Southeast Aquatic Resource Partnership
Southern Instream Flow Network

Third Annual Workshop
Implementation of the Southern Instream Flow Research Agenda

December 1-2, 2010 in Gulf Shores, Alabama

Agenda

Schedule	Topic	Speaker/ Facilitator
Wednesday		
7:30	Continental Breakfast (provided)	
8:00	Welcome/logistics/ workshop overview and expected outcomes	Scott Robinson
8:15	Introductions and State Updates	All participants
10:00	Break	
10:30	Southern Instream Flow Research Agenda *An overview of the research agenda and the first year of its implementation will provide the basic information attendees need to fully participate in the workshop.*	Mary Davis
11:00	Data Sprint *A regional aquatic database forms the basis for quantifying flow-ecology relationships. The Data Sprint will be introduced as means to enter regional aquatic data into the MARIS database framework. Concurrent Data Sprint sessions are scheduled later during the workshop.*	Robert Burgholzer and Andrew Loftus
12:00	Lunch – provided on-site Speaker: Paul Montagna (Harte Research Institute for Gulf of Mexico Studies, TA&M-Corpus Christi) on determination of freshwater inflow needs for estuaries	
1:00	River classification *The use of limited ecological data can be extended with the assumption that ecosystems with similar streamflow attributes and geomorphic characteristics*	John Faustini and Eloise Kendy

	respond similarly to flow alteration. A draft river classification system developed for southern rivers will be presented. Breakout groups will review the classes for applicability in their states.	
3:00	Break	
3:30	Flow Alteration Assessment *Given the complexity of aquatic ecosystems and the difficulty in developing comprehensive descriptions of flow-ecology relationships, there is a need to focus limited research resources. A regional assessment of sources of flow alteration and the affected flow regime components will be presented. Breakout groups will review the assessment for applicability in their states.*	Emily Watson and Steven Hamby
5:30	Wrap-up and adjourn for the day	
6:00	Social hour/cash bar Dinner on your own	
Thursday		
7:30	Continental Breakfast (provided)	
8:00	Catch up from yesterday	Mary Davis
8:15	Data Sprint update *Progress made in gathering and entering data the previous day will be reported along with expectations for more data compilation today.*	Robert Burgholzer
8:30	Communicating the value of instream flows *The second priority objective for SIFN has been to develop tools to help communicate to various audiences the need to protect instream flows. The approach will be described and tools demonstrated.*	Marilyn O'Leary and Lindsay Gardner
9:30	Development of Flow-Ecology hypotheses for the Susquehanna River Basin *The Nature Conservancy recently developed environmental flow recommendations for the Susquehanna River Basin Commission and US Army Corps of Engineers. This session will review the iterative process they used to classify rivers and develop flow-ecology hypotheses for each river type. It will be used as an example of how to develop hypotheses for regional ecological responses to flow alteration.*	Tara Moberg
10:00	Break	

10:30	Putting it all together: How can we use all of this information to develop instream flow standards? *This session begins work towards the next steps for SIFN. We will begin to develop flow-ecology relationships while testing the information presented so far. The research agenda products will be presented as map overlays to help identify the commonalities in ecological responses to flow alteration in southern rivers. Breakout groups will identify flow-dependent species groups for different river types in their states.*	Mary Davis
12:00	Lunch – provided on-site Speaker: Rua Mordecai, South Atlantic LCC Science Coordinator. The Landscape Conservation Cooperatives and links with the Southern Instream Flow Research Agenda	
1:00	Flow-Ecology hypotheses for Southern Rivers *Given the results of the morning's session to 'put it all together', this facilitated session will help guide participants in the development of flow-ecology hypotheses. The products will be an initial list of flow-ecology relationships for different types with the associated metrics.*	Mary Davis and Tara Moberg
3:00	Break	
3:30	From hypotheses to flow prescriptions: what's next? *Given the discussions over the past two days what have we learned to direct work on the research priorities? We will break out into groups to discuss river classification, flow alteration assessment and the regional aquatic database and make recommendations to focus them better on the instream flow research needs for the region.*	Mary Davis with John Faustini, Emily Watson, and Robert Burgholzer
4:30	Southern Instream Flow Research Program Future Direction and Funding *The research agenda highlights research needs and thereby coordinates sources of funding and research to address these priority topics. The goal is to ensure that instream flow research is focused on the needs of water resource managers for scientifically credible, protective state instream flow standards. Workshop participants will have an opportunity to evaluate progress to date on fulfilling the research agenda, and to make recommendations for its future.*	Eloise Kendy and Mark P. Smith
5:30	Adjourn and many thanks	

Southern Instream Flow Research Agenda:

A Proposal to Advance the Science

For Instream Flow Protection in Southern Rivers

Prepared by the
Southern Instream Flow Network
A program of the
Southeast Aquatic Resources Partnership
March 2010

The Southern Instream Flow Research Agenda is a collaborative effort to strengthen the scientific foundation to support state instream flow protection and standards in the Southern US. The agenda articulates the priority research topics identified by aquatic resource managers from 15 southern states as the scientific information necessary to inform, develop, and implement protective instream flow standards. Currently, there is little focus of research or funding on instream flow standards. The objective of this proposal is to highlight research needs and thereby coordinate sources of funding and research to address these priority topics. The goal is to ensure that instream flow research is focused on the needs of water resource managers for scientifically credible, protective state instream flow standards.

Background

The Southeastern United States is a global center of aquatic biodiversity. The region's rich array of habitats and mild climate support many fish, mussel, and other aquatic species, indeed the greatest number of aquatic species of special federal and state concern. Instream flows – the natural variations of water levels in rivers and streams - are critical to maintenance of these rich aquatic ecosystems. Every aspect of the lives of these animals and plants is cued by and inextricably tied to the high and low flows of our rivers. Healthy seasonal flows of rivers support an array of aquatic life, which in turn supports healthy commercial and recreational fisheries. Generations of Southerners depend on healthy fisheries for their livelihoods and some depend on it to feed their families. These resources are critical to multi-million dollar industries such as tourism and recreation. During Fiscal Year 2002, for example, the state of South Carolina earned more than $3.2 million from the sale of fishing licenses to both visitors and residents. Healthy influxes of fresh water mixing with the tidal flow of salt water create a robust estuary, which serves as a nursery for shrimp, crabs, oysters and a variety of fish species – all vital to the success of coastal commercial and recreational fishing operations. Georgia's estuaries support an annual $14 million commercial fishing industry.

Flow alteration from consumption and other water management practices is identified in State Wildlife Action Plans as one of the major threats facing aquatic habitats across the region. Projected population growth rates over the next several decades will increase demand for water and exert more pressure on already threatened aquatic resources. Instream flow policies of many states set thresholds for minimum flows that do not protect the natural variation of flow and are not protective of the health of these rivers. Recently, several leading resource organizations, including the National Fish Habitat National Board and its Science and Data Committee, the Southeast Aquatic Resources Partnership (SARP), Instream Flow Council, American Fisheries Society, and environmental organizations such as The Nature Conservancy and Environmental Defense Fund, have recognized the need for improved policies to protect instream flows.

Interest in developing effective instream flow protection has increased among water resource managers as recent droughts and interstate controversies have called attention to the limits of water resources and exacerbated conflicts for them. The droughts and controversies have highlighted the universal value of water for plants, animals, and people -- for economic and social as well as ecological health. State officials are mindful that aquatic resources are largely protected by the public trust doctrine in this region and stronger protection is needed. States in the Southeast have varying levels of instream flow protection, and with climate change adding uncertainty to our future water supplies, many states are trying to improve the effectiveness of their water management programs. However, state fish and wildlife agencies and their partners are often hampered by insufficient scientific information to substantiate recommendations for ecologically protective instream flow standards.

The importance of natural flow regimes to the ecological integrity of rivers has been established for decades, but more specific information is needed to develop and implement scientifically credible instream flow standards. In fact, recent reviews of resources to support instream flow standards reveal there is little available information to substantiate the ecological responses to flow alteration (Poff and Zimmerman 2009; unpublished reviews by SIFN and Susquehanna River Commission). Most flow studies, for example, relate site or species-specific conditions to magnitude of flow, but not to effects of alterations of hydrologic regimes. Monitoring results of ecological responses to flow alterations are sporadic. For the ecological study results that do exist, syntheses for state standards are difficult to make without comparable measures and a river classification system which is relevant to flow alterations. The science needed to support instream flow standards has only recently been defined under the Ecological Limits of Hydrologic Alteration (ELOHA, Poff et al. 2009) framework. Coordination of research now has a logic to follow and can be more efficient.

It is very difficult to find funding for research on natural aquatic ecosystems - a resource that is protected by southern states as a public trust. Despite the widespread recognition of the threat of altered hydrologic regime to the health of aquatic ecosystems, few funds are ear-marked for instream flow research to date. State fees for fishing licenses, for example, fund research for sport fish and their relationships to water levels, but are often focused only on reservoir operations. The National Conservation Needs (NCN's) identified by the Association of Fish and Wildlife Agencies have not addressed instream flow as a national funding priority (Note: SIFN was funded by SEAFWA under the support for partnerships NCN in 2007). US Fish and Wildlife Service funds usually support physical instream work, but exclude research or monitoring. Moreover, funding is limited for monitoring ecological responses to flow alterations permitted under state regulatory programs or federal permits for dam operations, which if properly designed would add to our understanding of these issues. As a result, the most basic questions about how altered flow regimes relate to aquatic ecosystems remain unanswered.

Priority Research Topics

In the Second Annual Workshop of the SARP Southern Instream Flow Network, held December 1-3, 2009 in Nashville, 60 regional aquatic resource managers and national experts in instream flow science and communications presented the state-of-the-science in setting instream flow standards (Go to www.southeastaquatics.net for more information). Discussions of case studies from 10 states resulted in a list of information and research needs for southern states to develop and implement science-based instream flow standards. Workshop participants voted for their priority topics. (See Appendix A for the complete list)

The five research topics listed below represent more than 40% of the votes. Following the workshop a committee of workshop participants clarified and expanded on each research topic for this proposal. These research priorities form an integrated baseline of information to support and direct instream flow research in the Southern U.S.

1. **Develop a regional river classification system:** The use of limited ecological data can be extended with the assumption that ecosystems with similar streamflow attributes and geomorphic characteristics respond similarly to flow alteration. A regional river classification system would allow states to supplement their own limited data for flow-ecology relationships with information from other states. To support instream flow standards, a classification system for southern aquatic ecosystems is needed that is based initially on ecologically-relevant streamflow characteristics. It should support subclassifications based on other factors that influence how biota respond to hydrologic alteration, such as water temperature and channel form and materials. Ideally such a river classification system could be integrated with similar classification efforts in the northeast and the national data being developed under the National Fish Habitat Action Plan.

2. **Identify commonalities in ecosystem responses to flow alterations:** Given the complexity of aquatic ecosystems and the difficulty in developing comprehensive descriptions of flow-ecology relationships, there is a need to focus limited research resources. Flow regime components need to be identified that are most likely to be altered under common influences in the southern landscape, including depletion by withdrawals, augmentation by interbasin transfers, and change from various types of reservoir operations such as hydropeaking, flood

control, and water supply. Components of the aquatic ecosystems most sensitive to these flow alterations need to be identified as well. Relevant ecological data can be compiled in the context of these types of alteration (Research Item #3) and then used to test scientific hypotheses about flow alteration – ecological response relationships (Research Items #4 and 5). Care should be taken to focus research on flow conditions that can be managed by instream flow standards in water management planning and regulatory programs.

3. **Compile regional aquatic ecology data sets:** A critical step in developing instream flow standards is to demonstrate ecological responses to alterations in the flow regime. Limits to flow alterations can then be set based on acceptable levels of ecological impacts. While flow regimes can be quantified, ecological information about riverine biota, geomorphology, water quality, and other processes is widely scattered, inconsistent, and difficult to access relative to measures of flow alteration. A compilation of regional ecological data sets would provide information to form and test flow-ecology hypotheses (Research Item #4), as well as allow the identification of information gaps and development of guidelines to improve the comparability of future study results. The ecological data compilation would leverage and broaden the use of local information to support stronger flow-ecology relationships across classes of rivers (Research Item #1).

4. **Develop hypotheses for regional ecological responses to flow alteration:** A holistic suite of flow-ecology relationships demonstrating responses to a gradient of altered flow regimes in the region (Research Item #2) form the scientific basis for setting ecological limits of hydrologic alteration for a class of rivers. Very few of these relationships have been identified, however, which limits the ability of southern states to substantiate state instream flow standards. The holistic suite of relationships should address all aspects of the ecosystem that are sensitive to flow alteration such as fish, macroinvertebrates, riparian vegetation, and other biota, as well as channel morphology, nutrient exchange, and other physical and chemical processes. An iterative process of developing hypothetical flow-ecology relationships to inform data synthesis (Research Item #3) and design of field studies (Research Item #5) needs to be established, which in turn will improve the flow-ecology relationships and the science supporting instream flow standards.

5. **Perform field studies to test ecological responses to altered flow regimes:** The objective of instream flow standards is to manage alterations to flow regimes and limit the associated ecological degradation. Rivers are complex ecosystems, and ecological degradation occurs in response to many changes in the environment. The hypothetical relationships between ecological conditions and flow alterations developed in Research Item #4 should help isolate flow as the cause of change. Field studies will confirm or refute these hypothetical relationships and strengthen the basis for instream flow standards to limit flow alteration. As discussed above, few of these studies exist. Many more studies are needed across a gradient of altered flow conditions that are common in southern rivers, such as due to various dam

operations, extractions, or augmentation from interbasin transfers. In addition, these studies need to address the holistic suite of flow-ecology relationships identified in Research Item #4 and across the range of river classes identified in Research Item #1.

Additional Needs Beyond Research

It is important to note that these priority research topics reflect the scientific topics discussed at the workshop. They do not include other information needs such as hydrologic modeling or the better understanding of the socio-political process involved with developing instream flow standards. In addition to research, workshop participants strongly supported development of communication tools. Messaging that links the flow-ecology relationships with stakeholder values were seen as very important. In addition, strong support was expressed at the workshop for the continuation of the Southern Instream Flow Network and its efforts to educate and facilitate exchange of information among water resource managers of the south.

Meeting Regional Instream Flow Research Needs

The five priority research topics provide an outline of the tasks necessary to form an integrated body of scientific information to support recommendations for state instream flow standards. This approach is consistent with the Ecological Limits of Hydrologic Alteration (ELOHA) process for determining instream flow standards, which is promoted by internationally respected scientists in instream flow ecology (Poff et al. 2009). The value of this body of information is in the development, testing, and feedback of results from the various tasks that refine and improve our understanding of how riverine ecological conditions change with altered hydrologic regime. It is important, therefore, to address all of these tasks in a coordinated fashion in a regional, long-term plan. To ensure sustainable results that are applicable to water resource management needs, the plan needs to be implemented by a partnership of funding agencies, water resource managers, researchers, and stakeholders.

The Southern Instream Flow Network has taken the lead in coordinating initial efforts to develop an instream flow research plan and program for southern states. The initial approach is to work with network members and other partners to raise awareness of potential funders and research associates about this effort and obtain their involvement. As Research Items #1-4 can be initiated this year, SIFN will coordinate these efforts using available resources, funds, and in-kind services from network members and other partners. Increased support for these efforts will be sought. Research Item #5 is fundamental to the success of the instream flow research program and is a long-term undertaking by researchers across the region. Results of the flow-ecology studies will feedback to inform and improve results from the other tasks. To meet long-term needs, efforts by SIFN and partners will also focus on establishing a Southern Instream Flow Research Program as early as January 2011.

The immediate, short and long-term objectives and needs identified below constitute an initial plan to meet the goals and objectives of the Southern Instream Flow Research Agenda. This plan will be reviewed and improved through the next few months.

Immediate need (by June 2010):

1. **Prepare budgets to fund instream flow research in FY 11 –** As tasks and products are identified and initiated under the research agenda, we anticipate that funding will need to be dedicated to continue and expand instream flow research. *We request that federal and state agencies review this agenda for where their mission and expertise allows participation and, if possible, to prepare budgets for FY11 that identify instream flow research as a priority.* Direct funding will be needed. In addition, commitment of resources and expertise for in-kind services will be needed as well.

2. **Initiate collaboration with regional researchers to develop flow alteration – ecological response hypothetical relationships and implement field studies to test them –**Researchers in federal, state and private research institutions have expressed interest in this research effort as it has a theoretical component that can inform applied, resource management problems in the region. The ability to collaborate across disciplines and leverage resources is an added benefit of directing some portion of their research programs to this effort. *Auburn University and other partners will assist SIFN in promoting the Southern Research Agenda to research institutions around the region and developing a collaborative effort focused on the priority instream flow research topics identified here.*

3. **Obtain initial commitment of resources to initiate development of regional river classification system (Research Item #1), identification of common hydrologic threats (Research Item #2), and the compilation of the aquatic ecology data base (Research Item #3) –** The first three research items are necessary elements to proceeding with the last two tasks. The information and resources may be available to begin these tasks in 2010. *We request that USFWS initiate a cooperative agreement with USGS to develop the regional river classification system. We also commit that SIFN uses existing resources to coordinate regional efforts to initiate Research Items #2-4 in a series of WebEx's and the Third Annual SIFN Workshop in the late fall 2010.*

Short-term Tasks and Needs (By December 2010)

1. Expand on efforts to secure funding and research interest in the Southern Instream Flow Research Agenda

2. Secure funding to extend funding for the Southern Instream Flow Network for three years (current funding expires in December 2010)

Long-term Goal

The Southern Instream Flow Research Program would serve to

- promote instream flow research in the region,
- serve as a clearing house for regional instream flow information,
- facilitate communications among state water resource managers, and
- help ensure protective instream flow standards are adopted by southern states .

A program coordinator would be responsible for developing and managing a work plan and research budget in coordination with a new Southern Instream Flow Research Consortium. The work plan objectives would be guided by the priority instream flow research topics identified above. The research budget would be funded by members of the research consortium. The research consortium would be comprised of federal, regional, and state water resource managers and researchers with interest in protecting the aquatic resources of the 15 states in the Southeastern Association of Fish and Wildlife Agencies. The Southern Instream Flow Network would become a part of the research program and continue in much the same manner to ensure coordination and communication with state water resource managers.

Outcomes and Benefits

The primary outcome of the Southern Instream Flow Research Agenda is to focus research and funding resources on the scientific products needed to inform credible, defensible, enforceable instream flow standards throughout the southeastern US. The regional approach will leverage limited resources to benefit many states as they work to develop or improve their instream flow standards. Timing is critical. As southern states are moving forward with water supply planning, the results of improved information will have a direct influence on the protection of southern rivers. A delay means a missed opportunity to protect the most diverse aquatic fauna and flora in North America.

MULTISTATE AQUATIC RESOURCES INFORMATION SYSTEM

www.marisdata.org

Integrating State Data into the National Fish Habitat Assessment

To address the need for quantitative aquatic species information over large geographic scales, the Multistate Aquatic Resources Information System (MARIS) initiative is currently being conducted by 11 states (Georgia, Illinois, Indiana, Iowa, Maryland, Michigan, Minnesota, Pennsylvania, New Jersey, New York, Wisconsin, and Wyoming). MARIS is designed to link existing aquatic databases of several states and to make that information accessible in a common format via the Internet. Each state maintains authority and responsibility for its own database, but supports Internet access through a defined set of summary queries and reports.

MARIS States (2010)

Beyond the strong collaborative working relationships between agencies, a unique feature of MARIS is the goal for implementing connections between data servers in each state and the centralized query server. This system alleviates many requests directly to states for data and greatly enhances utilization of data from multiple agencies.

DOES MARIS WORK?

One implication of this project is the ability to compile and compare status and trend information on aquatic species at larger geographic scales. An initial analysis of the system conducted by the U.S. Forest Service determined that the data available through MARIS was conducive to meeting this objective. Further analysis to link the information to existing physical/chemical databases, land use databases, GIS systems, etc. will provide agencies the capability of evaluating the effects of various management projects, land use decisions, climate change impacts, fish passag projects, and other factors on aquatic systems over larger inter-jurisdictional scales. The initial states in th MARIS project expressed willingness to work together and with the federal agencies, thus are establishing a template for data sharing that may be adopted by othe states that recognize the need and advantages of compatible information systems across the country.

BENEFITS OF PARTICIPATION

The MARIS initiative is a true example of the accomplishments that can be achieved through strong cooperative relationships between state and federal agencies. State agencies directly benefit by improving their internal system of data management and ultimately more streamlined and cost efficient programs. Financial support is generally provided to states to assist them in strengthening their internal fisheries information management systems. Additionally, MARIS states benefit greatly from interaction and exchange of ideas with other states and with from the technical expertise available from three research institutions currently under contract to conduct MARIS work, including the University of Iowa Geographic Modeling Systems Laboratory which houses the MARIS system.

All agencies benefit by gaining access to quality data on the status and trends of aquatic species across jurisdictional boundaries. Available data extends from the 1930s to the present in some states. The value of data that can be made available nationwide, when taking into account the time and effort expended on data collection, analyses, and compilation, is immeasurable. Based on current annual fisheries expenditures, this would be in the billions of dollars over a period of years. At the 1998 *Freshwater Fisheries Database Summit* attended by 47 state agencies, participants identified the MARIS model as one that should be explored and developed further.

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MARIS Definitions:The purpose of the FISH_INFO table is to provide information unique to the collection of fish and aquatic organisms during a specified sampling event.			Link dates of sampling to sampling locations by the unique keys. STATE+ORIGINATOR+WATER_ID for entire waterbodies or STATE+ORIGINATOR+WATER_ID+STATION_ID for sampling smaller areas within a waterbody.
This table last revised 9-30-2010			
Revised Field Name	**Caption**	**Revised Data Type**	**Revised Description**
STATE	State	Text 2	Mandatory - State Postal Code Abbreviation.
ORIGINATOR	Data Provider	Text 8	Mandatory - Agency and unit providing this data (e.g.,
WATER_ID	Water ID	Text 255	Mandatory - State-specific unique identifier for a waterbody (lake or stream). Primary linkage between
STATION_ID	Station ID	Text 255	An ID to identify a specific sampling site (e.g., a stream segment) - designated by the state. For stream segments or smaller areas within a large lake, the
SAMPLE_BEGIN_DATE	Sample Begin Date	Date/Time	Mandatory - Date of the beginning of data collection for the sampling event in MM/DD/YYYY format.
SAMPLE_END_DATE	Sample End Date	Date/Time	Mandatory - Date of the end of data collection for the sampling event in MM/DD/YYYY format. If sample is taken within a single day, SAMPLE_BEGIN_DATE is
TARGET	Target Species	Text 255	Species or species group code of fish targeted during the sampling effort, not standardized among states
TARGET_STD	Target Standard	Text 255	General standardized target group to separate fish community sampling from other sampling ("ALL", "TARGET", or "UNKNOWN"). ALL = the intent of the sample was that all fish observed were recorded or
STATE_SPECIES	Original state species code	Text 255	Mandatory - The original code used to designate the species in the state database - unique to each state.
MARIS_FISHSPECIES_I	Maris	Number	Auto generated number in MARIS lookup table for each
ITIS_TSN	ITIS Species Code	Number (Double)	Integrated Taxonomic Information System, Taxonomic Serial Number for fish species. Hyrbids will be assigned the family TSN. States only need to populate
GEAR_TYPE1	Gear Type Primary	Text 2	General standardized primary gear type category used in fish collection (FN = Fyke Net, TN=Trap Net, GN=Gill Net, PN=Pound Net, EL=Electrofishing, SE=Seine, TR=Trawl, EP=Eel pot, FP=Fish Pot,CP=Crab Pot,
GEAR_DESC1	Gear Description	Text 255	Detailed description of Primary gear used in fish collection (state specific, not standardized).
GEAR_TYPE2	Gear Type Secondary	Text 2	If more than 1 gear is used, the general standardizedSecondary gear type category used in fish collection (FN = Fyke Net, TN=Trap Net, GN=Gill Net, PN=Pound Net, EL=Electrofishing, SE=Seine,
GEAR_DESC2	Gear Description	Text 255	If more than 1 gear is used, the detailed description of the Secondary gear used in fish collection (state
TOTAL_CATCH	Total Catch	Number (Double)	Total number of fish caught in sample. If species occurrence is noted but not enumerated, this field
TOTAL_WEIGHT	Total Weight	Number (Double)	Total weight (kilograms) of fish caught in sample for surveys where all fish were weighed. If species
EFFORT_TIME	Time Fished	Number	Total duration of sampling effort, not including

Revised Field Name	Caption	Revised Data Type	Revised Description
TIME_UNITS	Time Unit	Text 10	State standard unit of time for sampling effort (HOURS, DAYS, NETNIGHTS, HAULS)
EFFORT_AREA_DIST	Sample Area or Distance	Number (Double)	Total area or distance sampled.
AREA_DIST_UNITS	Area or Distance Unit	Text 10	State standard unit of space (area or distance) for sampling effort (METERS, MILES, HECTARES,
CPUE_TIME	CPUE (Time)	Number (Double)	Catch Per Unit Effort Time. The total number of fish caught per standard unit of time - TOTAL_CATCH/EFFORT_TIME for a single gear type.
CPUE_SPACE	CPUE (Space)	Number (Double)	Catch Per Unit Effort Space. The total number of fish caught per standard unit of space (TOTAL_CATCH/EFFORT_AREA_DIST) for a single
BPUE_TIME	Biomass CPUE (Time)	Number (Double)	Catch Per Unit Effort Time Biomass. The total weight of fish caught per standard unit of time (TOTAL_WEIGHT/EFFORT_TIME) for a single gear
BPUE_SPACE	Biomass CPUE (Space)	Number (Double)	Catch Per Unit Effort Space Biomass. The total weight of fish caught per standard unit of space (TOTAL_WEIGHT/EFFORT_AREA_DIST) for a single
POP_EST	Population	Number	Population abundance estimate.
POP_EST_METHOD	Population Estimation Method	Text 5	Sampling method used to estimate population abundance (SCMR, MCMR, DEP, or OTHER). SCMR = Single Census Mark-Recapture MCMR = Multiple
POP_EST_MODEL	Population Estimation	Text 25	Population abundance estimator used. Choices include CHAPMAN, PETERSON, SCHNABEL, DE LURY,
POP_EST_AREA	Population Estimate	Text 10	Population estimate is for the entire waterbody or a smaller area of the waterbody. Choices ENTIRE, or
POP_EST_MEASURE	Population Estimate Area/Distanc	Number (Double)	For subsections of the waterbody, linear or areal distance for which the population estimate is measured (e.g., 1000)
POP_EST_MEASURE_UNITS	Population estimate	Text 10	Units used to measure POP_EST_MEASURE (METERS, MILES, HECTARES, KILOMETERS,
BIOMASS_EST	Biomass Estimate	Number (Double)	Biomass Estimate for sample reach. Sampling technique and estimator used is specific to the state.
SAMPLE_DESC	Sample	Memo	A brief description of sampling event.

FishTraits: A Database of Ecological and Life-history Traits of Freshwater Fishes of the United States. Emmanuel A. Frimpong and Paul L. Angermeier. Department of Fisheries & Wildlife Sciences, Virginia Polytechnic Institute & State University, Blacksburg, VA 24061-0321, Email: frimp@vt.edu, Phone: 540-231-6880

The FishTraits homepage (see www.cnr.vt.edu/fisheries/fishtraits)

We have compiled a database of > 100 traits for 809 (731 native and 78 nonnative) fish species found in freshwaters of the conterminous United States, including 37 native families and 145 native genera. The database, named FishTraits, contains information on four major categories of traits: (1) trophic ecology; (2) body size, reproductive ecology, and life history; (3) habitat preferences; and (4) salinity and temperature tolerances.

Species identifiers
SID: A unique identification for the species.
ALTSID: Alternate species identification.
FID: Family identification
GENUS: Genus name recognized by the AFS (Nelson et al. 2004).
SPECIES: Species name recognized by the AFS (Nelson et al. 2004).
GID: Genus identification
COMMONNAME: Common name recognized by the AFS (Nelson et al. 2004).
OTHERNAMES: Other common names encountered in accounts of the species.
NATIVE: Binary. Native status, as determined from the online database of non-indigenous species (Nico and Fuller 1999).
NOTES: A unique species number for footnotes and annotations.

Trophic ecology traits
NONFEED: Binary. Adults do not feed.
BENTHIC: Binary. Benthic feeder.
SURWCOL: Binary. Surface or water column feeder.
ALGPHYTO: Binary. Algae or phytoplankton, including filamentous algae.
MACVASCU: Binary. Any part of macrophytes and vascular plants.
DETRITUS: Binary. Detritus or unidentifiable vegetative matter.
INVLVFSH: Binary. Aquatic and terrestrial invertebrates including zooplankton, insects, microcrustaceans, annelids, mollusks, etc. Also includes larval fish.
FSHCRCRB: Binary. Larger fish, crayfish, crabs, frogs, etc.
BLOOD: Binary. For parasitic lampreys that feed mainly on blood.
EGGS: Binary. Eggs of fish, frogs, etc.
OTHER: Binary. Other diet components distinct from the preceding classes.

Body size and reproductive ecology (life history) traits
MAXTL: Continuous. Maximum total length in centimeters.
MATUAGE: Continuous. Mean, median, or modal age at maturity in years for females.
LONGEVITY: Continuous. Longevity in years based on life in the wild wherever available.
FECUNDITY: Count. Maximum reported fecundity.
SERIAL: Binary. Serial or batch spawner.

JAN–DEC: Continuous. The proportion of the month in the species' spawning season.
SEASON: Continuous. The sum of the proportions of each month in which spawning occurs.
REPSTATE: Categorical. Representative state (or region) whose account was used to record spawning season.
A_1_1: Binary. Nonguarders; Open substratum spawners; Pelagophils.
A_1_2: Binary. Nonguarders; Open substratum spawners; Litho-pelagophils.
A_1_3A: Binary. Nonguarders; Open substratum spawners; Lithophils (rock-gravel).
A_1_3B: Binary. Nonguarders; Open substratum spawners; Lithophils (gravel-sand).
A_1_3C: Binary. Nonguarders; Open substratum spawners; Lithophils (silt-mud).
A_1_4: Binary. Nonguarders; Open substratum spawners; Phyto-lithophils .
A_1_5: Binary. Nonguarders; Open substratum spawners; Phytophils.
A_1_6: Binary. Nonguarders; Open substratum spawners; Psammophils.
A_2_3A: Binary. Nonguarders; Brood hiders; Lithophils (rock-gravel).
A_2_3B: Binary. Nonguarders; Brood hiders; Lithophils (gravel-sand).
A_2_3C: Binary. Nonguarders; Brood hiders; Lithophils (mud).
A_2_4A: Binary. Nonguarders; Brood hiders; Speleophils (rock cavity).
A_2_4C: Binary. Nonguarders; Brood hiders; Speleophils (cavity generalist: rocks crevices, but also under log bark, openings in vegetation, metal cans, etc.).
B_1_3A: Binary. Guarders; Substratum choosers; Lithophils.
B_1_4: Binary. Guarders; Substratum choosers; Phytophils.
B_2_2: Binary. Guarders; Nest spawners; Polyphils.
B_2_3A: Binary. Guarders; Nest spawners; Lithophils (rock-gravel).
B_2_3B: Binary. Guarders; Nest spawners; Lithophils (gravel-sand).
B_2_4: Binary. Guarders; Nest spawners; Ariadnophils.
B_2_5: Binary. Guarders; Nest spawners; Phytophils.
B_2_7A: Binary. Guarders; Nest spawners; Speleophils (rock cavity/roof).
B_2_7B: Binary. Guarders; Nest spawners; Speleophils (bottom burrows or natural holes associated with structure or bank).
B_2_7C: Guarders; Nest spawners; Speleophils (cavity generalist).
C1_3_4_C2_4: Binary. A lumping of all bearers. may also be regarded as substrate-indifferent.

Habitat preference traits
MUCK: Binary. Muck substrate.
CLAYSILT: Binary. Clay or silt substrate.
SAND: Binary. Sand substrate.
GRAVEL: Binary. Gravel substrate.
COBBLE: Binary. Cobble or pebble substrate.
BOULDER: Binary. Boulder substrate.
BEDROCK: Binary. Bedrock substrate.
VEGETAT: Binary. Aquatic vegetation.
DEBRDETR: Binary. Organic debris or detrital substrate.
LWD: Binary. Large woody debris.
PELAGIC: Binary. Open water.
PREFLOT: Binary. Lotic and lentic systems but more often in lotic.
PREFLEN: Binary. Lotic and lentic systems but more often in lentic.
LARGERIV: Binary. Medium to large river.

SMALLRIV: Binary. Stream to small river.
CREEK: Binary. Creek.
SPRGSUBT: Binary. Spring or subterranean water.
LACUSTRINE: Binary. Lentic systems.
POTANADR: Binary. Potamodromous or anadromous.
LOWLAND: Binary. Lowland elevation.
UPLAND: Binary. Highland elevation.
MONTANE: Binary. Mountainous physiography.
SLOWCURR: Binary. Slow current.
MODCURR: Binary. Moderate current.
FASTCURR: Binary. Fast current.

Salinity and temperature tolerances
EURYHALINE: Binary. Species with wide salinity tolerance.
MINTEMP: Continuous. The 30-year average minimum January temperature at range centroid in degrees Celsius.
MAXTEMP: Continuous. 30-year average maximum July temperature at range centroid in degrees Celsius.

Geographic distribution
AREA: Continuous. Range area in square kilometers.
PERIMETER: Continuous. Range perimeter in kilometers.
PATCHES: Count. Number of separate patches in the distribution map.
LATRANGE: Continuous. Latitudinal range of species in kilometers.
LONRANGE: Continuous. Longitudinal range of species in kilometers.
LONGCENTROID: Continuous. Longitude at range centroid in decimal degrees.
LATCENTROID: Continuous. Latitude at range centroid in decimal degrees.

Conservation status
LISTED: Binary. Listed as endangered, threatened, of special concern.
REASON: Categorical. Endangered (E), Threatened (T), Special Concern (SC), or subspecies listed as any of these categories (SUB).
LIST1: Binary. Present or threatened destruction, modification, or curtailment of habitat or range.
LIST2: Binary. Overuse for commercial, recreational, scientific, or educational purposes.
LIST3: Binary. Disease.
LIST4: Binary. Other natural or anthropogenic factors affecting persistence (hybridization, exotic or transplanted species, predation, competition)
LIST5: Binary. Small range.
EXTINCT: Categorical.

NEW MARIS TABLE PURPOSE: The purpose of the SIZE AND AGE table is to capture information on those parameters collected in conjunciton with a specific sampling event. The table is prototype.

NOTE: This table is a prototype table designed to facilitate the use of MARIS for the Southern Instream Flow Network (SIFN). At this time, MARIS states **ARE NOT being asked to complete it** since it will undergo revisions. Before finalizing, the MARIS working group will need to evaluate and approve it. Inclusion of this table is primarily as a placehoder at the moment. These fields were suggested by a cpnsortium of states in the SIFN. NOTE: This table will be used in conjunction with other MARIS tables, so additional information (e.g., collection methodology, etc.) from those tables will be linked to records from this table. Refer to the other MARIS tables for descriptions of those additional variables. COMMENTS ON THIS TABLE ARE WELCOME!

This table last revised 11-19-2010

Field Name	Caption	Data Type	Description
STATE	State	Text 2	Mandatory - State Postal Code Abbreviation.
ORIGINATOR	Data Provider	Text 8	Agency and unit providing this data (e.g., MN DNR, PFBC)
WATER_ID	Water ID	Text 255	Mandatory - State-specific unique identifier for a waterbody (lake or stream). Primary linkage between Waterbody information and other MARIS tables.
STATION_ID	Station ID	Text 255	An ID to identify a specific sampling site (e.g., a stream segment) - designated by the state. For stream segments or smaller areas within a large lake, the Station_ID is also used to link the LOCATION information to the FISH INFO and WATER CHARACTERISTICS tables.
SAMPLE_BEGIN_DATE	Sample Begin Date	Date/Time	Mandatory - Date of the beginning of data collection for the sampling event in MM/DD/YYYY format.
SAMPLE_END_DATE	Sample End Date	Date/Time	Mandatory - Date of the end of data collection for the sampling event in MM/DD/YYYY format.
STATE_SPECIES	Original state species code	Text 255	Mandatory - The original code used to designate the species in the state database - unique to each state.
SIZE_MIN	Minimum Size	Number (double)	Minimum size specimen in sample
SIZE_MAX	Maximum Size	Number (double)	Maximum size specimen in sample
SIZE_MEAN	MeanSize	Number (double)	Mean size of sample
SIZE_MEDIAN	Median Size	Number (double)	Median size of sample
SIZE_N	Sample Size for Length	Number (double)	The sample size from which the length parameters were determined
SIZE_UNITS	Length Measurement Units	Text (2)	Standard used for measuring fish length (mm=millimeters, , cm=centimeters, in=inches.)
MEAS_TYPE	Type of measurment	Text 8	Method of measuring the length of fish (TL=total length; FL=Fork Length; SL=Standard Length)
AGE_MIN	Minimum Age	Number (double)	Minimum age specimen in sample
AGE_MAX	Maximum Age	Number (double)	Maximum age specimen in sample
AGE_MEAN	Mean Age	Number (double)	Mean age of sample
AGE_MEDIAN	Median Age	Number (double)	Median age of sample
AGE_N	Sample Size for Age	Number (double)	The sample size from which the age paramters were determined
AGE_TYPE	Aging Method	Text 8	Method used to age fish (SC=scales; OTO=Otoliths, SP=Spine; BC=Back calculated, COMB=combination, OTHER=other

This table last revised 11-19-2010

SE RIVER CLASSIFICATION

Parameters and Categories

Your Name:

State:

Ecoregions:

Parameter	**Range of values**	**Suggested categories**	**Priority (h, m, l)**
Hydrologic type			
Elevation			
Slope	<0.01 % >=0.01 < 0.1% >=0.1 < 1% > = 1 < 5% >5%	Very low gradient Low gradient Mod. gradient High gradient Very high gradient	
Drainage Area (stream size)	<100 km2 >=100 < 1000 km2 >1000 < 10,000 km2 >10,000 < 100,000 km2 >100,000 km2	Headwater streams Small rivers Medium rivers Large rivers Very large rivers	
Mean annual flow (stream size)			
Watershed yield (MAF/DA)			
Area-weighted mean annual precipitation			
Area-weighted mean annual air temp (water temperature)		Cold Cool Warm	
Wetland land cover types from NWI			
Valley floor/floodplain extent (delineated using ARA and/or			

TPI)			
Geology (presence of limestone)			
Geology (presence of highly or moderately erodible rock types)			
Soils permeability			
Soils erodibility			
Soil texture			
Ecological Drainage Unit			
Other (specify)			

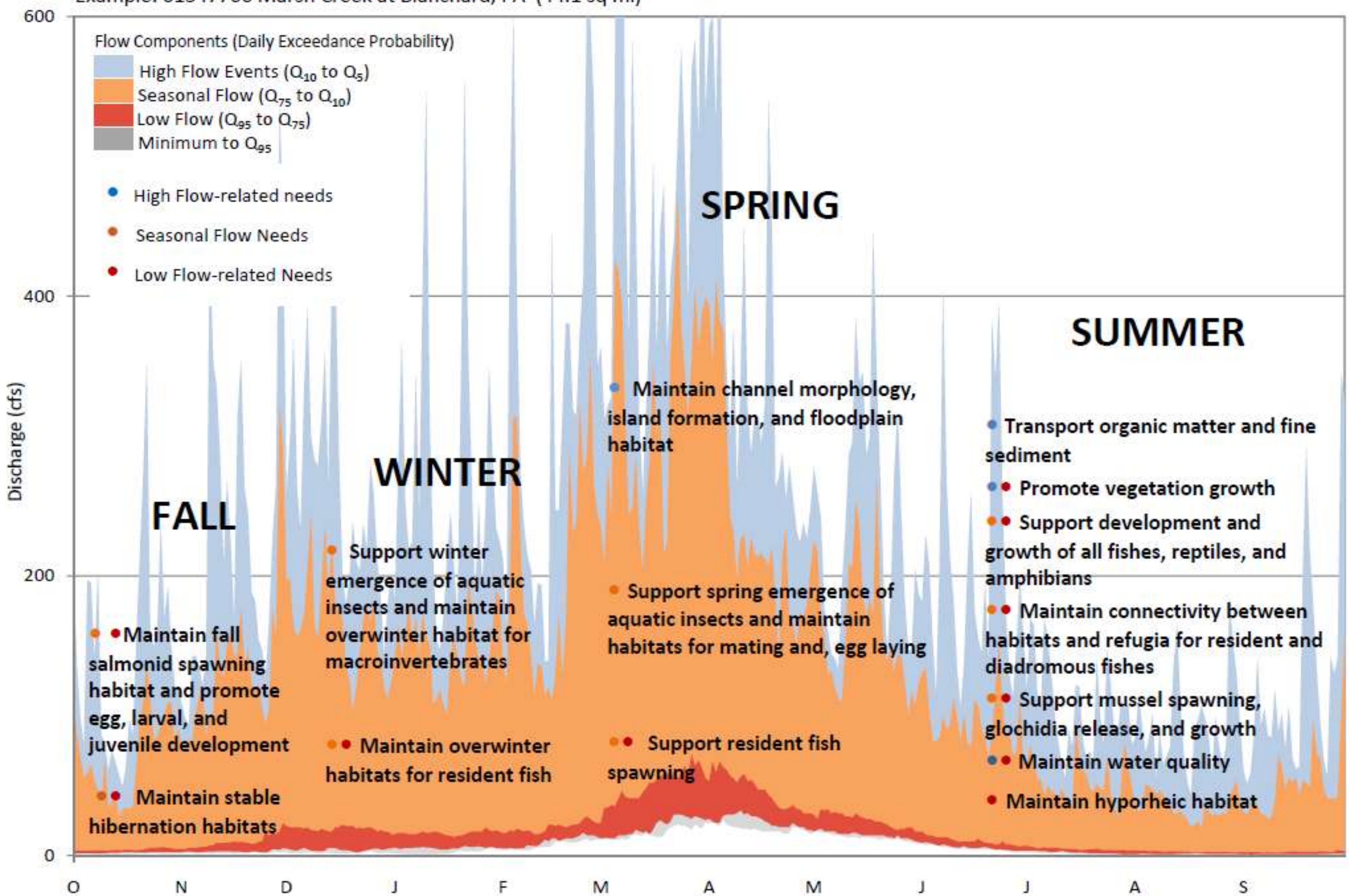
Sources of hydrologic alteration (USGS Water Use categories and NID reservoir operations)	Measures of hydrologic alteration											
	Mean January flow (cfs)	Mean April flow (cfs)	Mean July flow (cfs)	Mean October flow (cfs)	Mean annual minimum 7-day flow (cfs)	Mean annual maximum 7-day flow (cfs)	Mean annual frequency that Q25 is exceeded	Mean annual frequency of flow less than Q75	Mean number of flow rises	Mean fall rate		
Consumptive use												
Commercial Water Use – 38												
Domestic Water Use – 57												
Industrial Water Use – 71												
Thermoelectric Power Water Use (All fuel types) – 88												
Mining Water Use – 158												
Livestock Water Use (Total) – 171												
Irrigation Water Use –207												
Land use												
Natural												
Urban												
Agriculture												
Other												
Reservoir operations (National Inventory of Dams)												
Flood control												
Water supply												
Navigation												
Power generation												
Reservoir Evaporation (Data only for HUCs) - in thousand acre-feet 234												
Other water use measures												

Wastewater Treatment - Returns by public wastewater facilities 227												

Sources of ecologically relevant measures of hydrologic alteration in southeastern rivers. Each source will be scored for the relative degree (# of symbols) and direction of change (-, 0 +) in the hydrologic measure (an example is provided for public surface water supply). Consumptive water use is included as what may be a better alternative source of alteration to simply using surface and ground water withdrawals. Data from the USGS Water Use Reports may or may not be adequate to assess potential alterations to hydrologic regimes, depending on the assessment unit (i.e., stream reach or county).

Flow Components and Needs: Cold and Cool Headwaters and Small Streams

Example: 01547700 Marsh Creek at Blanchard, PA (44.1 sq mi)



Landscape Conservation Cooperatives

Shared Science for a Sustainable Future

America's natural systems and landscapes are impacted by increasing land use pressures and widespread resource threats such as habitat fragmentation, invasive species, and water scarcity. These changes are occurring at an unprecedented pace and scale and are amplified by a rapidly changing climate. By leveraging resources and strategically targeting science to inform conservation decisions and actions, Landscape Conservation Cooperatives (LCCs) are a network of partnerships working in unison to ensure the sustainability of America's land, water, wildlife and cultural resources.

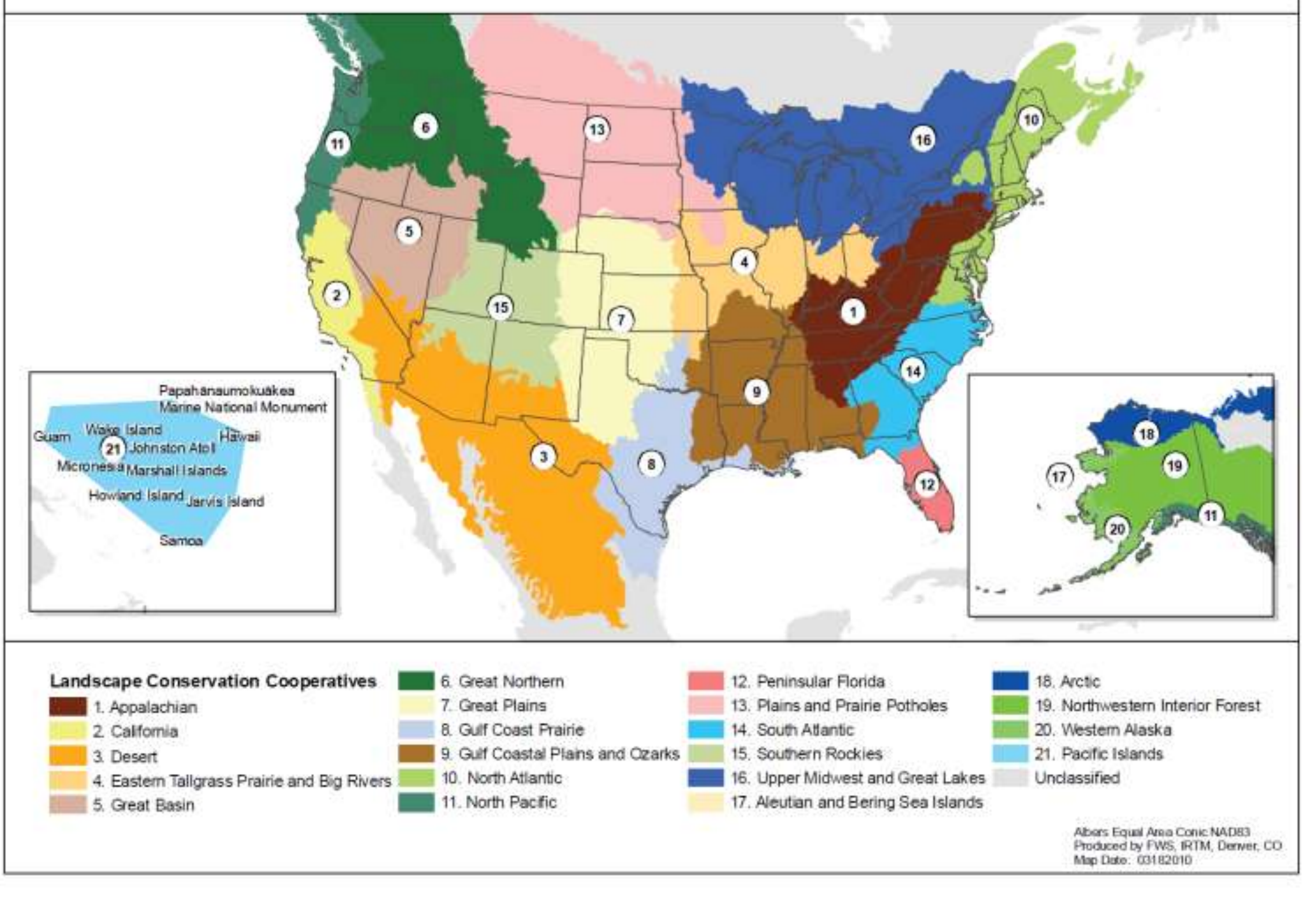
Facilitated by the Department of the Interior (DOI) as part of its collaborative, science-based response to climate change, LCCs complement and build upon existing science and conservation efforts—such as fish habitat partnerships and migratory bird joint ventures—as well as water resources, land, and cultural partnerships.

Each LCC operates within a specific landscape—21 geographic areas in total. Partners include federal, state, and local governments, tribes, universities, nongovernmental organizations, landowners, and other stakeholders.

Collectively, LCCs form a network of land, water, wildlife and cultural resource managers, scientists, and interested public and private organizations—within the U.S. and across our international borders—that share a common need for scientific information and interest in conservation.

By functioning as a network of interdependent units rather than independent entities, LCC partnerships can accomplish more together than any single agency or organization can alone.

Landscape Conservation Cooperatives



Core functions include:

- Identifying common science and conservation goals and priorities
- Developing science-based tools and solutions to meet shared conservation goals
- Supporting biological planning, conservation design and adaptive management
- Evaluating the effectiveness of scientific information and conservation actions.

Key Components

Each LCC will be guided by a steering committee with members from resource management and science agencies (federal, state, tribal and local). Nongovernmental organizations, universities, industry and others may contribute to the cooperative effort and may be part of the steering committee in some LCCs. Core staff will include a Coordinator and Science Manager for each LCC. Other staff supported by the partnership could include individuals with expertise in applied science (applying research results to the design, implementation, monitoring, and assessment of conservation actions), as well as geographers, GIS specialists, biometricians, cultural resource specialists and outreach specialists.

LCC products may include: resource assessments, climate model applications to appropriate scale, vulnerability assessments, inventory and monitoring protocols, and conservation plans anddesigns. Many of these products will be developed collaboratively with DOI Climate Science Centers and other science providers (e.g., USGS Science Centers, Forest Service Research Stations, and universities). LCCs can be a particularly useful resource for states as they revise their State Wildlife Action Plans. States could use the products generated by LCCs to identify priority resource management issues, gaps in scientific knowledge, data sharing needs and strategies for adaptation to climate change and other large-scale landscape stressors.

By functioning as a network of interdependent units rather than independent entities, LCC partnerships can accomplish more together than any single agency or organization can alone.

Conservation in Action

With an initial federal investment of $25 million in 2010, nine LCCs have been established across the country. These include the Arctic, Great Northern, Great Plains, North Atlantic, South Atlantic, Pacific Islands, Plains and Prairie Potholes, Gulf Coastal Plains and Ozarks, and California regions.

Across the nation, LCCs are already developing collaborative science projects to inform conservation decisions and actions. Here are a few examples of funded projects:

- In California's San Francisco estuary, climate experts have recently identified habitats most in need of conservation—those supporting the most diverse group of species and that are most vulnerable to impacts of climate change. In 2010, the California LCC will share this information with local conservation practitioners and land use planners in a report depicting those areas where conservation actions and protection will be most beneficial. From this report, a range of online decision tools will be developed, including GIS software.
- In the Northeast, partners have identified the need for conservation design tools that predict changes in stream flow and temperature due to climate change and the impacts of those changes on fish and wildlife species. The North Atlantic LCC is funding several complementary projects that address these needs and build on research already being conducted by academia, nongovernment organizations and states in the region. The projects will enable partners to consider climate impacts when identifying priority conservation actions and incorporate them into comprehensive landscape conservation plans.
- Climate change models suggest less summer precipitation and drier conditions in the prairie potholes region of Montana, a key habitat area for migratory birds, including many grassland bird species. The Plains and Prairie Potholes LCC is conducting a multi-scaled, spatial analysis linking focal grassland bird populations to specific habitat conditions and management practices.

In the face of accelerating climate change and other 21st-century conservation challenges, LCCs will continually seek out new scientific information, assess the effectiveness of conservation actions and make necessary adjustments as new information becomes available. This recurring feedback process will help scientists and resource managers deal with uncertainties on the landscape and transform new knowledge into more effective conservation plans and actions on the ground.

For more information on the national LCC network, visit
http://go.usa.gov/xd0
or contact Doug Austen
National LCC Coordinator
U.S. Fish and Wildlife Service
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