Sustainable Water Management Plan

Working together to share a common resource.

MAY 13, 2015

Approved for general release by the Governing Board of ACF Stakeholders, Inc.

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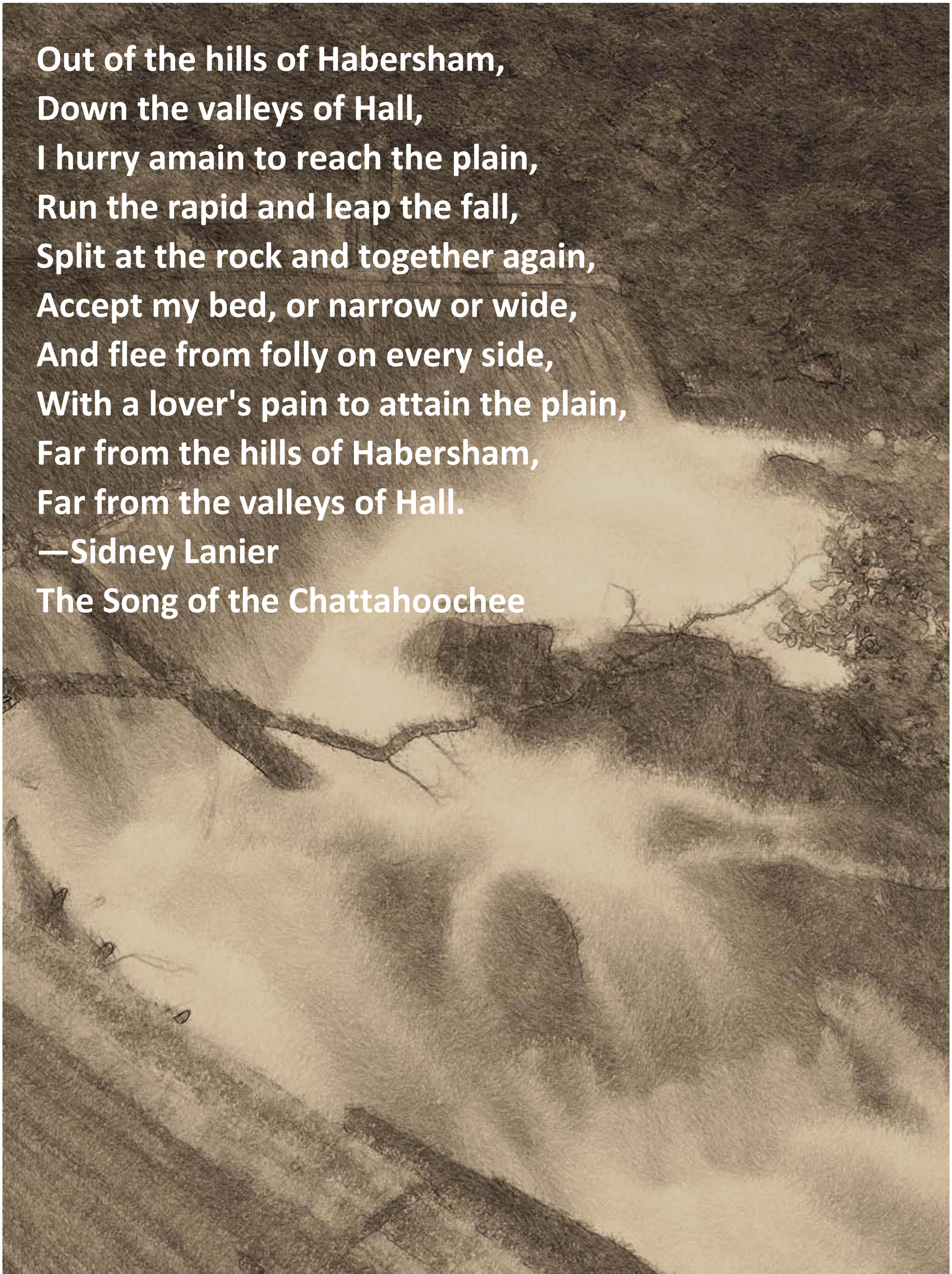


Out of the hills of Habersham,
Down the valleys of Hall,
I hurry amain to reach the plain,
Run the rapid and leap the fall,
Split at the rock and together again,
Accept my bed, or narrow or wide,
And flee from folly on every side,
With a lover's pain to attain the plain,
Far from the hills of Habersham,
Far from the valleys of Hall.
—Sidney Lanier
The Song of the Chattahoochee

Table of Contents

TABLES

FIGURES

Acronyms and Definitions

7Q10 – A low stream flow that statistically occurs for seven consecutive days once every ten years. One of the measures used for setting effluent limits and minimum releases from impoundments.

ACF Basin – The watershed of the Apalachicola, Chattahoochee and Flint Rivers, their tributaries and the Apalachicola Bay.

ACFS – ACF Stakeholders, Inc., a non-profit corporation with a Governing Board of 56 stakeholder members representing interests from all areas of the Basin extending through Alabama, Florida and Georgia.

ANERR – Apalachicola National Estuarine Research Reserve

AWEP – Agricultural Water Enhancement Program

AWWA – American Water Works Association

Basin – The watershed of the Apalachicola, Chattahoochee and Flint Rivers, their tributaries and the Apalachicola Bay.

BI – Basin Inflows

DSS – Decision Support System

BMP(s) – Best Management Practice(s)

CFS – Cubic feet per second. Measurement typically used for river flows (1 CFS = 0.646 MGD)

EPA – Environmental Protection Agency

ESA – Endangered Species Act

FEMA – Federal Emergency Management Agency

FERC – Federal Energy Regulatory Commission

GAEPD – Georgia Environmental Protection Division

GEFA – Georgia Environmental Finance Authority

GWRI – Georgia Water Resources Institute

IBT – Interbasin Transfer

IOP – Interim Operation Plan

IWA – International Water Association

LAS – Land Application System

MSL – Mean sea level, datum for the measure of topographic elevation

MGD – Million Gallons per Day (1 MGD = 1.547 CFS)

MNGWPD – Metropolitan North Georgia Water Planning District

NEPA – National Environmental Policy Act

NIDIS – National Integrated Drought Information System

NOAA – National Oceanographic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

NPS – National Park Service

NRCS – Natural Resource Conservation Service

NWFWMD – Northwest Florida Water Management District

PDSI – Palmer Drought Severity Index

PHDI – Palmer Hydrologic Drought Index

PPM - Parts Per Million

RES-SIM – The U.S. Army Corps of Engineers Hydrologic Engineering Center's Reservoir System Simulation is a computer program used to simulate reservoir facilities, operations, releases and reservoir levels.

RIOP – Revised Interim Operating Plan

QA/QC – Quality Assurance/Quality Control

SWMP – ACFS' Sustainable Water Management Plan

TMDL – Total Maximum Daily Load. TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards.

TUC – The University Collaborative (a collaborative group of universities established by ACFS)

UIF – Unimpaired Flow. Unimpaired flows (UIFs) are a modeled data set that adds an estimate of human uses to historical stream flows in an effort to calculate what the natural flows would have been absent human influences. UIFs are commonly used in water resources assessments to evaluate the effects of alternative development and management plans on a comparative basis. Specific numeric values should not be assumed to be accurate on an absolute basis, due to modeling errors.

USGS – United States Geological Survey

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

USFWS – United States Fish and Wildlife Service

WCM – Water Control Manual

WMA – Water Management Alternative

Executive Summary

The ACFS Vision

The waters of the Apalachicola, Chattahoochee and Flint (ACF) Rivers and the Apalachicola Bay bind and divide both the geography of Alabama, Florida, and Georgia and the users of the water.

This Basin is a water-rich region, yet one where attention to sustainable water resource management has become imperative. Although most needs are met in normal and wet years, the limits of the Basin's capacity to support competing water needs are being experienced under dry and drought conditions and more often in some locations and for some water uses. Improvements to the current conditions in the Basin are possible, however; and planning for dry and drought years is critical.

The ACFS mission is to change the operation and management of the ACF Basin to achieve equitable and viable solutions among stakeholders that balance economic, ecological, and social values and ensure that the entire ACF Basin is a sustainable resource for current and future generations.

The economic well-being of the southern U.S. and the sustainability of the waters in the ACF Basin are intertwined. However, decades of conflict have set the stage for deeply held positions over the future of the region. The regulatory arena is in flux, and litigation casts a shadow of uncertainty. It is time to turn this around.

ACF Stakeholders, Inc. (ACFS) urges the citizens of this Basin to focus on that which unites, rather than divides, us. We can and must act with common purpose to manage our shared water resources sustainably. Water efficiency and conservation measures, creative alternatives to water control operations, predictive drought management, investment in scientific knowledge for future decisions, and transboundary coordination and cooperation offer real ways to improve environmental, social and economic conditions in this Basin.

ACFS began in August 2008 as a small group of people who live and work in the Basin. Soon after, ACF Stakeholders, Inc. was operating as a non-profit corporation with a Governing Board of 56 stakeholder members representing interests from all areas of the Basin extending through Alabama, Florida and Georgia. The ACFS mission is to change the operation and management of the ACF Basin to achieve equitable and viable solutions among stakeholders that balance economic, ecological, and social values and ensure that the entire ACF Basin is a sustainable resource for current and future generations.

ACFS members have sought to develop a mutual understanding of the diverse interests in the Basin, to explore how the Basin operates, and to reach consensus on recommendations that, taken as a whole, would improve conditions in the Basin. This Sustainable Water Management Plan (SWMP) incorporates what ACFS has learned so far about positive choices that can start now. It also lays the groundwork for the studies and dialogue needed to enhance water management in the future.

The Audience

This SWMP recommends actions for the U.S. Army Corps of Engineers (USACE), other federal agencies, and the states of Alabama, Florida and Georgia, along with all public and private water users in the Basin.

USACE has a large influence in how water moves within the ACF Basin. The Master Water Control Manual, last updated in 1958, guides decisions regarding the ACF Basin operations for the five federal reservoir projects on the Chattahoochee and at its confluence with the Flint. A Revised Interim Operation Plan (RIOP) also sets release rules that specifically provide minimum flow guidance to the USACE based on Basin Inflow, time of year, and the amount of storage available in the federal projects to meet the various authorized purposes. While the USACE' influence is large, it is limited to the operation of federal reservoirs. The States of Alabama, Florida and Georgia also play critical roles in water resources management throughout the Basin. State permitting programs for wastewater discharges and water withdrawals affect most water users. Alabama, Florida and Georgia each have similar wastewater discharge permitting programs delegated from the federal Environmental Protection Agency (EPA). Water withdrawal permitting and regulation varies between the states.

Development of the Plan

ACFS worked closely with state and federal agencies to compile the best available water withdrawals and returns data in the ACF Basin and used this in modeling current and possible future conditions. ACFS also documented needs and concerns for different stakeholder groups and geographic areas of the Basin and incorporated these concerns in the Plan by developing performance metrics, linked in Appendix A, which were used in the modeling to assess Water Management Alternatives (WMAs).

Modelers used RES-SIM, developed by the USACE, and a river and reservoir model developed by the Georgia Water Resources Institute (GWRI) at the Georgia Institute of Technology called the ACF-DSS model to simulate the river and reservoir response under different hydrologic, development, and management scenarios. The Basin flow model was tailored to provide the outputs to enable results to be compared to the stakeholder developed performance metrics for the main stem flows. GWRI also conducted hydrodynamic modeling of the Apalachicola Bay to investigate the effects of river discharge on bay salinity. Atkins Global then utilized the outputs of the hydrodynamic model to help ACFS compare different water management alternatives on the Eastern oyster.

ACFS also worked with a consortium of universities in the region to assess transboundary water resource management institutions in the United States and around the world and to consider options appropriate for the ACFS Basin.

Recommendations

People benefit from healthy aquatic ecosystems, drawing on water resources for many needs. Sustainable water management requires attention to the challenges of maintaining a healthy aquatic ecosystem, particularly as the capacity of the system to meet all stakeholder needs becomes strained. ACFS members have concluded that improvements in meeting stakeholder needs and concerns in the ACF Basin, as compared to current conditions, are possible and that planning for dry and drought years has become critical.

The plan recommendations are grouped into five themes:

- Achieve Sustainable Use and Return
- Improve Water Storage and Control Operations
- Target Dry and Drought Years
- Advance Scientific and Technical Knowledge for Future Decisions
- Strengthen Basin Coordination

Ensuring reliable and sustainable water resources requires a combination of actions that, taken together, achieve greater benefits for the amount of water used. ACFS recommends that all water users contribute to this by identifying and implementing conservation measures and more efficient use of water. Recognizing that "what gets measured gets done," tracking and reporting progress over time also must be a priority.

Given the complexity of water resource management under changing conditions, it is important to make adaptive management – or learning about what actions achieve desired results and why, and making adjustments based on lessons learned – a priority. Adaptive management does not mean creating additional conditions of uncertainty for stakeholders who depend on the results of management decisions. Rather, adaptive management, by definition, is a structured iterative process of robust decision-making in the face of uncertainty, with the aim of reducing uncertainty over time via system monitoring. Water managers in the ACF Basin are urged to track the results of their efforts, assess whether those results accomplish what Basin stakeholders are seeking to achieve, and consult stakeholders when considering changes in management decisions based on new information.

Ultimately, actions that result in increased water returns generally benefit all users of the system. While setting quantitative conservation and efficiency targets will require more analysis, in part because circumstances vary, this plan identifies numerous opportunities for more sustainable use and return, and ACFS urges each water user, and managers of water users, to take action.

Modeling done for this plan also demonstrates how changes in the storage and operations of the current federal reservoirs, in combination with water efficiency and conservation measures, could simultaneously improve the instream flows that sustain aquatic habitats in the Basin, Apalachicola Bay and other instream uses, while providing for both current and future consumptive uses. These operational changes also result in improvements to instream uses in the Basin and the Bay at current consumptive uses.

Thus, based on the modeling conducted for this Plan, ACFS recommends that USACE adopt a policy of adaptive management in the revisions to the Water Control Manual, with the involvement of the states and stakeholders in the ACF Basin, implementing the following suite of actions taken together as a starting point to improve operations of the federal reservoirs on the Chattahoochee River:

- Raise the winter pool rule curve at West Point Lake from 628 ft to 632.5 ft.
- Define new zones to coincide with the USACE reservoir recreational impact zones and then only release water from an upstream reservoir when the downstream reservoir is in a lower zone.
- Adjust hydropower requirements to achieve more flexibility.
- Provide two pulsed water releases to achieve 9,000 cfs at Chattahoochee, FL for two weeks each, one in May and one in July.[1]

It is important to consider this suite of actions as a package. Using a banking analogy, some of the changes add to system “savings” and others “spend” those savings on priorities for restoring instream flows and levels and for consumptive uses during droughts. Thus, each is interdependent on the other to achieve the intended results.

The sustainability of the package of recommendations, particularly under drought conditions, is based on technical modeling performed by ACFS consultants. Their adoption was predicated on three conditions: 1) the system storage during drier years is not worse than storage associated with conditions experienced currently under drier years, 2) instream flows during drier years do not become target flows in normal and wetter years, and 3) the assumption (not modeled) that flood control will not be adversely affected. The sustainability of the package of recommendations and consistency with these conditions should be confirmed by the Corps prior to implementation.

This adaptive management approach also should include a regular assessment of the effects of this package of operational rules and adjustments, as frequently as advances in science and the results of data collection to monitor desired outcomes warrant, but no less often than every five years and more often in the first years after this approach is adopted. Such assessments should consider increases and decreases in water use over time and should seek to achieve conjunctive instream flow benefits to the environment, navigation, hydropower, and recreation through pulse magnitudes and durations under dry conditions

[1] Pulses were modeled as 9000 cfs flows at Chattahoochee, FL (not as an additional 9,000 cfs) – as well as 14,000 cfs – and only during periods when flows fell below 9,000 cfs (thus not reducing flows to 9,000 cfs when flows otherwise would have been higher).

consistent with the conditions identified above. USACE should utilize the expertise of one or more of its centers of excellence in implementing this adaptive management approach to draw on lessons learned across the country and to enable lessons learned in this Basin to be shared more widely.

In addition, ACFS recommends that USACE study and implement, if feasible, an increase in the rule curve at Lake Lanier by two feet. Over time, this would add about 78,000 acre-feet of storage capacity to the system, or about seven percent of the original Lanier active storage, which is needed now during drought years and will be needed as conditions and needs change in the future. This SWMP does not address allocation of this capacity; however, ACFS members concur that the increased storage resulting from operational changes should be shared equitably and used in a manner that relieves the adverse impacts of drought conditions.

Further, ACFS also recommends that USACE add a flow control node in the WCM at Columbus. This recommendation is contingent on the implementation of the adaptive management recommendation package above and is not a standalone recommendation. The minimum flows for the proposed node should be developed to retain an approximation of the historical flow frequency while still achieving the benefits to upstream and downstream interests sought in that adaptive management recommendation package.

Clearly, the amount of water available to meet stakeholder interests is less during droughts. Given the adverse impacts in the Basin of recent droughts, ACFS urges local, state and federal decision makers to establish consistent drought management plans that trigger incremental and equitable actions as early as possible to avoid the more dramatic reductions that might be necessary if actions are taken later. Water users and water managers need to be more proactive and less reactive if we are going to manage the system sustainably.

Specifically, ACFS urges USACE to utilize predictive drought indicators in the revised Water Control Manual. Various combinations of predictive drought indicators can be used that allow operation decisions to be made in drought years that enhance system flows while still preserving adequate reservoir storage during the drought. As a starting point for discussion, drought management planning discussions should consider:

- Triggers based on drought conditions (antecedent inflow, areal precipitation, and soil moisture), streamflows, time of year, and remaining storage in federal reservoirs.
- The RIOP uses composite storage alone as a drought trigger. USACE should also consider the state of the Basin (how dry or wet) in triggering drought operations. A drought index should be developed to guide the decision based on the predictive drought indicators selected (e.g. antecedent Mean Areal Precipitation and/or soil moisture). In addition, USACE should use regional sub-basin drought indicators (e.g. for the Apalachicola River, Apalachicola Bay, the middle Chattahoochee or the Flint) to consider changes in operations rather than waiting for designation of drought in the entire ACF Basin.

Developing a common, scientifically valid understanding of the ACF Basin is an essential foundation for sustainable water resource management in this Basin. In the development of this SWMP, ACFS members gained a better understanding of the Basin, including the Apalachicola Bay, but also encountered challenging gaps in scientific and technical knowledge both for near term decisions and for future adaptive management. ACFS members recommend that investments in knowledge about the Basin be made in the following areas, with suggested specific studies listed in Chapter 6:

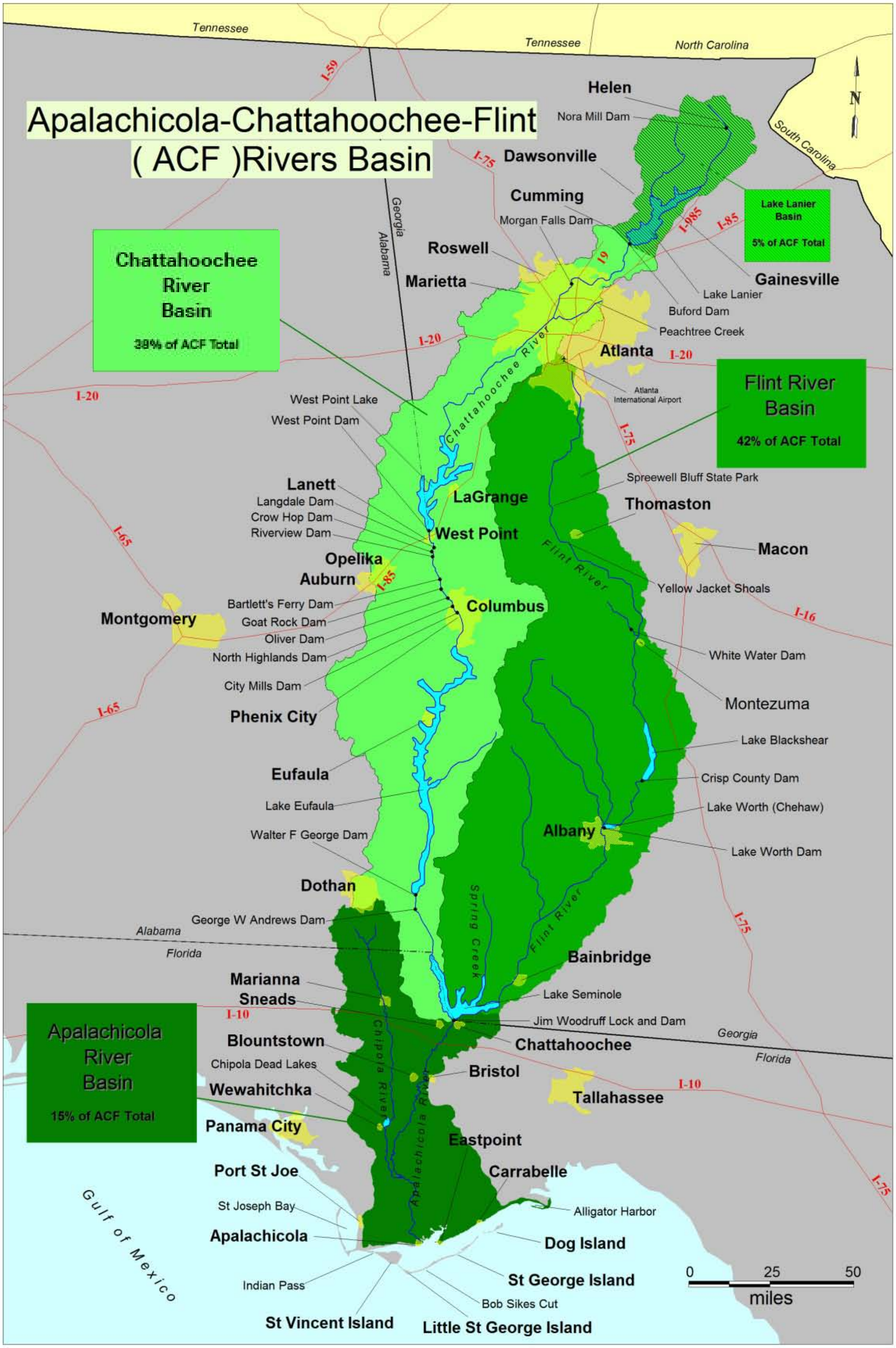
- Environmental and ecological studies
- Climate variability studies
- Shared real-time water use/return/storage/flow information
- Improvements in modeling

Finally, collaborative efforts are essential to finding sustainable water management solutions. We must sustain and enhance communication among stakeholders. Further, ACFS urges the states of Alabama, Florida and Georgia to participate in efforts to establish a transboundary water management institution for the ACF Basin. Such efforts could begin with a transitional entity, designed to provide a forum for discussing how best to structure a permanent transboundary water management institution. ACFS stands ready to assist in the formation of such a transitional process or entity.

These recommendations are detailed in the Plan, and ACFS urges decision makers and citizens in this Basin to take action to implement them.

Basin stakeholders' perspectives are presented in Appendix B. Stakeholders have described in their own words the interests and concerns that they are seeking to achieve. The consensus of ACFS is that stakeholders' diverse perspectives are important to understand. However, the perspectives expressed in Appendix B are not a consensus statement of ACFS as a whole nor are they necessarily a consensus of all the members associated with the various sub-basin or stakeholder interest group perspectives represented.

Figure 1-1 ACF Basin Map (Credit: Roy Ogles)



CHAPTER 1.

Introduction: A Vision of Sustainable Water Resources Management in the ACF Basin

Loggers made a remarkable discovery in the Apalachicola River in May 2006. The loggers found a 50-foot long canoe carved from a single cypress tree. This 19th century canoe was unique in shape and designed for the transport of cargo like cotton and honey. It was designed and built by hand for the task at hand.

If this Sustainable Water Management Plan were an object, it would be a hand-hewn canoe. ACF Stakeholders has carved this Plan from countless conversations since 2009.

ACFS members actively sought a mutual understanding of the diverse interests in the Basin, explored current science together, and reached consensus on recommendations that, taken as a whole, would improve conditions in the Basin for all. This Plan navigated the rapids and obstacles throughout the Basin with the support of engineering and environmental consultants, a professional facilitator, an executive manager, and tens of thousands of volunteer hours and other in-kind contributions from stakeholders around the Basin. In making a commitment to consensus solutions, ACFS members hope to divert the history of litigation in the Basin to a more collaborative approach to water management.

The ACFS mission is to change the operation and management of the ACF Basin to achieve equitable and viable solutions among stakeholders that balance economic, ecological, and social values and ensure that the entire ACF Basin is a sustainable resource for current and future generations.

The Challenges

The rivers of the ACF Basin bind and divide the geography of Alabama, Florida and Georgia and the users of this water.

The economic well-being of the southern U.S. and the sustainability of the waters in the ACF Basin are intertwined. However, decades of conflict have set the stage for deeply held positions over the future of the region. The three states have been in the courts and in various stages of negotiation to arrive at a water sharing agreement with no success. The regulatory arena is in flux, and litigation casts a shadow of uncertainty. It is time to turn this around.

The mission and the challenge taken on by ACFS has been and is to change the operation and management of the ACF Basin to achieve equitable solutions among stakeholders that balance economic, ecological, and social values and viable solutions that ensure that the entire ACF Basin is a sustainable resource for current and future generations.

Key interests of water resource users in the Basin now and in the future include:

- Sustainable water supply for Basin population.
- Dependable navigation on the congressionally authorized inland waterway system.

- Dependable hydropower production at the reservoirs congressionally authorized for hydropower.
- Attractive recreation and ecotourism opportunities and lake levels.
- Increased agricultural productivity.
- Shellfish and marine productivity in the Apalachicola Bay estuary and Eastern Gulf of Mexico.
- Instream flows or other measures that maintain ecological flows for floodplains, rivers, tributaries, and estuaries.
- Water quality and natural ecological functions of the entire ACF Basin.
- Freshwater availability for additional investment in both industry and power generation facilities in the Basin.

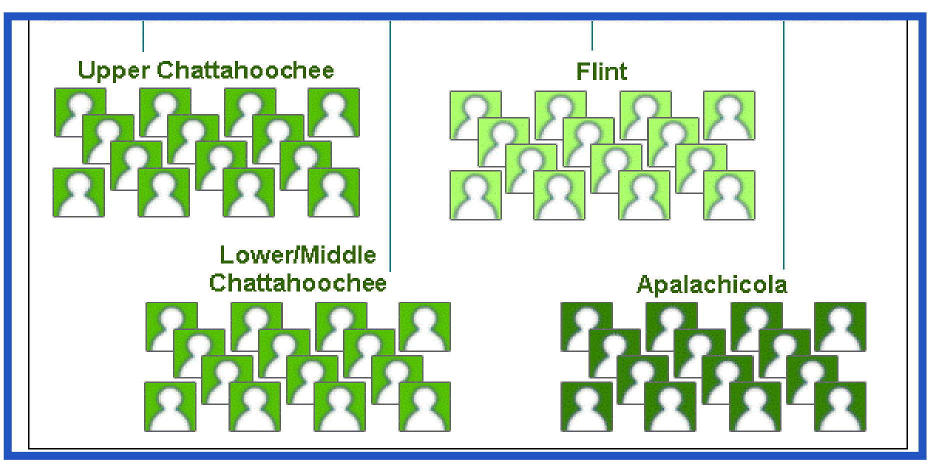
Because these interests had not been resolved, a group of individuals developed a new approach.

ACF Stakeholders - A New Approach

The ACFS began as a small group of people who live and work in the Basin. They met in August 2008 to discuss whether users in the Basin could act cooperatively and regionally; leaving the meeting with hope and the beginnings of a new partnership.

The stakeholders received encouragement to form a stakeholder group from USACE and in early 2009, 35 volunteers from throughout the ACF Basin, representing municipal, industrial, environmental, recreational, navigation and agricultural interests met as a steering committee to develop a mission statement, goals, an executive committee and workgroups. ACFS is a non-profit corporation with a Governing Board of 56 stakeholder members representing interests from all areas of the Basin extending through Alabama, Florida and Georgia as shown in Figure 1-2.

Figure 1-2 ACFS Organizational Structure

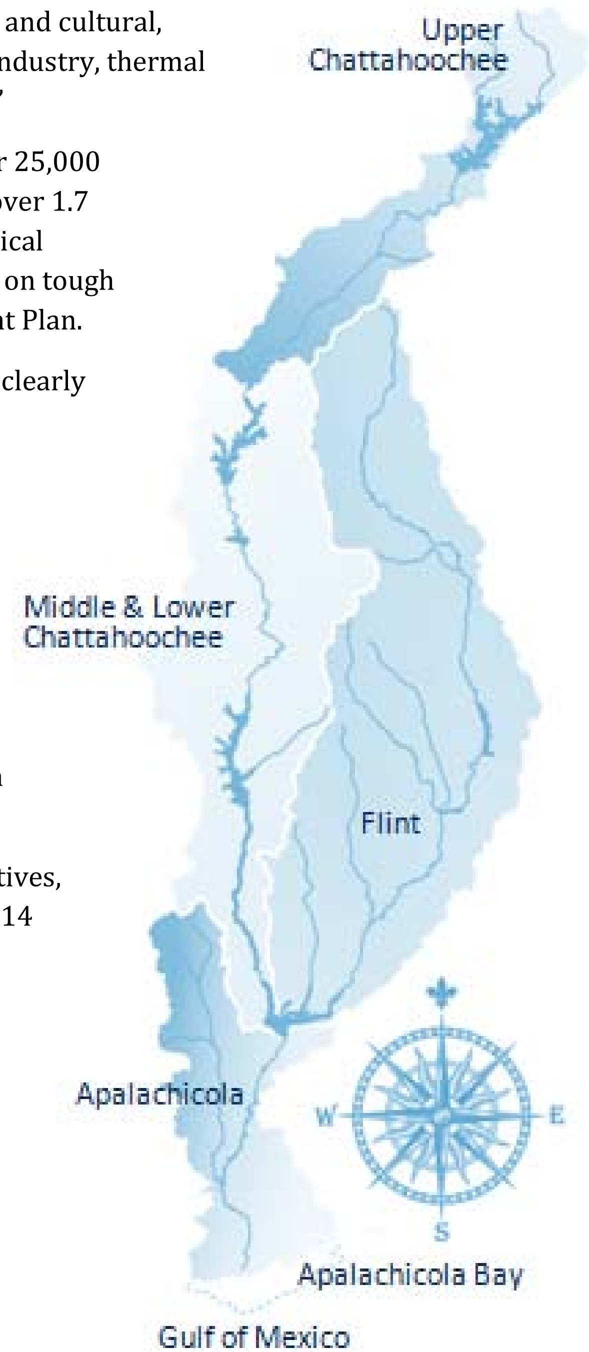


56 Members – 14 Interest Representatives per sub-basin

The Governing Board Members represent 14 different interest groups: water supply, farm and urban agriculture, recreation, local government, water quality, industry and manufacturing, navigation, historic and cultural, hydropower, environmental and conservation, seafood industry, thermal power, business and economic development and "other."

Since its founding, ACFS members have volunteered over 25,000 hours, established numerous active committees, raised over 1.7 million dollars of private financial support, funded technical analyses to inform its deliberations, engaged in dialogue on tough issues, and produced this Sustainable Water Management Plan.

Consensus didn't come easily. Differences of views were clearly expressed, but people also listened and learned. They established performance metrics and directed technical analyses to answer shared questions about current conditions and the effects of water management alternatives. They evaluated alternatives that achieved gains against stakeholder performance metrics, compromised, recognized the importance of adaptive management over the long term, and affirmed the imperative need to continue the dialogue on unresolved issues supported by additional research and information collection.



The Plan is intended to achieve six major planning objectives, which ACFS adopted early in the process integrating the 14 categories of stakeholder interests:

- Ensure and/or maintain adequate water supplies for public supply/municipal uses including wastewater assimilation needs of current and projected future populations.
- Maintain existing and promote future water availability and access for water dependent industries, power generation and recreational interests.
- Promote the optimization of the use of water for agricultural irrigation including: types of irrigation technology, selection of crops, sustainable and resource-based permitting, and water withdrawal monitoring.
- Determine the nature and extent of commercial navigation that the ACF Basin can effectively support.
- Protect the natural systems and ecology of the ACF Basin by defining and implementing desired flow regimes and lake levels, water quality

enhancements to maintain a healthy natural system and support a productive aquatic ecosystem in the Basin and the estuary.

- Create and support relationships with local governmental institutions and other public bodies within the ACF Basin to promote sustainability of water resources and to address concerns associated with the historical and cultural resources of the Basin as they relate to the management of the Basin's water resources.

ACFS established the following two major initiatives to meet these objectives -- a Sustainable Water Management Plan to develop solutions that will meet the region's needs now and in the future and a Transboundary Water Management Institutional Options Study.

Black & Veatch, the Georgia Water Resources Institute at the Georgia Institute of Technology, and Atkins Global provided technical support for the SWMP. Mark Masters and Gail Bingham provided management and facilitation support.

Transboundary Water Management Institutional Options Study

Implementation of sustainable water management solutions will require the coordination and cooperation of many in the private and public sectors and among the three states through which these three rivers flow. Competing interests are understandable, but the absence of a mechanism to work through differences must not continue. Thus, ACFS members have felt it important to investigate institutional models from other multi-state or transboundary river systems that might offer useful concepts and strategies for effective multi-state planning and management of the ACF Basin.

ACFS engaged the services of a partnership of universities in the area (University of Georgia, University of Florida, Auburn University, Albany State University and Florida State University), known as The University Collaborative (TUC), to describe existing and emerging institutional models.

This effort produced a report describing transboundary water institutions in the United States and internationally, an analysis of what functions are filled in the ACFS Basin and where any gaps may exist, and a set of recommendations for the future. The key findings are incorporated in the Basin Coordination theme of the Recommendations Chapter.

CHAPTER 2.

Plan Purpose, Methodology and Organization

Purpose

Sustainable management of water resources in the ACF Basin is needed, particularly during times of drought. The purpose of this Plan is to contribute to widespread public understanding of the ACF Basin, define the water quantity and water quality needs of the Basin stakeholders, evaluate alternative water management scenarios, improve conditions throughout the Basin, and urge action on Basin-wide management recommendations.

This is the first effort by a diverse consortium of grassroots stakeholders in the three states to arrive at a technically sound solution to the problem. It is specifically recognized that this Plan will need to be adapted in the future as additional information becomes known and conditions in the Basin change.

Sustainability means different things to different people. ACFS defined sustainable water management as the conditions when “the full array of benefits associated with water is met to an acceptable level for the needs of society, while maintaining the ecological integrity of its water and land resources now and in the future.”

Process and Methodology

In 2011, ACFS selected Black & Veatch, in cooperation with the Georgia Water Resources Institute (GWRI) at Georgia Tech, and Atkins Global to develop the Plan.

ACFS members provided input, debated, and discussed all Plan inputs, including hydrologic model input data, performance metrics, technical memorandums and modeling results. Complex technical tasks were aligned with consensus building needs. This allowed ACFS members to actively engage in the process, test different options, and explore trade-offs.

The approach and methods used are summarized below. The tasks described were interrelated, so were not necessarily conducted sequentially.

Performance Metrics and Water Management Alternatives

ACFS stakeholders identified water management alternatives to consider and defined performance metrics for evaluating those alternatives, with assistance from the technical experts. These were submitted by stakeholders and discussed in sub-basin caucus meetings.

Data and Information Gathering

Technical experts from Atkins Global, Black & Veatch, and GWRI discussed information availability and data/science needs and gaps with the stakeholders.

These experts produced memos, reports and presentations on the following topics:

- available literature on natural resources of interest for environmental flows *[Atkins Global]*
- relationship of flows to inundation levels *[Atkins Global]*
- water demands and returns *[Black & Veatch]*
- review of unimpaired flow data sets *[GWRI]*
- assessment of conditions in Apalachicola Bay *[Atkins Global]*

Environmental Literature Review

Atkins Global identified and reviewed 185 GIS data sources and 233 literature sources. A list of these sources was developed and annotated. The results of this literature review were used to assess whether existing data are adequate for completion of an instream flow assessment. Critical data gaps were identified.

Relationships of Flows to Inundation Levels for Environmental Flow Performance Measures for the Apalachicola River

Atkins Global evaluated existing information and data pertaining to flows, elevations, biological resources, and hydrodynamic and statistical models to identify potential approaches stakeholders might choose to use in developing their environmental flow performance metrics for the ACF rivers. A habitat-based approach was used and water levels necessary to inundate floodplain habitat were identified. This approach also recognized the importance of seasonal variations in the system, i.e., lower flows for the drier seasons of the year and higher flows during the wet season.

A conceptual approach was selected given information and funding constraints. For the Apalachicola River, this conceptual approach was based primarily on the work of: 1) Light et al. 1998 who examined acres of connected aquatic and floodplain habitat as a function of flow for the Apalachicola River at the Chattahoochee gage, and 2) the USFWS biological opinion prepared for USACE on the RIOP (2012)[2] regarding whether proposed USACE RIOP release schedules from Jim Woodruff Dam would jeopardize threatened and endangered mussels under the specified range of low flow conditions. The Biological Opinion also included some conservation recommendations that USACE can implement at its discretion. Flow data for the Apalachicola River was based on a 70-year UIF CMA (unimpaired flow, centered moving average) simulated data set developed by USACE and, thus, represented the monthly means and medians for a long period of time. Mean and/or median values were

[2] U.S. Fish and Wildlife Service. 2012. Biological opinion on the U.S. Army Corps of Mobile District, Revised Interim Operating Plan for Jim Woodruff Dam and the Associated Releases to the Apalachicola River. Prepared by USFWS Panama City Field Office, FL. 166 pp.

not assumed to be met every year, just as the 70-year monthly mean and median for the UIF will not be met every year.

Water Demands and Returns

Consumptive use is the difference between the total amount of water withdrawn from a defined hydrologic system and the total amount of measured withdrawn water that is returned to the same hydrologic system within a timely period. Consumptive use in the ACF Basin was important to understand for purposes of modeling potential alternatives for sustainable water management.

Current water demands estimates from existing sources were used as inputs to the ACF-DSS and RES-SIM models for the analysis of existing conditions in the Basin. Percentage increases and decreases from current demands also were used in the modeling to assess future conditions.

Water demands were compiled from information provided by each of the three states. In some cases, simplifying assumptions regarding growth were made to generate a consistent water demand projection data set. Uncertainties within the demands data set were presented.

Water demands compiled were broadly categorized into five major water-using sectors (agriculture, industrial, municipal, thermoelectric, and stream-aquifer or surface water impacts), three states (Alabama, Florida, and Georgia), three basins (Apalachicola, Chattahoochee, and Flint), and fourteen nodes. Agricultural uses also are included in the stream-aquifer impacts category.

In Alabama, Florida and Georgia, small water users falling below certain permit or reporting thresholds are not required to report their actual water use and an estimate for this use is not available. The magnitude of this non-reported water use is believed to be small relative to overall Basin demand; therefore, it is not considered an impediment to the ACFS' planning level analysis goals.

Net evaporation was not included in the tabulation of water demands for this task. However, loss due to net evaporation was included, and is an integral part of the surface water analysis modeling tools used by GWRI. Net evaporative losses are addressed specifically in the baseline modeling.

The data set prepared for use in the surface water models was based upon monthly average withdrawal and return values. A monthly forecast allows for the data set to exhibit an intra-annual pattern and, thus, captures seasonal variations in water demand. Historic monthly average data were used to generate a representative historic monthly intra-annual pattern and applied to future demand conditions. Intra-annual patterns are not the same for all water using sectors or for all geographies. Therefore, a unique intra-annual pattern was developed by node and by water using sector based upon historic data.

Ultimately, the net water use, or consumptive demand, was utilized as an input into the ACF-DSS model nodes. Treated wastewater that is land applied or managed in onsite septic systems was not considered a direct surface water return and assumed to be 100% consumptive for modeling purposes.

USACE used a similar methodology. However, differences between data used for this Plan and USACE data are observed for several reasons, including: different time scales, differences with regard to geographic assignment of withdrawals/returns to nodes, variability in how non-reporting agriculture use may be estimated, what the states had previously reported or provided to the USACE, political/litigation aspects, and others. While these differences (aside from drought versus non-drought) are known to be present, the comparison does provide an order of magnitude comparison that is useful. It is recognized that the ACFS current demand compilation does not reflect the highest consumptive demand that might be exerted on the ACF Basin during a drought condition.

Review of Unimpaired Flow Data Sets

Unimpaired flows (UIFs) represent historical streamflows that have been processed to remove as many human influences as possible. UIFs for the ACF River Basin have been developed by the USACE Mobile District in cooperation with the three states. The Georgia Environmental Protection Division (Georgia EPD) also has a UIF model. These UIFs have been used in various past planning and management investigations.

GWRI assessed existing UIF data series in two main phases: (1) a detailed, reach-by-reach analysis of all local data used in the UIF derivation process, and (2) a basin-wide evaluation of the cumulative UIF uncertainty impacts.

After reviewing this analysis and learning about the UIF data set being used by USACE and the states, ACFS considered undertaking the effort to improve the UIF dataset. However, given the time and monetary commitment to support this effort, and the time needed to coordinate with the three states and USACE for agreement on the improvements, ACFS decided to proceed with current conditions modeling runs using existing UIFs for trends and relative comparisons rather than for absolute numbers. ACFS also initiated development of a recommendation to the states and USACE regarding improvements to the UIF dataset, continuing on-going dialog with natural resource agencies regarding the environmental flows performance metrics relative to the concerns about errors in the UIF dataset, and including a discussion of the UIF uncertainties and how the ACFS made its decision to proceed using the current dataset.

Modeling

GWRI modeled flows and levels at 23 locations in the Basin and modeled salinity at nine locations in the Apalachicola Bay, first assessing baseline conditions and subsequently comparing a series of Water Management Alternatives against stakeholder performance metrics. In addition, GWRI produced modeled salinities in the Apalachicola Bay for selected water management alternatives using a hydrodynamic model. Atkins Global then used these salinity outputs to develop an analysis of potential effects of various WMAs on bay bottom salinities and oyster habitat in Apalachicola Bay.

GWRI used RES-SIM, developed by the USACE, and a GWRI-developed river and reservoir model called the ACF-DSS model, to simulate the river and reservoir response under different hydrologic, development, and management scenarios. The Basin flow model was tailored to provide the outputs to enable results to be compared to the stakeholder developed performance metrics for the main stem flows. Tributary flows were accounted for, but results were calculated and presented at specific nodes on the main stem rivers.

ACFS reviewed modeling results at each step.

The following outlines the approach to the analyses. Findings are summarized in Chapter 5.

Baseline Conditions Modeling

Baseline comparisons of the effects of evaporation, reservoir management, and consumptive uses were made using four progressive modeling scenarios. These were as follows:

- **Unimpaired flows.** This scenario characterized the system response under UIFs, without reservoirs, evaporation losses, or consumptive use.
- **Reservoir operation without active management.** This scenario assumed that all main-stem reservoirs exist and are operated in run-of-river mode with storage kept constant at the mid-point of the conservation zone.[3] No water demands are included in this scenario. Comparing scenarios one and two allowed analysis of the effects of evaporation from the reservoirs.
- **Reservoir operation with current management.** This scenario is similar to the second scenario, but with the reservoirs regulated according to the Revised Interim Operations Plan (RIOP) currently in effect. No water demands are included.
- **Existing conditions with current management, withdrawals, and returns**. This scenario is similar to the last scenario, but includes consumptive uses.

Water Management Alternative Modeling

The first round of WMA modeling incorporated as many stakeholder concerns as possible within the constraints of the current RIOP. Round-one modeling investigated the impacts of adjusting one variable at a time to provide a context

[3] High, low and mid-point runs were performed, with the mid-point runs chosen for the analyses.

as to the sensitivity of flows and levels in the system which included (basin terminology is discussed in more detail in Chapter 3):

- Consumptive use scenarios
- Interbasin transfer reduction
- Elimination of release ramp rates
- RIOP basin inflow definition
- Reservoir rule curve/storage
- Hydropower generation variation

ACFS recognized that stakeholder interests may not remain the same. In the future, the magnitude of stakeholder needs may change; ecosystem conditions may change; and improvements in science may inform stakeholders' understanding of the system. Thus, in the modeling, results were compared for all years and for dry years to help assess drier possible future conditions. In addition, the group considered changes in consumptive use that could occur in the future, both increases and decreases. Rather than seeking to agree on any particular consumptive use projection, stakeholders used the modeling to assess the capacity of the system to respond to a range of possible future growth or reductions and consider their recommendations for sustainable water management accordingly.

The second round of WMA modeling was designed to allow for more substantive changes to the ACF regulation rules while maintaining their functional structure. This modeling effort was focused on defining operating rules that balance the competing needs and demands in the system in different ways. This was done by comparing operational strategies under a range of water allocation priorities, including the following:

- Navigation.
- Consumptive use changes under different environmental flow regimes.
- Environmental flows.[4]

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[4] GWRI used flow guidelines outlined in 2013 USFWS letter to USACE, Re: ACF Water Control Manual Updates—Request for Information (November 13, 2013). These recommendations are supplemental to earlier recommendations USFWS submitted in 2010 and 2011, as described by USFWS: "The previous Planning Aid Letters (PALs; dated April 2, 1010, and March 1, 2011) and the draft FWCAR (dated June 17, 2011) identified resource values and issues in the basin, including rare species, and proposed changes, mitigation, or enhancement opportunities to minimize impacts and facilitate the Corps' National Environmental Policy Act (NEPA) analysis of the project. The comments in these documents still are applicable. We now are advising the Corps on the current WCM update. In our July 19, 2013, letter (enclosed), we (1) identified a revised reservoir operation alternative that would not result in excessive impacts to river flows or reservoir levels and (2) recommended that the Corps give it full consideration in their NEPA analyses. We followed up with a PAL that identified performance measures the Corps should use in NEPA evaluations of project effects on fish and wildlife resources and their habitat (August 29, 2013, enclosed)."

- Storage options under different environmental flow regimes.
- Hydropower changes under different environmental flow regimes.
- Combination changes of water uses and targets.

Round two modeling was conducted in two phases focusing on: (1) assessment and optimization of existing RIOP and reservoir rule curves, and (2) assessment of selected composite scenarios.

Round Two, Phase One focused on how changes to system operations could expand the benefits to all interests in the Basin. In other words, it attempted to answer the question of what is possible in the system and whether it is possible to expand the envelope of what it can do. This was accomplished through running a suite of scenarios that alternatively emphasized each of the following objectives: consumptive uses, lake levels, environmental flows, hydropower and navigation, translating them into the format used by USACE, and then demonstrating whether a scenario did a better job than current operational strategies by evaluating the new rule curves against ACFS stakeholder performance metrics using RES-SIM.

Round Two, Phase Two focused on composite scenarios that showed improvements to system performance over current conditions (i.e. they “expanded the envelope”) along with drought storage requirements and release options, modeling this using both current consumptive uses and long-term planning estimates using a percentage increase and decrease from current demands. The analysis of drought storage requirements provided findings pertaining to minimum composite and individual reservoir storage buffers required to meet current and projected consumptive uses and minimum environmental flows during critical drought periods. Impacts of pulsed Woodruff release patterns on Apalachicola Bay salinity and reservoir storage during critical drought periods also were assessed. The value of selected rule adjustments then were modeled under current and future consumptive use estimates.

A final set of optimization runs were conducted combining selected elements of the round two analyses into three “portfolios,” chosen by a consensus of the stakeholders, which are shown in Table 2-1. Portfolios were compared with and without pulses.

Table 2-1 Final Optimization Run Scenarios Modeled

Variable	Portfolio A	Portfolio B	Portfolio C
Consumptive Use	Current minus 30% (with adjustments on the Flint)*	Current	2050 minus 10% (with adjustments on the Flint)*
West Point Rule Curve Adjustment	Increase winter pool from 628 to 632.5 feet	Increase winter pool from 628 to 632.5 feet	Increase winter pool from 628 to 632.5 feet
Reservoir Coordination	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.
Hydropower Adjustment	Adjusted rules	Adjusted rules	Adjusted rules
Navigation	Spring shoulder	Spring shoulder	Spring shoulder
2 feet addition to Lake Lanier	Yes	No	Yes
Pulses**	14,000 cfs pulse for two weeks in May and 9,000 cfs pulse for two weeks in July	9,000 cfs pulse for all of May OR 9,000 cfs pulse for two weeks in May and two weeks in July	9,000 cfs pulse for 2 weeks in May and 2 weeks in July

** Portfolio A uses the following consumptive use projections:*

- *Chattahoochee and Apalachicola Rivers: Current -30%*
- *Flint River (Griffin, Carsonville, Montezuma): Current, adjusted to reflect return of all current interbasin transfers and conversion of all LAS to direct discharges at 50% of permitted LAS capacity*
- *Flint River (Griffin and Carsonville) flows augmented by up to 6.2 cfs and 9.3 cfs respectively when flows fall below monthly 7Q10 during low flows. If the maximum Griffin augmentation amount is not used and Carsonville flow is below its monthly 7Q10, then flows can be added at Griffin to aid Carsonville up to 6.2 cfs total. Monthly 7Q10 based on unimpaired flow (UIF) data 1939-1974 provided by GWRI.*
- *Flint River (Albany and below): Current -15%*

Portfolio C uses the CU as Portfolio A, except Chattahoochee and Apalachicola Rivers use 2050 projections -10%

*** Pulses were modeled as 9000 cfs flows at Chattahoochee, FL (not as an additional 9,000 cfs) – as well as at 14,000 cfs – and only during periods when flows fell below 9,000 cfs (thus not reducing flows to 9,000 cfs when flows otherwise would have been higher).*

Predictive Drought Management

Predictive drought management approaches also were evaluated. Specifically, ACFS explored how triggers based on forecasted values could be used to anticipate drought conditions earlier, when more modest reductions in water use could be put in place so that deeper reductions or even catastrophic shortages would be avoided.

Drought storage requirements also were assessed, using data from April 1, 2007 through December 31, 2008. Current and future consumptive use scenarios were run, with minimum release targets at Woodruff of 5,000, 5,500 and 6,000 cfs. The operational goal was to determine the minimum reservoir storage that would meet the consumptive uses and Woodruff release targets.

Bay Assessment

Salinity distributions were modeled throughout Apalachicola Bay using a hydrodynamic model developed by GWRI. Freshwater flows at the USGS Sumatra gage were also generated by GWRI using a watershed model; these flows were entered into the hydrodynamic model to evaluate the effect of differing upstream WMAs on salinity distributions throughout the Bay for the months of May through October.

Salinity distributions in the Bay under various WMAs were evaluated at five oyster regions in the Bay (see Figure 2.1) and at nine discrete stations located throughout the Bay (Figure 2.2). Daily salinity at oyster regions was calculated as the mean of the daily salinities of the number of model grid cells (each a discrete station) that represented a particular oyster region, as shown in Figure 2.1. Daily salinity at discrete stations was determined as the daily mean for each discrete grid cell. In both cases, only cells located on the Bay bottom were used to determine salinity (i.e., cells were not vertically averaged), since these cells would be the ones to which oysters would be exposed.

Figure 2-1 Location of Oyster Regions Evaluated in Apalachicola Bay

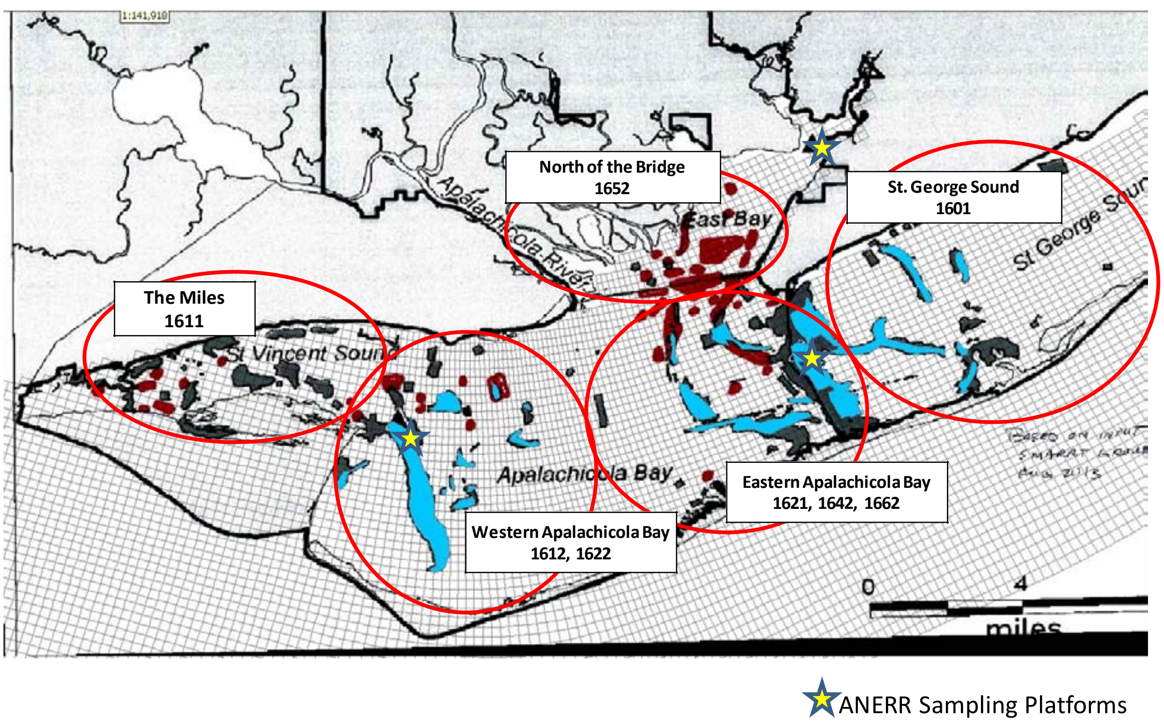
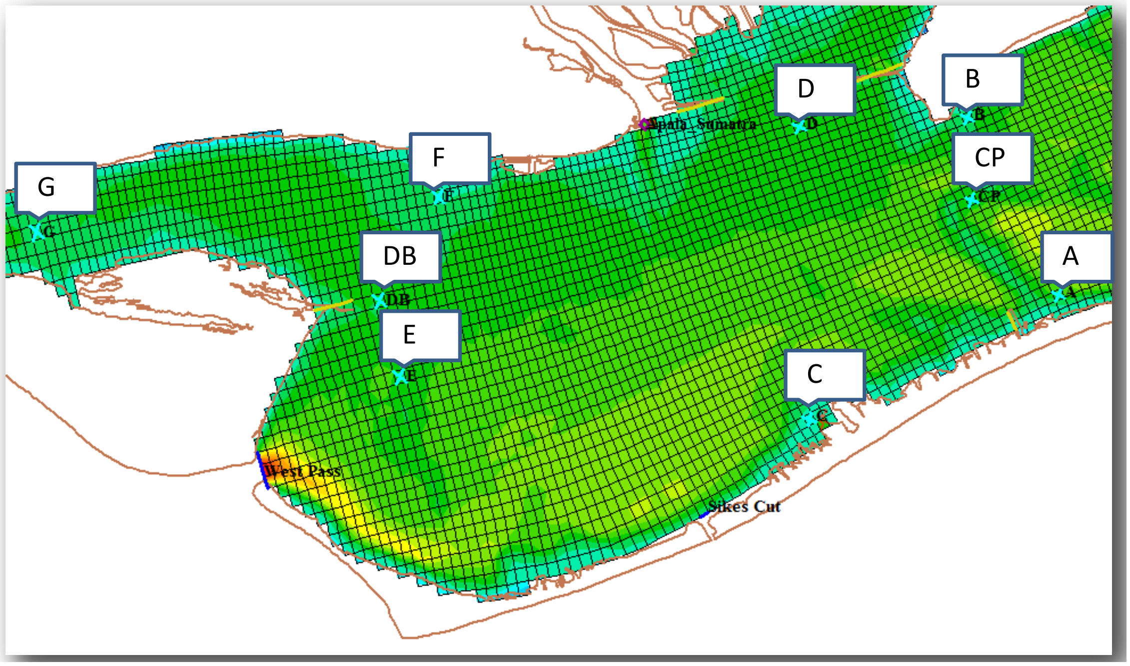


Figure 2-2 Location of Nine Discrete Stations Evaluated in Apalachicola Bay



Based on a literature review and discussions with researchers who have authored peer-reviewed studies of oysters, oyster predators/parasites, and/or oyster habitat, Atkins Global selected salinity ranges that may be desirable for oyster productivity. Model parameters were set in cooperation with GWRI with respect to results from WMA model runs used to evaluate WMAs and corresponding impacts to oyster bars (habitat). Finally, the degree to which modeled scenarios departed from the desirable or optimum salinity range (for oysters) in comparison to any other scenario was used to assess the relative merits of any one strategy against another.

Eight WMA scenarios were modeled using data from the period 1984 to 2008. These scenarios included the portfolios developed for the final optimization modeling runs described above as well as current management conditions and a model scenario using UIF flows.

CHAPTER 3.
Understanding the ACF Basin

ACF Basin

The Chattahoochee and Flint Rivers join at Lake Seminole on the Georgia-Florida state line to form the Apalachicola River. This ACF Basin extends from the Blue Ridge Mountains to the Gulf of Mexico at Apalachicola Bay with about 3/4 of the drainage Basin in Georgia and 1/8 each in Alabama and Florida. (See Figure 3.1 for Basin map.)

The Chattahoochee and Flint Rivers are distinct river systems, bound together at the confluence. The Flint River is nearly as long as the Chattahoochee River; however, it has only two main-stem reservoirs with limited ability to influence flow. In contrast, the Chattahoochee River has 14 main-stem dams with the ability to influence flow in the Basin. Over 300 miles of the Chattahoochee River are measured across reservoirs.

USACE operates five federal reservoir projects on the Chattahoochee River and its confluence with the Flint. Five Federal Energy Regulatory Commission (FERC) projects are licensed in the ACF Basin with seven small to medium-sized impoundments (Morgan Falls Dam, Lake Harding, Goat Rock Lake, Lake Oliver, North Highland Lake, Lake Blackshear and Lake Chehaw) as shown on Table 3-1.

Table 3-1 ACF Basin Main-Stem Dams

Project Name	Owner/State/ Year Initially Completed	Reservoir Size (Ac.)	Total Usable Storage (Ac-Ft.)	Power Capacity (kW)	Full Pool Lake Elevation (Ft.)
Buford Dam/Lake Lanier	COE / GA / 1957	38,542	1,087,600 [a]	125,000	1,071
Morgan Falls Dam	GPC / GA / 1903	580	2,240 [a]	16,800	866
West Point Dam and Lake	COE / GA / 1975	25,900	306,100 [a]	82,200	635
Langdale Dam	GPC / GA /1860	152	NA	1,040	548
Riverview Dam	GPC / GA / 1902	75	NA	480	531
Bartletts Ferry Dam	GPC / GA / 1926	5,850	57,000 [a]	173,000	521
Goat Rock Dam	GPC / GA / 1912	965	4,960 [a]	38,600	404
Oliver Dam	GPC / GA / 1959	2,280	6,080 [a]	60,000	337
North Highlands Dam	GPC / GA / 1900	131	935 [a]	29,600	269
City Mills Dam*	City Mills / GA / 1863	110	684 [b]	740	226
Eagle and Phenix Dam*	Consolidated Hydro / GA / 1834	NA	260 [b]	4,260	215
W. F. George Lock and Dam and Lake (Lake Eufaula)	COE / GA / 1963	45,180	244,400 [a]	130,000	190
George W. Andrews Lock and Dam and Lake	COE / GA / 1963	1,540	NA	None	102
Blackshear Dam and Lake	Crisp Co./ GA / 1930	8,700	144,000 [b]	13,000	237
Flint River Dam/Lake Chehaw	GPC / GA / 1920	1,400	NA	5,400	182
Jim Woodruff Lock and Dam/ Lake Seminole	COE / FL / 1954	37,500	NA	30,000	77

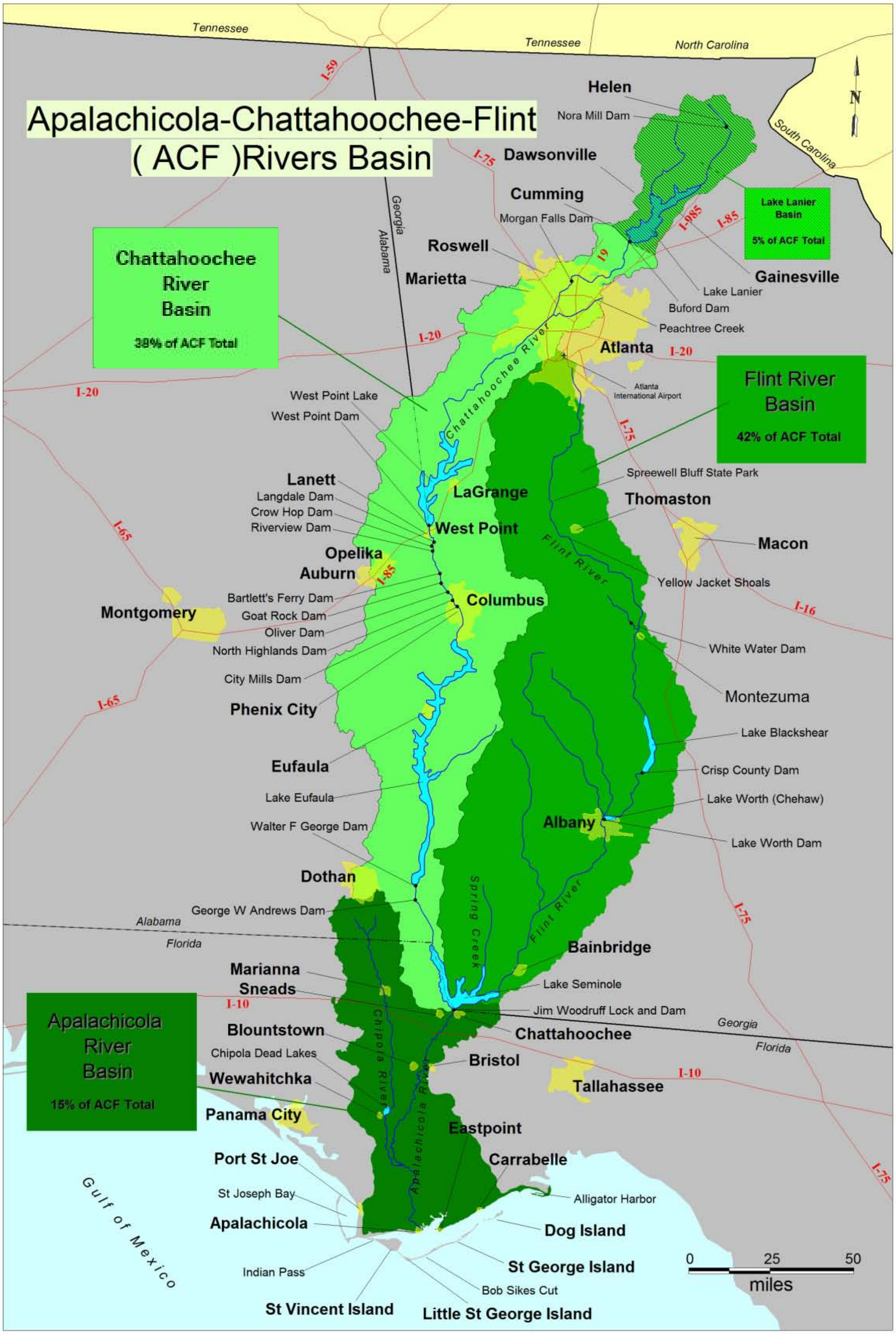
Legend: a=Conservation Storage; b=Total Storage

*Removed in 2013 to create habitat improvement and the whitewater course at Columbus, GA and Phenix City, AL.

Source: Adapted from the U. S. Army Corps of Engineers Final Scoping Report, Environmental Impact Statement, Update of the Water Control Manual for the Apalachicola-Chattahoochee-Flint River Basin, in Alabama, Florida, and Georgia.

The southern portion of the ACF Basin, south of the Fall Line, is underlain by Coastal Plain sand, gravel, and limestone aquifers. The Floridan aquifer, one of the most productive aquifers in the US, underlies a significant portion of the Basin in southwestern Georgia, southeastern Alabama, and parts of the Florida Panhandle. The streams and aquifers within the Coastal Plain region may be hydraulically connected such that groundwater and stream flow are exchanged. The direction and rate of water exchange is related to the geology and the head differential between the aquifers and streams. Where the groundwater head exceeds the stream head, groundwater is discharged into the stream. Aquifer withdrawals reduce groundwater elevations and can result in a reduction in the rate of groundwater discharge into many streams. During dry and drought periods, the hydraulic gradient may reverse and stream flow may be lost to the aquifer. In some parts of the lower ACF Basin, streams sometimes cease to flow as a result of climate and groundwater pumping.

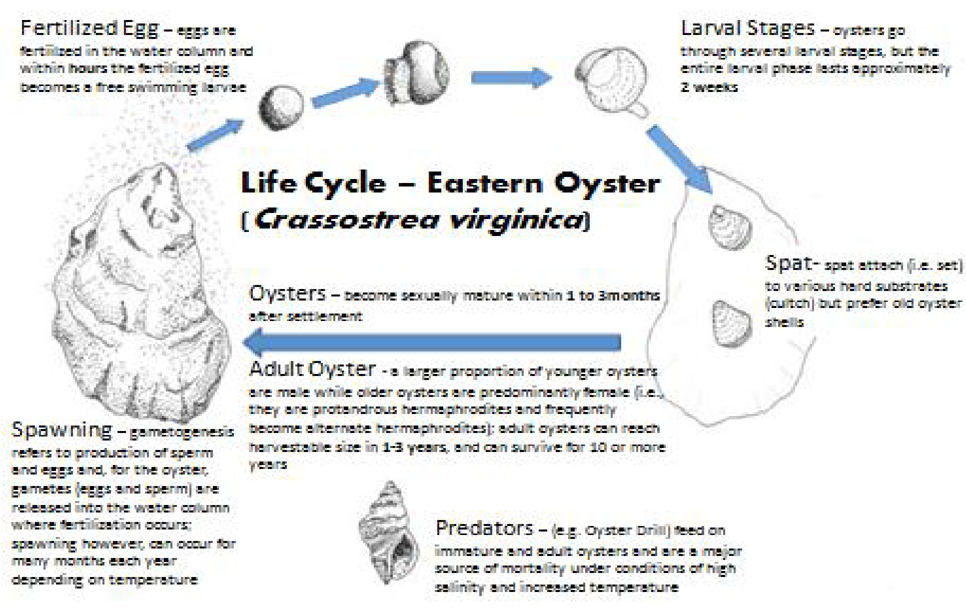
Figure 3-1 ACF Basin Map (Credit: Roy Ogles)



The Apalachicola River flows south for 106 miles through the Florida Panhandle into Apalachicola Bay, which discharges into the Gulf of Mexico. The Chipola River, Apalachicola River's largest tributary in Florida, drains one-half of the Apalachicola River Basin and has over 63 springs. The largest spring in the Chipola Basin is Blue Springs, also called Jackson Blue Spring.

The Apalachicola Bay and Estuary are an integral component of the ACF Basin; a fishery habitat for not only an historical oyster production industry, but also the other associated shrimp, crab and fin fish that spend part of their life-cycle in this habitat. The bay is an important nursery area for Gulf of Mexico commercial fish species as many spend a portion of their lives in the bay. Figure 3-2 illustrates the life cycle of the Eastern oyster which is vulnerable to the freshwater/salinity balance at different times during its life cycle (see performance metric on page 42).

Figure 3-2 Life Cycle of the Eastern Oyster



Instream Flows and Lake Levels

Instream flows and lake levels support navigation, recreation, hydropower, water quality and assimilative capacity, and habitat for aquatic dependent species in the ACF Basin.

Recreation on the federal reservoirs is closely tied to lake levels and directly impacts the economies of nearby communities. The reservoirs also provide for flood control and for storage of water that is released during dry years or times of year.

Instream flows also support recreation. Columbus has recently made significant modifications to their reach of the river to support a world-class whitewater course. Minimum flows were considered to support this major economic driver for the area.

Although navigation is an authorized purpose of the ACF System, navigation availability up the Apalachicola River has deteriorated over the past 20 years. Preliminary assessment by USACE and others suggests that about 21,000 cfs at the Chattahoochee USGS gage is needed to provide a commercially navigable channel (9 ft. x 100 ft.) without dredging as long as minor snag maintenance is accomplished.[5] Some dredging, with limited structural modifications, will also increase channel availability with a flow of 16,000 cfs.[6]

Floodplains provide habitat for numerous, aquatic dependent species. For example, on the Apalachicola River, a reduction in flow during high flow season by a certain percentage would reduce the ability of crawfish to emerge from the burrows in the floodplain, spawn, and have a successful hatch of young. This has effects throughout the food chain for all the wildlife (birds, fish, mammals, and reptiles) that feed on crawfish and for humans that make part of their living harvesting and selling crawfish.

There are sections of the Flint River and its tributaries that currently experience flows equivalent to historical droughts even during moderately wet and wet years. In addition, there are sections that currently experience zero and near-zero flows during drought years, affecting water quality, recreation and recreational navigation, aquatic life, and private property uses.

There are also many sections of the Chattahoochee and two sections of the Flint that experience altered instream flow regimes and in some cases temperature regimes due to impoundments and releases from those impoundments. Some of these alterations have in fact established desirable public benefits, such as the coldwater trout fishery (rainbow and brown) in Metro Atlanta downstream of Buford Dam/Lake Lanier, perhaps the best urban trout fishery in North America. Other affects are undesirable, such as the extirpation of shoal bass (Micropterus cataractae) from large segments of the Chattahoochee. Blockage of historical spawning and other migrations of striped bass, Alabama shad, and Gulf sturgeon have occurred as a direct affect of dam placement. Other effects on aquatic habitats are less direct, and are related to reservoir operation and consumptive water uses enabled by the existence of the impoundments. For example, shoal bass spawning downstream of the Crisp County dam on the Flint is disrupted by large daily fluctuations in flow regime due to power generation; the attenuated spawning is mitigated by substantial investment in the stocking of shoal bass by the state wildlife agency. Recently, over two miles of shoals on the

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[5] Verbal communications with Sam Hill (USACE) and Steve Leitman.

[6] Leitman, S, S. Graham, and C. Stover. An Evaluation of the Common Ground Between Environmental and Navigation Flows in the Apalachicola-Chattahoochee-Flint Basin. Report to Apalachicola Riverkeeper and Tri-Rivers Waterway Development Assoc. 2012.

Chattahoochee at Columbus have been re-exposed due to removals of small dams, generating new opportunities for recreation, recreational navigation, and biological recovery.

Consumptive Water Use

Adequate flows and levels also support consumptive water uses.

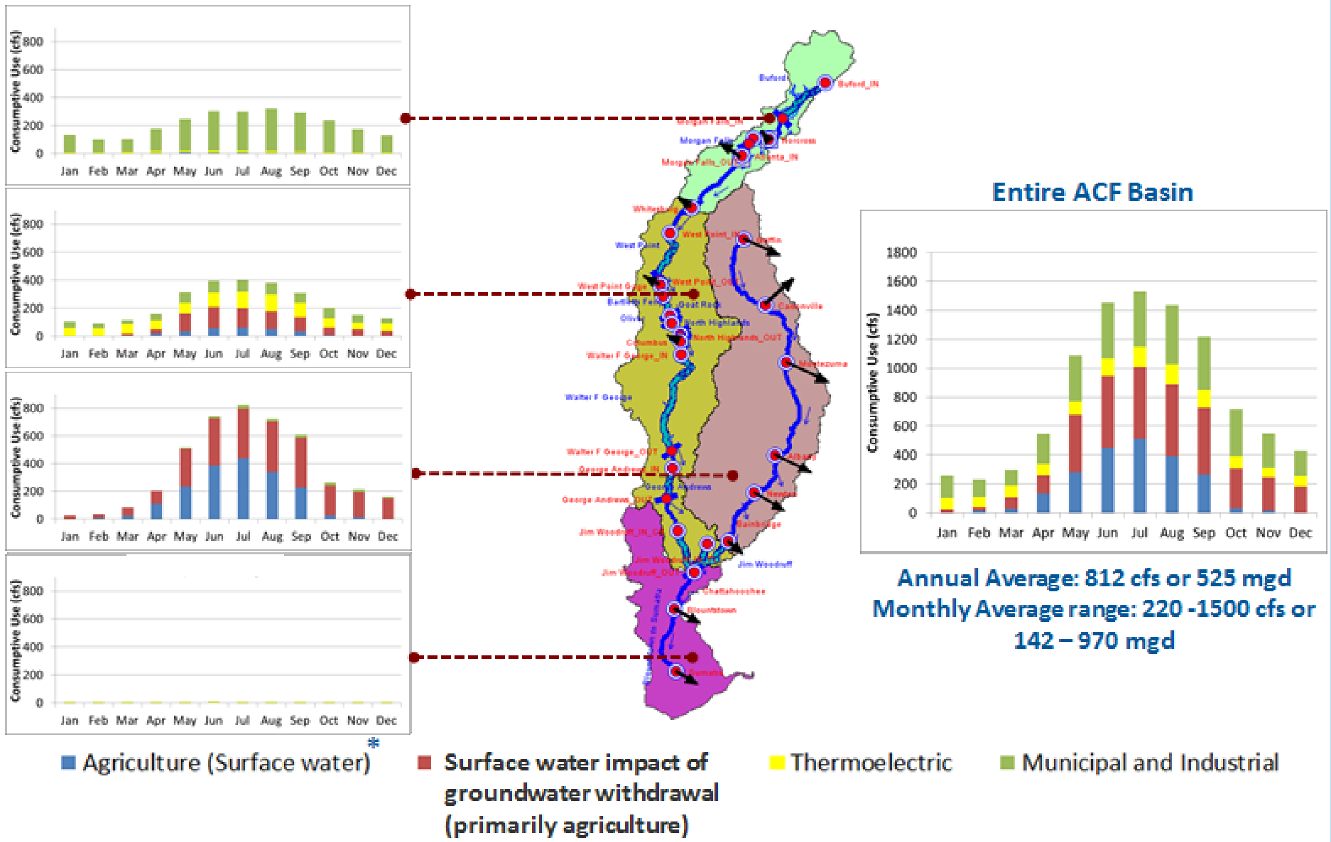
ACFS worked closely with state and federal agencies to compile the best available water withdrawals and returns data in the ACF Basin. Compiled water demands are broadly categorized into five major water-using sectors (agriculture, industrial, municipal, thermoelectric, and stream-aquifer impacts). While water use estimates for larger permitted users are generally well-defined, water use estimates for smaller withdrawals that fall below state permit thresholds are less well-defined.

For the development of the Plan, it was important to understand the amount of water that is returned to the hydrologic system after it is used. Consumptive use is the portion of the total amount of water withdrawn that is not returned to the original source and represents the net effect of water withdrawals and water returns. For the ACF Basin, the annual average consumptive use is 812 cfs, which varies from month to month and between wet, normal and dry years.

Consumptive use is not constant throughout the year, as is shown in Figure 3.3. The higher consumptive use, lower Basin inflow, and higher temperatures in the summer months combine to increase Basin water stress in the warmer seasons.

It is important to note, however, that in both the Flint and Chattahoochee portions of the system, water is stored in times of higher flow to meet water needs when flows are lower. This affects streamflow impacts in various ways. Some impacts occur at the time the water is stored, and other impacts occur based upon release prescriptions. Some, but not all, impacts occur when the water is withdrawn. As such, streamflow impacts do not necessarily coincide with the period in which consumptive use occurs, and it cannot be assumed that consumptive use in a given month reduces streamflow by the same amount.

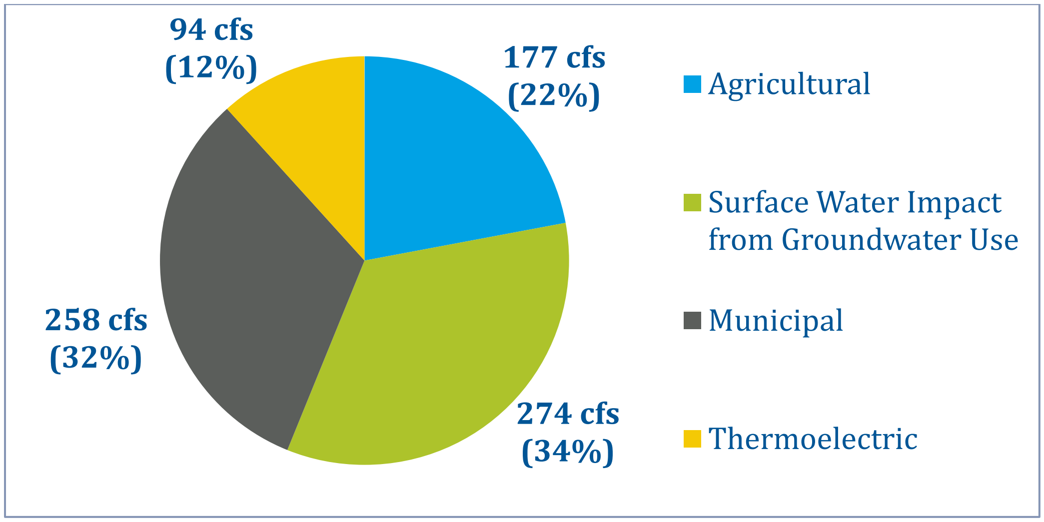
Figure 3-3 Current Consumptive Use in the ACF Basin



*The agriculture demand assumes the 2011 forecast year demands and 75th percentile dry year irrigation flows.

Current consumptive water use demand is summarized in Figure 3-4 on an annual average basis. The surface water impact category in this Figure includes effects on flows from groundwater use from agriculture and other sources. The following subsections describe some water use sectors in the Basin. The estimates are presented as annual averages, but seasonal and annual variations are relevant to meeting stakeholder needs. The estimates also do not include all water interests, particularly instream uses such as environmental flows and recreational opportunities, since these are not generally considered consumptive uses.

Figure 3-4 Current Consumptive Demand on Surface Waters (values are in cfs expressed as a percentage on an annual average basis)



Agricultural Use

Agricultural water demands include irrigation for crop production and non-irrigation uses for livestock operations, nurseries, and golf courses. Demand projections are primarily composed of estimates based on aggregate irrigation application depths applied to acres under production. Water withdrawals for agricultural uses are assumed to be 100 percent consumptive; therefore, no returns data are estimated or projected. The combination of surface water withdrawals for agriculture and the estimated surface water impacts of agricultural groundwater withdrawals represents the largest water using sector in the ACF Basin.

"Water is personal, water is local, water is regional, water is statewide. Everybody has a different idea, a different approach, a different issue, a different concern. Water is the most personal issue we have."

—Susan Marks, Journalist and Author

Impact on Surface Water

For the southern portion of the Basin, estimates for current groundwater pumping impacts to surface water are also included in the input data for Georgia. Groundwater pumpage-induced reductions to stream flow occur because of geologic conditions in the southern portion of the Basin. The discharge of groundwater to stream flow and loss of stream flow to the aquifer, or "surface water impact" is dependent on multiple variables including: stream dimensions, hydraulic conductivity of streambed materials, streambed thickness, stage of stream, hydraulic head in the aquifer, and groundwater pumping rates[7].

The data set available provides an estimate for stream-aquifer impacts from current groundwater withdrawals from individually permitted wells and from agricultural irrigation in Georgia. This data set reflects surface water impacts resulting from agricultural irrigation under dry year conditions ("75th percentile"). Surface water impact data sets for Alabama and Florida were not available.

Industrial Use

Industrial water use projections are highly dependent on assumed employment and/or production growth for the tri-state area. Industries require water for processes, sanitation, cooling, and other purposes, in addition to domestic (employee) water use. Water need is directly linked to production. Wastewater generation and returns by industries are tied to the process requirements specific to that industry.

Municipal Use

Municipal water and wastewater demands are generally associated with utilities possessing a water withdrawal permit for water use or a National Pollution Discharge Elimination System (NPDES) permit or reporting requirement for surface water returns. This water use sector includes residential and commercial water demand and demands of industries that are not separately permitted. Municipal land application facilities and septic systems have been assumed to be 100% consumptive.

Thermoelectric Use

Thermoelectric power generation requires water for cooling purposes. The amount of water consumed depends on the cooling technology as well as the power generation technology utilized.

Current Water Management

The ACF Basin functions as a complex, integrated system, and recent historic droughts have made more visible the variability of and stresses on the system.

[7] Torak, Lynn J., McDowell, Robin J., Ground-Water Resources of the Lower Apalachicola-Chattahoochee-Flint River Basin in Parts Of Alabama, Florida, and Georgia—Subarea 4 of the Apalachicola-Chattahoochee-Flint And Alabama- Coosa-Tallapoosa River Basins: USGS Open-File Report 95-321, United States Geological Survey, 1996.

Role of the U.S. Army Corps of Engineers

Water demands in the ACF Basin have changed since the construction of the reservoirs. USACE has attempted to meet changing and competing water uses by modifying how it operates its reservoirs.

The USACE Master Water Control Manual (WCM), last updated in 1958, guides decisions regarding the ACF Basin operations for the five federal reservoir projects on the Chattahoochee and at its confluence with the Flint. The WCM is intended to set operational guidelines to "achieve and balance all authorized project purposes" by operating the federal projects as a system. In the 1946 Rivers and Harbors Act, Congress adopted and authorized the works of improvement for the ACF Basin that were proposed in reports of the Chief of Engineers and South Atlantic Division Engineer, BG Newman (the Newman Report) in order to provide system wide benefits for multiple purposes including flood control, hydropower, navigation, water supply, fish and wildlife conservation, and recreation (Memorandum for Chief of Engineers from Office of Chief Counsel, USACE, June 25, 2012). In June 1990, USACE began operating the ACF Basin under its October 1989 Draft Apalachicola-Chattahoochee-Flint Basin Water Control Manual. Because of litigation, the 1989 WCM has never been finalized.

The USACE's authority to operate Lake Lanier for water supply was challenged by Alabama, Florida and others and was litigated for more than 20 years. In 2011, the 11th Circuit Court of Appeals overturned lower court rulings, stating, "the district court and the Corps erred in concluding that water supply was not an authorized purpose of the Buford Project under the [Rivers and Harbors Act]." (The litigation also included many other claims originally, but the 11th Circuit ruled these claims cannot not be adjudicated until the Corps takes "final agency action" to adopt a new water control plan.) The Court then directed the Corps to determine the balance between power production and other authorized project purposes. The Supreme Court declined to hear an appeal on the case.

Separately, in 2013, the State of Florida requested leave to file an original action against the State of Georgia to resolve disputes about the uses of the waters of the ACF Basin. Florida has requested the Supreme Court enter a decree "equitably apportioning" the waters of the ACF Basin between Georgia and Florida. It further requested that the Court cap Georgia's "depletive uses" at the level existing in 1992. The Supreme Court granted Florida leave to file its complaint in 2014, and the suit is now pending.

The Endangered Species Act requires federal agencies to consult with the U.S. Fish and Wildlife Service (or NOAA Fisheries where appropriate) to ensure that the effects of their actions "are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat." (USFWS Fact Sheet). Some stakeholders read the Newman Report's reference to fish and wildlife conservation to mean that USACE has a broader responsibility to manage the ecosystem as a whole, not just for listed species.

In March 2006, USACE consulted with USFWS regarding the effects of existing operations at Jim Woodruff Dam (Figure 3-5) and releases to the Apalachicola River for endangered and threatened species and associated critical habitat. Endangered and threatened species included the following:

- Gulf sturgeon. (A in Figure 3-5)
- Purple bankclimber mussel. (B in Figure 3-5)
- Chipola slabshell mussel. (C in Figure 3-5)
- Fat three ridge mussel. (D in Figure 3-5)

Figure 3-5 Endangered Species. Photos Courtesy of the USFWS.

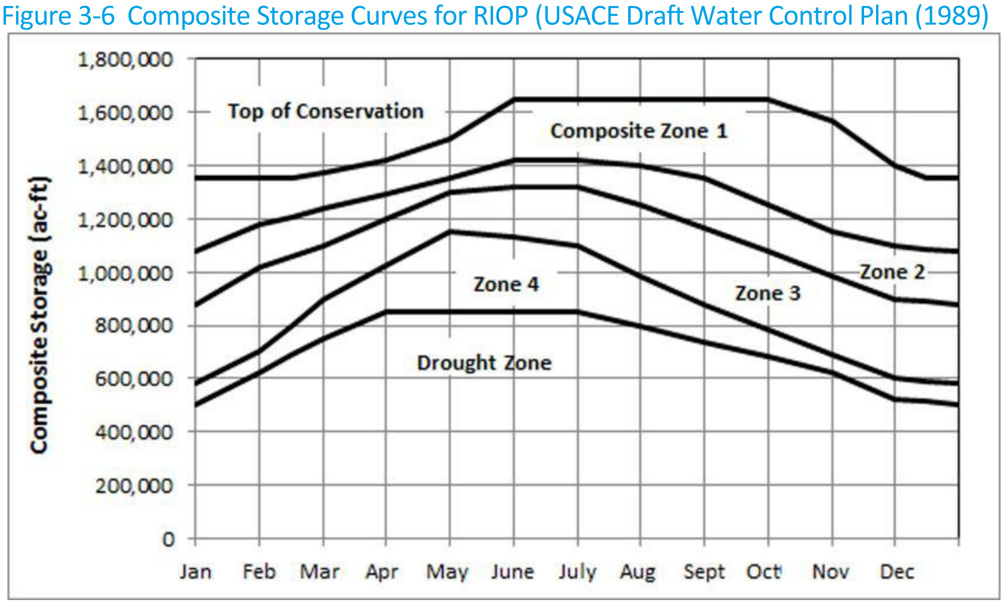
The formal consultation on what was termed the Interim Operation Plan (IOP) was completed with the issuance of a Biological Opinion in September of 2006. The IOP added new in-stream Apalachicola River flow requirements for protection of threatened and endangered species to the USACE ACF operational decision criteria. The IOP established minimum flows in the Apalachicola River based on different inflow rates into ACF reservoirs, and was intended to be an interim plan until an updated comprehensive WCM was adopted.

USACE consulted with USFWS in April 2008 to consider further revising the IOP, to be known as the Revised Interim Operation Plan (RIOP), to include a drought contingency plan while still providing support for federally listed species and their critical habitat. USFWS issued a final Biological Opinion in June 2008, determining that this RIOP would not significantly impact the federally listed species. While the RIOP is intended to govern releases from Jim Woodruff Dam, USACE attempts to operate the entire system of federal reservoirs while trying to meet the project purposes during critical drought periods.

USACE reinitiated consultation with the USFWS in November 2010 due to the availability of additional information about distribution and mortality of specific mussel species. The USFWS issued a Biological Opinion, and USACE announced additional changes to the RIOP in May 2012 based on this consultation. Changes included adjustments to the rule curves and resumption of normal operations when Zone 1 of composite storage is reached following drought contingency operations.

The RIOP is a relatively complicated set of release rules that provide minimum flow guidance to the USACE based on basin inflow, time of year, and the amount of storage available in the federal projects to meet the various authorized purposes. It is important to note that the USACE operates all the federal reservoirs as a system. Release rules are established for "action zones" based on the composite storage of the reservoirs. The composite storage is the sum of the storage in Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole as shown in Figure 3-6. The action zones provide for a phased approach to support authorized purposes through flow releases, and reflect flood storage in certain seasons of the year. The curves are similar in shape but vary in level and storage amount between the projects.

Figure 3-6 Composite Storage Curves for RIOP (USACE Draft Water Control Plan (1989)



The zone operational concept allows the USACE to provide flow support for Basin needs differently when available storage is lower, reflecting dryer conditions where releases and evaporation have exceeded the amount of flow into the federal projects. The "zone" concept is outlined below:

- **Zone 1**: Releases can be made to support navigation, hydropower, water supply, and water quality.

- **Zone 2:** Releases for navigation may be limited. Releases for hydropower are at a reduced level. Releases are made for water supply and water quality.
- **Zone 3:** Releases for navigation may be significantly limited. Releases for hydropower are at a reduced level. Releases are made for water supply and water quality.
- **Zone 4:** Releases for navigation are not supported. Releases for hydropower are at the minimum level. Releases are made for water supply and water quality.
- **Drought Zone:** Once the composite storage drops into the drought zone, releases to the Apalachicola may be lowered from 5,000 cfs to 4,500 cfs. When the composite storage rises above the drought zone, releases return to 5,000 cfs. The drought zone is approximately the sum of the "inactive" storage of Lake Lanier, West Point Lake, Walter F. George Lake, plus the Zone 4 storage of Lake Lanier. The inactive storage is the volume of the reservoirs designed for storing sediment that enters the reservoir, and is typically not used for water supply or discharge downstream.

Figure 3-7 Jim Woodruff Dam

The flow release decisions guided by the action zones described above give a general picture of how the reservoirs in the ACF are managed. There are more detailed guidelines for releases from Lake Seminole to the Apalachicola River. While the RIOP rule curves describe the releases from Lake Seminole only, the reservoir does not contain enough storage to support these releases itself. Therefore, the releases made to the Apalachicola River from Lake Seminole reflect the result of the system-wide operation of the ACF. The major determinants for releases are the time of year, the available storage in the reservoirs, and Basin inflow to accomplish desired flows in the Apalachicola River as shown in Table 3-2. The release levels vary by three seasons: spawning season (March through May), non-spawning season (June through November), and winter (December through February). Regardless of the season, when the composite storage reaches Zone 4, releases to the Apalachicola are reduced to 5,000 cfs or to 4,500 cfs if the composite storage is in the drought zone. The values in the following table are minimum values, not prescribed releases. Actual releases may be greater to meet other purposes, such as hydropower, navigation, flood control, etc.

Table 3-2 Revised Interim Operating Plan releases to the Apalachicola River (USFWS 2012)

Months	Composite Storage Zone	Basin Inflow (BI) (cfs)1	Release from Lake Seminole (cfs)1	Basin Inflow Available for Storage
March – May	Zones 1 and 2	>= 34,000	>= 25,000	Up to 100% BI > 25,000
		>= 16,000 and < 34,000	>= 16,000 + 50% BI > 16,000	Up to 50% BI > 16,000
		>= 5,000 and < 16,000	>= BI	
		< 5,000	>= 5,000	
	Zone 3	>= 39,000	>= 25,000	Up to 100% BI > 25,000
		>= 11,000 and < 39,000	>= 11,000 + 50% BI > 11,000	Up to 50% BI > 11,000
		>= 5,000 and < 11,000	>= BI	
		< 5,000	>= 5,000	
June – November	Zones 1, 2, and 3	>= 22,000	>= 16,000	Up to 100% BI > 16,000
		>= 10,000 and < 22,000	>= 10,000 + 50% BI > 10,000	Up to 50% BI > 10,000
		>= 5,000 and < 10,000	>= BI	
		< 5,000	>= 5,000	
December – February	Zones 1, 2, and 3	>= 5,000	>= 5,000	Up to 100% BI > 5,000
		< 5,000	>= 5,000	
At all times	Zone 4	N/A	>= 5,000	Up to 100% BI > 5,000
At all times	Drought Zone	N/A	>= 4,500	Up to 100% BI > 4,500
1 cfs = cubic feet per second				

The advantage in maintaining as much storage as possible in all the reservoirs, but particularly in the most upstream reservoir, is that this increases the degree of operational flexibility and system reliability to augment low flows throughout the Basin to provide at least partial support of Basin needs. Since future Basin hydrologic conditions and water uses may result in lower inflows to the projects than those experienced over the period of record since the construction of the reservoirs, it is important that the operating plan release requirements be established to accommodate desired needs without planned utilization of all available storage. At the time of this publication, USACE expects to release a draft Water Control Manual and Environmental Impact Statement in the summer of 2015, with a public comment period to follow the release of the draft. The Corps expects that the process will be complete in 2017.

Role of the States and Other Federal Agencies

While USACE has a large influence in how water moves within the ACF Basin, USACE does not address the quantity of water demands or the quantity and quality of return flows.

The ACF Basin is subject to several overlapping layers of water resource management by state and other federal agencies. State permitting programs for wastewater discharges and water withdrawals affect most water users. Wastewater discharge is a permitted activity that requires a NPDES permit issued by the individual state with flow and water quality limitations. Alabama, Florida and Georgia each have primacy for this permitting program delegated from the federal EPA, and each has similar programs.

Water withdrawal permitting, however, varies between the states. In Alabama, entities with the capacity to withdraw 100,000 gallons per day are required to register and submit an annual usage report to the Office of Water Resources. In Florida, permitted consumptive water users, which include agricultural water users, are required to submit usage reports on a monthly basis. In Georgia, users withdrawing more than 100,000 gallons per day are permitted and report water use. Georgia agricultural water users are permitted, but usage reporting to date has primarily been done by the state on an annual basis. The fact that the three states have different permitting rules and requirements has resulted in inconsistency in information availability on water usage throughout the ACF basin.

Additionally, the following items are relevant to water management in the ACF Basin:

- Adopted in 2000, the Georgia Flint River Drought Protection Act (OCGA §12-5-540) and its implementing rules (GA DNR Rule 391-3-28) originally provided for demand management of agricultural surface water use in times of drought via an irrigation suspension auction. The Flint River Water Development and Conservation Plan, adopted by GAEPD in 2006, led to changes in the Act rules that included making certain agricultural groundwater permits eligible for the suspension auction and providing GAEPD the discretion to implement the auction in smaller sub-watersheds rather than the entire Flint River Basin. This 2006 Plan also put in place revised agricultural permitting requirements specific to the Flint Basin, mandatory conservation practices for new irrigation systems and a moratorium on new agricultural withdrawals (surface water and Upper

Floridan groundwater) in areas identified as "Capacity Use." In 2014, the Georgia General Assembly amended the Act by modifying the irrigation suspension auction implementation language, mandating efficiency requirements for all irrigation systems by 2020 and addressing management of augmented flows provided by the state specific to maintaining habitat critical for "vulnerable aquatic life." Changes to the implementing rules consistent with the recent amendments to the Act were adopted by the Georgia Department of Natural Resources Board in December 2014.

- Federal Energy Regulatory Commission (FERC) licensing requirements for privately-owned hydroelectric impoundments. Morgan Falls, FERC Project #2237, expires in 2039. Bartlett's Ferry Dam/Lake Harding, FERC Project #485, expires in December of 2044. The Middle Chattahoochee Project (FERC Project #2177), which is comprised of the smaller Goat Rock, Oliver, and North Highlands projects, expires in 2034.
- The Georgia Comprehensive State-wide Water Management Plan as approved by the Water Council on January 8, 2008, is the guiding document for the development of Regional Water Plans in Georgia and documents State policies regarding water management. In 2011, ten regional water planning councils prepared regional water plans designed to manage water resources in a sustainable manner through 2050. Planning utilized an integrated water management approach that includes water resource assessments, estimates of current and future water needs for supply and assimilative capacities, and identification and selection of management practices. The Middle Chattahoochee, Upper Flint, and Lower Flint-Ochlockonee Water Councils encompass the majority of the ACF Basin area, although the Coosa North Georgia, Middle Ocmulgee, and Suwanee Satilla Water Councils all include some portion of the ACF Basin. All of these regional plans are scheduled to be updated in 2016.
- Through the Metropolitan River Protection Act (O.C.G.A 12-5-440 et. Seq)., the State of Georgia has created a 2000-foot protected buffer along both banks of the Chattahoochee River for an 85-mile reach encompassing the entire Atlanta region. The Act called for the Atlanta Regional Commission to adopt a plan to protect this corridor. All proposals for development within the corridor are reviewed by the Atlanta Regional Commission for consistency with the plan and all land-disturbing activities within the corridor are required to comply with this plan.
- The Georgia Water Stewardship Act of 2010, SB 370, reaffirms Georgia's commitment to creating a culture of water conservation. Hailed by the Georgia Conservancy as "one of the nation's most progressive water conservation policies," the Act requires local governments and water systems to restrict outdoor watering, update plumbing codes to require high efficiency fixtures, and conduct annual water loss audits. It also requires state agencies in Georgia to collaborate to encourage water conservation and enhance water supplies.

- In 2012, the Georgia Environmental Protection Division imposed a moratorium on new agricultural surface water withdrawals and new agricultural groundwater withdrawals from the Upper Floridan Aquifer in the Dougherty Plain.
- The Metropolitan North Georgia Water Planning District (Metro Water District) was created by the Georgia General Assembly in 2001 in order to preserve and protect water resources in the 15-county metropolitan Atlanta area. The Metro Water District is charged with developing comprehensive regional and watershed specific water resources plans to be implemented by local governments. Planning publications include a Watershed Management Plan, a Wastewater Management Plan, and a Water Supply and Water Conservation Management Plan. The Metro District Plans will be updated on the same schedule as the other regional water councils.
- The State of Florida has enacted a variety of water resources management programs, including designation of Franklin County (including the Apalachicola Bay) as an Area of Critical State Concern in 1985. This designation remains partially in effect. In addition, Florida has designated the Apalachicola Bay as an Aquatic Preserve. Other programs applicable to this Basin include the Outstanding Florida Waters program and a conservation and recreation lands acquisition program under which the State of Florida purchased approximately 265,000 acres in the lower Apalachicola floodplain, delta, Little St. George Island and the St. George Island State Park.
- The Apalachicola Basin is in the Northwest Florida Water Management District (NWFWMD or District). The District is one of five water management districts in Florida created by the Water Resources Act of 1972. The District works to protect and manage water resources in a sustainable manner for the continued welfare of people and natural systems across its 16-county region. Through planning efforts, the District identified up to 9 million gallons a day of alternative water supplies to protect coast wells from saltwater intrusion and to meet projected needs in Franklin and Gulf counties through 2025. In addition, the District has purchased land and undertaken restoration programs under a variety of state programs including, Save Our Rivers, Preservation 2000, the Surface Water Improvement and Management program, etc.
- The Alabama Water Agencies Working Group, a combination of state agencies with water resource responsibilities, on December 1, 2013 recommended an action plan and timeline for implementing a statewide water management plan.
- The Environmental Protection Agency (EPA) enforces existing federal clean water and safe drinking water laws, provides guidance and support for pollution prevention efforts, and works to develop additional regulations to protect watersheds and sources of drinking water.

- The United States Fish and Wildlife Service (USFWS) is a bureau within the Department of the Interior that enforces federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, and works to restore wildlife habitat, such as wetlands.
- The United States Geologic Survey (USGS) is the Nation's largest water, earth, and biological science and civilian mapping agency. USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. USGS maintains river gauging stations throughout the ACF Basin and the nation. USGS collects and disseminates this information to better understand water resources.
- The National Park Service's (NPS) mission is to care for special places saved by the American people. The National Park Service is a bureau of the U.S. Department of the Interior. NPS manages the Chattahoochee River National Recreation Area in the ACF Basin. This area preserves a series of sites within Atlanta and up to Lake Lanier along the Chattahoochee River that creates public recreation opportunities and access to historic areas.

This chapter described consumptive uses within ACF Basin and how the Basin is managed. The next chapter describes more about the benefits water provides to stakeholders in the ACF Basin and their needs and concerns.

CHAPTER 4.
Understanding Stakeholder Needs and Concerns

People benefit from healthy aquatic ecosystems, drawing on water resources for many needs. Analyses by GWRI and others show that most stakeholder needs are met in normal and wet years. Some stakeholders, such as those interested in instream flows to support recreation, navigation and aquatic ecosystems are concerned that their needs are not being adequately supported even in normal years. In addition, the Basin is more stressed in dry and drought conditions, with fewer stakeholder needs being met. Further, many stakeholders are concerned about how to plan for future needs in light of forecasted reductions in average rainfall or forecasted population increases.

ACFS documented and incorporated these concerns in this Plan by developing performance metrics. In general, performance metrics are a way to describe and compare what is important to stakeholders in the Basin. They are like yardsticks to measure the degree to which stakeholder interests or concerns are met by different water management alternatives.

ACFS members identified metrics by sub-basin and by interest group category. In 2012, individual sub-basin meetings were held to identify how interests might be translated into metrics. A table summary of the performance metrics was developed from the meetings and approved by the ACFS members for subsequent use on the project, and is linked in Appendix A.

Figure 4-1 Lower and Middle Chattahoochee Meeting to Discuss Performance Metrics

It is important for decision makers to understand that ACFS approved these metrics to ensure that all stakeholder interests would be represented in the list of metrics to be used. Approval does not mean that every stakeholder agreed with each other's metrics or that the system can meet those metrics under all conditions, but rather that every stakeholder had a "yardstick" that was meaningful to them for understanding whether possible recommendations would improve water management in the Basin.

The stakeholders recognized that some of their interests overlapped with other interests. For example, the need for high flows to support spring time fish spawning would also support flow needed for navigation. These and other conjunctive uses can be found throughout the Basin. They also recognized that tradeoffs will need to be made. Thus, modeling results were presented using the performance metrics developed by the stakeholders so that both the tradeoffs and the ability of the system to provide "joint gains" for many if not all stakeholders under different scenarios could be clearly understood.

Stakeholders identified many performance metrics in terms of flows and levels at specific, individual nodes in the Basin. Stakeholder interests also were presented in other metrics relevant to those interests. For example, recreation interests used USACE identified recreation impact levels. Salinity ranges were used as performance metrics for the Apalachicola Bay. These are described below and linked in Appendix A.

The following performance metrics examples are illustrative of the types of metrics used for various stakeholder interests. These have been included here, not because they are more important than other measures, but rather to provide examples representative both of diverse stakeholder interests and locations throughout the four sub-basins. See Appendix A for the complete list of performance metrics by node.

- Important metrics for **wastewater assimilation** included (among other locations) the percentage of time flows at:
  - Peachtree Creek are below 750 cfs.
  - Whitesburg are 1,000 cfs or greater (and the 7-day average is 1,350 cfs or greater).
  - Columbus daily average flows are 1,350 cfs or greater and the seven-day average is 1,850 cfs or greater.
  - Montezuma are below 317 cfs.
- **Water supply** flow metrics in some locations (e.g. Whitesburg and Columbus are the same as above). Other water supply interests included:
  - A long-term projected water demand of 705 mgd for Metro Atlanta
- **Recreation interests** identified metrics at (among other locations):
  - Lanier as the time that lake levels are below 1,061 ft.
  - Morgan Falls as the time that levels are greater than 864 ft.
  - Peachtree Creek as the percentage of time that flows are between 1,000 and 1,250 cfs.
  - Whitesburg as the percentage of time that flows are greater than 2,200 cfs based on 4 ft depth.
  - West Point as the percentage of time levels from April to October are 635 ft or above and 632.5 ft at all other times.
  - W.F. George as the percentage of time levels from April to October are 190 ft or above and 187.5 ft at all other times.
  - Woodruff as the percentage of time levels from April to October are 77.5 ft or above and 76.5 ft at all other times.
- **Navigation** stakeholders identified the following metrics, assuming Basin hydrology conditions allow:

- A typical navigational season beginning in January of each year and continuing for four to five months (January through April or May), with flows at the Blountstown, FL, USGS gage during the navigation season that are adequate to provide a 7 ft channel.[8] A navigation season will depend on actual and projected system wide conditions in the ACF Basin before and during January, February, March, April, and May. These conditions include:
  - A navigation season can be supported only when the ACF Basin composite conservation storage is in Zone 1 or Zone 2 of the Corps RIOP.
  - A navigation season will not be supported when the ACF Basin composite conservation storage is in Zone 3 and below. Provided drought operations have not been triggered, navigation support will resume when Basin composite conservation storage level recovers to Zone 2, and is forecast to remain above Zone 3 for a practical, continuous period.
  - A navigation season will not be supported when drought operations are in effect. Navigation will not be supported after drought operations have ceased until the ACF Basin composite conservation storage recovers to Zone 1.
  - Releases that augment the flows to provide for the navigation channel will also be dependent on navigation channel conditions that ensure safe navigation.

Though special releases will not be standard practice, they can occur for a short duration to assist navigation during the navigation season, provided the releases will not significantly affect other project purposes, and any fluctuations in reservoir levels or river stages will be minimum.

- Identified metrics for **aquatic resources** included:
  - Six percent reduction in flow at the Blountstown gage using the UIF CMA median monthly flows of pre-dam dry years to develop the flow lines for comparing alternatives. This was equated to an approximate overall 13% reduction in the functional value of the habitat in the riparian area of the Apalachicola River using a tool that was developed for the Apalachicola River based primarily on the work of: 1) Light et al. 1998 who examined acres of connected aquatic and floodplain habitat as a function of flow for the Apalachicola River at Chattahoochee gage, and 2) the USFWS biological opinion issued in 2012 regarding whether proposed USACE RIOP release schedules from Jim Woodruff Dam would jeopardize threatened and endangered mussels under the specified range of low flow conditions. The

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[8] The most recent channel survey and discharge-stage rating was used to determine a flow of 16,200 cfs is required to sustain a minimum navigation depth during the navigation season.

Biological Opinion also included some conservation recommendations that USACE can implement at its discretion.

- Maximizing monthly flows at the Blountstown gage during non-drought conditions fluctuating between 18,000 cfs and 14,000 cfs for the months of February through May, then between 16,000 cfs and 10,000 cfs annually also were identified by Apalachicola stakeholders for sustaining floodplain habitat and seafood productivity.
- Metrics developed for the Apalachicola Bay and Estuary included flows at the USGS Sumatra gage during droughts that maintain salinities within the range of 10-24ppt for a minimum of 50-55% of the time at locations specified throughout the Bay during the spawning, reproduction and recruitment season from May through October. During the primary growth season for oysters of November through April, salinities should be maintained in the desirable range a minimum of 75-80% of the time at these locations.
- Metrics for the Chattahoochee included:
  - For the Atlanta and Norcross nodes on the Chattahoochee, comparison of monthly mean and monthly median flows and percent change for WMAs against UIFs generated for all years (1939-2008).
  - 1029 cfs at the Atlanta gage to meet the flow requirement of 750 cfs at Peachtree Creek needed to assimilate metro Atlanta's treated wastewater.
- Identified metrics for the Flint included:
  - For the Griffin, Carsonville and Montezuma nodes, the percentage of time flow is more than 15% below the cumulative unimpaired average daily flow between February 15 and June 15 and more than 30% below at all other times. In addition, the percentage of time flow is greater than the monthly 7Q10 flow plus 80%.
  - For Albany, Newton and Bainbridge nodes, the percentage of time flow is more than 15% below the cumulative unimpaired average daily flow between February 15 and June 15 and more than 30% at all other times. Further, the percentage of time flow is greater than a 6% reduction in flow (monthly) for dry years and the percentage of time flow is greater than the monthly 7Q10 plus 30%.

- Cooling water for **industrial** and power water users requires flows at levels above intake pipes.
  - Several industrial water users on the middle/lower Chattahoochee, including two large paper mills and a nuclear power plant, rely on water from the river for cooling, industrial processes and waste water assimilation. Metrics for river flow in the middle and lower Chattahoochee include 2,000 cfs at the USGS Columbia gage to support these facilities. Other industrial and businesses in the middle Chattahoochee depend solely on adequate levels in West Point Lake to support mass production,

fire protection, business development, economic expansion and job growth.

- **Hydropower** identified metrics consistent with their permits or Congressional authorization:
  - Performance metrics in middle-lower Chattahoochee nodes are incorporated into the FERC license to the Georgia power Company for the Middle Chattahoochee Hydro project.
  - For the federal projects, nodes with specific weekly minimum megawatt hours generated per month are indicated in the performance metrics table linked in Appendix A (not all nodes have numeric criteria).
- **Agriculture**
  - Numeric criteria were not identified except at Carsonville and Montezuma gages on the Flint River, where the percent of time flow is below 180 cfs affects permitted agricultural withdrawals.

In Appendix B, stakeholders have described in their own words the interests and concerns that they are seeking to achieve with the performance metrics used in the modeling. The consensus of ACFS is that stakeholders' diverse perspectives are important to understand. However, the perspectives expressed in Appendix B are not a consensus statement of ACFS as a whole nor are they necessarily a consensus of all the members associated with the various sub-Basin or stakeholder interest group perspectives represented.

CHAPTER 5.

Findings

A summary of the findings from the modeling are provided below to provide a context for the recommendations that follow in Chapter 6.

Baseline Conditions: The Effects of Evaporation, Dam Operation and Consumptive Use

It is important to understand the effects of evaporation from the federal reservoirs, how releases from these reservoirs are currently managed, and consumptive uses. These are major drivers in the system to consider when framing recommendations intended to improve current conditions, since such recommendations are effective only to the degree that they address the cause behind an existing or potential future problem.

GWRI conducted the following baseline modeling (see the methods section of Chapter 2 for more detail):

- The impacts of evaporation were assessed by comparing the USACE UIFs to run of the river scenarios. The latter assumed all main-stem reservoirs exist and are operated with storage kept constant at the mid-point of the conservation zone.
- The impacts of current dam operations were assessed by comparing the UIF scenario to the RIOP without consumptive use.
- The impacts of consumptive use were assessed by comparing the RIOP scenario to the RIOP with consumptive use.

Detailed results of the modeling were compared by node, by sub-basin and for the Basin overall against performance criteria related to the following stakeholder interests:

- Lake levels and releases
- Recreation impacts and opportunities
- Navigation opportunities
- Consumptive use deficits
- Environmental flows
- Monthly river flows
- Hydropower

GWRI made the following observations from this analysis:

- While recognizing the need to improve the accuracy of the unimpaired inflow dataset at a daily resolution, the UIF scenario establishes a baseline flow regime throughout the ACF basin that allows for a relative comparison of various WMA model runs.

- Evaporation effects are higher during summer (hot, dry) months and dry years; changes in flows from the UIF scenario to the UIF with evaporation (UIF/Ev) scenario due to evaporation losses are larger at the downstream reservoirs in an absolute sense and larger at the upstream reservoirs in a relative sense; the long-term annual evaporation losses under the UIF/Ev scenario amount to about 20% of current Basin wide annual consumptive uses.[9]

- Operation of the system under the RIOP rules changes the natural seasonal distribution of flows (generated by the UIF scenario); average flows during high inflow months (winter/spring) are lower with regulation, and average flows during low inflow months (summer/fall) are higher with regulation; the relative effects of regulation are most pronounced in the upstream watersheds, while the absolute magnitudes are largest downstream in the Apalachicola; regulation may increase navigation opportunities at Chattahoochee and along the Apalachicola.

- Consumptive uses decrease river flows across the Basin by 7 – 13 % in the Chattahoochee and Apalachicola Rivers and by 5-35 % in the Flint River; federal reservoir levels also decrease with the addition of consumptive uses, with the largest decreases occurring under dry conditions when the reservoir levels are already low.[10]

Other Observations

- Current consumptive use targets are met at almost every node in the ACF Basin for the **RIOP/CU** scenario. The only exception is Griffin, where deficits are calculated during low flow events.

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[9] In considering evaporation losses, it should be noted that the same land mass as now occupied by the reservoirs also would lose water due to evapotranspiration if it were still in vegetation.

[10] In considering the modeled streamflow changes described in this section, it should be noted that determining the degree of streamflow reduction that results from consumptive use requires additional, careful analysis. Modeled streamflow differences may reflect (in whole or in part) changes in release patterns under the USACE's operational rules, rather than depletions caused by consumptive uses themselves. For example, changes to modeled consumptive uses may cause storage to cross a particular operational "threshold," leading to large changes in modeled releases at a particular point in time.

- Metrics computed based on dry years reveal important information about system performance under conditions of greater stress. It is highly recommended that attention be paid to dry year metrics and drought conditions during the evaluation of WMAs in order to help in the development of a plan that is truly sustainable.

The UIF dataset used as input for all of the scenarios is subject to errors and uncertainties when viewed on daily time-scales. In particular, high flow events are not well represented by the current UIF data set.

Eight scenarios were modeled for the entire period of record (1939 to 2008) conditions. The output from these runs was also post processed to calculate the requested metrics for the 13 driest years in the 1939 to 2008 period of record. Basin-wide effects include:

- Evaporation decreases spring/summer/fall average monthly flows.
- Regulated scenarios (i.e., **RIOP**) generally result in lower winter/spring and higher summer/fall releases than unregulated scenarios. The differences between regulated and unregulated scenarios are generally increased during dry years.
- Consumptive uses decrease average monthly flows and lake levels, especially during dry years. Recreational impacts are generally higher in the scenarios with consumptive uses versus those without consumptive uses. These differences are in the range of 0 to 20%. Consumptive uses reduce energy generation from 1091 to 1040 gigawatt hours (GWh) for all years.
- Navigation opportunities are slightly reduced with increasing evaporation at Chattahoochee (Apalachicola).
- Navigation opportunities at Chattahoochee are slightly higher for unregulated scenarios (**UIF**, **UIF/Ev**) than regulated scenarios (**RIOP**) during January to May. However, regulation may increase navigation opportunities during the dry months, especially during droughts.
- Limited consumptive use shortages are calculated only at Griffin up to 10% of monthly average water supply targets during dry years (September).

Round One Modeling: The Effects of Water Management Alternatives

The first round of modeling provided information on as many of the WMAs suggested by stakeholders as possible, with the exception of WMAs that required major changes to reservoir zones or RIOP curves. The WMAs involving more complex changes to reservoir regulation rules were included in Round Two. WMAs were assessed relative to all proposed stakeholder metrics.

The categories of WMAs analyzed included:

- Alternative consumptive use levels;

- Conservation storage change options at ACF reservoirs;
- Alternative interbasin transfer levels;
- Different reservoir ramp down outflow rates under existing reservoir zones and RIOP curves; and
- RIOP implementation driven by (1) unimpaired and (2) impaired Basin inflows.

Additional detail about the WMA scenarios modeled can be found in the Water Management Alternatives Technical Memorandum prepared by Black & Veatch.

Round one was similar to the baseline conditions modeling in that it minimized the number of variables changing at one time to help ensure that the stakeholders could tell what is causing an effect, i.e. whether a WMA led to improvements relative to baseline conditions or caused potentially adverse effects. This approach also revealed tradeoffs, to provide the basis for stakeholders to think together about the impacts of each proposal on others, whether positive or negative, and to design the round two scenarios to preserve improvements and address adverse effects.

Scenario Definitions

Several modeling runs were performed to compare with baseline conditions. All of the scenarios used the most recent USACE unimpaired flow data set (1939 to 2008) and, if applicable, the associated net evaporation rates. The model output was post processed for all years of the record as well as separately for the 13 driest years (1941, 1951, 1955, 1981, 1985, 1986, 1988, 1999, 2000, 2002, 2006, 2007, and 2008). Comparison of the metrics in these two cases provides an understanding of how metrics can vary from average conditions to dry years.

The scenarios are briefly defined below:

Baseline Scenarios (from Current Conditions Runs):

- **UIF:** Unimpaired flows without reservoirs and without consumptive uses.
- **RIOP/CU:** All reservoirs are regulated according to the Revised Interim Operations Plan currently in effect. Evaporation losses are considered and current consumptive uses are at the levels compiled by Black & Veatch.

Consumptive Use Scenarios: This group of scenarios is intended to evaluate how changing the consumptive uses affect the water resources in the Basin. Four scenarios at consumptive use levels differing by -30%, -15%, +15%, and +30% from the RIOP/CU baseline scenario, were chosen:

- **RIOP/CU -30**: Same as RIOP/CU, but with consumptive uses decreased by 30 % basin-wide.
- **RIOP/CU -15**: Same as RIOP/CU, but with consumptive uses decreased by 15 % basin-wide.
- **RIOP/CU +15**: Same as RIOP/CU, but with consumptive uses increased by 15 % basin-wide.

- **RIOP/CU +30**: Same as RIOP/CU, but with consumptive uses increased by 30 % basin-wide.

Interbasin Transfer Scenario: This scenario was chosen to evaluate the effect of Interbasin Transfers (IBT) on the ACF Basin water resources. Existing IBTs were quantified and then used to create a new consumptive use scenario that adjusts the current consumptive uses such that any existing transfers of water into and out of the Basin do not occur. While at some locations adjusting the IBTs result in higher consumptive uses when compared to the current uses, overall the IBT adjustments tend to lower consumptive uses throughout the Basin.

- **RIOP/CU IBT:** Same as RIOP/CU, but any consumptive use transfers into or out of the ACF Basin were removed.

Release Ramp Rate Scenarios: This scenario was chosen to determine the effect that ramp rates (i.e., limitations on the rate of change of reservoir releases or reservoir levels) have on the ACF Basin water resources.

- **RIOP/CU No RR:** Same as RIOP/CU, but all ramp rates (pertaining to reservoir level and release changes) have been removed.

RIOP Implementation Scenarios: This scenario group assesses alternative definitions of the Basin Inflows (BI). Basin Inflows are a key variable in the Revised Interim Operations Plan (RIOP) since release requirements (magnitudes and ramp rates) from Jim Woodruff Dam are directly linked to Basin Inflows during parts of the year and for certain flow ranges. Under the RIOP, the Basin Inflows represent the Basin-wide *impaired* inflows upstream of the Chattahoochee gage (i.e. unimpaired inflows minus evaporation and consumptive use losses). The following scenarios correspond to slightly different definitions of the Basin Inflows:

- **RIOP/CU BI: Evap**: Same as RIOP/CU, but with RIOP using Basin Inflows computed by adding back in evaporation losses.
- **RIOP/CU BI: CU**: Same as RIOP/CU, but with RIOP using Basin Inflows computed by adding back in consumptive uses.
- **RIOP/CU BI: CU+Evap**: Same as RIOP/CU, but with RIOP using Basin Inflows computed by adding back in consumptive uses *and* evaporation losses. Basin Inflows computed in such a manner most closely resemble unimpaired inflows

Reservoir Rule Curve and Storage Change Scenarios: This group consists of scenarios that make either structural changes to the system reservoirs or changes the location of the reservoir zones.

- **RIOP/CU WP**: Same as RIOP/CU, but with changes to the West Point zones.
- **RIOP/CU L+2**: Same as RIOP/CU, but with an additional 2 feet of storage in the conservation zone of Lake Lanier. This increase is applied to the top of the

Lake Lanier conservation zone, with all other zones at Lanier and the other system reservoirs remaining as in the original RIOP/CU.

- **RIOP/CU L+2 P**: Same as RIOP/CU, but with an additional 2 feet of storage in the conservation zone of Lake Lanier. This increase was applied proportionally to all Lanier conservation zones. All other reservoirs are operated as in RIOP/CU.

Hydropower Requirements Scenario: This scenario, when compared to the RIOP/CU baseline scenario, aims to determine the benefits and impacts that the hydropower generation requirements have on other water uses.

- **RIOP/CU No Power**: Same as RIOP/CU, but with all hydropower generation requirements removed from the operational plan. Hydropower can still be generated but releases are not made to specifically meet generation targets.

Detailed results of all scenario runs were compiled and presented for every node in the system similarly to the presentation of the Current Conditions Model runs. The detailed results were compared and summarized using performance metrics pertaining to:

- Lake levels and releases;
- River flows;
- Relationship of flows to levels for inundation of aquatic habitat;
- Recreation impacts and opportunities;
- Environment, Conservation, Water Quality, and Navigation opportunities;
- Hydropower; and
- Consumptive use target deficits.

In addition, information pertaining to each individual metric was also summarized across the Basin.

Summary Observations

While this summary identifies the major changes in performance metrics that result from different WMAs, the ACF stakeholders made the final determination about which WMAs represent an improvement over existing conditions.

Decreased water storage is experienced at times in scenarios that increase consumptive uses from current levels. Conversely, a decrease in consumptive uses (including through the removal of Inter Basin Transfers) increases storage throughout the system. Major infrastructure improvements or rule curve changes such as increasing Lake Lanier storage by 2 feet are also found to increase amounts of water available in the system. However, it is shown that the manner in which the additional storage is allocated affects the overall system performance.

Hydropower generation requirements are found to affect system conditions, tending to decrease reservoir levels. On the other hand, hydropower releases are also found to provide some in-stream flow benefits during certain months of the year.

Changing the Basin Inflows used in the RIOP implementation from impaired to unimpaired inflows has a long-term positive effect on the amount of in-stream flows being released. However, there are certain months of the year when using the unimpaired Basin Inflows would consistently result in lower in-stream flows when compared to the baseline RIOP/CU scenario. Such a shift also leads to lower average reservoir levels, since more water is released from the reservoirs to meet instream flow requirements. These changes are the result of RIOP rules that condition release requirements on the Basin-wide composite storage. A comprehensive re-analysis of the release requirements mandated by the RIOP has the potential to improve system operations and performance metrics. This aspect was explored in the second scenario assessment round.

Specific Findings

Specific findings are divided into two subsections. The first highlights the major relative benefit and impact responses *within* each scenario group relative to baseline conditions and the evaluation criteria. The second summarizes the relative benefits and impacts *across* the scenario groups.

Impacts within Individual Scenario Groups

This section highlights impacts *within* each scenario group relative to baseline conditions and the above-mentioned criteria.

Consumptive Use Scenarios: Increased CU results in lower reservoir levels and decreased Basin-wide flows. The opposite effect occurs when consumptive uses are decreased.

Inter Basin Transfer Scenarios: The Interbasin Transfer (IBT) scenario generally results in a net increase of the amount of water available in the ACF basin. This is due to the fact that there are more IBTs leaving the system than entering.

Release Ramp Rate Scenarios: The removal of ramp rates resulted in system responses that are not appreciably different from the RIOP/CU baseline scenario.

RIOP Implementation Scenarios: The RIOP operation shift from using Basin Inflows based on impaired flows to Basin Inflows more closely resembling unimpaired flows leads to lower average reservoir levels since more water is released from the reservoirs to meet in-stream flow requirements. However, the changes are not uniform throughout the year, and several months exhibit drops in river flows. This is partially due to the fact that the RIOP release requirements are dependent on basin inflows for only portions of the year and only within certain flow ranges. Furthermore, the RIOP release requirements are a function of the available composite reservoir storage and become lower as storage decreases. If large releases are made during a particular time period, it is possible that lower storages and hence lower release requirements and river flows may result in subsequent months.

Reservoir Rule Curve and Storage Change Scenarios: The alteration of the West Point rule curve increases the West Point elevation while having only minor impacts on the other reservoir and river flows. Increasing Lake Lanier storage by 2 feet also increases the average storage in that reservoir without impacting most of the rest of the system. However, the manner in which the increase is implemented changes the level of the benefits that can be accrued.

Hydropower Requirements Scenarios: Removing hydropower generation as an explicit operational goal obviously reduces hydropower generation availability (though power is still generated). On the other hand, several other metrics, such as reservoir levels and recreational opportunities are positively affected. The removal of generation requirements can however have an adverse effect on river flows and in-stream flow metrics for certain months of the year. Hydropower releases thus coincidentally provide some flow benefits that would not be provided by the RIOP alone. The in-stream flow metrics tend to be more similar to the UIF flow medians during the winter and spring months, but lower during the summer months.

Impacts Across Scenario Groups

This section highlights impacts a*cross* the scenario groups. Subsections for major metric categories (reservoir levels, in-stream flows, etc.) identify scenarios that are beneficial or detrimental to metric performance.

Reservoir Levels: Reservoir levels can be impacted by a variety of changes to the system operations, system infrastructure, and management options. Since several recreational benefits are directly derived from reservoir levels, similar conclusions would apply to these metrics.

- Scenarios with positive impacts: Consumptive use reductions increase reservoir levels. Removing IBTs also increases reservoir levels, though to a lesser degree. The addition of extra storage at Lake Lanier raises the levels in that reservoir. However, if the additional storage is only allocated to the top conservation zone, then there are only minor level increases during dry times. On the other hand, larger and more sustained increases can be achieved if some of the additional storage is also allocated to the lower zones. Changing the West Point zones increases West Point levels but leaves other reservoir levels essentially unaltered. Finally, removing hydropower requirements leads to significant average and minimum reservoir level increases.
- Scenarios with negative impacts: Reservoir levels decrease across the Basin when consumptive uses are increased. Additionally, changing the Basin Inflow computation from impaired to unimpaired flows results in lower reservoir levels since more water is released for in-stream flow purposes on average.

Reservoir Releases and River Flows, Including In-stream Flow Metrics: Several scenarios affect river flows and in-stream flow metrics, though such effects can be beneficial or detrimental depending on the time of the year.

- Scenarios with positive impacts: The reduction of consumptive uses (including reductions due to the removal of IBTs) increases river flows and improves in-stream flow metrics across the Basin. The removal of hydropower generation requirements tends to increase flows during the winter and spring months. Changing the RIOP Basin Inflow computation from impaired to unimpaired flows increases river flows and improves instream flow metrics during the spring and early summer months. Adjustments to the West Point zones generally increase releases from West Point (and other flows and releases downstream) during most of the year except in the fall and early winter.
- Scenarios with negative impacts: An increase of consumptive uses results in reductions of river flows and lower in-stream flow metrics. The removal of hydropower generation requirements decreases flow during the summer and fall months. Changing the RIOP Basin Inflow computation from impaired to unimpaired flows leads to declines in river flows during the late summer and fall months relative to RIOP/CU. However, the same change generates median flows that approximate the UIF baseline flow conditions better than the RIOP/CU scenario for spring and summer. In this sense, some of the environmental flow changes of the RIOP/CU BI: CU+Evp scenario may be considered to be positive.

Hydropower: Several scenarios affect hydropower generation, though these changes can be beneficial or detrimental depending on the time of the year.

- Scenarios with positive impacts: The reduction of consumptive uses (including reductions due to the removal of IBTs) tends to increase hydropower generation. Changing the RIOP Basin Inflow computation from impaired to unimpaired flows can lead to higher generation in the spring and early summer months of dry years. Increasing Lake Lanier storage positively impacts energy generation, though this benefit is more pronounced for the scenario where only the top conservation zone is increased.
- Scenarios with negative impacts: Removing hydropower generation as an explicit operational goal can reduce hydropower production significantly in several months, especially during dry years. Changing the Basin Inflow computation from impaired to unimpaired flows can lead to lower generation in the late summer and fall months.

Consumptive Uses: All of the scenarios meet the consumptive use targets at all locations except Griffin.

- Scenarios with positive impacts: Decreasing consumptive uses results in smaller deficits. This includes the IBT scenario since the removal of IBTs lowers consumptive uses at the Griffin node.

- Scenarios with negative impacts: Increasing consumptive uses results in larger deficits.

Round Two Modeling: Optimizing for Stakeholder Interests

Optimized reservoir management rule alternatives were modeled under current consumptive use conditions in a series of analyses that reflected increasing degrees of deviation from the current operational rules as follows:

- Analysis 1: Keeps the existing RIOP and hydropower rules and makes modifications to reservoir coordination within the confines of the existing rules.
- Analysis 2: Keeps the existing RIOP rules, makes modifications to reservoir coordination, and makes modifications to hydropower rules.
- Analysis 2b**:** Makes modification to reservoir coordination, makes modifications to hydropower rules, and makes modifications to RIOP rules. Modifications were designed to follow similar general structures as those used by USACE in the current operations.

Under current CUs, modifications to reservoir coordination rules in Analysis 1 increase composite storage relative to current operations at West Point and Lanier. The storage of the lower reservoirs (George and Woodruff) fluctuates over a wider range. Recreation benefits increase at Lanier and West Point and stay practically unchanged at Columbus, George and Woodruff. Environmental flow metrics at Chattahoochee and hydropower metrics remain unchanged or improve, especially during dry years.

The second round of analyses builds on Analysis 1 and makes modifications to the hydropower generation rules. Results show storage increases at West Point and Lanier, especially during dry years. Storage of the lower reservoirs (George and Woodruff) fluctuates over a wider range. Total energy generation remains unchanged, but average dependable generation is reduced. Minimum dependable hydropower increases during dry years. Recreation benefits increase at Lanier and West Point and remain practically unchanged elsewhere. Environmental flow metrics at Chattahoochee remain practically unchanged.

The third round of analyses builds on both Analysis 1 and 2 and adjusts RIOP rules such that when Chattahoochee flows are less than 10,000 cfs, it adds 550 cfs to Jim Woodruff outflows during the summer months (June through September). Results show that relaxation of hydropower requirements coupled with environmental flow target increases can provide benefits for upstream and downstream uses. Other observations for these modeling assumptions include:

- The composite storage and individual reservoir storages increase (relative to current operations) at West Point and Lanier during the winter and spring months. They are not worse than current operations during the summer and early fall months. The storage of the lower reservoirs (George and Woodruff) fluctuates over a wider range.

- Total energy generation remains unchanged, but average dependable hydropower generation is reduced. Minimum dependable hydropower increases (relative to current operations) during dry years. An analysis by hydropower stakeholders projected about $1 million in lost capacity and $3 million in energy losses in terms of replacement costs. Additional modeling is needed to investigate alternative sources of supply from other basins.
- Recreation benefits increase at Lanier and West Point and remain practically unchanged elsewhere in the ACF.
- Environmental flow metrics at Chattahoochee improve, especially during extreme low flows.

Optimization for future consumptive use increases suggests that, relative to current CUs, performance metrics generally decline, though the relative magnitudes vary among the different uses. Relaxation of hydropower requirements under future consumptive use conditions results in:

- Composite storage increases (relative to current operations) at West Point and Lanier, especially during dry years. The storage of the lower reservoirs (George and Woodruff) fluctuates over a wider range.
- Total energy generation remains unchanged, but average dependable hydropower generation is reduced.
- Minimum dependable hydropower at Lanier increases during dry years.
- Recreation benefits increase at Lanier and West Point and remain practically unchanged elsewhere in the ACF.
- Environmental flow metrics at Chattahoochee remain practically unchanged.

Based on these analyses, ACFS members requested a final round of modeling to compare several combinations of options and to model drought storage conditions. See Chapter 2 and Table 5-1 below for a summary of the "portfolios" modeled.

Table 5-1 Final Optimization Run Scenarios Modeled

Variable	Portfolio A	Portfolio B	Portfolio C
Consumptive Use	Current minus 30% (with adjustments on the Flint)*	Current	2050minus 10% (with adjustments on the Flint)*
West Point Rule Curve Adjustment	Increase winter pool from 628 to 632.5	Increase winter pool from 628 to 632.5	Increase winter pool from 628 to 632.5
Reservoir Coordination	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.	Define new zones to coincide with the USACE reservoir recreational impact zones. Only release from upstream if downstream reservoir is in a lower zone.
Hydropower Adjustment	Adjusted rules	Adjusted rules	Adjusted rules
Navigation	Spring shoulder	Spring shoulder	Spring shoulder
2 feet addition to Lake Lanier	Yes	No	Yes
Pulses**	14,000 cfs pulse for two weeks in May and 9,000 cfs pulse for two weeks in July	9,000 cfs pulse for all of May OR 9,000 cfs pulse for two weeks in May and two weeks in July	9,000 cfs pulse for 2 weeks in May and 2 weeks in July

** Portfolio A uses the following consumptive use projections:*

- *Chattahoochee and Apalachicola Rivers: Current -30%*
- *Flint River (Griffin, Carsonville, Montezuma): Current, adjusted to reflect return of all current interbasin transfers and conversion of all LAS to direct discharges at 50% of permitted LAS capacity*
- *Flint River (Griffin and Carsonville) flows augmented by up to 6.2 cfs and 9.3 cfs respectively when flows fall below monthly 7Q10 during low flows. If the maximum Griffin augmentation amount is not used and Carsonville flow is below its monthly 7Q10, then flows can be added at Griffin to aid Carsonville up to 6.2 cfs total. Monthly 7Q10 based on unimpaired flow (UIF) data 1939-1974 provided by GWRI.*
- *Flint River (Albany and below): Current -15%*

Portfolio C uses the CU as Portfolio A, except Chattahoochee and Apalachicola Rivers use 2050 projections -10%

*** Pulses were modeled as 9000 cfs flows at Chattahoochee FL (not as an additional 9,000 cfs) – as well as at 14,000 cfs – and only during periods when flows fell below 9,000 cfs (thus not reducing flows to 9,000 cfs when flows otherwise would have been higher).*

With the operational changes described and reductions in consumptive use (Portfolio A), there is more water in storage and, thus, more water available for increased environmental flows (pulses). At current consumptive uses, with these same operational changes but without the two foot increase in the rule curves at Lanier (Portfolio B), pulses can still be accommodated although at a lower level. The two foot increase at Lanier accommodates both increased consumptive use and pulses (Portfolio C). Generally, with all three portfolios, the window for navigation increases, recreation improves at Lanier and West Point but has some impacts at George and Woodruff, and dependable hydropower is reduced.

Drought storage modeling results suggest that, under current CUs and minimum Woodruff release targets in the 5,000 to 6,000 cfs range, drought storage requirements amount to 42 to 65 percent of the total composite conservation storage. Under projected future CU increases and minimum Woodruff release targets in the 5,000 to 6,000 cfs range, drought storage requirements amount to 58 to 86% of the total composite conservation storage. Lanier contributes more than 75% of the total required drought storage in all cases. Under projected future CU increases, the critical drought period for Lanier extends an additional year.

Predictive Drought Management

The impacts of extended drought affect all stakeholders in the ACF Basin. The earlier that drought conditions can be predicted, the earlier water managers can respond and, thus, the more likely those responses will have less adverse consequences. Thus, ACFS commissioned GWRI to examine potential changes to the Water Control Manual that would incorporate the use of predictive drought indicators that would reliably anticipate potential drought and non-drought periods and would enable USACE to adjust operations to mitigate stakeholder impacts or realize additional benefits. The study examined tools that would provide information on expected operational adjustments reliably and with sufficient lead time.

GWRI compared 90 distinct indices and their lag times (nine specific indices over 10 sub-basins or nodes) against the period of record for accuracy and reliability. Index variables with good explanatory value were the previous months' UIFs, soil moisture using the GWRI watershed model, and the Palmer Drought Severity Index (PDSI).

The reason the soil moisture reservoir is a useful predictor is that it is a major contributor to baseflow in surface water. They also noted that the best forecast models for different sub-basins may use different index variables.

GWRI modeled various combinations of assumptions with associated adjustments to reservoir operations and concluded that varying reservoir release rules based on predictive drought indicators would be beneficial to stakeholder interests. GWRI provided a set of assumptions and a method for predictive drought management that, as an example, produced results better than Portfolio B when compared against stakeholder metrics.

Apalachicola Bay and Estuary Assessment

The Apalachicola Bay and Estuary is a complex ecosystem, providing habitat to numerous plants and animals. There are many potential factors that may affect oyster health including increased disease and predation as salinity in the Bay increases without the typical rate of freshwater inflow – due to naturally dry conditions as well as water consumption, nutrient limitation of the food web, and levels of oyster harvesting. This SWMP addresses one factor in this complex system, which is the extent to which freshwater input to the Apalachicola Bay can be increased through better management throughout the ACF Basin.

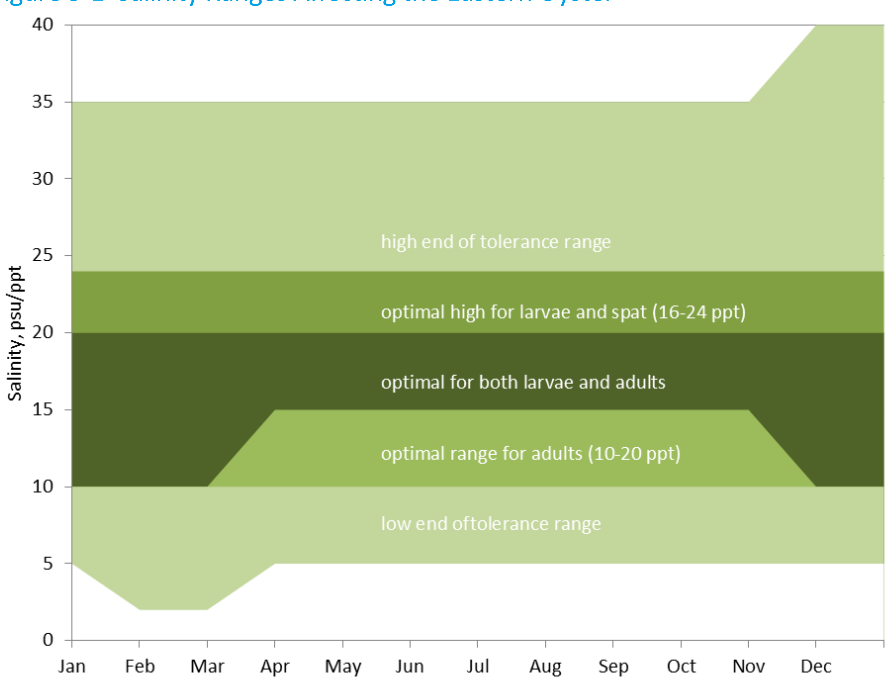
Salinity is often viewed as one of the principal drivers affecting oyster growth and reproduction. The salinity distributions in Apalachicola Bay change in complex ways in response to many factors, including freshwater inflow from the Apalachicola River, tides and wind. At high salinities, oysters are susceptible to predation and disease. The salinity conditions relevant to oysters, then, are a function both of the oysters' salinity tolerance and the tolerance of the organisms that prey on or affect the oysters.

Although oysters can survive high salinities (40 for adults and 35 for larvae), mortality due to both predation and parasitic infections (i.e. *Perkinsus marinus)* increases with increasing salinity, with a noticeable break between 17 (less predation/ parasitism) and 25 (greater predation/ parasitism) (Petes et al. 2012). Studies at Cat Point and Dry Bar in Apalachicola Bay showed maximum growth rates occurred between approximately 17 and 26 (Wang et al. 2008)

Atkins selected bay bottom salinities ranging from 10 to 24 psu/ppt as the most desirable for oyster habitat in Apalachicola Bay for purposes of comparing hydrodynamic model outputs for WMAs with respect to seasonal distribution of salinity at various oyster bar locations.

A simple summary of selected desirable salinity ranges for oyster adults, larvae, and spawning is presented in Figure 5.1.

Figure 5-1 Salinity Ranges Affecting the Eastern Oyster



A total of eight scenarios were evaluated, including historic flows (USGS data at Sumatra), modeled unimpaired flows (UIF), current conditions (RIOP with Consumptive Use and RIOP with no CU) as well as four round two portfolios as follows:

- Scenario 1) Historic Sumatra Flows (USGS flows)
- Scenario 2) Unimpaired Flows (UIF)
- Scenario 3) Revised Interim Operations Plan (RIOP with Consumptive Use (RIOP CU)
- Scenario 4) RIOP without Consumptive Use (RIOP No CU)
- Scenario 5) Portfolio B Run 1 (current CU, reservoir coordination adjustment, West Point and hydropower adjustments, single 4-week pulsed water release)
- Scenario 6) Portfolio B Run 2 (current CU, reservoir coordination adjustment, West Point and hydropower adjustments, two 2-week pulsed water releases)
- Scenario 7) Portfolio A (current CU reduced by 30% with variations for the Flint, reservoir coordination adjustment, West Point and hydropower adjustments, two 2-week pulsed water releases, 2 ft increase at Lanier)
- Scenario 8) Portfolio C (future CU reduced by 10% with variations for the Flint, reservoir coordination adjustment, West Point and hydropower adjustments, two 2-week pulsed water releases, 2 ft increase at Lanier)

Outputs from the GWRI hydrodynamic model were used to calculate the percentage of time and number of days that salinities were in the desirable range for oysters (10-24 salinity range from May to October) at the five oyster regions in the bay and nine discrete stations. Salinity distributions were examined for a subset of months (May to October) that coincide with the period over which gametogenesis is likely to occur (when water temperature meets or exceeds 26°C).

Model results predicted the greatest increase in number of days in the range of salinities described above under Portfolio A at seven of the nine discrete stations and all of the five areas. With two exceptions (stations C and E), model results from all of the round two portfolios predicted increased number of days in the identified range in comparison with current conditions (scenario 3/RIOP with CU).

The relative performance among the various WMA scenarios was compared based on the number of days in which salinities under each scenario fall within the 10-24 ppt salinity range from May to October selected by Atkins. This is summarized in Table 5.2 both for discrete stations and for oyster regions.

Table 5-2 Scenario Ranking by Station and by Oyster Region

Station	A	B	C	CP	D	DB	E	F	G
More days	7	7	7	7	7	7	7	6	5
	6	6	6	6	6	5	3	8	7
	8	8	8	8	8	6	5	7	6
	5	5	3	5	5	8	6	5	8
Fewer Days	3	3	5	3	3	3	8	3	3

Oyster Region	NOB	EAB	WAB	SGS	MILES
More Days	7	7	7	7	7
	6	6	6	6	6
	8	8	8	8	8
	5	5	5	5	5
Fewer Days	3	3	3	3	3

A comparison of the frequency at which salinity is in the range of 10 to 24 ppt at the Cat Point Station during May through October for the eight modeled scenarios is provided as an example in Table 5.3.

As an example, the suite of changes modeled in Scenario 7 (reductions in consumptive use, 2 feet of additional storage in Lanier, hydropower adjustments, and other operational changes) would result in a 20% increase in time (from 19.7% to 24% or 7.9 additional days) with salinity between 10 and 24 ppt in the eight driest years, as compared to Scenario 3 (RIOP with consumptive use). The consultants selected Bay bottom salinities ranging from 10-24 PSU/ppt as the most desirable (salinities) for oyster habitat in Apalachicola Bay. As directed by ACFS, the consultants then used this salinity range to compare the relative benefits of each scenario. The consultants did not draw conclusions as to the degree to which these scenarios will improve the health and productivity of oysters. Therefore, ACFS recommends that the effects of these flows on oyster health be studied carefully. ACFS has concluded that the combination of changes modeled in Scenario 6 (Portfolio B2) be considered as a starting point for adaptive management. (See recommendation in Chapter 6, Theme 2).

Table 5-3 Cat Point Station Results

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 7	Scenario 5	Scenario 6	Scenario 8
Rank	**Year**	CP_USGS	CP_UIF	CP_RIOP_CU	CP_RIOP_No_CU	CP_Portfolio A	CP_PortfolioB1	CP_PortfolioB2	CP_PortfolioC
1	2007	7.6%	12.0%	7.6%	10.9%	16.8%	8.2%	10.9%	10.9%
2	2000	12.5%	13.0%	9.2%	13.6%	13.6%	11.4%	13.0%	12.5%
3	1986	21.2%	24.5%	19.0%	25.0%	23.9%	20.1%	19.6%	20.1%
4	2006	29.3%	38.0%	27.7%	39.1%	33.7%	28.3%	31.5%	29.9%
5	2002	2.7%	4.9%	3.3%	4.3%	7.6%	3.8%	4.9%	4.3%
6	2008	20.1%	28.8%	17.9%	24.5%	21.7%	18.5%	21.2%	21.7%
7	1993	39.1%	38.0%	34.2%	38.0%	34.8%	34.2%	34.2%	34.2%
8	1990	45.1%	42.4%	38.6%	41.8%	39.7%	39.1%	39.1%	39.1%
9	1999	34.2%	35.9%	34.2%	38.6%	35.9%	36.4%	34.2%	33.7%
10	1988	33.7%	36.4%	33.2%	36.4%	33.2%	32.1%	31.5%	32.6%
11	2001	41.3%	41.8%	40.2%	41.3%	40.8%	39.7%	39.1%	39.7%
12	1985	47.8%	46.2%	38.6%	44.0%	40.8%	39.7%	39.7%	39.7%
13	1992	41.8%	48.9%	38.6%	45.1%	40.8%	39.1%	39.1%	37.5%
14	1995	44.6%	49.5%	40.2%	44.0%	41.3%	40.2%	40.2%	40.8%
15	1987	51.1%	50.5%	47.3%	50.5%	47.8%	47.3%	47.3%	47.3%
16	1996	72.3%	70.7%	67.4%	71.7%	69.6%	68.5%	68.5%	67.4%
17	2004	55.4%	59.8%	54.3%	58.7%	56.0%	54.9%	54.3%	53.8%
18	1997	69.6%	60.3%	56.0%	58.7%	57.6%	55.4%	55.4%	56.5%
19	1998	60.3%	69.0%	68.5%	70.7%	65.2%	60.3%	60.3%	64.7%
20	1989	76.1%	76.1%	69.6%	75.5%	72.3%	71.2%	71.2%	69.6%
21	1984	67.4%	66.3%	64.7%	67.4%	65.2%	64.7%	64.7%	64.1%
22	1991	72.8%	68.5%	69.0%	68.5%	69.6%	69.0%	69.0%	69.0%
23	2005	57.6%	57.1%	56.5%	56.5%	57.6%	57.1%	57.1%	57.1%
24	2003	81.5%	80.4%	81.0%	82.1%	81.0%	81.0%	81.0%	81.0%
25	1994	77.2%	78.8%	76.6%	77.2%	76.1%	76.1%	76.1%	76.1%

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 7	Scenario 5	Scenario 6	Scenario 8
Rank	**Year**	CP_USGS	CP_UIF	CP_RIOP_CU	CP_RIOP_No_CU	CP_Portfolio A	CP_PortfolioB1	CP_PortfolioB2	CP_PortfolioC
Mean of Frequency for All Years		46.5%	47.9%	43.7%	47.4%	45.7%	43.8%	44.1%	44.1%
Mean of Frequency for 8 Driest Years		22.2%	25.2%	19.7%	24.7%	24.0%	20.4%	21.8%	21.6%
Mean of Frequency for 7 Driest Years		18.9%	22.7%	17.0%	22.2%	21.7%	17.8%	19.3%	19.1%
Mean of Frequency for 6 Driest Years		15.6%	20.2%	14.1%	19.6%	19.6%	15.0%	16.8%	16.6%
Mean of Frequency for 5 Driest Years		14.7%	18.5%	13.4%	18.6%	19.1%	14.3%	16.0%	15.5%
Mean of Frequency for4 Driest Years		17.7%	21.9%	15.9%	22.1%	22.0%	17.0%	18.8%	18.3%
Mean of Frequency for 3 Driest Years		13.8%	16.5%	12.0%	16.5%	18.1%	13.2%	14.5%	14.5%
Mean of Frequency for 2 Driest Years		10.1%	12.5%	8.4%	12.2%	15.2%	9.8%	12.0%	11.7%
2007		7.6%	12.0%	7.6%	10.9%	16.8%	8.2%	10.9%	10.9%

CHAPTER 6.
Recommendations

ACFS has concluded from the findings above that improvements to the current conditions in the Basin are possible and that planning for dry and drought years is critical.

ACFS urges decision makers and citizens in this Basin to implement the recommendations that follow in order to improve current conditions in the Basin and achieve more sustainable water management in the future.

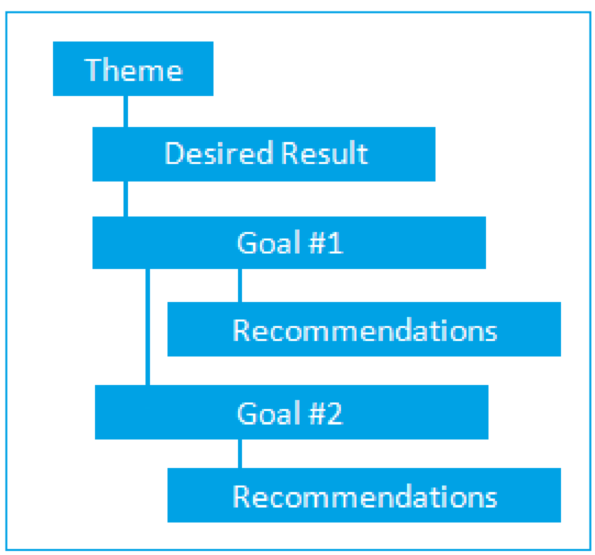
We can and must act with common purpose to manage our shared water resources sustainably. Water use efficiency and conservation measures, creative alternatives to water control operations, predictive drought management, investment in scientific knowledge for future decisions, and transboundary coordination and cooperation offer real ways to improve environmental, social and economic conditions in this Basin.

The recommendations are organized into the following themes:

- Achieve Sustainable Use and Return
- Improve Water Storage and Control Operations
- Target Dry and Drought Years
- Advance Scientific and Technical Knowledge for Future Decisions
- Strengthen Basin Coordination

The recommendations are grouped into themes, intended to achieve a desired result or goal. The structure of these themes is shown below.

Each theme is elaborated in the sections that follow, identifying desired results and goal(s) and actions for achieving those goals. However, these five themes do not stand alone. Implementation of the recommendations from each individual theme is needed for sustainable water management of the ACF Basin.



Decision makers and citizens alike play important roles to implement these actions, to learn from the results, and to adapt our actions in the future based on what we learn. Suggested roles and responsibilities are highlighted in the Implementation chapter that follows.

THEME 1

Achieve Sustainable Use and Return

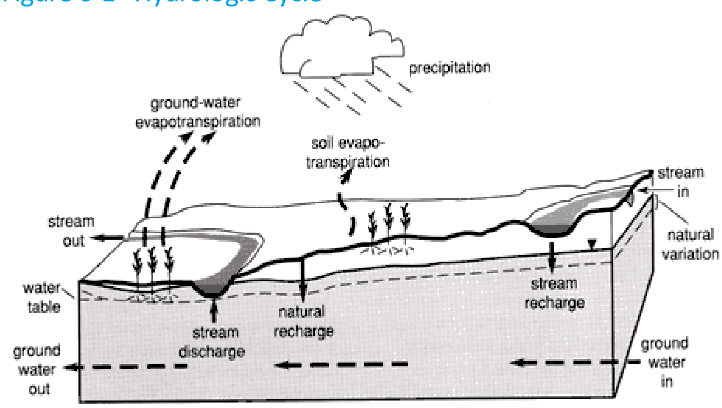
Desired Result: Ensure a reliable supply of water to sustain ecosystems to support environmental, social and economic needs.

Comparing sustainable water management to personal finance can help convey some basic concepts. If you manage a checking account sustainably, you likely do the following:

- Ensure accurate accounting of all the transactions.
- Avoid spending more than you deposit.
- Plan for emergencies by having a savings account.

A water budget operates in much the same way. The choices people make are important for sustainable water resources management, since human activities can affect the amount and timing of water flows. Unlike your personal bank account, however, there is not one entity that controls and manages the deposits and withdrawals in a basin.

Figure 6-1 Hydrologic Cycle



Water budgets also are complicated by the fact that the amount of water varies seasonally and annually, and water moves within a basin through a hydrologic cycle, as shown on Figure 6-1.

To ensure a reliable and sustainable supply of water to sustain environmental, social and economic needs, ACFS agreed on the following goals:

- Goal 1: Recognize success in water use efficiency
- Goal 2 : Achieve water use efficiency and conservation improvements
- Goal 3 : Increase water returns and return flows back to the basin of origin

Individual goals are discussed in the following sections.

Goal 1: Recognize success in water use efficiency

Sometimes when you are climbing a mountain, it is easy to forget how far you have climbed until you look back and see where you started. The adage "what gets measured gets done" also can prove helpful benchmarking in maintaining momentum and achieving more. Thus, ACFS recommends that all state and local agencies measure and recognize water efficiency gains on a regular basis.

In the ACF Basin, water efficiency gains include the following:

Municipal

Cities and towns throughout the regional are increasingly aware of the importance of reducing their impact on aquatic resources. For example, the city of Columbus GA returns much of the water it withdraws from the Chattahoochee River because approximately 95% of its service area is sewered. In addition, the total water withdrawn throughout the Metropolitan North Georgia Water Planning District decreased by almost 12% from 2000 to 2010, while the population increased by almost 1,000,000 people.

Agricultural

Agricultural water use efficiency continues to improve through innovation with mechanical retrofits that spray water closer to the ground so less water is lost to evaporation. Variable rate irrigation is another innovation that allows a farmer to refine irrigation patterns through GPS–based software, remove non–crop areas from irrigation and view soil moisture data from sensors in the field. The University of Georgia, the Natural Resources Conservation Service (NRCS), regional soil and water conservation districts, the Georgia Water Planning and Policy Center at Albany State University, and other institutions in Georgia and elsewhere are helping to develop, refine, and advance agricultural irrigation efficiency through research and demonstration projects. At the University of Georgia's Stripling Irrigation Research Park, researchers are studying new irrigation efficiency methods and technologies, including irrigation scheduling, variable rate irrigation, conservation tillage, and deficit irrigation. The NRCS's Conservation Innovation Grants program has supported projects in the region in the past few years to promote the adoption of irrigation automation for water use efficiency as well as the use of low-cost irrigation scheduling tools. NRCS also supported the Agricultural Water Enhancement Program (AWEP), a voluntary conservation initiative that provided financial and technical assistance to agricultural producers to conserve surface and groundwater and improve water quality.

Energy

Georgia Power and the Electric Power Research Institute have recently opened a Water Research Center at Georgia Power's Plant Bowen, near Cartersville, GA, to research water-dependent technologies associated with power generation. The center provides a research platform for testing technologies to address efficiencies of water use in generating electricity. Research may also result in lower water withdrawal and/or consumption, and improved overall water quality in power plant processes.

While more can be done to support Basin wide implementation of water conservation measures, recognizing success provides an important accounting benchmark and helps focus on sector appropriate demand reduction strategies in the future.

Recommended Actions

ACFS recommends that:

1.1.1 All appropriate agencies within each state should report status and outcomes of use and return policies, regulations, and practices that affect water quantity and quality in the Basin and report progress so that states can share successes with all water users in the Basin.

1.1.2 All stakeholders in the Basin promote education and public awareness of issues associated with sustainable water management planning and implementation.

Goal 2: Achieve Water Use Efficiency and Conservation Improvements

It is one thing to find fault with an existing system. It is another thing altogether, a more difficult task, to replace it with an approach that is better.

–Nelson Mandela

Analyses by the Georgia Water Resources Institute and others show that conditions improve for most stakeholder interests with reduced consumptive use in the Basin especially during dry and drought years. Under existing reservoir operations, reducing demand increases storage in federal projects increasing lake levels which, in turn, reduces the risk of having insufficient water to satisfy Basin needs during drought.

Water use efficiency and conservation can reduce consumptive use. Water use efficiency means using improved technologies and practices that deliver equal or better service with less water. For example, leak detection programs can reduce the amount of water, pressure, and energy required to deliver the same amount of water to consumers' taps. Efficiency measures conserve water. Conservation can also include beneficial reductions in water use. For example, a water conservation management practice could involve minimizing lawn watering in order to conserve water in a drought. Further advances in water use efficiency and conservation are expected in coming years.

ACFS recommends that:

1.2.1 States implement the water use efficiency and conservation policies and practices that will achieve:

- Reduced impacts to stream flow of consumptive use from agriculture by 15% overall through a suite of management practices that minimize water loss from agriculture including equipment retrofits, identification of source switching opportunities, and tillage practices including sod-based rotation.
- 80% efficiency by 2020 of all center pivot irrigation systems in the ACF Basin.
- More efficient cooling towers.
- Increased use of xeric landscaping.

- Improved commercial and industrial water conservation.
- Conservation rate structures for residential water users.
- Water efficient toilets when old ones are being replaced.
- Water utility programs to assess and reduce water system leakage.
- Limitations on non-agricultural outdoor water use during dry periods.
- Local government or permitted utility long-range water supply plans, which include the following components: a description of the water system, anticipated needs and how they will be met (including specific conservation targets), storm water management systems, system water loss and integrity, and public information/education to highlight water management concerns.
- Encouragement for experimentation for programs with the potential to improve water conservation and efficiency.

The following discussion elaborates ACFS intent with respect to several of the recommendations above.

Reduced impacts to stream flow from consumptive use from agriculture

Agriculture in the ACF Basin, particularly in the Dougherty Plain of the lower Flint and upper Apalachicola, has made tremendous strides in water-use efficiency over the last 15-plus years. Tillage practices plus hardware and software upgrades have decreased annual individual-producer water use on a per-acre basis between 5 and 20%, depending upon location and other factors. Yet, overall agricultural water use has increased over that time period, and hydrologic effects on surface-water flows have increased apace. Some of the streams which are impacted by agriculture have experienced decreases in baseflow of between 80 and 100%. Intense research on water use and management practices has been accomplished and is ongoing. There are significant opportunities to not only increase water-use efficiency, incrementally, but to also produce an instream result in terms of improvement of baseflows. Thus, ACFS is recommending as an initial operational goal to increase baseflows in areas directly impacted by agriculture by approximately 15%. Changes in a wide variety of business and management practices will be necessary to achieve this goal. ACFS recognizes these as viable areas of best practice and management activity:

- Continued hardware and software retrofits and upgrades of existing irrigation equipment inventories: end-gun shutoffs; drop nozzles; variable-rate irrigation systems including incorporation of soil-moisture sensor technologies; sub-surface irrigation systems.
- Identification of opportunities to switch agricultural users from surface-water sources, and groundwater sources that are tightly connected to surface waters, to alternative sources of water (such as deeper aquifers) so that surface flows are restored and conserved. The process of identifying such opportunities should be careful to include detailed

analyses and understanding of how and to what degree alternative sources may be actually connected to the surface waters and overlying aquifers, working diligently to avoid further diminishments of overall regional resources.

- Expansion of conservation tillage practices, where applicable, such as sod-based rotation and no-till, along with other on-farm practices such as stream buffers and grassed waterways that improve soil health, water retention and water quality.
- Strategic uses of conservation easements to diminish water use and increase aquifer recharge.

Related to the goal of increasing agriculturally-affected instream flows by 15%, not only must we maintain a detailed understanding of mainstem measured flows, we must also achieve and maintain a detailed understanding of flows on major tributaries such as Spring, Ichawaynochaway, and Kinchafoonee/Muckalee creeks. Extensive databases exist and many analyses are already extant for these major tributary flowages. In most cases, the period of record equals those of mainstem gages. Their flows must be included in initial analyses and monitoring to assure maximum probabilities of success. Otherwise, there will be no clear method of measuring progress.

Improved commercial and industrial water conservation

Government officials and water managers should consider developing a commercial water audit program that targets high water users in the commercial and industrial sectors. Auditors can offer site specific assessments of use and provide suggestions for improved efficiency. These audits should consist of a site visit, characterization of existing water uses, and recommended changes to process and operations to reduce water usage.

Government officials and water managers should consider offering financial incentives, such as a rebate program, to high water users in the commercial and industrial sectors to reduce demand and improve efficiency. Rebates can be offered to businesses that retrofit buildings with high efficiency plumbing fixtures and equipment.

Government officials and water managers should consider dedicating resources to educate and assist new commercial and industrial customers on the importance of water efficiency and conservation. New customers can receive information on the maintenance of cooling towers, identifying leaks, and analyzing historical water data to identify previously undiscovered problems – such as leaks or inefficient equipment.

Government officials and water managers may also implement conservation rates for commercial customers. While increasing block rate structures may be appropriate for customers that have water use profiles similar to residential customers, commercial buildings that have more predictable water use patterns should be subject to uniform rates at minimum.

Conservation rate structures for residential water users

Conservation rate structures should set pricing signals that motivate customers to reduce waste. If properly designed, they can allow a utility to promote efficient water use while also ensuring the utility's revenue stability. Generally speaking, there are four different pricing structure options that are effective in encouraging conservation:

- Increasing Block Rate – reduces water use by increasing the per-unit charges for water as the amount used increases. The first block is charged at one rate, the next block is charged at a higher rate, and so forth. This is a common rate structure and is considered an effective and aggressive water conservation measure.
- Time of day pricing – higher prices are charged during a utility's peak demand periods.
- Water surcharges – a higher rate is imposed on excessive water use – i.e. water consumption that is considered higher than average.
- Seasonal rates – prices rise and fall according to water demands and weather conditions – higher prices usually occur during the summer.

Periodic rate adjustments may be needed to ensure that funds needed for regular operations are not jeopardized.

Replacement of old and inefficient toilets

Local water providers may offer a program to convert older and inefficient toilets to higher efficiency models (1.28 gpf) within their community. Strategies to distribute, install, or provide incentives to replace these fixtures on accounts owning pre-1993 built homes can employ the following options:

- Rebate incentive programs – customers can receive a credit to the water bill, cash, or voucher offsetting the cost for a new high efficiency toilet.
- Direct install program – the customer can exchange older toilets for a low-flow toilet with discounted installation through the water provider.

Water providers should focus on homes built prior to 1993 as they are most likely to contain inefficient toilets. Water providers should work with their jurisdiction's planning department to determine the number of housing units built by decade to determine the level of investment that will be required for a successful retrofit program.

Programs to assess and reduce water system leakage

Water systems should develop a program for identifying and reducing local water system loss. Water systems may implement the IWA (International Water Association)/AWWA (American Water Works Association) methodology for determining the extent of water losses in the distribution system. This methodology is especially relevant in that it identifies the areas of biggest water losses as well as their financial impact. Based on the data provided, the local water provider can develop a program to control water loss that is specific to their particular system. Additionally, a leak detection and repair program to recover lost water may benefit the water provider in that it can delay the need for developing new water sources and infrastructure.

The water system should keep the following in mind when developing such programs:

- Water losses should be assessed on an annual basis.
- Based on the assessment, a program should be developed for reducing water system loss.
- Achievable goals should be set to limit water losses.

Xeriscape/Climate Appropriate Landscaping

Local water providers and local governments should provide public education materials to residents on the benefits of xeriscape or climate appropriate landscaping. Education materials should demonstrate the effective methods for planning, installing, and maintaining a xeriscape. Xeriscape methods include planning around sun/shade areas, analyzing soil to understand type and fertilization needs, proper plant and turfgrass selection appropriate for climate, efficient irrigation design, sufficient mulch application, and appropriate maintenance to keep a healthy landscape.

Non-agricultural Outdoor Water Use

Water managers can also limit outdoor water demand through the implementation of a watering schedule. Decision makers should consider encouraging residents and other non-agricultural water users to direct their water consumption for the purposes of planting, growing or maintaining ground cover, trees, shrubs or other plants to appropriate times of the day (i.e. before 10 a.m. and after 4 p.m.). Outdoor water use for purposes other than watering of plants, such as washing personal cars or power washing, should be restricted to an odd/even day schedule.

Reducing outdoor water waste may be an appropriate tool to reduce water demand during dry periods. Local governments and utilities may adopt a water waste policy or ordinance to reduce the occurrence of improper irrigation and outdoor leaks. Non-compliance with the policy or ordinance may be treated as a municipal code violation.

Goal 3: Achieve Increased Water Returns

The effect of consumptive use is to decrease flows, particularly during dry years. Assuming all other things being equal, if the amount of water that is returned to the Basin is increased, consumption would be reduced and flows increased.

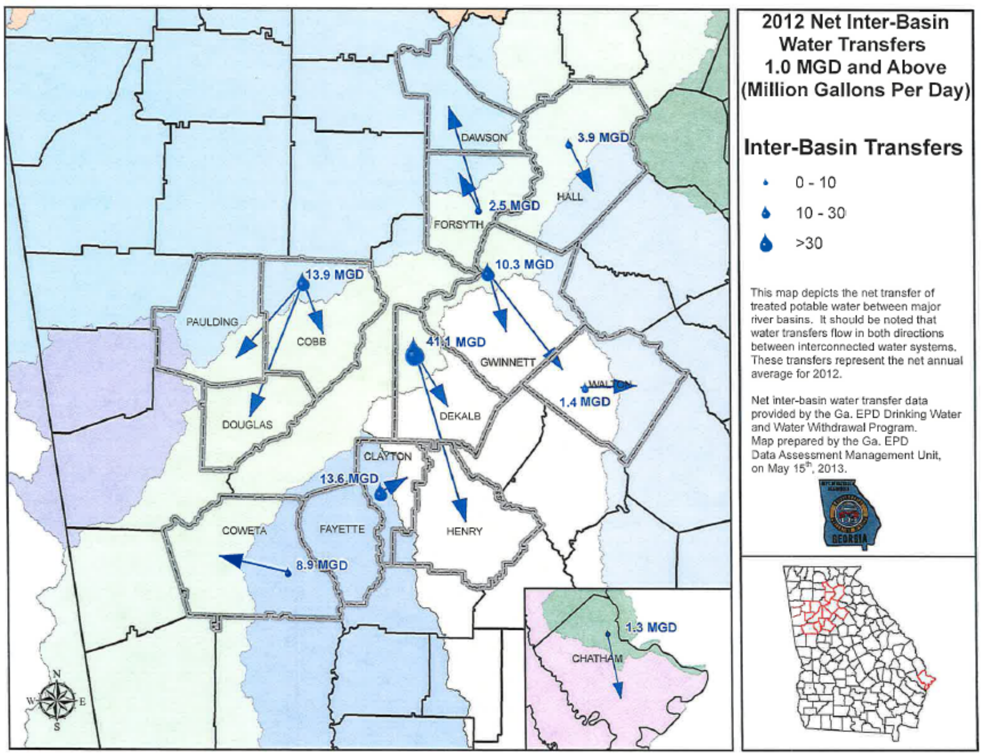
For some areas in the ACF Basin, portions of a water service area may be supplied from different river basins than the treatment and disposal of the resulting wastewater. This is an example of an interbasin transfer.

While, in some instances, it is possible for a wastewater provider to return some water from an interbasin transfer to the source basin once it has been treated at a wastewater facility, this can be expensive. For example, Clayton County was recently permitted to return 6.6 million gallons per day (mgd) to the Flint Basin rather than the Ocmulgee Basin. The estimated construction cost is $15 million. A summary of the interbasin water transfers for Chattahoochee and Flint Basins in Georgia during calendar year 2012 is shown on Figure 6-2 and in Table 6-1[11].

Table 6-1 Summary of the Interbasin Water Transfers for Calendar Year 2012

River Basin	Water Gained (cfs/mgd)	Water Lost (cfs/mgd)	Net (+/- cfs/mgd) [1]
Chattahoochee	35.2/22.8	89.4/57.8	-54/-35.0
Flint	0.0/0.0	34.8/22.5	-34.8/-22.5
[1] **Positive value indicates cumulative gain while a negative value indicates cumulative loss.**			

Figure 6-2 2012 Net Interbasin Water transfers 1.0 mgd and Above: From Georgia Department of Natural Resources Environmental Protection Division



ACFS modeled a scenario in which net interbasin transfers out of the Basin were offset by flow increases into the Basin. Results show that this change increased reservoir levels and river flows. This is due to the fact that there are currently more interbasin transfers leaving the ACF Basin than entering. Consequently, "net neutral" interbasin transfers results in a net increase of the amount of water available in the ACF Basin.

[11] 2012 Annual accounting of interbasin transfers in Georgia. Produced by Georgia Department of Natural Resources Environmental Protection Division.

Other observations included the following:

- Flint Flows: Flint flows at all locations in the upper Flint Basin (above the Dougherty Plain) are sensitive to interbasin transfers changes, especially in dry years. Removal of the interbasin transfers results in a 20% flow increase at Griffin and a 7% increase at Carsonville during dry years.
- Reservoir Levels: Interbasin transfers removal increases the minimum lake level at Lanier by 2 feet during dry years.
- Consumptive Use: Interbasin transfers removal reduces consumptive use deficits at Griffin from 15% to nearly 3%. This is due to the fact that at this location adjusting the interbasin transfers increases return flows that were previously discharged into an adjacent basin, thereby effectively decreasing the consumptive use target.
- Hydropower: Interbasin transfers removal results in slight improvements in meeting hydropower minimum generation requirements.
- Environment: All other things being equal, removing IBTs improves environmental metrics.

Natural Flow Paradigm is the preservation of the natural flow variability and ecological function of river systems.

-From the Instream Flow Council 2008

The Instream Flow Council (IFC) is a non-profit organization made up of wildlife agencies working to improve the effectiveness of instream flow programs and activities for conserving fish and wildlife and related aquatic resources.

ACFS recommends that:

1.3.1 Water users should implement actions that maximize water returns where ever possible. This can include, among other actions:

- Increasing connections to centralized sewage treatment, where feasible;
- Storm water management strategies that increase groundwater infiltration;
- Minimizing land application, where possible;
- Retrofitting and/or minimizing interbasin transfers (i.e. returning flows back to their basin of origin), where feasible.

Increased returns are important throughout the Basin. Increasing returns from municipal and industrial withdrawals in the Upper Flint to a level closer to the percentage returns in other parts of the Basin is a particular priority.

1.3.2 ACFS recommends that USACE study incentivizing return flows to federal multi-purpose reservoirs in the ACF Basin by crediting such flows to the appropriate users, taking into consideration the location and timing of returns and potential Basin impacts, including water quality and hydropower generation. Such a study should have as its goals improving the availability of water throughout the Basin and minimizing the need for new reservoirs.

THEME 2
Improve Water Storage and Control Operations

Desired Result: Realize improved environmental, social and economic benefits from available water resources.

Healthy aquatic ecosystems ensure people and aquatic life have adequate water for instream and consumptive uses. Understanding how these ecosystems have evolved in response to flow variability is central to making decisions that keep them healthy.

Over the past 50 years, the ACF Basin has experienced alterations to its flow regime due to impoundments and reservoir operations, withdrawals, discharges, dredging, channelization, impervious surfaces, and climate change. These changes have had both beneficial and adverse consequences. While storage provides benefits in terms of the reliable delivery of water to users and environment during normal variations in flow, aquatic habitat and other ecosystem functions on which people rely have been reduced by these same alterations in normal flow variations. Recent droughts have posed further challenges to the system's resiliency, or ability to maintain function and integrity for all stakeholder interests.

However, progress toward the protection and restoration of ecosystem function and integrity – and the benefits those provide for all – can be achieved if decision makers explicitly consider the natural variability of a river's hydrologic regime in terms of magnitude, timing, duration, frequency, and rate of change, when evaluating the environmental impacts of WMAs.

"JUST AS RIVERS HAVE BEEN INCREMENTALLY MODIFIED, THEY CAN BE INCREMENTALLY RESTORED, WITH RESULTING IMPROVEMENTS TO MANY PHYSICAL AND BIOLOGICAL PROCESSES."
Poff, et.al., "The Natural Flow Regime," BioScience Vol. 47 No. 11. 1997.

Recommended Actions

Modeling done for this plan demonstrates how changes in the storage in and operations of the current federal reservoirs, in combination with the water efficiency and conservation measures discussed in Theme 1, could simultaneously improve instream flows that sustain aquatic habitats in the Basin and the Apalachicola Bay while providing for both current and future consumptive uses. These operational changes also result in improvements to instream uses in the Basin and the Bay at current consumptive uses.

This demonstration is the basis for optimism that improvements in the benefits from operations of the federal dams can be achieved. However, modeling results must be confirmed in practice under the complex and variable realities of natural seasonal and annual variations in rainfall and human use. In reviewing the modeling results, stakeholders have additional questions about the degree of risk to upstream storage in the worst drought years, whether environmental flows at a magnitude and duration larger than what was modeled are possible and under what conditions, and how releases from the reservoirs might be managed to mimic natural flow variability more closely and still provide for authorized uses.

Thus, based on the modeling conducted for this plan, ACFS recommends that:

2.1 USACE adopt a policy of adaptive management in the revisions to the Water Control Manual, with the involvement of the states and stakeholders in the ACF Basin, implementing the following suite of actions taken together as a starting point to improve operations of the federal reservoirs on the Chattahoochee River:

- Raise the winter pool rule curve at West Point Lake from 628 ft to 632.5 ft.
- Define new zones to coincide with the USACE reservoir recreational impact zones and then only release water from an upstream reservoir when the downstream reservoir is in a lower zone.
- Adjust hydropower requirements to achieve more flexibility.
- Provide two pulsed water releases to achieve 9,000 cfs at Chattahoochee, FL for two weeks each, one in May and one in July. [12]

It is important to consider this suite of actions as a package. Using the banking analogy again, some of the changes add to system "savings" and others "spend" those savings on priorities for restoring instream flows and levels and for consumptive uses during droughts. Thus, each is interdependent on the other to achieve the intended results.

The sustainability of the package of recommendations, particularly under drought conditions, is based on technical modeling performed by ACFS consultants. Their adoption was predicated on three conditions: 1) the system storage during drier years is not worse than storage associated with conditions experienced currently under drier years, 2) instream flows during drier years do not become target flows in normal and wetter years and 3) the assumption (not modeled) that flood control will not be adversely affected. The sustainability of the package of recommendations and consistency with these conditions should be confirmed by USACE prior to implementation.

This adaptive management approach also should include a regular assessment of the effects of this package of operational rules and adjustments, as frequently

[12] Pulses were modeled as 9000 cfs flows at Chattahoochee, FL (not as an additional 9,000 cfs) – as well as 14,000 cfs – and only during periods when flows fell below 9,000 cfs (thus not reducing flows to 9,000 cfs when flows otherwise would have been higher).

as advances in science and the results of data collection to monitor desired outcomes warrant, but no less often than every five years and more often in the first years after this approach is adopted. Such assessments should consider increases and decreases in water use over time and should seek to achieve conjunctive instream flow benefits to the environment, navigation, hydropower, and recreation through pulse magnitudes and durations under dry conditions, consistent with the conditions identified above. USACE should utilize the expertise of one or more of its centers of excellence in implementing this adaptive management approach to draw on lessons learned across the country and to enable lessons learned in this Basin to be shared more widely.

In addition to this suite of recommendations for the current revisions to the WCM, ACFS also recommends the following. Both recommendations affect the water budget in the Basin, although in different ways:

2.2 USACE study and implement, if feasible, a 2 ft increase in the rule curve at Lake Lanier.

Over time, raising the rule curve at Lanier by two feet would add about 78,000 acre-feet of storage capacity to the system, or about 7% of the original Lanier active storage, which is needed now during drought years and will be needed as conditions and needs change in the future. This SWMP does not address allocation of this capacity; however, ACFS members concur that increased storage resulting from operational changes should be shared equitably and used in a manner that relieves the adverse impacts of drought conditions.

2.3 USACE study and implement, if feasible, modifying the calculation of Basin Inflow to account for consumptive use, taking overall system operations into account.

Adjusting the current method for calculating Basin Inflow needs to be better understood in a system-wide context, since it could result in changes to current operations and, thus, how well stakeholder performance objectives are met. The current method now results in downstream users experiencing lower flows with increased upstream consumptive use. Such a study also should consider: 1) potential adverse effects throughout the system if the recalculation results in system storage being expended sooner or reservoir levels remaining lower, 2) potential adverse impacts downstream if the recalculation results in longer duration of flows at the 5000/4500 cfs level, 3) the challenges of collecting consumptive use information, and 4) the effects on other authorized purposes including flood control.

Further, ACFS also recommends that:

2.4 USACE add a flow control node in the WCM at Columbus. This recommendation is contingent on the implementation of recommendation 2.1 above and is not a standalone recommendation.

The minimum flows for the proposed node should be developed to retain an approximation of the historical flow frequency while still achieving the benefits to upstream and downstream interests sought in recommendation

2.1. The following, observed from technical modeling used to develop Recommendation 2.1, should guide establishment of flow criteria:

- Daily flow at Columbus of 1,350 cfs was maintained at a frequency of approximately 97% for all years and 90% for dry years (see Chapter 5 for detailed discussion of model scenarios).
- West Point Lake elevation of greater than 632.5 ft was maintained at a frequency of approximately 82% for all years and 50% for dry years, and an elevation of 628 ft was maintained at a frequency of nearly 98% in all years and approximately 82% in dry years.
- Daily flow at Columbia of 2000 cfs was maintained at a frequency of approximately 97% for all years and 90% for dry years.

Criteria for minimum flows and lake levels that may occur as a result of extreme drought events should be developed through additional technical and stakeholder engagement and should incorporate the use of predictive drought triggers as discussed in Recommendation 3.2. USACE should work with Georgia Power and the State of Georgia to determine how operations need to be coordinated in order to meet these minimum flows effectively since Georgia Power reservoirs are between West Point Lake and the Columbus node.

This recommendation is intended to be implemented in the context of the overall recommendation that USACE take an adaptive management approach to the WCM, considering the needs and performance objectives of all stakeholders within the Basin. This includes the needs of upstream and downstream users as well as a variety of water needs throughout the Middle & Lower Chattahoochee Basin including: lake levels at West Point Lake for recreation and other purposes, municipal water supply (Columbus, Phenix City, AL, Ft. Benning), wastewater assimilation (Columbus, Phenix City, Ft. Benning, Meade Westvaco, GA Pacific Corp), recreation (whitewater boating in Columbus), environmental (shoal habitat restoration in Columbus) and nuclear power generation (Plant Farley).

In addition, ACFS recommends that:

2.5 USACE should work with the USFWS and other appropriate federal or state agencies to consider the Apalachicola River, Floodplain and Bay freshwater flow needs.

In its June 2012 Legal Opinion, USACE Chief Counsel states that "The system wide plan of development for the ACF Basin was intended to provide benefits for the purposes of hydropower, navigation, and flood control, estimated in annual average dollar values, and also to provide benefits for the purposes of municipal and industrial water supply, recreation, and fish and wildlife conservation, which were not quantified in the same manner." The legal opinion goes on to state that fish and wildlife protection and conservation are also general purposes for the ACF projects pursuant to the Fish and Wildlife Coordination Act.

Other federal law, policies and guidance exist that allow USACE to be proactive in sustaining and restoring ecosystem function and instream flows.

Finally, ACFS recommends that:

2.6 USACE update the Water Control Manual on a regular schedule, with a process for amending the Water Control Manual on a more frequent basis.

Recommended Actions for Navigation

Navigation is an authorized purpose of the ACF System. Navigation availability up the Apalachicola River has deteriorated over the past 20 years as outlined under the Stakeholder Interest Section. Preliminary assessment by the Corps suggests that about 21,000 cfs at the Chattahoochee USGS gage is needed for a commercially navigable channel (9 ft. x 100 ft.) without dredging as long as minor snag maintenance is accomplished.[13] Dredging may also increase channel availability, but must be done in a manner sensitive to aquatic habitat. It has also been shown that these flow levels to accommodate navigation may also have positive implications for other conjunctive instream flow uses including fish and wildlife, recreation and hydropower.[14] Floodplain habitat health can improve with appropriately timed releases for a duration that provides inundation beneficial for vegetation, fish and wildlife. A report was developed that documents this conceptually. Sustained flows at lower levels may also have positive benefits for water based recreation in lower and mid Chattahoochee River reservoirs and the Apalachicola River when channel depths of 3 to 5 feet can be maintained through low water months. Hydropower releases can provide low cost clean energy if releases are appropriately timed.

The following are recommended steps to USACE and its partners to improve navigation and related uses, while avoiding adverse environmental impacts:

2.7 USACE perform necessary field and design studies to confirm water flows needed and to define improvements to provide a reliable navigation channel with and without dredging, including time and conditions when full nine foot commercial channel is or may not be available and the degree to which such improvements can be done while preserving or enhancing aquatic habitat.

2.8 USACE perform necessary channel maintenance to maximize channel availability both in high flow without dredging for full nine foot channel depths and for sub-optimal channel depths (e.g. a seven foot channel). Studies outlined in recommendation 2.7 should consider channel

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[13] Verbal communications with Sam Hill (USACE) and Steve Leitman.

[14] Leitman, S, S. Graham, and C. Stover. An Evaluation of the Common Ground Between Environmental and Navigation Flows in the Apalachicola-Chattahoochee-Flint Basin. Report to Apalachicola Riverkeeper and Tri-Rivers Waterway Development Assoc. 2012.

modifications that will enhance channel availability during lower flow periods.

2.9 US Coast Guard provide effective guides for channel usage by all river travelers including facilities to support electronic boat guidance.

2.10 Local, state and federal governments and private sector should cooperate to support economically feasible and environmentally sensitive development that would support commercial and recreational benefits from navigation.

Additional Discussion

Stakeholders also discussed but did not agree on including water supply planning generally in this Sustainable Water Management Plan. Clearly, the responsibility to plan for water supplies should accompany population growth. However, stakeholders do not agree that new surface water reservoirs or aquifer storage in the ACF Basin are environmentally sustainable and purchase of water from other basins raises issues beyond the scope of this Plan.

THEME 3
Target Dry and Drought Years

Desired Result: Establish a shared framework for action and specific policy tools to reduce the adverse impacts of drought conditions.

Droughts in many ways are like economic recessions. It is difficult to know when they start and end. Drought lacks a universal definition. One commonly accepted definition is that drought is a condition when there is insufficient water to meet needs.[15] Drought is often said to be one of the most complex of all natural hazards, with more people affected by it than any other hazard.[16]

The Southern U.S. has experienced severe to exceptional drought conditions in the last ten years. During droughts, ACF experiences critical stresses with respect to most water uses and interests, such as reduced reservoir levels and streamflows, increased risk in maintaining adequate water supply, lowered hydropower potential, and reduced navigation availability.

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[15] Redmond, K. The depiction of drought—A commentary. Bulletin of the American Meteorological Society 83(8):1143–1147, 2002.
[16] Wilhite, DA; Glantz, MH. Understanding the drought phenomenon: The role of definitions. Water International 10:111–120, 1985.

Drought Planning Overview

Drought results in precipitation deficiencies and exacerbates demand placed on water resources. A drought today of similar intensity and duration as a past drought also may produce different impacts.

Because of this complexity, drought plans serve as important tools that help guide state and water managers throughout the different stages of a drought. There are a variety of different processes water users and states may follow to develop an effective plan as shown in Figure 6-4.

Figure 6-3 Lake Lanier Photo and U.S. Drought Map from January 2008

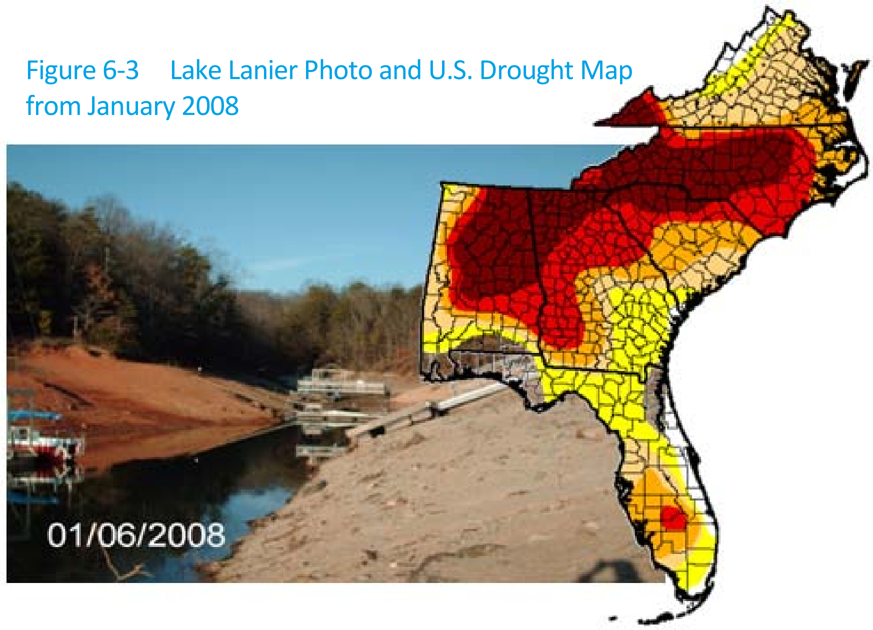

Figure 6-4 Drought Planning Processes

Multiple indicators for characterizing drought conditions exist, including precipitation deficits, stream flow, groundwater levels, and reservoir storage levels as shown in Table 6-2. Triggers, which are the specific values of indicators for activating drought responses, are often uniquely determined for each region. Establishing accepted drought triggers can help identify the onset and severity of deteriorating drought conditions and provide a warning for adequate drought response.

The three states have different indicators or triggers that water resource managers can use since each water basin or region is unique. Multiple jurisdictional boundaries, water supply demands and returns, and the number of water users can determine the scope and complexity of potential drought triggers.[17] While multiple drought indicators may improve detection, decision makers often use multiple indicators without realizing their spatial or temporal inconsistencies.

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[17] American Water Works Association (AWWA). (2008). Drought Management Planning Handbook, Publication, Denver.

Table 6-2 Indicator Considerations

Indicator	Notes	Advantages	Disadvantages
Reservoir Level	Historical reservoirs levels are not reliable drought indicators due to changes in operations and uses over time. Instead, drought triggers relying on simulations using historical hydrology with current basin conditions should be considered.	Generally easy to measure.	Simulated levels may have to be used.
Streamflow	Streamflow is the result of the total moisture in the watershed. It is a function of soil moisture, groundwater levels, runoff, and precipitation.	Accessible data through the network of USGS gages. Integrates soil moisture, groundwater level, runoff, and precipitation into a single indicator.	To remove effects of changing operations and water use over time, simulated streamflow or unimpaired streamflow should be used.
Groundwater Level	More important for many public water supply systems in the Coastal Plain.	Generally easy to Measure. Readily available where wells exist; groundwater levels in near surface aquifers reflect expected baseflow.	Groundwater levels are usually the slowest to respond to drought and the slowest to recover from drought. Other factors such as pumping could complicate the use of groundwater levels. Information available only where wells exist.
Drought Monitor	Integrates several drought indices and ancillary indicators into a weekly operational drought-monitoring map product.	A "big picture" assessment of drought conditions. Relatively simple presentation allows public, media, policy makers, and others to assess drought conditions.	Not intended to reflect drought conditions at smaller resolutions.
Precipitation (SPI)	Standardized Precipitation Index (SPI) quantifies precipitation deficit for multiple timescales, such as for 3-, 6-, 9-, and 12- month prior periods, relative to those same months historically.	Standardized, so its values represent the same probabilities of occurrence, regardless of time period, location, and climate.	1) No soil water-balance component, thus no ratios of evapotranspiration/potential evapotranspiration (ET/PET) can be calculated. 2) Generally calculated for a single gage, which may or may not adequately capture the spatial resolution.
PDSI AND PHDSI	Palmer Drought Severity Index (PDSI) and Palmer Hydrologic Drought Index (PHDI) The PDSI is derived from a moisture balance model, using historic records of precipitation, temperature, and the local available water capacity of the soil. The PHDI uses a modification of the PDSI to assess longer term moisture anomalies.	Permit comparisons of drought events over relatively large areas. Offer a long-term historic record, going back more than 100 years.	Cumulative frequencies vary, depending on the region and time period under consideration Indices are based on departures from climate normals, with no consideration of precipitation variability, so they tend not to perform well in regions with extreme variability in rainfall

Adapted from the following sources:

[1]Steinemann, A., Hayes, M., and Cavalcanti, L. (2005). "Drought indicators and trigger." Drought and water crises: Science, technology, and management issues, D. Wilhite, ed., Dekker, New York, 71-92.
[2]Wilhite, DA; Glantz, MH. Understanding the drought phenomenon: The role of definitions. Water International 10:111–120, 1985.
[3]Mizzell, Hope, Improving Drought Detection in the Carolinas: Evaluation of Local, State and Federal Drought Indicators, Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Department of Geography College of Arts and Sciences, University of South Carolina, 2008.

Modifying Drought Management in the ACF Basin

Drought management involves temporary, equitable reductions in water uses during droughts to conserve water so that deeper reductions or even catastrophic shortages can be avoided. A drought management plan typically includes triggers and reductions, either of which can be tiered to reflect increasing levels of drought. Triggers are conditions that activate or deactivate different levels of the drought management plan. Reductions are the amounts by which water uses are decreased once a level of the drought management plan has been triggered. Reductions can be applied in different ways to different water users or can vary by location.

Conceptual differences exist between two types of indicators, those based on measurements and those based on forecasted values. Examples of measured indicators include: reservoir storage or levels, composite reservoir storage, recent stream flows, groundwater levels, and drought indices such as the Standard Precipitation Index or Palmer Index. Forecasted values include: prediction of inflow quantities over coming months, classification of an upcoming season into wet/normal/dry categories, and modeled soil moisture. Triggers can be constructed by combining multiple indicators.

Measured indicators are more likely to be accurate, but are considered "lagging" indicators in that they often trigger action after drought has already become severe and options are more limited. Indicators based on forecasted values may not be as accurate, but they may allow more proactive and gradual reductions because those actions can be put in place earlier.

Recommended Actions

ACFS urges local, state and federal decision makers to establish consistent drought management plans that trigger incremental and equitable actions as early as possible. Water users and water managers need to be more proactive and less reactive in order to manage the system sustainably.

3.1 The states of Alabama, Florida and Georgia should collaborate in the development of a drought management plan, perhaps in the context of a regional MOU that includes the following:

- Defines drought conditions, using NOAA as a resource
- Identifies triggers for actions
- Delineates responses by water use sector
- Documents changes in operational strategies

The states are urged to collaborate with USACE, USGS, USFWS, EPA and NOAA (NIDIS) to develop a mechanism for determining drought triggers and to develop an ongoing evaluation of drought conditions in the Basin. Additionally, the states should develop appropriate conservation actions throughout the Basin and work with USACE to develop appropriate changes in operations when flows and levels reach drought conditions in sub-regional portions of the ACF Basin. Such a mechanism should recognize that reservoir operations and other actions taken by people may create drought-like conditions for some users even when the Basin as a whole is not in drought. Graduated drought mitigation actions should be considered for sub-basins not experiencing drought to help address conditions within sub-basin(s) experiencing drought.

3.2. ACFS urges USACE to utilize predictive drought indicators in the revised Water Control Manual. Various combinations of predictive drought indicators can be used that allow operation decisions to be made in drought years that enhance system flows while still preserving adequate reservoir storage during the drought. As a starting point for discussion, drought management planning discussions should consider:

- Triggers based on drought conditions (antecedent inflow, areal precipitation, and soil moisture), streamflows, time of year, and remaining storage in federal reservoirs.
- The RIOP uses composite storage alone as a drought trigger. USACE should also consider the state of the Basin (how dry or wet) in triggering drought operations. A drought index should be developed to guide the decision based on the predictive drought indicators selected (e.g. antecedent Mean Areal Precipitation and/or soil moisture). In addition, USACE should use regional sub-basin drought indicators (e.g. for the Apalachicola River, Apalachicola Bay, the middle Chattahoochee or the Flint) to consider changes in operations rather than waiting for designation of drought in the entire ACF Basin.

3.3 The State of Georgia, through financing or other mechanisms, should facilitate the augmentation of instream flows through the use of existing storage in existing reservoirs constructed, owned or operated by local governments, especially in the Upper Flint River Basin.

3.4 USACE should develop special operations to address extended drought (multi-year) conditions in the Basin, based on the proactive, predictive triggers and responses as recommended above.

THEME 4
Advance Scientific and Technical Knowledge for Future Decisions

Desired Result: Improve understanding of the watershed to support adaptive management.

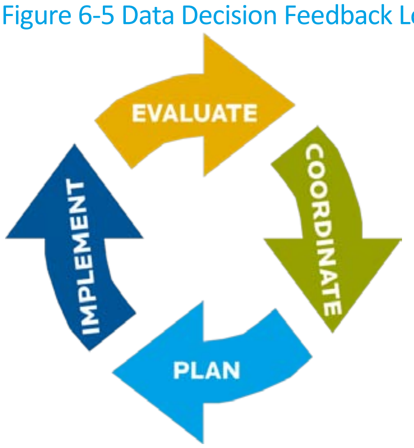
Developing a common, scientifically valid understanding of the ACF Basin is one of the goals of ACFS. In the development of the Plan, ACFS members gained a better understanding of the Basin and the Apalachicola Bay, but also encountered challenging gaps in scientific and technical knowledge both for near-term decisions and for future adaptive management. This theme identifies some of the information needs in the Basin.

What is Adaptive Water Management?

Traditionally, water resource management involved using historical data to predict future conditions.

Adaptive water management is an approach that is able to operate under a wider range of variability and with a greater focus on gathering data to inform future decisions. It encourages articulation of performance measures, monitoring to assess how well planned actions are achieving the intended objectives, and adjustments in plans based on what was learned. Within the corporate setting, similar concepts are total quality management and continuous improvement.

Figure 6-5 Data Decision Feedback Loop



The WaterSMART Geographic Focus Area Study in the ACF Basin

WaterSMART, which stands for Sustain and Manage America's Resources for Tomorrow, is an initiative launched by the U.S. Department of the Interior in February 2010 to implement the SECURE Water Act. One of the three geographic areas that the USGS is focusing on is the ACF Basin. This study will build on existing USGS data collection and modeling capabilities to enhance estimates of water use, develop linked surface-water and groundwater models, and develop relations between streamflow and ecological conditions.

The ACF Basin Focus Area Study has three major components:

- Estimating water use. The water-use component is developing a site-specific database of water use for the ACF Basin, developing improved methods for estimating agricultural withdrawals, and compiling available water-use projections.
- Modeling surface-water and groundwater flow. The hydrologic modeling component will consist of a surface-water model for the entire ACF Basin and a groundwater model for the lower ACF Basin. These models will be linked where agricultural pumpage of groundwater is greatest.
- Developing a better understanding of the ecological effects of hydrologic alterations. The ACF River Basin's physical and biological diversity, and its importance to diverse water users, provide an ideal context for developing tools that will allow stakeholders to better estimate streamflow requirements for ecological purposes. Ecological water science activities in the ACF combine basin-wide streamflow models with on-the-ground measurements of changes in the occurrence or abundance of different kinds of fish and mussel species.

The Study is expected to be completed in 2015. Additional information can be found by visiting:
http://water.usgs.gov/watercensus/acf.html

Adaptive management is a structured, iterative process of optimal decision-making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring.[18] As new knowledge is gained, predictive models can be updated and management decisions adapted based on new data collected on the performance of the previous decision as shown on Figure 6-5. The feedback loop is the tool at the heart of adaptive management.

[18] Stankey, George H; Roger N. Clark and Bernard T. Bormann. Adaptive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 73 p.

Recommended Actions

ACFS members recommend that investments in the knowledge about the Basin be made in the following areas:

- Environmental and ecological studies
- Climate variability studies
- Shared real-time water use/return/storage/flow information
- Improvements in modeling

Additional Environmental and Ecological Studies

ACFS agrees that maintaining the ecological integrity of the water and land resources now and in the future is a priority. Understanding what will be needed to achieve this will require additional environmental and ecological studies. These include information needed for instream flow assessments in all three rivers, expanded Bay modeling and interconnectivity between land application, agricultural water use and groundwater recharge, among others.

Specifically, ACFS suggests that USACE develop a full instream flow assessment, taking into consideration the natural variability of the ecosystem's hydrologic regime (magnitude, timing, duration, frequency and rate of change) as a framework for the EIS for the revisions to the Water Control Manual. This should be done in coordination with USFWS, NOAA, EPA, ACFS and others.

Climate Variability Studies

Climate varies over seasons and years instead of day-to-day like weather. In April 2014, 300 experts guided by a 60-member Federal Advisory Committee produced the National Climate Assessment, which summarizes the impacts of climate change and variability on the United States, now and in the future. For the Southeast, the report noted the following:

- While temperatures across the Southeast and Caribbean are expected to increase during this century, projections of future precipitation patterns are less certain than projections for temperature increases.[19]
- The net water supply availability in the Southeast is expected to decline over the next several decades, particularly in the western part of the region as shown in Figure 6-6[20].

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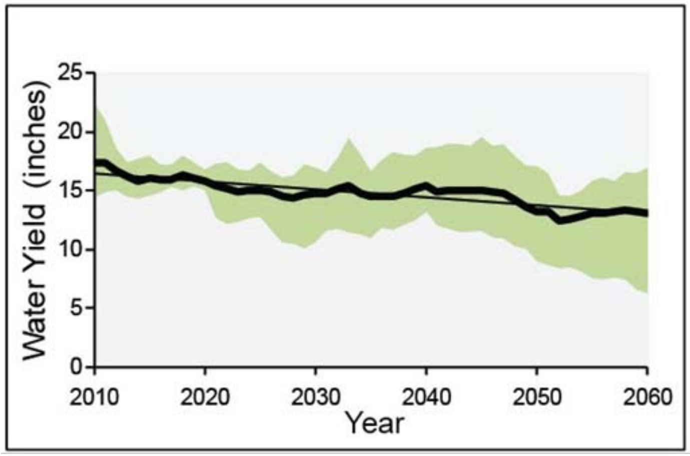
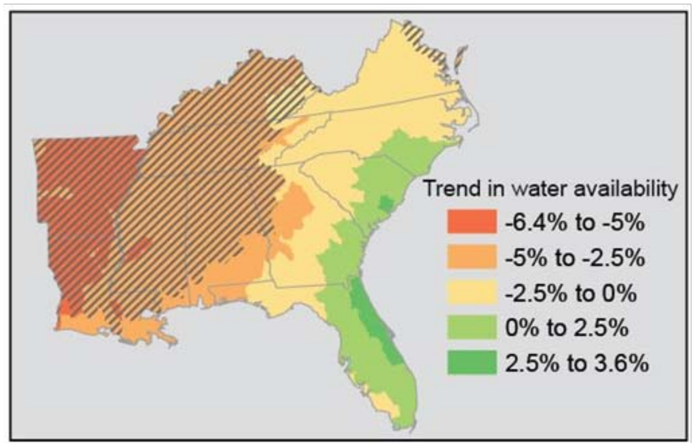
[19] Kunkel, K.E., L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, C.E. Konrad, II, C. M. Fuhrman, B.D. Keim, M.C. Kruk, A. Billet, H. Needham, M. Schafer, and J.G. Dobson, 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment.

[20] Sun, G., S. Arumugam, P.V. Caldwell, P.A. Conrads, A.P. Covich, J. Cruise, J. Feldt, A. P. Georgakakos, R.T. McNider, S.G. McNulty, D.A. Marion, V. Misra, T. C. Rasmussen, L. Romolo, and A. Terando, 2013: Impacts of climate change and variability on water resources in the Southeast USA. Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability, K.T. Ingram, K. Dow, L. Carter, and J. Anderson, Eds., Island Press, 210-236.

A better understanding of the implications of possible future conditions can help with management decisions. For example, since changes in temperature can have an effect on reproduction in fish, additional scientific research could help determine the potential impacts on fish spawning and migration in the ACF Basin from changing rainfall, temperature increases, and sea level rise.

Figure 6-6 Projected trend in Southeast annual water yield due to climate change. The green area represents the range in predicted water yield from four climate models (Adapted from the 2014 National Climate Assessment Report from the U.S. Global Change Research Program)





Shared Real-time Water Use/Return/Storage/Flow Information

Access to real-time water information is fractured among different federal agencies, state agencies, and water users. For example, while USGS provides data access to river flow (approximately 15 minute interval) and lake levels (daily basis), there is no single location where stakeholders and water managers can access information concerning the status of the Basin's rivers and lakes.

ACFS members believe better real-time water data will enhance Basin water management decisions.

Improvements in Modeling

During the development of the SWMP, questions about specific sources of data used as inputs to modeling basis arose. For example, the UIFs dataset used in the modeling was examined in a study for ACFS by the Georgia Water Resources Institute/Georgia Tech. UIFs for the ACF Basin have been developed by the U.S. Army Corps of Engineers Mobile District and by the Georgia Environmental Protection Division (GAEPD). These UIFs have been used to evaluate the comparative effects of alternative development and management plans. The study found some methods to improve this dataset; however, additional funding to improve this dataset was not available.

Some stakeholders are concerned about policies that rely on UIFs to the extent that uncertainties in the assumptions may lead to a UIF data set that substantially diverges from historical stream flows. Although modeling results using UIFs are intended for evaluating the relative benefits or impacts of water management alternatives, these stakeholders are concerned that modeling outputs may lead to policies that do not accomplish the intended goal. For example, modeled results may be too optimistic and, thus, policies allocate more water than will actually be available over time, if consumptive uses actually are higher than assumed or evaporation losses are lower than assumed.

Recognizing that all UIF data sets have flaws, ACFS decided to use the existing UIF data sets, in part because of the time and expense involved in commissioning a revised UIF data set, but also so that the modeling conducted for this plan would provide comparable results to modeling being done by USACE for the Water Control Manual revision.

In making this decision, ACFS also approved initiating development of a recommendation to the states and USACE regarding improvements to the UIF dataset, continuing on-going dialog with natural resource agencies regarding the environmental flows performance metrics, relative to the concerns about errors in the UIF dataset and a discussion of the UIF uncertainties.

Therefore ACFS members recommend that:

4.1 USACE, in cooperation with the states, improve and further refine the UIF data set currently available for the ACF Basin. These refinements should assess the timing of the relationship among precipitation, evapotranspiration and flow; whether farm ponds supplement, reduce, or do not meaningfully alter low flows during droughts; and other items as determined appropriate by USACE.

4.2 The following additional studies be considered, among others, as funding becomes available. Government agencies, academic institutions and private organizations may wish to undertake or to sponsor specific studies within their areas of expertise or mandate; collaborative efforts are encouraged; and results should be shared widely.

Table 6-3 ACF Basin Studies to Consider

Additional Environmental and Ecological Studies
Connectivity between surface and groundwater in the upper Apalachicola lower Flint Basin.
Desired flow regimes for specific species of interest for reaches throughout the Basin.
Instream flow assessment that determines flow variability and flow needs in the Flint River.
Flow needs for both cold water (trout) and warm water (shoal bass) fisheries in the upper Chattahoochee River.
Comprehensive hydraulic, hydrologic, hydrodynamic and geomorphic assessments and monitoring of Apalachicola Bay and establish a Bay Recovery and Management Plan to sustain 7500 acres of healthy oyster bar habitat.
Apalachicola River fluvial geomorphologic assessment and restoration project evaluation and prioritization for recovery of flood plain connectivity, channel pattern, profile, and cross section and overall ecological function.
An Apalachicola Bay Management Plan specifically related to saltwater intrusion, fishery management, etc.
Expanded bay monitoring.
Additional measures to improve consistency in the performance data. Additional measures could include the number of days with inundated floodplain and monthly increases/decreases in acres of healthy oysters in the Apalachicola Bay.
Interconnectivity between land application, agricultural water use, and groundwater recharge.
Study on flow impacts to eastern gulf.
Woodruff Dam structural improvements to eliminate operational constraints
Potential river channel modifications including physical habitat restoration to improve ecological conditions and improve flood plain connectivity.
Potential bay modifications that could enhance maintenance of desirable salinity ranges for oysters during low flow conditions.
Improve understanding the impact of farm ponds and other impoundments and their hydrologic function.
Upper Flint Reservoir Study to investigate the feasibility of utilizing existing reservoir in the upper Flint for support of instream flows during droughts.
Feasibility of converting direct stream withdrawals to groundwater sources and exploring the feasibility of switching those Floridan Aquifer withdrawals that have strong (>0 .4 or 0.5:1) connections to surface stream flows to deeper aquifers, along with the exploration of the switching of surface withdrawals.
Climate Variability Studies
Climate variability projections in the ACF Basin to improve the accuracy of forecasted weather patterns, resulting rainfall projections, and sea level rise.
Effect of climate variability on sea level rise on Apalachicola Bay and its estuaries.
Effect of climate variability on fish spawning and migration in the ACF Basin.
Effect of climate variability on impacts of and potential mitigation both for droughts and floods, including implications for flood control and storage infrastructure.
Provide real-time flow and storage information and move toward the capability to add real-time withdrawal and return flow information.
Increase the number of rainfall/ flooding forecast sites in the Basin.
Develop comprehensive database of ACF rainfall data (this could also provide useful information for Basin modeling).
Develop a web-based tool to explain real-time water management constraints and drivers.
Improve the unimpaired flow (UIF) data set, in particular to address systematic errors that may exist.
Increase the number of continuous, real-time water flow, groundwater monitoring, and water quality monitoring stations in the Basin
Other Studies
West Point and Lanier Studies to implement rule curve changes.
Alternative Water Supply studies to meet projected increases in consumptive use in the Basin.

Funding for Additional Studies

ACFS recommends that funding be appropriated for additional studies in order to ensure continued progress toward better water management in the ACF Basin. Recommendations include the following:

4.3 Federal funding should be sought for federal, state and regional basin studies.

4.4 All states should provide funding for ongoing research studies for enhanced Basin understanding.

Consistent Permitting and Better Water Use / Return Reporting

4.5 ACFS members agree that more consistent permitting and better water use and return reporting would be beneficial to water management in the ACF Basin and urge Alabama, Florida and Georgia to review their policies for consistency with the following desired objectives:

- Water withdrawal permits for all groundwater and surface water withdrawals in the Basin will be required for users greater than 100,000 gallons per day.
- All permitted municipal and industrial water users (including both surface and groundwater) self-report daily water withdrawals in electronic format on a monthly basis. All permitted agricultural users (including both surface and groundwater) self-report water withdrawals in electronic format annually. States should report status and outcomes of use over time to the public.
- All water dischargers self-report daily water discharges in electronic format on a monthly basis.
- Permit issuers should develop usage benchmarks calculated in a consistent way.
- Establish a consistent, strong permit enforcement program.
- Perform a comparative evaluation of the water use regulatory and permitting systems and consider adopting approaches that would enhance water availability for the existing and future uses/needs in the ACF Basin.

THEME 5
Strengthen Basin Coordination

Desired Result: Establish sustainable, efficient, and adaptive Basin-wide management of water resources.

The Water Resources Reform and Development Act of 2014, signed by the President on June 10, 2014, could not be clearer. Discussing conflicts in the ACF, Congress states the following in Section 1051:

> *"Interstate water disputes of this nature are more properly addressed through interstate water agreements that take into consideration the concerns of all affected States including impacts to other authorized uses of the projects, water supply for communities and major cities in the region, water quality, freshwater flows to communities, rivers, lakes, estuaries and bays located downstream of projects, agricultural use, economic development and other appropriate concerns. To that end, the Committees of jurisdiction strongly urge the Governors of [Florida, Georgia, and Alabama] to reach agreement on an interstate water compact as soon as possible, and we pledge our commitment to work with the affected States to ensure prompt consideration and approval of any such agreement."*

ACF Stakeholders agree that a mechanism for Basin coordination should be established through a carefully constructed, enduring management framework that fosters collaboration and responds to changing conditions. This is possible if a concerted effort is made. Congress has issued an invitation; the time to respond is now.

The current adversarial relationship between the states cannot be ignored and should not be dismissed. Nor should it paralyze action. The current climate of litigation is, in fact, the reason it is more critical than ever to provide an *immediate* forum for discussions among water users, state and federal agencies, and state executive offices. Thus, ACFS recommends establishment of a transitional organization that brings all parties together at least to start a conversation that might lead to a common vision and framework for a formal transboundary institution.

Establishment of a transboundary water management institution can coordinate and integrate existing water programs, address gaps, provide an ongoing forum for building consensus and resolving conflicts between jurisdictions and upstream and downstream users, and anticipate and respond equitably to changing conditions in climate, population, and land use.

No organization currently exists to perform such essential services in the ACF. A new transboundary organization can provide the ongoing administrative infrastructure needed to transcend current jurisdictional divisions to promote water security, aquatic health and biodiversity, and economic development for all three states.

Many lessons can be learned from the numerous examples of transboundary water management institutions across the United States and around the world. Among these lessons is the value, even the necessity, of engaging all concerned in determining the functions and shaping the institutional arrangements best tailored to the specific needs and circumstances in that Basin. In other words, begin now but take the time needed to establish a lasting mechanism. This is particularly important in the ACF Basin.

Transitional organizations have been successful facilitating the discussion and consensus necessary to build support for permanent transboundary water management institutions. For example, in 1955, after 25 years of litigation and a U.S. Supreme Court decree, the governors of the states in the Delaware River Basin and the mayors of Philadelphia and New York established the Delaware River Basin Advisory Committee to survey its water resources and recommend a course of cooperative action; the group's work ultimately resulted in the drafting and adoption of the Delaware River Basin Compact in 1961 and the creation of the Delaware River Basin Commission. The Ohio River Valley Water Sanitation Commission was established in 1948 specifically to oversee pollution control pursuant to a federal-interstate compact. In determining whether they should expand their role to include water supply and other functions, the Commission in 2011 established a Water Resources Committee to identify the Basin's water resources, examine laws and regulations, and evaluate the need for and feasibility of an expanded role. The Committee includes state and federal agency representatives, appointees of the Chairman of the Commission, and ex officio technical experts.

Recommendations for a Transitional Organization Leading to a Future Transboundary Institution

Based on research of The University Collaborative funded by ACFS, ACFS recommends:

5.1 Establishment of a transitional organization that brings together stakeholders with state and federal agency representatives to develop a common vision and framework for a future permanent transboundary institution to facilitate sustainable and adaptive management of the Basin that shares water equitably among stakeholders, balancing economic, ecological and social values.

ACFS recommends consideration of three scenarios. Two initial alternatives for structuring a transitional organization in the ACF Basin are provided. In the first alternative, ACFS would maintain its current organizational framework and host the transitional organization. The other two alternatives involve creating a new entity. With the second alternative, ACFS would provide the organizational home for the new entity but would accommodate federal and state representatives. Two potential models for the second alternative are: (a) the Catawba-Wateree River Basin Advisory Commission, and (b) the ACT[21]/ACF Comprehensive Study Executive Coordination Committee and Technical Coordination Group which was active in the 1990s. The third alternative would establish a new organization, independent of ACFS. ACFS expects to make a decision on an approach in 2015.

In the ACF, the most critical role for a transboundary organization to address is the fragmentation of existing water management programs and entities in the Basin by providing a forum for collaborative planning and decision making. The organization would not duplicate existing programs but would enhance them. In 2013‐2014 the TUC conducted a Gap Analysis of Water Management Functions in the ACF and, based on these findings, ACFS has identified the following as the most important functions on which a permanent transboundary organization should initially focus its efforts:

- Acting as a data clearinghouse and facilitator of common data standards (collection, management, etc.);
- Encouraging and facilitating coordination and consensus building and providing conflict resolution services;
- Supporting development of basin-level water management plans, specifically related to conservation and returns, supply augmentation and drought management; and
- Educating the general public and specific stakeholders about the need for transboundary management and particular opportunities and strategies for doing so.

More detail about these functions is defined below.

Data Clearinghouse and Facilitation

Data management and facilitation is critical in the ACF, where disputes over research and data reliability have resulted in a number of impasses. Here, a permanent water management organization could: (1) provide easily accessible, accurate and relevant data to decision makers, researchers and the general public; (2) facilitate new studies to close current gaps in data to better inform decisions; and (3) compile comprehensive datasets critical for sustainable water management (currently lacking). Easily accessible and comprehensive data could improve decision making and research and help engage and inform the general public.

[21] Alabama-Coosa-Tallapoosa (ACT)

Coordination, Consensus Building and Conflict Resolution

Empowering parties to work together rather than at cross purposes is the most important task for a permanent ACF transboundary institution. Facilitation of communication will be critical in building consensus for coordinated management and a unified vision to attract funding and other investment. Resolving conflicts is also a critical role. Water management is by its nature contentious, and transboundary negotiations can, as has been experienced in the ACF, quickly become antagonistic. Professionally facilitated consensus building and conflict resolution can help prevent disputes and find acceptable solutions to those that are unavoidable.

Adaptive Planning

Adaptive planning is used to achieve widespread institution-level goals (such as comprehensive water quality or water allocation planning) and to address specific issues (such as drought or flooding), through a structured and iterative process of decision making that aims to reduce uncertainties through time. Three priority areas for adaptive planning were identified through facilitated discussions at 2014 ACFS Governing Board meetings in Apalachicola, FL and Eufaula, AL: 1) drought, 2) supply augmentation, and 3) conservation/returns.

Drought planning is engaged in by a number of transboundary institutions, including the Murray-Darling Basin Authority in Australia, the Interstate Commission on the Potomac River Basin, and the Delaware River Basin Commission. Numerous federal, state, and regional organizations have initiated some form of drought planning in the ACF. However, these efforts are insufficient because they are limited in geographic scope and/or authority; thereby reducing their ability to influence activities outside of agency jurisdiction or across state lines. Building upon successful aspects of these efforts and harnessing existing momentum would be one appropriate course for a permanent ACF organization.

Supply Augmentation, which includes supplementing inadequate supplies with traditional (reservoirs, interbasin transfers) and non-traditional (desalination, storage and recovery) sources, requires long-range planning. These approaches are and will continue to be utilized in the ACF, and a permanent transboundary organization should be involved in planning here to some extent to ensure a system-wide perspective is maintained.

Finally, Conservation/Returns includes decreasing water demand and increasing returns to the system. Because of the large impact on water supply and the potential to alleviate effects of drought, a transboundary organization should play some role in developing plans for conservation and returns, in order to ensure costs and risks, as well as benefits, are shared evenly.

Education

It is critical to keep the public informed of transboundary water management activities and the reasons for organizational decisions. A supportive public makes compliance with and implementation of decisions more likely and generates the political support that assures a more informed, smoothly functioning, appropriately funded, and long-lasting organization.

Additional Recommendations

In addition to the formation of a transitional organization to provide a forum for shaping a common vision and framework for a formal transboundary institution, ACFS also recommends that:

5.2 The Sustainable Water Management Plan for the ACF Basin should be revised on a 5 to 10-year schedule.

CHAPTER 7.
Implementation

Achieving the ACFS' vision for improvements to conditions in the Basin requires implementation of the recommendations identified and detailed in Chapter 6. What follows are general implementation actions, not necessarily the full recommendations, grouped by the suggested responsible party.

United States Army Corps of Engineers:

- Study incentivizing return flows to federal multi-purpose reservoirs in the ACF Basin by crediting such flows to the appropriate users, taking into consideration the location and timing of returns and potential Basin impacts, including water quality and hydropower generation. Such a study should have as its goals improving the availability of water throughout the Basin and minimizing the need for new reservoirs (1.3.2).

- Adopt a policy of adaptive management in the revisions to the Water Control Manual, with the involvement of the states and stakeholders in the ACF Basin, implementing the following suite of actions taken together as a starting point to improve operations of the federal reservoirs on the Chattahoochee River (2.1):
  - Raise the winter pool rule curve at West Point Lake from 628 ft to 632.5 ft.
  - Define new zones to coincide with the USACE reservoir recreational impact zones and then only release water from an upstream reservoir when the downstream reservoir is in a lower zone.
  - Adjust hydropower requirements to achieve more flexibility.
  - Provide two pulsed water releases to achieve 9,000 cfs at Chattahoochee, FL for two weeks each, one in May and one in July. [22]

- Study and implement, if feasible, a 2 ft increase in the rule curve at Lake Lanier (2.2).

- Study and implement, if feasible, modifying the calculation of Basin Inflow to account for consumptive use, taking overall system operations into account (2.3).

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[22] Pulses were modeled as 9000 cfs flows at Chattahoochee FL (not as an additional 9,000 cfs) – as well as 14,000 cfs – and only during periods when flows fell below 9,000 cfs (thus not reducing flows to 9,000 cfs when flows otherwise would have been higher).

- Add a flow control node in the WCM at Columbus. This recommendation is contingent on the implementation of Recommendation 2.1 above and is not a standalone recommendation (2.4).
- Work with the USFWS and other appropriate federal or state agencies to consider the Apalachicola River, Floodplain and Bay freshwater flow needs (2.5).
- Update the Water Control Manual on a regular schedule, with a process for amending the WCM on a more frequent basis (2.6).
- Perform necessary field and design studies to confirm water flows needed and to define improvements to provide a reliable navigation channel with and without dredging, including time and conditions when full 9 ft commercial channel is or may not be available and the degree to which such improvements can be done while preserving or enhancing aquatic habitat (2.7).
- Perform necessary channel maintenance to maximize channel availability both in high flow without dredging for full 9 ft channel depths and for sub-optimal channel depths (e.g. a 7 ft channel). Studies outlined in recommendation 2.7 should consider channel modifications that will enhance channel availability during lower flow periods (2.8).
- Utilize predictive drought indicators in the revised Water Control Manual. Various combinations of predictive drought indicators can be used that allow operation decisions to be made in drought years that enhance system flows while still preserving adequate reservoir storage during the drought. As a starting point for discussion, drought management planning discussions should consider (3.2):
    - Triggers based on drought conditions (antecedent inflow, areal precipitation, and soil moisture), streamflows, time of year, and remaining storage in federal reservoirs.
    - The RIOP uses composite storage alone as a drought trigger. USACE should also consider the state of the Basin (how dry or wet) in triggering drought operations. A drought index should be developed to guide the decision based on the predictive drought indicators selected (e.g. antecedent Mean Areal Precipitation and/or soil moisture). In addition, USACE should use regional sub-basin drought indicators (e.g. for the Apalachicola River, Apalachicola Bay, the middle Chattahoochee or the Flint) to consider changes in operations rather than waiting for designation of drought in the entire ACF Basin.
- Develop special operations to address extended drought (multi-year) conditions in the Basin, based on the proactive, predictive triggers and responses as recommended above (3.4).

- In cooperation with the states, improve and further refine the UIF data set currently available for the ACF Basin. These refinements should assess the timing of the relationship among precipitation, evapotranspiration and flow; whether farm ponds supplement, reduce, or do not meaningfully alter low flows during droughts; and other items as determined appropriate by USACE. (4.1).

- Contribute to the knowledge in the ACF Basin by implementing the full instream flow assessment described on page 83, taking into consideration the natural variability of the ecosystem's hydrologic regime (magnitude, timing, duration, frequency and rate of change) as a framework for the EIS for the revisions to the Water Control Manual, as well as other studies described in Table 6.3.

Other Federal Agencies:

- Contribute to the knowledge in the ACF Basin by providing funding for and/or implementing the studies described in Table 6.3 (4.2 and 4.3) *(All)*.

- Contribute to development of predictive drought indicators and triggers for drought management control in collaboration with USACE and the States (3.1) *(National Oceanic and Atmospheric Administration (NIDIS), US Geological Survey, US Fish and Wildlife Service, US Environmental Protection Agency and others)*.

- Develop effective guides for channel usage by all river travelers including facilities to support electronic boat guidance (2.9) *(US Coast Guard).*

The states of Alabama, Florida and Georgia:

- All appropriate agencies within each state should report status and outcomes of use and return policies, regulations, and practices that affect water quantity and quality in the Basin and report progress so that states can share successes with all water users in the Basin (1.1.1).

- Implement water use efficiency and conservation policies and practices that will achieve (1.2.1):
  - Reduced impacts to stream flow of consumptive use from agriculture by 15% overall through a suite of management practices that minimize water loss from agriculture including equipment retrofits, identification of source switching opportunities, and tillage practices including sod-based rotation;
  - 80% efficiency by 2020 of all center pivot irrigation systems in the ACF Basin;
  - More efficient cooling towers;
  - Increased use of xeric landscaping;
  - Improved commercial and industrial water conservation;
  - Conservation rate structures for residential water users;

  - Water efficient toilets when old ones are being replaced;
  - Water utility programs to assess and reduce water system leakage;
  - Limitations on non-agricultural outdoor water use during dry periods;
  - Local government or permitted utility long-range water supply plans, which include the following components: a description of the water system, anticipated needs and how they will be met (including specific conservation targets), storm water management systems, system water loss and integrity, and public information/education to highlight water management concerns;
  - Encouragement for experimentation for programs with the potential to improve water conservation and efficiency.

- Collaborate in the development of a drought management plan, perhaps in the context of a regional Memorandum of Understanding, that includes the following: (1) defines drought conditions, using NOAA as a resource, (2) identifies triggers for actions, (3) delineates responses by water use sector, and (4) documents changes in operational strategies (3.1).

  In doing so, also collaborate with USACE, USGS, USFWS, EPA and NOAA (NIDIS) to develop a mechanism for determining drought triggers and to develop an ongoing evaluation of drought conditions in the Basin. Additionally, the states should develop appropriate conservation actions throughout the Basin and work with USACE to develop appropriate changes in operations when flows and levels reach drought conditions in sub-regional portions of the ACF Basin. Such a mechanism should recognize that reservoir operations and other actions taken by people may create drought-like conditions for some users even when the Basin as a whole is not in drought. Graduated drought mitigation actions should be considered for sub-basins not experiencing drought to help address conditions within sub-basin(s) experiencing drought.

- Contribute to drought management planning discussions in the context of the WCM and regional drought management planning, considering triggers based on drought conditions (antecedent inflow, areal precipitation, and soil moisture), time of year, and remaining storage in federal reservoirs (3.1).

- Through financing or other mechanisms, facilitate the augmentation of instream flows through the use of existing storage in existing reservoirs constructed, owned or operated by local governments, especially in the Upper Flint (3.3) *(Georgia)*.

- Contribute to the knowledge in the ACF Basin by providing funding for and/or implementing the studies described in Table 6.3 (4.2 and 4.4).

- Establish more consistent permitting and better water use and return reporting to inform water management in the ACF Basin, reviewing their policies for consistency with the following desired objectives (4.5):
  - Water withdrawal permits for all groundwater and surface water withdrawals in the Basin will be required for users greater than 100,000 gallons per day.
  - All permitted municipal and industrial water users (including both surface and groundwater) self-report daily water withdrawals in electronic format on a monthly basis. All permitted agricultural users (including both surface and groundwater) self-report water withdrawals in electronic format annually. States should report status and outcomes of use over time to the public.
  - All water dischargers self-report daily water discharges in electronic format on a monthly basis.
  - Permit issuers should develop usage benchmarks calculated in a consistent way.
  - Establish a consistent, strong permit enforcement program.
  - Perform a comparative evaluation of the water use regulatory and permitting systems and consider adopting approaches that would enhance water availability for the existing and future uses/needs in the ACF Basin.
- Participate in a transitional organization that brings together stakeholders with state and federal agency representatives to develop a common vision and framework for a future permanent transboundary institution to facilitate sustainable and adaptive management of the Basin that shares water equitably among stakeholders, balancing economic, ecological and social values (5.1).

Local Governments, Utilities and other Permit Holders:

- Water users should implement actions that maximize water returns where ever possible. This can include, among other actions (1.3.1):
  - Increasing connections to centralized sewer treatment, where feasible;
  - Storm water management strategies that increase groundwater infiltration;
  - Minimizing land application, where possible;
  - Retrofitting and/or minimizing interbasin transfers (i.e. returning flows back to their basin of origin), where feasible.

ACFS and/or Other Stakeholders:

- All stakeholders in the Basin should promote education and public awareness of issues associated with sustainable water management planning and implementation (1.1.2).
- Encourage local, state and federal agencies and the private sector to cooperate to support economically feasible and environmentally sensitive development that would support commercial and recreational benefits from navigation (2.10).
- Work with state and federal partners to establish a transitional organization that brings together stakeholders with state and federal agency representatives to develop a common vision and framework for a future permanent transboundary institution to facilitate sustainable and adaptive management of the Basin that shares water equitably among stakeholders, balancing economic, ecological and social values (5.1).
- Support local, state and federal partners in securing funding to complete the additional studies recommended in Table 6-3.
- Review and revise the Sustainable Water Management Plan on a 5 to 10 year schedule (5.2).

APPENDIX A:
Performance Metrics

A comprehensive table of performance metrics as well as a detailed report concerning performance metric development is available at ***http://www.acfstakeholders.org/swmp***

APPENDIX B:
Stakeholder Perspectives

Basin stakeholders' perspectives are presented in the following sections. The perspectives presented were prepared by subgroups of stakeholders, both at a regional sub-basin and stakeholder interest group level. They do not reflect a consensus of ACFS membership, the various sub-basin groups, or stakeholder interest groups and members of a sub-basin group or stakeholder interest group may disagree with the perspective included in this Appendix.

Geographic Stakeholder Interests

Apalachicola Sub-basin

The development of this Sustainable Water Management Plan for our Caucus has demonstrated the importance and enjoyment of the relationships, knowledge and experience gained from our fellow stakeholders within the Apalachicola Sub-basin Caucus as well as our fellow stakeholders in the Chattahoochee and Flint ACF sub-basins. As a Caucus and as individuals, we want to thank our fellow stakeholders and others, funders, state and federal stakeholders, and consultants that have joined and supported our enterprise and journey and express our desire to continue to work together with sufficient resources.

Having now lived the ACFS challenges of the legal aspects of the courts since Oct. 2013 and experienced that as an obstacle to a good outcome for us all we do recognize that perhaps there may be some potential benefit to the "jurisdiction" of the court to forcing the issues and parties to one table.

Using the best available, commonly accepted data and science to work from creates understanding and provides for discussion not otherwise possible. Using an ACF Basin-wide/watershed approach, collaborative, facilitated transparent process, structure and commitment has been the key to our potential success through the ACFS proposed Sustainable Water Management Plan and a Transboundary Water Management Institution. Adaptive management has been and must continue to be a component for both the Basin and the process over the years into the future. To that end we offer the following Apalachicola Sub-basin Caucus perspective.

Sub-basin Organization and Perspective

Six years ago, stakeholders representing various water needs in the Apalachicola Basin began an initiative to "build bridges" to other ACF Basin stakeholders to our north in Georgia and Alabama. After years of personal effort on the part of Basin leaders, this initiative resulted in a joint intent by stakeholders in the ACF Basin to institutionalize common ground and seek an equitable distribution of ACF waters through change in the management of the shared waters of the ACF Basin. Stakeholders of Florida, Georgia, and Alabama came together in crafting a Charter and By-laws for a 501c3 ACF Stakeholder organization.

The resultant Apalachicola Sub-Basin Stakeholders were drawn from each of the six counties along the River and Bay (Calhoun, Franklin, Gadsden, Gulf, Liberty, and Jackson). The 14 ACF Stakeholder Governing Board members represent Charter specific interest groups. Six of these members are also appointed representatives of the Apalachicola Riparian County Stakeholder Coalition (RCSC). These RCSC members, while representing an ACFS identified Interest Group, additionally serve from each of the six counties and report the overall progress of the ACFS back to their respective County Commissions It is the conviction of the Apalachicola Sub-Basin Caucus that a substantive, scientifically validated, and equitable water management plan for the ACF Basin is still achievable and critical to the interests of <u>all</u> ACF Stakeholders. Further, that the final form of that Sustainable Water Management Plan (SWMP – including the supporting technical documents) must be successfully implemented through a Transboundary Water Management Institution involving the Stakeholders, the Federal Agencies (USACE, USFWS, NPS, EPA, NOAA, etc.), Congressional representation, and the riparian States in a new transparent process.

It was a profound, shared dissatisfaction with 20-plus years of fruitless negotiation, mediation and litigation that motivated us to join in forming ACF Stakeholders some five years ago. Our "Holy Grail" from that time unto today is institutionalizing the Mission of the ACFS in a Sustainable Water Management Plan (SWMP) and Transboundary Water Management Institution (TWIO). A recent return to the failed path of lawyer-led litigation, adversarial posturing and attorney-client "privilege" has threatened to destroy more than four years of substantive, shared progress. Only sheer determination to realize the projected "return on investment" of our Stakeholders and retained commitment to this grassroots process motivates continuation.

Preserving Natural Flow Variability

The Apalachicola River and Estuary system is of exceptional ecological importance, constituting one of the least polluted, most undeveloped, resource-rich systems left in the United States (Edmiston 2008). Combined, the river and bay have been designated by the United Nations as an International Biosphere Reserve, by the United States as a National Estuarine Research Reserve, and by the State of Florida as an Outstanding Florida Water with significant portions of the lower river and Bay designated as Aquatic Preserves. The river harbors the most diverse assemblage of freshwater fish in Florida, the largest number of species of freshwater snails and mussels, and the most endemic species in western Florida. Apalachicola Bay is one of the most productive estuaries in the Northern Hemisphere, historically supporting commercially important oyster beds and a wide variety of fish, and providing habitat for migratory birds and other animals. The river basin is home to some of the highest densities of reptile and amphibian species on the continent. The Apalachicola River and Bay are closely linked, as the river waters and its inundated floodplain are the biological factory that fuels the productivity of the estuary.

Despite its enormous ecological value, the Apalachicola River, Floodplain and Bay ecosystem has been degraded through a long history of human alterations, including impoundment of water by upstream reservoirs, consumptive use of water by farms and cities upstream, 19th -20th century navigational dredging and channel alterations by the U.S. Army Corps of Engineers (Corps), and bank alterations. The combined effect of these activities has been to alter the river's flow regime; destabilize and widen the river channel; reduce the river's hydraulic complexity and habitat diversity; smother and displace habitat in the river's rich sloughs, floodplains, and channel margins. Restoration assessments and activities are required to reverse the trends and loss of the biological, physical and chemical integrity of the ecosystem.

In addition to its high ecological diversity and seafood productivity, the Apalachicola portion of the Basin provides significant economic activity resulting from agriculture, tourism, forest products, manufacturing among others. For instance Jackson County is one of the highest peanut producing counties in the nation and has one of the largest wood pellet manufacturing mills in the world, providing a large export industry that helps foreign countries meet their commitments to reduce carbon emissions. Tourist flock to the six county area along the Apalachicola for excellent hunting and fishing and unique natural attractions such as Jackson Blue Springs Recreation Area (A first magnitude spring in Jackson County), USACE Lake Seminole Park and Angus Gholson Nature Park (featuring endangered plants and excellent birding) in the City of Chattahoochee and Gadsden County, Torreya State Park, TNC Apalachicola Bluffs and Ravines Preserve, TNC Dog Island Preserve, Little St. George Island State Preserve, NWFWMD Florida River Water Management Area in Liberty County, Dead Lakes State Park in Wewahitchka, the Apalachicola Wildlife and Environmental area, St. George Island State Park (ranked one of the best in the country) St. Vincent Island Wildlife Reserve, Apalachicola National Forest, and Apalachicola National Estuarine Research Reserve education center in Franklin County. The history of the area can be seen still alive at The Pioneer Settlement in Blountstown and historic community of Apalachicola. A major effort is underway by RiverWay South Apalachicola/Chattahoochee (RWSAC) to make these unique natural, historic and cultural tourist amenities an international destination.

Because the Apalachicola Sub-basin is both the natural and consequent termination point of upstream stakeholder water needs, management of freshwater flows into the Apalachicola can put at risk floodplain inundation and the critical salinity levels for seafood and marine life productivity in the Estuary and Eastern Gulf of Mexico. The following analysis provides the limits and quantities of freshwater flows stakeholders in the sub-basin have concluded are needed to sustain the health and productivity of this unique ecological, economic and cultural asset. It is a starting point and requires an over-riding commitment to adaptive management to:

- Preserve the natural flow variability and ecological functions of a river and bay system. The first principle of protecting instream flow is that the natural variability of flows (magnitude, timing, duration, frequency) in natural channels provides favorable conditions for native plants and animals.
- Minimize the loss of acres of river and floodplain habitat that are occurring under specific flow reductions for the Apalachicola River.
- Maintain flow regimes at the Sumatra gage that provide salinity conditions in the Bay to sustain historic acres of healthy oyster bars and submerged aquatic habitat in the lower river, delta and estuary.
- Based on a review of existing literature, available data and analysis accomplished by stakeholders' consultants and performance metrics to achieve a maximum overall 13% habitat loss for dry year flows, sub-basin stakeholders concluded that a maximum 6% reduction in flow from pre-dam dry years provides adequate inundation of the floodplain for this ecosystem to be sustainable.

In the development of alternative water management concepts, Apalachicola sub-basin stakeholders used this performance metric, the Presumptive Flow Standards recommended by The Nature Conservancy, and the alternative habitat loss/flow relationships to evaluate the extent to which modeled flows and the resultant loss of habitat and floodplain function are significant, and fundamentally alter the integrity of the ecosystem.

Measuring the Health and Productivity of the Sub-basin: Critical Flow Needs

The salinity and water quality of the Bay is driven by and closely correlated with the freshwater inflow from the river and surrounding floodplain. Desirable salinity conditions, water levels and quality, and nutrients can serve as true indicators of the health and productivity of the river, floodplain and bay. Historic observable measurements are necessary to understand the flows needed to sustain the functions, health and productivity of the floodplain/bay habitat and fisheries at historic levels. Apalachicola sub-basin stakeholders seek to regain sufficient freshwater flows into the River, Floodplain and Bay that recover the economy upon which their social and cultural heritage is based. Performance metrics were developed from IFA results, Bay Assessment evaluations, local knowledge of the fishermen, and GWRI modeled outputs. Specific performance metrics include:

- Maximize monthly flows at the Blountstown gauge during non-drought conditions fluctuating between 18,000 cubic feet per second (cfs) and 14,000 cfs for the months of Feb thru May, then between 16,000 cfs and 10,000 cfs annually.

- Minimize the time flows during drought conditions go below 14,000 cfs for the months of April thru June (Spat Set) and minimize the time flows go below 8000 cfs for the months of July thru November (oyster growth). This may be accomplished by instituting pulses that would achieve or approach pre-dam flow. This, in essence, is a spring pulse from mid-April thru mid-June and a second mid-summer pulse in July/August time period that would keep the salinity conditions moderated thru the summer and fall. The spring pulse is considered the most important and the timing and volume of the second pulse will be dependent on additional modeling to determine how quickly the Bay reacts to pulses from the river.

- Provide flows at the USGS Sumatra Gage during droughts that maintain salinities within the desirable range (10 - 24 PPT as defined in the Bay Assessment) for a minimum of 50-55% of the time at locations specified throughout the Bay during the spawning, reproduction and recruitment season from May thru October. During the late fall and winter (primary growth season) months of November, December, and January-April, salinities should be maintained in the desirable range a minimum of 75-80% of the time at locations throughout the Bay.

The following assumptions and considerations are provided to understand the basis for the above flow requirements:

- The flow regime at the USGS gauge at Sumatra that will produce between 10 and 24 PSU at specified points in the Bay when entered in the hydro-dynamic model. The timing and duration of increased flows and/or reduced flows for pulses should be correlated to these salinities in the desired range for oyster productivity and growth.
- Metric performance should be monitored and adapted for as required both as weekly average flows at Sumatra in cfs and weekly average salinity levels in PSU at locations in the Bay.
- Management approaches should consider conjunctive release opportunities we should model and seek to exploit. (e.g. The timing of pulses to accommodate optimum timing for spat generation/spat set and spat and oyster growth should be aligned with potential Navigation and Power Generation “releases”.
- *The Corps’ interpretation of the Congressionally authorized purpose for Fish and Wildlife on the ACF System should set a solid foundation for equitable treatment of upstream and downstream water users by addressing Apalachicola’s needs on a broader Ecosystem function foundation rather than just the Endangered Species Act.* This authority has been provided by a number of federal laws including but not limited to: WRDA 2007, Endangered Species Act, Clean Water Act, Safe Drinking Water Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Coastal Zone Management Act, other laws,

executive orders, and national policies promulgated in the past decade, and mitigation requirements applicable to Corps civil works project.

Flow Augmentation Opportunities

The Apalachicola Sub-Basin Caucus has identified additional interests and concerns that members believe will improve the likelihood of future success in achieving adequate and dependable river flows. These include:

1. Basin-wide water conservation programs, supported by state legislation, that will achieve water demand reduction, including such measures as conservation pricing, leak elimination, public education, provide water saving devises, and water reuse where feasible and practical, including phased drought management planning with water reduction thresholds based on the nature and extent of drought conditions.
2. Long-range water supply planning (needs and sources) by all water utilities and major water users by 2020.
3. Water use permitting in each State which incorporates significant conservation measures into its permitted allocation criteria.
4. Drought management planning, incorporating a water loss limit for the ACF Basin based on the occurrence of drought and meeting basic water demand needs during that climatological condition.
5. Objective and agreed-upon “triggers” for forecasting/indicating a condition of drought in the ACF Basin; and prioritization of water uses to provide for use cutbacks with implementation of the Drought Management Plan.
6. Changing the USACE flow management rules during drought conditions to reflect the USACE requirement to protect the Federal fishery that is the Apalachicola Estuary as an “essential use” of up-stream dam/reservoir operations.
7. Identifying measurable flow nodes in the Basin where imposition of required controls might have the greatest potential impact on relieving negative impacts of prolonged drought on the community of ACF Stakeholders.
8. Enactment of comprehensive state agriculture water use permitting systems to reduce the increasing demand on ground and surface water supplies in the ACF Basin. Sub-basin stakeholders believe the new permitting system should include:
   - Establishment of maximum daily uses based on type of crop and type of irrigation application system.
   - Permit issuance periods in areas of potential water supply deficits to five years.

- Mandatory threshold reductions in water withdrawals based on level reductions in regional monitor wells and prevent the mining of water.
- Permit enforcement including: site inspections, flow monitors, weekly pumping completion reports, irrigation system efficiencies, and other auditing procedures.
- Permits based on actual water pumpage and not on well sizes, capacities, or acres irrigated.
- Utilization of available irrigation technologies (e.g. drip irrigation, sod-based practices, crop selection) and the costs/benefits of these alternatives and also consider limits on agriculture water uses from center pivot systems.

9. Assessment of the feasibility for the development of Alternative Water Supply sources in the ACF Basin where projected water demands exceed current uses.
10. Evaluation of need and the development of recommendations for securing alternative water supply sources to support the increasing water needs of the Upper Chattahoochee Sub-Basin metropolitan areas including: the purchase of water from other regional sources on a wholesale basis, the development and/or enhancement of additional water storage capacity (both above and below ground in periods of excess flows), water reuse, and elimination of water losses within the existing supply systems.
11. Opportunities to support projected Upper Basin water demands by the purchase of wholesale waters from the Tennessee Valley Authority (TVA) within the State of Georgia.
12. Water reuse systems for domestic and industrial wastewater, storm water, and other waters to maximize utilization potentials for all waters.
13. An audit of each public water and sewer system to identify and eliminate water losses from these systems.
14. Comparative evaluation of the water use regulatory and permitting systems in Alabama, Florida, and Georgia and recommend approaches in these systems which would effectively enhance water availability for the existing and future uses/needs of the Basin.
15. Emphasis by local governments on water conservation, conservation pricing, controlling stormwater, wetlands preservation, water losses from faulty utility systems, and the development of long-range water supply plans.
16. Designation of the ACF Basin in their respective States as an Area of State Water Supply Concern, which should trigger an extensive number of water

control applications for both water conservation and alternative water supply development.

17. Creation of a Regional Water Supply Authority with the specific mission of planning, developing, and managing water supplies for existing and future Upper Basin metropolitan water supply needs.

18. Regional Water Management based on hydrologic boundaries along the lines of the system of regional districts in Florida with the authority for permitting water wells, water withdrawals and uses, managed storage of surface waters, artificial recharge, and water supply.

19. In order that all three states have adequate and equivalent enabling legislation to conduct comprehensive water management in their respective states, Georgia and Alabama should consider passing language comparable to the Florida Model Water Code (1972) which provides the basis for Florida's water management programs. Florida should keep this Model Water Code and adopt legislation where Georgia or Alabama legislation would improve control of water resources. The intent of this legislation is to give more control over management of the water resources in each state.

In summary, the Apalachicola Sub-Basin Caucus has attempted to explain our perspective on the issues relating to the critical needs of the Apalachicola River, Floodplain, and Estuary and to present management objectives intended to recover natural conditions and productivity. We feel strongly that this Sustainable Water Management Planning process has become a positive and permanent milestone in our Basin's water management for current and future generations. While the Plan does not include everything we have suggested, it does represent a substantial improvement to the current situation and should provide some enlightened and workable solutions to optimize our collective river and bay management as we continue to work towards our collective sustainable future. We thank our fellow stakeholders for this opportunity to plan with them.

Middle and Lower Chattahoochee

The essential goals of the middle-lower Chattahoochee sub basin are sustainability of historical flows since the Corps' ACF project was completed in 1975 and better flow management to benefit hydropower, recreational, navigational, industry water quality purposes, flood control, domestic water supply and protection of endangered species.

The middle-lower Chattahoochee River reaches extend some 130 miles across the piedmont and coastal plain regions of Georgia and Alabama. Included are three major federal projects: West Point, Walter F. George, and J. Woodruff. Although some 40% of the total ACF Basin drainage feeds the river along this stretch, the three main reservoirs can only hold about 27% of the total storage capacity of the system.

The middle-lower Chattahoochee reach is located between a large growing urban area upstream and a downstream endangered species habitat that requires storage release from the Corps' reservoirs to meet minimum flows in dry periods. Increases in consumptive uses and significant changes in flow management for environmental needs have the potential to challenge the sustainability of flows and lake levels in the middle-lower Chattahoochee. High agricultural irrigation demands in the Basin have the potential to stress the water supply, especially during droughts when reduced Flint River flows increases reliance on Chattahoochee storage to meet environmental flows in the Apalachicola River. Establishment of specific flow target sub basin metrics in the Corps' revised Water Control Manual would offer significant confidence to stakeholders in this geographic area of the ACF Basin for sustainable flows and levels in the future. The middle-lower Chattahoochee sub basin is not requesting an increase in allocations to meet its needs but is requesting sustainability, so that allocations outside the sub-basin do not diminish historical water supply.


Lake Eufaula

Recreation on the federal reservoirs, West Point and Walter F. George, is a very important stakeholder interest. Stakeholders identified that recreation and local economies were closely intertwined. Metrics for desired reservoir levels were established to support avoiding low lake levels during peak use periods. Low lake levels have been shown to have adverse impacts on local, regional and state economies. In addition, Columbus has recently made significant modifications to their reach of the river to support a world-class whitewater course. Minimum flows were considered to support this major economic driver for the area.

The middle-lower Chattahoochee stakeholders saw commercial navigation, an original congressionally authorized purpose, as currently inactive and desires its renewal. Metrics for reservoir levels and river flows were developed to support seasonal commercial and year-round recreational navigation in this sub basin.

For the Columbus/Phenix City/Fort Benning region, the largest metropolitan and military area in the middle-lower Chattahoochee sub basin, minimum flows referenced in the Performance Metrics Table, which are also incorporated into the Federal Energy Regulation Commission (FERC) license to the Georgia Power Company for the Middle Chattahoochee Hydro project represent a request for flow sustainability. The referenced minimum daily flow (1350 cfs) has been achieved 97.6% at the time between 1975-2008, even though this flow target is not included in the Corps' Water Control Manual. By having these metrics incorporated into the Corps revised Water Control Manual, the Columbus area will have reliability established that its primary water needs for municipal (public health, safety, economic development), military (national security), recreation, aquatic habitats, navigation, industry, water quality and hydro power will be achievable within the 2050 planning horizon.

There are several major industrial water users on the middle / lower Chattahoochee that have domestic water supply needs. There are two large paper mills and a nuclear power plant that rely on Chattahoochee water for cooling, industrial processes and waste water assimilation. Metrics for river flows were identified in the corresponding reaches to support adequate pump suction and dilution flow for these industries.

The water needs of other communities and interest groups within the middle-lower Chattahoochee, including agriculture, environment, water quality and others have been considered and are reflected in the ACFS Performance Metrics Table.

Upper Chattahoochee

The ACFS "Upper Chattahoochee sub-basin" originates in the portions of Lumpkin, White and Habersham Counties that drain to form the Chattahoochee headwaters and runs south and west to USGS's Franklin Gage in Heard County, Georgia. This sub-basin includes Lake Lanier, a major federal project, and much of the greater Atlanta metropolitan area, which is home to approximately five million people, or half of Georgia's population. It is noteworthy that Lake Lanier stores 65% of the total managed reservoir conservation water storage in the ACF Basin even though the drainage basin is roughly 6 percent of the ACF watershed drainage area, making management of it critical, especially during a drought.

Many distinct stakeholder perspectives exist in the Upper Chattahoochee sub-basin that must be understood and balanced in the management of the Upper Chattahoochee system specifically and the broader ACF more generally. These stakeholders are: environment and conservation, hydropower, industry, thermal power and manufacturing, recreation, and water supply. A brief summary of each stakeholder group's most important interests, issues and challenges are provided below.

Environment and Conservation. From the north Georgia mountains to the Florida border, the Chattahoochee River is impacted by unplanned development, storm runoff and trash from industries, roads, and construction sites, and discharges from sewage treatment plants. Withdrawals from the river by municipalities and industries also affect its health through consumptive loss of water that is not returned to the river, impacting downstream water quality, recreation and ecology. While significant improvements have been made, much remains to be accomplished to restore and preserve the river system's ecological health for the people and wildlife that depend on the river system.

Hydropower. Appropriate management of lake levels (water in storage) is critical to producing hydropower, which is of vital importance to the region's energy mix. Buford Dam, with a maximum generating capacity of 125,000 kilowatts, is one of the larger hydropower generating plants in the ACF Basin. However, the project's reservoir retains [65] % of the storage of the ACF Basin, and is operated by the Corps of Engineers in coordination with all of the federal hydropower projects on the Chattahoochee River. The Morgan Falls Hydroelectric Plant, operated by Georgia Power and located in Roswell, Georgia, has a maximum generating capacity of 16,800 kilowatts. It is operated in a modified run-of-river mode to generate power and to re-regulate peaking flows from Buford Dam to meet flow releases requested by the Atlanta Regional Commission. The project also generates power while reregulating flow. The project's reservoir, Bull Sluice, has 673 acres of surface area at full pond.

Industry, Thermal Power and Manufacturing. Water plays a vital role in the economic activity in the Upper Chattahoochee sub-basin. Industrial, thermal power and manufacturing water users all rely on adequate lake levels and stream flows to support the region's business practices.

Recreation. In addition to the homeowners, boaters and businesses interested in maximizing and maintaining water levels in Lake Lanier, many residents and visitors enjoy recreational opportunities throughout the sub-basin including Lake Lanier and the Chattahoochee National Recreation Area which, combined, have over 10 million visitors annually and over $400 million in annual economic contribution.

Water Supply. This sub-basin has substantial water supply needs due to its large population and robust economic activity. For example, over 70 percent of metro Atlanta's population of five million people relies on the Chattahoochee River for drinking water. In light of these sizable needs, Metro-Atlanta water suppliers are committed to and keenly interested in water conservation and water stewardship. In line with these interests, the Metro District has implemented a rigorous conservation program. As a result, despite population increases of over 1,000,000, water use in metro-Atlanta has declined by over 10 percent from 2001 levels. Additionally, metro-Atlanta users return approximately 67 percent of all water withdrawn, where it is available to meet downstream needs. Data collected by the Metro-Atlanta water suppliers, the group of local governments and utilities uniquely responsible for securing and supplying the sub-basin's current and future water supply needs, show that Metro-Atlanta consumes approximately 3% of the average annual flow in the Apalachicola River.

The Metro-Atlanta water suppliers are also keenly interested and concerned about the limits of what conservation can achieve in terms of water savings and other benefits. Although the region has achieved water use reductions despite a decade of population growth, water conservation savings cannot offset population growth indefinitely. In light of future water supply needs, one of our fundamental interests is ensuring the availability of additional supplies to meet future water supply needs in the Upper Chattahoochee sub-basin. Ultimately, the most important source of water for metro-Atlanta is the Chattahoochee River system.

Another fundamental interest for the Metro-Atlanta water suppliers that withdraw from Corps of Engineers' operated reservoirs is the need for the Corps to adopt policies that create incentives or grant credit for return flows to those reservoirs. Metro-Atlanta water suppliers have already invested more than $2 billion to construct the infrastructure necessary to return large quantities of water to federal reservoirs. This infrastructure investment has resulted in the return of more than 50 mgd to the federal projects, a number we expect to grow larger with appropriate crediting of return flows. The Metro-Atlanta water suppliers see a number of benefits associated with the adoption of such policies. For example, we believe that return flows provide a reliable source of stored water which can be held until needed by those returning these flows in the event of limited natural inflows. Additionally, we anticipate that crediting return flows will limit impacts to natural resources and enhance reservoir levels. If return flows into the existing, shared federal reservoirs are not credited, some of our water providers may see a strong incentive to build their own storage reservoirs. This approach carries environmental costs, increased evaporative losses, and increased impacts due to alterations in in-stream flow that can be avoided with a sound return flow credit policy.

Flint

The Flint rises in the Georgia Piedmont province in the hills of Coweta, Fayette, Fulton, and Clayton counties, which now form much of south and southwest metropolitan Atlanta. The headwater is in Eastpoint, GA, near Hartsfield-Jackson International airport, the busiest passenger air terminal in the world. The Flint River, with a watershed of about 8,460 square miles, is slightly smaller in drainage area than the Chattahoochee, but has historically contributed 40-50% of the annual flow into the ACF Basin. The Flint and the Chattahoochee are markedly different in many ways including the geology, ecology, hydrology and stream-flow management (reservoirs). The urban and suburban areas of the upper Flint watershed are home to over 600,000 Georgians and thousands of businesses; the total population of the watershed being about 1,000,000.

The 'river' in the uppermost portion of the Flint is a network of creeks, large and small, that historically have provided water for the human population and the environment. Impoundments have been constructed on many tributary streams to capture water during wet periods to be used later for water supply. Withdrawals and returns in the upper Flint watershed are unbalanced, and are maintained by an engineered, interconnected system which withdraws water from the streams as well as from the impoundments, including withdrawing water from the stream to fill certain of the impoundments. Many of these withdrawals are governed by permits that are conditioned on low-flow guidelines that may not be adequate to protect instream flows or the environment. On the returns side of the equation, utility records show that only 25-30% of withdrawals are discharged to the Flint on any given day. The 70-

75% that is not returned to the supplying streams is directed to interbasin transfers (Ocmulgee/Altamaha and Chattahoochee Basins), land application systems, landscape reuse systems, and sprawling suburbs serviced by septic tank drain-field systems.

Numerous private impoundments, vast acreages of paved and other impervious surfaces, channelization of tributaries, and changing rainfall patterns are also adversely impacting upper Flint flows. Professional opinions vary, but most analyses indicate that approximately 25% of the observed flow declines can be attributed to changes in rainfall patterns, leaving the remainder of the decline related to the human uses of the water and management of runoff, some of which may be remedied, some not. The fact remains that the net result of the combined factors has significantly reduced dry-period and drought flows in the upper Flint to unacceptable levels. Since 1975, low flows in the upper Flint have decreased between 50 and 100% depending upon location and selection of the flow-measurement statistics. Natural instream uses and instream private use rights have been attenuated. Clearly, changes in water management are necessary in order to meet the present and future human demands for the upper Flint, while restoring and preserving an aquatic habitat that supports the many sports, as well as numerous rare and endangered species that rely on a semblance of historic stream flow patterns for existence.

In the lower reaches of the upper Flint the Piedmont briefly gives way to a system of ridges, small mountains, reaching from Alabama into Georgia that resulted from geologic faulting many millions of years ago. The Flint is here recognizable as a river and historically has provided over 40 miles of high quality whitewater paddling, outstanding fishing for endemic shoal bass, and spectacular riverfront vistas. High biological diversity reigns in this area of the river, the tributaries, and along their banks. A mixture of Appalachian, Piedmont, and Coastal Plain species meet where Spanish moss adorns riverside trees immediately adjacent to mountain laurel and rhododendron, in turn adjacent to Piedmont native azaleas. Shoal spider lilies cover the shallows, displaying their splendor in May and June each year. This is also the area that the U. S. Army Corps of Engineers proposed to inundate with one to four impoundments, a portion of the original ACF development plan laid out in the late 1940s. These plans were blocked by a broad political spectrum of activists and elected officials in the 1970s. Many claim that if these reservoirs had been built 'there would be no flow issues in the ACF today', postulating that the storage in these impoundments, originally slated to support navigation, would now support modern downstream uses, including needs for Apalachicola Bay. This of course ignores the current private and public uses and values in the area that would be have been flooded by impoundments, and ignores the functions that intact riverine habitat provides.

The middle Flint, or upper Coastal Plain portion, is a hilly, sandy region of large orchards, timber plantations, cattle operations, poultry operations, and small towns. Tributary streams in this region generally remain perennial, but unmanaged increases in consumptive use could adversely impact these streams, which are closely tied to the underlying aquifers. Baseflow in the main stem of this region of the Flint has declined by more than 30% since 1975, partially due to reduced upper Flint flows emerging from the Piedmont. However, at least 60% of the reduction is due to factors occurring within the region.

The lower Flint region begins in the upper reaches of the Crisp County Power impoundment (aka Lake Blackshear) where the river bed transitions from soft, silty sediments transported from the Piedmont to hard, fossil-rich limestone. In the Dougherty Plain area of southwestern Georgia, carbonate rocks comprise the Floridan aquifer, which has been described as one of the most productive aquifers in the U.S. The limestone rocks are at or near land surface and receive recharge directly and indirectly from an average annual precipitation of about 52 inches. Many of the area streams have cut into the aquifer and provide a dynamic connection between the stream and the aquifer. During much of the year, the groundwater elevations exceed the stream and water from the aquifer supplies additional flow to the stream. However, during periods of dry and drought climatic conditions, when the use of groundwater and stream water for crop irrigation peaks, the flow from the aquifer is reduced and may cease. This relationship has changed profoundly since 1975. Groundwater flow reversals have been documented in springs proximate to the Flint River. As a result of the reduced and depleted groundwater flow, the flow of numerous streams in the region is frequently diminished, ranging from reductions of around 70% to complete cessation.

Since the 19th century settlement the Dougherty Plain has been home to row cropping and orchards, which by the mid-19th century had been established on an industrial scale. But it was not until the late 20th century that the advent of mechanized irrigation combined with mechanized tillage and petroleum-based fertilizers and pesticides launched the Dougherty Plain region to an elevated position in the global market. Cotton, corn, and peanuts are king; truck crops and pecans are of growing importance; pasturage and poultry are solidly established; and grain sorghum receives its annual share of dedicated acres. Annual farm gate values are in the billions of dollars. Combined with a timber plantation and hunting plantation economy, this rural economic engine has established itself as the most important industry in Georgia.

This economy is fueled by water. Dry-land (un-irrigated farming) has not ceased to exist, but is a minor component of the agribusiness system. Water use, straight from the creeks, from agricultural impoundments, and from the Floridan aquifer, launched in the mid-1970s and accelerated through the end of the century. Recent spikes in the commodity market and corresponding increased farm production has placed additional demands on regional resources.

Effects of human water use on stream flow in the Flint Basin were noted by scientists and water managers as early as the 1980s. Recent stream flow evaluations using USGS records indicate that climate changes and intense water use have adversely impacted natural stream flow throughout much of the Flint Basin particularly during periods of below normal rainfall. Because of these impacts, a moratorium in Georgia on agricultural withdrawals from surface and Floridan aquifer sources in the lower Flint region was established in 1999 and then lifted in 2006 except for a core area of the Dougherty Plain (known as “Capacity Use Areas” or the “Red Zones”). Then, in late July of 2012, due to continued diminishments of surface flows, the moratorium was again expanded to 100% of the Dougherty Plain. Thus the private use rights and values, in addition to the public values and benefits of instream flow and a full Floridan aquifer have been truncated. It is important to note that these restrictions occurred in the lower Flint only, and on agricultural uses only. Upper and middle Flint uses have not been restricted in any way, and no municipal or industrial uses have been restricted anywhere in the basin.

Because of the observed impacts of agricultural water use on the region's water resources and because using less water generates less production overhead, agricultural researchers have made tremendous advances in the efficiencies of irrigation technologies. Certain center-pivot applications use upwards of 30% less water per acre per year than technologies of 40 years ago. New tillage practices, drip irrigation, and other techniques hold greater promise. But the effects on aquifer levels and surface flows remain. A new concern is that now numerous new irrigation wells have been installed into the deeper Claiborne aquifer system, which underlies the Floridan and is a source of municipal and industrial supply. The connectivity of this deeper aquifer to overlying resources and the sustainable yield of the Claiborne are poorly understood, and development of this resource is only lightly regulated.

It is critical that the water resources available for instream uses throughout the Flint be improved. The entire Flint Basin is suffering the effects of change due to population growth and municipal/industrial needs for water and sewer, development and land use, agricultural practices and increased irrigation withdrawals, permitting and implications of that permitting, as well as climate and the associated extremes of drought and flood. Improvements in management of the issues that we can influence hold promise to accommodate these changes. It is possible to establish sustainable flow regimes over the entire Flint Basin. Success will increase the flexibility for management of the Chattahoochee impoundments, and simultaneously diminish the impairments to the private and public users of the Flint and its tributaries.

The Flint Caucus of ACF Stakeholders is compelled to remind readers of the significant achievements in conservation and water management that are already in place throughout the watershed. For example, Flint Basin utilities within the Metro North Georgia Water Planning District have implemented numerous water conservation programs and, by monitoring and limiting certain withdrawals based on preliminary target streamflows, have helped lay the foundation for future adaptive management within the region. Likewise, industrial users throughout the basin have invested millions of dollars in infrastructure to reduce withdrawals, increase quantity and quality of returns and implement water reuse programs. For agriculture, the percentage of producers employing on-farm water conservation measures, some of which were described above, is at an all-time high. However, conservation and efficiency that leads only to ever-increasing consumptive use is environmentally, and ultimately economically, unsustainable.

To actually improve flows throughout the Flint, and indeed throughout the ACF, commitments to instream results are critical. Members of the Caucus note that, within the context of this SWMP, of all consumptive users, only agriculture has committed to making positive changes in flow regimes versus mere commitments to conservation. Members of the Caucus also note that declines in Flint River flows began in the mid-to-late 1970s due to rapid and progressive increases in human water use, primarily in the upper and lower portions of basin, less so in the middle reaches. Poor management strategies coupled with a false paradigm that an endless supply of water existed resulted in a significantly over permitted river basin. In the Flint, a fully operational SWMP will depend upon not only conservation and efficiency among agricultural, municipal, and industrial users, but a substantially strategic array of permit decisions by state water managers.

Stakeholder Interests by Interest Group Category

The needs and concerns of stakeholders by interest group category are discussed in the following subsections.

Navigation

Navigation has always been a part of the ACF Basin from the early canoes to the 300 ton steamboats that plied the rivers in the 1800s. This growth was initially fueled by the cotton industry and later by the logging industry. Through the late 1980s, more than 1,000,000 tons of freight per year were transported in the rivers, including sand & gravel, agricultural chemicals and petroleum products.

Navigation is an authorized purpose for all the federal projects in the ACF Basin. In accordance with the Clean Water Act of 1972, the USACE obtained water quality certifications from the State of Florida for maintenance dredging in the Apalachicola River, beginning in 1979. Over the years, conditions placed on the certification have imposed increasing restrictions on dredged material disposal area usage. Problems with dredged spoil disposal permitting eliminated USACE dredging operations and resulted in the deterioration of the main channel in the Apalachicola River. A recent study performed by the Tri Rivers Waterway Development Association and the Apalachicola Riverkeeper, however, has indicated that navigation flows and winter-spring needs for improving ecological conditions are compatible. While a year round navigation program is desired, a system that would operate in specific seasons would be an improvement.

Recreation

Recreation is an essential and growing activity in the ACF watershed. Recreation often involves visiting areas that contain bodies of water such as parks, wildlife refuges, wilderness areas, public fishing areas, and water parks, as well as vast stretches of the rivers and their tributaries. Most of these areas are publicly accessible.

While tabulating the exact daily recreational uses throughout a watershed is difficult, the U.S. Army Corps of Engineers reported in 1995 the following visitation rates for riverine recreation in the ACF Basin[23] :

- 781,500 visitor days to the Apalachicola, Chipola, and Flint Rivers
- 3,500,000 visitor days to the Chattahoochee River National Recreation Area (the 36 miles immediately downstream of Buford Dam)

Georgia Parks reported 823,000 visitor days to Sprewell Bluff and State Parks on the Flint. Camp Thunder, one of the top-10 boy scouting destinations in the U.S., has nearly 30,000 annual visitors on the upper Flint. With the removal of the City Mills and Eagle and Phenix Dams, the natural flow of the Chattahoochee River through downtown Columbus, Georgia has been restored and now whitewater rafts and kayaks fill the river.

Recreation opportunities on the lakes are also plentiful. In 2006 USACE documented:

- 7,552,119 visitor days to Lake Lanier
- 3,300,836 visitor days to West Point Lake
- 4,340,890 visitor days to Lake Walter F George (Eufala)
- 1,223,532 visitor days to Lake Seminole
- Total of 16,417,377 visitor days to USACE lakes

Based on the Corps of Engineers data, the total direct economic benefit from the Corps lakes is $583.05 million. However, more focused studies on West Point and Lake Lanier document substantially higher numbers when other economic factors are considered.

Economic impact data are not available for the Flint or the Apalachicola sub-basins. However, considering the numerous public and private recreational venues on the Flint from above Sprewell Bluff to Bainbridge and from Lake Seminole to Apalachicola Bay, the total economic impact of recreational activities in the total ACF Basin likely exceeds $2 billion dollars annually.

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[23] U.S. Army Corps of Engineers (USACE), Mobile District. 1998. *Draft Environmental Impact Statement, Water Allocation for the Apalachicola-Chattahoochee-Flint (ACF) River Basin, Alabama, Florida, and Georgia.* U.S. Army Corps of Engineers, Mobile District, Mobile, Alabama, Table 4-57 and page 4-214

Recreation often is not prioritized as a critical benefit of the ACF watershed by operational and policy decision makers. This causes social, environmental and economic harm. This is also exacerbated during droughts when recreation benefits are often ignored. Seasonal metrics were developed as part of the development of this SWMP for minimum reservoir levels and river flow to support recreation.

Water Quality

ACF Basin is faced with water resources challenges including maintaining superior water quality within the entire Basin. Some areas in the Basin are performing better than others when it comes to watershed management efforts focused on water quality. ACF Stakeholders has a goal of meeting or exceeding all federal, state, and local water quality standards within our watershed borders and supporting all designated uses. All the waters inside the ACF Basin have been designated by USEPA with highest use "fishable and swimmable".

ACF Stakeholders have developed a set of metrics to ensure that proper water quality is available for all interest groups within the Basin. Water quality goals within ACF are related to:

- Protecting aquatic health and habitat including threatened and endangered species
- Assisting with educating the public on the need for good stewardship of our limited water resources
- Helping to increase and enhance recreational opportunities on or next to the waters within our Basin
- Protecting drinking water supplies
- Ensuring proper assimilative capacity for wastewater discharges, which is often a function of water quantity
- Promoting best management practices when it comes to stormwater runoff and non-point source pollution

When water quality standards or goals are not being met then a plan shall be developed to get these areas back into compliance. This includes any stream segments currently listed as impaired by State and Federal agencies. Where there are water quality improvement plans (or TMDLs) within the ACF Basin, ACF Stakeholders shall be willing partners to assist where needed to make these plans a success. It is the goal of ACF Stakeholders to improve water quality conditions in all areas of our Basin.

Water Supply Interest Group

The key responsibility of Water Providers is to provide reliable, clean and safe drinking water to the citizens and businesses which are served. This includes identifying and securing adequate water supplies, treating and distributing water, and working with other stakeholders to develop and implement a comprehensive approach to sustainable water management planning.

The metrics selected by the Water Supply Interest Group focus on specific stream flows and lake levels and are informed by levels of risk associated with ensuring adequate availability of water supply. Representative lake levels were identified for lakes used for water withdrawal and water storage. Additionally, flows were identified at key locations associated with existing or anticipated river withdrawals. It should be noted that the flows and levels selected as metrics are used for comparative purposes only. The exact flow or level selected was not a target. Furthermore, in many cases a single number was picked in a given vicinity to serve multiple interests. For example, in the Columbus region, the same flow level was selected as a stakeholder metric for water supply, water quality (which includes wastewater discharge) and recreation.

The following are examples of Water Supply stakeholder interest metrics:

Lake Lanier – Percent of years at full pool (1071) by May 1st

Lake Lanier - Percent of weeks above the 90% refill threshold

Lake Lanier – Monthly rate of decrease

West Point Lake – Percent of time level is > 635 (April – October), >632.5 (November – March)

Columbus – Percent of time daily average >1350 cfs, 7-day average > 1850 cfs

Woodruff Lake - Percent of time level is > 77.5 (April – October), >76.5 (November – March)

Griffin - Percent of time daily average <60 cfs

Sumatra – Elevation at City of Port St. Joe water supply canal

Many of the flows and levels selected for metrics have been used by the USACE for operating the river for decades. As such, we anticipate considerable familiarity with the specified metrics. The risk of water demands not being met is also of concern. Key criteria to evaluate risk included the amount of time reservoirs were sustained at various levels, the likelihood of reservoir recharge and the rate of change in reservoir levels. Although water quality is of significant importance to water suppliers, the modeling work performed by the ACFS did not address water quality. As such, water quality metrics associated with water supply were not included in the water supply interest category.

Given the primary concern of Water Providers is meeting current and future water needs, Water Suppliers are concerned that all tools and options remain available; including river and reservoir management, conservation, improved water efficiency, engineered solutions and sound growth policy. From a water supply perspective, optimization of USACE operations with respect to water releases and the implementation of sustainable planning goals that are based on net returns rather than water withdrawals are fundamental to sustainable water management. Similarly, the adoption of policies that create incentives for increasing return flows, including credit for return flows and funding to return flow to the basin of origin, is of significant interest.

As a group responsible for billions of dollars of infrastructure whose members are subject to considerable regulation, ongoing consideration of costs, benefits, and equity across the full range of policy decisions associated with sustainable water management is important. When programs are required to be implemented and tracked, setting baselines that take into account work that has already been performed is significant.

Region Specific Concerns of Water Suppliers. Water suppliers have many concerns in common; however, there are concerns which are specific to regions and specific utilities.

Metropolitan Atlanta. The Metro Atlanta water suppliers are specifically interested in developing conservation programs that could be implemented appropriately throughout the Basin. Likewise, it is important that strategies implemented upstream not be used to the exclusion of other programs and projects for providing additional downstream flow.

Columbus Metropolitan Area. A primary concern for the Columbus region is sustaining the flow levels that have been occurring since completion of the Corps' ACF project (West Point Reservoir in 1975). These flows at Columbus (1350 cfs minimum daily flow and 1850 cfs minimum weekly flow) are included in the FERC license issued to the Georgia Power Company for the Middle Chattahoochee Hydropower Project. These flows meet both current and future needs for municipal water supply in the Columbus area based on the planning horizon of this plan. To ensure that these flows continue to be met, it is important to the water suppliers in the Columbus area that the USACE include a flow control node in the upcoming update of the USACE's Water Control Manual which targets the 1350 cfs minimum daily flow and the 1850 cfs minimum weekly flow levels.

Upper Flint. The Upper Flint water suppliers are concerned that current management practices to store water during high flow periods are not recognized for their limited impact during dry periods. There are multiple water supply reservoirs in the Flint River Basin that are pumped storage off the main stem. Withdrawals from the river are set up in a tiered structure that is based on the amount of flow in the river (a sort of Prescribed Adaptive Management system). Low flow in the river equals zero to low withdrawals and high flows allow more water to be withdrawn.

Agriculture

A wise sage once said: "To protect the water you must first protect the land". Since the days of the Civil War, farmers and other regional stakeholders in the ACF Basin have been excellent stewards and taken great care to conserve this unique landscape. Besides sustaining working landscapes, stewardship of the land, in turn, provides wildlife habitat, protects our clean air, and serves as a critical recharge area for our aquifers. This region contains some of the most pristine riparian and river habitat found in the contiguous U.S., and is home to numerous protected species of plants and animals.

The scenic beauty and diverse recreational opportunities provided by these streams and lands are integral to the cultural heritage and quality of life for stakeholders throughout the ACF Basin. As one example, Jackson County Florida, on Lake Seminole and the Apalachicola River, has by far the largest freshwater spring in the ACF Basin. Jackson Blue Spring, a rare natural resource used for cave diving, recreation and tourism, averages flows of more than 100 million gallons of freshwater per day. However, Jackson Blue Spring flows also have the second highest nitrate concentrations of Florida's 33 first-magnitude springs, which is attributed to high density farming in the springshed. Prudent land use is critical in order to protect water quality within our aquifer recharge areas.

Jackson Blue Spring

The Floridan aquifer of the lower ACF Basin is the primary source of fresh drinking water for the stakeholders of southeastern Alabama, northwest Florida and southwestern Georgia. It also is the source for most industrial and agricultural supply in the lower ACF Basin. Because of the hydraulic connection between many regional streams and the Floridan aquifer, pumping from one source can adversely impact the other. During most of the year, the Floridan aquifer is a large contributor to stream flow throughout this karst region, but the contribution declines as a result of drought and heavy groundwater withdrawals. Reduced stream flows and aquifer contributions to flows during drought in the Flint and Chipola Basins also reduces flows to the Apalachicola River, which increases demands on the Chattahoochee River and the U S Army Corps of Engineers reservoirs. Intense water use, coupled with pervasive droughts requires augmentation of stream flows from reservoirs to support endangered species and support the ecology of the Apalachicola Bay; this is one of the primary water-sharing issues embedded within the long-term conflict between the States.

Agricultural economists have predicted that as the effects of climate change worsen in the Midwest, that the Southeastern U.S. will become the "breadbasket" of the Nation. The use of water to supplement rainfall is essential to ensure that regional farmers can meet our future food and fiber needs. An adequate water supply is the lifeblood for the agriculture based economy of the stakeholders within the lower Flint and upper Apalachicola region. The sale of farm goods, and the industry to support farm production, annually generates many billions of dollars within the lower ACF.

Because of the relatively flat landscape and dependable supply of water, the Dougherty Plain physiographic district of southwestern Georgia, southeastern Alabama, and northwestern Florida has supported intense development of irrigated agriculture. An abundant water supply and ability to irrigate greatly increases crop yields, crop quality, crop diversity, and land values. Agricultural irrigation in this region, particularly in the lower Flint River and upper Chipola River sub basins, markedly increased since the late 1970s. Agricultural irrigation peaks during the May to October growing season, but in normal to wet years, irrigation's impact on stream flow and aquifer levels does not jeopardize availability of water in the region and the stream ecology is generally not adversely impacted. However, that is not the case during dry conditions, when both direct stream and groundwater withdrawals can significantly impact most streams in the region. Climate change or the conversion to more water-intensive vegetable crops could increase agricultural water demand in the future.

Crop irrigation cannot be turned on and off as in other types of water use. Once the crop is planted and growing, it must have a uniform application of water, either from rainfall or irrigation, to survive and flourish. In Alabama, Florida and Georgia scientists and farmers are working together to improve water use efficiency through the development and implementation of water saving measures such as installation of drop-pipe low-pressure sprinkler systems, end-gun shut offs and variable-rate irrigation systems among other water conservation practices. Pending Georgia legislation will require an 80% efficiency rating for irrigation systems in order for farmers to obtain water withdrawal permits. In 2000, Georgia legislature enacted the Flint River Drought Protection Act in an effort to reduce the impact of agricultural withdrawal during critical drought periods. Because of the potential impact of existing irrigation systems in the lower Flint River Basin, the Director of Georgia Environmental Protection Division placed a temporary moratorium on all new agricultural permits in this region, effective 2012. However, conservation and stream augmentation are being achieved using efficient application during irrigation and reaching into other water sources such as deeper aquifers to supplement impacted stream flows during intensive drought periods. Farmers and researchers in the region have studied and implemented conservation based best management practices that include limited/strip-till, and no-till farming. Developing farming practices now include, among others, the Sod-Based-Rotation (SBR) production system which is reported to increase productivity while using minimal inputs of nutrients and water. Agricultural water supply is not an authorized purpose of the federal ACF Reservoirs; however, it is a significant consumptive use in the ACF Basin. Improved water conservation and efficiency are key elements of developing a sustainable water management plan for agriculture and the ACF Basin.

In the upper ACF Basin, within the Piedmont physiographic region, the landscape changes from large irrigated fields to an urban landscape of homes, industry, and shopping centers. However, that urban landscape created a significant demand for water; particularly during periods of drought. Urban agriculture has adapted conservation strategies over the past three decades to mitigate these demands. Many urban landscapes were originally irrigated using highly treated potable water which put significant stress on the distribution systems of municipal water systems. Recurring droughts of the past 14 years, and resulting water use restrictions began to impact landscape installation, as well as the maintenance of existing landscapes. As a result, new landscape irrigation strategies and technologies emerged. Specialized irrigation equipment such as rain sensor shut-offs, drip irrigation, and micro-spray applications became the norm. Beyond that, new design trends such as those used in green infrastructure, help protect both water supply and quality.

Our water supply has and continues to play a critical role in the sustainability of agriculture in the ACF Basin. A dependable supply of water will determine which areas have the ability to attract new business, industry, and agriculture, and prosper economically. The value of the water resources of the ACF Basin to continue to support our myriad agricultural practices is immeasurable in terms of economics and human welfare. For this reason, the prudent development and diligent conservation of our water resources are key elements of developing a sustainable water management plan for the ACF Basin.

Industry and Manufacturing

Industry and Manufacturing concerns vary greatly across the Basin, ranging from intensive water using industry such as pulp and paper production to less water intensive water industry, such as car manufacturing. While more opportunities undoubtedly exist, many industries have already undertaken water conservation measures to reduce consumption. Industry and manufacturing requires an adequate water supply now and in the future.

Seafood Industry

The nutrient-rich, sediment-filled, waters that flow from the Apalachicola-Chattahoochee-Flint river system initiates the complex network of food chains in the Apalachicola Bay, helping to create one of the most productive estuaries in the northern hemisphere. The 210 square miles of bay provides an abundance and variety of fish and shellfish from its shallow waters, such as Apalachicola Bay's world famous oysters, and its plentiful shrimp and finfish. The Florida Department of Agriculture and Consumer Services reports that Apalachicola Bay is home to 180 types of fish, 360 types of marine mollusks and 1300 specimens of plant life. In 1997, 1.4 million pounds of oysters were shucked in local seafood houses.

Historically, Apalachicola Bay produced about 90 percent of Florida's oysters and 10% of the nationwide supply. Equally important, shrimp harvested from the waters around Apalachicola Bay generates more than a million pounds per year. Blue crabs are harvested from the inshore waters of the Bay, providing approximately 10% of commercial market sales. The Bay continues to be one of Florida's best saltwater fishing locations for both commercial catch and recreational anglers.

Unfortunately, these statistics do not reflect oyster harvest production today. Harvesters and processers that work and rely on the Bay for their livelihood have experienced a collapse of commercial oyster harvesting since production turned down significantly in 2012 as a result of an extended drought period along with other ripple effects. Harvesters of other seafood products report that they are also feeling the economic pressure resulting from this most recent Bay crisis. On August 12, 2013, the National Oceanic and Atmospheric Administration (NOAA) declared a commercial fishery failure of the oysters in Apalachicola Bay, citing the flow of fresh water from the Apalachicola River has decreased in recent years.

Decisions made today…from water flow - to Bay recovery efforts - to economic challenges…will directly affect the future of the seafood industry.

Hydropower

The Hydropower Stakeholder Interest Group can be divided into two groups – federally owned, multi-purpose projects (Buford Dam – Lake Lanier, West Point Dam – West Point Lake, Walter F. George Dam – Lake George or Eufaula, and Jim Woodruff Dam – Lake Seminole) and private Federal Energy Regulatory Commission (FERC) licensed projects (Morgan Falls, Riverview, Langdale, Bartlett's Ferry, Goat Rock, Oliver, and North Highlands on the Chattahoochee and Crisp County and Worth on the Flint). These projects lie in each of the four sub-basins of the ACF river system. The federally owned projects control storage and provide flow augmentation and flow regulation. The FERC-licensed projects are for the most part run-of-river projects and do not control storage nor are they able to augment or re-regulate flows to any significant extent. Their operation is governed by the terms of their FERC licenses.

The federal multi-purpose projects were authorized by Congress to satisfy federally authorized purposes based on project reports prepared by the Corps of Engineers that demonstrated the benefits would exceed the costs, i.e., a benefit to cost ratio greater than one. Given the hydrology of the ACF Basin, the hydropower function of the federal projects was conceived, designed, constructed and is operated to provide hydropower during a "peaking" operation. Without hydropower as an authorized project purpose the benefit to cost ratio would not have exceeded one and therefore the projects most likely would not have been built. For projects on the Chattahoochee, the benefit of hydropower generation was a significant portion of the expected project benefits. The costs for each project were allocated among the authorized project purposes based on the actual costs and expected benefits, with the hydropower purpose being allocated from a low of 48% to a high of 81% of project costs. The power is sold by the Southeastern Power Administration (SEPA) to its statutorily defined customers (not-for-profit cooperative and municipal utilities) in North Carolina, South Carolina, Georgia, Alabama, Florida and Mississippi for the benefit of the U.S. Treasury at a rate that is required to recover 100% of the cost of generation, including the allocated cost of construction and interest. Modification or elimination of peaking operations would impact the value from the sale of power and, therefore, the benefits anticipated from the investment and cost allocation.

There are a number of water quantity and timing issues that affect hydropower, many of which do not affect any other stakeholder in a similar fashion. Hydropower as a peaking resource must provide capacity and energy during specific hours of the day to have value to the utilities that buy it. In the southeast and more specifically within the Southeastern Power Administration marketing territory, the hydropower peaking resource must be available to be called upon during the peak hours, which are typically between the hours of 2:00 PM and 7:00 PM (1400 – 1900 Hours) on a five-day work week (Monday-Friday) during the summer. It is during this block of hours that the value of the hydropower resources is at its peak. Generation on hot summer afternoons is especially crucial as this is when the annual peak demands occur and is the time when utilities must have all of their generation available. Being able to generate at full capability during this peak is the basis for maximizing the peaking value.

SEPA's utility customers have been purchasing the output of these generators since they were initially constructed. The customers rely on the availability of these purchases as an integral part of their power supply portfolio. Alternative operating scenarios that allow all hydropower generation to be scheduled during the summer afternoon peaks will have little impact on value. However, tradeoffs that shift generation between months, between weeks or even between days (particularly between weekdays and weekends), could have a significant impact on value. The value is determined by the cost of replacing any reduction in hydropower generation with other, more expensive sources, offset by any lesser reduction in cost at the time the hydropower is actually generated.

Because the availability of hydropower generation is significantly affected by drought, electric utilities plan for a power system that relies on only the hydropower capacity and energy that can be delivered during the worst droughts. Further, demand for electricity, particularly in the South to power air conditioners, tends to be higher during drought periods, which are typically hotter than normal. Thus, the only mitigation for drought operations is to construct other generators to be available when hydropower generation is not available.

In order to create the highest value from the ten projects in the ACT, ACF and Savannah river basins in South Carolina, Georgia and Alabama, SEPA markets the output of these projects as a system, allowing some generation to be shifted between projects in the case of droughts, mechanical breakdown, maintenance outages, or other constraints, to create a more reliable product. (The Woodruff project is marketed as a stand-alone system in Florida.) SEPA works with the Corps to schedule generation among the projects in order to make the best use of the diversity of these projects, given the water available to be released from storage at any given time.

The federal hydropower customers recognize and understand the competitive environment for the use of the waters of the ACF Basin, especially during times of drought. It is this recognition and understanding that has always guided the federal hydropower customers in agreeing to the use of the water storage in the federal reservoirs for a "higher and better" use, as long as the economic impact is not unfairly shouldered by the federal hydropower customers when hydropower operation is curtailed, modified or eliminated in order to support the "higher and better" use.

Thermal Power

Thermoelectric power generation requires water for cooling purposes. The amount of water consumed depends on the cooling technology as well as the power generation technology utilized. Federally mandated cooling tower technologies consume water through evaporation while once-through cooling does not consume water. Of the water withdrawn across the ACF Basin for power generation cooling, the vast majority is returned to the cooling water sources. Cooling towers release heat to the atmosphere while once-through cooling returns heat back to the cooling water source. At any one time the amount of thermoelectric power being generated directly correlates to end-user demand for electricity. Demand side management and advances in power generation cooling water technologies may reduce water consumed during thermopower generation.

Georgia's state wide water plan forecasted water needs for future energy production. The projections beyond 2020 were only at a state level. Regional estimates could not be made through 2050 because the location of the additional energy capacity is unknown (**http://www.georgiawaterplanning.org/documents/Energy_Tech_Memo_102910.pdf**).

Local Government

Local governments' interests vary across the Basin depending on population, land use, and specific industries. In general, local governments' interests are met when stakeholder interests within their jurisdiction are met. In addition to other conjunctive interests, local governments are concerned with flood control. The ability of the federal projects to provide flood control benefits is of importance to these stakeholders.

Environment and Conservation

Principles of Sustainable Water Management

Inherent in defining sustainable water management for the ACF Basin is protection of the river and bay ecosystem to support people and wildlife. Protecting the ACF ecosystem depends in part on restoring those ecological functions that have been pushed outside of the realm of natural variability. It would be an obvious mistake to impact the ACF ecosystem beyond the point of recovery, pushing the ecosystem into an alternate equilibrium that does not provide all of the basic ecological services that our economy and culture are based upon. A nearly equal mistake is the risky proposition of repeatedly pushing the ecosystem to the edge of equilibrium, given that we do not know under what circumstances recovery may become impossible. The ACF river/bay ecosystem provides life support for our existence. Once we start down the slippery slope of consumptive use or artificial flows that exceeds the limits of sustainable conditions within the rivers and bay, it is only a matter of time before ecological decline is accompanied by water shortages to irrigate food crops, drinking water supply, wastewater assimilation, and other commercial, industrial, and recreational uses upon which people depend.

History provides numerous examples of over allocation of water resources, and other alterations, leading to ecosystem decline and human suffering. Loss of fisheries, inadequate clean drinking water, floodplain loss, property destruction in floodplains, and even catastrophic events such as famine during normal droughts adorn history's span. We have the opportunity to adopt ACF operations and best management practices that protect and restore ecosystem function and integrity. We can make our communities and economies resilient and sustainably productive. Full ecological function, realized as profitable businesses, healthy communities, robust cultures, and equitable benefits will be the hallmarks of successful long-term sustainable water management.

Success requires that:

- Water supply and use is met solely by the water that exists currently within the ACF Basin. Borrowing, or taking, from one ecosystem to offset impacts in another ecosystem leads not only to shifting environmental impacts without alleviation but also to degradation of neighboring communities left to suffer economic losses or worse at our expense. In order to avoid this inequity,
    - Water taken from the ACF must be returned to the ACF Basin, and any water taken from other basins must be returned to that respective basin.
    - Groundwater levels must be fully protected and naturally recharged, or nearly so, annually during normal weather conditions. During the dry periods of normal and wet years, and during drought periods, groundwater withdrawals must not

deplete groundwater levels below the point where healthy surface flows cease.

- Instream flow conditions that support ecological function are maintained, not only in terms of volume, but also variable flows over time and space necessary to sustain both the river and bay.
- Water withdrawn from surface waters should be treated after use to a quality as good or better as when withdrawn and returned to the surface water.

We can achieve the aforementioned by sustaining instream flows consistent with the Natural Flow Paradigm. Over the last several decades scientists and laypeople alike have accepted that the Natural Flow Paradigm is essential to the ecological integrity of river systems. The first principle of instream flow is that natural flow (magnitude, timing, duration, frequency) in natural channels provides favorable conditions for native plants and animals (Instream Flow Council 2008). Healthy instream flows also ensure we have adequate water to support human uses, including clean drinking water, wastewater assimilation, recreation, navigation, power generation, and fisheries support.

Aquatic ecosystems evolve over time not only in response to natural flow variability, but also in response to human-induced changes in hydrology, climate, species composition, water quality and other factors. Aquatic ecosystems are unique because their integrity and function depends on flow variability over time and space. Significant flow alteration can adversely impact aquatic and riparian organisms, and those human services that depend upon intact ecosystems to persist.

Over the past 50 years, the ACF Basin has experienced significant alterations to its flow regime due to impoundments, withdrawals, discharges, dredging, channelization, impervious surfaces, and climate change. For much of the Chattahoochee and Flint portion of the ACF Basin, scientific information is lacking with respect to the impacts of flow alteration on the system's biological diversity. Impacts are better documented on the Apalachicola, but need more study to understand discrete causation. More intense and frequent weather events, and a well documented rise in sea level, pose additional challenges to the system's resiliency. The ability to maintain function and integrity will become increasingly difficult. In order to maximize resiliency, decrease uncertainty, and provide a 'cushion' for future change, adaptive management is a crucial tool, and is in fact our best hedge against data deficiency, current uncertainties, and conflicting stakeholder goals.

Understanding the Current Condition of Apalachicola, Chattahoochee and Flint Sub-basins

An understanding of the basis of comparisons to natural flow conditions is necessary in order to correctly interpret modeling results and findings of ecological analyses. The Unimpaired Flow data set (UIF) used by the US Army

Corps of Engineers was used by ACFS in the model runs analyzing initial environmental conditions as well as comparing various water management alternatives. In theory, the UIF represents non-impacted or "natural" river flows. In reality, the UIF is not a true, quantitative representation of "unimpaired" or "natural" flows for a variety of reasons, including errors and omissions in the information underlying the UIF data itself (see the ACFS UIF report). Moreover, some human-induced changes, particularly those due to land use alteration, remain unaccounted for in the data set. Discussions within the subsets of the ACFS Board (e.g. the TOCWG) and by the full Board resulted in agreement to use what is essentially an artificial dataset, understanding not only the flaws and their import/implications, but also the need to improve the data as soon as possible.

Most of the analyses have been with the aid of several relatively simple spreadsheet models that incorporate a benchmark flow record extending from January 1, 1939 to December 31, 2008. These spreadsheets have been constructed so that any flow record of comparable length could be inserted in place of the UIF and used as a "baseline." For example, a simulated run-of-river flow record spanning the same time period could be used, should the ACFS decide that is the more appropriate "benchmark." Similarly, a corrected UIF could be used.

Although questions have been raised regarding various uncertainties associated with the UIF, given the schedule and funding available it was necessary to use existing data that can be compared to the Corps model runs. The environmental caucus agreed to go forward with a UIF dataset known to be incorrect at the temporal and spatial scale necessary for truly assessing the environmental impacts and benefits associated with various water management alternatives. This agreement to move forward with the existing UIF dataset contained the explicit understanding that because these flaws limit confidence in the results, ACFS thereafter agrees to a qualitative rather than 'absolute quantitative' approach. In other words, we (the entire ACFS technical review group, a subset of the ACFS Board known as the TOCWG) agreed to evaluate results by asking whether a given water management alternative moves the flow regime closer or further from a natural flow regime. However, we were unable to use the UIF, or any data set, to address the question of precisely how much flow and in what spatial and temporal configuration is necessary to ensure ecosystem protection and recovery. In order to effectively manage the ACF ecosystem in an adaptable and sustainable way, the UIF data set must be updated and corrected. Improved management of the ACF river/bay ecosystem can be initiated using this first iteration of an SWMP, to which our perspective is appended. But future iterations of the SWMP and future management must include improvements to the UIF as well as other inputs and tools.

It is also important to know that the gages or nodes analyzed in this process were all mainstem nodes. This was due to financial and time constraints. While there were at least two nodes added to the analysis beyond what the Corps and the states have historically examined, none of the nodes on the major tributaries of the Chattahoochee, Flint, or Apalachicola were analyzed. Many of these unanalyzed nodes are best positioned to examine the details of certain types of flow impairments in the ACF system. Future iterations of ACFS and other modeling should incorporate an expansion of nodal analyses as time and finances allow.

Finally, it is paramount to understand that flows in the ACF system have been vastly altered. In many cases, major tributaries experience flows during the dry portions of wet and normal years that were characteristic of drought flows prior to the mid-1970s. These same tributaries experience extended periods of extremely low flows (deteriorated by 50 to 100% below pre-1970 drought flows), including zero flows, during recent droughts. The Chattahoochee's flows are highly controlled and regulated by impoundments, and the Corps does not address instream needs other than wastewater assimilation at two nodes on its entire reach. The Flint's flows are vastly altered by consumptive uses. The upper Apalachicola, including its Chipola tributary, is experiencing a significant increase in agricultural well permitting, while the main channel and floodplain are experiencing flows significantly lower than normal dry and drought flows for much longer periods of time. The net result of these changes in the system is the loss of major portions of creek, riverine, floodplain and estuarine habitats, functions and associated benefits. Some of these losses can be recovered, others cannot. There are several improvements to the system that can and must be effectuated, soon. There are others that must wait on additional, improved analyses. The Environment/Conservation Interest Group views this first version of the SWMP as that, a first version, that provides a beginning from which to improve sustainability and resiliency of the ACF Basin. This work must continue, and indeed ACFS has designed this process so that it can continue.

Business and Economic Development

Water is a critical input to production in many economic sectors within the ACF Basin. Access to safe and adequate water is essential for business and economic development. The nexus between water, energy, and food is well documented; yet, its total economic value immeasurable.

Direct use of water in the Upper Chattahoochee basin is concentrated in major sectors of the economy, which include hospitality, urban-agriculture, farm, energy production, beverage, manufacturing and public water supply, among many others. The output from these sectors and associated activity elsewhere in the region, support nearly 5 million residents and over $300 billion in economic impact. Interactions among these sectors have demonstrated an "energy-water-food nexus," in which demands for water, energy resources, and agricultural products are interrelated. As a result, the use of water in these sectors cannot be viewed in isolation; changes in one sector can have a direct and significant impact on the demand for, and availability of, water to others. Thus, the economy as a whole is directly or indirectly dependent upon the output of industries for which water is an important input, and is potentially sensitive to water supply shocks or shortages.

Protecting and efficiently managing our water resources is essential to maintaining a strong, vibrant economy. The impact of a water supply shock can extend well beyond the industries that are immediately affected, with implications for consumers and ripple effects on activity in other areas of the economy including loss of jobs and industrial output.

Climate variability is expected to further stress local water resources, increasing the risk of prolonged droughts in the region. It is important to recognize that water does not have one single value; even in the context of a single use, its value may change over time. This is true for all water-uses and stakeholder interests in the Basin.

Historic and Cultural

The rivers in the ACF Basin have helped to shape the history and cultural development in the Basin. Water in sufficient quality and quantity maintains the historic character of areas and is often associated with tourism. The ability to control floods for the preservation of archeological sites is also important.

Urban Agriculture

Urban agriculture interests vary across the Basin depending on population density and land use. Access to sufficient quantity of water to support establishment of new plantings and to maintain, residential landscaping, parks, green spaces, and recreation facilities are needed. Fulfilling this stakeholder interest also supports the urban agricultural industry.