**Brook Trout Related Research Projects**

**Catchment Scale Brook Trout Status Assessment**

Project Leaders: Mark Hudy (USGS), Amanda Colton (USFS), and Jason Coombs (UMass)

In 2011, the EBTJV began updating its range wide brook trout status assessment at the catchment scale. The assessments for the mid-Atlantic and southern states have been completed and the analysis of the data sets provided by the northern states is underway, with a completion date expected by May, 2014.

**Brook Trout Habitat Patch Layer**

Project Leaders: Mark Hudy (USGS) and Jason Coombs (UMass)

The end products of this work will be NHD+ layer with brook trout occurrence and brook trout patch layer at the catchment scale. This tool will enable retrospective analysis by producing patch layers through time and quantifying patch loss. A framework for future analysis using occupancy models that result in the capability to assign catchments with the probability of having brook trout present.

* “Patch” = a group of contiguous catchments occupied by wild brook trout. Patches are not connected physically either due to fish passage barriers, warm water habitat, or downstream invasive species. Patches are assumed to be genetically isolated populations.
* “Patch Populations” - number of patches = 2,698; average size = 1,541 ha; median size = 855 ha.
* Patch Metrics (based on occupancy sampling of catchments) - number of patches; number of patches with increasing size/connectivity (additional upstream and downstream catchments with brook trout); number of patches decreasing in size/connectivity (loss of catchments); average patch size of the entire resource; and, number of patches with allopatric or sympatric (with brown or rainbow) populations.

Need: to have a system that utilizes the catchment scale brook trout assessment data to identify priority areas for brook trout conservation actions (protection, enhancement, and restoration).

* The Chesapeake Bay Program is considering using allopatric brook trout catchments, Audubon priority forest blocks, and state identified healthy watersheds to identify priority areas as well as using oil and gas well locations and climate change vulnerability maps associated with the subwatershed brook trout status assessment.
* At the subwatershed scale, EBTJV uses a model that consists of the following six core metrics to predict brook trout distribution and status at this scale: percentage of forested land, combined sulfate and nitrate deposition, percentage of mixed forest in the water corridor (riparian habitat), percentage of agriculture, road density, and latitude. Threshold levels of concern for these metrics include forested landed that is less than 68%, combined NO3 and SO4 deposition value greater than 24 kg/ha; agricultural lands is 12-19% or higher; and, road density is greater than 1.8-2.0 km/km2.

**Climate Change Vulnerability**

Publication link: <http://easternbrooktrout.org/resources/science-publications/ranking-site-vulnerability-to-increasing-temperatures-an-exposure-sensitivity-approach/ranking-site-vulnerability-to-increasing-temperatures-in-southern-appalachian-brook-trout-streams-in-virginia-an-exposure-sensitivity-approach/view>

Climate change vulnerability classification model for brook trout populations; brook trout populations are classified into one of four quadrants based on direct measurements or model predictions of sensitivity and exposure. Low exposure, low sensitivity populations are most likely to persist under various climate change scenarios.

* Cluster metrics: elevation, maximum air temperature, % ground water, % forest, solar gain.
* Predictive metrics – Exposure (81.1 % concordance): elevation (m), % forest corridor, watershed area (km2); Sensitivity (75.2% concordance): maximum air (°C), watershed area (km2), solar\_mean\_corridor.
* Solar gain (30 meter pixel): topography, aspect, elevation, latitude, longitude, riparian cover.
* Solar radiation (upper quartile) – canopy cover (<70%)

**Riparian Restoration to Promote Climate Change Resilience in Eastern U.S. Streams**

Project Leaders: AppLCC, USFS – Keith Nislow, and UMass Jason Coombs

Link: <http://applcc.org/research/dst-restoration-under-climate-change-group/a-web-based-tool-for-riparian-restoration-prioritization-to-promote-climate-change-resilience-rpccr-in-eastern-u.s.-streams>

Abstract:

Provision of shade via riparian restoration is a well-established management adaptation strategy to mitigate against temperature increases in streams. Effective use of this strategy depends upon accurately identifying vulnerable, unforested riparian areas in priority coldwater stream habitats. The Riparian Restoration Prioritization to Promote Climate Change Resilience (RPCCR) is a web-based tool currently under development which is designed to allow managers to rapidly identify these high-priority riparian restoration targets. The objective of this research is to complete development of the RPCCR, link it with the Appalachian LCC website, and integrate it with ongoing stream temperature monitoring and modeling efforts within the Northeast Climate Science Center (NECSC) and participating Landscape Conservation Cooperatives.

Project Status:

Data layers assembled by the Eastern Brook Trout Joint Venture as well as those layers that summarize catchment and brook trout patch levels have been acquired. For the data visualization component, a build out in the Appalachian LCC's cloud server space in currently being implemented. For the Riparian Restoration to Promote Climate Change Resiliency tool, the remainder of the solar gain layer has been acquired and merged with the existing partial layer to cover the complete range of the Eastern Brook Trout Joint Venture.

**Optimal Stream Survey Design for Detection of Fish Population Trends: Insights Gained from Long-Term Monitoring**

Link to Draft Manuscript: <http://easternbrooktrout.org/resources/science-publications/stream-survey-design/optimal-stream-survey-design-for-detection-of-fish-population-trends-insights-gained-from-long-term-monitoring/view>

Abstract:

Use of surveys to detect trends in population abundance over time can be difficult due to high natural variability. Salmonid populations are no exception, with reported coefficients of variation (CV) ranging fro 15%-108%. Given the finite amount of resources available to managers, knowledge of how survey design affects the ability of monitoring to detect population trends would be highly beneficial. To assess the affects this research applied varying spatial and temporal survey designs to a brook trout population dataset that contained nineteen years of fine-scale survey data, and had a positive linear trend over that interval. Spatial designs revealed that annual sampling of four 50 meter sections (10% of available habitat) that were initially randomly selected but remain fixed over the monitoring period resulted in CV (51.4%) and statistical power (0.88) values comparable to those obtained from sampling the entire stream (46.7%, 0.99). Temporally, sampling the entire stream at a fixed annual frequency ranging from 2 to 5 years resulted in significant trend detection in only 29% (4/14) of all monitoring possibilities. The low detection rate was caused by high abundance variability, evidenced by the fact that complete stream annually monitoring required a minimum of seventeen years before reaching adequate statistical power (0.81).

**Patched-Based Metrics: A Cost Effective Method for Short- and Long-Term Monitoring of EBTJV Wild Brook Trout Populations**

Link to Manuscript: <http://easternbrooktrout.org/resources/science-publications/stream-survey-design/patch-based-metrics-a-cost-effective-for-short-and-long-term-monitoring-of-ebtjv-wild-brook-trout-populations/view>

Abstract:

The wild Book Trout *Salvelinus fontinalis* resource throughout the range of the Eastern Brook Trout Joint Venture (EBTJV) has been significantly reduced over the last 150 years and faces ongoing and future threats from climate change, land use changes, invasive species, and loss of genetic integrity. Monitoring both short- and long-term trends on individual Brook Trout populations and the resource as a whole are important needs of managers. Currently, standard population estimates using mark-recapture and depletion removal estimates are not viable for large scale monitoring because of expense, inability to detect trend (i.e. large coefficient in variation), and problems expanding the sample to the entire population. However, extensive fine- scale occupancy data (at the catchment level) exist for many states. We used this fine-scale catchment data to identify unique “patches” of Brook Trout. We define a “patch” as a group of contiguous catchments occupied by wild Brook Trout. Patches are not connected physically (separated by a dam, unoccupied warm water habitat, downstream invasive species, etc.) and are generally assumed to be genetically isolated. The median patch size from Pennsylvania to the southern range distribution edge is 850 ha and 85.3% of patches were less than 3,000 ha in area. With preliminary patch-level genetic data from Virginia, we found a strong positive relationship between patch size and effective number of breeders (Nb), with notable outliers associated with patches that contain reclaimed habitat (positive residuals) and the presence of invasive Rainbow Trout *Oncorhynchus mykis*s (negative residuals). We also found that subsamples from large patches yield similar estimates of genetic metrics, which suggests that our patch-based approach should be applicable even to potentially problematic large patches. We recommend the use of patches for large-scale monitoring of eastern Brook Trout. Recommended patch metrics include: number of patches with allopatric populations (Brook Trout only), number of patches with sympatric nonnative trout populations (Brook Trout with Rainbow Trout or Brown Trout *Salmo trutta*), average size of patches, number of patches increasing in size (connectivity), number of patches decreasing in size, number of patches with decreasing or stable genetic diversity, and number of patches with increasing, decreasing or stable number of effective breeders (Nb, an indicator of reproductive output and success). A monitoring design combining fixed annual “sentinel” patches and a rotating panel design for other patches has the potential to be a cost effective tool for managers to detect trends in wild Brook Trout populations.

**Fragmentation and Patch Size Shape Genetic Structure of Brook Trout Populations**

Link to Publication: <http://easternbrooktrout.org/resources/science-publications/brook-trout-genetics-research/fragmentation-and-patch-size-shape-genetic-structure-of-brook-trout-populations/view>

Abstract:

We tested the relative influence of habitat patch size and connectivity on genetic structure and effective population size in eight brook trout (Salvelinus fontinalis) habitat patches in a watershed in Virginia, USA. Variation at eight microsatellite loci in 2229 young-of-the-year brook trout for two successive cohorts (2010 and 2011) was examined. Genetic differentiation across all populations was pronounced. Overall F'ST was 0.397 (95% CI: 0.322–0.525) and overall FST was 0.124 (95% CI: 0.096–0.159). Above-barrier patch size had a strong positive relationship with genetic diversity, Nˆ b, and genetic differentiation. Our analysis is consistent with greater extinction risk in smaller above-barrier patches. Larger above-barrier patches contained greater genetic diversity but reduced Nˆ b relative to adjacent below-barrier patches. The primary effect of barriers may be to reduce available above-barrier spawning habitat, even for larger above-barrier patches. Below-barrier patches also showed evidence of reduced genetic diversity and lack of connectivity. Genetic monitoring focused at gaining a broader understanding of the relationships here will be necessary to fully evaluate local extinction risks.

**Decision Support Tool to Assess Aquatic Habitats and Threats in North Atlantic Watersheds and Estuaries**

Project Leaders: NALCC and Downstream Strategies – Fritz Boettner

Link: <http://northatlanticlcc.org/projects/downstream-strategies-project/decision-support-tool-to-assess-aquatic-habitats-and-threats-in-north-atlantic-watersheds>

Project Summary:

Downstream Strategies (DS) and its partners will create and implement a flexible and dynamic aquatic assessment process with the North Atlantic Landscape Conservation Cooperative (NALCC) and its partners. This approach has been widely accepted by aquatic and fish experts across the country. DS will assemble data and analyze conditions to understand fish distribution, habitat, and threats to aquatic species across the NALCC region in streams, rivers, and estuaries. We will engage stakeholders throughout all stages of the project to ensure compatibly of results with the specific goals of the NALCC. The central focus of this project will revolve around a flexible modeling process that has been highly refined from similar on-going and completed projects across the country. Multiple models of different species or species groups will be performed and result in expected species distribution maps, as well as identification and quantification of threats and stressors to the species modeled. The DS project team will utilize the spatially-explicit model results to populate a multi-criteria decision support tool (DST) that will integrate the components of each model developed. The DST will provide a highly functional and user-friendly mechanism for resource managers to visualize, rank, and manipulate inputs to prioritize areas for conservation action.

**Forecasting Changes in Aquatic Systems and Resilience of Brook Trout**

Project Leaders: NALCC and UMass – Ben Letcher

Link: <http://northatlanticlcc.org/projects/forecasting-changes-in-aquatic-systems-and-resilience-of-aquatic-populations-in-the-nalcc-decision-support-tools-for-conservation/forecasting-changes-in-aquatic-systems-and-resilience-of-aquatic-populations-in-the-nalcc-decision-support-tools-for-conservation>

Abstract:

The objective of this project is to develop a web-based decision support system for evaluating effects of alternative management scenarios on local population persistence of brook trout under different climate change scenarios. The project includes the following tasks:

Task 1: Hierarchical modeling framework to account for multiple scales and sources of uncertainty in climate change predictions. UMass will develop the theory and application of a hierarchical Bayesian model to forecast local (catchment scale) population persistence of brook trout.

Task 2: Statistical models to predict stream flow and temperature based on air temperature and precipitation. UMass will develop an empirical model for the relationship between air temperature and water temperature as a function of local environmental conditions.

Task 3: Incorporate climate change forecasts into population persistence models. UMass will obtain an ‘envelope’ of downscaled global circulation data on precipitation and air temperature and incorporate these into the models in Task 1 using relationships from Task 2 in order to forecast local population persistence across climate change scenarios.

Task 4: Develop a decision support system for evaluating effects of alternate management strategies in the face of climate change. UMass will develop a web-based application for examining effects of management scenarios on local population persistence.

Project Status:

As of September 2013, initial stream flow forecast models have been developed for the region; these will now be validated. Stream temperature models are also in development. Work is underway on the development of large-scale brook trout occupancy and abundance models. Initial models for the state of Connecticut illustrate expected change in occupancy of streams by brook trout based on changes in air temperature, precipitation, and the amount of forests in the vicinity of streams. A beta version of the web application has been designed, combining climate, land cover, stream flow, stream temperature, and brook trout population responses.

**Impacts of Climate Change on Stream Temperature**

Project Leaders: DOI Northeast Climate Center and UMass – Austin Polebitski, Ben Letcher, and Richard Palmer

Link: <http://northatlanticlcc.org/projects/impacts-of-climate-change-on-stream-temperature/bringing-people-data-and-models-together-2013-addressing-impacts-of-climate-change-on-stream-temperature>

Abstract:

Stream temperature has a direct and indirect effect on many biological, physical, and chemical processes in the freshwater environment. For example, metabolic rates of most stream organisms are controlled directly by temperature. Feeding and breeding behaviors are altered when temperature changes, resulting in divergent preferences for habitat for cool-water and warm-water species. Conservation and management decisions regarding aquatic systems face new challenges as future temperatures are projected to rise markedly and flow timing is projected to shift for many watersheds in the Northeast under climate change impacts.

Few previous studies have focused on how climate change may impact headwater systems, despite the importance of these areas for aquatic refugia. The lack of these studies has resulted in the majority of climate impact assessments focusing on conservation of ecological systems at broad levels, and has not focused on turning results into useful and actionable information for managers on the ground.

A critical and timely research question is: “What data and modeling frameworks are needed to provide scientists reliable, climate-informed, water temperature estimates for freshwater ecosystems that can assist watershed management decision making?” Our project will answer this through two primary activities: 1) gathering and compiling existing stream temperature data within the DOI-Northeast region and subsequent deployment of data loggers to areas where additional data are needed, and 2) an intercomparison of state-of-the-art statistical and deterministic stream temperature models to evaluate their ability to replicate point stream temperature measurements and model scalability to non-gaged sites with the Northeast region.

The expected results for this project are: 1) a web-accessible database containing stream temperature data from across the Northeast domain, 2) identification of critical areas in need of long term monitoring efforts, and 3) deployment of temperature loggers to enhance existing long term monitoring network and 4) a comprehensive model intercomparison, focusing on model accuracy, flexibility, and parsimony. The team will compare the ability of weekly/monthly stream temperature models to estimate stream temperatures across the domain, and examine the ability of hourly/daily models to predict in a select number of case study basins. A comparison between monthly and daily models will provide an assessment as to whether temporal resolution impacts stream temperature estimates.

Project Status:

Nov. 2012 - the project team has joined with the team for the related project "A stream temperature inventory mapper and data portal for evaluating climate change effects on New England, Mid Atlantic and Great Lakes states streams" to coordinate activities and share data. Together, the teams are collecting stream data from across the Northeast-Midwest region. Representatives from 20 states have been contacted so far. Plans are being made to deploy additional stream temperature data loggers and to manage the data collected.

**Restoring Aquatic Connectivity and Increasing Flood Resilience**

Project Leaders: NALCC and UMass – Keith Nislow and Erik Martin

Link: <http://northatlanticlcc.org/projects/aquatic-connectivity/restoring-aquatic-connectivity-and-increasing-flood-resilience>

Abstract:

This project is being closely coordinated with a companion project funded by the Department of Interior's Hurricane Sandy Mitigation Funds.

In 2011, intense and sustained rain from Hurricane Irene and Tropical Storm Lee washed out roads throughout mountains of New York and New England as culverts running under those roads were not designed to handle such enormous volumes of water. Additional flooding from Hurricane Sandy, which lashed the Northeast coast and adjacent inland areas in October 2012, caused additional damage. The widespread effects of these massive storms underscore the need for a regional science-based approach to prioritize and increase the resiliency of roads to floods.

Improving the resiliency of roads has multiple benefits beyond protecting human health, safety, and property. Upgrading, repairing or replacing culverts can also increase connectivity and movement of fish and wildlife. This addresses a critical problem because aquatic systems in the Northeast are extremely fragmented by undersized or damaged road culverts that are unfit to provide passage for fish, other aquatic organisms and wildlife. Beyond their in-stream benefits, fish-friendly culverts also help sustain nearby wetlands and floodplains while they nourish coastal beaches with sediment.

The objectives of this project are to:

1. Creation of network of people and organizations in the North Atlantic region collaborating in the assessment of road-stream crossing and working to restore aquatic connectivity
2. Reconfigure River and Stream Continuity online database and compile data from field assessments of road-stream crossings that have already been conducted
3. Reconcile various road-stream assessment protocols and scoring systems currently in use throughout the North Atlantic region
4. Develop a recommended suite of protocols for use across the North Atlantic region
5. Create an infrastructure to support collection of road-stream crossing data in an integrated fashion across the North Atlantic region
6. Final report and delivery of electronic data

Project Status:

This project was approved by the North Atlantic LCC Steering Committee in November 2013. The agreement to implement this project is being finalized.

**Restoring Aquatic Connectivity and Increasing Flood Resilience - Hurricane Sandy Mitigation**

Project Leader: NALCC – Andrew Miliken

Link: <http://northatlanticlcc.org/projects/aquatic-connectivity/restoring-aquatic-connectivity-and-increasing-flood-resilience-hurricane-sandy-mitigation>

Abstract:

This project is being closely coordinated with a companion project funded by the North Atlantic LCC.

In 2011, intense and sustained rain from Hurricane Irene and Tropical Storm Lee washed out roads throughout mountains of New York and New England as culverts running under those roads were not designed to handle such enormous volumes of water. Additional flooding from Hurricane Sandy, which lashed the Northeast coast and adjacent inland areas in October 2012, caused additional damage. The widespread effects of these massive storms underscore the need for a regional science-based approach to prioritize and increase the resiliency of roads to floods.

Improving the resiliency of roads has multiple benefits beyond protecting human health, safety, and property. Upgrading, repairing or replacing culverts can also increase connectivity and movement of fish and wildlife. This addresses a critical problem because aquatic systems in the Northeast are extremely fragmented by undersized or damaged road culverts that are unfit to provide passage for fish, other aquatic organisms and wildlife. Beyond their in-stream benefits, fish-friendly culverts also help sustain nearby wetlands and floodplains while they nourish coastal beaches with sediment.

This project involves a number of tasks that will assist local, state, and federal partners in protecting roads and improving fish passage. It will develop a database and mapped locations and condition assessments of road stream crossings based on existing data and models, support additional surveys of road stream crossings, predict future storm discharge levels, assess risk and prioritize crossing improvements. The resulting regionally-consistent data on stream crossing locations and future flood conditions will help towns, states and communities manage future intense storms and improve conditions for aquatic organisms. The project will be facilitated by the North Atlantic LCC and the Fisheries Program of the U.S. Fish and Wildlife Service and guided by partners and users from the conservation, transportation, and state and municipal planning sectors.

The project will take place over three years in coastal watersheds in New Jersey, Delaware, Connecticut, Rhode Island, Massachusetts, Maryland and Virginia. Partners include USFWS, the Nature Conservancy, Trout Unlimited and the U.S. Forest Service.

**Climate Change Vulnerability Index for Northeast Species**

Project Leaders: NALCC and NatureServe

Link: <http://northatlanticlcc.org/projects/completing-northeast-regional-vulnerability-assessment-incorporating-the-natureserve-climate-change-vulnerability-index/completing-northeast-regional-vulnerability-assessment-incorporating-the-natureserve-climate-change-vulnerability-index>

Abstract:

Numerous studies show that ongoing climate change will have major effects on the distribution and conservation status of much of our biodiversity. Resource managers urgently need a means to identify which species and habitats are most vulnerable to decline in order to direct resources where they will be most effective. To address this need, NatureServe and Heritage Program collaborators have developed a Climate Change Vulnerability Index (CCVI) to provide a rapid, scientifically defensible assessment of species’ vulnerability to climate change. The CCVI integrates information about exposure to altered climates and species-specific sensitivity factors known to be associated with vulnerability to climate change. This project will apply the CCVI to 60 species to be selected in collaboration with state wildlife experts, the Science Technical Review committee of the North Atlantic Coast, and with Manomet. Species selected for assessment will represent a) Federal Trust species of high responsibility by the NALCC, b) foundation species for habitats currently being assessed for climate change vulnerability by the Manomet Center for Conservation Sciences, and c) Species of Greatest Conservation Need (SGCN) as identified by the Regional Conservation Needs program.

Project Status:

October 2013: With the help of an advisory committee, NatureServe selected 64 species for assessment (listed below under "Related content.") The set includes a mixture of foundational and representative species and species of high regional concern. Species assessments have been completed for all 64 species and a draft of the final report has been provided to the North Atlantic LCC for review.

Species Chosen for NatureServe’s Climate Change Vulnerability Assessment

Species of high regional concern – primarily “high responsibility species” and “high concern” species as identified in the Nature Conservancy’s review of the 13 Northeast State Wildlife

Action Plans

Representative species – species whose habitat needs or ecosystem function are similar to a group of other species. Most of those listed below were previously identified in a process led by the U.S. Fish and Wildlife Service in the North Atlantic region.

Foundational species – species that are major determinants of ecosystem structure and function and that thus have a large influence on other species with which they co-occur.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ecosystem Type** | **Species** | **Species of****high regional****concern** | **Representative****species** | **Foundational****species** |
| Streams to small rivers | Brook Floater | X |  |  |
| Brook Trout | X | X |  |
| American Water Shrew |  | X |  |
| Louisiana Waterthrush |  | X |  |
| So. Pygmy Clubtail |  | X |  |
| Tape grass |  |  | X |

**Stream Temperature Inventory and Mapper**

Project Leaders: DOI Northeast Climate Science Center – Jana Stewart, David Armstrong, and James McKenna

Link: <http://northatlanticlcc.org/projects/stream-temperature-inventory-and-mapper/a-stream-temperature-inventory-mapper-and-data-portal-for-evaluating-climate-change-effects-on-new-england-mid-atlantic-and-great-lakes-states-streams>

Abstract:

Climate change is expected to alter stream temperature and flow regimes over the coming decades, and in turn influence distributions of aquatic species in those freshwater ecosystems. Effects of climate change on streams are expected to vary both spatially and temporally and will also be influenced by landscape factors such as geographic setting. To better account for these changes, there is a need to inventory, compile, and collect both short- and long-term stream temperature data across the Northeast Climate Science Center (NECSC) region for managers to gain an understanding of baseline conditions, historic trends, and future projections. This project will work towards development of a coordinated, multi-agency regional stream temperature framework and database for New England, Mid-Atlantic and Great Lakes States by:

1) Compiling metadata about existing stream temperature monitoring locations

2) Developing a web-based decision support mapper to display, integrate, and share information

3) Building a community of contacts with interest in this effort

4) Developing data portal capabilities that integrate stream temperature data from several sources.

The results will provide opportunities to coordinate stream monitoring efforts and provide basic information to plan for and assess the effects of climate change on streams.

Project Status:

Nov. 2012 - the project team has joined with the team for the related project "Bringing people, data, and models together – addressing impacts of climate change on stream temperature" to coordinate activities and share data. Together, the teams are collecting stream data from across the Northeast-Midwest region. Representatives from 20 states have been contacted so far. A web-based decision support mapper (NorEaST) has been piloted using data compiled by the USGS New Hampshire Water Science Center.

**Bringing people, data, and models together - addressing impacts of climate change on stream temperature**

Project Leaders: DOI Northeast Climate Science Center – Austin Polebitski

Link: <http://applcc.org/research/bringing-people-data-and-models-together-addressing-impacts-of-climate-change-on-stream-temperature>

Abstract:

Few previous studies have focused on how climate change may impact headwater systems, despite the importance of these areas for aquatic refugia. The lack of these studies has resulted in the majority of climate impact assessments focusing on conservation of ecological systems at broad levels, and has not focused on turning results into useful and actionable information for managers on the ground. A critical and timely research question is: “What data and modeling frameworks are needed to provide scientists reliable, climate-informed, water temperature estimates for freshwater ecosystems that can assist watershed management decision making?” This research will answer this through two primary activities: 1) gathering and compiling existing stream temperature data within the DOI-Northeast region and subsequent deployment of data loggers to areas where additional data are needed, and 2) an intercomparison of state-of-the-art statistical and deterministic stream temperature models to evaluate their ability to replicate point stream temperature measurements and model scalability to non-gaged sites with the Northeast region. The expected results for this project are: 1) a web-accessible database containing stream temperature data from across the Northeast domain, 2) identification of critical areas in need of long term monitoring efforts, and 3) deployment of temperature loggers to enhance existing long term monitoring network and 4) a comprehensive model intercomparison, focusing on model accuracy, flexibility, and parsimony. The team will compare the ability of weekly/monthly stream temperature models to estimate stream temperatures across the domain, and examine the ability of hourly/daily models to predict in a select number of case study basins. A comparison between monthly and daily models will provide an assessment as to whether temporal resolution impacts stream temperature estimates.

**Development of a Hydrologic Foundation and Flow-ecology Relationships for Monitoring Riverine Resources in the Marcellus Shale Region**

Project Leaders: AppLCC and New York Cooperative Fish and Wildlife Research Unit – Todd Walter

Link: <http://applcc.org/research/aquatic-ecological-flows-group/development-of-a-hydrologic-foundation-and-flow-ecology-relationships-for-monitoring-riverine-resources-in-the-marcellus-shale-region>

Abstract:

The emergence of hydraulic fracturing has led to the rapid expansion of natural gas drilling in the Marcellus Shale deposit in portions of Pennsylvania and West Virginia. Millions of gallons of water are needed per fracturing event and will likely put a substantial strain on regional surface and ground water supplies, as well as lead to changes in stream flow that may alter available habitat for freshwater biodiversity and other ecological processes in adjacent freshwater ecosystems. There is a great need for the development of region-wide flow policies to protect stream ecosystems and enhance long-term management of aquatic resources. To that end, this research will develop model(s) that predict ecological responses to flow alteration within the Marcellus Shale region of the Appalachian Landscape Conservation Cooperative (LCC).

Project Status:

The 1st phase of the Aquatic Ecological Flows project was recently completed, which reviewed existing tools and gathered available data within the project area on hydrologic and ecological flow models that would be suitable for the region.

**NorEaST – Stream Temperature Web Portal Demonstration and Application**

Project Leader: DOI Northeast Climate Science Center and Jana Stewart

Link: <http://necsc.umass.edu/projects/noreast-%E2%80%93-stream-temperature-web-portal-demonstration-and-application>

Abstract:

Climate change is expected to alter stream temperature and flow regimes over the coming decades, and in turn influence distributions of aquatic species in those freshwater ecosystems. To better anticipate these changes, there is a need to compile both short- and long-term stream temperature data for managers to gain an understanding of baseline conditions, historic trends, and future projections. Unfortunately, many agencies lack sufficient resources to compile, QA/QC, and make accessible stream temperature data collected through routine monitoring. Yet, pooled data from many sources, even if temporally and spatially inconsistent, can have great value both in the realm of stream temperature and aquatic response. The NorEaST web portal was developed to serve as a coordinated, multi-agency regional framework to map and store continuous stream temperature locations and data for New England, Mid Atlantic, and Great Lakes States. Stream temperature monitoring locations and metadata can be viewed for nearly 7900 monitoring locations across 22 states, contributed by 41 different organizations. The research team will continue to build upon this effort; develop a data framework and standards, initiate user-testing, and develop targeted applications to demonstrate to a broad audience the utility of large scale, multi-agency stream temperature data for use in decision making.

**A Decision Support Mapper for Conserving Stream Fish Habitats of the Northeast Climate Science Center (NE CSC) Region**

Project Leader: DOI Northeast Climate Science Center and Craig Paukert

Link: <http://necsc.umass.edu/projects/decision-support-mapper-conserving-stream-fish-habitats-northeast-climate-science-center-ne>

Abstract:

Human impacts occurring throughout the NE CSC, including urbanization, agriculture, anddams, have multiple effects on the region’s streams which support economically valuable stream fishes. Changes in climate are expected to lead to additional changes in stream habitats and fish assemblages in multiple ways, including changing stream water temperatures. To manage streams from current impacts and future changes, managers need region-wide information for decision-making and developing proactive management strategies. This project meets that need by integrating results of a current condition assessment of stream habitats based on fish response to human land use, water quality impairment, and fragmentation by dams with estimates of which stream habitats may change in the future. Results will be available for all streams in the NE CSC region through a spatially-explicit, web-based viewer, the Climate Change Visualization and Integration of Ecological and Watershed Resources (CCVIEWeR). With this tool, managers can evaluate how streams of interest are currently impacted by land uses and assess if those habitats may change with climate. These results, available in a comparable way throughout the NE CSC, provide natural resource managers, decision-makers, and the public a wealth of information to better protect and conserve stream fishes and their habitats.

**Making Decisions in Complex Landscapes: Headwater Stream Management Across Multiple Agencies**

Project Leader: DOI Northeast Climate Science Center and Evan Grant

Link: <http://necsc.umass.edu/projects/making-decisions-complex-landscapes-headwater-stream-management-across-multiple-agencies>

Abstract:

Brook trout and stream salamanders are important trust species in northeastern headwater streams. There is growing evidence that headwater stream ecosystems are especially vulnerable to changing climate and land use, but their conservation is challenged by the need to address the threats at a landscape scale, often through coordination with multiple management agencies and landowners. This project seeks to fill a gap, providing an example of cooperative landscape decision-making to address the conservation of headwater stream ecosystems in the face of climate change. Project researchers will facilitate two structured decision making processes at the HUC-4 watershed scale, with multiple management agencies, to frame their decision contexts. Using this framing, the team will develop decision-support tools, including predictive models of headwater stream habitat and species response that agencies can use to design long-term management strategies, taking account of climate change and its uncertainty.

**Characterization of Spatial and Temporal Variability in Fishes in Response to Climate Change**

Project Leader: DOI Northeast Climate Science Center and Brian Irwin

Link: <http://necsc.umass.edu/projects/characterization-spatial-and-temporal-variability-fishes-response-climate-change>

Abstract:

Currently, there exists much uncertainty regarding how climate change will influence different populations or ecosystems. To improve current understanding and forecasting of population responses to climate variability, the role of variability must be considered when examining system dynamics and species interactions. This project will use an analytical framework to quantitatively estimate how variation in fish populations may respond to climate change and other important changes regionally. This study also aims to communicate scientific uncertainties in ways that are useful to decision makers and to provide decision makers and managers with the ability to detect and predict impacts of climate change on fish populations.

**Brook Trout Research at Leetown Science Center Experimental Stream Laboratory**

Project Leaders: Nathaniel (Than) P. Hitt and Stephen Faulkner

Link: <http://www.lsc.usgs.gov/?q=aeb-research>

Overview:

Experimental streams allow for the control of ecological factors that are typically confounded in field studies. The Experimental Stream Laboratory (ESL) at the Leetown Science Center (LSC) is designed to manipulate water temperatures from approximately 10 – 35 °C and to combine thermal habitat with combinations of other key environmental factors for stream fishes (e.g., introduced salmonids, woody debris, energy sources). Brook trout conservation is a high priority for state, federal, and non-governmental partners, and there are three potential applications of the ESL for brook trout research - interactive effects of thermal stress and invasive species, effects of groundwater upwelling on habitat use, and functional role of brook trout genetic diversity.