It is not clear if having a minimum of 28 samples at each site, per the scientific requirements of the excursion analysis protocol, is one of the factors guiding development of a new sampling strategy discussed in Chapter 1B.

Collaboration, communication, and coordination, as shown in the monitoring framework in Figure 1B-2, is very much needed between Chapter 1B's assessment of water quality monitoring and the data needs of the excursion analysis protocol employed in Chapter 3A.

As the new Everglades Protection Area Phosphorus Criterion Achievement Assessment comes online, compliance methods are well defined in the criterion itself. There is a separately designed network to supply the data; however it is not clear if the data needs for the assessment influence the sampling strategy at the 58 stations in the network (or if the project requirements, alone, associated with the various stations, guide the sampling strategy). The fact that only 30 stations of the 58 had sufficient data to support the compliance protocol in the TP criterion (page

3C-4, line 124), suggests that the sampling strategies employed at the 58 stations do not account for the data needs of the TP criterion. Or are there reasons, such as dry conditions, that greatly limited sampling in WY 2007?

The definition of compliance contained in the TP criterion (Chapter 3C) is rather specific and, due to critical ecosystem health issues, does not integrate well with the 'excursion analysis protocol' employed for the other water quality constituents assessed in Chapter 3A (thus the need to break the compliance assessments in Chapter 3 into parts A and C). At what point does the monitoring and compliance assessment of TP move from warranting a special section of Chapter 3 into the routine standard assessment compliance descriptions presented in Chapter 3A, even if different excursion analysis methods are employed? This question is asked in the context of providing more integration of water quality assessments across South Florida and across water quality constituents – to better connect with development of a more integrated water quality monitoring design for South Florida, as well as a more integrated view of water quality in South Florida that can be presented in future SFER reports. Chapter 1B in the 2007 SFER hinted at how this might be accomplished.

Additional questions from Chapter 3:

1. Are the water quality standards, whose compliance is being evaluated in Chapter 3, applicable to only flowing water or any water in the water column at any time of sampling, whether flowing or not? Or is the sampling strategy, described in Chapter 1B, relevant to only the permit requirements associated with the pumping?
2. Can the sampling strategy, described in Chapter 1B, be connected to the excursion analysis protocol, described in Chapter 3A, to insure the minimum numbers of samples are available to support evaluation of standard compliance? If it is not possible to insure the minimum number of samples will be collected each year at each sampling site (e.g. due to economic constraints), is it possible to revisit the excursion analysis protocol to better match available samples with chosen methods to evaluate standard compliance? Currently, there are several excursion data analysis methods employed in order to handle a range of sample sizes available at the sampling sites.
3. Can there be a reminder in the text of the sampling strategy for pesticides. Use of the term 'pesticide monitoring events' suggests that there is a separate sampling strategy used for pesticides. Are the pesticide data stored in DBHYDRO?
4. In the specific conductance discussion on page 3A-21, lines 403-404, it is noted that all but one of the WY 2007 exceedences occurred during periods of no recorded flow. Will the new sampling strategy, described in Chapter 1B miss many of these exceedences in the future since only flowing water will be sampled? Consistency of excursion analysis results, across any sampling strategy change, is of concern. Sampling strategy changes have many ramifications, which if understood, often can be accommodated in a scientifically sound manner (e.g. using both sampling strategies for a year to provide correlation among the old and new strategies).
5. On page 3A-33, it is noted that the non-ECP permit was amended on July 13, 2006. This legally driven change to the monitoring program (or more broadly, water quality information system) has implications to the consistency of information provided over both time and space. Can protocols be established to incorporate such modifications

into the monitoring program in a well documented and transparent manner? This would help all those who use DBHYDRO data understand the changes taking place in the sampling regime employed.

6. On page 3A-30, lines 546-548, the following quote is noted: “To document the accuracy of the collected data ….the District has compared WY 2007 water quality data from non-ECP structures to state water quality standards.” How does comparing data to standards insure its accuracy? The QA/QC procedures, followed in the collection of the data, insure its accuracy for use in standard compliance work.

Recommendation (Integrative):

Chapter 1B and Chapter 3A and 3C address the foundations upon which standard compliance assessment is based (sampling strategy and data analysis, respectively). There is a pressing need for these two features of monitoring design to be coordinated during the monitoring redesign described in Chapter 1B.

CHAPTER 3B: MERCURY AND SULFUR MONITORING, RESEARCH, AND ENVIRONMENTAL ASSESSMENT IN SOUTH FLORIDA

Technical Review

This year's Mercury and Sulfur Monitoring, Research and Environmental Assessment chapter (3B) is an excellent overview of the mercury and sulfur problems in the Everglades, how mercury and sulfur interact with other nutrients (and with each other), how the SFWMD has addressed concerns about environmental problems in the Everglades, on-going research with biota and mercury, the role of sulfur, and the new initiatives to understand mercury cycling. It clearly notes the importance of more data on sulfur cycling, and highlights the need for detailed examination of hotspots, coupled with an engineering mass balance approach to an STA (or similar area).

The major problems are noted, along with new research needed to understand how to reduce mercury levels further, particularly in fish. The data, models and conclusions in chapter 3B reflect the complex problem faced by many agencies dealing with mercury and sulfur in freshwater ecosystems. The data generated by the SFWMD are proving useful for other aquatic ecosystems throughout the United States. In many areas, the mercury research program is a leader that is providing testable paradigms for other aquatic systems. The summary is excellent, and hits the high points. It is particularly useful to have a bulleted summary of all the major findings from the overall mercury program. Research with mercury and sulfur in the Everglades ecosystem continues to be a productive collaboration between different agencies in understanding the complex issues.

The authors are to be commended on writing a chapter that is very readable and accessible to a broad range of readers. It is written in a style that can be easily followed, and that make the main points clear. Further, this year's report more clearly describes the research findings, with appropriate references to the primary literature. This year's summary will be particularly useful to a wide range of stakeholders, including those new to the Everglades process, although there should be more references to where new readers can find the full documentation for some of the past conclusions and research. This year's report is readable, concise, and presents clear data. Further, the report makes the data readily accessible to scientists not previously familiar with the Everglades. They have effectively used bass and Great Egrets as bioindicators of mercury exposure (although data on a short-lived species such as mosquitofish would also be useful), and have one of the longest running such data sets in the country from one region. The chapter accurately and fairly reflects the state of the knowledge about mercury fate and effects in wildlife, and sulfur effects within the system.

Unlike many models to understand the fate and effects of mercury, the Everglades Mercury Cycling Model is dynamic and makes use of additional data as it becomes available. This is a key point that will increase our general understanding of mercury cycling. The suggestion that further modeling is required to understand how to reduce mercury still further is a move in the right direction. Integration of sulfur into the models is an important step in understanding chemical dynamics within the Everglades, and should be given high priority. The models would profit from data that examine mercury and sulfur levels in water and biota from the same location at the same time (at greater frequency) and an in-depth and transparent peer-review.

Further, the chapter is much improved over last years for several reasons: 1) The current findings are clearly stated with more specific data than previously, 2) The inclusion of previous findings puts the 2008 findings in perspective and aids the general reader place the current report within a context of the overall mercury situation in the Everglades, 3). The inclusion of sulfur into the mercury problem makes it possible for the reader to see the interconnections and understand research directions. Questions still remain about the relationship between sulfur and methylation (including levels that inhibit and enhance it).

The new findings are exciting in that they include three important areas: 1) continued biomonitoring to explore temporal and spatial trends in mercury, 2) Results of experiments to determine if the mercury levels are having effects on key bioindicators (wading birds), and 3) The relationship between mercury and sulfur. The inclusion of previous findings is also very important because it provides a context for the current work, and allows the general reader to get up to speed with previous work. The inclusion of sufficient references in the previous findings was extremely helpful, and much improved over previous reports. Separation of the previous findings into sections an improvement and allows the reader to quickly acquire the background information for the current chapter.

Mercury in Everglades Fish and Wildlife

The long data sets for several sites for mercury in largemouth bass is extremely useful in both showing long-term trends, and in identifying where mercury levels have not declined, but are indeed rising. A fuller discussion of possible mechanisms would be in order; these anomalies require extensive data collection and experimentation in order to determine causes. The lack of statistical significance for temporal trends in FL 11 is interesting and problematic in terms of explaining mercury levels in fish and wildlife. Further, the increase in mercury in feathers of egrets mirrors the problem in fish.

Research funds need to be focused toward understanding why mercury levels remain high in fish from some areas of the Everglades, why these are shifting, and what the slight increase in feather levels is a result of. The clear increases in Holey Land Wildlife Management Area are disturbing in light of other deceases within the system.

Atmospheric Deposition of Mercury to the Everglades

This year's section examines the wet deposition in terms of spatial and temporal trends, and then relates these patterns to the patterns in fish and wildlife. The long temporal series is making it possible to relate deposition to wildlife levels in a way that is not possible in other places, and contributes greatly to our understanding of mercury cycling.

The overall VWM mercury concentrations in wet deposition, combined with seasonal dynamics do not seem to adequately explain the mercury in FL11. The increases in mercury wet deposition from early 2003 to 2004 seem to be an explanation for the increases in mercury in

Everglades fish in some regions, but it is unclear why this explanation works for some areas and not others. That is, why is the wet deposition different in some regions that would lead to this dynamic shift?

Sulfur Levels, Sources and Effects on the Everglades

Again, this year's report clearly examines sulfur dynamics within the Everglades, and puts sulfur within a context of its effect on methylation of mercury. It is clear, concise, and has adequate citations for statements, and the authors are to be commended. Further, managing sulfate inputs into the Everglades is examined as an option for reducing MeHg.

The analysis of the source of the sulfate to the Everglades is an important addition to the chapter because it is well thought out, well documented, convincing, and relies on several lines of evidence. Three questions remain: what is the contribution of current to legacy sulfur, what are the other sources, and what contribution is coming from the EAA? These warrant considerable study.

The summary of the effects of sulfur on the Everglades system was both essential to the rest of the chapter, and a good summary. The complicated interactions of sulfur with both mercury dynamics and other toxic effects, including eutrophication, make the construction of an Everglades sulfur mass balance extremely important. Also mapping the conditions in different parts of the Everglades might become critical to management.

Research Needs

This section is clearly written, and lays out the specific research needs identified in previous reports. The experiments with fish-eating birds are extremely useful, although the initial page needs to have more details of actual effects. Further, these experiments were quite intriguing, but the write-up needs more actual data presented, and accompanying statistics to allow the reader to judge. Where is the experiment going, and for how long, and what is its relationship to management?

Quantifying the global versus local mercury sources for South Florida remains one of the key questions for managing the system. A few more details on the plans, and whether they will be implemented would be helpful.

A detailed research project to examine levels of mercury and sulfur (all forms) in water, sediment and biota should be undertaken that has a sufficiently robust sampling plan (temporally and spatially, once a week) that will provide sufficient data to generate hypotheses about the interactions among compartments.

The future activities section brings together the studies described in the previous sections, and lists the next steps. However, a literature review, and review of data from the Everglades is needed to elucidate the threshold levels of mercury and sulfur inputs that result in methylation.

Recommendations (Technical)

1. A mass balance model for sulfur and mercury should be developed both for large areas (such as some of the STAs) and for hotspots of methylmercury accumulation.

2. A detailed research project to examine levels of mercury and sulfur (all forms) in water, sediment and biota should be undertaken that has a sufficiently robust sampling plan (temporally and spatially, such as once a week) that will provide sufficient data to generate hypotheses about the interactions among compartments. Data on all compartments must be taken at the same time to allow correlation.

3. More frequent sampling of mercury levels (and sulfur in its various forms) in sediment, water, and fish tissue (mosquitofish and bass), as well as water levels, should be undertaken in hotspots and non-hotspots of methylmercury. Sampling must be at the same time, and weekly.

4. Bioindicators of methylmercury should include both short-lived fish (such as mosquito fish) that indicate local exposure, and longer-lived fish (bass) that integrate over time and space. Further, bass are considerable interest because of human exposure.

5. The relative contribution of small urban sources of mercury to the Everglades needs further study to ascertain both its importance and the potential for reducing mercury loads.

6. Determine the levels of sulfate that amplify methylation (e.g. especially maximum levels, and the level that inhibits methylation).

Integrative Review

Mercury and sulfur dynamics within the Everglades is an issue that cross-cuts several different chapters, including strategies for reengineering water quality monitoring (1B), status of water quality (3A), Ecology of the Everglades (6), Everglades research plan (6-1), and invasive exotic species (9), since in the later case, species are differentially affected by mercury. Mercury and sulfur issues should be integrated among the chapters, and within chapter 3B. Further, the mercury chapter should provide an overview of how the data they are collecting, and they mercury cycling information that are accumulating, relate to overall restoration and management within the Everglades, as well as to specific regulations and acts or laws.

APPENDIX 3B-2: SULFUR AS A REGIONAL WATER QUALITY CONCERN IN SOUTH FLORIDA

This well-written appendix brings to the fore an issue that has been noted in previous panel reports but which to date has not been dealt with in a comprehensive manner. It is an important addition to the 2008 SFER as the issue of sulfur management is related to phosphorus concentrations and cycling, methylation of mercury, and sulfide toxicity – all of which are related to water quality in ways that are not clearly understood at this time. Therefore it is paramount that a research effort similar in nature to the one proposed in Chapter 3B and this appendix be mounted in order to address the integrated nature of these various constituents.

The findings developed to date, and to be made from additional data collection and analysis in the future, are of such a fundamental nature that these results are more likely to drive management goals and objectives rather than respond to them. Regardless, the issues and potential concerns are grave enough to warrant additional research.

The panel strongly endorses the purpose of this appendix as stated in lines 39-40 as being one to "improve stakeholder understanding of sulfur as a water quality criterion in South Florida.". Stakeholders will be able to better appreciate both the complexity and potential hazards to the environment and human health of continued elevated release of sulfur to the EPA.

In response to the two specific questions the panel was asked to address:

Are the findings and conclusions supported by "best available information", or are there gaps or flaws in the information presented in the document?

The sulfur cycle in any wetland system is highly complex and not as well understood as the carbon, nitrogen and phosphorous cycles within the same systems. In addition, considerable evidence exists in the literature that the sulfur cycle is linked to inorganic mercury methylation, a topic of increasing concern in the Everglades ecosystem. Considering the complexity of C, N and P cycles (and thus S cycling) in general, and the spatial and temporal scale of cycling with the greater Everglades system specifically, it is reasonable to expect that there would be major gaps in our understanding of sulfur and mercury in the Everglades system. Clearly, there is insufficient data to draw broad conclusions or make informed policy decisions at this point, and additional data collection and analysis must be a major component of the research required to make informed policy decisions.

Are there other interpretations of the data and other available information that should be considered by the authors and presented to decision makers? If so, the panel shall identify specific studies that should be addressed or available data to support alternative findings.

With some debate within the panel, it is our consensus belief that more effort should be made to better delineate the sources of sulfur to the EPA. A close reading of the appendix leads one to a logical conclusion that agriculture in general, and the EAA specifically, is the most likely source of the majority of the sulfur loading, but a) the methods used to make these assertions have not been formulated using typical scientific hypothesis testing, and b) this probability does not preclude the logic of investing in a substantive and far-reaching research effort to confirm where the problem(s) lie. Indeed, given the complexity of the sulfur cycle, the problem that has been documented is not from a single source or sector, but rather the result of a multitude of direct and indirect decisions taken overtime. Before any efforts toward mandatory sulfur control in contributing areas are initiated, the contributing sources must be more definitively known. Regardless, efforts to develop voluntary BMPs for sulfur reduction in likely contributing areas should be initiated. To this end the IFAS should be encouraged better refine sulfur requirements for specific crop, ornamental, and residential plant species growth in an effort to limit the amount of sulfur applied to contributing areas.

Much discussion was made at the public workshop about the need to develop a sulfur balance for the EAA and EPA, but we do not believe the SFWMD and partnered agencies have clearly articulated the goal of this sulfur balance research. Identification of the goal is crucial to the successful implementation of a research plan. For example, if the goal is primarily sulfur source delineation, then an accurate accounting of primarily sulfate concentration data out of, but especially in to, various components of the system may be adequate for success. Such an approach was a focus of the research plan proposed at the public workshop.

However the panel believes a better goal is a more comprehensive understanding of sulfur cycling within components of the system (such as the STAs) and how sulfur cycling influences mercury methylation within the greater Everglades system. The studies conducted to date within the context of the Everglades system are too limited – broad conclusions cannot be made from them and more mission-oriented research is required. This will be a much more ambitious research program than proposed at the public workshop and it is our belief that this effort may ultimately be more comprehensive than the effort dedicated to P cycling and control. However, considering that the link between sulfur loading and mercury methylation, phosphorous release due to internal eutrophication, and to plant toxicity is well established in wetland environments in a general sense, but not the Everglades system specifically (though the methyl-mercury problems are well documented), the district is well advised to take the first crucial steps down this path.

The SFWMD and contributing agencies should take a two pronged approach toward delineating the extent, severity and root causes of sulfur loading and associated mercury methylation. As this linkage appears to be more acute than the linkage between sulfur loading and either internal eutrophication or sulfide toxicity, a focus on this linkage would seem to be a logical first step, though other linkages should not be ignored. One prong should be a more detailed characterization of the interactions between sulfate, sulfide, mercury methylation and bioaccumulation at a site with elevated levels of mercury in top predators (i.e. a hot spot). The second prong should be the detailed characterization of a true sulfur balance in a model component of the greater Everglades system. This balance should include an accounting of inputs and outputs to the system including heretofore poorly or un-measured pathways such as surface/porewater sulfate/sulfide interactions and sulfide volatilization. The goal should be a closed mass balance for sulfur to better characterize the activity of sulfate reducing bacteria (SRB) and that activity's link to mercury methylation. A selected STA or STA cell might be the perfect model component as a good compromise of scale. In both research prongs characterization of sulfur/mercury interactions should be the major goal of the data collection effort. To date, data that might be useful for these determinations has been collected on an ad hoc basis or for basic monitoring and compliance purposes and is therefore less useful for drawing the necessary cause-and-effect relationships.

Recommendations

1. A systematic approach should be taken to determine the sulfur loading to major components of the system to better define sources. This information would guide planners to locations most likely to yield the greatest reductions in sulfur loading.

2. A research effort to develop a closed mass balance for sulfur considering all potential sources, sinks, and transformations (modeled after Figure 1 including suggested revisions) should be initiated for a model component system. One of the STAs would seem to be a rational size component for one of these studies. This information would help set threshold limits for sulfur loading to limit mercury methylation, with secondary goals for phosphorous release and sulfide toxicity.

3. More detailed analysis of the methyl-mercury bio-accumulation pathways within the food chain should be established including generation rates, prey fish and predatory fish and fish eating animals, with specific focus on game fish and human health.

CHAPTER 4: PHOSPHORUS CONTROLS FOR THE BASINS TRIBUTARY TO THE EVERGLADES PROTECTION AREA

This chapter is very well written and an excellent example of how an accountability chapter should be constructed. The text is concise, to the point, and communicated effectively. The existing regulatory framework in place and the management objectives developed to meet those regulations are very well addressed as are the regulatory needs. The compliance issues, particularly in the EAA and C-139, are clearly articulated, and the proposed analyses, studies, and contracted research to address those issues are well thought out and appear to be on target to gather the information needed to address those issues.

As was done at the public workshop, material on the BMP point system would be a helpful inclusion to the chapter.

Recommendations

1. While the BMP “equivalents” provide an innovative basis for BMP implementation, the panel recommends that the “equivalents” assigned to each BMP be reviewed periodically in light of additional experience gained with and effectiveness found for each BMP.” An explanation, analysis, and evaluation of this system was requested by the Panel and provided by District staff at the 2008 SFER public hearing.

2. The Panel strongly supports the District’s activities in the C-139 basin regarding the research, development, and implementation of BMPs to control phosphorus and the rule development taking place to enhance the District’s ability to support its regulatory activities in this area.

3. It was recommended in the Panel’s 2007 SFER report that “Continued “tightening” of the chapter is recommended using summary tables where possible … and references to background information in other documents that are readily available on the District’s website or some other location.” While no recommendation was made regarding the chapter outline because the outline appeared to be well structured, the chapter could still be “tightened” as recommended previously to reflect further the Accountability nature of its purpose.

CHAPTER 5: STA PERFORMANCE, COMPLIANCE AND OPTIMIZATION

Accountability Review

Chapter 5 highlights the efforts of the SFWMD to understand and manage natural processes occurring in wetland environments for the enhancement of water quality, and through that improvement, improve the health of the Everglades ecosystem. Fundamental processes occurring within constructed wetlands such as the Stormwater Treatment Areas (STAs), at the scale being operated in South Florida, are not well understood. In fact it is arguable that most of what is known about constructed wetlands on this scale has been learned over time by the data collection and management decisions on these STAs. The performance data and research updates contained within this report provide broad insight into efforts to better manage the STAs for phosphorous removal while enhancing wildlife habitat and public recreation.

It is clear that management of the STAs was complicated this year by the drought. Several new cells and flow ways became "flow capable" this year but could not be utilized due to a lack of water. Optimal operation of other flow ways was limited due to the presence of endangered and migratory birds drawn to nesting and feeding sites created by low water levels within the STAs created by low water levels. Management did take advantage of refurbishing opportunities in some cells and flow ways due to the drought such as removal of P-rich accrued layers and obliterating old roadways and irrigation ditches that previously diminished the hydraulic efficiency of the these cells. One would expect these efforts would increase performance in future years. Despite drought-induced operational limitations, all STAs meet the stated regulatory requirements.

All data identified as being part of a regulatory requirement appear to be listed in a rather succinct form in summary tables and all STAs were deemed to be in compliance with EFA and NDPES operating permits.

The authors have made many revisions to the structure of this document in response to suggestions to last year's comments. In general, these have made a positive influence and help make a determination of the accountability assessment more straight forward. Several more have been made this year in an effort to make individual graphs and tables more self-sufficient. One addition strongly recommended for future reports is the inclusion of a table of the numerical values for all applicable water quality standards including Florida class III (as already included in Table 5-7) but also all EFA and NPDES standards. In addition to regulatory requirements, target values (for parameters not regulated by routinely measured) should be included. These values should then be compared to those measured at the compliance point for all STAs, thereby making a comparison between expectations and performance quite obvious. This would greatly aid an accountability assessment for this chapter. Also it would be helpful if timelines for changing regulations (such as when systems move beyond start-up phase) should be included in an accompanying table.

In general, a better description of management goals is warranted. Perhaps the new strategic plan to be developed in 2008 will help with this.

Technical Review

The panel notes that very many suggestions for improvement in the presentation of the Chapter were made in the initial review comments of the draft report. Despite the volume of suggested revisions, the authors responded in an extremely professional, timely, and comprehensive manner and we appreciate their thoroughness and diligence in response. In some cases the authors have asked questions of the reviewers for clarification and in few others seem to have missed the intent of the comments.

We look forward to seeing the STA Management Division's Strategic Plan and a detailed comparison of the performance of emergent, SAV and PSTA cells. Also the statements indicating that more data will be collected to make comparisons between STA performance is welcomed. These directions would seem to be the next logical step to better assess performance of the STAs.

Recommendations

1. A summary table directly comparing performance to permit requirements for all permitted parameters (regardless of specific law or code) on a parameter by parameter basis should be included in an opening section of this chapter to better assess how well the STA's are working from a regulatory perspective. If an important parameter does not have regulatory criterion perhaps a target value could be used in the comparison.

2. We strongly support the new directions to be taken in 2008 to better assess a) why some STA's appear to have steady or improving performance with time while other do not; and b) the performance of different cells with different vegetation communities within a specific STA.

3. The panel believes that one of the STAs or perhaps a specific cell would be an excellent location to perform a detailed mass balance for sulfur to better determine its effect on mercury methylation, phosphorus release, and plant toxicity. These results might shed light on recommendation 2 above.

CHAPTER 6: ECOLOGY OF THE EVERGLADES PROTECTION AREA

This chapter provides a wealth of information about ecological research in the Everglades, based upon an impressive amount of work covering an array of subject areas. In general, it continues to provide excellent context for Everglades restoration activities. The chapter covers hydrological patterns (1 project) and four main ecological areas: wildlife (4 projects), plants (3 projects), the ecosystem (3 projects), and the landscape (5 projects). The aim was to select projects of focus (17 in total) based on short-term operational needs and long-term restoration goals. The projects generally were presented so that overall goals were clearly linked to the descriptions. In the Summary, Table 6-1 is valuable in providing an excellent overview framework.

The chapter authors provided excellent, detailed responses to the panel's many comments, questions and suggestions. Their responses were thoughtfully conceived, meticulous, and soundly based. The authors indicated that most of the information in their responses would be added to the chapter. Once that is done, Chapter 6 will be outstanding in both integrative and technical quality. This evaluation provides an overview of the chapter. It also focuses on points that remain to be considered, and/or additional information in the authors' responses that was not indicated for inclusion in the chapter.

Integrative Review

From an overall integrative standpoint, the draft version of Chapter 6 unfortunately contained little cross-referencing to other Chapters, and little by way of integrative data summaries and analyses bridging projects within the original draft of Chapter 6.

Within each section of the draft version, though, strong integration generally was indicated. The Hydrological set-up section was excellent in integrating the various project areas. The Plant Ecology section was strongly integrated, as was the Wildlife Ecology section except for the fourth project, development of a qualitative macroinvertebrate index for ecosystem conditions. While the potential for integration of this index is high, some serious technical problems in the design call into question the overall utility of this index (below).

In the Ecosystem Ecology section, the Reflux Study is especially well integrated. The Fire Project mentions that many sub-studies have been initiated to assess ecosystem processes affected by fire (water quality, soil and vegetation nutrient biogeochemistry, plant biomass production and storage, plant species dynamics, ecosystem modeling). The chapter authors indicated that explanation would be included as to how these sub-studies are being integrated into the overall goal of identifying ecotypes of special concern and focusing on their biogeochemical linkages. It should also be mentioned that such integration is well explained in Appendix 6-1.

In the CHIP, improved integration would be helpful in the "Higher Trophic Level Responses" sub-section; for example, the section focused its description on wading birds and mentioned (as personal communication) that prey densities in WCA-2 were relatively low in WY2007, without cross-referencing to the excellent information presented about prey densities in the Wildlife Ecology section. Another sub-section of the CHIP, "Microbial Change", presented few replicated data on microbiota and seemed a very preliminary description. The Ecosystem

Ecology section also includes a description of a preliminary study to apply signature pigments methodology to assess periphyton composition and then to use this information to assess ecosystem condition. Considering the explanation provided by the District about the underlying methodology (to be added to the chapter), there is high potential utility of periphyton signature pigments as an integrative tool across Everglades ecosystems.

Technical Review

Chapter 6 was designed to provide only basic contextual technical background about projects that have been described in detail within earlier SFER's. Nevertheless, sufficient information for context was inconsistent and lacking in most sections (hypotheses, experimental design, rationale, duration, metrics, and expectations). In addition, appropriately detailed descriptions were lacking about new projects, especially the macroinvertebrate index and the application of signature algal pigments in using periphyton to assess ecosystem condition (mentioned above).

In response to panel comments, the chapter authors clarified many points but did not indicate whether some of this information would be included in the revised chapter (e.g. the relationship between wading bird foraging/ nesting behavior and hydrology; the rationale for potentially extending the study for more than three years to adequately characterize the differing hydrological/prey cycles; the additional data needed to understand the experiment described from lines 453-; the relationship between fine root turnover and active growth; effects of differential aeration at the heads and tails of tree islands; the relationship between inflow and porewater inputs of phosphorus, etc.).

I. Hydrologic Patterns – This excellent section includes a helpful comparison of WY 2006 and 2007.

II. Wildlife Ecology – The focus of four described projects continues to be on interactions between wading birds, aquatic prey species, and hydrology, with the short-term goal of preventing further environmental degradation and the long-term goal of restoring historical wildlife populations.

Wading bird nesting patterns – WY2007 was a poor year for wading bird nesting, with a 36% decline in nests compared to WY2006. Continued focus on wading birds (especially great egret, snowy egret, tricolor heron, white ibis, and wood stork) as indicators of wetland ecosystem health, and the four parameters used to assess recovery of pre-drainage wading bird nesting patterns are highly merited. The loss of the major (Alley North) rookery in WCA-3 was clearly described; estuarine rookeries were also minimal in WY2007, and nests in the ENP dramatically declined, attributed to two large reversal events in March – early April.

Food limitation on wading bird reproductive success - (3-year study, to include comparison of years with different hydrologic conditions) – The overall hypothesis tested in this experiment is that white ibis nesting success is limited by food supply. Provisional analyses indicated that extra food significantly increased nestling mass growth and survival of "B" chicks (2nd chick born), supporting the hypothesis that white ibis nesting success is limited by food supply. Age of mortality and mean age of dispersal were not affected by treatment or hatching order.

Prey availability and foraging success of wading birds – Prey availability was identified is the major factor limiting reproductive success in wading birds, yet factors affecting prey availability are poorly known. The objectives of these experiments were to assess effects of submersed aquatic vegetation (SAV, year 1) and emergent vegetation (year 2) x water depth on prey availability for wading birds. The authors focused on foraging site selection and foraging success rather than attempting to measure prey availability directly. Prey were hypothesized to be more available in shallow water with lower SAV densities.

Macroinvertebrates for rapid assessment of environmental conditions in subtropical wetlands – Although the premise of this study – that macroinvertebrates can be valuable indicators of ecosystem conditions – is well founded, the approach used in developing the qualitative macroinvertebrate index (only field-identifiable fauna, only presence/absence) seems too superficial and limited to be fruitful. The "Methods" section, needed to evaluate the efficacy of this index, was seriously lacking. Although additional information is to be provided in the revised chapter, the authors continued to maintain that the selected Rapid Assessment Procedure will allow minimal personnel given 30-60 minutes to collect and process data, and make an immediate general statement regarding ecosystem condition. Thus far, however, no replicates have been taken, preventing evaluation of the efficacy of this qualitative index. The authors stated their intent to incorporate additional samples as replicates, but replicates need to be taken at the same time (date). They also mentioned several approaches to assess system impairment, but did not clarify their rationale for designating impaired versus reference marshes.

III. Plant Ecology – In three projects in WY 2007, there was continued focus on hydrology toward understanding the dynamics and dominance of dominant plant species and algal assemblages.

Ridge and slough transplant experiments – A new slough competition study was initiated at the Loxahatchee Impoundment Landscape Assessment Facility. The historical perspective is instructive - that the central portion of the Everglades historically was a flow-way with a corrugated ridge-and-slough landscape; and that loss of spatial patterning has been attributed to reduced flow, but the experimental basis to predict whether increased flow will restore the natural vegetation is lacking. These valuable experiments will examine how flow rate and depth interact with plant structure to build ridge and slough habitats. The hypothesis and the experimental design are clearly conveyed, including the helpful diagram in Figure 6-14.

Tree seedling stress evaluation, based on a complex, ongoing greenhouse experiment – This well- written section targets the slough, ridge and tree island mosaic complex. The goal of this study is to determine changes in structural and functional integrity of the Everglades from management practices, and the extent to which the natural integrity can be restored. Specifically, the experiment is designed to examine the influence of the frequency and intensity of hydrologic extremes on recruitment of tree seedlings on tree islands, including species responses to (1) constant hydrology (drought, optimal, flooded) – tested in WY2007; (2) fluctuating hydrology (sequential order of drought and flood); and (3) the potential mitigating influence of an interspersed period of average (non-extreme) conditions. The three species selected for study represent a range of flood tolerance.

Tree island root evaluation – The authors made a strong case for the premise that the dynamics of fine root production, mortality and decomposition across nutrient and hydrological gradients and hydroperiods may strongly influence restoration success. They assessed fine root dynamics in previously established plots on three tree islands including a tropical hammock with short hydroperiods, a cocoplum-dominated tree island with moderate hydroperiods (< 6 months inundated), and a willow tree island with artificial flooding (< 6 months inundated). The data indicate that fine root production was highest at the head of tree islands with contrasting short/intermediate hydroperiods and high TP (low TN:TP ratios). In contrast, root biomass was higher near the tail of these tree islands, and highest in the flooded tree island. Turnover of fine roots was higher in the low-water-depth, P-rich soils of the near-tail areas, suggesting that fine roots decompose more slowly in these less-than-optimal conditions. The authors suggested that soil formation on tree islands primarily occurs through organic matter decomposition and slow turnover of fine roots, although supporting information about litterfall and soil formation was not included.

IV. Ecosystem Ecology

The overall goal of the three projects included in this section is to identify ecotypes of special concern and focus on biogeochemical linkages therein.

Rapid assessment of periphyton diagnostic pigments (chemotaxonomy) – The authors described a preliminary study of assessment of algal composition via diagnostic pigments, and, from there, development of a classification regression tree analysis of algal groupings (based on the pigment signatures) to estimate water quality parameters (TP, TKN, DO, pH, temperature, specific conductance, DO). This section, describing new effort, suffered from almost complete lack of information about the methods and approaches used; this problem will be rectified in the revised chapter.

Evaluation of phosphorus flux (Reflux Study) – The authors described ongoing work in a 4-year project (through 2008) in the northern cattail region of WCA-2A. The project is related to the long-term goal of improving wetland regions impacted by excess P. The objectives are to (1) quantify *in situ* sediment P fluxes to the water column; (2) use field enclosures to evaluate management practices (herbicides, burns) to immobilize P in the sediments; and (3) to apply a dynamic model to simulate sediment P flux under different conditions.

A. Phosphorus export (objective 1) - an experiment was conducted to compare P export by 3 control enclosures vs. 3 enclosures to which “SAV-treated” water lower in total phosphorus (TP) was added. The data indicated that the SAV-treated units were exporting P. Additional measurements indicated that porewater was rich in soluble reactive phosphate (SRP), with low but significant P flux from the sediment to the overlying water column.

B. Management practices vs. sediment P flux (objective 2) – An enclosure experiment was used to evaluate effects of management practices as herbicide and herbicide + submersed macrophytes on sediment P flux. The data indicate that porewater is an important source of P to the water column in cattail-dominated areas, and that recovery of these areas will not be likely until both inflow P and porewater P are reduced. The authors logically call for more research to assess the rates and mechanisms controlling P flux from porewater to the overlying water.

The Fire Project (Accelerated Recovery of impacted areas) – The rationale for this important project is to assess whether repeated prescribed fire is effective in accelerating ecosystem recovery of cattail (and willow)-dominated, P-enriched areas by favoring re-establishment of sawgrass and other native species (found in Appendix 6-1-20; should be added to the chapter). The project is designed to document natural versus accelerated recovery at the landscape level (found in Appendix 6-1-20; should be added to the chapter). The objectives are to use repeated prescribed fires to encourage a long-term species shift from cattail back to sawgrass, and to accelerate burial of P-enriched peat below the active root zone. The large-scale experiment follows a before-after-control-impact-paired series design and includes 6 plots (each 300 m x 300 m) with upstream, within-plot and downstream sampling stations. There are 2 unenriched controls; 2 highly (P) enriched sites dominated by cattail; and 2 moderately enriched sites with a cattail/sawgrass mix. Treated plots are being burned periodically (wildfire affected 1 moderately enriched plot in Feb. 2006, as the first fire in the Fire Project; prescribed fire was applied to 1 highly enriched plot in July 2006). Detrital biomass, P release, periphyton and cattail responses are being tracked.

Cattail Habitat Improvement Project (CHIP) – The goal of the CHIP is to provide a preliminary assessment of the role of active management in accelerating improvement of cattail habitat (found in App. 6-1-19 – should be identified in the chapter). The overall goal of the *in situ* large-scale experimental study in the CHIP is to assess how well cattail areas can be restored, considering two major objectives: (1) assess whether created openings (via fire and herbicides) will lead to increased wildlife diversity and abundance, and (2) compare the ecosystem functions of these open areas versus natural sloughs (same hypotheses for both, found in App.6-1-18 – should be contained in the chapter). The experimental treatments are applied with the aim of maintaining plots at 10% or less cattail cover; the first comprehensive sampling was completed in Jan.-Feb. 2007. Thus far, herbicide (as glyphosate or glyphosate + imazapyr) was applied in May 2006, August 2006, and March 2007, and a prescribed burn was applied in July 2006. Overall, the results from the first 6 months of data collection support the hypothesis that openings are ecologically better (higher nutrient fluxes, more nutritional plants, more foraging by wading birds).

A. Water and floc nutrient chemistry - The surface water quality of open and control sites was compared up to ~3.5 weeks post-burn. In the overlying water, the P species were described as significantly higher in open versus control sites. Floc data were also collected, apparently at 6 months post-burn: floc of open plots had significantly higher TP but lower SRP, lower total carbon (TC) and total organic carbon (TOC) than control plots, with no change in TN or ash pre- vs. post-burn.

B. Microbial change – As stated in App. 6-1-29, an understanding of changes in the structure and functions of microbial communities in peat accumulation and nutrient turnover will be essential for successful restoration of the Everglades. Thus far, few replicated data for microbiota are available in this description of preliminary information.

C. Higher trophic level responses – Low water levels in Jan. 2007 prevented sampling of invertebrates and fish. Wading bird abundance (11 species) was significantly higher in open plots than in control or unenriched plots. An attempt was also made to assess cryptic birds (5 species) based on visual sitings; highest numbers were observed in enriched and transitional control plots.

V. Landscape Ecology – This section provides generally excellent, essential information about long-term changes in large-scale structure and function.

CERP vegetation mapping – The vegetation mapping products, developed from 1,400 aerial photographs (2004-), should provide a valuable baseline for RECOVER.

Book on the pre-drainage Everglades – This should be an exciting, excellent contribution. The forensic approach is excellent.

Soil profiles of macrofossils – This important work takes an innovative approach, initially targeted for Shark Slough, in using macrofossils (especially sawgrass and other macrophyte seeds; also fossil pollen, spores, exoskeletons, shells, etc.) with appropriate dating techniques, as well as certain biomarker proxies to reconstruct historical vegetation on a smaller scale (10s of meters) and characterize boundary movements between ridge and slough communities.

Recommendations

1. Chapter 6 should be more strongly cross-referenced to other chapters, and within the chapter, the four major ecological areas of focus should be more strongly integrated. Accordingly, the chapter Summary should be revised to include additional overview of the objectives and hypotheses, project duration, agencies involved, integration of the major projects, and brief description of planned future directions.

2. New projects (e.g. the macroinvertebrate index and application of periphyton signature pigments) should be described in detail to enable evaluation of technical merit. Sufficient information about ongoing or recently completed projects and experiments, needed for context, should also be presented consistently within each major ecological area of focus.

3. Altered design of the macroinvertebrate index is encouraged and should include replication and rigorous statistics, and to consider more than field-identifiable organisms and more than simply presence/absence.

4. Additional research planned by the District to assess the rates and mechanisms controlling P flux from porewater to the overlying water column will yield valuable insights about P dynamics in the Everglades.

5. In the tree islands root evaluation study, supporting information should be included about litterfall and soil formation.

APPENDIX 6-1: ENVIRONMENTAL RESPONSES TO WATER MANAGEMENT: A STRATEGIC RESEARCH PLAN FOR THE EVERGLADES DIVISION

Technical Review

This chapter is an excellent overview of water management strategies, and provides a good description of organization, problems, and possible solutions. The inclusion of a table of contents makes it easier for the reader to find subjects. The introduction and background clearly lays out the objectives, priorities, and implementation plans. As such, it is a clear statement with finite and do-able objectives. The organizational chart listed on the first page, however, is confusing; it is unclear how this relates to anything else in the document. It would also help the organization if a paragraph were added to the end of the introduction that briefly summarizes the organization of the rest of the chapter.

Table 6A-1 is extremely important as a basis for understanding the overall Everglades research plan in relation to clear goals and objectives. The authors are to be congratulated on making the research objectives clear.

This is an opportunity for the program to add areas that clearly need addressing, and should be placed within the water management area. Invasive species is one such area that seems to be missing from this chapter, and in the invasive species chapter, several of the species seemed to be partly dependent on water level regimes. For example, are there any plans to determine whether invasive fish are having an effect on fish communities such that prey are less available to wading birds? In this same line, it would be useful to make sure that tribal interests are included in the synthesis area.

There should be a clear connection between the hypotheses and the individual studies being described. That is, it should be easy to see which hypothesis an individual study is addressing. While these are explained in Table 6a-1, it should also be stated under each study. Perhaps these could be placed under management and restoration objectives, making the chapter more reader friendly.

The overall organization of each section, and the consistency between sections, makes this an extremely useful document, and one deserving considerable discussion. This chapter would be improved with the addition of literature citations to work mentioned. It might also help to have references in Table 6A-1 that tell the reader where to go for details about the specific studies. This could also go into the individual studies mentioned. In other words, there has to be a place for the reader to find more details on each of the study components that make up the overall research plan.

The hypotheses as written are not really hypotheses, but statements. Usually a hypothesis is worded in such a way that it could be tested (e.g. for hypothesis 1 it would be - Wading bird nesting colony location, size and timing are related to changes in water levels). A hypothesis usually gives the reader some indication of a causal relationship, and these are mainly declarative statements.

Finally, at the end of the hypotheses for each section, and before the description of the studies it would be useful to have a paragraph that lays out how each of the studies in the section relate to one another, and to management goals. In other words, lay out the rationale for how they were selected.

Most of the comments above relate to all the sections, and below are comments specific to each section. Most of the technical review relates to concepts the authors should consider in future iterations.

Examining the Food Web

The problem of mercury and its effects on the food web, and the methylation of mercury in the periphyton, should be included. Similarly, the effects of invasive species should be integrated in some way, as these species will have a drastic effect on foods webs.

Managing for Accelerated Recovery

What attention has been given to other methods for accelerated recovery except herbicides and burning for this project? It would be useful to have a sentence or two about alternatives that are, or have been considered. LTP 1 is very useful because it can be tested.

Have models been used to predict recovery times, both for natural recovery and for accelerated recovery? Do the models predict differences as a function of herbicides vs. fire? What about fire intervals as a factor? Although modeling will be conducted for scaling up, it is not clear that modeling has been used to predict behavior of the system itself under different conditions.

It would be useful to have a little more information about natural and accelerated recovery: time frames, differences among microhabitats, effects on wildlife and plant communities, and effects on invasive plant spread.

Understanding Ecosystem Processes

While the two main questions addressed under this section are indeed quite important, we wonder whether other similar questions should be addressed, such as the relationship of Okeechobee to the Everglades proper and the relationship of the more northern modules with the Everglades proper. These same functional linkages are extremely important to overall management of the system. Similarly, are there other overview questions besides microbial and soil processes that are needed to understand ecosystem processes. While they may not be addressed at this time, they should be mentioned. One such question that comes to mind is the relationship between reptile invasives, native reptiles, and food web interactions. Many of the hypotheses listed for the relationship between the Everglades and Florida Bay would be of interest for the linkages between other components of the system.

The conceptual models for ecosystem function are very useful, and the study of the effect of sea level rise is critical to the system. Many of the models being developed will be useful throughout the Everglades. I wonder, however, about the definitions of stability in the system, given the externals of potential changes in sea level? Further, do the models also examine interactions with the bay with respect to compartments (e.g. open water, mangroves, and so on).

Numerical modeling, largely through CERP's Florida Bay and Florida Keys Feasibility Study (FBFKFS), is being used as a tool for information synthesis and forecasting responses of Florida Bay to water management activities, especially focusing on (1) salinity magnitude, spatial and temporal variability; (2) estuarine hydrodynamics, especially water residence time; (3) nutrient loadings and other pollutants; (4) structure and productivity of SAV habitat and associated fauna, especially fish. The modeling efforts are impressive, and should be continued. This effort includes development of a suite of large-scale dynamic numerical models to guide restoration of more natural and historical flows to the bay. An identified key constraint is that the changes in hydrology imposed by restoration must not further degrade water quality in the bay or the Keys coral reef areas. The suite of models being integrated includes:

Watershed models – USGS' TIME, Tides and Inflows in the Mangrove Ecotone; a wetland hydrologic model to estimate freshwater flows; and mangrove zone models to estimate nutrient inputs to the bay);

Ocean boundary hydrodynamic model (HYCOM – Hybrid Coordinate Ocean Model, to provide ocean boundary conditions);

Bay integrated hydrodynamic and water quality models (the EFDC – Environmental Fluid Dynamics Code, central to the entire modeling effort; includes consideration of biogeochemical processes such as nutrient uptake and transformation, nutrient sequestration, and primary production); and

Bay biological models – for example, the evolving Florida Bay seagrass community module developed by the District is to be incorporated into an EFDC model. Also planned for integration into the EFDC model are a phytoplankton simulation module and higher trophic level models for critical species (e.g. pink shrimp).

This ongoing and planned effort aims to synthesize the knowledge base and datasets on the Florida Bay ecosystem to enable assessment of the effects of hydrologic changes from management practices.

The Florida Bay Everglades Linkage study is extremely important. This is the first place that stewardship has appeared as a long-term goal, and this is an important aspect of the overall research and restoration plan. Are there any historical data on inputs into Florida Bay that might indicate what restoration goals might look like (do the data indicate anything about temporal and spatial patterns?). This would extend not only to direct measures of nutrient input, but the effect in terms of algal blooms (which might be a surrogate problem for which there are data). Presentation of the models (Fig. 6A-4) is useful because it shows the complexities of the interactions, and makes the text more understandable.

The Plan frankly acknowledges widespread public concerns about water management effects on Florida Bay water quality that need to be clearly addressed through project modification to improve water quality and prevent degradation, and/or through providing quantitative analyses that provide strong scientific basis to refute the concerns. One major concern and critical uncertainty identified in the Plan is that increased freshwater flows to the bay will concomitantly increase nutrient loadings (especially N and P species), stimulating undesirable algal blooms. The overall objective of planned projects is to quantify the status and trends of nutrient inputs to the bay, and general water quality conditions in the bay, targeting performance measures as nutrient loading and chlorophyll *a* concentrations (indicator of phytoplankton biomass). Projects to address this objective will involve a combination of long-term monitoring (in place planned for strengthening?), research, and quantitative synthesis through modeling. The monitoring and research is planned to include (1) nutrient loading to the southern wetlands from canals, (2) N and P transformation, retention and transport through the southern marshes to the bay, as influenced by hydrologic changes, and (3) nutrient cycling within the bay. An important targeted area for emphasis is nutrient retention/transport studies in Whitewater Bay, which is expected to receive much more freshwater flow through hydrologic management. Research on phytoplankton dynamics and light extinction will also include landscape-scale analysis of water quality monitoring network data, and experiments about research processes that influence phytoplankton and benthic algal production/ productivity (e.g. the role of various forms of dissolved organic matter).

Analyzing Landscape Structure and Function

The examination and study of the Everglades system on a landscape scale is a necessary part of restoration, although perhaps the most difficult. In this section was the mention of a 100-year time frame, and perhaps this concept needs to be expanded so that it is clear when specific goals are to be met throughout the report. The holistic approach taken in this section is optimal for an overview of the Everglades restoration. The use of 100 years makes it clear that a series of interim goals and assessment measures need to be developed.

The mapping being proposed is also important for the overall Everglades work, both for managers and scientists, and for the greater public, including public policy makers. The issue of ground-truthing needs to be considered, as well as adding some details about the scale of the data. It is not clear from the description how the historical information (as well as the peat cores) are going to be integrated into the current vegetation mapping. Who is responsible for comparing historical vegetation mapping with the current products? This comparison should prove particularly useful in the restoration process, and for the public to understand the nature and extent of ecosystem disruption.

The experiments to understand flow effects on plant community interactions are very important to overall restoration goals, and more details need to be provided on how the experiment will contribute to understanding in the greater Everglades area. It is a matter of scaling up the effects observed? The meta-scale transport processes study should go a ways toward understanding the scaling up. The ridge and slough pattern is critical to Everglades restoration, and any studies aimed at understanding how to maintain existing ones should be vigorously pursued. The management and restoration objectives for the ridge and slough pattern analysis and modeling project are well-stated and important.

Tree island formation and maintenance are clearly integral to the restoration efforts in the Everglades, and play a key role in ecosystem dynamics. To what degree have the effects of potential sea level rise been factored into the thinking, models and research plans. For this project, it might be useful to relate the management and restoration objectives to the larger picture. That is, how will understanding litterfall help with restoration of tree islands? Are there any plans to actually build new tree islands to experimentally determine if this is feasible or even possible?

Since the water regime is expected to change in the future as a function of water management, what thought has been given to selecting tree island sites that most mimic the future water level regimes to predict future effects? If not, then some preliminary water regimes should be tested to examine these effects. At the very least, the flooding tolerances data to be collected are extremely important to answering some of these questions.

The role of exotics in tree island formation is another critical question. This is one of the few places in this chapter where invasives are seriously considered, yet they should be integrated into as many of the research projects as possible as they will become even more important in the future of the Everglades. Monitoring is extremely important, and every effort should be made to encourage monitoring of the program at Loxahatchee with respect to exotic invasive plants.

Finally, Mangrove structure and function has been an area that has received little attention, but which has great potential for affecting the Florida Bay system. Since this system serves as a buffer for the Everglades from storms, as well as to coastal communities, it deserves some careful studies. Are there historical data that would allow for an understanding of the spatial and temporal changes in the location and extent of the mangrove system? Are any data available from the 1940s, 50s or later?

Synthesis

Ecological evaluation is a critical part of ecosystem management, and is usually done with a goods and services approach. Both ecological economics and ecological services approaches usually examine the value of ecosystems from an extractive and services viewpoint. Yet, many subsistence and American tribal peoples view ecosystem values in a more holistic and larger context. Every attempt should be made to go beyond the goods and services approach when evaluating ecosystems.

In response to the four specific questions the panel was asked to address:

Given that the District is a water management agency, does the research plan represent a good strategy for addressing key scientific and management-relevant questions related to hydrology, water quality, habitat, wildlife, and ecosystem management?

The chapter provides an excellent first attempt at a research plan that addresses the key scientific and management relevant questions related to hydrology, water quality, habitat, wildlife, and ecosystem management. However, two aspects are noticeably absent: the potential effects of mercury and other contaminants, and invasive species. Further, the plan should provide more insight into how it will integrate research products with future management decision making.

There should be more detail in the science plan on how the researchers will connect all phases of research with management recovery goals.

Given that the Everglades Division does research across a very broad landscape, at multiple scales, what is the best way to integrate the spatial and temporal dynamics of these projects?

The integration of temporal and spatial scales of the research projects has not been directly addressed in this research plan, and would be an important aspect of the plan. The basic strength of this plan lies in the increasingly well-developed modeling approaches that continue to be built and refined based upon empirical datasets that are strengthening over time. Modeling specialists in ecological endeavors typically are frustrated because they are often consulted after research and monitoring studies are designed – often, after such projects are finished. Here, in contrast and as an ongoing effort, the District is focusing on conceptual, hydrologic, and mechanistic models to identify the most important information that should be obtained in order to evaluate progress in restoration efforts. The District should continue to emphasize and to increase emphasis on the use of these carefully constructed, constantly improved-upon models to integrate the spatial and temporal dynamics of its Everglades projects. It should be clearer how the synthesis will occur, and how it will interface with restoration and operational decisions taken by management. Model validation needs to be considered.

Is the research strategy a logical progression from previous studies and will it provide projects that are relevant to management decisions?

The research strategy follows logically from the research projects that are on-going, as well as new projects. The components have been designed to feed directly into short-term and long-term management goals of restoration of the Everglades.

What important ecological and management issues are not addressed in this Strategic Research Plan?

Any research plan has ecological and management issues that are not currently addressed, due to both funding and time constraints. As mentioned above, some topics are missing: a) the effect of mercury, sulfur and phosphorus levels on ecosystem functioning, b) the role of invasive species in the structure and function of the Everglades, including the food web, and c) in the Florida Bay algal blooms component, sampling, research and modeling efforts should go beyond chlorophyll *a* to consider the responses of dominant bloom species and functional groups of phytoplankton, and the responses of known noxious macroalgal species. There could be a closer tie to specific management objectives, and to long-term goals of recovery. It is astonishing that ecosystem valuation techniques have never been applied to the Everglades. The Ecological Valuation section of the Plan is not mandated or listed as a restoration need, but the District deserves major credit for including it – this is an exciting section, and the work that it describes is critical, very much needed as part of the process to guide restoration efforts and to help the general citizenry understand them.

Recommendations

1. Consider the relationship of the science plan to the decisions that will be made in the next year, and beyond.

2. Develop methods and procedures (such as dedicated workshops, forums, regular conference calls) to integrate the science questions of decision-makers into the overall research strategy.

3. Develop methods and procedures (such as workshops, newsletters, hot-live phone numbers) to integrate the science questions of stakeholders into the overall research strategy.

4. Develop an overall framework for understanding the relationship between accelerated recovery and natural recovery (times, approaches, methods).

Integrative Review

The Plan explains that research project linkages with each other are not shown in a conceptual diagram because it would "look like spaghetti". Nevertheless, it acknowledges that such a diagram would be useful in revealing strong linkages, dependencies, and critical paths (line 139). A nice example of an integrative diagram is shown in Figure 6A-3; it would be helpful to include such diagrams for the other sections.

The Florida Bay effort also provides a strong illustration of project integration, planned through several levels of numerical analysis including calculations of improved nutrient budgets, statistical analyses/models of monitoring/Dataflow data, mass balance modeling, and dynamic water quality modeling. In the seagrass component, the approach to understand interactions of freshwater flow, salinity, water quality, and seagrass dynamics. The plan is to integrate modeling, fieldwork and laboratory research including a strong set of mesocosm studies to measure nutrient uptake and kinetic parameters of seagrasses under different inter-specific competition treatments, strengthened by field verification studies to "ground-truth" the data.

Impediments to progress in managing the South Florida water supply network in a holistic, integrative manner are very nicely explained, as are strategies for surmounting these impediments (lines 1436-1455). The Plan recognizes the need for projects that examine not only direct effects of management actions, but indirect effects, feedback loops, and habitat stability (lines 2269-2270).

The value of Table 6A-1 cannot be overstated – this table provides an excellent overview of the Plan, including linkages of each project with scientific needs of CERP and with State and Federal regulations and policies. The Plan is organized, in part, around a set of clearly defined hypotheses that guides the research of each major section. The Application of Results sections are also well conceived and clearly presented.

- Chapter 6 should be more strongly cross-referenced to other chapters, and within the chapter, the four major ecological areas of focus should be more strongly integrated. Accordingly, the chapter Summary should be revised to include additional overview of the objectives and hypotheses, project duration, agencies involved, integration of the major projects, and brief description of planned future directions.

CHAPTER 7A: COMPREHENSIVE EVERGLADES RESTORATION PLAN ANNUAL REPORT

Accountability Review

The panel noted and strongly supports the efforts by the District to reorganize this chapter to “embrace a more holistic approach to ecosystem restoration through advancement of the Northern and Southern Everglades initiatives.” On the whole, the panel feels that the District has prepared a streamlined and improved chapter that is in large part responsive to the various accountability and integrative initiatives of the SFER. The responses provided to the questions submitted to the authors during the draft review period were thorough and helped clarify several outstanding questions by panel members. The panel also acknowledges the important questions and technical corrections provided by staff of the Florida Department of Environmental Protection to specific details on CERP implementation.

Integrative Review

To some degree CERP can be conceived of as the point where the science/management integration continuum plays out at both the watershed and landscape levels. The science leads to management decisions which are then implemented. The links between CERP goals and CRP’s, Acceler8, the RECOVER programs and other programs under the direction of the State or the Federal Government such as LOPP, LOER the Northern Everglades and Estuaries Protection Program manifest the absolute need for integration of both science and management and are more clearly presented in the 2008 SFER than in previous reports. The responses by the chapter authors to the questions posed by the review panel and the discussion during the public sessions helped clarify the role of these various programs towards the overall restoration goals for the entire region.

The panel wishes to note that the Water for the Environment section of this chapter helps the reader understand the relationship of ecological programs to CERP activities and also leads to logical conclusions as to the pace and status of the overall restoration effort. However, the panel continues to feel it should be made explicit that, even after implementation, adaptations to future plans will be forthcoming, if for no other reason than the results of the ongoing monitoring programs, referred-to as the overall CERP implementation process, will continue to influence future research and management activities.

Recommendations

1. The panel endorses the concept of Project Implementation Reports and recommends that the experiences gained be used to develop a “lessons-learned” or a type of BMP list for better understanding the interactions of projects for the medium and long term as related to the CERP.

2. The relationships between what is proposed in chapter 1B and this chapter should be clarified in future reports.

3. The District should continue to reinforce the logic of the adaptive management concept in the implementation of CERP activities and in is public education and outreach efforts.

4. The panel supports the idea of adding a short section summarizing the relationship between implemented CERP projects and the ongoing monitoring programs of the District to this chapter. Perhaps a table simply noting what types of monitoring is being done and if the results of such monitoring are being reflected in other projects would be sufficient to ensure the relationship between CERP projects and the adaptive management concept.

5. While the methodology of informal exchanges of ideas among the various programs related to CERP goals through weekly meetings is a valid way for scientists and managers to gain information, consideration should be given to strengthening and formalizing this process. The complexity of the restoration process demands that accurate and complete information on research results be shared across the District and with other agencies involved with the management of this large and complex region.

CHAPTER 7B: RECOVER IMPLEMENTATION AND MONITORING FOR CERP

Accountability Review

The panel noted the concise manner in which this chapter is organized and presented. RECOVER is a program to organize and apply scientific and technical information in ways that are most effective in supporting CERP activities. It links science and management in a system-wide planning, evaluation, and assessment process and benefits from the results of Adaptive Management activities applied throughout the region. Further, the panel understands and agrees with the underlying concept that there will always likely be a range of views as to the strategies that are employed to best reach the overall goal of the CERP as well as the outcomes of that process.

It is very important the public understands that, as the report states, the development and application of performance measures is a dynamic process, one impacted by new science and technologies. As we have continued to state, if this concept is not understood, certain interest groups will question the efficiency of using taxpayer dollars to implement the CERP.

Integrative Review

The panel agrees with the authors that the RECOVER program is essential to any assessment of the overall ecological health of the South Florida region (physical, biological, chemical parameters) particularly in terms of measuring the impact of CERP initiatives. The overall ecological health of the region must be evaluated against an integrated set of milestones and indicators and continually adjusted to the results of one set of activities on planned actions based on monitoring efforts. It is also clear that CERP and RECOVER are parts of the same whole; fully interdependent to the overall success of the restoration of South Florida.

The lessons learned section of this chapter provides the readers of this report an opportunity to examine specific issues that the RECOVER team has found interesting and which should influence future actions and helps tie together the various site “report cards” or status reports as to actions taken and successes achieved. The panel recommends that this section be continued. However, the panel also found a couple of the statements to be rather self-evident such as indicating the need for ongoing funding and the incremental nature of science given the changing physical, chemical and ecological variables influencing management/policy decisions. The panel also notes that measuring natural variability is a very inexact science at best, and incremental in nature and can only influence the general direction of future research efforts.

Recommendations

1. The panel recommends continued use of site specific reporting for this chapter.

2. The panel notes the increasing importance that RECOVER activities will play in understanding the effectiveness of CERP activities in the future. This may require additional financial support – an investment to more effective long-term management of the South Florida region.

3. The panel supports the continued use of adaptive management in RECOVER activities.

4. The integrative nature of the lessons learned section should be strengthened by referencing specific actions taken or lessons learned during the previous year which may impact future CERP actions.

CHAPTER 8: THE LONG-TERM PLAN FOR ACHIEVING WATER QUALITY GOALS IN THE EVERGLADES PROTECTION AREA

Accountability Review

This chapter is well written and concise but should logically be read together with chapters 1B and 3, and cross-referenced with the results presented in chapters 4, 5, and 7A. This chapter will become more important overtime and might logically be combined with chapter 3. Chapter 1B might also form a logical introduction to this combined chapter once a comprehensive water quality methodology is employed. Still in its present format, it is a logical context to the implementation of a number of ongoing projects related to the Long-Term Plan goal of achieving water quality goals in the EPA, bringing understanding to the complexity of this effort. Table 8-1 continues to be of importance to the overall understanding of this chapter and others in the SFER.

Integrative Review

The panel notes the overall progress realized in reducing P levels into areas south of Lake Okeechobee (chapter 10) and the EPA, and particularly the statement that the long-term Everglades water quality goal is for all discharges to the EPA. However, the panel is fully aware that the drought conditions have impacted the measured level of TP to all areas south of the Lake in recent years. The panel is also clear that when the wet year cycle returns the pulse of downstream P will return to normal levels after a relatively short period. While TP remains the most notable indicator of that objective, it is clear that a number of other criteria, such as sulfur, will influence and be taken into account in defining acceptable water quality. The panel also notes that previous reports (SFER's) have supported the concept that additional measures are necessary to achieve the overall Everglades water quality goal as required by 31 December 2006 by the Everglades Forever Act, but found no mention of this deadline in chapter 8 of the 2008 SFER.

It is the understanding of the panel that many CERP projects are still in the early planning or implementation stages and therefore unclear as to how they will impact water quality, yet the monitoring program outlined in chapter 1B will take a considerable amount of time before it is agreed-to and implemented. A coordinated water quality monitoring and reporting plan will obviously have to be in place in order to be able to make specific recommendations for long-term water quality policies and to manage the expanding administrative reporting costs of so many agencies and programs.

Recommendations

1. The panel requests that some comment be made in future reports between efforts to integrate this methods and outputs of what is reported in this chapter and chapter 1B with the goals and outcomes of this chapter.

2. The impact of drought on water quality should be included in the 2009 SFER. The panel feels that some information should be added on the drought contingency plans for management of various components in the system especially the STAs, noting for example, what components might be sacrificed to maintain critical functions of critical components, what criteria will be used.

3. Some mention of the potential importance of sulfur to water quality should be presented in the 2009 SFER, as this will obviously become a much more important research focus in the near-term.

4. The title of this chapter includes the word “plan.” Given that the 2008 SFER includes two “science plans” it would be helpful to have the text reflect on how the chapter 8 plan is related to their science plans proposed both upstream and downstream of the focus of the chapter.

5. A short explanation of water quality monitoring activities, related to chapter 8, with those of both upstream and downstream monitoring activities would be helpful in understanding how monitoring is integrated across South Florida (and with chapter 1B – redesign effort).

CHAPTER 9: NONINDIGENOUS SPECIES IN THE SOUTH FLORIDA ENVIRONMENT

One of the advantages of the CERP and RECOVER programs for the Everglades is the potential to respond to new and emerging problems that the overall ecosystem faces. Examining and understanding nonindigenous species is one of the key components of any Everglades recovery program. The holistic approach of trying to catalogue all nonindigenous plants that seem to be (or could be) a problem in the Everglades is a daunting task, but an essential one, and this chapter is an excellent start. The chapter provides an excellent overview of the species biology of several nonindigenous invasive species.

Accountability Review

Overall, this chapter is an excellent extension of previous work with nonindigenous species. It provides updated information and evaluations of the relative potential for threats within each module. The summary places the problem of nonindigenous species within the context of restoration in the Everglades, and appropriately indicates the overall lack of knowledge for many of these species. For the general public, it would be useful to have some overall observations or conclusions about the impacts of these species (and some indication of the key invasive and problematic ones) in the summary.

A number of agencies and organizations have recognized the problem of nonindigenous species, particularly nuisance plants and animals whose populations are affecting native species. This problem seems to be one that has received the administrative attention it deserves, and several groups are working together to develop a database that can be used by all to track invasive species. The chapter rightly identifies one of the main problems: that invasive species work has centered around those with agricultural or other economic effects, rather than those species that cause ecosystem disruption. A table might be useful to identify the agencies and groups that are involved with the nonindigenous species problem, and what their tasks are.

One of the key tools is to track the spread and abundance of nonindigenous species so that the spatial and temporal aspects of the problem are known to all managers, public policy makers, and the public. Much of the monitoring is still aimed at the large, invasive tree species that can be easily monitored from the air to arrive at good estimates of acreage of each species. While this is useful for these species, it does not address smaller plants and most animals that would not be visible from the air.

Summary and conclusions

The chapter updates what is known about nonindigenous species and their impacts in South Florida terrestrial and aquatic environments within CERP and RECOVER representing eight regional modules including the Florida Keys, Florida Bay and the Southern Estuaries, the Greater Everglades, Big Cypress, Lake Okeechobee, Northern Estuaries – East, Northern Estuaries – West (Caloosahatchee), and the Kissimmee River basin. Table 9-2 provides an excellent compilation of the exotic plant and animal species lists for these modules, while pointing out that the animal species information likely is not comprehensive because of limited availability of distribution data on exotic animals. The approach for developing a suite of ecological indicators on exotic plant species to evaluate CERP restoration progress is nicely explained (p.9-24). These indicators will not be similar to other RECOVER indicators because, as the authors state, nonindigenous species are inherently ill-suited to indicate ecological function, process or structure in a restoration context. The color-coded progress assessment ("stop light") technique remains an innovative, excellent tool for evaluating status and projected conditions, species by species, within each module. The descriptions of selected exotic species, their impacts, and efforts to track/control them are excellent and fascinating, as in previous SFER's. The authors' synthesis of information needs and gaps is clear and compelling, culminating in their identification of the top five priorities that must be addressed to realistically, effectively approach management and control of exotic species in South Florida.

Recommendations (Accountability)

Develop manageable sub-goals that can be assigned to particular units, managers, or entities.

1. The Summary should mention some of the worst exotic species problems (plant and animal), as well as some (albeit few) "success stories" in their management, control or eradication (e.g. *Caulerpa* in coastal areas) to show that, at least for some species, with concerted effort it *can* be achieved.

2. The various sections should be checked for parallel organization.

3. Include a flow chart of agencies/entities engaged in assessment and management of which nonindigenous species within each module.

Technical Review

The authors are to be commended for including animals in this chapter, despite the lower quantity and quality of much of the data. It is a start on a very difficult task, and Table 9-2 is excellent (although some indication of severity could be indicated by a larger letter X). The exotic plant indicators are excellent, and a similar plan should be instituted for animals. It would also be useful to take the most invasive plants and have one chart that shows them in all the regions (e.g. Table 9-4 and so on).

The descriptions are excellent, and include a short history, effects, and where it occurs, the control measures. In all cases, it would be useful if there were an introductory sentence in each subsection that discussed the plants to be described for that section. It would also help if for each major plant species (or animal for that matter), a statement was made about its legal use (that is, is it sold, illegal to plant?). The cross-referencing for descriptions of the same species in different modules is excellent (although in the final version it would be helpful if the editors actually put in page numbers so the reader can easily find the sections on the same species).

Feral cats, as duly noted for the Keys, are a problem throughout the world, and very extensive public relations programs are necessary. This effort should be greatly increased throughout South Florida and the US generally. We have not done enough about this particular problem.

The efforts to control the most invasive and problematic plant species are on-going, and simply require more money, time and effort to prevent large-scale ecological changes to the Everglades. The occurrence of two haplotypes of Brazilian pepper is extremely interesting, with major consequences for control, duly noted. This illustrates the complexity of the control issues, and makes the report outstanding.

The python seems to be the species of greatest concern for a wide range of key native animals species in the Everglades, and one that will have myriad cascading effects. Every effort should be made to control them (legal, educational, removal, and reproductive control). Since pythons are egg-layers, a study should be initiated to determine where they nest and to eradicate the eggs. Breeding them in captivity should also be made illegal.

The recent invasion of Sacred Ibises breeding is extremely interesting, and since it is so recent, it can be controlled at this point, and this should be done now, before it becomes another Cattle Egret in North America. No efforts of control are mentioned, and they should be considered.

The complexities of the feral hog problem typify the problems of invasive species generally. There are often interests that want a given species to remain, and how to deal with different stakeholders is critical (and this topic may deserve a species workshop overall).

Given the problems with reptiles in this and other modules within the region, it seems prudent to convene a workshop to address these problems, figure out the best control measures for each species, and talk about overall funding, as well as a public education program. Some of these species promise to create even bigger problems if they expand into some of the other regions.

The feral hog removal experiment seems quite critical to understanding the problem in other regions of Florida, and deserves a little more attention (especially for the public readers of this report, and in light of conflicting stakeholder interest in the species). There should be expansion of the types of damage they caused, and to what species.

Integrative Review

Non-indigenous species have the potential to drastically affect almost every aspect of the structure and function of the Everglades area. Thus, their effects should be integrated into many of the chapters, including Ecology of the Everglades (6), Everglades research plan (6-1), Comprehensive Everglades Restoration Plan (7A), Lake Okeechobee (10) and Kissimmee Basin (11). Further, nonindigenous species are affecting the efficacy of the performance measures, and can potentially have a greater effect than any other factor (including quantity and quality of water).

Recommendations (Integrative)

1. Integrate the presence and effects of non-indigenous species into the overall research plans, including Everglades Research Plan (chap 6-1) and the Coastal Ecosystem Research Strategy (chap 12-1).

2. Examine the effect of invasive species on performance measures.

3. Relate nonindigenous species management and control to specific recovery goals, which relates to a management strategy and evaluation of the overall critical species to control.

CHAPTER 10: LAKE OKEECHOBEE PROTECTION PROGRAM - STATE OF THE LAKE AND WATERSHED

Accountability Review

Chapter 10 presents a defensible account of data and findings for the areas being addressed, the coverage is appropriate. The chapter is emphasizing this year different aspects of Lake Okeechobee, but that is consistent with earlier versions of the report. The findings are strongly linked to management goals and objectives. The authors of Chapter 10 were responsive to the Panel's recommendations and comments. This chapter has been enhanced from the 2007 report by additional material which addresses several points raised by the Panel last year.
The major legislation, plans and projects affecting Lake Okeechobee (LOPA, LOPP, LOWP, LOER Action Plan [expanded in 2007 to include the St. Lucie and Caloosahatchee systems], LOWCP, the USACE's Tentatively Selected Plan [TSP], LOIWRP, ERP basin rule) and anticipated effects and accomplishments are nicely described. The Northern Everglades and Estuaries Protection Program seems a welcome addition that will help restoration efforts. The "Watershed Phosphorus Control Programs" section was helpful and interesting; it tracks the progress of District and partners' activities in BMP programs (urban and agricultural) and various projects/incentives – some very innovative - designed to reduce P loading to the Lake. Efforts to assess BMP effectiveness (p.10-32) unfortunately seem weak in places, but are mostly outside the District's control.

Technical Review

The caliber of the considerable technical information presented in Chapter 10 is generally excellent, including great supporting figures and tables and very clear, interesting explanations with sound rationale. This chapter contributes a well-written, very nicely illustrated, interesting and frank account of progress and impediments in restoration of Lake Okeechobee, including a compelling description of the havoc wreaked on restoration efforts by major hurricanes followed by a sustained record drought. Long-term impacts on the lake have been described as excessive P loads, unnaturally high and low water levels, and rapid spread of exotic and nuisance plants in the littoral zone. In WY2007 the lake received only one-sixth of the flow that it received in WY2006; to maintain water supply in the EAA, 14 temporary pumps had to be deployed. Discharges from the lake to the EAA, the St. Lucie basin and the Caloosahatchee basin were less than half the 15-year annual average. The present 5-year average P load is more than four-fold higher than the TMDL target; the TP load for WY2007 was much lower than in previous years because of non-point loading reductions imposed by the drought, yet the average inflow-weighted TP concentration increased substantially (e.g. p.10-42) so that the net P loads to the Lake in WYs2006-2007 were similar. An increase in inflow TP concentrations during WY2007 despite much-reduced flow from the Kissimmee River is troubling, and was suggested to have been related to higher contribution of flow and loads from smaller, more agriculturally intensive basins (p.10-43). The net sedimentation coefficient (per year) has declined substantially in the lake since the 1970s (including consideration of data from WY2007), indicating that the Lake is less able to absorb excess TP loads from the watershed.

Of 11 performance measures (PMs), only 1 (the diatom : cyanobacteria ratio) has been achieved and the underlying reason(s) for that success is uncertain. The goal for water clarity in shoreline

areas (100% light visibility to the lake bed from May through September) was only attained ~10% of the time in the past 5 years, and the goal for algal bloom frequency (5% of all samples exceeding 40 ppb of chlorophyll *a*) was exceeded in ~8% of all samples.
The serious problem of residual P accumulations in the watershed ("legacy P", an excellent descriptive term) is identified as a major impediment that will delay the TP reductions targeted for completion by 2015 for the TP TMDL. It is exciting, though, to learn that the storage and dynamics of legacy P are beginning to be evaluated by the District, to assess how much P is currently stored in the watershed, and how long it will take for legacy P to reach stable levels (p.10-31).

The chapter updates District scientific and restoration activities presented in the 2007 SFER, focusing on water quality, water levels, and aquatic vegetation. It briefly describes the substantial predictive modeling efforts (e.g. the spatially explicit, integrated hydrodynamic, sediment transport, and water quality LOEM – p.10-63). It would be helpful to provide more detailed discussion of the model and its ongoing refinement merit/applications, perhaps in the 2009 SFER.

As in previous SFER's, it updates an excellent analysis of land uses in the Lake watershed, essential information needed to support District planning and management activities. It also provides historic and WY2007 comparisons of TP and TN budgets to the lake, including a breakdown of contributions by various tributaries, canals and other sources. Research and demonstration projects that were initiated, continued or completed in WY2007 are nicely summarized (Table 10-8; additional information on ecological experiments with SAV, p.10-64). A clear synopsis is included of water quality monitoring in the watershed (p.10-36). In WY2007, comparison of aerial photo-based vegetation maps from 1996 versus 2003 showed that cattail coverage had decreased by ~10%; torpedo grass and water lily coverage had each increased by ~25%; and bulrush coverage had decreased by ~20%. An interesting study examined the redistribution of muck sediments and nutrients (P, N) from the central pelagic zone to more nearshore and littoral regions. A major dredging effort removed 1.6 x 10^6 m^3 of muck, with ~273 mt of P from six littoral zone locations to help restore SAV habitat. In addition, the District's efforts to establish more pond apple and cypress habitat by plantings continued in selected locations. Remarkably, the drought created such dry conditions that it exposed the lake's huge marsh area; in February and May 2007, more than 80% of the emergent vegetation in the western marsh was burned via wildfires or prescribed burns to eliminate much of the exotic torpedo grass and invasive cattail. The authors nicely explained the scientifically sound rationale underlying this effort.

Recommendations

1. Give in this chapter more information about the levels of mercury in the fish populations in the lake. It was dismaying to learn that Lake Okeechobee's limits for mercury are among the least restrictive of all advisories in Florida.

2. Include in the chapter more information known about *Nymphaea* abundance in the lake and whether an increasing abundance is beneficial or detrimental to the lake ecosystem.

3. The information on water quality monitoring (p.10-36) would be strengthened by discussion of the compatibility of techniques used over time by the District and others. Give more details whether techniques have been consistent over time.

4) It is important to understand plans for assessing the overall impact of exotic species (plants and animals) on the Lake ecosystem. It would seem that such information would be needed to assess the effectiveness of some performance measures. Thus, we recommend that a detailed table of the exotic plants and animals that inhabit Lake Okeechobee be included in this chapter. We suggest that the table indicate what is known about each species' distribution in the Lake; what is being done to monitor each one; what is being done to attempt to manage or control each one; particular species of concern for the Lake ecosystem that are not being managed; and plans to address those species of concern.

5. It is recommendable to expand the experiments described on page 10-64 " Light influence on the growth and germination of submerged aquatic vegetation" with more interacting factors e.g. phosphorus in the sediment.

6. The chapter describes atrazine and hexazinone as relatively nontoxic to mammals, but conflicting information occurs in the literatures, especially considering insidious, chronic impacts. Additional discussion with supporting references is needed in this chapter.

7. Although this chapter provides an excellent compilation on environmental conditions, District activities, and restoration progress for WY2007, it still needs more integration with other chapters. It would be strengthened by additional integration summarizing effects of the lake in WY2007 on the St. Lucie and Caloosahatchee estuaries.

8. The chapter should include a description of plans to account for potential impacts on the lake from urban/suburban development affecting the upper watershed.

CHAPTER 11: KISSIMMEE BASIN

As a major source of water, pollutants and other materials to Lake Okeechobee and downstream ecosystems, activities and conditions in the Kissimmee basin can have significant effects throughout South Florida. The major goal of the District under the Kissimmee River Restoration Project (KRRP) is to restore ecological integrity to the Kissimmee River and floodplain ecosystem while retaining the existing level of flood control in the watershed as a whole. Chapter 11 provides an excellent historic account of Kissimmee River/watershed channelization impacts, and an update on environmental conditions and District activities toward restoration goals in WY2007. The chapter is designed to be reduced in content from previous years, and focuses on four general areas including (1) a description of environmental conditions in the Kissimmee River watershed, (2) newly available data from the KRREP (Kissimmee River Restoration Evaluation Program), (3) recent planning efforts, and (4) summary updates on the status of selected projects.

Chapter 11 was designed primarily for accountability review (progress in District programs and projects during WY2007), and secondarily for technical review. It was also deemed constructive to consider this chapter for integrative review, since one of four main sections of its organization is “Cross-Watershed Activities”, which is strongly integrative in character. It also seems problematic that this chapter was assigned for technical review. It was shortened from the format of previous years as stated above, technical discussion and details that would previously have been included were omitted by design.

This chapter describes a difficult water year with a sustained, severe drought that wreaked havoc with District plans and progress in restoring the Kissimmee River. Restoration efforts in the Kissimmee watershed are already an uphill battle, given the severe channelization and deepening of the Kissimmee River in 1962-1971 by the C&SF Project and other flood control projects that were imposed (lines 128-129). WY2007 provides a realistic illustration of the fragility of restoration efforts against major human water supply needs in the region and extreme climatic events (e.g. Hurricane Wilma in WY2006 followed by this severe drought in WY2007). Releases from the upper watershed to the Kissimmee River were stopped for 252 days (8 Nov. 2006 – 18 July 2007), effecting no-flow conditions in the Phase I reach and eliminating much of the floodplain area habitat for wading birds. Thus, WY2007’s dry season was the first since Phase I completion that failed to meet the restoration expectation of ~30 birds/km^2. Discharges from S-65 to the Kissimmee River were stopped from 16 October to 18 July. Only intermittent flow was released from S-65E to Lake Okeechobee from 16 Oct. 2006 – 21 July 2007, and thereafter no releases occurred at S-65E for the rest of WY2007. One ecosystem component that may have profited from the drought was native lake littoral zone SAV in the Upper Basin.

In the workshop for the 2008 SFER, the chapter authors provided generally helpful, detailed responses to the panel’s comments, questions and suggestions, and they indicated that many of the panel’s suggested changes and requests for clarification and additional information would be addressed in the final chapter version. Therefore, this evaluation focuses on points and information that remain to be considered or additional information in the authors’ responses that was not indicated for inclusion in the chapter.

Accountability Review

In WY2007, the District completed preliminary planning for KRRP Phases II and III, and continued efforts to assess restoration progress. New data from the Phase I area included two water quality studies (DO, P), floodplain vegetation responses (from aerial photos in 2003) and an analysis of wading bird nests and foraging use of the Kissimmee River floodplain. The District logically continued to follow the Zone B1 line in 2007, based on the fact that multiple years of data are needed to evaluate the efficacy of this management alternative.

An important feature of the District's approach to managing the Kissimmee waters is the use of an emergency modeling team to guide operations during flood events, and the use of adaptive management in periodic re-evaluations and revisions of the stage regulation schedules for the C&SF Project structures. The authors indicate that the KBMOS provides an example of a regulation schedule review. Missing from the writing, though, was explanation as to how the accountability of KRRP will actually be evaluated as restoration efforts continue.

The KBMOS is an exciting, valuable effort in the restoration process. Its final deliverable (June 2008) will be modified interim and long-term operating criteria for the Kissimmee basin water control structures that optimize ecosystem recovery within mandated hydrologic requirements. Development of the LTMP, another excellent effort, appears to be progressing well. Among the smaller projects described in this chapter, the Three Lakes Wildlife Management Area and Rolling Meadows/Catfish Creek restoration projects are progressing, but very unfortunately, the promising Packingham and Buttermilk Sloughs project had to be abandoned because the wildlife (birds) accompanying restoration would have conflicted with operations at a nearby airport (FAA Advisory Circular – hazardous wildlife attractants).

Technical Review

Overall, the technical quality of this chapter is sound. The inclusion of data past the end of WY2007 enabled the authors to discuss the full duration of the sustained drought. Figures 11-4 and 11-5 are well conceived and very helpful in conveying how conditions changed in East Lake Toho and Lake Toho over time.

The chapter authors provided additional helpful information to clarify the relative contribution of agriculture versus other sources of phosphorus; changes in P loads since 2001; the effects of restoration construction activities on P spikes; the historical perspective on snail kite nests; the source of spoil material for backfilling efforts; consideration of benthic (and other) invertebrates in restoration efforts; rationale regarding present efforts to restore pre-channelization floodplain vegetation (present higher proportion of wetland shrub species vs. broadleaf marsh species); and the District's public outreach component in the Kissimmee basin.

The District has not examined the effect of oxygen sags on P release from river and lake sediments, but is considering a study of P assimilation/release as wetlands are restored in the Pool D floodplain and flow is diverted to remnant channels.

The District is tracking mercury bioaccumulation and impacts in the Kissimmee basin by focusing on mercury concentrations in fish tissues, but this point, and the data, were not mentioned in the chapter.

Among the exotic plant and species in the Kissimmee basin, two plant species were briefly mentioned.

Monitoring of submersed aquatic vegetation in KCOL lakes is planned to begin in 2008.

The panel expressed concern, as for the 2007 SFER, about the use of mean dissolved oxygen (DO) as a restoration performance measure (PM). In responses to panel comments, the District clarified that daily minimum DO was not used as a PM metric because reference data are lacking upon which to base a minimum acceptable threshold. The chapter authors acknowledged that minimum DO is a very important parameter. They clarified that data are available from (2) continuous DO monitoring stations, and that 4 additional continuous DO monitoring stations are planned as part of Phase II/III studies, but information was not provided about the number and locations of these stations.

In responses to panel comments, the District also clarified that the PM for DO concentrations would fail if DO near the channel bottom was less than 1 mg/L more than 50% of the time; that the threshold is based on data collected in the channelized system, wherein DO is less than 1 mg/L nearly all of the time; that no reference (pre-channelization) data exist for bottom-water DO; and that Phase II/III baseline studies will better integrate DO concentrations near the river bottom with benthic invertebrate community structure.

Several panel comments on the draft chapter concerned the description of a fish kill, its relationship to DO concentrations, and questions about physiological stress to fish health. The chapter authors clarified in response that the fish kill was relatively small, affected a small area, surrounding refugia areas were available, and fish were not observed to show [*overt* signs of] stress which was defined as gulping air at the water surface. The authors also provided data from other studies showing that fish can *survive* hypoxia (3.35 mg DO/L). The panel's two major concerns remain, however, that (1) the data considered for lack of fish stress were for adult stages, rather than for sensitive younger life stages; and (2) consideration should be included for physiological fish stress *beyond* overt signs such as gulping air at the surface, since it is well known that many fish species (especially young stages) are seriously affected physiologically by chronic exposure to DO concentrations < 4 mg/L.

Integrative Review

One of the four main sections of Chapter 11's organization is "Cross-Watershed Activities", which is strongly integrative in character and generally excellent in quality. A major priority of the Kissimmee Watershed Program is to integrate watershed and river restoration management strategies. The District's recognition of the critical need for this integration was also reflected in its action to expand the Kissimmee Program to include more of the Kissimmee watershed, especially some of the Kissimmee Chain of Lakes (KCOL, 19 water bodies). In addition, the stated goal of Phase II/III evaluation is to better understand relationships among individual components of ecosystem response to restoration through increased integration of a subset of studies.

Chapter 11 helpfully, if too briefly on some issues, explains how management of the Kissimmee relates to/coordinates with management of the rest of the Everglades system. Regional water-related issues, beyond the watershed, that will affect the Kissimmee basin – for example, urbanization – were identified as a primary District concern. The District is continuing to strengthen relationships with agencies and other entities that control these areas, which are outside of the District's purview. In responses to panel comments about the draft chapter, the authors provided helpful information about how the monitoring and assessment component of the KCOL LTMP should eventually be coordinated with RECOVER, including evaluation performance measures.

Coordinated initiatives presently include the KRRP, KRHRP, and the interagency KCOL LTMP. The latter Plan is designing collaborative strategies for identifying when management intervention is needed, or when management actions should be modified to achieve targeted goals. Integration is also being strengthened by the KBMOS major modeling effort, which assesses basin-wide effects of alternative operations schedules for flow control structures in the watershed while also considering impacts of the resulting discharges on Lake Okeechobee. Flows in the Kissimmee River are formally considered in decisions for managing outflows at Lake Okeechobee.

P loading from the Kissimmee River is included in estimates of P loadings to Lake Okeechobee, but there is no coordination of monitoring between the Kissimmee River and the Everglades Protection Area.

Although the panel previously has called for consideration of mercury holistically throughout the District, in the panel's view there seems to be a "disconnect" on this issue, considering that present District efforts focus only assessment of potential changes in mercury mobilization resulting from the Everglades Construction Project. This situation has resulted largely because other agencies are heavily involved in mercury monitoring.

The authors also provided further explanation at the workshop about how the Kissimmee restoration plans will be integrated with management of exotic plant species, but exotic plant species were only briefly mentioned and exotic animal species were not mentioned.

Recommendations

1. Efforts should continue to develop a plan of selected approaches for modeling and monitoring of phosphorus movement and retention, legacy P (P storage), and present/future P loading. A

study of P assimilation/release should be completed as wetlands are restored in the Pool D floodplain and flow is diverted to remnant channels.

2. Explanation should be included as to how the accountability of KRRP will be evaluated as restoration efforts continue, and how the Kissimmee restoration plans will be integrated with management of exotic plant and animal species.

3. The authors' clarification about why minimum DO has not been used as a PM should be included in the chapter, as well as information about the number and locations of continuous DO monitoring stations. In addition, the chapter writing should be tempered to consider that chronic, physiological DO stress to fish health beyond overt signs such as fish death or fish gulping air at the water surface are known to occur from hypoxic conditions (< 4 mg DO/L), especially for sensitive young life history stages.

4. Information that clarifies various points should be added to the revised chapter, including the relative contribution of agriculture versus other sources of phosphorus; changes in P loads since 2001; the effects of restoration construction activities on P spikes; the historical perspective on snail kite nests; the source of spoil material for backfilling efforts; consideration of benthic (and other) invertebrates in restoration efforts; rationale regarding present efforts to restore pre-channelization floodplain vegetation (present higher proportion of wetland shrub species vs. broadleaf marsh species); and the District's public outreach component in the Kissimmee basin.

5. Increased phosphorus levels at the southern end of Lake Kissimmee are as yet unexplained, and could confound management goals. The sustained drought impeded work to resolve the sources. This important work should be emphasized as soon as climatic conditions permit, with progress assessed in the 2009 SFER.

6. It was encouraging to learn that, because of recent changes to LOPA (the Lake Okeechobee Protection Act), the Lake Okeechobee Works of the District Rule is being revised to include the Upper Kissimmee basin, so that implementation of BMPs will be required of landowners, rather than on a volunteer basis. More information about mandatory BMPs in the Upper Kissimmee basin should be included in future SFER's once this revision to the rule is in place.

7. Explanation should be included on the entities that monitor mercury in the Kissimmee basin, as well as a description of mercury concentrations in fish tissues, background information on mercury levels that impair fish health (all life stages of major species), and a brief summary of mercury advisories.

8. The District's planned detailed monitoring study of submersed aquatic vegetation in KCOL lakes will provide valuable information and should be completed.

CHAPTER 12: MANAGEMENT AND RESTORATION OF COASTAL ECOSYSTEMS

The mission of the South Florida Water Management District is "to manage and protect water resources of the region by balancing and improving water quality, flood control, natural systems and water supply", and to fulfill this mission the District has as a goal the restoration of "coastal watersheds and receiving water bodies through local initiatives and partnerships and applied scientific research" and the decrease in "flood damages District-wide through flood management planning" (from the District's Strategic Plan 2007-2017). Given this District mission and goal, this chapter on coastal ecosystem management and restoration is focused on the major estuaries within the District's jurisdiction, namely the: Southern Indian River Lagoon and St. Lucie River and Estuary; Loxahatchee River Estuary; Lake Worth Lagoon; Biscayne Bay; Florida Bay; Naples Bay; Estero Bay; and Caloosahatchee River Estuary and Charlotte Harbor. Just as the estuary of focus in the 2007 SFER Report was the Loxahatchee River Estuary, the estuary of focus this year was Florida Bay.

Early in this chapter it is stated that the primary role of the Coastal Ecosystems Program (CEP) is "to provide the required information necessary to design effective restoration and protection measures for the estuaries, and inform decision makers" and that "a primary objective of the District is to ensure that an appropriate pattern of fresh water is supplied to the estuaries," and to do this requires knowledge about:

- Current conditions and ecology of each one of the water bodies and watersheds;
- Appropriate ecological endpoints;
- Means to predict changes to the freshwater inflow patterns.

This is a substantial task which the District has embraced, and it is a task that is complex, difficult, and long-term based on the experience of other water management agencies in Gulf coast and Atlantic states in which water resource needs of coastal systems have been studied.

The stated primary role of the CEP is to provide the information needed to design effective restoration and protection measures for the District's eight priority Coastal Ecosystems. This year's Chapter 12 is outstanding in its structure and content. In WY2007, the District's Coastal Ecosystems division, which oversees science programs for all of the coastal areas except Florida Bay, also developed a *Coastal Ecosystems Science Plan* (Appendix 12-1; Florida Bay's strategic science plan is included in Appendix 6-1) to better guide restoration efforts in the coastal estuaries. While this plan will be discussed in more detail in the review of Appendix 12-1, it should be noted that the Coastal Ecosystems Program has constructed an approach for coastal ecosystem management that is basically sound as a solid starting point for managing the coastal ecosystems, the waters that flow to them, and their watersheds. While the Plan is not necessarily unique - for it embodies approaches taken by water regulatory agencies in other states since at least the 1950s in which water resources are often scarce and in which the coastal ecosystems support commercially important finfish and shellfish and their associated support structure - the Plan is an integration of science, engineering, and management within the District and perhaps most importantly it begins to elevate the value of freshwater inflows (and their needed spatial and temporal variability) to Florida's southern estuaries to a level commiserate with municipal, industrial, and agricultural irrigation water supply.

As comprehensive as this Plan is, the one concern with it is its strong focus on salinity as the primary indicator for management purposes of freshwater inflows on the estuaries within the District's boundaries. Yes, salinity is a strong indicator of the impact of freshwater inflows on estuaries and it is a major influence on the distribution of biota in estuaries due to their tolerance limits as noted above, but the flux of organic materials and nutrients to estuaries and their cycling within the estuaries governs system productivity. For commercially important species, it is productivity or commercial yield from coastal systems that is most important. What is largely missing from the Plan is the consideration of organics and nutrients. The District's management objectives of (1) improving timing, volume, and delivery of fresh water, (2) improving operation of District infrastructure, (3) improving and protecting water quality, and (4) rehabilitating estuarine habitats are very good objectives, and it is presumed that over time the District will practice adaptive management and over time move beyond salinity as it primary indicator of the impacts of freshwater inflows to other indicators that are also water quality as well as biologically based such as food chains (phytoplankton and detrital), nutrient cycling, and primary and productivity.

Recommendations

1. The Panel recommends that the Summary be strengthened so that it is more representative of the work done in developing the Science Plan but also that carried out in the major estuaries within the District's jurisdiction.
2. The Panel recommends that Table 12-1 be enhanced by:
   a. Denoting more clearly the major parts of the Science Plan currently indicated in the heading of the first column of each page;
   b. Including the status of the MFL's in each estuary; and
   c. Including as practical basic information on each estuary (see comment 4a below);
3. As has been pointed out by the Panel in the past two SFER report reviews, there still appears to be little review, analysis, and incorporation into the District's coastal work, especially for the determination of and impacts of freshwater inflows, of research performed outside of Florida. While the District has developed a strong approach to estuarine management, it could be stronger if experience gained in other states with freshwater inflow management was incorporated, and the Panel recommends that the CEP take advantage of the work done elsewhere on coastal ecosystem management, particularly the management of freshwater inflows to keep estuaries functioning as estuaries.
4. For each estuarine system, the Panel recommends that additional information be provided routinely on an annual basis to get a sense of the "state of the bay", namely:
   a. Physical characteristics such as volume at mean tide, surface area at mean tide, average depth at mean tide, measures of tidal exchange such tidal prism, major currents, major geomorphic features;
   b. Hydrologic characteristics such as annual average inflows by year for previous 20 years at least, annual average hydraulic residence times, average annual constituent residence times taking into account tidal exchange, and fraction of freshwater based on annual average salinities;

c. Water quality characteristics such as annual average concentrations and temporal variations of key constituents (e.g., salinity, DO, organics, and nutrients) bay wide and spatially that conveys general information about water quality conditions throughout the estuary;

d. Biological data such as general concentrations (volumetric, areal, etc. as appropriate) of primary producers (e.g., phytoplankton, submerged aquatic vegetation) and secondary producers (e.g., zooplankton, benthic organisms, key species/VEC's), and associated organisms.

5. The Panel recommends that a short section (i.e., no more than half a page each) be added to each estuary describing the mathematical models that have been prepared and their status. This additional information would balance the descriptions provided of sampling programs for water quality and biota and other material provided. Any efforts to develop and apply simplified models (e.g., CSTR, plug flow, dispersive flow) and intermediate models (e.g., finite segment models in one-, two-, or three dimensions) should be described as well.

6. For each estuarine system, accountability needs to be addressed via a statement as to how the hydrologic and water quality modeling, water quality data, and biological data are being used to manage this estuary at the present time, how water management in the watershed upstream relates to that management, and how well water quality goals have been met during the year. While District staff state their intention to provide such linkages when each of the individual science plans are fully developed, the Panel strongly recommends that those management objectives be recognized and stated up front and that the science plans incorporate those objectives.

7. Specific comments on each estuarine system are below:

   a. Southern Indian River Lagoon and St. Lucie River and Estuary – While District staff noted that VSS would be considered for the Northern Everglades Initiative study and used in the calibration of the sediment module of the CH3D water quality model, the Panel recommends that water quality monitoring include a measure of organic materials such as Volatile Suspended Solids or Total Organic Carbon in the water column to complement other nutrient constituents.

   b. Loxahatchee River Estuary – The Panel continues to recommend that more than one transect be maintained in the lower tidal area of the Northwest Fork to support detection of long-term changes in that area.

   c. Lake Worth Lagoon – The Panel recommends that the concern about sedimentation and turbidity that was raised but not explained in this section be addressed as well as whether shallowing of the Lagoon due to sediment deposition measured and whether it was considered as a cause for water volume decrease and hence salinity decrease.

   d. Biscayne Bay – The Panel recommends that results of salinity distribution in the Bay be presented in the 2009 Draft SFER Report as well as other water quality constituents as available.

   e. Florida Bay – The Panel recommends that District staff continue to quantify the sources of nutrients that led to the algal bloom in eastern Florida Bay and southern Biscayne Bay as the explanation for the source of the bloom does not yet appear to be resolved.

f. Naples Bay – The Panel recommends that District staff clarify the resource needs and time frame for developing more components of the Science Plan for this bay.

g. Estero Bay - The Panel recommends that District staff clarify the resource needs and time frame for developing more components of the Science Plan for this bay.

h. Caloosahatchee River Estuary and Charlotte Harbor – The Panel recommends that the results of additional nutrient limitation studies be presented in the 2009 Draft SFER Report and that District staff clarify the resource needs and time frame for developing more components of the Science Plan for this bay.

APPENDIX 12-1: COASTAL ECOSYSTEMS DIVISION SCIENCE PLAN

In response to the three specific questions the panel was asked to address**:**

Is the research strategy proposed by the Coastal Ecosystems Division (CED) scientifically sound and consistent with the state of the art in coastal science?

There is confusion about interchanging the terms "research strategy" and "plan". Appendix 12-1 unfortunately does not include strategic scientific plans to address the four major objectives that are the stated focus. The writing does demonstrate in-depth understanding of the "state of the art in coastal science", but clear plans for each coastal ecosystem are lacking. In addition, the research framework described for use in developing plans for these systems is based mostly on freshwater flow and salinity limits, and does not include consideration of nutrients carried with these flows, which are vital to the productivity of these systems.

Given that the District is a water management agency, is this a good strategy for addressing water quality, water quantity, and habitat problems that may be related to water management, or are there better alternatives?

As indicated, a clear plan for addressing the water quality, water quantity, and habitat problems for each coastal ecosystem is lacking. It is also difficult to determine timescales of the plans (e.g. Table 6, Timeline column). There is, however, a general research framework presented that can be used to develop plans.

If this is a reasonable strategy, how could the strategy or its application be improved?

The projects described are reasonable and valuable, but strategic planning is not clear. The Florida Bay plan (Appendix 6-1) provides a strong template that could be followed to clarify, strengthen, and/or develop strategic science plans for each coastal ecosystem in Appendix 12-1.

General Comments

Chapter 12 discusses eight prioritized estuaries, combining the Caloosahatchee and Southern Charlotte Harbor. Appendix 12-1 attempts to consider the nine estuaries and their watersheds separately. The overall identified stresses to the coastal estuaries are disruption of the natural magnitude and timing of freshwater input, increasing pollution (nutrients, bacteria, toxic substances, suspended sediment); and loss of critical estuarine habitat and biological communities.

The stated major goal of this plan is to manage, protect and rehabilitate coastal ecosystems. The writing describes a generalized applied research strategy to develop plans for the coastal ecosystems by addressing four major management objectives (below). The foundation for this rationale is a [very] general conceptual model developed by Alber (2002), and use of a resource-based Valued Ecosystem Component approach (nicely explained on p.12) in combination with an Integrated Modeling and Resource Assessment Framework (including watershed models; estuarine hydrodynamic, sediment transport, and water quality models; and ecological models – p.11). The intent logically is to consider each coastal ecosystem and its watershed, i.e.

watershed-scale management. The benefit of using models that range from simple to complex are clearly conveyed (p.13). The models are to be applied as an iterative, evolutionary process as available data increase, understanding is strengthened, and models are improved. Three clear examples are included which provide excellent illustrations of the application of this process (Caloosahatchee River and Estuarine MFL, Southern Indian River Lagoon Feasibility Study, Restoration Plan for the Northwest Fork of the Loxahatchee River).

The second major part of this Appendix is divided into four components:

Background

The background section demonstrates knowledge of "state-of-the-art" estuarine/coastal science. This section also provides the very general conceptual model used as an overall framework for the CED Science Plan. The authors clarify the important point that while the conceptual model integrates science, it does not address temporal and spatial variability. The next section, "Summary of Coastal Ecosystem Models", has a helpful table of estuary and watershed models that the CED has applied in each coastal ecosystem that shows where (by coastal ecosystem) and how the CED has applied various models to date. This section might better be included as the last subsection of the "Background" section.

Major Environmental Problems and Management Objectives

This section title also needs to encompass the inclusion of summarized approaches that have been taken or are planned to address the major objectives:

Objective 1 - Improve freshwater quantity/timing – the plan relies upon CERP, Acceler8, and the Northern Everglades Protection Plan to construct new infrastructure that will partly restore more natural freshwater deliveries (p.7).

Objective 2 - Improve operation of District Infrastructure – Two identified components are provision of weekly input based on the status of the Caloosahatchee and St. Lucie estuaries (based mostly on best professional judgment), and application of science (evaluation of different discharge scenarios, development of improved predictive tools) to the operational rules and protocols of District infrastructure. The Caloosahatchee and St. Lucie evidently were selected as the "marker" coastal ecosystems to address this objective because "larger projects" (line 388) are being built there.

Objective 3 - Improve and protect water quality – Appendix 12-1 describes little that has been done as of yet to address this important objective. Scientific studies have mostly focused on water quality status, trends, and pollutant loadings from the watersheds. More recently, nutrient inputs/cycling has begun to be emphasized, including development of acceptable levels (targets) and indicators. Additional Water quality models have also begun to be developed. These activities are building toward the ability to address this objective.

Objective 4 - Rehabilitate estuarine habitats – Appendix 12-1 describes District efforts thus far to address this important objective as including funding of "on-the-ground" restoration efforts (mangrove plantings, construction of artificial oyster reef habitat, trial SAV plantings); assessing seagrass ability to repopulate habitats, and use of the Valued Ecosystem Component approach (from the US EPA) to establish water quantity and water quality targets. The "on-the-ground" activities clearly are rehabilitation efforts; the latter two are needed to build toward the ability to rehabilitate. It is difficult to evaluate, from the writing, the extent to which the District has been successful thus far in rehabilitating estuarine habitats.

Water Body Science Plans

This section seems mistitled because it consists of program inventories and a description of some planned activities, rather than science plans. The short introduction fails to clarify that Florida Bay is omitted, or to provide brief rationale for its inclusion in Appendix 6-1. Much of the writing for each coastal ecosystem is simply descriptive information. In contrast, the brief history of District efforts and approaches that is provided for each coastal ecosystem provides helpful context. Each section generally also contains a description of historic and present water quality monitoring and modeling efforts, and past/present biological investigations and VEC evaluations. Each section ends with a list of planned activities for FY2008 or FY2008-9; for some ecosystems, [immediate] future information needs; and for some ecosystems, an inventory of present-into-near-future science *programs*. *Missing, though, is clear explanation of project and modeling integration.*

For example, in the St. Lucie sub-section, readers are directed to Table 6 for the science plan, only to find that Table 6 inventories current science *programs*; it does not present a *strategic science plan* to address the four major objectives identified for major focus. The sub-section for the Southern Indian River Lagoon presents no plan, even by title – rather, Table 7 is appropriately entitled, "recent investigations". Examination of this table indicates (last column) that the milestones addressed thus far help to address only Objective 1. No strategic plan is developed to chart a course for how the four objectives will be concretely addressed within a 5-year or 10-year timeframe. The plan for the Loxahatchee system is succinctly presented on p.45: it is designed to *"establish and support monitoring programs which gather information on a structured, focused basis that provide information on water quantity, water quality, timing, and distribution of increased dry season flows and improved wet season flows"*. The writing indicates that the information gained (addressing only Objective 1 above) will be used to form the basis for addressing Objective 2. Readers are referred to Table 8 for a summary of the science plan; again, they find only an inventory of projects. The project objectives are listed, but there is no indication of how the projects will be integrated into a science plan to address the four major objectives identified in this Appendix for each of the coastal ecosystems. Nor is there indication of what the priorities mean (effort planned? timeline?), except that 1 is the highest rating (footnote).

As another example, the "science plan" offered for the Lake Worth Lagoon is contained in several lines (lines 1524-1533), summarized by the first sentence therein – *"The CED Science Plan for Lake Worth Lagoon currently anticipates a continuation of the existing level of effort"*. This is not a plan. It does not provide a strategic roadmap of how/what efforts will be integrated to tangibly address the four objectives in order to improve this highly impacted, highly urbanized system. Table 9 in the Biscayne Bay subsection tellingly has blank space under every project for "District Strategic Milestones" that are targeted or achieved. The other coastal ecosystems, similarly, suffer from lack of presentation of a clear, strategic science plan that addresses and integrates the four overarching major objectives identified by Appendix 12-1 for all of the coastal ecosystems.

Technical and Integrative Reviews

The technical merit of the proposed general framework is meritorious but too limited in scope because it focuses almost entirely on freshwater flows and salinity. The general "Integrated Modeling and Resource Assessment Framework" has the potential to be strongly integrative across the coastal ecosystems, but it has not yet been developed and applied to designing plans.

Recommendations

1. The title of this document does not describe the contents of Appendix 12-1 and should be changed to "A Generalized Applied Strategy for Developing Research Plans for the Coastal Ecosystems". Other writing in the Appendix should also be altered accordingly.

2. The "Water Body Science Plans" section should be entitled, "Program Inventories and Some Planned Activities", as science plans are not contained within it. The extensive descriptive information about each ecosystem, mostly taken directly from Chapter 12, should be omitted since it does not contribute toward the goal of providing a clear strategic science plan for each system.

3. The general framework being considered to develop plans for the coastal ecosystems is based mostly on freshwater flows and salinity limits, and should be expanded to include consideration of major water quality parameters such as nutrients and toxic substances, as well as the roles of exotic and invasive species (influences on performance measures).

4. The Florida Bay plan (Appendix 6-1) provides a strong template that should be followed to develop strategic science plans for each coastal ecosystem in Appendix 12-1. In Appendix 6-1, the Florida Bay strategic science plan (which should be mentioned in Appendix 12-1, although a small amount of overlap is included in the [incomplete?] coverage of Florida Bay in Table 2) is framed around several key hypotheses that guide the research. It includes an Application of Results section that is well conceived and clearly presented. It provides a strong illustration of project integration, planned through several levels of numerical analysis including calculations of improved nutrient budgets, statistical analyses/models of monitoring/Dataflow data, mass balance modeling, and dynamic water quality modeling. In the seagrass component, the approach to understand interactions of freshwater flow, salinity, water quality, and seagrass dynamics is planned to integrate modeling, fieldwork and laboratory research including a strong set of mesocosm studies to measure nutrient uptake and kinetic parameters of seagrasses under different inter-specific competition treatments, strengthened by field verification studies to "ground-truth" the data.

5. A table should be added after Table 1 that provides examples of different levels of complexity of linked models to address estuarine water quality issues.

6. For Objective 4, Appendix 12-1 should clarify the extent to which the District has been successful thus far in rehabilitating estuarine habitats.