RESTORE Council Proposal Document

General Information

Proposal Sponsor: U.S. Department of the Interior (DOI) – U.S. Geological Survey (USGS)

Title:
Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins

Project Abstract:
The U.S. Department of the Interior, through the U.S. Geological Survey (USGS), is requesting $3.4M in Council-Selected Restoration Component funding for the proposed Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins project. This would include $3.0M in planning funds as FPL Category 1, as well as a $400K implementation component as an FPL Category 2 priority for potential funding. The project will support the primary RESTORE Comprehensive Plan goal to restore water quality and quantity through activities to create a decision support model to provide information on freshwater inflows to streams, bays, and wetlands. The Operational Analysis and Simulation of Integrated Systems (OASIS) model will simulate the routing of water through watersheds in the river basins, providing a tool for resource managers to evaluate questions of concern, such as the influence of water resource alteration on restoring and conserving habitat, water quality, and living coastal resources. New gaging stations will be installed to fill critical freshwater inflow data gaps and support data needs for future monitoring assessments

The Alabama Water Agencies Working Group and other water resource managers have identified a critical need for data on inflows and models to understand how the timing and delivery of flow affects downstream ecological resources. The OASIS model will provide state and local agencies with modeled outcomes on various water-use strategies and supporting information to guide water resource management activities and restoration areas to focus on in the future. Project duration is 4 years.

FPL Category: Cat1: Planning/ Cat1: Implementation

Activity Type: Project

Program: N/A

Co-sponsoring Agency(ies): N/A

Is this a construction project?:
No

RESTORE Act Priority Criteria:
(II) Large-scale projects and programs that are projected to substantially contribute to restoring and protecting the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast ecosystem.

Priority Criteria Justification:
The flow-accounting model for the Mobile and Perdido River basins primarily meets the second RESTORE Act Comprehensive Plan goal that addresses large-scale projects that are projected to substantially contribute to restoring and protecting the water quality and quantity of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the

Gulf Coast ecosystem. This large-scale project covers over 42,000 square miles, includes the Mobile Bay/Mobile-Tensaw Delta and Perdido Bay and River priority geographic areas in Alabama, Florida, and Mississippi, and crosses geopolitical boundaries to capture the ecoregional gradient (i.e., upland, riparian, estuarine and coastal habitats). This proposal will have far-reaching measurable and sustainable effects by providing the needed tools (e.g. model and streamgages), data, and information that could be used by state and local decision-makers to restore more naturalized timing and delivery of freshwater supported by the monitoring of discharge in coastal river systems of Alabama, Florida, and Mississippi. Restoration of the timing of freshwater inflows can positively affect shellfish, fisheries, habitat, and water quality. Increasingly, state and local decision-makers and federal agencies are turning their attention to the restoration of flows as part of a holistic approach to restore water quality and habitat and to protect and replenish living coastal and marine resources and the livelihoods that depend on them. Once the framework is developed and delivered to the decision-makers, it can be used well beyond the duration of the project.

Project Duration (in years): 4

Goals

Primary Comprehensive Plan Goal:
Restore Water Quality and Quantity

Primary Comprehensive Plan Objective:
Improve Science-Based Decision Making Process

Secondary Comprehensive Plan Objectives:
N/A

Secondary Comprehensive Plan Goals:
N/A

PF Restoration Technique(s):
Improve science-based decision-making processes: Develop tools for planning and evaluation

Location

Location:

The decision-support framework will be built for the Mobile River basin which covers approximately 41,000 square miles (65% of the State of AL, 12% MS, portions of GA and TN) and the Perdido River basin which covers approximately 1,100 square miles (70% of the State of AL, 30% FL) (Figure 1).

HUC8 Watershed(s):

South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Perdido Bay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Upper Conecuh)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Patsaliga)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Sepulga)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Lower Conecuh)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Middle Coosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Lower Coosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Middle Tallapoosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Lower Tallapoosa)
South Atlantic-Gulf Region(Alabama) - Alabama(Upper Alabama)
South Atlantic-Gulf Region(Alabama) - Alabama(Cahaba)
South Atlantic-Gulf Region(Alabama) - Alabama(Middle Alabama)
South Atlantic-Gulf Region(Alabama) - Alabama(Lower Alabama)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Luxapallila)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Sipsey)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Mulberry)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Sipsey Fork)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Locust)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Upper Black Warrior)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Lower Black Warrior)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Middle Tombigbee-Chickasaw)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Lower Tombigbee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Mobile-Tensaw)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Mobile Bay)
Tennessee Region(Middle Tennessee-Elk) - Middle Tennessee-Elk(Bear)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Perdido)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Middle Tombigbee-Lubbub)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Noxubee)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Upper Chickasawhay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Pensacola Bay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Choctawhatchee(Pea)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Escambia)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Town)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Tibbee)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Chunky-Okatibbee)
South Atlantic-Gulf Region(Pearl) - Pearl(Upper Pearl)
Lower Mississippi Region(Lower Mississippi-Yazoo) - Yazoo(Little Tallahatchie)
Lower Mississippi Region(Lower Mississippi-Yazoo) - Yazoo(Yalobusha)
Lower Mississippi Region(Lower Mississippi-Big Black) - Big Black-Homochitto(Upper Big Black)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Upper Tombigbee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Buttahatchee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Sucarnoochee)

South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Escatawpa)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Mississippi Coastal)

State(s):
Alabama
Mississippi
Florida

County/Parish(es):
AL - Autauga
AL - Baldwin
AL - Blount
AL - Bullock
AL - Butler
AL - Calhoun
AL - Chambers
AL - Cherokee
AL - Chilton
AL - Choctaw
AL - Clarke
AL - Conecuh
AL - Coosa
AL - Crenshaw
AL - Cullman
AL - Dallas
AL - DeKalb
AL - Elmore
AL - Escambia
AL - Etowah
AL - Greene
AL - Hale
AL - Jefferson
AL - Lawrence
AL - Lee
AL - Lowndes
AL - Macon
AL - Marengo
AL - Marshall
AL - Mobile
AL - Monroe
AL - Montgomery
AL - Morgan
AL - Perry
AL - Pickens
AL - Pike
AL - Russell
AL - St. Clair
AL - Shelby
AL - Sumter
AL - Talladega
AL - Tallapoosa
AL - Tuscaloosa

AL - Walker
AL - Washington
AL - Wilcox
AL - Bibb
AL - Clay
AL - Cleburne
AL - Fayette
AL - Franklin
FL - Escambia
AL - Lamar
AL - Marion
AL - Randolph
AL - Winston
MS - Choctaw
MS - Clay
MS - Chickasaw
MS - Clarke
MS - Itawamba
MS - Lowndes
MS - Kemper
MS - Lauderdale
MS - Lee
MS - Monroe
MS - Noxubee
MS - Oktibbeha
MS - Pontotoc
MS - Prentiss
MS - Tippah
MS - Tishomingo
MS - Union
MS - Webster
MS - Wayne
MS - Winston

Congressional District(s):
AL - 5
AL - 6
AL - 2
MS - 1
MS - 3
AL - 1
AL - 4
MS - 4
AL - 3
FL - 1
AL - 7

Narratives

Introduction and Overview:

The overall objective of the Clean Water Act (CWA) is to "restore and maintain the chemical, physical and biological integrity of the nation's waters" [section 101(a)]. The interim goal of the CWA is to provide for "water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water" (section 101(a)]. The EPA and the State agencies tasked with implementing CWA programs have made substantial progress in protecting the waters of Alabama, Florida, and Mississippi for more than 40 years. However, based on the National Coastal Assessment survey and other water quality reporting data, there is still substantial work to be accomplished, and new and complex challenges continue to emerge and need to be addressed. The water quality index for the coastal waters of the Gulf Coast region is rated only fair, with 24 % of the coastal area rated poor and 58 % of the area rated fair for water quality condition (USEPA, 2016) (See Figure 2).

In the Mobile and Perdido River basins and across the Gulf region, a wide variety of land use factors have been identified that could contribute to the declining water quality of the Alabama and western Florida coast (Kennicutt, 2017). Land use factors such as deforestation, agriculture, industrialization, and urbanization can alter water quantity and quality and can affect downstream uses. However, there has yet to be comprehensive regional analyses to evaluate one of the most essential factors for the health of the Gulf – the timing and delivery of fresh water to the bays, estuaries and coastal communities. Freshwater flows are widely considered within the scientific community to be the "master variable" for support of healthy and functional riverine ecosystems because instream flow is a major factor for healthy ecological systems in estuaries, affecting all levels of physical, chemical and biological functions (Poff et al., 1997). Every aspect of the lives of aquatic plants and animals is cued by and inextricably linked to the natural variability of our rivers and streams (SIFN, 2010).

For more than six decades, there has been recognition that freshwater inflow is essential to support the health and function of estuaries. The scientific community has expressed the need to more fully evaluate and respond to concerns about reductions to or changes in the timing and delivery of freshwater flows to estuaries, including bays and estuaries within the Gulf of Mexico. As early as 1953, the vital importance of flows to the fisheries of Texas bays and estuaries was recognized (Hildebrand and Gunter, 1953). According to the Alabama Department of Economic and Community Affairs and the Alabama Water Association Working Group, compiling data regarding water use and trends is vital to assessing the water resources of the state with emphasis on baseline conditions. In addition to this baseline data, the state sets out in detail the need for a more comprehensive accounting of the water resources in Alabama (Water Management Issues in Alabama, 2012).

Anthropogenic changes to the timing, volume, and distribution of freshwater flows to bays and estuaries affects salinity, sediments and particulate matter and can affect loss of habitat and nursery areas, declines in spawning and productivity, and alteration in species composition and abundance (Harte Institute, 2014; Albers, 2002). Therefore, maintaining the natural timing and delivery of freshwater flows from rivers to estuaries is critical for establishing appropriate estuarine circulation patterns, salinity gradients, sediment transport, and nutrient supplies that support the production of valuable coastal fisheries. (Powell et al., 2002). Despite this recognition, the natural resource community has yet to undertake a comprehensive approach to collecting and evaluating instream flows.

Many estuarine and coastal habitats, critical for estuarine health, are significantly degraded by changes to the timing and delivery of freshwater flows. Seagrass beds, for instance, are one of the most important near shore coastal habitats in the Mobile and Perdido River Basins and are very vulnerable to anthropogenic changes because they are particularly sensitive to water quality changes. Seagrasses support fish and invertebrate community structure, are extremely productive and are used by a wide variety of species as nurseries, feeding grounds, and refuge from predation (Livingston, 1990). Seagrasses are a vital part of the food web and provide food for many organisms. Similarly, oyster beds, mangroves, marsh lands and soft-bottom un-vegetated sediment habitats are all vulnerable to degradation based on anthropogenic alteration of the land and water that causes changes to the timing and delivery of freshwater flows.

Freshwater flows carry nutrients, sediments, pollutants and organic matter; therefore, upstream changes in flow delivery can affect: (1) downstream water quality such as alteration of water salinities; (2) variation in oxygen and temperature conditions; and (3) changes in the distribution and transport of nutrients, carbon and particulate organic matter to the estuary. This could lead to an increased susceptibility to algal blooms and other habitat impairments. Quantitative relationships between alteration in flow frequency, duration, and/or magnitude and downstream ecological responses of fishes and macroinvertebrates have been documented in the literature (Irwin et al., 2019; Freeman and Marcinek, 2006; Poff and Zimmermann, 2009). Quantifying the connection between freshwater flow and water quality is challenging due to site specificity and the complex nature of estuarine ecosystems. The unavailability of comprehensive datasets that capture the physical, chemical and biological interactions within habitats have limited the ability to understand and model these systems.

The state-of-the-science for implementing restoration of flows for freshwater and estuarine ecosystem health has improved markedly over the past two decades. Some example approaches include modification of operational flow regimes through dam re-regulation, dam removal, conservation and efficiency practices, and improved placement and operation of surface and groundwater withdrawals. However, these efforts can often be hampered by the lack of readily available data on stream flows and available monitoring gages to collect those data. Often projects are implemented without an understanding of historical changes in the timing and delivery of flow over time, as well as the complex nature of the data and the models needed to interpret results for decision-making.

To improve the opportunity for science-based decision-making processes, we propose to collect data and develop a flow accounting model that will incorporate vital information relating water resources management actions, such as maintenance of minimum flows, to support freshwater habitat in Alabama, Florida, and Mississippi watersheds included in the Mobile River and Perdido River basins. This need for streamflow modeling was identified in recommendations related to evaluation of instream-flow science and decision making put forth by the Alabama Water Agencies Working Group (AWAWG; 2013, 2017). The USGS Lower Mississippi Gulf Water Science Center has performed studies similar to the project proposed here. Flow-accounting models have been developed for the Obed Wild and Scenic River in Tennessee and is in development for the Pearl and Pascagoula River basins in Mississippi. Flow-accounting models are commonly used and have been the focus of many peer-reviewed studies (Pearsall et al., 2005; Richter, 2007; Sheer and Dehoff, 2009; Stephenson, 2011; Sauchyn et al., 2016; WaterSMART, 2016, 2018; NASEM, 2018).

This 4-year, $3.4 million project will provide a comprehensive assessment of flow ecology and develop a basin-wide model for state and local decision-makers to use for restoration and natural resource management projects in Alabama, Florida, and Mississippi. It also supports a process to engage stakeholders and decision makers in development of this decision support tool. Specifically, the project includes:

- Providing focused watershed studies;
- Developing decision-support model/system for stakeholders; and

- Working with state partners to determine priorities for installing new gages.

The project will utilize USGS “Approved” streamflow data publicly available through the USGS National Water Information System (https://waterdata.usgs.gov/nwis/sw). This data is quality-assured by USGS Hydrographers. Nationally, USGS streamflow data describes stream levels, streamflow, lake and reservoir levels and surface-water quality. In addition to USGS data, this project will utilize withdrawal and discharge data from public utilities and industry provided by cooperators (GSA, ADECA, ADCNR) in the study area. The USGS will use U.S. Environmental Protection Agency discharge permit data publicly available via the EPA Enforcement and Compliance History Online website. Biological data collected using sampling protocols by the State of Alabama will be used to determine the flow-ecology relationship in combination with discharge data within the focus watershed. In addition to data listed, the project will utilize operations data from reservoirs within the watershed as input for the flow-accounting model, trend analysis, streamflow alteration analysis, low-flow analysis, and flow-ecology analysis.

The Operational Analysis and Simulation of Integrated Systems (OASIS) model will be used to simulate the routing of water through watersheds in the basin. OASIS is a flow-accounting model which balances inflows with outflows. It can dynamically link with other available groundwater, water quality and watershed models, providing flexibility to address complex interactions (Frei et al., 2012). The OASIS post-processor also allows for easy end-to-end linkages between modeled flows and ecological responses. In the Obed River Basin in Tennessee, output from the model was linked to the USGS’s EflowStats package in R, which was then used to automatically compute ecological habitat metrics that could be compared across scenarios (Cartwright et al., 2017). This software provides a robust tool for decision-makers to evaluate planning alternatives, such as the impact of various water resource alterations on restoring and conserving habitat, water quality, and living coastal and marine resources throughout the basin and in the receiving estuary. It can also be used to evaluate key uncertainties, such as how climate change could be mitigated by various management strategies or planning alternatives (WaterSmart, 2018).

This OASIS model has been used around the world and has provided water resource managers and stakeholders with simulated benefits of various water use scenarios, such as declines in reservoir storage. The OASIS flow-accounting models and other hydrological decision-support frameworks with linkages to OASIS have been utilized in over 40 River Basins in the United States as well as in the Bay of Plenty Region, New Zealand and Yellow River Basin, China. The models have been used to inform management decisions and aid in:

- Evaluating and improving the reliability of water supply system
- Allocation and management of water resources
- Evaluation of proposed release protocol from impoundments
- Water availability assessments
- Evaluation of the impact of multiple operation scenarios
- Dispute resolution
- Informing environmental flow policies
- Refining safe yield estimates with/without optimal operation
- Developing probabilistic triggers to avoid water shortages
- Developing basin-wide water management strategies
- Simulating various hydropower operation scenarios
- Assessing basin-wide effects of various operation scenarios
- Testing and implementation of water shortage response plans
- Assessing instream flow regulations

The evaluation of various water use scenarios provides information upon which to base conservation measures to ensure freshwater flow to support not only community needs but the needs of ecosystems and biota within river basins. In many instances, the OASIS model has provided a basis by which communities have altered their water management plans to more closely mimic natural flows. The OASIS model has been "bench-tested" and has informed many management decisions. For example, it was applied to develop the NYC Operations support tool used for planning and operations of NYC's complex reservoir system, as well as to inform management decisions in Alberta Canada (https://watersmartsolutions.ca/knowledge-base/bow-river-project-final-report/), and the state of North Carolina (https://deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment/basinwide-hydrologic-modeling). The previously described use and applications of the OASIS model suggest that it is an appropriate choice for evaluating instream-flow alternatives in the Mobile and Perdido River basins.

Proposed Methods:

Flow accounting models provide a tool that managers can use to evaluate how streamflow alteration in upstream basins affects downstream conditions. Ideally, models such as these must be empirically based, flexible, compatible with other platforms, while also being easy to use and providing readily interpretable output.

The OASIS model (Hazen and Sawyer (formerly HydroLogics, Inc.), 2011) is an excellent example of such a model and is a unique software program that realistically simulates the routing of water through a watershed. OASIS has been used by environmental groups, industrial clients, and water utilities throughout the United States and informs the allocation of water for approximately 20% of the population of the United States at locations such as the lower Rio Grande-Pecos-Conchos, Savannah, Cape Fear, Pamlico, Neuse, and Roanoke rivers basins. OASIS is an extremely powerful tool that estimates streamflow availability in the context of varying supply demands, management options, and changes in operational rules and constraints. This tool enables parties with diverse and often conflicting goals to work together to develop solutions that mutually satisfy diverse objectives. In application, OASIS will allow resource managers in Alabama, Florida, and Mississippi to understand the frequency and duration that existing or proposed operating rules may be violated and will provide a straightforward means to evaluate alternatives. The model identifies the best means of moving water through the Mobile and Perdido River basins to meet a prescribed set of goals and constraints.

As a flow-accounting model, OASIS will enable water resource managers in Alabama, Florida, and Mississippi to evaluate a range of potential management scenarios, such as modifying release curves for selected reservoirs upstream in order to evaluate changes in freshwater delivery to an estuary. It is a mass-balance model which is resource specific and automatically writes continuity of flow equations and reduces errors when building models describing river basins. The model uses an Operations Control Language (OCL), which provides a way to evaluate operating rules that are tested and implemented. As a mass-balance model, OASIS does not predict water quality parameters, however, it is easy to integrate output from other models (i.e., groundwater and water quality). OASIS and its easy-to-use graphical user interface, dashboards, and processing programs is a tool for stakeholders and water resource managers designed to enable various drought and water use and availability exercises.

Input datasets for the OASIS model include monthly and daily demands, surface water withdrawal and discharge timeseries data, reservoir storage-area-elevation data, reservoir rule curves and model weightings, and evaporation/precipitation data. Statistical analyses of the data to establish model streamflow relationships will include Mann-Kendall trend analysis, cluster analysis, correlation analysis, Quantile-Kendall analysis, and various low-flow analyses. The OASIS post-processor will compute basic statistics, and perhaps more importantly will produce output in a variety of formats for statistical analysis in other programs. Additionally, the OASIS OCL language will be used to create and track user-defined variables that represent performance measures specific to the basin. In addition to running standard simulations (i.e., a set period of hydrology sequentially), OASIS also has a model called “Position Analysis” (PA) which runs ensembles forecasts. OASIS can automatically generate the ensembles inflows, based on the historic inflow record, and statistically adjust them based on antecedent flows. It also can be configured to run ensemble inflows from external data sources and display potential future flow conditions in a probabilistic way.

The flow accounting model takes hypothetical flow alterations and translates them into characteristics of streamflow. It describes predicted characteristics of streamflow such as magnitude, duration, frequency, timing, and rate of change. The mass-balance model is spatially explicit and operates at a daily time step which enables the model to calculate flow by adding inflow (e.g., flow upstream and effluent discharge) and subtracting outflow (e.g. water withdrawals, reservoir evaporation). The model is designed to be interactive and enables by Alabama, Florida, and Mississippi resource managers to evaluate strategies and gather additional stakeholder input.

The methods utilized and outputs developed are going to be similar to the peer-reviewed data, reports and journal articles generated in the ‘Obed National Wild and Scenic River’ study and the RESTORE FPL1 ‘Baseline Flows’ study. Listed below are several of the publications from the USGS Lower Mississippi-Gulf Water Science Center exploring flow-ecology relationships and the collection of data required for those studies:

- Putting Flow–Ecology Relationships into Practice: A Decision-Support System to Assess Fish Community Response to Water-Management Scenarios (Cartwright et al., 2017);
- Modelling ecological flow regime: an example from the Tennessee and Cumberland River basins (Knight et al., 2012);
- Hydrologic Data for the Obed River Watershed, Tennessee (Knight et al., 2014);
- Species-Richness Responses to Water-Withdrawal Scenarios and Minimum Flow Levels: Evaluation Presumptive Standards in the Tennessee and Cumberland River Basins (Driver et al., 2020);
- Copula Theory as a Generalized Framework for Flow-Duration Curve Based Streamflow Estimates in Ungaged and Partially Gage Catchments (Worland et al., 2019);
- Freshwater Delivery to the Gulf of Mexico: An Analysis of Streamflow Trends in the Southeast US from 1950 – 2015 in review (Rodgers et al., 2020);
- Prediction and Inference of Flow Duration Curves Using Multioutput Neural Networks (Worland et al., 2019); and
- The use of support vectors from support vector machines for hydrometeorologic monitoring network analyses (Asquith, 2020).

Stakeholders in Alabama (GSA, ADECA, ADCNR), Mississippi (MDEQ), and Florida (Northwest Florida Water Management District [NWFLWMD], FLDEP) along with other federal, state and local agencies will participate in providing input data on water withdrawals, wastewater discharges, inter-basin transfer and biological data for the OASIS model. A Technical Advisory Committee (TAC) with State members representing the Mobile and Perdido River basins will be established to discuss, plan and provide data for model construction and to discuss how the model output will be used to address management needs. This involvement during model development and verification will ensure all parties are represented, that there is transparency in the process, and that performance measures and the evaluation of alternative and current management strategies are developed collaboratively. TAC involvement from model conception to scenario development and outcomes will create a collaborative environment based upon a shared knowledge and understanding of the methods employed by the flow-accounting model and the physical capabilities and limitation of the hydrologic systems they are charged with managing.

Flow Ecology

Streamflow metrics and aquatic biota community data for freshwater sites throughout the river basins will be evaluated using multivariate techniques to determine which components of the annual hydrograph are critical to the health of freshwater biota. The analysis will be conducted using streamflow metrics and their respective deviation from reference hydrologic profiles developed in RESTORE FPL1 'Baseline Flows' study (Knight et al., 2008; Carlisle et al., 2010a, and 2010b). The result of the analysis will be a subset of streamflow metrics that, when altered, result in an observed ecological response, or ecological limit function (Knight et al., 2012). This function can be used to evaluate potential changes to streamflow (water use, landscape / land use change, and climate) in terms of potential ecological response (degradation). The results will provide managers with a scientific basis for decision making.

This flow ecology analysis described in Knight et al., 2012 and Cartwright et al., 2017 will be a multi-step process (Figure 3) that includes:

1. Definition of one or more hypothetical or proposed flow alterations;
2. Translation of the flow alterations into predicted streamflow characteristics (e.g., magnitude, frequency, timing, duration, rate of change, and predictability of high- and low-flow events);
3. Formatting of predicted streamflow characteristics as an independent variable in the flow-ecology relationship under the hypothetical or proposed alteration; and
4. Application of the flow-ecology relationship to the independent variable in order to predict the ecological response to the proposed alteration/alterations.

The process is designed to incorporate existing flow-ecology relationships into the flow-accounting model such that it:

1. Integrates multiple water-management decisions and their hydro-ecologic effects;
2. Uses a methodology that is consistent and transparent;
3. Is adaptable, flexible, and allows for updates of locations of ecological assessments, scenarios, and water-management assets;
4. Derives specific ecological predictions from translated water-management decisions;
5. Subsets ecological predictions into meaningful ecological categories;
6. Engages with end-users throughout model development; and
7. Is efficient and cost-effective for end-users.

Installation of Streamflow Gages

As part of the RESTORE Baseflow study, the USGS performed a network analysis to determine gaps in the streamgaging networks of the 5 Gulf states. The USGS will leverage the results of this analysis to inform stakeholders of potential locations for 5 new streamgages in year 1 and provide operating and maintenance support in years 2-4 in the Mobile and/or Perdido River basins to address the gaps identified. Funding for the operation and maintenance of the streamgages is included in the budget for the duration of this project. Additional funding would have to be secured for O&M of the gages after year 4 of this project. The funds requested for streamgage installation are intended to cover 5 streamgages; however, final decisions will be based on sites chosen and reflect installation costs.

Milestones

Stakeholders were engaged prior to proposal submittal to gage interest in the project and to discuss how best the USGS, State and local experts can work together to assemble the necessary datasets, conduct targeted analyses, and generate an operational tool that will provide federal, state, and local agencies with supporting data necessary to inform science-based decisions for restoration, flood, and drought management efforts in the Mobile River and Perdido River basins. Listed below are milestones identified from stakeholder conversations which will be used to judge the success of the project:

Year 1:

- Evaluate which streamflow metrics are most critical to ecological endpoints in Focus Watershed.
- Start building input data sets and setting up input data sets for the OASIS model.
- Evaluate temporal changes in critical streamflow metrics along large rivers in the Focus Watershed.
- Work jointly with ADECA, GSA, ADCNR, NWFLWMD on installation of new streamflow gages at pre-determined locations.

Year 2:

- Finalize all components of the OASIS model.
- Continue streamflow metric analysis.
- Work jointly with ADECA, GSA, ADCNR to assess how temporal changes in critical streamflow metrics along large rivers in the Focus Watershed are impacting aquatic biology health (SAV, macro-invertebrates, etc.).
- Conduct streamflow gage O&M.
- Journal article on focused streamflow trends analysis.
- Journal article on focused hydrologic alteration.

Year 3:

- Journal article on streamflow-ecology model.
- Journal article on streamflow metrics trends at key large river nodes in the Focus Watershed.
- Journal article on low-flow statistics for focused study area.
- Conduct streamflow gage O&M.

Year 4:

- Release OASIS model and model documentation.
- Cooperator/USGS OASIS model training.
- Journal article on OASIS model.
- Conduct streamflow gage O&M.

Environmental Benefits:

The USGS, working with water resource management agencies, have long been at the forefront of developing and implementing environmental flow science, and improving models used by resource managers to implement flow regimes to protect and restore critical habitat and protect and maintain species. The benefits of providing advanced decision-support models and data include the ability to evaluate indirect environmental benefits of various water resource management and restoration projects and actions, and hopefully improving the efficacy of those actions. An additional benefit of the proposed project is associated with the potential mitigation of future risks such as sea level rise, subsidence, and/or storms. The flow-accounting model will allow resource managers to generate “what if” scenarios in reallocating water flows to address long-term risks and uncertainties. Scenarios of water-use change affected by industry, urbanization, agriculture, climate change and other future risks and uncertainties can be incorporated into water use allocations in the flow-accounting model to better understand threats to downstream ecological resources. The flow-accounting model will provide state and local agencies (e.g. GSA, ADCNR, ADECA, NWFLWMD and others) with modeled outcomes on water-use strategies and allow comparisons of benefits and tradeoffs among various water resource projects.

Metrics:

Metric Title: PRM012 : Tool development for decision-making - # tools developed
Target: 1
Narrative: Success of PRM012 will be measured by the completion and delivery of the OASIS model to shareholders and decision makers in Alabama, Florida, and Mississippi. Upon delivery, Hazen and Sawyer (formerly HydroLogics, Inc.) will provide training to the states on model use and the graphical user interface. The tutorial will enable the continued use of the model including the adaptation of previous scenarios when new data becomes available. In addition to model delivery, a report describing model output will be submitted for publication.

Metric Title: PRM006 : Monitoring - # streams/sites being monitored
Target: 5
Narrative: Success of PRM006 will be measured by the construction and installation of five streamgages in year 1, operation and maintenance in years 2-4, and delivery of publicly available, quality-controlled data via the web.

Risk and Uncertainties:

There is limited risk in using a flow-accounting model for application in the Mobile and Perdido River basins. The OASIS model has been previously developed and applied in numerous river systems throughout the U.S., including parts of the Mobile River basin and a RESTORE FPL1 application in the Pascagoula-Pearl in Mississippi. However, streamgage damage or destruction is an operational risk in implementing the second component of this project. The uncertainty that exists in regard to model development is primarily associated with uncertainty in the input data provided, since the flow accounting model is just a mass-balance of inputs and outputs. There are measurement and equipment errors associated with the input data that need to be accounted for. The OASIS model development process includes verification of inflows, through simulations forcing the model to match historic operational data and looking at overall simulation agreement and making adjustments where necessary. Once the OASIS model is built, it is easy to switch inputs to quickly look at the sensitivity to uncertainty in inputs. OASIS can be called by a batch program to facilitate running a large set of alternative inflow datasets, for example, from downscaled Global Climate Change models or from inflows generated through Monte Carlo simulation.

Mitigation - Streamgages are subject to vandalism and/or destruction by natural events (e.g., overtopping, washed off bridges, lightning strikes). The USGS assumes the financial risk for these events when operating streamgages. If a gage funded through this project is damaged through natural events or vandalism, instrumentation will be replaced. If vandalism becomes a continuous problem, an alternate location (different location on same stream or potentially different stream) will be identified. Downtime in gage operations will be minimized by completing repairs as quickly as possible.

There are also operational benefits associated with mitigation of future risks. The water use accountability model generated by this project will allow resource managers to generate “what if” scenarios in reallocating water flows to address long-term risks and uncertainties. Scenarios of water-use change affected by industry, urbanization, agriculture, climate change and other future risks and uncertainties can be incorporated into water use allocations in the OASIS model to better understand threats to downstream ecological resources.

Monitoring and Adaptive Management:

This project will be completed with state-of-the-art scientific methods utilizing data generated and described in the RESTORE FPL1 Baseline flows project (https://www.sciencebase.gov/catalog/item/59b7ed9be4b08b1644df5d50) and existing water use and ecological data from State partners. The network analysis performed as a part of the 'Baseline Flows' project will be used to inform locations of 5 new continuous streamflow gages, that will be installed, maintained and monitored for four years following USGS National Standards, and data will be made available through the USGS National Water Information System (https://waterdata.usgs.gov/nwis/sw). In addition, the lessons learned from the focused watershed study in the Baseflow project will be applied to this project and as new and emerging processes or methods become available, they will be incorporated.

Data Management:

Data and corresponding FGDC-compliant metadata used in analysis will be managed in accordance with the U.S. Geological Survey data archival and publishing standards and are subject to those described in White House OSTP Memorandum and OMB Open Data Policy. These policies require federal agencies to collect or create information in a way that supports downstream information processing and dissemination activities. This includes using machine readable and open formats, data standards, and common core and extensible metadata for all new information creation and collection efforts. The required metadata will facilitate the discovery of relevant project information and promote data use for future gulf restoration efforts. Data sets (tabular and GIS) assembled and used in analyses will be stored on a dedicated local server and backed up in accordance with USGS Lower Mississippi River-Gulf WSC data stewardship and preservation policies and in accordance with RESTORE Council Guidelines. Derivatives of published or existing data and metadata generated during this project will be published and made publicly available in standard machine-readable formats through recognized outlets, such as the ScienceBase USGS data release community folder. ScienceBase also provides a centralized permanent archive for USGS data and information products.

The model will be delivered and installed at a location determined by the State of Alabama along with complete documentation including all assumptions, operating rules, inputs, inflow development and various model parameters. Training for State of Alabama staff and other stakeholders will be provided over 2 days. Model developers have extensive experience in providing training for users of the models to ensure sufficient skills for running the model, modifying inputs/assumptions for new scenarios, and generating and analyzing output. The training will also include materials that can be used for training of new staff. Trained staff will be able to update input datasets and run and utilize the model well beyond the life of this project.

Collaboration:

The USGS has consulted with Commissioner Chris Blankenship (and his staff) and Alabama water agencies concerning the proposed work. These conversations helped develop the initial proposal and refinements that include construction of new streamflow gages in the river basins. Presentations of the proposal were provided to RESTORE Council members in Alabama, Florida and Mississippi. On the local level, conversations occurred with members of the NW FL WMD who have minimum flow objectives in the Perdido River basin that this project may help support, along with state agencies in Alabama, Florida, and Mississippi. Additionally, the Technical Advisory Committee (TAC) State members from Alabama and Mississippi that were established under the 'Baseline Flows' (EGID1 from FPL1) project have had further collaboration discussions on the scope of the proposed project.

Public Engagement, Outreach, and Education:

This project is particularly well-suited for providing a significant amount of outreach and educational opportunities to both the public as well as to state and local decision-makers. It will expand the general knowledge of the importance of streamflow and provide newly emerging information that demonstrates the ecological and economic benefits of maintaining or restoring ecological flows. Two elements of this project that will be emphasized in the communication strategy are:

1. Communicating Information on the Ecological and Economic Benefits of Restoring Flows. The state-of-the science on understanding freshwater flows might not be well understood by the public. The project will incorporate information on the ecological and economic importance of freshwater flows to coastal communities -- in fact sheets, press briefs, on-line tools and publicly-accessible publications. Outreach materials will demonstrate how stream flow information is vital to management and policy decisions regarding flood and drought protection, industrial and municipal water supply, pollution control, storm water management, and stream ecosystem health; how the OASIS model is used to evaluate the various competing priorities for water use (e.g., population growth, irrigation, power generation, restoration of aquatic habitat) in Mobile and Perdido River basins; how stream flow records from long-term stream gages are essential to assessing how the stream flow metrics related to floods, droughts, and aquatic stream health are being modified by human actions; and how stream flow data are essential for effective restoration planning and assessment of water resources projects.

2. Publishing Successful Stories of Flow Restorations. USGS will profile and publicize successful flow restorations that have taken place in the Gulf of Mexico region resulting in ecological and economic benefits for communities. Flow restoration projects in Alabama, Florida, and Mississippi will be highlighted and used to educate stakeholders on the consequences of flow alteration on downstream ecological resources and how restoration of flows can provide both ecological and economic benefits.

Leveraging:

Funds: $1,500,000.00
Type: Bldg on Others
Status: Received
Source Type: Other Federal
Description: The RESTORE FPL1 ‘Baseline Flows’ project will provide foundational datasets and statistical analyses for model development that will be incorporated into the decision-support framework for the Mobile and Perdido River basins (estimated at $1.5-$2M). Datasets generated during the ‘Baseline Flows’ project will be used to determine potential locations of new streamflow gages and flow-ecology methodologies employed to create the flow-accounting model.

Funds: $1,000,000.00
Type: Bldg on Others
Status: Received
Source Type: State
Description: This project will leverage a fish and invertebrate sampling program and database (estimated at greater than $1M) funded by the Geological Survey of Alabama (GSA). This database is critical for describing ecological response to various flow regimes, which could then be evaluated using the OASIS model.

Environmental Compliance:

The modeling component of this project is a planning effort and will utilize the Council’s Categorical

Exclusion for the National Environmental Policy Act. Installation of streamgages is considered implementation and will require a categorical exclusion. We will use USGS Categorical Exclusion USGS 516 DM 9.5E, E. Operation, construction, installation, and removal of scientific equipment. USGS has prepared the environmental compliance documentation needed to move the implementation component of this proposed activity into FPL Category 1. All applicable federal, state and local regulations will be complied with in the course of implementing this project.

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Budget

Project Budget Narrative:
Year 1: $850,000 Focus Watershed Assessments and Streamflow Gage Installation
Evaluate which streamflow metrics are most critical to ecological endpoints in Focus Watershed.
Start building input data sets and setting up input data sets for the OASIS model.
Evaluate temporal changes in critical streamflow metrics along large rivers in the Focus Watershed.
Work jointly with ADECA, GSA, ADCNR, NWFLWMD on installation of new streamflow gages at pre-determined locations.

Year 2: $850,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Finalize all components of the OASIS model Continue streamflow metric analysis.
Work jointly with ADECA, GSA, ADCNR to assess how temporal changes in critical streamflow metrics along large rivers in the Focus Watershed are impacting aquatic biology health (SAV, macro-invertebrates, etc.).
Streamflow Gage O&M.
Article on focused streamflow trends analysis.
Article on focused hydrologic alteration.

Year 3: $1,000,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Article on streamflow-ecology model.
Article on how streamflows metrics have changed over time at key large river nodes in the Focus Watershed.
Article on low flow statistics for focused study area.
Determine funding source for continuation of new streamflow gages.
Streamflow Gage O&M

Year 4: $700,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Release OASIS model.
Article on OASIS model.
Communication Blitz on key results and application of the model.
Streamflow Gage O&M

Total FPL 3 Project/Program Budget Request:
$ 3,400,000.00

Estimated Percent Monitoring and Adaptive Management: 5 %
Estimated Percent Planning: 67 %
Estimated Percent Implementation: 12 %
Estimated Percent Project Management: 9 %
Estimated Percent Data Management: 7 %
Estimated Percent Contingency: 0 %

Is the Project Scalable?:
Yes

If yes, provide a short description regarding scalability.:
Readily scalable to include other large river basins across the five Gulf States. The cost associated with a given river basin is strongly correlated to basin size, local resource interests, and leveraging of data and information sources.

Environmental Compliance[1]

Environmental Requirement	Has the Requirement Been Addressed?	Compliance Notes (e.g.,title and date of document, permit number, weblink etc.)
National Environmental Policy Act	Yes	Council NEPA Categorical Exclusion for planning will be utilized for the modeling component of this project. See uploaded USGS categorical exclusion documentation for streamgage installation - USGS concluded that the installation of stream gages is not a major federal action. Therefore, the applicable bureau categorical exclusion was used. 516 SM Chapter 9.5. E.
Endangered Species Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
National Historic Preservation Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Magnuson-Stevens Act	N/A	Note not provided.
Fish and Wildlife Conservation Act	N/A	Note not provided.
Coastal Zone Management Act	N/A	Note not provided.
Coastal Barrier Resources Act	N/A	Note not provided.
Farmland Protection Policy Act	N/A	Note not provided.
Clean Water Act (Section 404)	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
River and Harbors Act (Section 10)	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Marine Protection, Research and Sanctuaries Act	N/A	Note not provided.

[1] Environmental Compliance documents available by request (restorecouncil@restorethegulf.gov).

Marine Mammal Protection Act	N/A	Note not provided.
National Marine Sanctuaries Act	N/A	Note not provided.
Migratory Bird Treaty Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Bald and Golden Eagle Protection Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Clean Air Act	N/A	Note not provided.
Other Applicable Environmental Compliance Laws or Regulations	N/A	Included additional note regarding Native American sacred sites.

Maps, Charts, Figures

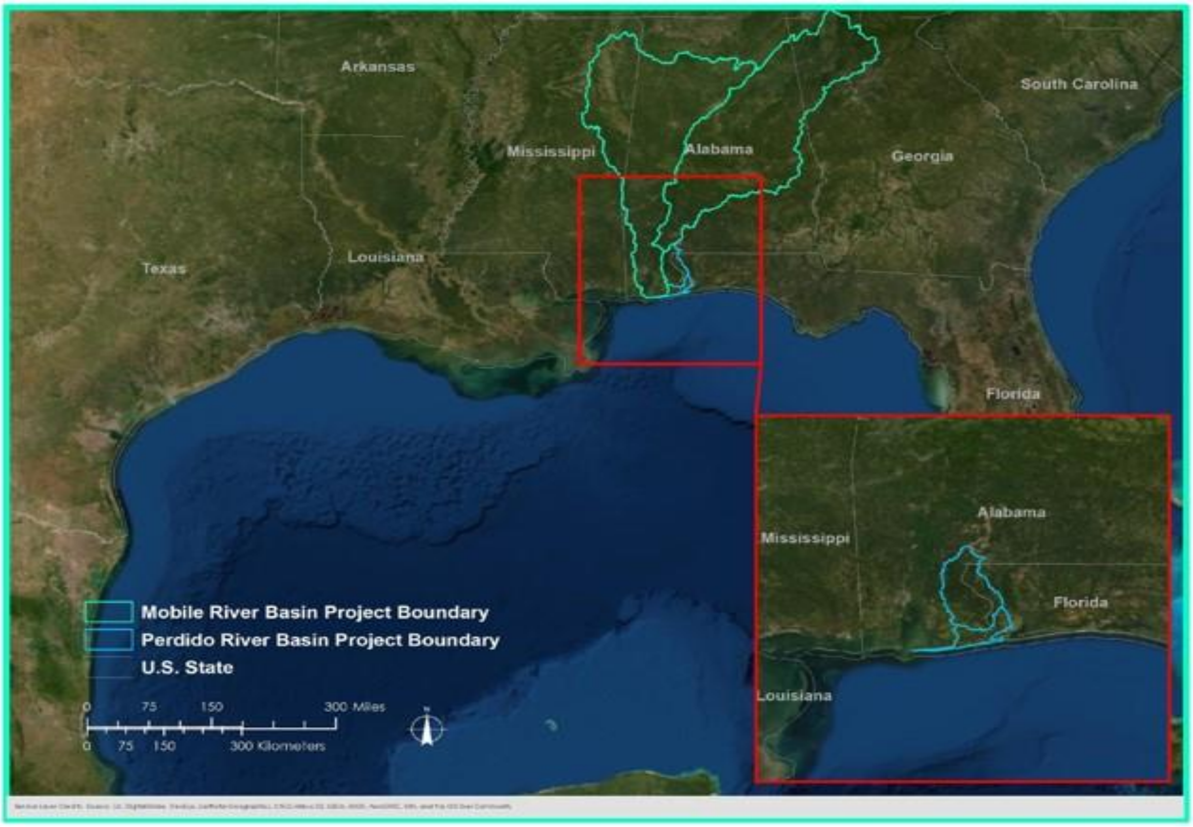

Figure 1: DOI/USGS Ecological flow project location

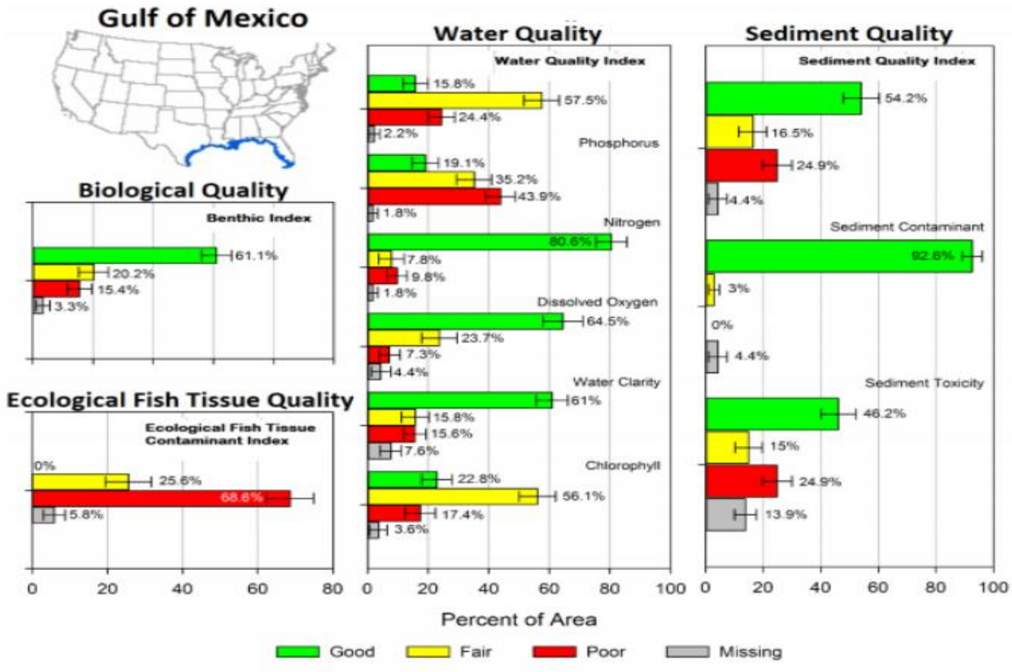

Figure 2: Overall water quality conditions of Gulf Coast estuaries (USEPA, 2016)

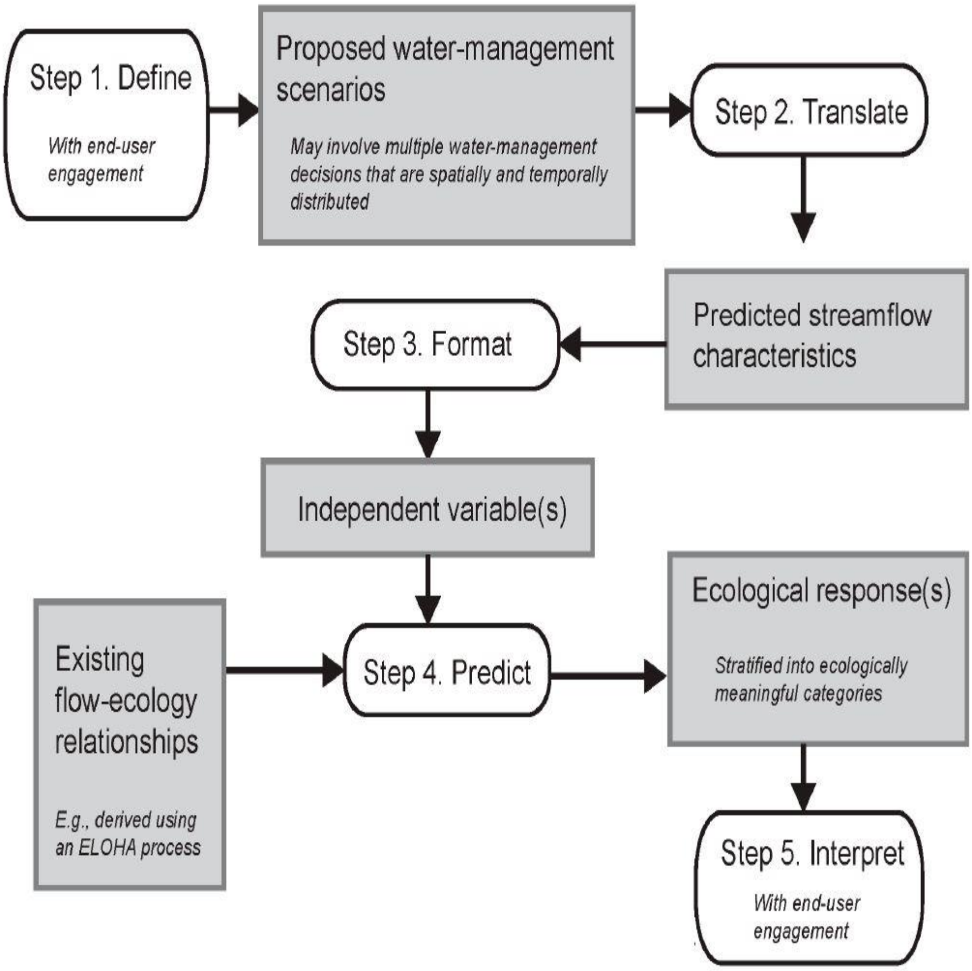

Figure 3: Conceptual model to operationalize flow-ecology relationships into decision-support systems for water resource managers (Cartwright et al., 2017)

Office of the Governor

Kay Ivey
Governor

Alabama Department of Economic and Community Affairs

Kenneth W. Boswell
Director

State of Alabama

April 9, 2020

Rodney Knight
USGS Lower Mississippi-Gulf Water Science Center
640 Grassmere Park, Suite 100
Nashville, Tennessee 37211

Dear Mr. Knight,

Thank you for the opportunity to review the USGS proposal entitled "Development of an Ecological Flow Decision-Support Model for Mobile River and Perdido River Basins". We are very interested in the development of tools that will assist our office regarding the assessment of water availability in the State.

The Alabama Office of Water Resources, a division of the Alabama Department of Economic and Community Affairs, administers the Alabama Water Use Reporting Program (AWURP) which has become the repository for water-use data in the state. In 2017, OWR published an assessment of current and projected water withdrawals and consumptive water use (or net demands) in Alabama as well as a comparison of those consumptive uses to summaries of the state's surface-water resources. These assessments were conducted at the eight-digit Hydrologic Unit Code (HUC-8 subbasin) level and provided a vital aspect of understanding Alabama's surface water resources including the estimation of surface-water withdrawals, returns, and net water availability in each subbasin.

A streamflow accounting model of the Mobile and Perdido River Basins as described in this proposal will help the Alabama Office of Water Resources enhance what we have already been able to accomplish in our surface-water assessment effort in Alabama. The streamflow accounting model can help with ecological flow assessments and as well as assist with conducting water-availability assessments at a finer resolution such as the HUC-10 or HUC-12 subbasin level. Tools such as these are needed to help guide potential enhancements to state water policies and water resource management activities as well as indicate where additional focus may be needed in the future.

The Alabama OWR looks forward to collaborating with the USGS by sharing information from the AWURP to be used in the OASIS model development In addition, we appreciate the efforts of the USGS to explore the use of the latest tools and models to help improve the amount and accuracy of information used in the water use and availability assessment process.

Sincerely,

J. Brian Atkins

J. Brian Atkins, P.E.
Division Chief, Office of Water Resources

401 Adams Avenue • Suite 580 • P.O. Box 5690 • Montgomery, Alabama 36103-5690 • (334) 242-5100

GEOLOGICAL SURVEY OF ALABAMA

Berry H. (Nick) Tew, Jr.
State Geologist

420 Hackberry Lane
P.O. Box 869999
Tuscaloosa, Alabama 35486-6999
Phone (205)349-2852
Fax (205)349-2861
www.gsa.state.al.us

April 14, 2020

Ms. Mary Josie Blanchard
U.S. Department of the Interior
Office of the Assistant Secretary for Policy, Management and Budget
1849 C Street, NM, Room 5113
Washington DC 20240

Dear Ms. Blanchard:

I want to express the support of the Geological Survey of Alabama for the Department of the Interior, United States Geological Survey, project titled *Ecological flow decision-support framework for the Mobile River Basin*. The primary goal of the project, to develop a decision support model that can be used by stakeholders to make science-based decisions on how freshwater flows and water quality changes in the upstream reaches of the Mobile, Alabama, and Perdido River systems will affect the Alabama and western Florida coastal region, can provide multiple benefits to the people of Alabama.

The Geological Survey of Alabama (GSA) provides service and information to Alabama and its citizens as a natural resource data gathering and research agency. As part of its mission, GSA explores and evaluates the mineral, water, energy, biological, and other natural resources of the State of Alabama and conducts basic and applied research in these fields.

We believe that this effort will result in (1) a better understanding of in-stream flows necessary to support healthy environmental habitats for aquatic species throughout the reaches of the three river basins, (2) enhanced monitoring of in-stream flows in areas where new gages will be installed, and (3) the ability to evaluate the contributions of groundwater to in-stream flows by integrating monitoring data with the OASIS model developed during the project. This project will complement ongoing efforts to evaluate and restore freshwater flows to riparian and estuarine habitats throughout the Mobile, Alabama, and Perdido basins region.

As a result, we support the goals of this project and will work with other partners to ensure a successful outcome. Specifically, we will provide any technical assistance needed by the project manager.

Sincerely yours,

Berry H. (Nick) Tew, Jr.
State Geologist and
Oil & Gas Supervisor

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Science and Service for the People of Alabama

RESTORE Council FPL 3 Proposal Document

General Information

Proposal Sponsor:
U.S. Department of the Interior – U.S. Geological Survey

Title:
Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins

Project Abstract:
This project will create a decision support model to provide vital information on freshwater inflows to streams, bays, and wetlands of the Mobile and Perdido River Basins. The Operational Analysis and Simulation of Integrated Systems model will be used to simulate the routing of water through watersheds in the river basins, and the software will be used by resource managers in the basins to evaluate questions of concern, such as the influence of water resource alteration on restoring and conserving habitat, water quality, and living coastal resources. New gaging stations will be installed to fill critical freshwater inflow data gaps and support data needs for future monitoring assessments. Readily available data on inflows, and available models to understand how the timing and delivery of flow effects downstream ecological resources, have been identified as a critical need by the Alabama Water Agencies Working Group and other water resource managers (AWAWG; 2013, 2017). The flow-accounting model will provide state and local agencies such as the Alabama Department of Conservation and Natural Resources with modeled outcomes on various water-use strategies and provide supporting information to guide water resource management activities and restoration areas to focus on in the future. The modeling component will cost $3,000,000 with design and implementation over the four-year life. The stream gaging component will cost $400,000 with installation in year one and O&M in years 2-4.

FPL Category: Cat1: Planning/ Cat1: Implementation

Activity Type: Project

Program: N/A

Co-sponsoring Agency(ies): N/A

Is this a construction project?
No

RESTORE Act Priority Criteria:
(II) Large-scale projects and programs that are projected to substantially contribute to restoring and protecting the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast ecosystem.

Priority Criteria Justification:
The flow-accounting model for the Mobile and Perdido River basins primarily meets the second RESTORE Act Comprehensive Plan goal that addresses large-scale projects that are projected to substantially contribute to restoring and protecting the water quality and quantity of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast ecosystem. This large-scale project covers over 42,000 square miles, includes the Mobile Bay/Mobile-Tensaw Delta and Perdido Bay and River priority geographic areas in Alabama, Florida,

and Mississippi, and crosses geopolitical boundaries to capture the ecoregional gradient (i.e., upland, riparian, estuarine and coastal habitats). This proposal will have far-reaching measurable and sustainable effects by providing the needed tools (e.g. model and streamgages), data, and information that could be used by state and local decision-makers to restore more naturalized timing and delivery of freshwater supported by the monitoring of discharge in coastal river systems of Alabama, Florida, and Mississippi. Restoration of the timing of freshwater inflows can positively affect shellfish, fisheries, habitat, and water quality. Increasingly, state and local decision-makers and federal agencies are turning their attention to the restoration of flows as part of a holistic approach to restore water quality and habitat and to protect and replenish living coastal and marine resources and the livelihoods that depend on them. Once the framework is developed and delivered to the decision-makers, it can be used well beyond the duration of the project.

Project Duration (in years): 4

Goals

Primary Comprehensive Plan Goal:
Restore Water Quality and Quantity

Primary Comprehensive Plan Objective:
Improve Science-Based Decision-Making Process

Secondary Comprehensive Plan Objectives:
N/A

Secondary Comprehensive Plan Goals:
N/A

PF Restoration Technique(s):
Improve science-based decision-making processes: Develop tools for planning and evaluation

Location

Location:
The decision-support framework will be built for the Mobile River basin which covers approximately 41,000 square miles (65% of the State of AL,12% MS, portions of GA and TN) and the Perdido River basin which covers approximately 1,100 square miles (70% of the State of AL, 30% FL) (Figure 1).

HUC8 Watershed(s):
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Perdido Bay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Upper Conecuh)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Patsaliga)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Sepulga)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Lower Conecuh)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Middle Coosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Lower Coosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Middle Tallapoosa)
South Atlantic-Gulf Region(Alabama) - Coosa-Tallapoosa(Lower Tallapoosa)
South Atlantic-Gulf Region(Alabama) - Alabama(Upper Alabama)
South Atlantic-Gulf Region(Alabama) - Alabama(Cahaba)
South Atlantic-Gulf Region(Alabama) - Alabama(Middle Alabama)
South Atlantic-Gulf Region(Alabama) - Alabama(Lower Alabama)

South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Luxapallila)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Sipsey)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Mulberry)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Sipsey Fork)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Locust)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Upper Black Warrior)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Lower Black Warrior)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Middle Tombigbee-Chickasaw)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Lower Tombigbee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Mobile-Tensaw)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Mobile Bay)
Tennessee Region(Middle Tennessee-Elk) - Middle Tennessee-Elk(Bear)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Perdido)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Middle Tombigbee-Lubbub)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Noxubee)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Upper Chickasawhay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Florida Panhandle Coastal(Pensacola Bay)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Choctawhatchee(Pea)
South Atlantic-Gulf Region(Choctawhatchee-Escambia) - Escambia(Escambia)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Town)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Tibbee)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Chunky-Okatibbee)
South Atlantic-Gulf Region(Pearl) - Pearl(Upper Pearl)
Lower Mississippi Region(Lower Mississippi-Yazoo) - Yazoo(Little Tallahatchie)
Lower Mississippi Region(Lower Mississippi-Yazoo) - Yazoo(Yalobusha)
Lower Mississippi Region(Lower Mississippi-Big Black) - Big Black-Homochitto(Upper Big Black)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Upper Tombigbee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Black Warrior-Tombigbee(Buttahatchee)
South Atlantic-Gulf Region(Mobile-Tombigbee) - Mobile Bay-Tombigbee(Sucarnoochee)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Escatawpa)
South Atlantic-Gulf Region(Pascagoula) - Pascagoula(Mississippi Coastal)

State(s):
Alabama
Mississippi
Florida

County/Parish(es):

AL - Autauga
AL - Baldwin
AL - Blount
AL - Bullock
AL - Butler
AL - Calhoun
AL - Chambers
AL - Cherokee
AL - Chilton
AL - Choctaw
AL - Clarke
AL - Conecuh
AL - Coosa
AL - Crenshaw
AL - Cullman
AL - Dallas
AL - DeKalb
AL - Elmore
AL - Escambia
AL - Etowah
AL - Greene
AL - Hale
AL - Jefferson
AL - Lawrence
AL - Lee
AL - Lowndes
AL - Macon
AL - Marengo
AL - Marshall
AL - Mobile
AL - Monroe
AL - Montgomery
AL - Morgan
AL - Perry

AL - Pickens
AL - Pike
AL - Russell
AL - St. Clair
AL - Shelby
AL - Sumter
AL - Talladega
AL - Tallapoosa
AL - Tuscaloosa
AL - Walker
AL - Washington
AL - Wilcox
AL - Bibb
AL - Clay
AL - Cleburne
AL - Fayette
AL - Franklin
FL - Escambia
AL - Lamar
AL - Marion
AL - Randolph
AL - Winston
MS - Choctaw
MS - Clay
MS - Chickasaw
MS - Clarke
MS - Itawamba
MS - Lowndes
MS - Kemper
MS - Lauderdale
MS - Lee
MS - Monroe
MS - Noxubee
MS - Oktibbeha
MS - Pontotoc
MS - Prentiss
MS - Tippah
MS - Tishomingo
MS - Union
MS - Webster
MS - Wayne
MS - Winston

Congressional District(s):

AL - 5
AL - 6
AL - 2
MS - 1
MS - 3
AL - 1
AL - 4
MS - 4
AL - 3
FL - 1
AL - 7

Narratives

Introduction and Overview:

The overall objective of the Clean Water Act (CWA) is to "restore and maintain the chemical, physical and biological integrity of the nation's waters" [section 101(a)]. The interim goal of the CWA is to provide for "water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water" (section 101(a)]. The EPA and the State agencies tasked with implementing CWA programs have made substantial progress in protecting the waters of Alabama, Florida, and Mississippi for more than 40 years. However, based on the National Coastal Assessment survey and other water quality reporting data, there is still substantial work to be accomplished, and new and complex challenges continue to emerge and need to be addressed. The water quality index for the coastal waters of the Gulf Coast region is rated only fair, with 24 % of the coastal area rated poor and 58 % of the area rated fair for water quality condition (USEPA, 2016) (See Figure 2).

In the Mobile and Perdido River basins and across the Gulf region, a wide variety of land use factors have been identified that could contribute to the declining water quality of the Alabama and western Florida coast (Kennicutt, 2017). Land use factors such as deforestation, agriculture, industrialization, and urbanization can alter water quantity and quality and can affect downstream uses. However, there has yet to be comprehensive regional analyses to evaluate one of the most essential factors for the health of the Gulf – the timing and delivery of fresh water to the bays, estuaries and coastal communities. Freshwater flows are widely considered within the scientific community to be the "master variable" for support of healthy and functional riverine ecosystems because instream flow is a major factor for healthy ecological systems in estuaries, affecting all levels of physical, chemical and biological functions (Poff et al., 1997). Every aspect of the lives of aquatic plants and animals is cued by and inextricably linked to the natural variability of our rivers and streams (SIFN, 2010).

For more than six decades, there has been recognition that freshwater inflow is essential to support the health and function of estuaries. The scientific community has expressed the need to more fully evaluate and respond to concerns about reductions to or changes in the timing and delivery of freshwater flows to estuaries, including bays and estuaries within the Gulf of Mexico. As early as 1953, the vital importance of flows to the fisheries of Texas bays and estuaries was recognized (Hildebrand and Gunter, 1953). Anthropogenic changes to the timing, volume, and distribution of freshwater flows to bays and estuaries affects salinity, sediments and particulate matter and can affect loss of habitat and nursery areas, declines in spawning and productivity, and alteration in species composition and abundance (Harte Institute, 2014; Albers, 2002; Figure 3). Therefore, maintaining the natural timing and delivery of freshwater flows from rivers to estuaries is critical for establishing appropriate estuarine circulation patterns, salinity gradients, sediment transport, and nutrient supplies that support the production of valuable coastal fisheries. (Powell et al., 2002). Despite this recognition, the natural resource community has yet to undertake a comprehensive approach to collecting and evaluating instream flows.

Many estuarine and coastal habitats, critical for estuarine health, are significantly degraded by changes to the timing and delivery of freshwater flows. Seagrass beds, for instance, are one of the most important near shore coastal habitats in the Mobile and Perdido River Basins and are very vulnerable to anthropogenic changes because they are particularly sensitive to water quality changes. Seagrasses support fish and invertebrate community structure, are extremely productive and are used by a wide variety of species as nurseries, feeding grounds, and refuge from predation (Livingston, 1990). Seagrasses are a vital part of the food web and provide food for many organisms. Similarly, oyster beds, mangroves, marsh lands and soft-bottom un-vegetated sediment habitats are all vulnerable to degradation based on anthropogenic alteration of the land and water that causes changes to the timing and delivery of freshwater flows.

Freshwater flows carry nutrients, sediments, pollutants and organic matter; therefore, upstream changes in flow delivery can affect: (1) downstream water quality such as alteration of water salinities; (2) variation in oxygen and temperature conditions; and (3) changes in the distribution and transport of nutrients, carbon and particulate organic matter to the estuary. This could lead to an increased susceptibility to algal blooms and other habitat impairments. Quantifying the connection between freshwater flow and water quality is challenging due to site specificity and the complex nature of estuarine ecosystems. The unavailability of comprehensive datasets that capture the physical, chemical and biological interactions within habitats have limited the ability to understand and model these systems.

The state-of-the-science for implementing restoration of flows for freshwater and estuarine ecosystem health has improved markedly over the past two decades. Some example approaches include modification of operational flow regimes through dam re-regulation, dam removal, conservation and efficiency practices, and improved placement and operation of surface and groundwater withdrawals. However, these efforts can often be hampered by the lack of readily available data on stream flows and available monitoring gages to collect those data. Often projects are implemented without an understanding of historical changes in the timing and delivery of flow over time, as well as the complex nature of the data and the models needed to interpret results for decision-making.

To improve the opportunity for science-based decision-making processes, we propose to collect data and develop a flow accounting model that will incorporate vital information relating water resources management actions, such as maintenance of minimum flows, to support freshwater habitat in Alabama, Florida, and Mississippi watersheds included in the Mobile River and Perdido River basins. This 4-year, $3.4 million project will provide a comprehensive assessment of flow ecology and develop a basin-wide model for state and local decision-makers to use for restoration and natural resource management projects in Alabama, Florida, and Mississippi. It also supports a process to engage stakeholders and decision makers in development of this decision support tool. Specifically, the project includes:

- Providing focused watershed studies;
- Developing decision-support model/system for stakeholders; and
- Working with state partners to determine priorities for installing new gages.

The Operational Analysis and Simulation of Integrated Systems (OASIS) model will be used to simulate the routing of water through the watersheds in the basin. This software provides a tool for decision-makers to evaluate planning alternatives, such as the impact of various water resource alterations on restoring and conserving habitat, water quality, and living coastal and marine resources throughout the basin and in the receiving estuary. Analysis and information developed by this proposal will provide federal, state, and local agencies with supporting data necessary to inform science-based decisions for restoration, flood and drought management efforts in the Mobile River and Perdido River basins. This need for modeling was identified in recommendations related to evaluation of instream-flow science and decision making put forth by the Alabama Water Agencies Working Group (AWAWG; 2013, 2017).

This OASIS model has been used in many parts of the country and has provided water resource managers and stakeholders with simulated benefits of various water use scenarios, such as declines in reservoir storage. Evaluating various water use scenarios provides information upon which to base conservation measures to ensure freshwater flow to support not only community needs but the needs of ecosystems and biota within river basins. In many instances, the OASIS model has provided a basis by which communities have altered their water management plans to more closely mimic natural flows (Figure 4).

Proposed Methods :

Flow accounting models provide a tool that managers can use to evaluate how streamflow alteration in upstream basins affects downstream conditions. Ideally, models such as these must be empirically based, flexible, compatible with other platforms, while also being easy to use and providing readily interpretable output.

The OASIS model (Hazen and Sawyer (formerly HydroLogics, Inc.), 2011) is an excellent example of such a model and is a unique software program that realistically simulates the routing of water through a watershed. OASIS has been used by environmental groups, industrial clients, and water utilities throughout the United States and informs the allocation of water for approximately 20% of the population of the United States at locations such as the lower Rio Grande-Pecos-Conchos, Savannah, Cape Fear, Pamlico, Neuse, and Roanoke rivers basins. OASIS is an extremely powerful tool that estimates streamflow availability in the context of varying supply demands, management options, and changes in operational rules and constraints. This tool enables parties with diverse and often conflicting goals to work together to develop solutions that mutually satisfy diverse objectives. In application, OASIS will allow resource managers in Alabama, Florida, and Mississippi to understand the frequency and duration that existing or proposed operating rules may be violated and will provide a straightforward means to evaluate alternatives. The model identifies the best means of moving water through the Mobile and Perdido River basins to meet a prescribed set of goals and constraints.

As a flow-accounting model, OASIS will enable water resource managers in Alabama, Florida, and Mississippi to evaluate a range of potential management scenarios, such as modifying release curves for selected reservoirs upstream in order to evaluate changes in freshwater delivery to an estuary. It is a mass-balance model which is resource specific and automatically writes continuity of flow equations and reduces errors when building models describing river basins. The model uses an Operations Control Language (OCL), which provides a way to evaluate operating rules that are tested and implemented in addition to easily integrating output from other models (i.e., groundwater and water quality). OASIS and its easy-to-use graphical user interface, dashboards, and processing programs is a tool for stakeholders and water resource managers designed to enable various drought and water use and availability exercises.

The flow accounting model takes hypothetical flow alterations and translates them into characteristics of streamflow. It describes predicted characteristics of streamflow such as magnitude, duration, frequency, timing, and rate of change. The mass-balance model is spatially explicit and operates at a daily time step which enables the model to calculate flow by adding inflow (e.g., flow upstream and effluent discharge) and subtracting outflow (e.g. water withdrawals, reservoir evaporation). The model is designed to be interactive and enables by Alabama, Florida, and Mississippi resource managers to evaluate strategies and gather additional stakeholder input.

Stakeholders in Alabama (GSA, ADECA, ADCNR), Mississippi (MDEQ), and Florida (Northwest Florida Water Management District, FLDEP) along with other federal, state and local agencies will participate in providing input data on water withdrawals, wastewater discharges, inter-basin transfer and biological data for the OASIS model. A Technical Advisory Committee (TAC) with State members representing the Mobile and Perdido River basins will be established to discuss, plan and provide data for model construction and to discuss how the model output will be used to address management needs. This involvement during model development and verification will ensure all parties are represented, that there is transparency in the process, and that performance measures and the evaluation of alternative and current management strategies are developed collaboratively.

TAC involvement from model conception to scenario development and outcomes will create a collaborative environment based upon a shared knowledge and understanding of the methods employed by the flow-accounting model and the physical capabilities and limitation of the hydrologic systems they are charged with managing.

Flow Ecology

Streamflow metrics and aquatic biota community data for freshwater sites throughout the river basins will be evaluated using multivariate techniques to determine which components of the annual hydrograph are critical to the health of freshwater biota. The analysis will be conducted using streamflow metrics and their respective deviation from reference hydrologic profiles developed in RESTORE FPL1 'Baseline Flows' study (Knight et al., 2008; Carlisle et al., 2010a, and 2010b). The result of the analysis will be a subset of streamflow metrics that, when altered, result in an observed ecological response, or ecological limit function (Knight et al., 2013). This function can be used to evaluate potential changes to streamflow (water use, landscape / land use change, and climate) in terms of potential ecological response (degradation). The results will provide managers with a scientific basis for decision making.

This flow ecology analysis will be a multi-step process (Knight et al., 2013) that includes:

1. Definition of one or more hypothetical or proposed flow alterations;
2. Translation of the flow alterations into predicted streamflow characteristics (e.g., magnitude, frequency, timing, duration, rate of change, and predictability of high- and low-flow events);
3. Formatting of predicted streamflow characteristics as an independent variable in the flow-ecology relationship under the hypothetical or proposed alteration; and
4. Application of the flow-ecology relationship to the independent variable in order to predict the ecological response to the proposed alteration/alterations.

The process is designed to incorporate existing flow-ecology relationships into the flow-accounting model such that it:

1. Integrates multiple water-management decisions and their hydro-ecologic effects;
2. Uses a methodology that is consistent and transparent;
3. Is adaptable, flexible, and allows for updates of locations of ecological assessments, scenarios, and water-management assets;
4. Derives specific ecological predictions from translated water-management decisions;
5. Subsets ecological predictions into meaningful ecological categories;
6. Engages with end-users throughout model development; and
7. Is efficient and cost-effective for end-users.

Installation of Streamflow Gages

As part of the RESTORE Baseflow study, the USGS performed a network analysis to determine gaps in the streamgaging networks of the 5 Gulf states. The USGS will leverage the results of this analysis to inform stakeholders of potential locations for 5 new streamgages in year 1 and provide operating and maintenance support in years 2-4 in the Mobile and/or Perdido River basins to address the gaps identified. Funding for the operation and maintenance of the streamgages is included in the budget for the duration of this project. Additional funding would have to be secured for O&M of the gages after year 4 of this project. The funds requested for streamgage installation are intended to cover 5 streamgages; however, final decisions will be based on sites chosen and reflect installation costs.

Environmental Benefits:

The USGS, working with water resource management agencies, have long been at the forefront of developing and implementing environmental flow science, and improving models used by resource managers to implement flow regimes to protect and restore critical habitat and protect and maintain species. The benefits of providing advanced decision-support models and data include the ability to evaluate indirect environmental benefits of various water resource management and restoration projects and actions, and hopefully improving the efficacy of those actions. An additional benefit of the proposed project is associated with the potential mitigation of future risks such as sea level rise, subsidence, and/or storms. The flow-accounting model will allow resource managers to generate “what if” scenarios in reallocating water flows to address long-term risks and uncertainties. Scenarios of water-use change affected by industry, urbanization, agriculture, climate change and other future risks and uncertainties can be incorporated into water use allocations in the flow-accounting model to better understand threats to downstream ecological resources. The flow-accounting model will provide state and local agencies (e.g. GSA, ADCNR, ADECA, NWFLWMD and others) with modeled outcomes on water-use strategies and allow comparisons of benefits and tradeoffs among various water resource projects.

Metrics:

Metric Title: PRM012 : Tool development for decision-making - # tools developed : Planning, Research, Monitoring

Target: 1

Narrative: Success of PRM012 will be measured by the completion and delivery of the OASIS model to shareholders and decision makers in Alabama, Florida, and Mississippi. Upon delivery, Hazen and Sawyer (formerly HydroLogics, Inc.) will provide training to the states on model use and the graphical user interface. The tutorial will enable the continued use of the model including the adaptation of previous scenarios when new data becomes available. In addition to model delivery, a report describing model output will be submitted for publication.

Metric Title: PRM006 : Monitoring - # streams/sites being monitored : Planning, Research, Monitoring

Target: 5

Narrative: Success of PRM006 will be measured by the construction and installation of five streamgages in year 1, operation and maintenance in years 2-4, and delivery of publicly available, quality-controlled data via the web.

Risk and Uncertainties:

There is limited risk in using a flow-accounting model for application in the Mobile and Perdido River basins. The OASIS model has been previously developed and applied in numerous river systems throughout the U.S., including parts of the Mobile River basin and a RESTORE FPL1 application in the Pascagoula-Pearl in Mississippi. However, streamgage damage or destruction is an operational risk in implementing the second component of this project.

Mitigation - Streamgages are subject to vandalism and/or destruction by natural events (e.g., overtopping, washed off bridges, lightning strikes). The USGS assumes the financial risk for these events when operating streamgages. If a gage funded through this project is damaged through natural events or vandalism, instrumentation will be replaced. If vandalism becomes a continuous problem, an alternate location (different location on same stream or potentially different stream) will be identified. Downtime in gage operations will be minimized by completing repairs as quickly as possible.

There are also operational benefits associated with mitigation of future risks. The water use accountability model generated by this project will allow resource managers to generate "what if" scenarios in reallocating water flows to address long-term risks and uncertainties. Scenarios of water-use change affected by industry, urbanization, agriculture, climate change and other future risks and uncertainties can be incorporated into water use allocations in the OASIS model to better understand threats to downstream ecological resources.

Monitoring and Adaptive Management:

This project will be completed with state-of-the-art scientific methods utilizing data generated and described in the RESTORE FPL1 Baseline flows project (https://www.sciencebase.gov/catalog/item/59b7ed9be4b08b1644df5d50) and existing water use and ecological data from State partners. The network analysis performed as a part of the 'Baseline Flows' project will be used to inform locations of 5 new continuous streamflow gages, that will be installed, maintained and monitored for four years following USGS National Standards, and data will be made available through the USGS National Water Information System (https://waterdata.usgs.gov/nwis/sw). In addition, the lessons learned from the focused watershed study in the Baseflow project will be applied to this project and as new and emerging processes or methods become available, they will be incorporated.

Data Management:

Data and corresponding FGDC-compliant metadata used in analysis will be managed in accordance with the U.S. Geological Survey data archival and publishing standards and are subject to those described in White House OSTP Memorandum and OMB Open Data Policy. These policies require federal agencies to collect or create information in a way that supports downstream information processing and dissemination activities. This includes using machine readable and open formats, data standards, and common core and extensible metadata for all new information creation and collection efforts. The required metadata will facilitate the discovery of relevant project information and promote data use for future gulf restoration efforts. Data sets (tabular and GIS) assembled and used in analyses will be stored on a dedicated local server and backed up in accordance with USGS Lower Mississippi River-Gulf WSC data stewardship and preservation policies and in accordance with RESTORE Council Guidelines. Derivatives of published or existing data and metadata generated during this project will be published and made publicly available in standard machine-readable formats through recognized outlets, such as the ScienceBase USGS data release community folder. ScienceBase also provides a centralized permanent archive for USGS data and information products.

Collaboration:

The USGS has consulted with Commissioner Chris Blankenship (and his staff) and Alabama water agencies concerning the proposed work. These conversations helped develop the initial proposal and refinements that include construction of new streamflow gages in the river basins. Presentations of the proposal were provided to RESTORE Council members in Alabama, Florida and Mississippi. On the local level, conversations occurred with members of the NW FL WMD who have minimum flow objectives in the Perdido River basin that this project may help support, along with state agencies in Alabama, Florida, and Mississippi. Additionally, the Technical Advisory Committee (TAC) State members from Alabama and Mississippi that were established under the 'Baseline Flows' (EGID1 from FPL1) project have had further collaboration discussions on the scope of the proposed project.

Public Engagement, Outreach, and Education:

This project is particularly well-suited for providing a significant amount of outreach and educational opportunities to both the public as well as to state and local decision-makers. It will expand the general knowledge of the importance of streamflow and provide newly emerging information that demonstrates the ecological and economic benefits of maintaining or restoring ecological flows. Two elements of this project that will be emphasized in the communication strategy are:

1. Communicating Information on the Ecological and Economic Benefits of Restoring Flows. The state-of-the science on understanding freshwater flows might not be well understood by the public. The project will incorporate information on the ecological and economic importance of freshwater flows to coastal communities -- in fact sheets, press briefs, on-line tools and publicly-accessible publications. Outreach materials will demonstrate how stream flow information is vital to management and policy decisions regarding flood and drought protection, industrial and municipal water supply, pollution control, storm water management, and stream ecosystem health; how the OASIS model is used to evaluate the various competing priorities for water use (e.g., population growth, irrigation, power generation, restoration of aquatic habitat) in Mobile and Perdido River basins; how stream flow records from long-term stream gages are essential to assessing how the stream flow metrics related to floods, droughts, and aquatic stream health are being modified by human actions; and how stream flow data are essential for effective restoration planning and assessment of water resources projects.

2. Publishing Successful Stories of Flow Restorations. USGS will profile and publicize successful flow restorations that have taken place in the Gulf of Mexico region resulting in ecological and economic benefits for communities. Flow restoration projects in Alabama, Florida, and Mississippi will be highlighted and used to educate stakeholders on the consequences of flow alteration on downstream ecological resources and how restoration of flows can provide both ecological and economic benefits.

Leveraging:

Funds: $1,500,000.00
Type: Bldg on Others
Status: Received
Source Type: Other Federal
Description: The RESTORE FPL1 ‘Baseline Flows’ project will provide foundational datasets and statistical analyses for model development that will be incorporated into the decision-support framework for the Mobile and Perdido River basins (estimated at $1.5-$2M). Datasets generated during the ‘Baseline Flows’ project will be used to determine potential locations of new streamflow gages and flow-ecology methodologies employed to create the flow-accounting model.

Funds: $1,000,000.00
Type: Bldg on Others
Status: Received
Source Type: State
Description: This project will leverage a fish and invertebrate sampling program and database (estimated at greater than $1M) funded by the Geological Survey of Alabama (GSA). This database is critical for describing ecological response to various flow regimes, which could then be evaluated using the OASIS model.

Environmental Compliance:

The modeling component of this project is a planning effort and will utilize the Council's Categorical Exclusion for the National Environmental Policy Act. Installation of streamgages is considered implementation and will require a categorical exclusion. We will use USGS Categorical Exclusion USGS 516 DM 9.5E, E. Operation, construction, installation, and removal of scientific equipment. USGS has prepared the environmental compliance documentation needed to move the implementation component of this proposed activity into FPL Category 1. All applicable federal, state and local regulations will be complied with in the course of implementing this project.

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Budget

Project Budget Narrative:
Year 1: $850,000 Focus Watershed Assessments and Streamflow Gage Installation
Evaluate which streamflow metrics are most critical to ecological endpoints in Focus Watershed.
Start building input data sets and setting up input data sets for the OASIS model.
Evaluate temporal changes in critical streamflow metrics along large rivers in the Focus Watershed.
Work jointly with ADECA, GSA, ADCNR, NWFLWMD on installation of new streamflow gages at pre-determined locations.

Year 2: $850,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Finalize all components of the OASIS model Continue streamflow metric analysis.
Work jointly with ADECA, GSA, ADCNR to assess how temporal changes in critical streamflow metrics along large rivers in the Focus Watershed are impacting aquatic biology health (SAV, macro-invertebrates, etc.).
Streamflow Gage O&M.
Article on focused streamflow trends analysis.
Article on focused hydrologic alteration.

Year 3: $1,000,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Article on streamflow-ecology model.
Article on how streamflows metrics have changed over time at key large river nodes in the Focus Watershed.
Article on low flow statistics for focused study area.
Determine funding source for continuation of new streamflow gages.
Streamflow Gage O&M.

Year 4: $700,000 Focus Watershed Assessments and Streamflow Gage Operation and Maintenance
Release OASIS model.
Article on OASIS model.
Communication Blitz on key results and application of the model.
Streamflow Gage O&M.

Total FPL 3 Project/Program Budget Request:
$ 3,400,000.00

Estimated Percent Monitoring and Adaptive Management: 5 %
Estimated Percent Planning: 67 %
Estimated Percent Implementation: 12 %
Estimated Percent Project Management: 9 %
Estimated Percent Data Management: 7 %
Estimated Percent Contingency: 0 %

Is the Project Scalable?:
Yes

If yes, provide a short description regarding scalability.:
Readily scalable to include other large river basins across the five Gulf States. The cost associated with a given river basin is strongly correlated to basin size, local resource interests, and leveraging of data and information sources.

Environmental Compliance[1]

Environmental Requirement	Has the Requirement Been Addressed?	Compliance Notes (e.g.,title and date of document, permit number, weblink etc.)
National Environmental Policy Act	Yes	Council NEPA Categorical Exclusion for planning will be utilized for the modeling component of this project. See uploaded USGS categorical exclusion documentation for streamgage installation - USGS concluded that the installation of stream gages is not a major federal action. Therefore, the applicable bureau categorical exclusion was used. 516 SM Chapter 9.5. E.
Endangered Species Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
National Historic Preservation Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Magnuson-Stevens Act	N/A	Note not provided.
Fish and Wildlife Conservation Act	N/A	Note not provided.
Coastal Zone Management Act	N/A	Note not provided.
Coastal Barrier Resources Act	N/A	Note not provided.
Farmland Protection Policy Act	N/A	Note not provided.
Clean Water Act (Section 404)	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
River and Harbors Act (Section 10)	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Marine Protection, Research and Sanctuaries Act	N/A	Note not provided.
Marine Mammal Protection Act	N/A	Note not provided.
National Marine Sanctuaries Act	N/A	Note not provided.
Migratory Bird Treaty Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Bald and Golden Eagle Protection Act	Yes	See uploaded USGS categorical exclusion documentation for streamgage installation under NEPA upload.
Clean Air Act	N/A	Note not provided.
Other Applicable Environmental Compliance Laws or Regulations	N/A	Included additional note regarding Native American sacred sites.

[1] Environmental Compliance document uploads available by request (restorecouncil@restorethegulf.gov).

Maps, Charts, Figures

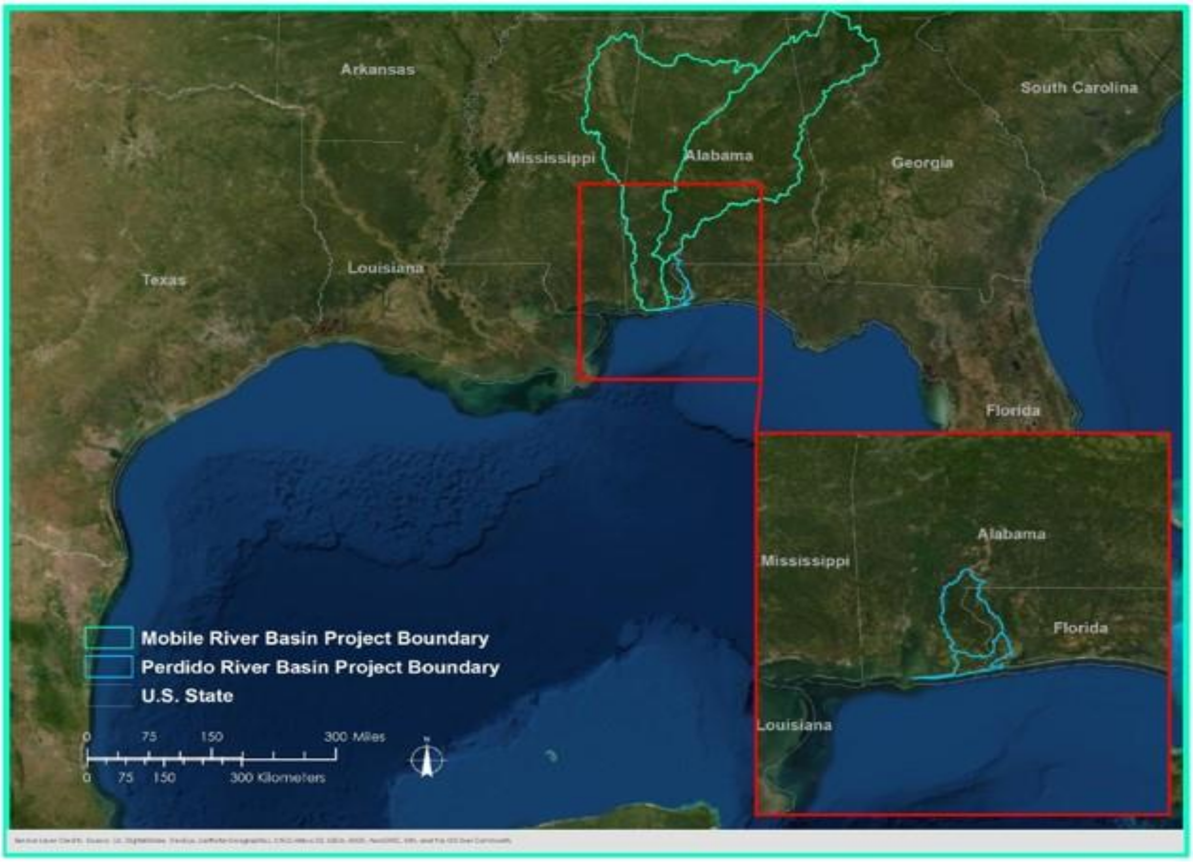


Figure 1. DOI/USGS Ecological flow project location

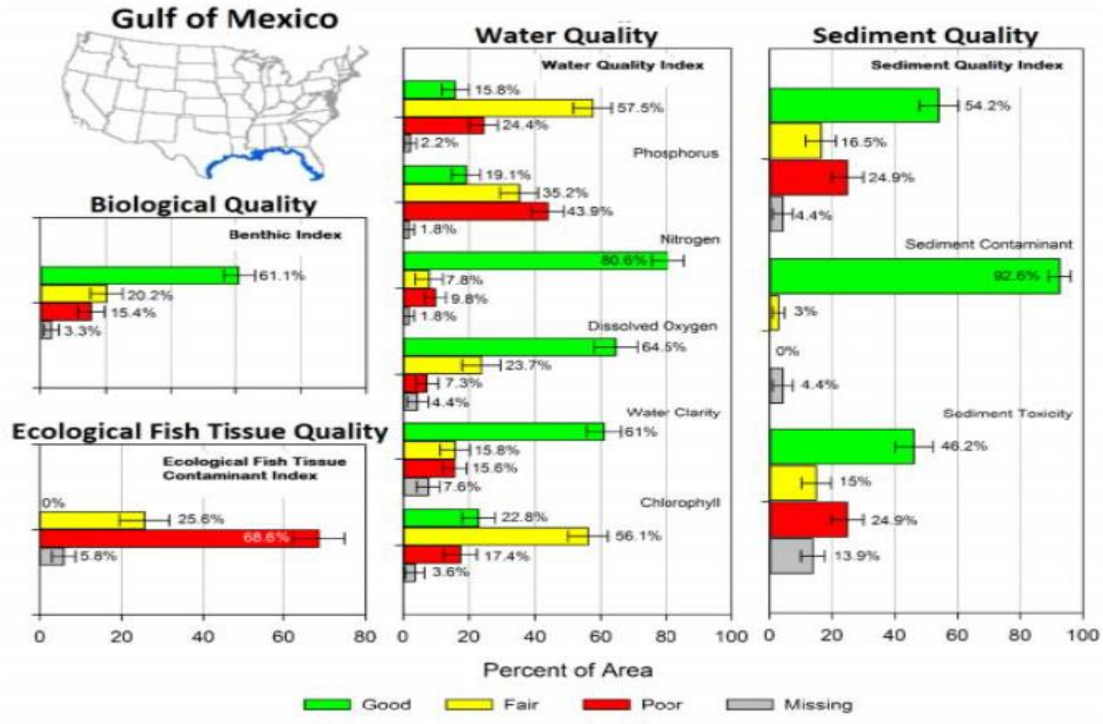


Figure 2. Overall water quality conditions of Gulf Coast estuaries (USEPA, 2016)

Figure 3. Conceptual model of estuarine freshwater flow impacts (Albers, 2002).

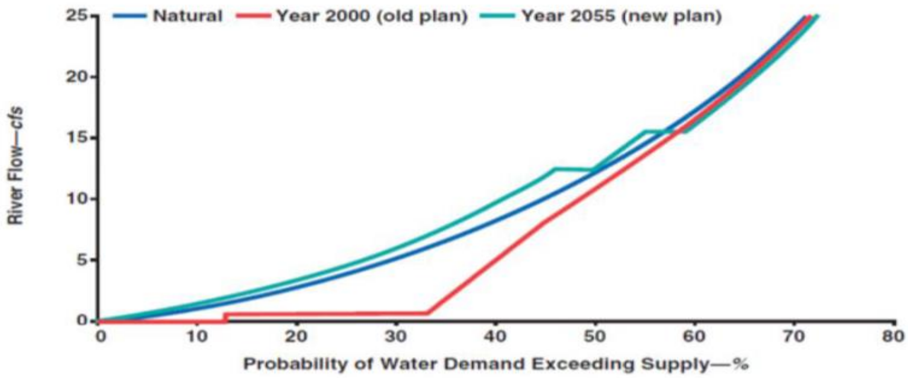


Figure 4. Altered water management planning from "Meeting urban water demands while protecting rivers" (Richter, 2007).

Other Uploads

Main Uploads_0:
Ecological Flow Proposal Letters of Support 4-21-20.pdf
Link to Download
http://www.restorethegulf.gov/apps/piper/web/Uploads/Download/proposal/571/46

FPL 3b Internal Staff Review of Proposal Submitted 4/24/2020

Project/Program	Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins (DOI/USGS)		
Primary Reviewer	Jean Cowan	Sponsor	DOI
EC Reviewer	John Ettinger	Co-Sponsor	

1. Is/Are the selected Priority Criteria supported by information in the proposal?		Yes
Notes		

2. Does the proposal meet the RESTORE Act geographic eligibility requirement?		Yes
Notes		

3. Are the Comprehensive Plan primary goal and primary objective supported by information in the proposal?		Yes
Notes		

4. Planning Framework: If the proposal is designed to align with the Planning Framework, does the proposal support the selected priority approaches, priority techniques, and/or geographic area?		Yes
Notes		

5. Does the proposal align with the applicable RESTORE Council definition of project or program?		Yes
Notes		

6. Does the budget narrative adequately describe the costs associated with the proposed activity?		Yes
Notes		

7. Are there any recommended revisions to the selected leveraged funding categories?			No
Notes			

8. Have three external BAS reviews been completed?		More information needed
Notes	Please see the external BAS review comments, and external reviews summary attached with these review comments.	
9. Have appropriate metrics been proposed to support all primary and secondary goals?		Yes
Notes		
10. Environmental compliance: If FPL Category 1 has been selected for the implementation component of the project or program, does the proposal include environmental compliance documentation that fully supports the selection of Category 1?		Yes
Notes	The environmental compliance documentation appears to be complete with respect to the laws applicable to a Council funding approval. If this proposal is selected for inclusion in FPL 3b, Council staff would simply need to clarify that the DOI Categorical Exclusion document attached to the proposal has been signed by DOI.	
11. Geospatial Compliance: Have the appropriate geospatial files and associated metadata been submitted along with a map of the proposed project/program area?		Yes
Notes		

FPL 3b BAS Review Summary
Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins
May 2020

Overall the external Best Available Science reviews for the proposal *Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins* (DOI/USGS) are mixed. Reviewers 1 and 2 question whether the sponsor has provided reasonable justification that the proposal is based on science that uses peer-reviewed data, and request additional evidence that the scientific basis of this project is justified using science that maximizes the quality, objectivity, and integrity of information. Though the model is considered robust, reviewers request more information supporting the proposed approach, including what datasets will be used, how data will be integrated within OASIS, where the model has been previously applied, and how it has performed. More information is requested on statistical methods and uncertainty quantification (Reviewer 2) as well as the linkages between flow regime and species responses (Reviewer 1), including justification that data resolution will be sufficient for analysis.

All reviewers agree that the project has clearly defined goals and objectives, but are conflicted as to whether measures of success aligning with the primary project goals are identified. Specifically, Reviewers 2 and 3 point out that the demand for the model and its outputs are not addressed in the proposal, leaving the value of the “model delivery” metric unclear. Reviewer 1 is unclear on whether the model can inform management without being “bench tested in a larger structured decision-making format.” Reviewer 2 suggests adding milestones for what will be accomplished and how it will be used, and lists potential approaches for integrating local expertise to ensure model tools can be applied and maintained. Reviews also are conflicted as to whether the methods for the proposed project are clearly defined with appropriate justification. Reviewer 1 is concerned that biotic changes will not be detectable, and requests additional description of the model and the data collection procedures to provide justification (including a figure depicting model inputs and outputs). Review 2 raises the need to follow examples from the literature that account for different hydrological processes generating base flow (e.g. groundwater-surface interactions), but is also concerned that modelers will not be able to predict water quality parameters that OASIS assumes to be conservative.

Two of the three reviewers feel the proposal objectives and methods require further justification using peer reviewed literature and publicly available information. Reviewer 1 feels additional cited literature is needed to address model characteristics and performance, such as state variables, input data, projection capabilities, model dynamics and complexity, and comparisons with other models. Reviewer 2 agrees that additional literature support for the selection of the OASIS model is needed, particularly from peer-reviewed sources.

Though they request additional justification, most reviewers generally feel that the proposal’s methods are adaptable to the chosen geographic areas, and that the proposal identifies a data management strategy that will support project measures of success. In general reviewers agree that all literature sources used to support the proposal are accurately and completely cited, and represented in a fair and unbiased manner, though Reviewer 2 again points out the need for more citations. Two of the three reviewers feel that the information discussed and used for project justification is recent and relevant to the proposed activity.

The proposal's evaluation of uncertainties and risks in achieving its objectives over time, including both short- and long-term risks, is another area of concern for some reviewers. Reviewers 1 and 2 point out that uncertainty in model inputs and results are not addressed in the proposal (e.g., through use of uncertainty and sensitivity analyses). Reviewer 1 also requests information on how the work will be sustained in a long-term way, including the use, sharing, and maintenance of the model after the project period. Reviewer 3 finds the project's vulnerability to long-term environmental risks to be minimal and well laid out, though Reviewer 2 feels modeling issues related to climate change and pollutants are not addressed. Reviewer 1 points out the suitability of the project for helping managers understand and minimize impacts of long-term environmental risks. Socio-economic factors are raised as an additional short-term risk to take into consideration as part of model development (Reviewers 1 and 2).

All reviewers believe the environmental benefits of the proposed activity are clearly defined, aside from previously raised questions over how use of the model will be integrated into existing regulatory frameworks. However, most reviewers (1 and 2) find that the proposal does not adequately evaluate the successes and failures of similar projects, either in terms of previous model applications or as part of a larger structured decision-making framework. Reviewers 1 and 2 request that the sponsor provide additional information to demonstrate their experience in implementing projects similar to the one being proposed, including their (or their partners') experience with the model, how the model has been used to inform management, what publications have resulted from work with the model, and literature indicating whether the model has been widely cited or had scrutiny from peer-review (Reviewer 1). Reviewer 2 states that the project team's CVs are needed to determine their suitability for this work, though it is understood that CVs are not requested as part of project proposals.

To sample the final reviewer comments, the following remarks were provided by Reviewer 2 and Reviewer 3 respectively:

"Overall, this is a worthy fundable effort, however the proposal needs to be improved. This is a 4 million dollar modeling project to study two catchments and [a] lot can be done . . . The field part of installing gauges is a fundable project now, but the modeling project should be funded after a careful revision to address some of the comments."

"This project clearly uses science and justified protocols for the development of important data that will be important for decision makers and water resource managers moving forward."

USGS responses to FPL3b BAS review comments on "Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins"

The USGS Lower Mississippi-Gulf WSC is appreciative for the Best Available Science review of our proposed project. Where appropriate, we amended our proposal to provide additional context and supporting evidence as requested. Included in this document are both responses to the BAS Review that were included in the proposal as well as additional details that can help clarify some of the material presented in the proposal. Additionally, there were no specific Council staff comments to respond to.

Reasonable justification - **Reviewers 1 and 2 question whether the sponsor has provided reasonable justification that the proposal is based on science that uses peer-reviewed data.**

To address the use of peer-reviewed data, we included the following on page 7:

The project will utilize USGS peer-reviewed and "approved" streamflow data publicly available through the USGS National Water Information System (https://waterdata.usgs.gov/nwis/sw). These data are quality-assured by USGS Hydrographers following national standards. Nationally, USGS streamflow data describes stream levels, streamflow, lake and reservoir levels and surface-water quality. In addition to USGS data, this project will utilize withdrawal and discharge data from public utilities and industry provided by stakeholders (GSA, ADECA, ADCNR) in the study area. The USGS will use U.S. Environmental Protection Agency permitted discharge data which is publicly available via the EPA Enforcement and Compliance History Online website. Biological data collected using sampling protocols designed by the State of Alabama will be used to determine the flow-ecology relationship in combination with peer-reviewed and "approved" streamflow data within the focus watershed. In addition to the data listed, which will be used in model development and the trend, streamflow alteration, low-flow, and flow-ecology analysis, the project will utilize operations data from reservoirs (e.g. operations policies, minimum and maximum storage, elevation-storage-area relationships, and rules curves) within the watershed as input for the flow-accounting model.

To address additional evidence regarding the scientific basis of the project, we included additional references on the use of flow-accounting models on page 6, and references that describe specific applications USGS has conducted using the OASIS model on page 9, that include specifics on how it was applied to assess changes in water management, what datasets were used, and how it performed in assessing flow-ecology relationships.

Statistical methods and uncertainty quantification**: Reviewer 2 request information on statistical methods and uncertainty quantification.**

We incorporated the following details on page 9.

Statistical analyses of the data to establish model streamflow relationships will include Mann-Kendall trend analysis, cluster analysis, correlation analysis, Quantile-Kendall analysis, and various low-flow analyses. The OASIS post-processor will compute basic statistics, and perhaps more importantly will produce output in a variety of formats for statistical analysis in other programs. Additionally, the OASIS OCL language will be used to create and track user-defined variables that represent performance measures specific to the basin. In addition to running standard simulations (i.e., a set period of hydrology sequentially), OASIS also has a model called "Position Analysis" (PA) which runs ensembles forecasts. OASIS can automatically generate the ensembles inflows, based on the historic inflow record, and statistically adjusts them based on antecedent flows. It also can be configured to run ensemble inflows from external data sources and display potential future flow conditions in a probabilistic way.

Therefore, the OASIS model development process can verify inflows, through simulations forcing the model to match historic operational data and looking at overall simulation agreement and making adjustments where necessary. Once the OASIS model is built, it is easy to switch inputs to quickly look at the sensitivity to uncertainty in inputs. OASIS can be called by a batch program to facilitate running a large set of alternative inflow datasets, for example, from downscaled Global Climate Change models or from inflows generated through Monte Carlo simulation.

Flow regime and species response linkages: **Reviewer 1 requests more information on the linkages between flow regime and species responses including justification that data resolution will be sufficient for analysis.**

We incorporated the following details on page 9.

The methods utilized and outputs developed are going to be similar to the peer-reviewed data, reports and journal articles generated in the 'Obed National Wild and Scenic River' study and the RESTORE FPL1 'Baseline Flows' study. Listed below are several of the publications from the USGS Lower Mississippi-Gulf Water Science Center exploring flow-ecology relationships and the collection of data required for those studies:

- Putting Flow–Ecology Relationships into Practice: A Decision-Support System to Assess Fish Community Response to Water-Management Scenarios (Cartwright et al., 2017);
- Modelling ecological flow regime: an example from the Tennessee and Cumberland River basins (Knight et al., 2012);
- Hydrologic Data for the Obed River Watershed, Tennessee (Knight et al., 2014);
- Species-Richness Responses to Water-Withdrawal Scenarios and Minimum Flow Levels: Evaluation Presumptive Standards in the Tennessee and Cumberland River Basins (Driver et al., 2020);
- Copula Theory as a Generalized Framework for Flow-Duration Curve Based Streamflow Estimates in Ungaged and Partially Gage Catchments (Worland et al., 2019);
- Freshwater Delivery to the Gulf of Mexico: An Analysis of Streamflow Trends in the Southeast US from 1950 – 2015 *in review* (Rodgers et al., 2020);
- Prediction and Inference of Flow Duration Curves Using Multioutput Neural Networks (Worland et al., 2019); and
- The use of support vectors from support vector machines for hydrometeorologic monitoring network analyses (Asquith, 2020).

The resolution of streamflow data was evaluated as part of the RESTORE FPL1 'Baseline Flows' study and there are sufficient long-term gages in the Mobile and Perdido River basins to support the analyses and modeling effort. We included additional details on page 6 to describe the datasets that will be utilized as a part of the study.

The methodology employed by the USGS Lower Mississippi-Gulf Water Science Center (see figure below from Cartwright et al. 2017) to explore flow-ecology relationship has been utilized in several studies, and the methodology employed can be used to detect changes in species richness. Preliminary investigation of the ecological datasets that will be used in the Mobile and Perdido River basins suggest they are sufficient for the anticipated analyses.

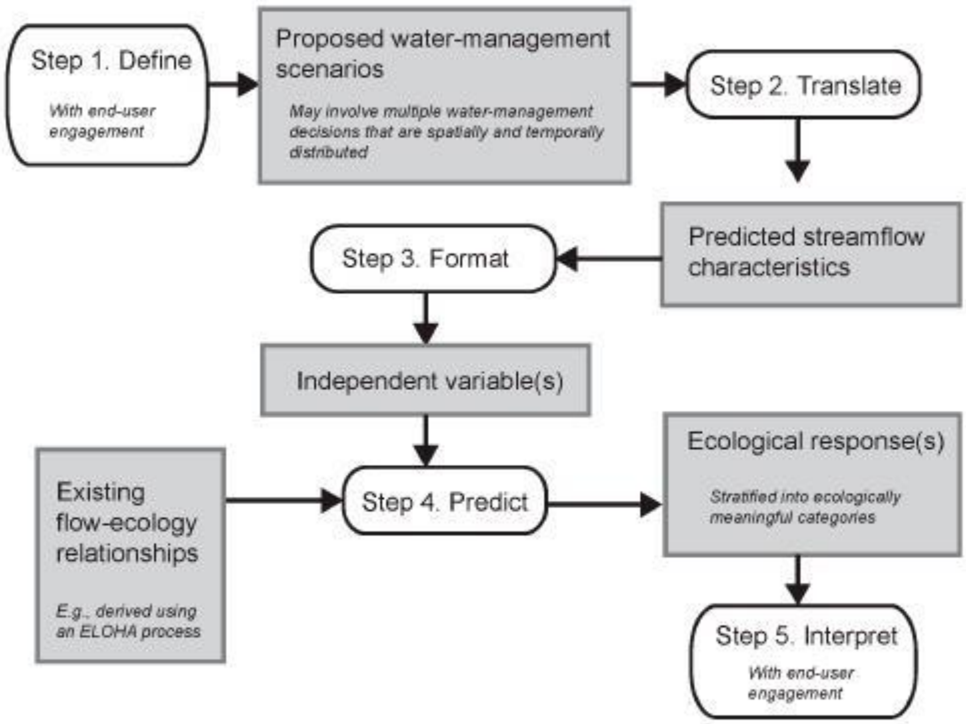


Figure 1. A conceptual model to operationalize flow–ecology relationships into decision-support systems for water-resource managers.

Model Demand: **Reviewers 2 and 3 point out that the demand for the model and its outputs are not addressed in the proposal, leaving the value of the "model delivery" metric unclear.**

The ability to account for changes in water use availability has been identified by a number of stakeholders in the Mobile and Perdido River basins. To further capture that need, we included the following detail on page 5.

According to the Alabama Department of Economic and Community Affairs and the Alabama Water Association Working Group, compiling data regarding water use and trends is vital to assessing the water resources of the state with emphasis on baseline conditions. In addition to this baseline data, the state sets out in detail the need for a more comprehensive accounting of the water resources in Alabama (Water Management Issues in Alabama, 2012).

The demand for this type of model is also expressed through other flow accountability model applications that are being conducted in Alabama and Florida using OASIS, such as the Alabama-Coosa-Tallapoosa River Basin and the Kissimmee/Everglades, respectively. The USGS is currently working on a flow-accounting model for the State of Mississippi as part of the RESTORE FPL1 Base Flows project.

The reason the project is being proposed and the metric "tool development for decision-making" was identified, is because it was cited as a need in water management plans in Alabama and Florida.

Model and Informed Management: **Reviewer 1 is unclear on whether the model can inform management without being "bench tested in a larger structured decision-making format."**

Throughout the introduction on pages 6, 7 and 8, we provided additional detail on how, where and why flow-accounting models have been used to inform management. The additions include:

Flow-accounting models have been developed for the Obed National Wild and Scenic River in Tennessee and is in development for the Pearl and Pascagoula River basins in Mississippi. Flow-accounting models are commonly used and have been the focus of many peer-reviewed studies (Pearsall et al., 2005; Richter, 2007; Sheer and Dehoff, 2009; Stephenson, 2011; Sauchyn et al., 2016; WaterSMART, 2016, 2018; NASEM, 2018.

This OASIS model has been used around the world and has provided water resource managers and stakeholders with simulated benefits of various water use scenarios, such as declines in reservoir storage. The OASIS flow-accounting models and other hydrological decision-support frameworks with linkages to OASIS have been utilized in over 40 River Basins in the United States as well as in the Bay of Plenty Region, New Zealand and Yellow River Basin, China. The models have been used to inform management decisions and aid in:

- Evaluating and improving the reliability of water supply system
- Allocation and management of water resources
- Evaluation of proposed release protocol from impoundments
- Water availability assessments
- Evaluation of the impact of multiple operation scenarios
- Dispute resolution
- Informing environmental flow policies
- Refining safe yield estimates with/without optimal operation
- Developing probabilistic triggers to avoid water shortages
- Developing basin-wide water management strategies
- Simulating various hydropower operation scenarios
- Assessing basin-wide effects of various operation scenarios
- Testing and implementation of water shortage response plans
- Assessing instream flow regulations

The OASIS model has been "bench tested" and has informed many management decisions. For example, it was applied to develop the NYC Operations support tool used for planning and operations of NYC's complex reservoir system, as well as to inform management decisions in Alberta Canada (https://watersmartsolutions.ca/knowledge-base/bow-river-project-final-report/), and the state of North Carolina (https://deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment/basinwide-hydrologic-modeling). The previously described use and applications of the OASIS model suggest that it is an appropriate choice for evaluating instream-flow alternatives in the Mobile and Perdido River basins.

Milestones: **Reviewer 2 suggests adding milestones for what will be accomplished and how it will be used and list potential approaches for integrating local expertise to ensure model tools can be applied and maintained.**

To address this comment, we included a Milestones sub-section at the end of the Methods section on page 11.

Experts were engaged prior to proposal submittal to gage interest in the project and to discuss how best the USGS, State and local partners can work together to assemble the necessary datasets, conduct targeted analyses, and generate an operational tool that will provide federal, state, and local agencies with supporting data necessary to inform science-based decisions for restoration, flood, and drought management efforts in the Mobile River and Perdido River basins. Listed below are milestones identified from stakeholder conversations which will be used to judge the success of the project:

- Year 1:
  - Evaluate which streamflow metrics are most critical to ecological endpoints in Focus Watershed.
  - Start building input data sets and setting up input data sets for the OASIS model.
  - Evaluate temporal changes in critical streamflow metrics along large rivers in the Focus Watershed.
  - Work jointly with ADECA, GSA, ADCNR, NWFLWMD on installation of new streamflow gages at pre-determined locations.

- Year 2:
  - Finalize all components of the OASIS model.
  - Continue streamflow metric analysis.
  - Work jointly with ADECA, GSA, ADCNR to assess how temporal changes in critical streamflow metrics along large rivers in the Focus Watershed are impacting aquatic biology health (SAV, macro-invertebrates, etc.).
  - Conduct streamflow gage O&M.
  - Journal article on focused streamflow trends analysis.
  - Journal article on focused hydrologic alteration.

- Year 3:
  - Journal article on streamflow-ecology model.
  - Journal article on streamflow metrics trends at key large river nodes in the Focus Watershed.

    - Journal article on low-flow statistics for focused study area.
    - Conduct streamflow gage O&M.

  - Year 4:
    - Release OASIS model and model documentation.
    - Cooperator/USGS OASIS model training.
    - Journal article on OASIS model.
    - Conduct streamflow gage O&M.

We already identified in the proposal on page 9 and 10 how we will be engaging with all the stakeholders and how we will use a Technical Advisory Committee throughout the study to integrate local expertise and engage on model design, development and application throughout the process. The TAC and other stakeholders will be provided training using the graphic-user interface and model maintenance upon completion of the project. As stated in the proposal, the model will reside with the state of Alabama at a location that they will determine (most likely a State agency server) and proper model documentation will be provided.

Accounting for different hydrological processes: **Review 2 raises the need to follow examples from the literature that account for different hydrological processes generating base flow (e.g. groundwater-surface interactions), but is also concerned that modelers will not be able to predict water quality parameters that OASIS assumes to be conservative.**

We incorporated additional references on pages 6, 7, and 8 that illustrates what hydrologic processes OASIS accounts for and other models that can be dynamically linked and integrated (see figure below).

We also added the following text on page 7:

OASIS is a flow-accounting model which balances inflows with outflows. It can dynamically link with other available groundwater, water quality and watershed models, providing flexibility to address complex interactions (Frei et al., 2012). The OASIS post-processor also allows for easy end-to-end linkages between modeled flows and ecological responses. In the Obed River Basin in Tennessee, output from the model was linked to the USGS's EflowStats package in R, which was then used to automatically compute ecological habitat metrics that could be compared across scenarios (Cartwright et al., 2017).

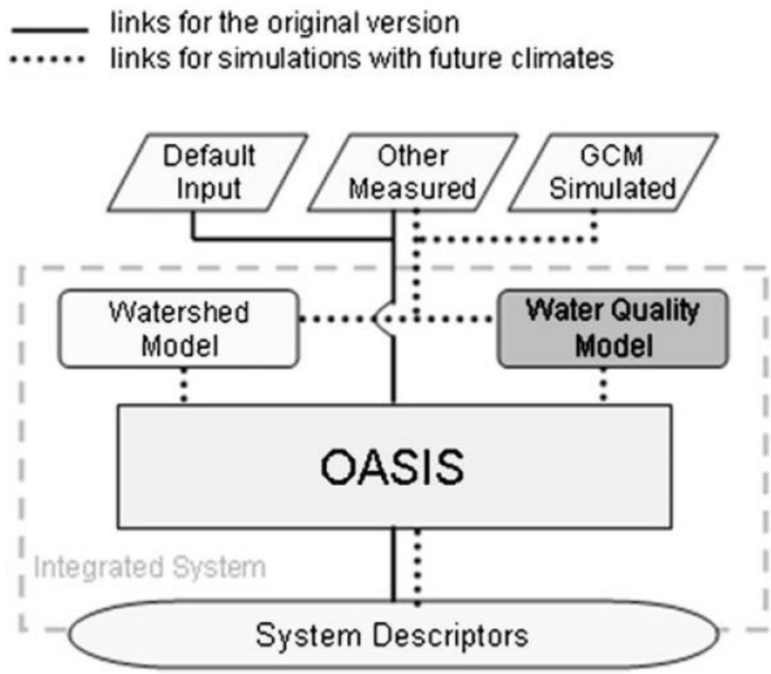


Figure from Frei et al., 2012.

Cited literature: **Reviewer 1 and 2 feel additional data is needed to address model characteristics and performance, such as state variables, input data, projection capabilities, model dynamics and complexity, and comparisons with other models and that additional literature support for the selection of the OASIS model is needed, particularly from peer-reviewed sources.**

Throughout the introduction and methods on pages 6-10, we provided additional detail and peer-reviewed references on how, where and why flow-accounting models (and OASIS in particular) have been used to inform management. We also identified peer-reviewed USGS publications that describe the details of the OASIS model.

We also specified input data used in the OASIS model including monthly and daily demand, surface water withdrawal and discharge timeseries data, reservoir storage-area-elevation data, reservoir rule cures and model weightings, and evaporation/precipitation data.

Model Uncertainty: **Reviewers 1 and 2 point out that uncertainty in model inputs and results are not addressed in the proposal (e.g., through use of uncertainty and sensitivity analyses).**

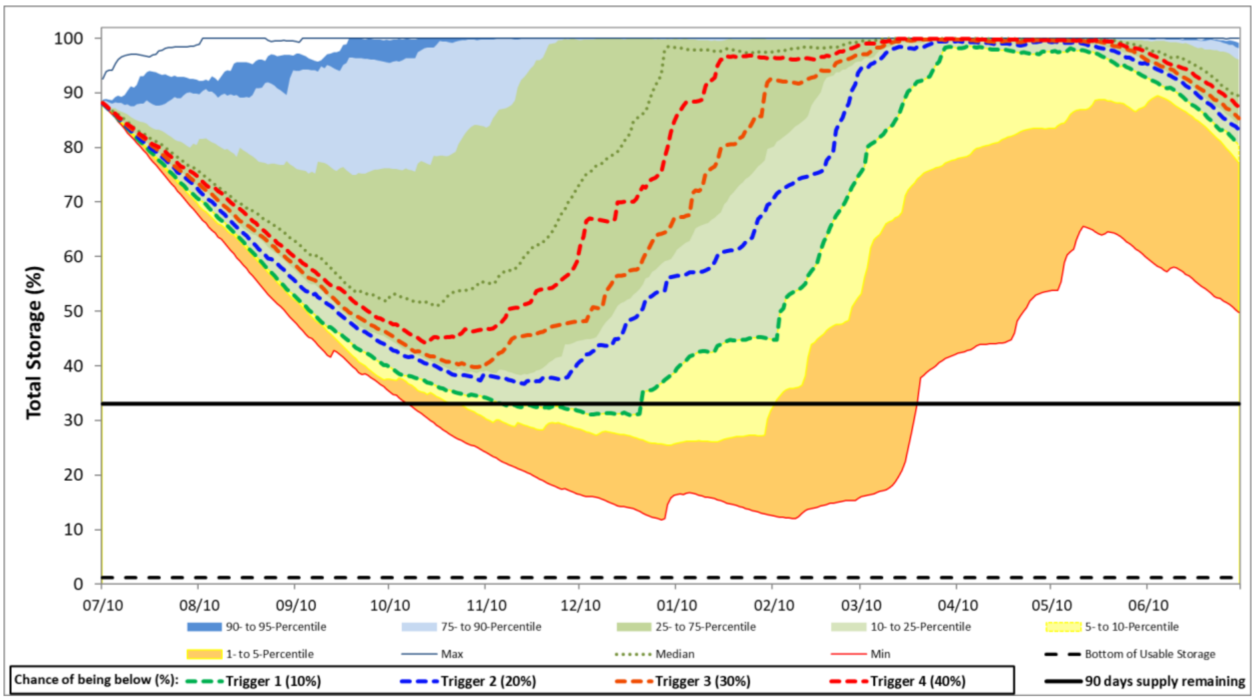
We incorporated the following additional details on page 12.

The uncertainty that exists in regard to model development is primarily associated with uncertainty in the input data provided, since the flow accounting model is just a mass-balance of inputs and outputs. There are measurement and equipment errors associated with the input data that need to be accounted for. The OASIS model development process includes verification of inflows, through simulations forcing the model to match historic operational data and looking at overall simulation agreement and making adjustments where necessary. Once the OASIS model is built, it is easy to switch inputs to quickly look at the sensitivity to uncertainty in inputs. OASIS can be called by a batch program to facilitate running a large set of alternative inflow datasets, for example, from downscaled Global Climate Change models or from inflows generated through Monte Carlo simulation.

In addition to the sensitivity analyses, ensemble forecasts may be used to assess uncertainties and model sensitivity. On page 9, we included the following:

In addition to running standard simulations (i.e., a set period of hydrology sequentially), OASIS also has a model called "Position Analysis" (PA) which runs ensembles forecasts. OASIS can automatically generate the ensembles inflows, based on the historic inflow record, and statistically adjust them based on antecedent flows. It also can be configured to run ensemble inflows from external data sources and display potential future flow conditions in a probabilistic way.

For example, see the sample reservoir forecast plot below.



Long-term Use and Maintenance: **Reviewer 1 also requests information on how the work will be sustained in a long-term way, including the use, sharing, and maintenance of the model after the project period.**

The model will be delivered and installed at a location determined by the State of Alabama along with complete documentation including all assumptions, operating rules, inputs, inflow development and various model parameters. Training for the State of Alabama staff and other stakeholder on the use of the OASIS model in general use and specific to the model developed for this proposed project will be provided over 2 days. Model developers have extensive experience in providing training for users of the models to ensure skills that are sufficient for running the model, modifying inputs/assumptions for new scenarios, and generating and analyzing output. The training materials can be used to train new staff. Addition of this data on page 13.

Modeling issues related to climate change: **Reviewer 2 feels modeling issues related to climate change and pollutants are not addressed.**

We included an additional statement in the introduction on page 7 that OASIS model has been used to evaluate climate affected scenarios (shown below).

It can also be used to evaluate key uncertainties, such as how climate change could be mitigated by various management strategies or planning alternatives (WaterSmart, 2018).

We will work with the stakeholders in Alabama and with the Technical Advisory Committee to identify what climate related alterations we may want to include in the model scenarios. Pollutants are not incorporated explicitly in the model structure and only would be considered indirectly if needed to assess flow-ecology relationships.

Risk: **Reviewers 1 and 2 feel that socio-economic factors should be raised as additional short-term risk to take into consideration as part of model development.**

We believe there are limited short-term socio-economic risks in developing the model. There is currently support in Alabama for developing and applying the model (see letters of support). There is potential risk in the extent to which the model will be used in water resource decision-making, but the updated datasets in and of themselves will also inform decisions. We find that there are more socio-economic benefits than risks in this project and have described them on page 14 under “Communicating Information on the Ecological and Economic Benefits of Restoring Flow”.

Success and failures of similar projects: **Reviewers 1 and 2 find that the proposal does not adequately evaluate the successes and failures of similar projects, either in terms of previous model applications or as part of a larger structured decision-making framework.**

We provided throughout the proposal and in the Bibliography section previous model applications that have been part of a decision framework. Some of those are listed below. Additionally, we have listed over 40 River basins below that have utilized OASIS flow-accounting models and other hydrological decision-support frameworks with linkages to OASIS. The flow-accounting model has wide-spread geographic application (both coastal and inland) and has been used throughout the United States and internationally. We investigated project publications to evaluate features of the flow accounting models and associated decision-support systems that proved most effective in addressing the question or concerns of the model application (similar to those that would be addressed in this project) as well as commonly identifying limitations of the model. We determined that OASIS was the most appropriate model and decision-support system for the Mobile and Perdido River basins based on our review to meet criteria established for the project identified on page 10 (listed below)

1. Integrates multiple water-management decisions and their hydro-ecologic effects;
2. Uses a methodology that is consistent and transparent;
3. Is adaptable, flexible, and allows for updates of locations of ecological assessments, scenarios, and water-management assets;
4. Derives specific ecological predictions from translated water-management decisions;
5. Subsets ecological predictions into meaningful ecological categories;
6. Engages with end-users throughout model development; and
7. Is efficient and cost-effective for end-users.

List of Papers:

- Adaptive Management of Flows in the Lower Roanoke River, North Carolina, USA (Pearsall et al., 2005)
- Converging Waters: Integrating Collaborative Modeling with Participatory Processes to Make Water Resources Decisions (Stephenson, 2011)
- Meeting urban water demands while protecting rivers: A case study from the Rivanna River in Virginia (Richter, 2007)
- A Roadmap for Sustainable Water Management in the Athabasca River Basin (WaterSmart, 2018)
- Adaptive Water Resource Planning in the South Saskatchewan River Basin: Use of Scenarios of Hydroclimatic Variability and Extremes (Sauchyn et al., 2016)
- Science-based Collaboration: Finding Better Ways to Operate the Conowingo Pond (Sheer and Dehoff, 2009).
- *Climate Vulnerability and Sustainable Water Management in the South Saskatchewan River Basin, Final Report.* 129 pages. Alberta WaterSMART. 2016. Available online at http://albertawater.com/ and http://www.ai-ees.ca.
- Review of the New York City Department of Environmental Protection Operations Support Tool for Water Supply. National Academies of Sciences, Engineering, and Medicine. 2018 Washington, DC: The National Academies Press. Available online at https://doi.org/10.17226/25218.

Locations where the OASIS flow-accounting models and other hydrological decision-support frameworks with linkages to OASIS have been utilized:

- Alameda Creek – East Bay Drainage
- Alabama-Coosa-Tallapoosa River Basin
- Apalachicola-Chattahoochee-Flint River Basin
- Appomatox River Basin
- Black Warrior River Basin
- Broad River Basin
- Cape Fear River Basin
- Duck River Basin
- Delaware River Basin
- Greater Bridgeport, CT
- French Broad River Basin

- Hackensack River Basin
- Kansas River Basin
- Kissimmee/Everglades and West Palm Beach
- Klamath River Basin
- Little Tennessee River Basin
- Lower Colorado River Basin
- Lower Rio Grande River Basin
- NYC-Hudson (Catskills and Croton) River Basin
- Neosho River Basin
- Neuse River Basin
- North Central Region, Tennessee
- Potomac River Basin
- Rivanna River Basin
- Roanoke River Basin
- Savannah River Basin
- South Cumberland Region, Tennessee
- Sacramento and San Joaquin River Basins
- Shepaug River Basin
- Salt River Basin
- Spokane River Basin
- Susquehanna River Basin
- Tar River Basin
- Upper Eel River Basin
- Verde River Basin
- Yadkin River Basin
- Western Municipal Water District
- Athabasca River Basin
- Bow River Basin
- Oldman River Basin
- Red Deer River Basin
- Lakes Rotorua and Rotoiti, Bay of Plenty Region, New Zealand
- Yellow River Basin, China

Additional information: **Reviewers 1 and 2 request that the sponsor provide additional information to demonstrate their experience in implementing projects similar to the one being proposed, including their (or their partners') experience with the model, how the model has been used to inform management, what publications have resulted from work with the model, and literature indicating whether the model has been widely cited or had scrutiny from peer-review (Reviewer 1).**

Flow accounting models have been utilized throughout the country to analyze surface water availability for many years. OASIS is one of many flow-accounting models available. The USGS Lower Mississippi Water Science Center has experience using this model, its' inputs, outputs, and applicability for use in this proposal and study area. Phase II of RESTORE Base Flow FPL1 project emphasis is a flow accounting model for the Pearl and Pascagoula River basins in Mississippi. In addition, the USGS has many years of experience implementing projects like this. Listed below are several of the many projects the USGS Lower Mississippi Gulf Water Science Center has implemented, completed, or is working on at this time. Addition of this text on page 6.

- RESTORE Base Flow FPL1 Phase I and Phase II
- MAP (Mississippi Alluvial Plain Project)
- NAWQA (North American Water Quality Assessment Phase I and II)

Listed below are several of the publications from the USGS Lower Mississippi-Gulf Water Science Center exploring flow-ecology relationships and the collection of data required for such analysis:

- Putting Flow–Ecology Relationships into Practice: A Decision-Support System to Assess Fish Community Response to Water-Management Scenarios (Cartwright et al., 2017)

- Modelling ecological flow regime: an example from the Tennessee and Cumberland River basins (Knight et al., 2012)
- Hydrologic Data for the Obed River Watershed, Tennessee (Knight et al., 2014)
- Species-Richness Responses to Water-Withdrawal Scenarios and Minimum Flow Levels: Evaluation Presumptive Standards in the Tennessee and Cumberland River Basins (Driver et al., 2020)
- Copula Theory as a Generalized Framework for Flow-Duration Curve Based Streamflow Estimates in Ungaged and Partially Gage Catchments (Worland et al., 2019)
- Freshwater Delivery to the Gulf of Mexico: an Analysis of Streamflow Trends in the Southeast US from 1950 – 2015 *in review* (Rodgers et al., 2020)
- Prediction and Inference of Flow Duration Curves Using Multioutput Neural Networks (Worland et al., 2019)
- The use of support vectors from support vector machines for hydrometeorologic monitoring network analyses (Asquith, 2020)

The USGS has the expertise in the various scientific disciplines needed to complete regional-scale projects such as this. We added details regarding experience with similar projects on page 6 and recent referenced work on page 9.

Proposed USGS Staffing: **Reviewer 2 states that the project team's CVs are needed to determine their suitability for this work, though it is understood that CVs are not requested as part of project proposals.**

The USGS has a team of scientists that have been identified for this project that are experts in streamflow monitoring, analytics, and modeling; flow-ecology analysis; OASIS applications; and streamgage installation, operation and maintenance. Numerous recent publications from this USGS team have been identified in the proposal that illustrate their suitability to conduct the work. The USGS leads for this work are Dr. William Asquith, Dr. Kirk Rodgers, and Dr. Victor Roland. Full C.V.'s are available if needed.

WILLIAM H. ASQUITH, Ph. D, Ph. D., P.G.
EMPLOYMENT AND AFFILIATION:
Research Hydrologist - 1992–present
U.S. Geological Survey (USGS)
Oklahoma–Texas Water Science Center
Adjunct Scientist 2009–present
Texas Tech University (Geosciences)

KIRK D. RODGERS, Ph. D
EMPLOYMENT AND AFFILIATION:
Hydrologist and Environmental Flows Unit Chief - 2010-Present
U.S. Geological Survey (USGS)
Lower Mississippi-Gulf Water Science Center
Adjunct Professor 2014-present
University of Arkansas-Little Rock (Earth Science and GIS)

VICTOR L. ROLAND II, Ph. D
EMPLOYMENT AND AFFILIATION:
Hydrologist - 2012-present
U.S. Geological Survey (USGS)
Lower Mississippi-Gulf Water Science Center
Adjunct Professor 2016-Present
Tennessee State University

Gulf Coast Ecosystem Restoration Council

FPL 3b Internal Best Available Science Review Panel Summary

July 2020

Introduction

On Tuesday, June 30, and Wednesday July 1, 2020 the RESTORE Council convened the Funded Priorities List (FPL) 3b Internal Best Available Science (BAS) Review Panel. The purpose of this internal panel was to use Council member-agency expertise to address external BAS review comments provided for FPL 3b submitted project/program proposals, and potentially identify project/program synergies not identified prior to proposal submission. The ultimate goal of the panel was to provide Council members with substantive best available science content to inform their decision-making.

The internal panel was convened via webinar with representatives from each of the Council's eleven member agencies present. Each BAS Panel member was provided the following:

1) Full FPL 3b proposals
2) 3 external BAS reviews for each proposal
3) Summary of external BAS reviews for each proposal
4) Proposal Sponsor's response to the BAS reviews summary
5) Any proposed revisions to the proposal

Proposal sponsors provided a brief synopsis of their proposal to the panel, a summary of comments made in external reviews, and discussed their proposed response to the external reviews. Council staff then solicited feedback from the panel on the proposal sponsor's presentation of comments and responses to those comments, and any additional BAS concerns. Council staff also solicited feedback on any existing or future synergies with other Gulf restoration activities. The proceedings of the meeting for this proposal are summarized below.

Department of the Interior

Ecological Flow Decision-Support for Mobile River and Perdido River Basins (DOI/USGS)

Feedback from the panel on the proposal sponsor's presentation of comments and responses to those comments, and any additional BAS concerns:

References: Has the sponsor provided reasonable justification that the proposal is based on science that uses peer-reviewed data?

- The BAS panel agrees that DOI has appropriately addressed this comment.

Statistical methods: Requests information on statistical methods and uncertainty quantification.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Justification: Requests more information on the linkages between flow regime and species responses including justification on data resolution.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Applications: Demand for the model and its outputs are not addressed in the proposal.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Coordination: Add milestones for what will be accomplished and how it will be used and list potential approaches for integrating local expertise to ensure model tools can be applied and maintained.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Lessons learned: Proposal does not evaluate the successes of similar projects, in terms of previous model applications or as part of a larger structured decision-making framework.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Past experience: The project team's CVs are needed to determine their suitability for this work, though it is understood that CVs are not requested as part of project proposals.

- The BAS panel agrees that DOI has appropriately addressed this comment.

Panel comments on existing or future synergies with proposed activity:
Alabama has had conversations with DOI/USGS on this work and looks forward to coordinating on a technical level to apply tools such as the one proposed where they may be useful in Perdido Bay.

SCIENCE EVALUATION

Bucket 2: Comprehensive Plan Component

Proposal Title: Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins	
Location (If Applicable): Gulf-wide	
Council Member Bureau or Agency: U.S. Department of the Interior, U.S. Geological Survey	
Type of Funding Requested: Planning / Implementation	

Reviewed by: Reviewer 1
Date of Review: May 2, 2020

Best Available Science:

These 4 factors/elements help frame the reviewer's answers to A, B and C found in next section:

Question 1.	
Have the proposal objectives, including proposed methods, been justified using peer reviewed and/or publicly available information?	Need more information

Comments:

The authors provided adequate descriptions of their proposed methods which constitute three different foci: 1) The derivation of a flow model using the OASIS modeling system, 2.) outreach and education activities including the convening of a technical advisory committee, 3.) and the installation and maintenance of streamflow gages in the Mobile and Perdido River basins. These three overlapping and complementary objectives are generally well described and moderately well supported. Some aspects of the model were described but the model capabilities and description were not well supported using peer-reviewed sources. No peer reviewed sources in hydrological and watershed journals were provided. The cited literature was superficial to inform the reader about the model including the state variables, input data,

projection capabilities, and complexity and dynamics of the model. In a project of this scale, in which the primary costs involve model development and construction, these aspects of the model need to be well described – at a minimum they need to make a strong tie to other aspects of the project, e.g. How will the TAC help reconcile uncertainties in data inputs and how will the model need to be modified to those data available for the study region? What are the types of projections that can be accomplished and how will these be validated? Where has the model been employed and what were the specific benefits to stakeholders? I would have liked to see the authors describe in detail the benefits of using this model as opposed to other methods and have these statements supported by the literature.

Question 2.	
If information supporting the proposal does not directly pertain to the Gulf Coast region, are the proposal's methods reasonably supported and adaptable to that geographic area?	Yes
Comments:	
Yes, I believe they are. The model, the outreach, and the deployment of stream gages for data collection are standard approaches and can be employed in the northern Gulf of Mexico. The specific needs of Mississippi and Florida, though mentioned in the narrative as protentional users of the model, are not described. I agree with the authors and believe the approach may be useful in these states as well, but the authors do not support this claim with a letter or statement of support to state the willingness of other jurisdictions to use the proposed approach.	

Question 3.	
Are the literature sources used to support the proposal accurately and completely cited? Are the literature sources represented in a fair and unbiased manner?	Yes
Comments:	
Yes, the literature is superficial but seems appropriate and an honest support of the statements of the narrative. The narrative is generally not well supported in providing specific detail about the modeling approach and the literature cited is primarily focused on providing general support for addressing the needs to maintain ecosystem structure and function by better managing stream flow.	

Question 4.	
Does the proposal evaluate uncertainties and risks in achieving its objectives over time? (e.g., is there an uncertainty or risk in the near- and/or long-term that the project/program will be obsolete or not function as planned?)	Need more information
Comments:	
This is one of my concerns with the project. There is very little in the narrative to describe how the modeling work will be sustained in a long-term way and thus give the maximum possible return on investment. Specifically, how will the methods of collection and integration into the model be sustained? Will the stakeholders have enough knowledge to maintain the model, and how will the model will be maintained after the project period? Finally, will the model executable be stored as an API online or will it reside in a private server?	

Based on the answers to the previous 4 questions, and *giving deference to the sponsor to provide within reason the use of best available science,* the following three questions can be answered:

Question A	
Has the applicant provided reasonable justification that the proposal is based on science that uses peer- reviewed and publicly available data?	Need more information
Comments:	
I believe the model is reasonably robust, however the authors do not provide detailed examples of where and how the model has performed. The narrative should better describe why the proposed approach is the best and the features that make it preferable to alternatives. A table documenting the successful application of the model to impact management and regulatory activity would be useful here. I found that the figures provided (fuzzy and not very useful) in this respect did not support the proposed methods very well – this would have been an opportunity to provide very specific and relevant details about the utility of the modeling exercise – and the costs would have been better justified.	

Question B	
Has the applicant provided reasonable justification that the proposal is based on science that maximizes the quality, objectivity, and integrity of information (including, as applicable, statistical information)?	Need more information

Comments:
One aspect of the work that the improvement of water flow and maintenance of estuarine function will benefit biota is not well developed. The focus of the proposal on the fishes, invertebrates, and sea grasses that will benefit from improvements in flow regimes, it is not clear how this will be determined. The use of the term "ecosystem health" is so generic that it really means nothing for managers, the flow ecology relationship is likely incredibly complex and not well developed here. The use of descriptive multivariate statistical techniques may be adequate but the temporal, spatial, and taxonomic resolution of these response data are not well described. It is reasonable that much of these analyses will be confounded to some extent by the lack of high resolution data.

Question C	
Has the applicant provided reasonable justification that the proposal is based on science that clearly documents and communicates risks and uncertainties in the scientific basis for such projects/programs?	Need more information
Comments:	
It is not clear from the description of the model how uncertainty in input data, model misspecification, and ambiguity in the response variables will be evaluated. It is not clear if the OASIS model has stochastic components that can be simulated and to what extent the lack of understanding of flow processes can be incorporated into the model. A systematic evaluation of uncertainty will be necessary for management to be effective; it is not clear if that will be the subject of investigation. In general, modeling efforts have sensitivity runs and an associated evaluation of how changes to the structure and the parameter values alter the state variables of interest.	

Science Context Evaluation:

Question A

Has the project/program sponsor or project partners demonstrated experience in implementing a project/program similar to the one being proposed?	Need more information

Comments:

It is not clear how the model or the modeling framework has been used in the past to inform management or the publications that have resulted from their work. The literature cited did not indicate that the model was widely cited or that it had scrutiny from peer-review. It is not clear what the partner's or proposer's experience with the model is.

Question B

Does the project/program have clearly defined goals objectives?	Yes

Comments:

In general yes, three specific objectives are outlined in the proposal narrative: 1) The derivation of a flow model using the OASIS modeling system, 2.) outreach and education activities including the convening of a technical advisory committee, 3.) and the installation and maintenance of streamflow gages in the Mobile and Perdido River basins. Because the model will not be bench tested in a larger structured decision-making format, it is not clear if the results can be considered robust for management.

Question C

Has the proposal provided a clear description of the methods proposed, and appropriate justification for why the method is being selected (e.g., scientifically sound; cost-effectiveness)?	No

Comments:

The description of the methods for the determination of the response variables (the biota) are not well described and the modeling used to evaluate the impacts of alternative regimes do not seem adequate – I would expect that a BACI or controlled design would be necessary as would an a priori analysis to understand, given the variability in biotic communities and the observation error, whether biotic changes, if they exist, could be detected. Multivariate statistical descriptive methods will not allow the quantitative description of the impacts of altering regime flow. Instead these methods will allow a description of the direction of change and some indication of magnitude of impact. The model is not well described and a figure describing inputs and outputs should be presented to make it clear to the reader what these are and how they are treated mechanistically in the model.

Question D	
Does the project/program identify the likely environmental benefits of the proposed activity? Where applicable, does the application discuss those benefits in reference to one or more underlying environmental stressors identified by best available science and/or regional plans?	Yes
Comments:	
Yes, the project does identify, in general terms, the environmental benefits to the construction of a flow model and the implementation of new flow gages. It is not clear how these data and methods will be integrated into the existing regulatory framework.	

Question E	
Does the project/program have measures of success (i.e., metrics) that align with the primary Comprehensive Plan goal(s)/objectives? (Captures the statistical information requirement as defined by RESTORE Act)	No
Comments:	
The implementation of the model and the delivery of stakeholders in Alabama, Florida, and Mississippi are considered success. It is not clear from the proposal to what extent this model and its output are wanted in Mississippi and Florida however.	

Question F	
Does the proposal discuss the project/program's vulnerability to potential long-term environmental risks (i.e., climate, pollution, changing land use)? (Captures risk measures as defined under best available science by the RESTORE Act)	Yes
Comments:	
The project addresses these concerns and if the project is funded should serve to mitigate, or at least provide the tools to managers for mitigation of long-term environmental processes as well as short term variation. The use of the model to generate simulations is appropriate for understanding and helping to minimize long-term impacts.	

Question G	
Does the project/program consider other applicable short-term implementation risks and scientific uncertainties? Such risks may include the potential for unanticipated adverse environmental and/or socio-economic impacts from project implementation. Is there a mitigation plan in place to address these risks? Any relevant scientific uncertainties and/or data gaps should also be discussed. (Captures risk measures as defined under best available science by the RESTORE Act)	Need more information
Comments:	
It is not clear from the narrative that it does. However, I think that must be the case given the publicly available reports about the capability of the model. Socio-economic factors are not considered in this proposal. It might be the case that the authors will wish to evaluate those impacts qualitatively with concerned stakeholders on their TAC.	

Question H	
Does the project/program consider recent and/or relevant information in discussing the elements above?	Yes
Comments:	
Yes, the proposal addresses recent and relevant information for understanding impacts, long and too a lesser extent, short term impacts.	

Question I	
Has the project/program evaluated past successes and failures of similar efforts? (Captures the communication of risks and uncertainties in the scientific basis for such projects as defined by the RESTORE Act)	No
Comments:	
One of the primary foci of understanding the impacts of the assessment and management framework is to perform a systematic examination of all aspects of decision making. I would like to have seen the authors propose a much larger structured decision-making framework to understand how success can be built on the knowledge of similar efforts. The documentation of the model (its biases and how it handles imprecision) is necessary to better understand model limitations.	

Question J	
Has the project/program identified a monitoring and data management strategy that will support project measures of success (i.e., metrics). If so, is appropriate best available science justification provided? If applicable, how is adaptive management informed by the performance criteria? (Captures statistical information requirement a defined by the RESTORE Act)	Yes
Comments:	
The proposed work has a data management plan in place and that the data will be accessible using a USGS web portal. This approach conforms to the best available methods for data storage and dissemination.	

Please summarize any additional information needed below:
Click here to enter text.

SCIENCE EVALUATION

Bucket 2: Comprehensive Plan Component

Proposal Title: Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins	
Location (If Applicable): Gulf-wide	
Council Member Bureau or Agency: U.S. Department of the Interior, U.S. Geological Survey	
Type of Funding Requested: Planning / Implementation	

Reviewed by: Reviewer 2
Date of Review: May 10th 2020

Best Available Science:

These 4 factors/elements help frame the reviewer's answers to A, B and C found in next section:

Question 1.	
Have the proposal objectives, including proposed methods, been justified using peer reviewed and/or publicly available information?	Need more information
Comments:	
One of the shortcomings of this proposal is the lack of in-depth literature analysis. This 4 million dollar proposal has about 17 cited references, most of them are reports. There are very few (less than 10) published peer-reviewed, high-quality journal citations. Development of a model using the OASIS code is the stated objective but it bit unclear by OASIS was selected, what are the potential shortcomings (such lack of groundwater preditions), lack of non-conservative water quality parameters, to name a few.	

Question 2.	
If information supporting the proposal does not directly pertain to the Gulf Coast region, are the proposal's methods reasonably supported and adaptable to that geographic area?	Need more information
Comments:	
Need more literature data to show how and why this method is useful for the proposed geographic area.	

Question 3.	
Are the literature sources used to support the proposal accurately and completely cited? Are the literature sources represented in a fair and unbiased manner?	Need more information
Comments:	
As stated before, one of the shortcomings of this proposal is lack of literature information.	

Question 4.	
Does the proposal evaluate uncertainties and risks in achieving its objectives over time? (e.g., is there an uncertainty or risk in the near- and/or long-term that the project/program will be obsolete or not function as planned?)	No
Comments:	
There is no discussion on uncertaintly analysis. It is unclear how uncertainties in weather predictions and rainfall data will be intergrated within the model.	

Based on the answers to the previous 4 questions, and *giving deference to the sponsor to provide within reason the use of best available science,* the following three questions can be answered:

Question A	
Has the applicant provided reasonable justification that the proposal is based on science that uses peer- reviewed and publicly available data?	Need more information
Comments:	
It is unclear what datasets will be used in the model. Flooding conditions will depend on hurricane forecasts and other prediction, how will these information will be integrated within OASIS?	

Question B	
Has the applicant provided reasonable justification that the proposal is based on science that maximizes the quality, objectivity, and integrity of information (including, as applicable, statistical information)?	Need more information
Comments:	
They propose to use a known computational tool, OASIS. However, there is no discussion of any statistical analysis and uncertaintly quantification.	

Question C	
Has the applicant provided reasonable justification that the proposal is based on science that clearly documents and communicates risks and uncertainties in the scientific basis for such projects/programs?	No
Comments:	

No, no discussion of model uncertainties. Also, no discussion of issues related to the lack groundwater decription in the OASIS model.

Science Context Evaluation:

Question A	
Has the project/program sponsor or project partners demonstrated experience in implementing a project/program similar to the one being proposed?	Need more information
Comments:	
This is an important shortcoming. This is not the PI problem. The proposal call should have asked for the CVs of the project team so the reviewer can assess the quality of the team. Currently, I have no basis to asses whether the team has necessary experience to complete this work.	

Question B	
Does the project/program have clearly defined goals objectives?	Yes
Comments:	
The general objective is to develop a computer model and build some stream gauges	

Question C

Has the proposal provided a clear description of the methods proposed, and appropriate justification for why the method is being selected (e.g., scientifically sound; cost-effectiveness)?	Need more information

Comments:

The computer code proposed here does not seem to account for many hydrological processes such as groundwater-surfacewater intractions that generate the base flow. Researchers have attempted to integrate more advanced models such a Hydrogeoshere (HGS) address such needs.
http://www.kgs.ku.edu/Hydro/Publications/2015/OFR15_1/OFR2015-1.pdf
I would like to see authors attempt to develop and use such a creative approach. Note OASIS can be linked to tools like this through its OCL interface.

Another limitation is water quality simulation. According to OASIS manual,
http://ftp.hydrologics.net/documents/OASIS_Manual4-2010.pdf
the model uses simple mixing algorithm and assumes contaminants to be conservative. Critical water quality parameter such as carbon, nitrogen or oxygen in a stream are not conservative, how will you predict them?

Question D

Does the project/program identify the likely environmental benefits of the proposed activity? Where applicable, does the application discuss those benefits in reference to one or more underlying environmental stressors identified by best available science and/or regional plans?	Yes

Comments:

They have provide sufficient information for this

Question E

Does the project/program have measures of success (i.e., metrics) that align with the primary Comprehensive Plan goal(s)/objectives? (Captures the statistical information requirement as defined by RESTORE Act)	Need more information

Comments:

Construction of stream gauges is a good metric. The modeling metric is however bit unclear. "Delivery of the OASIS" mean what? The training will be done by the developers so it is not clear what the modeling team will deliver. Need clear milestones for every year on what they will accomplish and how the information will be used. Also, states may not have the capability to use these tools, therefore they should intergrate some local expertise as part of the model development efforts. One possible approach is to work with local universities and intergrate them within the research project so these tools can be put to some good use and can be updated in the future. Also, NOAA's National Water Center in Tuscaloosa is developing a National Water Model. These efforts could be integrated with NOAA's efforts to make it broadly applicable. Also, USGS Hydrologic Information Facility (HIF) is currently moving to Tuscaloosa and they are supposed manage stream gauges, so the stream gauge construction efforts should be coordinated with HIF to maximize its use.

Question F	
Does the proposal discuss the project/program's vulnerability to potential long-term environmental risks (i.e., climate, pollution, changing land use)? (Captures risk measures as defined under best available science by the RESTORE Act)	No
Comments:	
No. Issues related to climate change efforts are not discussed. Also, the water quality model within OASIS is weak and that needs to be upgraded to model realistic pollution scenarios.	

Question G	
Does the project/program consider other applicable short-term implementation risks and scientific uncertainties? Such risks may include the potential for unanticipated adverse environmental and/or socio-economic impacts from project implementation. Is there a mitigation plan in place to address these risks? Any relevant scientific uncertainties and/or data gaps should also be discussed. (Captures risk measures as defined under best available science by the RESTORE Act)	Need more information
Comments:	
No discussion of socio economic impacts	

Question H	
Does the project/program consider recent and/or relevant information in discussing the elements above?	Need more information
Comments:	
Not really	

Question I	
Has the project/program evaluated past successes and failures of similar efforts? (Captures the communication of risks and uncertainties in the scientific basis for such projects as defined by the RESTORE Act)	No
Comments:	
This is an important part and the authors should include a section that describes past application of OASIS and how it worked or did not work, and also method to improve them. For example, Kansas folks used HGS to improve groundwater predictions, studies such as this should be explored and reviewed. http://www.kgs.ku.edu/Hydro/Publications/2015/OFR15_1/OFR2015-1.pdf	

Question J	
Has the project/program identified a monitoring and data management strategy that will support project measures of success (i.e., metrics). If so, is appropriate best available science justification provided? If applicable, how is adaptive management informed by the performance criteria? (Captures statistical information requirement a defined by the RESTORE Act)	Need more information

Comments:
Need more information

Please summarize any additional information needed below:
Overall, this is a worthy fundable effort, however the proposal needs to be improved. This is a 4 million dollar modeling project to study two catchments and lot can be done. The proposal also needs a clear budget showing how the money will be spent, how many modelers will be working in this project? Is this code free, how much it will cost for the states to buy and manage this OASIS model? How much budget is allocated for training. Also CVs of the project team should be included. The field part of installing gauges is a fundable project now, but the modeling project should be funded after a careful revision to address some of the comments. It is important that this work be intergrate with other on-going effots at local universities and research institutions. For example, USGS HIF does stream gauge work, can this project efforts integrate with their efforts. NOAA National Water Model makes flood predictions, how will you integrate your modeling efforts with theirs? What is the difference? Major RI-research institutions in Alabama (Univ of Alabama at Tuscaloosa, and Auburn Univ.) have strong hydrological modeling groups that look at various modeling aspects including groundwater modeling, recharge simulation, and assimilation of sattilite data such as soil moisture data, GRACE data etc. Try and integrate them to strengthen the modeling efforts and also to promote education and outreach.

SCIENCE EVALUATION

Bucket 2: Comprehensive Plan Component

Proposal Title: Develop Ecological Flow Decision-Support for Mobile River and Perdido River Basins	
Location (If Applicable): Gulf-wide	
Council Member Bureau or Agency: U.S. Department of the Interior, U.S. Geological Survey	
Type of Funding Requested: Planning / Implementation	

Reviewed by: Reviewer 3
Date of Review: 5/10/2020

Best Available Science:

These 4 factors/elements help frame the reviewer's answers to A, B and C found in next section:

Question 1.	
Have the proposal objectives, including proposed methods, been justified using peer reviewed and/or publicly available information?	Yes
Comments:	
Click here to enter text.	

Question 2.	
If information supporting the proposal does not directly pertain to the Gulf Coast region, are the proposal's methods reasonably supported and adaptable to that geographic area?	Yes
Comments:	
The proposal clearly lays out how the upstream water bodies directly impact the Gulf Coast region.	

Question 3.	
Are the literature sources used to support the proposal accurately and completely cited? Are the literature sources represented in a fair and unbiased manner?	Yes
Comments:	
To the best of my knowledge the sources are presented accurately and fairly. It has been many years since I have written a document that cited scientific resources.	

Question 4.	
Does the proposal evaluate uncertainties and risks in achieving its objectives over time? (e.g., is there an uncertainty or risk in the near- and/or long-term that the project/program will be obsolete or not function as planned?)	Yes
Comments:	
Click here to enter text.	

Based on the answers to the previous 4 questions, and *giving deference to the sponsor to provide within reason the use of best available science,* the following three questions can be answered:

Question A	
Has the applicant provided reasonable justification that the proposal is based on science that uses peer- reviewed and publicly available data?	Yes
Comments:	
Click here to enter text.	

Question B	
Has the applicant provided reasonable justification that the proposal is based on science that maximizes the quality, objectivity, and integrity of information (including, as applicable, statistical information)?	Yes
Comments:	
Click here to enter text.	

Question C	
Has the applicant provided reasonable justification that the proposal is based on science that clearly documents and communicates risks and uncertainties in the scientific basis for such projects/programs?	Yes
Comments:	
Click here to enter text.	

Science Context Evaluation:

Question A	
Has the project/program sponsor or project partners demonstrated experience in implementing a project/program similar to the one being proposed?	Yes
Comments:	
Click here to enter text.	

Question B	
Does the project/program have clearly defined goals objectives?	Yes
Comments:	
Click here to enter text.	

Question C	
Has the proposal provided a clear description of the methods proposed, and appropriate justification for why the method is being selected (e.g., scientifically sound; cost-effectiveness)?	Yes
Comments:	
Click here to enter text.	

Question D	
Does the project/program identify the likely environmental benefits of the proposed activity? Where applicable, does the application discuss those benefits in reference to one or more underlying environmental stressors identified by best available science and/or regional plans?	Yes
Comments:	
The project clearly lays out how the proposal will benefit both decision-makers and water managers in various ways to benefit the environment and how it can be used to make decision based on a variety of stressors.	

Question E	
Does the project/program have measures of success (i.e., metrics) that align with the primary Comprehensive Plan goal(s)/objectives? (Captures the statistical information requirement as defined by RESTORE Act)	Yes
Comments:	
Click here to enter text.	

Question F	
Does the proposal discuss the project/program's vulnerability to potential long-term environmental risks (i.e., climate, pollution, changing land use)? (Captures risk measures as defined under best available science by the RESTORE Act)	Yes
Comments:	
This proposal clearly has minimal risk involved, but the authors lay out what those small risk are very clearly.	

Question G	
Does the project/program consider other applicable short-term implementation risks and scientific uncertainties? Such risks may include the potential for unanticipated adverse environmental and/or socio-economic impacts from project implementation. Is there a mitigation plan in place to address these risks? Any relevant scientific uncertainties and/or data gaps should also be discussed. (Captures risk measures as defined under best available science by the RESTORE Act)	Yes
Comments:	
Click here to enter text.	

Question H	
Does the project/program consider recent and/or relevant information in discussing the elements above?	Yes
Comments:	
Click here to enter text.	

Question I	
Has the project/program evaluated past successes and failures of similar efforts? (Captures the communication of risks and uncertainties in the scientific basis for such projects as defined by the RESTORE Act)	Yes
Comments:	
Click here to enter text.	

Question J	
Has the project/program identified a monitoring and data management strategy that will support project measures of success (i.e., metrics). If so, is appropriate best available science justification provided? If applicable, how is adaptive management informed by the performance criteria? (Captures statistical information requirement a defined by the RESTORE Act)	Yes
Comments:	
Click here to enter text.	

Please summarize any additional information needed below:
This project clearly uses science and justified protocols for the development of important data that will be important for decision makers and water resource managers moving forward. I do not need any more information.