Review of the St. Johns River Water Supply Impact Study: Report 2

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Committee to Review the St. Johns River Water Supply Impact Study

Water Science and Technology Board

Division on Earth and Life Studies

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by **Jerome B. Gilbert**. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Review of the St. Johns River Water Supply Impact Study: Report 2

BACKGROUND

This report is the second from the National Research Council (NRC) Committee to Review the St. Johns River Water Supply Impact Study, which is providing ongoing advice to the St. Johns River Water Management District (the District) as it considers withdrawing additional water from the St. Johns River in east-central Florida for future public supply (see the Statement of Task in Box 1). In its first report (NRC, 2009), published in August 2009, the committee gave a series of recommendations, some broad and others specific to the seven scientific workgroups that are conducting the Water Supply Impact Study (WSIS).

A major focus of the committee's subsequent meeting in Orlando, FL (September 30-October 2, 2009) was the District's responses to the August report. In addition, several conference calls were held with District scientists during which they explained how they are responding to NRC (2009). This report expresses the committee's thoughts and opinions on the District's efforts in that regard and is targeted at the District scientists that have conducted the WSIS. The committee wishes to acknowledge the significant extent to which the District has taken the committee's advice. Much of this report focuses on particular areas where the committee concludes that additional or continued attention and work are warranted. Thus, not every issue found in NRC (2009) that is being adequately managed by the District is mentioned in this report. Furthermore, because of its intended audience and the interim nature of its advice, this report does not contain background material about the WSIS or the seven workgroups. Rather, the reader is referred to NRC (2009) for work conducted prior to May 2009. Progress since May 2009 can be derived from the District's website for the WSIS (http://sjrwmd.com/surfacewaterwithdrawals/impacts.html), including presentations from the public symposium held September 23-24, 2009, in Gainesville, FL.

Box 1 Statement of Task

An NRC committee overseen by the Water Science and Technology Board of the National Academies will review the progress of the St. Johns River Water Supply Impact Study (WSIS). Communities in the St. Johns River watershed in east central Florida are facing future drinking water supply shortages that have prompted the St. Johns River Water Management District (the District) to evaluate the feasibility of surface water withdrawals. At the current time, drinking water is almost exclusively supplied by withdrawals from groundwater. Reliance on groundwater to meet the growing need for public supplies is not sustainable. The St. Johns River and the Lower Ocklawaha River are being considered as possible alternatives to deliver up to 262 million gallons of water per day to utilities for public supply. In January 2008, the District began an extensive scientific study to determine the feasibility of using the rivers for water supply, and it has requested the advice of the National Academies as the study progresses.

The WSIS is composed of six major tasks, being carried out by District staff scientists aided by a suite of outside experts, each with national standing in their scientific discipline. These activities include modeling of the relevant river basins, determining what criteria should be used to evaluate the environmental impacts of water withdrawals, evaluating the extent of those impacts, coordinating with other ongoing projects, and issuing a final report. The NRC committee will review scientific aspects of the WSIS, including hydrologic and water quality modeling, how river withdrawals for drinking water will affect minimum flows and levels in the two rivers, the impact of removing old and introducing new wastewater streams into the rivers, the cumulative impacts of water withdrawals on several critical biological targets, and the effects of sea level rise. Potential environmental impacts being considered by the District include altered hydrologic regimes in the river, increased pollutant concentrations in the rivers (e.g., sediment, salinity, nutrients, temperature), associated habitat degradation, and other direct effects on aquatic species due to the operation of the new water supply facilities.

OVERARCHING ISSUES

Chapter 2 of NRC (2009) detailed a number of overarching issues to be kept in mind as the District proceeds with the WSIS. These included the need to provide for greater integration of workgroups (including the development of conceptual models and testable hypotheses), the need for water and nutrient budgets (including the extent to which withdrawn water is returned to the river), and the extent to which water withdrawals may lead to dewatering of the adjacent floodplain. The District's response to these overarching recommendations is described in further detail below.

Integration

NRC (2009) recommended that "as a way of integrating the work of the seven science groups, the District should further develop conceptual frameworks of qualitative interactions." Subsequently, each of the workgroups has created a detailed conceptual model showing linkages and paths of activity between relevant causes and effects of water withdrawals. These models also have been incorporated into an overall conceptual model for the WSIS, showing how each of the workgroups is related to the others. These models have been helpful in understanding how

the collection of data and subsequent analyses of each workgroup are related to the hypotheses that each has developed, and to understanding the interactions among groups. The linkages in the conceptual models developed thus far appear to be fairly general. They should be improved by showing more characteristics of the data and information being transferred (e.g., units of measurement, amount, frequency, duration, etc.) and by making sure that interactions between any two workgroups are agreed upon and shown in the conceptual models of both groups (which would further improve coordination among the workgroups).

Water Budget

NRC (2009) stated that "it would be useful for the District to assemble basic water budget information for the drainage basin and its major subunits." Subsequently, the District provided water budgets for a few locations in the lower and middle river basin, showing the contributions of upper basin water, rainfall, evaporation, tributaries, springs, diffuse groundwater (from the Upper Floridan aquifer), and reverse flow to the water budget for the wettest and driest four-month seasons. The components of discharge from the middle St. Johns River were provided in million gallons per day (MGD) and percent for annual average conditions (1995–2005) and for the dry year 2000. Also, a water budget diagram was provided for the lowest seven-day discharge at Astor (for early September 2000). The District is encouraged to continue creating these budgets, particularly ones that reflect potential water withdrawals at critical periods of time and in critical locations. Critical times might be defined in terms of vulnerable life stages of flora and fauna, and critical locations could include potential withdrawal points and minimum flow and level (MFL) transects. Water budgets also would be helpful in understanding the anticipated effect on the St. Johns River of reduced flow to the Indian River Lagoon.

Return Flows

Water withdrawals are being treated in the WSIS as consumptive uses with no return flows of withdrawn water to the system. This approach was thought to represent a worst case scenario of withdrawal impacts on the river, although as noted in NRC (2009) it might not represent a worst case scenario from a water quality perspective. However, the District is now trying to analyze return flows to the river and has created a figure *Estimated Distribution and Fate of Water Supply Withdrawal from the St. Johns River in East-Central Florida,* in which 42 percent of the 155 MGD withdrawn is assumed to be returned to the river via direct discharge or infiltration. The committee supports this analysis and does not think the District needs to refine it or somehow consider how to return an even greater percentage of flow to the river. Nonetheless, the committee suggests that the District try to account for return flows in one of the withdrawal scenarios being developed by the hydrology/hydrodynamics workgroup. In lieu of this exercise (if time and money do not permit), it is thought that the half-withdrawal scenario might approximate having a return flow of about 42%; this should be explained in the District's next report on the WSIS.

Dewatering of the Floodplain

NRC (2009) noted that "careful analysis should be completed to determine the floodplain area to be dewatered as a result of the lower water levels, including the timing and duration of dewatering events." This was thought to be important for numerous workgroups. In addition to the refinement of digital elevation models (DEMs) being performed by the wetlands workgroup (see below), the District recently produced several hypsometric curves that show inundated area versus water elevation for several locations along the river, which represents another approach for determining the area that might be dewatered by a withdrawal event. A meaningful refinement of these curves would be to (1) expand the scale of the y-axis to focus on those water levels between the 90 percent and 10 percent exceedance levels, (2) indicate on the graphs a level that is 4 cm below the median, which is the maximum amount that water levels are predicted to drop in the upper part of the middle basin due to the proposed withdrawal (NRC, 2009), and (3) note the decrease in inundated area due to that estimated reduction in water level.

INDIVIDUAL WORKGROUP ISSUES

There are seven individual scientific workgroups carrying out the WSIS: (1) hydrologic and hydrodynamic modeling, (2) biogeochemistry, (3) plankton, nutrients, and total maximum daily loads, (4) benthos, (5) littoral zone/submersed aquatic vegetation, (6) fish, and (7) wetlands and wetland-dependent species. Each workgroup is examining its defined issues across the entire St. Johns River system, from the headwaters to the mouth, from the channel to beyond the margin of the floodplain, and from the soil and channel substrate to the water surface and above.

Hydrology/Hydrodynamics Workgroup

Surface Water

The District appears to be on the correct path to addressing the principal concerns regarding surface water hydrodynamics and hydrology discussed in NRC (2009). These concerns involved connections between hydrology and ecology, model calibration and sensitivity, and uncertainty analyses (along with several smaller issues not discussed here).

The District's presentation of the WSIS conceptual model at the third committee meeting indicated significant progress in formalizing the connections from the hydrologic models to the ecological groups. There is some concern that feedback from the ecological groups to the hydrologic modeling has not been shown formally in the conceptual models, but the District indicated that these feedbacks do exist. District staff mentioned that the hydrologic data needs of all the ecological workgroups are being compiled, and the committee hopes to review this when available.

The District staff provided an explanation of how they intend to calibrate and examine the sensitivity of the hydrodynamic models; their approach seems reasonable. The committee encourages the District to document their ongoing calibration carefully to provide a roadmap for understanding the results.

The District is still working on its approach for uncertainty analyses and plans to provide documentation to the committee at a future date.

Groundwater

NRC (2009) made recommendations about three topics with respect to groundwater that have yet to be addressed fully: modeling of wetlands hydraulics, transient models, and density-dependent models. First, because of time and budget constraints the current groundwater modeling does not take into account temporal changes in flow and salinity emanating from the upper Floridan Aquifer. The District performed a limited sensitivity analysis on groundwater contributions to the hydrodynamic model that suggests modeled river discharge is relatively insensitive to changes in groundwater flux. However, when considering salinity, the effects could be more significant. The committee does not think that a transient modeling effort would be overly time consuming and suggests that the results from the transient model (East Central Florida Transient Model or ECFT) be obtained and compared to the steady state model to verify that the models agree with one another. However, the District does not feel that the ECFT model now available is adequate for the St. Johns basin, as it has yet to be calibrated to base flow data from the St. Johns River. The committee is looking forward to further analysis from the District that might rule out the need for a transient groundwater model.

With respect to the recommendation to consider density-dependent flow, District scientists stated that sufficient data are not available to perform this type of analysis. It is probable that river salinity contributed by the upper Floridan Aquifer will not substantially increase with the small change in river stage that would result from water withdrawal. Nevertheless, the District should provide a data analysis to support its assumptions, including evidence that there is low variability of salinity in groundwater underlying the basin. Even a back-of-the-envelope calculation that could dismiss the Floridan Aquifer as important (for both flow and salinity) would be helpful. For example, if it were assumed that the entire 155 MGD withdrawal were replaced by groundwater and that groundwater has a constant salinity, the resulting changes in river flow and salinity, particularly under extreme (e.g., drought) conditions, could be estimated easily. Preliminary work by the District suggests that potentiometric head is relatively insensitive to higher salt concentrations in groundwater.

The District's division of groundwater and surface water into different groups appears to have left the shallow aquifers and the extent to which they might be dewatered without a clear study lead. The committee has concerns that alterations of shallow groundwater exchange in floodplain areas due to reduced overbank flooding could change salinity balances as well as the time/space extents of flooding in the wetlands. How the surficial aquifer is conceptualized in the HSPF model also is not clear. Finally, only recently has the committee heard how surficial groundwater data from the MFL transects will be used and analyzed (see the section below on the wetlands workgroup). The committee looks forward to the results of these analyses and encourages the wetlands workgroup to communicate its results to the groundwater modelers.

Wetlands Workgroup

The District has addressed many of the concerns about the wetlands workgroup raised by NRC (2009). Progress has been made to improve the low-resolution elevation data used to generate a DEM of the floodplain and its wetlands. District staff have begun to create a DEM using available LIDAR data that will provide much finer vertical resolution. They also plan to use the elevation data collected on the MFL transects to validate and refine the DEM where these data are available. Although work has begun on the LIDAR data, uncertainty about the vertical resolution of the data should be resolved as soon as possible. District scientists recognize that the DEM is crucial for other workgroups, such as the fish, biogeochemistry, and benthos workgroups, and are coordinating with those groups to complete this effort.

The District has also adopted the hydrogeomorphic approach to classify wetlands to help deal with the complexity of wetland types on the floodplain and determine the dominant source of water to different wetland classes (i.e., surface water versus groundwater). The wetlands workgroup rightly supposes that floodplain areas fed by surface water are more at risk from dewatering than those that are fed by groundwater. The District has contracted with a wetland hydrologist to analyze the data collected from wells on the MFL transects to determine how tightly the groundwater and river levels are linked. The committee looks forward to the results of this is a much-needed analysis, including details on the planned STELLA model of floodplain hydrology.

Phase II includes plans for development of a GIS model to identify sensitive wetland areas. The committee has concerns about the assumptions used to build this model because few details on the methodology have been presented, such as how the data layers in the GIS model will be weighted.

The number and type of species to include as indicators of impacts to wetland-dependent fauna have been broadened in response to NRC input. Taxa under consideration include the American alligator and amphibian, reptile, and mammal communities. The committee looks forward to an in-depth explanation from the workgroup detailing how these types of data will be collected and analyzed. It is the committee's understanding that the District plans a two-phase approach, one on the predictive side using the suite of species described above, and one on the monitoring side (post-water withdrawals) where a different set of species (e.g., plant communities) might be used to assess impacts. Existing biological monitoring protocols, such as the Floristic Quality Index, could be useful for the latter, but their implementation will require some data collection by the District to determine how to best use these methods for assessing possible impacts of water withdrawals.

Finally, the committee still believes that an integrative method to measure soil subsidence, such as Sediment Elevation Tables, is worth considering as a field-based tool to assess the effects of altered hydrology (for example, if dewatering caused the oxidation and subsidence of organic soils, potentially leading to nutrient release). As mentioned in NRC (2009), these measurements are both easy to make and relatively inexpensive. Use of this method would have the added benefit of fostering collaboration between the wetlands, biogeochemistry, and hydrology workgroups. This suggestion was not addressed by the wetlands workgroup in its September 2009 presentation to the committee.

Biogeochemistry Workgroup

With regard to the biogeochemistry workgroup, some of the recommendations from NRC (2009) have been acted upon. A few issues, however, merit continued attention. The committee supports the workgroup's plan to obtain information on nutrient release rates from wetland soils in the St. Johns River basin rather than using rates from outside the basin, as was done in Phase I. In NRC (2009), the committee encouraged the biogeochemistry workgroup to use procedures for measuring nutrient and colored dissolved organic matter (CDOM) release rates from drying soils that would yield data reflective of environmental conditions, and the committee re-emphasizes that recommendation here.

Second, the committee expressed concern that the equation being used by District scientists to estimate changes in nutrient fluxes from wetland soils as a result of desiccation is simplistic because it assumes that the changes are solely due to changes in oxidation rates. An implicit assumption in the equation is that net primary production in the plant community does not change. The workgroup responded to these concerns, which the committee views positively, but the focus of the response on net primary production does not address the broader concerns that the committee had about the simplistic nature of the equation. Although the equation may be a reasonable approach for measuring the release of phosphorus from batches of dried sediments under laboratory conditions, it does not consider several processes that may control the actual export of nutrients from re-inundated wetland sediments into the flowing river under ambient conditions. These include (1) nutrient uptake by biofilms on the soil surface, by roots of macrophytes, and by epiphytes on leaves of wetland plants, and (2) sorption of phosphate and ammonium onto ion-exchange sites on soil minerals and organic matter. These processes make it likely that the fraction of the nutrients released by drying of wetland soils that actually gets transported into the river will decrease with distance of the soil from the river channel. Studies at the field scale would appear to be essential to quantify these factors.

Third, the committee's first report concluded that the workgroup did not make a persuasive case that changes in CDOM would have significant ecological impacts. The District did not address this concern in its oral response to the report, and the committee remains skeptical. The District also did not respond directly to the recommendation that predicted increases in nutrient loadings resulting from increases in desiccation of wetland soils need to be put into context of the overall nutrient loadings in the system, particularly with regard to loadings to downstream lakes experiencing algal bloom problems. This context needs to include attention to nutrient ratios, the temporal scales of loading changes, and anthropogenic contributions to nutrient loading (which will increase as the basin population grows). Thus, for example, in order to fully estimate the biogeochemical impacts of water extraction from the St. Johns River, it will be important for the WSIS to consider the likely nutrient content of return water. The committee understands that District scientists are planning to develop and analyze nutrient budgets for the St. Johns River and selected component sub-systems, and it re-emphasizes the importance of the above issues in doing those analyses.

Finally, the workgroup is encouraged to explore some theoretical models to determine nutrient release rates because the planned empirical release rate measurements are going to take a long time and have to be done seasonally.

Plankton Workgroup

NRC (2009) listed four key issues for the plankton workgroup to consider: (1) estimation of the effects of increased water withdrawals on CDOM loadings and concentrations, (2) tighter integration with the hydrodynamics and biogeochemistry workgroups, (3) consideration of potential impacts on bacterioplankton, and (4) implementation of a water quality simulation model (CE-QUAL-ICM). The workgroup has made significant progress in addressing these recommendations. The new conceptual model for the workgroup incorporates and integrates data from the biogeochemistry and hydrodynamics workgroups. District scientists have implemented the CE-QUAL-ICM water quality model, which currently is undergoing calibration, validation, and testing. Many of the model components will be based on empirical relationships derived from ongoing monitoring efforts. Furthermore, the calibrated and validated model will provide valuable insights into the probability of hypoxia in the lakes and the CDOM and bacterioplankton components outlined above.

Several graphs presented by the workgroup suggested a "factor ceiling," that is, a pattern with an upper (sloping) limit to the data and lots of scatter below. This pattern has been observed in numerous ecological studies (e.g., Fausch et al., 1984; Blackburn et al., 1992; Thomson et al., 1996; Scharf et al., 1998). The lesson learned from these studies is that a line through the data is less representative of a biological reality than a line at the upper bound of data points, which represents a maximum physiological output (e.g., as a function of temperature). Divergence from that line (to lower levels) results from some other factor limiting physiological activity. The workgroup is encouraged to keep this concept in mind during data analysis with an eye toward identifying the primary limiting factor that defines the upper bound and secondary factors the produce a pattern of divergence from that upper bound.

Benthos Workgroup

The benthos workgroup continues to tune their ideas in important ways. The workgroup plans to continue exploring salinity as a determinant of the distribution and abundance of estuarine invertebrates. Although the importance of salinity is widely recognized, the committee is concerned that salinity provides a narrow window through which to understand potential changes in invertebrate assemblages that may occur in response to water withdrawals. Discussion by the submersed aquatic vegetation (SAV) workgroup emphasized the importance of the interactions of salinity, turbidity, light levels, and species composition of SAV—a cumulative set of interactions that will also influence invertebrate species composition, distribution, and abundances.

Several questions were raised about the freshwater invertebrate program for Phase II. The workgroup suggested that river channel habitats in Segment 7 were poor for invertebrates, apparently because of a lack of littoral vegetation and, as a result, did not intend to study benthos in this segment. However, District staff commented that healthy unionid mussel beds have been found in that reach. The committee would like to see a more careful analysis before the importance of Segment 7 to benthic invertebrates is discounted. In particular, it is important to define what criteria are being used to define a region as containing "poor habitat," such as the presence of inorganic soils, no lakes in the segment, vegetation changes from marsh species to cordgrass, ample salt in the soil, and so on.

Another concern is the presumption that energy and material flows in food webs go unidirectionally from invertebrates to fish. In fact, many invertebrates, such as blue crabs, feed on fish, demonstrating the potential importance of flow in both directions in this segment of the food web. The workgroup is encouraged to consider this in their conceptual model.

NRC (2009) suggested multi-metric analysis of benthos beyond functional feeding groups. Subsequently, the workgroup is developing five ecosystem/community index measures. The autotrophy-heterotrophy index was assigned a threshold value of 0.75, while the four other indexes (mobility, oxygen requirement, voltinism, and habitat stability) have been assigned the same threshold value of 0.50. Information, including references, should be provided on how the indexes are to be calculated and to explain the choice of threshold values.

Finally, it was suggested by District scientists that fish-feeding studies might be conducted concurrently with benthic monitoring in an effort to link changes in benthic assemblages to fish metrics. The committee encourages such studies if and only if the workgroup clearly defines (1) the fish species that will be the focus of those efforts and (2) how these studies will be accomplished across a broad enough range of species to provide meaningful results in the time available and with the funding levels likely to be forthcoming.

SAV Workgroup

The littoral zone workgroup addressed several concerns raised in NRC (2009) and generally have made excellent progress since the May 2009 committee meeting. They have continued with their efforts to project the impacts of water withdrawals on SAV in the littoral zone by understanding species responses to salinity. One particularly cogent set of experiments involved detection of stress enzymes, and the results from this matched extremely well with the overall salinity relationships largely derived from the literature in the draft Phase 1 document (SJRWMD, 2008).

Previously it was unclear why a higher salt-tolerant species such as *Ruppia maritime* would not simply take over when and if *Vallisneria americana* was negatively affected by water withdrawals. There now appears to be firm basis for the role of CDOM limiting light in the water column, which then inhibits the growth of *Ruppia* in the lower St. Johns River.

A map of the actual areas of SAV that might be lost under various water withdrawal scenarios would be helpful for communicating where there might be the most significant impacts. In addition, the committee looks forward to analysis of data from the *in situ* "salinity sonde unit" that is now being placed in the shallows (to compare with salinity data being collected in the main channel). There is always concern in an estuary that has a large number of submarine seeps and springs that the data collected from the shallows does not match the mainstem very well, and these data can help to resolve this issue.

One final consideration would be to assess the potential impacts of water withdrawals on *Hydrilla verticillata* (an introduced species) in what is now the tidal freshwater portion of the St. Johns River. Water withdrawals could actually increase the *Vallisneri*a habitat at the expense of *Hydrilla* (which is very sensitive to salinity intrusions and, if they are persistent, will eventually die). It is possible that space in the littoral zone vacated by *Hydrilla* could be colonized by *Vallisneria* moving upriver. The committee suggests that the workgroup consider potential gains in *Vallisneria* habitat under various withdrawal scenarios. Although this effort would not be on

the same scale as the previous work with *Vallisneria*, it would help to give a balanced approach in terms of assessing overall environmental costs and benefits of potential water withdrawal.

Fish Workgroup

The District has addressed many of the concerns stated in NRC (2009) regarding the approach of the fish workgroup. Data tables in the Phase I draft report (SJRWMD, 2008) were corrected. The September 2009 committee meeting and a subsequent conference call clarified the District's fish sampling schedule and the data to be generated by that schedule, including the need for spatial and temporal coverage. There are a number of fish taxa that the workgroup will be quantifying beyond clupeids, which will allow it to do a more synthetic assessment of the potential impacts of water withdrawal. The workgroup also has considered the issue of day versus night sampling adequately. Two issues on potential entrainment and impingement remain. First, regarding the need to estimate mortality for various stages of fish from the literature, the District agreed to provide a hierarchical set of plans if mortality data cannot be found, such that this committee can clearly evaluate the available options. Second, the extent to which analysis of current sampling data is being used to inform future sampling scenarios was not clear. Although it would have been ideal if data analysis had proceeded quickly enough to inform the current sampling cycle, the large amount of data collected made that difficult. The District plans to have all the data collected in one calendar year analyzed by the end of that year. Contingent upon future funding of fish sampling, these data analyses will inform any future sampling. The committee recognizes these limitations.

The committee's concerns about spatial and temporal changes in salinity and how these might affect fish in the estuary were largely resolved. The plan for the Fisheries Independent Monitoring Service (FIMS) team seems sound and well conceived. The District and the FIMS team are cautioned to consider not just some preferred salinity range but also the tails of those distributions, as individual fish will be found outside those narrower salinity ranges. Finally, the contraction versus expansion of fish species distributions relative to salinity changes because of water withdrawal was discussed; the District will examine changes in species abundances and distributions carefully and agreed that the goal is to maintain a balanced and sustainable fish community.

A final issue from NRC (2009) was the need for careful evaluation of the effects of water level changes on wetland margins in the middle and upper basin. Many fish species use wetland margins and wetland environmental mosaics as spawning and nursery areas. In addition, adults of many species are distributed in vegetated wetland areas as they search for food and avoid predators. The District's plan to understand the extent of areas dewatered by potential water withdrawals is to use the newly acquired LIDAR data to construct better DEMs across the range, in consultation with the wetlands workgroup. However, the fish workgroup suspects that these DEMs will be at too coarse a scale to observe alterations in the distribution and abundance of many fish species in wetland areas brought about by water withdrawal. Thus, the workgroup intends to also use the MFL transect data to provide a more realistic examination of the likely effects of water withdrawal on populations of many fish species at a scale (a few feet) more relevant to the fish. The two approaches will be compared to verify and enhance the DEMs. The committee strongly encourages the fish and wetlands workgroups to further discuss this issue because LIDAR data typically can be collected at a scale from about 15 to 50 cm and because the

wetlands workgroup is also planning to use the MFL transect data. Ideally, it would be prudent to combine these DEM analyses with real-world data of fish use of these environments, from both literature sources and sampling within the middle and upper St. Johns Basin. Nonetheless, the committee sees the workgroup's approach as improved and looks forward to the results.

FINAL THOUGHTS

The District is making significant progress in responding to the recommendations in NRC (2009) and in carrying out the WSIS. The committee looks forward to further interaction from the workgroups as they enter Phase II.

One final thought regarding the graphing of data is warranted. The committee has frequently reviewed District graphs meant to compare model results with actual observations. In most of the cases observed by the committee, the predicted and observed values share a common x-axis, which can give a false sense of the predictability of the simulation, especially in terms of ability of the model to predict individual values. While it can be argued that what the District scientists care about most is modeling trends correctly (in terms of where major peaks and valleys occur) and obtaining simulated results with the same statistical properties (mean and variance) of the observations, it is still important to use a more rigorous graphical method than the committee has observed to date. Model performance should be assessed by plotting the predicted vs. observed values (y vs. x) and performing a linear regression analysis on the data. At the very least, such plots should be included as an inset in the graphs with a common x-axis that are currently being used.

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