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

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Committee to Review the St. Johns River Water Supply Impact Study; National Research Council

Summary

THE WATER SUPPLY IMPACT STUDY

The St. Johns River Water Management District is responsible for managing water resources in the St. Johns River basin, which comprises 23 percent of Florida. Approximately 4.73 million people (one quarter of Florida's population) live in the area served by the District, which contains the growing cities of Jacksonville, Orlando, and Gainesville. In order to meet the increasing water supply needs of the District's residents and other water users, the District is considering supplementing its historical supply of groundwater with water from the St. Johns and Ocklawaha Rivers. To better understand the potential ecological impacts of such withdrawals, in 2008 the District began a large scientific study called the Water Supply Impact Study (WSIS).

In late 2008, the Water Science and Technology Board (WSTB) of the National Academies was asked to review the progress of the WSIS, including such scientific aspects as hydrologic and water quality modeling and how river withdrawals will affect wetlands, biogeochemical processes, plankton, benthos, the littoral zone, fish, and wetlands wildlife in the basin. For two and half years, the WSTB Committee has followed the activities of eight District workgroups as they modeled the relevant river basins, determined the criteria to evaluate the environmental impacts of water withdrawals, evaluated the extent of those impacts, and coordinated with other ongoing projects. The first report of the Committee reviewed the Phase 1 hydrologic and environmental assessment tools and relevant data, and made recommendations regarding proposed work for the second phase of the WSIS. The Committee's second report focused on how the District was responding to the recommendations in its first report. The third Committee report primarily evaluated the hydrologic and hydrodynamic work being performed by the District. This fourth and final product of the Committee focuses on the ecological impact analyses conducted by the environmental workgroups, presents final thoughts about the hydrologic and hydrodynamic studies, and provides some overall perspectives on the WSIS. This report does not discuss the recommendations and content of the previous three NRC reports in great detail.

HYDROLOGY AND HYDRODYNAMICS

Because the goal of the WSIS was to assess potential impacts of withdrawing freshwater from the St. Johns River, understanding the basin hydrology and river hydrodynamics was vital to analyzing and understanding possible ecological effects. The District used a suite of surface hydrology, hydrodynamic, and groundwater models to analyze potential physical changes that would be brought about by withdrawals, including changes in river flow, stage, salinity, and water age (i.e., the length of time a water parcel remains in the river).

The Committee found the work of the hydrology and hydrodynamics (H&H) workgroup on building, testing, and analyzing its hydrologic and hydrodynamic models, including efforts to quantify the propagation of data uncertainty into hydrodynamic model uncertainty, to be state-of-the-art science. The District is building their WSIS analyses on a hydrodynamic foundation that is well-tested, robust, and well-understood. The H&H workgroup could further improve its efforts by comprehensively synthesizing its model results in its final report. This would put into context the relationships between key mechanisms of the river system and their responses to forecast conditions. In particular, the workgroup should pay attention to two major competing effects—sea-level rise and increased runoff due to future land use changes such as urban and suburban development—that affect water surface levels and salinity, and the uncertainties associated with these effects should be discussed. This "big-picture view" of the river should be directed at non-modelers and non-hydrologists so that they can better understand the implications of the extensive modeling studies.

A previous report of the Committee noted the limitations of the surface water hydrology modeling program HSPF and the steady-state groundwater flow models based on MODFLOW. Because HSPF has limited value for wetlands, the District was urged to (and subsequently did) continue developing the Hydroperiod Tool and analyzing water level data from transects used to develop regulations on minimum flows and levels (MFLs) to determine the correspondence between river stage and wetland hydroperiod and thus the potential responses of different wetland types to water withdrawals. In the future, the District also should develop a groundwater model that simulates the full interaction of the river with the surficial aquifer system and the Upper Floridan aquifer under both steady state and transient conditions. This should include an uncertainty analysis for groundwater discharge to the river based on hydraulic conductivity, which may have uncertainties of an order of magnitude or more for basins the size of the St. Johns.

ENVIRONMENTAL WORKGROUPS

Seven environmental workgroups used information from the H&H results in combination with hydroecological models of possible effects to predict the potential impacts of water withdrawals on (1) wetland vegetation, (2) soil biogeochemical processes, (3) plankton communities, (4) submersed aquatic vegetation (SAV), (5) freshwater and estuarine benthos, (6) fish, and (7) wetlands wildlife. Each workgroup was asked to characterize potential environmental effects of water withdrawals using three criteria: persistence, strength, and diversity. Persistence was defined in terms of recovery time relative to the return interval for conditions causing a given effect; strength was defined in terms of both the intensity and scale (geographic area affected); and diversity was defined in terms of the range of environmental attributes showing effects. Based on the three criteria, the District developed five categories of effects ranging from negligible to extreme. For each ranking, the workgroups assigned an uncertainty level (ranging from very low to very high) defined with reference to (1) the availability of a predictive model, (2) supporting evidence, and (3) understanding of the mechanism for an effect. These categories for levels of effect and uncertainty were defined in an effort to obtain consistency among the workgroups in assessing effects—a strategy condoned by the Committee and carried out effectively by the District scientists. The following sections summarize key findings of the environmental workgroups and describe the major issues that the Committee had regarding the approach and/or results of each workgroup. Other detailed criticisms are found in the body of the report (primarily in Chapters 3 and 4).

Wetlands

The wetlands workgroup was tasked with assessing the potential effects of surface water withdrawals on floodplain wetlands, specifically changes to vegetation communities that might result from altered hydrology and/or changing salinity regimes. To accomplish this they first identified river segments that have the highest likelihood of change. These then became the focus of subsequent analyses. The workgroup assessed existing MFL transect data on wetland plant community types across the elevational/hydrological gradient of the floodplain in those river segments to determine how the communities might change with withdrawals. LiDAR data were acquired for some areas of the watershed to create a digital elevation model (DEM), which was then subjected to a GIS analysis to predict hydroperiod changes in wetlands. The goal of this analysis was to determine whether water withdrawals have the potential to (1) alter the species composition of floodplain wetland communities, (2) alter the extent of wetlands or various wetland communities found there, and/or (3) lead to a shift in the location of boundaries between wetland types. The workgroup focused on river segment 8, where impacts to river stage were predicted to be greatest, and segment 2, where changes in the salinity regime were predicted to be highest. The wetlands workgroup found "moderate" impacts to wetlands in segments 2 and 8 under the most extreme future withdrawal scenario.

The wetlands workgroup produced a solid analysis of potential impacts of water withdrawals to the St. Johns River. Their integration of a LiDAR-based DEM with floodplain stage exceedence curves to assess the spatial extent of hydrological impacts is a novel approach, resulting in a robust picture of the spatial extent of dewatering and shifting boundaries between wetland types. The salinity analysis strategically made use of the Ortega River tributary as a model system from which results could be translated to the larger St. Johns River. Because the Committee is confident that the methods developed by the workgroup will be adaptable to other river segments and be useful to analyze potential changes in river flow in the future, it recommends expanding the analysis as more data and resources become available.

Biogeochemistry

The biogeochemistry workgroup identified several potential effects of water withdrawals on biogeochemical processes in the St. Johns River and its drainage basin, all related to the possibility that soil accretion would be reduced or oxidation of organic soils (histosols) would be enhanced in riparian wetlands of the river as a consequence of changes in stage induced by water withdrawals. The workgroup concluded that two effects of water withdrawal had potentially high significance: reduced nutrient sequestration and increased release of colored dissolved organic matter. The workgroup considered how much additional release of the constituents of interest would occur from soil organic matter as a result of water withdrawals, how much of the additional material would be exported from the wetlands to lakes, and what effects could result in downstream ecosystems. Using data on release rates gathered from the literature and very limited data from their own field and laboratory studies, the workgroup assessed the changes in DOC, TP, NH_4^+-N, and TKN loading, as well as changes in dissolved oxygen concentrations, that would accompany water withdrawals and associated lowering of water levels. Only segment 8 received the full analysis, and the workgroup found that the impacts of an extreme withdrawal scenario would be negligible.

Although most of their efforts to obtain experimental data were not successful, the workgroup did a thoughtful and objective analysis on their few experimental results. Studies to determine values of nutrient and DOC release rates from exposed wetland soils were unsuccessful for the most part, and no experimental data were available on attenuation of nutrient and DOC loads as water would flow from re-inundated wetlands into Lake Poinsett. Nonetheless, the workgroup found a relevant compilation of attenuation rates from natural and constructed treatment wetlands in the literature.

The multiple regression relationship used in the report to relate increases in DOC loading to decreases in DO in Lake Poinsett was not strong ($r^2 = 0.42$). Given the very small values of predicted changes in DOC concentrations produced by the modeling analysis for even the "worst case" withdrawal scenario, however, the Committee concludes that a more sophisticated analysis could not be justified. Overall, the Committee agrees with the general levels of effect identified by the biogeochemistry workgroup for the various river segments—conclusions that were based largely on the H&H modeling analysis, but it regards the workgroup's assessment of uncertainty levels for the predicted impacts on some river segments as too low.

Plankton

The plankton workgroup was charged with determining the possible environmental impacts of water withdrawals on plankton communities in the St. Johns River, most of which were consequences of enhanced growth of phytoplankton. Consequently, algal bloom dynamics was a primary focus of the work. The plankton workgroup set thresholds for adverse ecological effects of algal blooms, modeled the relationships between bloom characteristics and hydrology, and determined whether water withdrawals would cause or exacerbate adverse effects of algal blooms. The group predicted changes in phytoplankton biomass, community composition, N_2 fixation, cladoceran zooplankton abundance, algal toxins, and dissolved O_2 concentrations as a function of changes in water age. They used both empirical methods based on historical data collected on the lower, middle, and upper St. Johns River since the mid-1990s, and a mechanistic water quality model called CE-QUAL-ICM. The workgroup concluded that the range of withdrawal scenarios likely would have little impact in excess of pre-existing algal bloom conditions in segments 2, 3, 4, and 6 of the St. Johns River.

The overall approach of the plankton workgroup was logical and used the best available information to derive and parameterize the models. The plankton workgroup adopted two relatively independent approaches to assess the impacts on phytoplankton bloom dynamics and consequent changes in water quality. For the one segment of the river where both approaches were applied, results of the mechanistic and empirical models were similar, which strengthens their conclusions. Many of the multiple regression equations used to quantify the relationships between "water age" and phytoplankton characteristics were robust ($r^2 > 0.80$), which also promotes confidence in the models. The conclusions of the plankton workgroup are supported by the evidence presented and the predictions are based upon the best available data.

One weakness of the plankton study is that potential changes were compared to a 1995 base case scenario. As the workgroup showed, however, conditions in 1995 were not ideal, and many sections of the river suffered from persistent algal blooms and anoxia. Water withdrawals may not worsen conditions, but clearly they will not improve conditions in the river. Another weakness is that historical estimates of N_2 fixation were based on nitrogen mass balances for Lake George, thus representing the net effects of several source and sink processes. In addition, prediction of the effects of withdrawals on N_2 fixation was based only on changes in water age and assumed that nitrogen concentrations in the river would not change from the data used to compute the historical amounts.

Littoral Zone: Submersed Aquatic Vegetation

The littoral zone work group focused their analysis in the middle and lower basin on *Vallisneria americana*, which has been identified in 92 percent of the MFL transects in the basin. *Vallisneria* was thus regarded an excellent indicator of the condition of the SAV community in the littoral zone of the St. Johns estuary. The workgroup formulated and tested two main hypotheses: (1) salinity intrusions could result in stress to *Vallisneria* that over extended time periods could reduce its growth and survival in the estuarine portion of the St. Johns River, and (2) water withdrawals that result in the lowering of water levels in the non-tidal portions of the St. Johns River could restrict the overall area suitable for SAV growth. To address the first issue, a salinity/time exposure relationship was developed for *Vallisneria* from an extensive literature review, bolstered by experimental data on several levels. To address the latter issue, the workgroup determined a depth/stage relationship for SAV based on anecdotal data and information from river segments 2 and 3. They predicted that the effects of the two worst case scenarios (for salinity in segments 2 and 3 and for stage in segments 7 and 8) were negligible.

The conclusions of the SAV workgroup regarding impacts of lowering water levels upstream and increasing salinity levels downstream on SAV are well thought-out and arise from careful data analysis. The assessments appear to be "state of the art" and robust with regard to salinity and water levels. Indeed, in several instances the workgroup pushed beyond what is normally achieved in environmental assessments, especially with regard to creating a useful *Vallisneria* "salinity stress model" from the literature and experimental data based on stress enzymes.

The workgroup was advised to keep abreast of two management issues. The first is that future water withdrawals will be necessitated by increased population density, which will lead to higher nutrient loadings from the watershed and thus increase the duration and intensity of phytoplankton blooms in the St. Johns River unless strong management efforts are undertaken to control nutrient export. This secondary effect of the proposed water withdrawals could be as much a problem as salinity and water levels in determining the fate of SAV in the St. Johns River ecosystem. Second, salinity will increase in the estuarine portion of the St. Johns River as downstream dredging projects and sea-level rise progress. As discussed in greater detail in Chapter 3, a more detailed exploration of SAV that can withstand higher salinity is warranted.

Benthos

The benthos and fish workgroups were divided into freshwater and estuarine components, which took different approaches to understanding the potential impacts of water withdrawals.

Freshwater Benthos

The workgroup based its analysis on the hypothesis that changes in stage prompted by water withdrawals would have a direct impact on the density and distribution of target taxa, as well as on community and population metrics such as diversity, density, and biomass. Stage also was predicted to impact benthos indirectly via changes in wetlands acreage and structure. In contrast to most other ecological workgroups, the freshwater benthos workgroup did not have any hydroecological models to predict the magnitude of changes in benthic conditions as a function of hydrologic changes resulting from water withdrawals. A short-term field study at Lake Monroe, Lake Poinsett, and Yankee Lake was conducted in 2009 to observe patterns for several community- and population-level metrics that could be related to hydrology. Also, a number of studies on the ecology and habitat requirements of crayfish and apple snails in the upper St. Johns River basin and the Everglades were reviewed. The workgroup combined this information with H&H model results on water levels to make predictions, using professional judgment and a "weight of evidence" approach, about the potential effect of water withdrawals on benthos. Their final predictions for the extreme withdrawal scenarios ranged from negligible to moderate. Uncertainty was high in almost every segment because of the lack of a predictive hydroecological model, the lack of monitoring data, and the considerable variability observed in results of the 2009 study.

The freshwater benthos workgroup's analysis was based on little benthic data in the St. Johns River, which greatly limits the Committee's ability to determine the validity of the conclusions. None of the results gleaned from the 2009 study could be attributed uniquely to effects of hydrologic conditions as opposed to seasonal and other possible water quality effects. The Committee's concerns are, however, somewhat lessened by the knowledge that the likely future withdrawal scenario will reduce water levels by much less than the extreme scenarios evaluated by the workgroup.

The lack of quantitative hydroecological models may reflect the state of the science in benthological research; if so, this study illustrates the need for such models to be developed. The workgroup recognized the limitations of their analysis and proposed a future monitoring strategy, for which the Committee offers numerous suggestions (see Chapter 3).

Estuarine Benthos

The estuarine benthic community was hypothesized to be susceptible to changes in flow and salinity that might accompany water withdrawal. Data for the analysis were derived from a long-term data set of the Florida Department of Environmental Protection and a short-term data set from the U.S. EPA's Environmental Monitoring and Assessment Program at sites along the lower St. Johns River. Additional data on white shrimp and blue crab were obtained from the Fisheries Independent Monitoring Service (FIMS) Program, coupled with supporting material from the literature on life history and environmental requirements of these species. The workgroup used linear and/or nonlinear regression analyses to relate mean macro-infaunal abundance and abundances of the most common taxa with mean salinity. Using the same three metrics as the freshwater analysis (community changes, population changes, and changes to target taxa), the workgroup found that the overall response of estuarine benthos to the extreme withdrawal scenario was negligible to minor.

Overall, the estuarine benthos analyses were more sophisticated than the freshwater benthos analyses. Nonetheless, the Committee had several concerns. First, there were no direct statistical models for abundance and inflow such that quantitative predictions could be made (as in other ecological parts of the WSIS). The interpretations appear to have been derived from how salinity changes with withdrawal scenarios and how abundance relates to salinity. Second, more work on the direct effects of salinity on epifauna needs to be completed before epifaunal impacts can be dismissed. Third, potential impacts on infaunal and epifaunal benthic organisms of salinity increases and coupled low DO levels, which could occur periodically in the lower river, should receive further study.

The benthic workgroup provided several suggestions for future work on mitigation and data collection, all of which are appropriate and important to consider. The workgroup expressed concerns about the lack of station-specific sediment composition and associated benthic communities. They also discussed the need to understand water withdrawal effects on meroplankton (pelagic larvae of benthic organisms), which are important food sources for many fishes.

Fish

Freshwater Fish

The processes of concern to the freshwater fish workgroup included how changes in water levels, flow, floodplain inundation and frequency, and entrainment/impingement, may lead to changes in vital fish metrics at different levels of organization. The workgroup examined members of five freshwater habitat-use guilds relative to water withdrawals in the Upper Basin between Lake Poinsett to Lake Woodruff. The potential degree of impacts on four guilds was estimated using best professional judgment by examining the ecology of selected species of each guild with reference to a specific withdrawal scenario. The fifth habitat-use guild—littoral zone, marsh, and floodplain small fishes assemblages—used MFL transect data in a model that generates fish densities based on flooding duration, which was developed for a similar habitat-use guild in the Everglades. Finally, to analyze the potential impacts of entrainment/impingement on fish, the workgroup conducted a sampling program to determine the species composition and abundance of spawning fish in river reaches where water withdrawal structures have been proposed. The workgroup's predictions regarding impacts ranged from minor to major (for entrainment/impingement) under extreme withdrawal scenarios.

Overall, the freshwater fish workgroup posed appropriate questions related to potential impacts on fish assemblages and addressed them as much as available data would allow. There are, however, some concerns. First, although the approach focuses mainly on mean water level with a few comparisons of extreme levels (low and high), it does not capture cumulative effects of water withdrawals on fishes, such as concentration of fishes into reduced water volumes and loss of prey for wading and fish-eating birds, snakes, and mammals. Consecutive drought years, which likely would have considerably more negative impacts on fishes, were not examined. The workgroup report was written as if the entire assemblage of fishes within each habitat-guild had been examined when, in fact, only common representatives of each assemblage were examined. Finally, the discussion of entrainment and impingement focused on various shad species and did not fully consider all species collected.

Estuarine Fish

The effects of water withdrawals on estuarine fish assemblages (open water small estuarine fishes, estuarine marsh fishes, estuarine benthic fishes, sciaenid fishes, and marine fishes) relate to changes in water levels, flow, and changes in spatial distribution of salinity. Analyses were based exclusively on FIMS data for fish distribution and abundance, and associated statistical relationships between various measures of abundance and inflow that were developed. The analyses were conducted for "pseudospecies" only, defined as gear-, size class-, month-, and zone-specific designations for each species. For all groups, the workgroup predicted moderate impacts under the worst case withdrawal scenario in river segments 1 to 3.

The estuarine fish workgroup is commended for modifying, in response to the Committee's input over the course of two years, their approach to the complex issue of how fish will respond to changes in flow and salinity. As with the freshwater fish, the estuarine fish workgroup posed appropriate questions related to potential impacts on fish assemblages and addressed them as much as available data would allow. With respect to the use of pseudospecies, the detailed changes noted for each pseudospecies in a given fish assemblage are probably not as important as the total number of changes within the assemblage relative to the modeled scenarios.

The fish workgroup predicted a "major" response to water withdrawal, but this was for an extreme scenario that is not plausible. Because the response surrounds the potential entrainment or impingement of larval organisms at intake sites, it is imperative that precautions are taken when designing intake structures to avoid these impacts. The workgroup should consider when entrainment/impingement is temporally important (such as during seasonal spawning peaks). If protective intake structures cannot be constructed, the District may need to write conditions into its permits that require water suppliers to reduce surface water extraction during those peak recruitment periods.

Wetlands Wildlife

The wetlands wildlife workgroup assessed the potential effects of surface water withdrawals on 320 species of vertebrate wildlife that depend on the St. John's River floodplain habitat. The workgroup used a qualitative approach to evaluate impacts because quantitative data are lacking on responses to changing hydrologic regimes for many of the species. Information gleaned from the literature, in combination with input from the wetlands, benthos, and fish workgroups, was used to make best professional judgments on the effects of withdrawals on wildlife with respect to salinity in river segments 1 and 2, and with respect to altered hydroperiod in segments 7 and 8.

To accomplish this, species were assigned to one of four "wildlife hydrologic types" and floodplain habitats were assigned one of four hydrologic regimes for wetlands. The wildlife hydrologic types then were combined with the floodplain hydrologic regimes in a qualitative model that describes the predicted distribution of species along the floodplain's hydrologic gradient (from permanently flooded to dry). The workgroup also used results from the H&H, wetlands, benthic invertebrates, and fish workgroups to determine the final levels of effect. Under the extreme withdrawal scenario, major impacts were predicted for estuarine wildlife in segment 1, moderate impacts were predicted for estuarine wildlife in segment 2, and moderate impacts were predicted to freshwater wildlife in segments 2, 7, and 8.

The wetlands wildlife analysis was limited by the lack of quantitative, species-specific information on the response of wildlife to altered hydrology and salinity. Thus, the analysis is an integration of a very thorough literature review along with the results of the H&H modeling and input from the wetlands, benthic invertebrate, and fish workgroups. The literature synthesis was thorough and will be of benefit to future research and management efforts in the St. Johns basin because it covers such a broad range of species.

The findings of the wildlife workgroup were obscured by the diverse ways in which species were classified according to their hydrologic attributes. Four categories of wildlife "hydrologic types" were introduced, but the effects of water withdrawals were shown for only two of these categories. Establishing wildlife hydrologic types is a sound way to deal with the diversity of habitat requirements for the species included in the analysis, but the terms used to describe them are not fully appropriate. For wildlife species, the categories generally describe how much water the species needs for its annual habitat requirements without consideration of key life history stages. This is particularly troublesome for amphibians, all of which are obligate species in the sense that they require standing water for reproduction.

GENERAL CONCLUSIONS ABOUT THE WSIS

When the Committee first became involved with the WSIS (early 2009), the study objectives to examine the effects of surface water withdrawal on a broad range of environmental issues seemed to be quite an undertaking given the available data and disparate paths of analysis. However, as the study progressed and the Committee presented its comments, relevant data were collected and the analytical work was increasingly conducted along biological "chains of causation." **The District scientists welcomed the Committee's recommendations and implemented them when feasible, thus overcoming many of the limitations noted by the Committee early in the project. The Committee commends the WSIS workgroups for their careful and thoughtful responses to its suggestions.**

Even those workgroups stymied by a lack of relevant data and information were able to make some conclusions about the likelihood of effects from water withdrawals (albeit with high uncertainty). Insofar as the H&H results indicate that withdrawals will produce relatively small changes in areas and depths of inundation, the inability of these workgroups to make more certain predictions is somewhat ameliorated. Indeed, had the WSIS benefitted from having the results of the hydrologic/hydrodynamic analysis at an earlier date, it is likely that the District would not have invested so much effort in determining some environmental responses to altered flows and levels. **In general, the District did a competent job relating the predicted environmental responses (including their magnitude and general degree of uncertainty) to the proposed range of withdrawals. The overall strategy of the study and the way it was implemented were appropriate and adequate to address the goals that the District established for the WSIS.**

Several critical issues that are beyond the control of the District or were outside the boundaries of the WSIS limit the robustness of the conclusions. These issues include future sea-level rises and increased stormwater runoff and water quality degradation of surface runoff engendered by future population growth and increases in impervious area and pollutant generation associated with urban development. The predicted effects of sea level rise and land use change on water levels and flows in the river are greater in magnitude than the effects of the proposed surface water withdrawals, but they have high uncertainties. The District should acknowledge these limitations in its final report and, using an adaptive management strategy, it should plan to run its models with more recent rainfall and land use records and with emphasis on water quality as well as quantity.

In addition, the workgroups did not appear to consider the possibility of "back-to-back" extreme events (e.g., several extreme droughts separated by only a short period of normal rainfall) in their impact analyses. They also tended to present mean responses to changes in driver variables with little or no consideration of the variance in response. Although mean values are the most likely responses from a statistical perspective, ranges (or variances) of responses also should be considered in analyzing potential environmental impacts of changes in driver variables. Such responses may be less likely than mean values, but they may not have negligible probabilities and could be more detrimental than the mean responses.

Insofar as the MFL regulations limit the withdrawal allowable during low flow periods, the Committee remains concerned whether MFLs will be rigidly enforced in the future. If there is an extended drought in the future, water suppliers might not be able to withdraw water from the river for months or even years on end. It is not obvious that this would be socially acceptable. Finally, now that the WSIS is nearly complete, the District should reexamine the results from their earlier water supply study, which concluded that additional groundwater withdrawals would lead to undesirable impacts on natural vegetation. The Committee recommends that the District compare the levels and nature of impacts associated with withdrawals from the two (surface and groundwater) sources of additional water supply for the region.

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

Water Science and Technology Board

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Preface

The tremendous population growth experienced by Florida over the past half century has imposed correspondingly large stresses on and costs to the state's natural resources, including its abundant but ecologically fragile water resources. As a whole, the state's population almost quadrupled over the past 50 years—from 4.95 million in 1960 to 18.8 million in 2010. Although much of the growth has been focused along or near Florida's very long coastline, the interior parts of the state also have shared in the boom. For example, metropolitan Orlando, which lies in the southwest part of the St. Johns River basin that is the focus of the study reviewed in this report, has grown from fewer than 340,000 people in 1960 to an urban/suburban conglomerate of more than 2.1 million people spread over several counties and many hundreds of square miles.

Population growth has stressed drinking water supplies in many parts of Florida. In 2008, for example, the Tampa Bay area opened a 25 MGD (million gallons per day) desalination plant, the largest seawater desalination plant in the United States. In the St. Johns River basin, a 2005-2006 water supply planning study conducted by the St. Johns River Water Management District (SJRWMD, hereafter referred to as the District) showed that increasing water withdrawals from the Upper Floridan Aquifer—the principal groundwater supply of the basin and most of peninsular Florida—beyond those projected to occur by 2013 would lead to undesirable declines in the aquifer's piezometric surface. The planning study was conducted as part of the District's dual responsibility to provide water supplies for human uses in the basin and to protect its water resources. The District concluded that the predicted decline in the aquifer's piezometric surface would lead to unacceptable levels of harm to native vegetation in large areas of the drainage basin. As a consequence, the District began to consider alternative sources of supply for the population growth that was expected in the region. These sources included recycling and reuse of wastewater and a variety of water conservation measures, but the District concluded that these would not be sufficient and thus began to consider surface water withdrawals from the St. Johns River and its major tributary, the Ocklawaha River.

A major two-phase study on the potential environmental impacts of such water withdrawals was initiated by the District in 2008 and is scheduled for completion in early 2012. Involving more than 80 technical staff and consultants, the study, which became known in 2009 as the Water Supply Impact Study, or WSIS, has been an unusually comprehensive examination of the hydrologic and hydrodynamic changes that would occur as a result of water withdrawals from the rivers and a wide range of environmental and ecological consequences that could ensue. In late 2008, just as the WSIS was transitioning from the Phase 1 review of existing information to the full-scale assessment activities in Phase 2, the District requested that the National Research Council (NRC) form a committee to provide independent review and ongoing advice regarding the impact study. Typical of NRC committees, the composition of the "Committee to Review the St. Johns River Water Supply Impact Study" was designed to be highly multidisciplinary. Its nine members were selected for their expertise across the range of scientific and engineering disciplines involved in the WSIS, and each of them brought along a broader perspective as environmental scientists and engineers that was invaluable to the Committee's work. I have been privileged to serve as the Committee's chair since its first meeting in Jacksonville in January 2009.

The Committee thus has followed the WSIS process since the end of the first phase of the study. From the outset, the Committee viewed its primary role as advisory to an ongoing study rather than merely critiquing some completed body of work. The Committee conducted its responsibilities with vigor, producing four formal reports (including this one) over the course of its nearly three years of operation, and also providing oral advice at six formal meetings with the District's staff and through roughly twice the number of conference calls devoted to the progress and issues of specific workgroups. Members of the Committee thus devoted a large amount of their time over the past three years to reviewing the WSIS study, and I want to thank them for their efforts and for the collegiality exhibited in the closed session discussions and in questions to District scientists. I especially want to thank the following committee members: Ben Hodges for his ability to digest and explain to the rest of the Committee the huge work products and detailed reports of the Hydrology and Hydrodynamics workgroup, which were critical to understanding the potential environmental impacts of water withdrawals; Siobhan Fennessy for her willingness to do "double duty" in reviewing the work of both the wetlands workgroup and the wetlands wildlife workgroup; and Mark Peterson for leading the estuarine benthos review in addition to the considerable workload understanding impacts to fish.

On behalf of the Committee, I would like to express our sincere gratitude to the members of the District who participated in the Committee's review of the WSIS. We especially thank the leadership team: Tom Bartol, Director, Bureau of Water Supply, Ed Lowe, Senior Scientist and Director, Bureau of Environmental Services, and Mike Cullum, Director, Bureau of Engineering. We appreciate their hospitality and their efforts to ensure that the formal meetings were useful and informative to the Committee. We also appreciate the efforts of the eight workgroup leaders to provide instructive briefings on their groups' progress: Mike Coveney, plankton; Donna Curtis, wetland wildlife; Dean Dobberfuhl, littoral zone, submersed aquatic vegetation (SAV); Larry Keenan, biogeochemistry; Palmer Kinser, wetlands; Rob Mattson, benthos; Steve Miller, fish; and Pete Sucsy, hydrodynamics and hydrology. Their responsiveness in answering questions and their openness and willingness to accept suggestions from the Committee is much appreciated. In conjunction with formal meetings, the Committee participated in four enlightening and enjoyable field trips on different sections of the St. Johns River. Workgroup leaders and other WSIS technical staff participated in these trips and were helpful in describing the system to the Committee. We appreciate the efforts made by the following people in planning and guiding these field trips: Tom Bartol, Ima Bujak, Robert Burks, Dean Dobberfuhl, Dina Hutchens, and Michelle Lacasse. We also thank Tom Bartol, Dean Campbell, Michael Coveney, Michael Cullum, Dean Dobberfuhl, Sonny Hall, John Hendrickson, Jane Mace, Erich Marzolf, and Peter Sucsy for technical presentations during the trips.

Completion of the Committee's work would not have been possible without the stellar efforts of the project's study director, Laura Ehlers. Her powers to organize, ask relevant and probing questions, synthesize, and keep the committee on track with completing its tasks are truly remarkable, and they were invaluable for the successful completion of the Committee's tasks. We also thank Stephanie Johnson for keeping the Committee in fine operating mettle while Laura was on maternity leave. Meeting and travel logistics were ably arranged by Michael Stoever and, for one meeting, Sarah Brennan.

This report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of the independent review is to provide candid and critical comments to assist the NRC in making its published reports as sound as possible and to ensure that they meet 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 persons for their review of this report: Emily Bernhardt, Duke University; Matthew Cohen, University of Florida; Wendy Graham, University of Florida; Michael Kavanaugh, Geosyntec Consultants; Judy Meyer, University of Georgia (retired); Jayantha Obeysekera, South Florida Water Management District; and Ernst Peebles (University of South Florida). These reviewers provided many constructive comments and suggestions, which we gratefully acknowledge. They were not asked to endorse the conclusions and recommendations, however, and they did not see the final draft of the report before its release. The review process for this report was overseen by Jerome Gilbert, NAE, who was appointed by the NRC to verify that the independent review was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of the report, however, rests with the Committee and the National Research Council.

Patrick Brezonik, Committee Chair

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