



# NFWF

EasyGrantsID: 58636

National Fish and Wildlife Foundation – Bring Back the Natives 2017, Full Proposal

Title: The national aquatic eDNA Atlas and data exchange: A crowd-sourced environmental DNA database, website, and biodiversity archive of native and invasive species occurrence to facilitate strategic conservation and management investments

Organization: U.S. Forest Service

## Grant Information

### Title of Project

The national aquatic eDNA Atlas and data exchange: A crowd-sourced environmental DNA database, website, and biodiversity archive of native and invasive species occurrence to facilitate strategic conservation and management investments

<b>Total Amount Requested</b>	\$ 73,017.97
<b>Matching Contributions Proposed</b>	\$2,554,000.00
<b>Proposed Grant Period</b>	01/01/ 2018 - 12/31/ 2019

### Project Description

Expand the aquatic environmental DNA (eDNA) Atlas database, website, digital tools, and sample repository (the eDNA Archive) to a national scope to assist with coordination of monitoring, biodiversity surveys, and information exchange among all agencies, organizations, and citizen science groups focused on conservation and management of aquatic species in flowing and standing waters. The new project will use the same database structure and information technology tools as those in the previously funded western eDNA Atlas project to create a national system and provide an efficient way of precisely describing species distributions and sharing data to support strategic conservation investments for suppressing invasive species and preserving native species. Species occurrence and distribution data will be summarized in user-friendly digital formats, documented with comprehensive metadata, and disseminated through a dynamic ArcGIS Online tool at the project website.

### Project Abstract

Conservation of aquatic biodiversity during an era of rapid environmental change and species invasions requires interagency coordination and high-quality databases and information to guide strategic investing. Recent advances in genomics, spatial analysis of crowd-sourced biological datasets, and use of digital media for information dissemination provide a means to create a nationally integrated system for surveying, monitoring, modeling, and mapping aquatic species in aquatic environments. We will develop that system as an open-access, national clearinghouse and data exchange to make available all information about sampling locations and species detections from the National Genomics Center's rapidly growing archive of eDNA samples. The archive has grown to 12,000 samples in the last four years and thousands of new sites are sampled and archived annually. The archive is crowd-sourced through partnerships with state, federal, tribal, and private resource agencies and organizations that volunteer their field time to collect samples. Broad availability of the data facilitates its efficient use and stimulates additional surveys and contributions to the database that further enhance its value. As eDNA samples grow throughout the ranges of species, distribution models will be developed to provide detailed maps of native and invasive species occurrence and to describe factors affecting distributions such as climatic conditions, species interactions, and habitat conditions.

### Organization and Primary Contact Information

Organization	U.S. Forest Service
Organization Type	Federal Government



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## Budget Narrative

**Budget Narrative:** Budget is based on salary costs associated with key personnel needed to develop, implement, and maintain the eDNAAtlas database and associated digital products. Each person has worked closely with project scientists on previous projects and is experienced in the tasks they would be asked to do as part of the eDNA project.

### 1. Personnel

Personnel -

Personnel - Gwynne Chandler, the database designer, is skilled in developing relational databases that are implemented within Access and Oracle. She will work closely with project scientists as the eDNAAtlas database is expanded to include the remainder of the country to ensure that the database structure contains necessary species field codes and supports rapid searches of eDNA samples or their summary into project reports and maps or may be linked to habitat variables for use in species distribution modeling efforts. She will update and maintain the database with new eDNA samples and perform custom queries of the database to extract information needed by project partners.

Sherry Wollrab, GIS analyst, is skilled in performing technical tasks associated with digital map software and will work with project scientists to develop custom software scripts for generating a systematic eDNA sampling grid for streams, rivers, and lakes in the remainder of the country that is consistent with the western U.S. Those sample coordinates will be linked to the eDNA database structure designed by Gwynne Chandler and uploaded to a dynamic ArcOnline mapping tool that shows current and potential sampling locations in each of the 1,366 4th-code hydrological unit basins across the remainder of the U.S. After geotechnical tasks associated with sampling grid development are completed, Sherry will work with Gwynne Chandler and Tommy Franklin to update the database with new eDNA species occurrence samples and assist with development of custom maps or database queries based on requests from project partners.

Sharon Parkes-Payne, the website designer, is skilled in the development of custom websites and will work with project



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scientists to develop an attractive website that hosts and distributes digital data products (e.g., maps, spreadsheets, sampling protocols, GIS files) associated with the eDNAAtlas project. The website will facilitate direct queries of the master eDNA database through an interactive ArcOnline mapping tool. The ArcGIS Online tool will be similar to this functioning prototype associated with the Rangewide Bull Trout eDNA project (<https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=6d5597b2755c4c00a35613b7a1849760>). The eDNAAtlas website will be designed to comply with all federal standards and be fully searchable on the world-wide-web based on keywords associated with the project. After website launch, Sharon will serve as the webmaster by performing regular maintenance tasks and adding new content as it is developed over the course of the eDNA project.

Tommy Franklin, the eDNA program coordinator, will be charged with the solicitation, handling, and reporting of eDNA data. The first aspect is to solicit new partners and manage current partners in the eDNA surveys. This involves coordinating with participants, teaching the collection protocol, responding to questions, and giving brief webinars. The second aspect involves managing the eDNA equipment library, scheduling and handling the mailing and receipt of eDNA supplies and equipment, and ordering replacement materials. It further involves negotiating draft agreements for funding of eDNA sampling and managing those grants. The final aspect is the cataloging and processing eDNA samples upon receipt, appending the results of the laboratory analyses to spreadsheets in a format compatible with entry to the eDNAAtlas database, and ensuring those files are uploaded by Gwynne Chandler. It also involves preparing brief reports to individual participants specific to the samples they contributed.

## 2. Travel

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Domestic Airfare - Per Flight -

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International Airfare - Per Flight -

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Train - Per Ticket -

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Rental Car - Per Day -

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Taxis - Per Trip -

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Mileage - Per Mile -





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The following pages contain the uploaded documents, in the order shown below, as provided by the applicant:

Upload Type	File Name	Uploaded By	Uploaded Date
Full Proposal Narrative - Marine	2 2017 National eDNAAtlas_BBTN-NFWF_Narrative_Revised 12-9.docx	Isaak, Dan	12/11/2017
Project Map	EastUSwithHUCs 1966.jpg	Isaak, Dan	12/11/2017
Letters of Support	2017 Letter of Support #9_An eDNAAtlas for the East_NC.pdf	Isaak, Dan	09/06/2017
Letters of Support	2017 Letter of Support #1_An eDNAAtlas for the East_EBTJV.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #2_An eDNAAtlas for the East_USFS R9.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #3_An eDNAAtlas for the East_TU.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #4_An eDNAAtlas for the East_South Atlantic LCC.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #5_An eDNAAtlas for the East_GCPO LCC.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #6_An eDNAAtlas for the East_USFS WO.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #7_An eDNAAtlas for the East_Florida LCC.pdf	Isaak, Dan	09/02/2017
Letters of Support	2017 Letter of Support #8_An eDNAAtlas for the East_American Rivers.pdf	Isaak, Dan	09/02/2017
Statement of Litigation	5 2017 Statement%20of%20Litigation.doc	Isaak, Dan	09/02/2017
Board of Trustees, Directors, or equivalent	4 2017 BoardTrustees_RMRS.docx	Isaak, Dan	09/02/2017
Other Documents	7 GAAP_RMRS.doc	Isaak, Dan	09/02/2017



## Full Proposal Project Narrative

**Instructions:** Save this document on your computer and complete the narrative in the format provided. The final narrative should not exceed six (6) pages; do not delete the text provided below. Once complete, upload this document into the on-line application as instructed.

1. **Activities:** Elaborate on the primary activities that will be employed through the grant. Explain how these activities are expected to lead to the outcome(s). Describe how these activities relate to established plans (management, conservation, recovery, etc.) and priority conservation needs in the specific project location.

Effective conservation and management of freshwater biota during an era of rapid climate change, nonnative species invasions, and habitat degradation requires unprecedented levels of interagency coordination and high-quality spatial information to guide decision-making. Strategic investment strategies and prioritization of limited resources are required because conservation needs always exceed available resources. Those factors motivated our earlier efforts to develop the interagency NorWeST stream temperature database and climate scenarios (website: <http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>; Isaak et al. 2017a), as well as the Climate Shield species distribution models for identifying native trout refuge streams (Isaak et al. 2015; website: <http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html>) using crowd-sourced datasets contributed by >100 natural resource agencies and organizations in the western U.S. Fundamental to the success of those projects in fostering robust user-communities and efficiency was the development of online, centralized databases and precise, well-documented digital map information that provided a common currency for data use, sharing, and visualization among many organizations.

Information of a similar caliber is needed for all freshwater aquatic species throughout the U.S. to monitor their status and trends, determine where populations are most robust or susceptible to decline, and guide conservation investments. Unfortunately, the necessary data and information for most species are lacking, whether at the scale of species distributions in individual streams, throughout river basins, or across ranges. Even well-studied species are often undersampled in many portions of their ranges. ESA-listed bull trout, for example, have been intensively studied and inventoried for 20 years but the species' recovery plan (USFWS 2016) recently emphasized the need for new surveys to address geographical gaps and determine the status of populations in large numbers of potential habitats. Existing data gaps may sometimes be partially addressed by compiling historical datasets, but even when such data exist they are often in disparate locations and paper reports that largely preclude their efficient use in digital databases, or are so dated and imprecise as to offer little usable information.

Quite often, significant new sampling efforts are needed to provide adequate coverage for many species in portions, or the entirety, of their ranges. Given that perennial stream and river networks in the U.S. encompass more than one million kilometers, those sampling efforts must be efficient, cost-effective, rapid, and reliable. Environmental DNA (eDNA) sampling has emerged in recent years as a faster (McKelvey et al. 2016) and more sensitive (Wilcox et al. 2016) aquatic species sampling technique compared to traditional methods such as electrofishing, seining, snorkeling, and angling. Moreover, the collection of eDNA samples requires only ~15 minutes at a field site, all gear and samples are easily carried in a daypack, and samples stored on filter paper are stable for several weeks prior to laboratory processing, which combine to make rapid inventories of aquatic systems feasible in ways previously impossible. With the availability of standardized, simple, and robust data collection protocols (Carim et al. 2016), it also means that field work and sampling campaigns can be crowd-sourced among many agencies, stakeholder groups, and citizen scientists to cost effectively and reliably sample large areas. And because each eDNA sample contains the DNA of all species of fish, amphibians, and macroinvertebrates at a site,

those sampling campaigns effectively provide a definitive biodiversity archive that can be used to develop information about individual species, guilds, or entire aquatic communities.

The utility of combining eDNA sampling and crowd-sourcing is exemplified by our Rangewide Bull Trout eDNA project (Young et al. 2015; [http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout\\_eDNA.html](http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html)), which has coordinated a survey of ~5,000 stream locations in hundreds of streams among dozens of agencies and organizations throughout the northwestern U.S. during the last two field seasons. Coordination and quality control was achieved by the creation of a standardized sampling grid and spatial coordinates which are available through the website for download. Parties interested in conducting bull trout surveys communicate with scientists at the National Genomics Center for Wildlife and Fish Conservation (NGC) to receive technical advice, training in sample collection, and are mailed all necessary field sampling gear (Carim et al. 2016). After eDNA samples are collected, gear and samples are returned to the NGC lab for processing and final results showing species occurrence at individual sites are uploaded to an ArcGIS Online data mapping tool which facilitates easy access to the data in geospatial file formats accompanied by metadata

(<https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=6d5597b2755c4c00a35613b7a1849760>). Data and results provided by the Bull Trout eDNA project are accepted and used as the best available science by decision makers in all relevant agencies because of stringent quality controls and user-friendly data formats, and because their personnel often participated in the collection of the data. Although the bull trout project has a broad scope that encompasses significant portions of four large western states (OR, WA, ID, MT), it represents only one of dozens of eDNA survey efforts for freshwater species being conducted through interagency partnerships with the NGC across the U.S. As a result, the NGC database has grown in the last four years to encompass more than 12,000 samples and thousands of new samples are now routinely collected each year.

With the continued surge in eDNA sampling, tens of thousands of highly reliable species occurrence records will be generated in future years. Converting those records into high-quality information for decision-makers, however, requires three additional steps. First is the development of a database capable of organizing and efficiently summarizing and manipulating thousands of eDNA sample records for reporting purposes and use in subsequent analyses. Significant additional value can also be added to eDNA samples by integrating them into status map summaries based on nationally consistent geospatial frameworks like the National Stream Internet (NSI; <http://www.fs.fed.us/rm/boise/AWAE/projects/NationalStreamInternet.html>) and the National Hydrography Dataset (<https://nhd.usgs.gov/>). The second step is sharing that information through custom websites in a variety of user-friendly digital formats accompanied by appropriate metadata descriptions. Project investigators have extensive experience in these areas, as evidenced by development and execution of several previous projects at regional and national scales referenced herein. Third, eDNA data need to be used with models that predict the distributions of species across portions or the entirety of their ranges. Even with extensive eDNA surveys, the sampled areas will often be small relative to the extent of potential aquatic habitats so models can be used to predict the probability that species occur at unsampled locations. Models also provide the capability of estimating how habitat characteristics and biological interactions affect occurrence of target species, which is necessary to describe ecological niches and predict where species may be most vulnerable to climate change, nonnative species invasions, or other factors alter habitat suitability.

To accomplish those tasks and ensure that new eDNA samples are utilized to their fullest potential, we earlier proposed development of the eDNAAtlas for the western U.S. in which the NGC's eDNA-based species occurrence records would be cataloged, integrated to a relational database, and made available through a custom website. That proposal was funded by NFWF in 2016 and good progress is being made in database development as well as development and execution of technical protocols to process NSI and NHD geospatial datasets for 750 4<sup>th</sup> code hydrologic units that encompass rivers and streams in the western U.S. The eDNAAtlas project website with that information will be launched in early 2018 and will use an ArcGIS Online tool to provide access to spatial sampling coordinates and NGC eDNA species occurrence records from the database. Here, we propose extending the geographic domain of the eDNAAtlas project, inclusive of the database and associated geospatial datasets used to design and guide systematic eDNA surveys, through the eastern U.S. (an additional 1,000 4<sup>th</sup> code hydrologic unit basins) to provide a national eDNAAtlas and comprehensive interagency database (**Outcome 1**). For a suite of priority species for which data densities are sufficient, eDNA samples will be used in habitat-based occurrence models to predict and summarize species distributions as user-friendly digital map products made available through the eDNAAtlas website (**Outcome 2**). Both outcomes will provide a template for efficient sampling, monitoring, and

modeling of freshwater species in aquatic environments nationally, provide precise information to inform aquatic species conservation strategies, and create significant synergies among and within dozens of natural resource agencies, organizations, and citizen scientists (**Outcome 3**).

**Outcome(s):** Elaborate on the outcome(s) summarized previously in the application; discuss what makes this outcome(s) achievable and important.

*Outcome 1: Extend the eDNAAtlas database and associated geospatial stream datasets through the eastern U.S.*

Achieving this outcome rests on several components, all of which are currently underway in the western U.S. and would be extended nationally using standard data protocols pending funding of the current proposal. First, all eDNA samples collected through interagency partnerships with the NGC will be cataloged and permissions obtained from data contributors to share the results of their eDNA samples. Existing collaborations to collect eDNA samples involve hundreds of volunteer stakeholders representing dozens of state, federal, and tribal agencies, universities, NGOs, private citizens, and consulting firms throughout the U.S. As a result, the NGC sample archive has grown to include samples from over 12,000 locations and is growing by thousands of additional samples each year. The NGC fosters the partnerships that provide those samples, and will continue to do so, by providing project partners—at no charge—the equipment, supplies, sampling protocol, and spatial sampling templates required to conduct species inventories.

Storing, manipulating, and summarizing the thousands of eDNA sample results requires developing a custom relational database similar to the Oracle and Access databases we have previously developed for the NorWeST and Rangewide Bull Trout eDNA projects. The eDNAAtlas database must also integrate seamlessly with the geospatial datasets for the NSI hydrography layer to enable consistent data displays and development of map products throughout the country. The NSI stream layer also provides a template on which a systematic grid of potential eDNA sampling points will be created at 1-km intervals for all streams and rivers. Sample points will be assigned unique identifiers and integrated with existing eDNA samples to create a comprehensive relational database that is spatially indexed.

A custom eDNAAtlas website will be developed to provide open access to NGC eDNA sample results which partners agree to share, as well as the field sampling coordinates to assist with future sample collection campaigns. Sample location information and species occurrence data will be documented with metadata and downloadable from the website using a dynamic ArcGIS Online map tool similar to the one developed for the Bull Trout eDNA project. At present, the NGC shares results only with those collecting data for a particular species or project, so making the broader data archive available simultaneously to the entire stakeholder community will provide significant value that is likely to lead to the recruitment of new partners, more data contributions, and additional efficiencies of scale. Displaying that information will allow biologists to see which areas have been sampled for various species, to prepare local project evaluations of species at risk, to describe species distributions, to conduct status assessments, and to assess data gaps and target additional surveys. In some instances, participating agencies may prefer that certain data not be made available online, and all such requests will be honored. Project investigators have extensive experience designing and implementing attractive websites that serve information in multiple digital formats to facilitate data sharing and use by multi-agency user communities. Those websites currently receive ~50,000 visits annually and service downloads for thousands of digital data products. The new eDNAAtlas website will also be prominently branded with the NFWF logo and hyperlinked to the Bring Back the Natives program website to ensure that funding support is properly acknowledged and awareness of the program is raised.

*Outcome 2: Species distribution models and precise maps.* As the number of eDNA samples becomes sufficiently large for some species, species distribution models can be developed to predict occurrence probabilities for target species based on stream habitat characteristics, climate variables, and the presence of invasive species competitors. We have extensive experience developing those models from large crowd-sourced datasets using spatial-stream-network models (Isaak et al. 2014, 2015, 2017a, 2017b) but also anticipate that the caliber of eDNAAtlas datasets will attract other researchers because species distribution modeling constitutes a large and growing scientific discipline in which high-quality datasets are at a premium (Guillera-Arroita et al. 2015). We will encourage use of the database by other researchers through broad advertisement of the eDNAAtlas database, recognizing that a diversity of modeling

approaches and researchers are likely to yield novel insights about the ecology and distribution of aquatic species that will benefit conservation efforts. Resultant occurrence models could then be used to predict high-resolution species distribution maps across broad areas such as river networks or the entirety of species' ranges. The models would also facilitate detailed descriptions of species ecological niches, locations of climate-mediated boundaries (e.g., areas that are too warm or cold for a species to occur), and habitats that may be most susceptible to invasions. Because the eDNAAtlas database would house data for many species using the same architecture and file formats, the statistical codesets developed to model one species could be easily adapted to model other species. As models and species distribution maps are developed, they will be summarized in user-friendly digital formats and distributed through the project website to provide strategic information for conservation planning.

*Outcome 3: Synergy.* An important outcome of the eDNAAtlas is the synergy it will create within and among dozens of agencies and resource organizations that share a common, open-access database. Based on our previous experiences with developing and delivering crowd-sourced interagency databases for the NorWeST and Rangewide Bull Trout eDNA projects, an order of magnitude more value is provided by data once they are organized into functional databases and shared among user-community members in convenient digital formats and dynamic online mapping tools. Field campaigns to collect eDNA data can be designed such that redundancy with existing datasets or other agencies is minimized while definitive status assessments for species of concern are generated. Moreover, after eDNA samples are collected and processed in the laboratory, they are permanently archived both digitally in the database and physically at the NGC laboratory. Those samples represent a biodiversity library, the eDNAArchive, that provides a benchmark for aquatic biodiversity at the time of sample collection that can facilitate future sample reanalysis for additional species as needed. Species occurrence records summarized and delivered in user-friendly data file formats through the ArcGIS Online tool are easily linked to environmental descriptors associated with the NSI and NHD hydrography datasets to facilitate efficient report summaries, custom maps, or use in species distribution model development. Once a distribution model is developed for a species, the prediction maps of potential habitats can help identify areas of uncertainty throughout a stream network or a species' range, which can then be used to refine subsequent sampling efforts so they are targeted at the most valuable locations needed to resolve species distributions and environmental relationships. And as the number of samples collected in pursuit of target organisms grows in the eDNAAtlas database, the potential biological information it contains grows exponentially because each sample contains the DNA of all aquatic species for a distance of approximately 1 km upstream from sample sites. Those samples can be assessed for the presence of non-target species in the future if the need arises without additional field work, or may someday be processed using laboratory procedures that provide information about species abundance or all aquatic community members as technologies like high-throughput sequencing and meta-barcoding continue to advance and become cost effective (Thomsen et al. 2012).

2. **Tracking Metrics:** Indicate how the project will monitor/assess progress on the metrics selected previously in the application. Please note any challenges or limitations anticipated with tracking the metrics.

*Volunteer participation – Number of volunteers participating.* The large majority of eDNA samples currently within the NGC archive were collected by approximately 300 individuals with partner groups that volunteered time to travel to field sites and collect samples at stream locations. The same crowd-sourcing model based on volunteer field work will continue to be relied on for future sampling so the number of volunteers will scale directly with the number of sites sampled as eDNA monitoring efforts continue to grow. If the above estimate is accurate that the NGC archive triples in size during the next two years, then the number of volunteers would be approximately 800.

3. **Project Team:** List key individuals and describe their qualifications relevant for project implementation.

[Dan Isaak](#): PI on several projects that have developed large crowd-sourced databases and websites for distributing information to interagency aquatics communities. PI on the National Stream Internet project that provides a consistent national geospatial framework for stream datasets and analyses and Co-PI on the Range-wide Bull Trout eDNA project.

[Mike Young](#): Expert on the ecology of native and introduced freshwater species in the western U.S. Founding member of the NGC and expert in eDNA sampling development and applications. Principal investigator responsible for developing and overseeing the Range-wide Bull Trout eDNA project and Co-PI on the Climate Shield refuge stream project.

[Keith Nislow](#): Expert on the ecology of native and introduced freshwater species. He has conducted extensive research on bioenergetics modeling for juvenile salmonids, effects of forest change on aquatic habitats, invertebrates, and fishes, use of genetic and isotopic markers to understand Atlantic salmon movement and dispersal between habitats, the role of anadromous fish in the transport of nutrients and materials to and from freshwater ecosystems, and the effects of hydrologic alteration on river and floodplain ecosystems.

[Andy Dolloff](#): Expert on the ecology of native and introduced freshwater species in the southeastern U.S. He has conducted extensive research on trout and coldwater fish ecology, the dynamics of large wood in streams, effectiveness of forestry Best Management Practices, and the influences of natural and human-related disturbance on brook trout and stream ecology.

[Kevin McKelvey](#): Expert in the development of broad-scale species surveys. Founding member of the NGC and expert in eDNA sampling development and applications. PI responsible for developing and overseeing the national lynx survey, an effort to document the distribution of this small carnivore across its U.S. range. Co-PI on the range-wide, eDNA-based bull trout survey.

[Mike Schwartz](#): Expert in the development of genetic tools for the assessment of species distribution and status. Founding member and Director of the NGC and expert in eDNA sampling development and applications. PI responsible for developing and overseeing the national lynx survey, an effort to document the distribution of this small carnivore across its U.S. range. Co-PI on the range-wide, eDNA-based bull trout survey.

[Dave Nagel](#): Geospatial expert and Co-PI on several projects (National Stream Internet, Climate Shield, and NorWeST) that have developed extensive sets of geospatial data products for fish distributions throughout the western U.S.

4. **Other (Optional)**: Provide any further information important for the review of this proposal.

The online sources below provide examples of principle investigator qualifications, previous projects, and data products that set the foundation for what would be achieved in the national aquatic eDNA Atlas proposal. The ArcGIS Online tool associated with the Rangewide Bull Trout eDNA project provides a functional regional data portal similar to that currently being developed to distribute data for many species contained in the eDNA Atlas database for the western U.S.

### **Websites**

Cold-Water Climate Shield project: <http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html>

National Genomics Center for Wildlife & Fish Conservation: <http://www.fs.fed.us/research/genomics-center/edna/>

National Stream Internet project: <http://www.fs.fed.us/rm/boise/AWAE/projects/NationalStreamInternet.html>

NorWeST Stream Temperature project: <http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>

Rangewide Bull Trout eDNA project: [http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout\\_eDNA.html](http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html)

ArcGIS Online database tool for the Rangewide Bull Trout eDNA project:

<https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=6d5597b2755c4c00a35613b7a1849760>

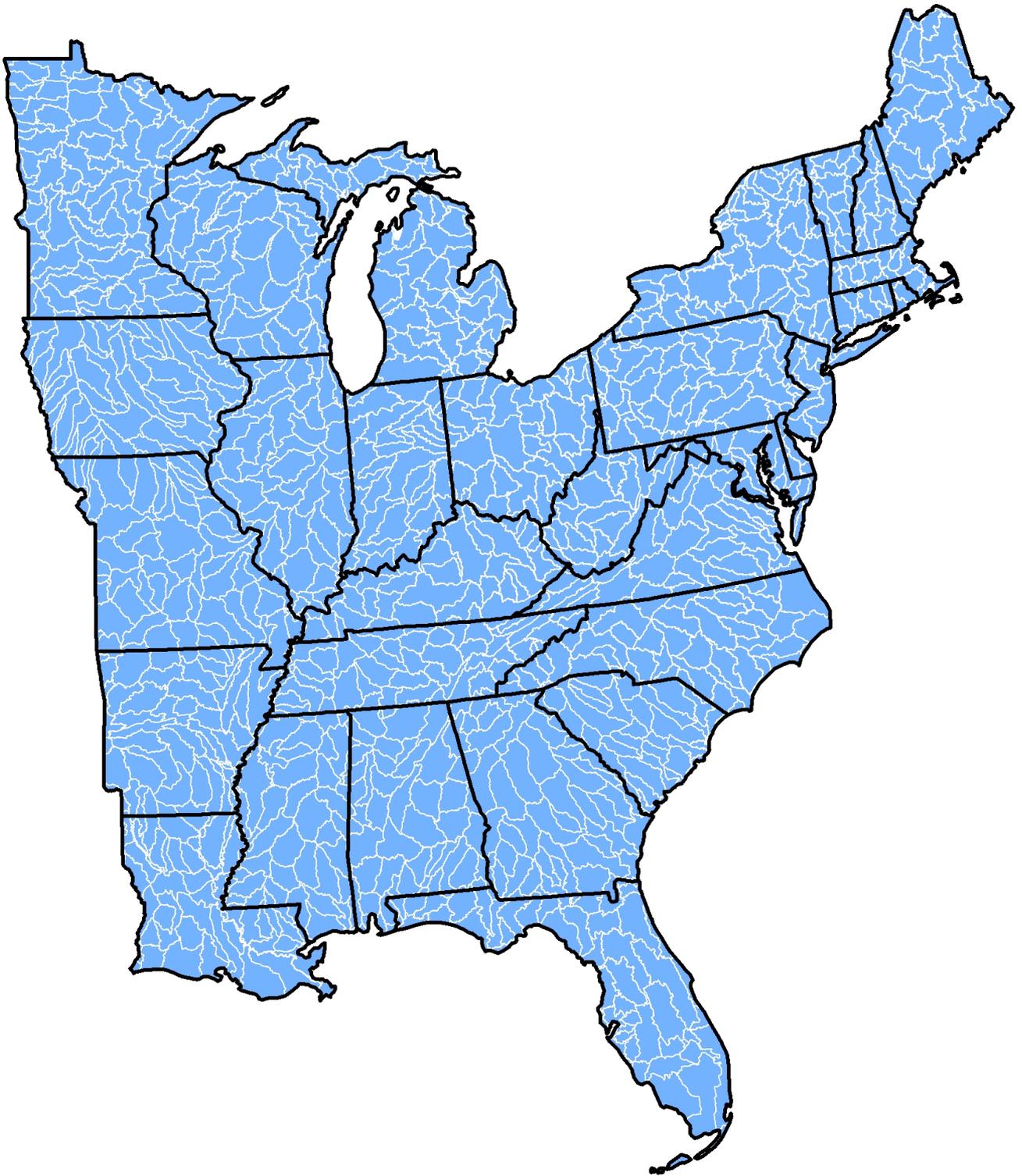
Spatial Statistical Network models: <http://www.fs.fed.us/rm/boise/AWAE/projects/SpatialStreamNetworks.shtml>

### **References**

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Guillera-Arroita, G., J. Lahoz-Monfort, J. Elith, A. Gordon, H. Kujala, P. Lentini, M. McCarthy, R. Tingley, and B. Wintle. 2015. Is my species distribution model fit for purpose? Matching data and models to applications. *Global Ecology and Biogeography* 24: 276-292.

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## ◊ North Carolina Wildlife Resources Commission ◊

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Gordon S. Myers, Executive Director

5 September 2017

Bring Back the Natives Program  
National Fish and Wildlife Foundation  
1133 Fifteenth St., N.W., Suite 1100  
Washington, D.C. 20005

Dear Bring Back the Natives Project Proposal Review Committee,

I am writing to share my support for the *eDNA Atlas for the East* project proposed by the U.S. Forest Service (USFS), National Genomics Center for Wildlife and Fish Conservation, and the Boise Spatial Streams Group. As Coldwater Research Coordinator for the North Carolina Wildlife Resources Commission (NCWRC), I feel this project has the potential to enhance the role of eDNA in North Carolina's assessment of the State's only native salmonid: Brook Trout.

Extensive efforts to evaluate the distribution of Brook Trout in North Carolina have been underway for many decades. These efforts have provided extensive knowledge of the species' historic and current distribution, but not all waters have been assessed. The opportunity to utilize eDNA sampling in these remaining, remote watersheds may prove to be an effective methodology to assist us in completing Brook Trout distribution efforts. Furthermore, the State's existing understanding of Brook Trout distribution may serve as an opportunity to confirm and refine eDNA methodologies as they are being developed.

This project is also appealing given the ability of the NCWRC and USFS National Forests in North Carolina staff to direct or collect needed samples, while having the authority to determine what information is displayed on-line. As such, the proposed project should develop a tool that complements existing NCWRC data and increases information exchange among fisheries management agencies.

Thank you for your time and consideration.

Sincerely,

A handwritten signature in black ink, appearing to read "Jacob Rash".

Jacob Rash  
Coldwater Research Coordinator



Eastern Brook Trout  
**JOINT VENTURE**  
A Fish Habitat Partnership

# Eastern Brook Trout Joint Venture

## A Fish Habitat Partnership

[www.easternbrooktrout.org](http://www.easternbrooktrout.org)

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July 31, 2017

To: National Fish and Wildlife Foundation

The Eastern Brook Trout Joint Venture (EBTJV) is pleased to provide this letter of support for the project proposal titled “The national aquatic eDNAtlas: A crowd-sourced environmental DNA database, website, and biodiversity archive for native and invasive aquatic species across the U.S.” that will extend the western database architecture to include the eastern U.S. Developing an eDNAtlas for the eastern portion of the U.S. will provide Brook Trout managers with an essential decision-making tool since it will allow eDNA results to be easily shared within a consistent, open-access database that is updated regularly and facilitates data summaries and analyses. Additionally, the focus of the Project supports several of the EBTJV’s conservation goals as it’s aimed at providing support for conserving, enhancing or restoring Brook Trout populations that have been impacted by habitat modification, non-native species and other population level threats; and, it encourages management agencies to take a common approach towards addressing regional environmental and ecological threats.

A handwritten signature in black ink, appearing to read 'S. G. Perry'.

Stephen G. Perry, Coordinator  
Eastern Brook Trout Joint Venture

**FILE CODE:** 2760

**DATE:** August 2, 2017

Bring Back the Natives Program  
National Fish and Wildlife Foundation  
1133 Fifteenth St., N.W., Suite 1100  
Washington, D.C. 20005

Dear Bring Back the Natives Project Proposal Review Committee:

On behalf of the Eastern Region's Forest Fisheries Programs I strongly endorse the proposal by the USDA Forest Service to develop an open-access aquatic eDNA database that describes species distributions and facilitates data sharing and coordination of crowd-sourced sampling efforts among natural resource agencies and groups involved in conservation and management efforts throughout the eastern U.S. The group previously developed these sorts of crowd-sourcing projects for eDNA and stream temperature data that span the western U.S., which have proven very popular as the associated databases are heavily used by an aquatic community comprised of hundreds of individuals from >100 agencies and conservation groups. The database structure currently used in the west will be expanded to include all streams, rivers, and lakes in the eastern U.S. and the information will be provided through a user-friendly data portal at a custom website.

This project has significant potential to increase coordination amongst resource management agencies, improve efficiency, and allow better management of native species. I appreciate the opportunity to express my support and I hope you will give it your full consideration.

Sincerely,



Amanda Kunzmann  
Regional Fisheries Program Manager, Eastern Region





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**Chris Wood**  
*President & CEO*

August 6, 2017

Program Director, Bring Back the Natives  
National Fish and Wildlife Foundation  
1133 Fifteenth Street, N.W., Suite 1000  
Washington, D.C. 20005

Dear Program Director:

Trout Unlimited (TU) is pleased to support the excellent proposal by Dr. Dan Isaak and his colleagues to develop an open-access national aquatic eDNA atlas that will include the eastern US. We have worked closely with Dr. Isaak and his colleagues on previous broad-scale data gathering efforts, including an open-access eDNA project for bull trout in the western US and for an open-access stream temperature network across the West. Dr. Isaak has a great ability to pull together these large, cutting-edge projects and we believe that he has assembled an excellent team of partners from across the eastern US to successfully complete this latest endeavor.

Environmental DNA ( eDNA) provides a powerful tool to document the distribution of aquatic species based on genetic products found downstream of the target species. Trout Unlimited has successfully integrated our angler-based members to collect water samples, following quality assurance/quality control protocols, for the eDNA bull trout project. Developing an atlas for eastern aquatic species also is a project that TU is very interested in. We believe that our large network of volunteer members in organized chapters throughout the East will be interested in participating in this new project and we are committed to encouraging their engagement as well as our conservation staff in the region.

We have been extremely impressed with Dr. Isaak's leadership with diverse teams of scientists and the public to create functional and accurate aquatic databases that are well used by literally thousands of agency staff, anglers, and the general public. We view this proposal as an excellent opportunity for the National Fish and Wildlife Foundation. His projects always seem to exceed expectations.

Furthermore, we believe that this project will yield significant conservation gains. We continue to find new habitats and populations for eastern brook trout, a species that is relatively well studied and monitored by state fish and wildlife agencies, to the extent possible related to budget restrictions and staff capacity. Many other aquatic species, such as the Hellbender and non-game fish species, are not so fortunate and it may be necessary to employ relatively new technologies such as the eDNA sampling program to compensate for the limited monitoring capacity of state and federal resource agencies. These tools not only improve agency capabilities but they provide excellent opportunities for the growing cadre of citizen scientists to participate.

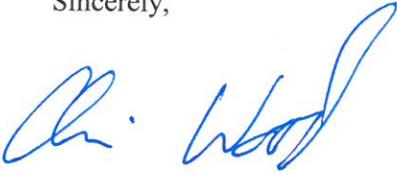
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**A mission to conserve, protect, & restore North America's coldwater fisheries and their watersheds.**

National Office: 1777 N Kent St., Suite 100, Arlington, VA 22209  
T: (703) 284-9403 F: (703) 284-9400 cwood@tu.org www.tu.org

Developing new tools that not only expand the scope of aquatic monitoring but increase the efficiency and timeliness of sampling should go a long way to improving stewardship of these resources. Trout Unlimited is delighted to see this proposal and we look forward to working with the project proponents to realize the potential of this eDNA aquatic atlas project for the eastern US.

Sincerely,

A handwritten signature in blue ink, appearing to read "Ch. Wood", written in a cursive style.

Cc: Dr. Dan Isaak



# SOUTH ATLANTIC LANDSCAPE CONSERVATION COOPERATIVE

August 17, 2017

Dr. Dan Isaak  
USDA Forest Service Research and Development  
322 East Front Street, Suite 401  
Boise, Idaho

Dear Dan,

I am writing in my capacity as Coordinator of the South Atlantic Landscape Conservation Cooperative (LCC) to express support for the proposal entitled “*The national aquatic eDNA Atlas: A crowd-sourced environmental DNA database, website, and biodiversity archive of native and invasive species to facilitate strategic conservation and management investments,*” proposed by the US Forest Service National Genomics Center for Wildlife and Fish Conservation. This project will provide a database structure for cataloging and archiving eDNA information for all streams, rivers, and lakes in the eastern U.S. The South Atlantic LCC is a partnership of state, federal, nonprofit, and private organizations dedicated to conserving a landscape capable of sustaining natural and cultural resources for current and future generations.

The “*eDNA Atlas*” project will expand an existing and successful framework used in the western U.S. to a nationwide model to develop and share eDNA sampling results on a national scale. These data can then be used to develop species distribution maps and descriptions of ecological niches and suitable habitats. Model outputs and distribution maps will be accessible to a broad range of stakeholders and partners interested in locations of aquatic species of concern. These rapidly-evolving technologies directly complement South Atlantic LCC efforts to prioritize areas for shared conservation action through the South Atlantic Conservation Blueprint. The Blueprint is a living spatial plan to conserve natural and cultural resources that identifies priority areas for conservation action based on ecosystem indicator condition and connectivity. More than 500 people from over 150 different organizations have actively participated in Blueprint development to date.

I am pleased to support this proposal as it addresses the shared conservation values and goals for the entire South Atlantic region. Please contact me if you have questions or desire further information about the South Atlantic LCC.

Mallory G. Martin  
Coordinator, South Atlantic LCC

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August 15, 2017

Program Director, Bring Back the Natives  
National Fish and Wildlife Foundation  
1133 Fifteenth Street, N.W., Suite 1000  
Washington, D.C. 20005

Dear Program Director:

The Gulf Coastal Plains & Ozarks Landscape Conservation Cooperative (GCPO LCC) offers this letter of support for the proposal entitled *“The national aquatic eDNA Atlas: A crowd-sourced environmental DNA database, website, and biodiversity archive for native and invasive species to facilitate strategic conservation and management investments”*, proposed by U.S. Forest Service, National Genomics Center for Wildlife and Fish Conservation (NGCWFC). Since 2011, the GCPO LCC has worked to achieve our **vision of success**: to ensure natural and cultural landscapes capable of sustaining healthy ecosystems, clean water, fish, wildlife, and human communities in the 180-million- acre Gulf Coastal Plains & Ozarks region through the 21st century. The GCPO LCC is one of a network of 22 LCCs that span the United States and Pacific Ocean.

Over the last 7 years, the GCPO LCC has supported over 45 science projects aimed at fulfilling our mission to “define a shared vision for sustainable natural and cultural resources in the face of a changing climate and other threats; design strategies to achieve that vision; and deliver results on the ground through leadership, partnerships, contributed resources, evaluation and refinement over time.” For aquatic systems, much of our work has focused on ecological assessments of rivers and stream systems within the GCPO LCC, and we are now beginning to shift our focus to aquatic species-habitat relationships. The work proposed by the NGCWFC offers excellent potential to augment and enhance our knowledge and understanding of aquatic species-habitat relationships in the GCPO LCC, and to develop monitoring approaches to strengthen and verify model results. There are already ongoing efforts within the GCPO LCC to use eDNA technology to monitor aquatic invasive species such as Asian carp. The creation of an easily accessible online database will enhance these efforts, and provide the opportunity for better coordination and collaboration among the disparate entities that presently conduct these data collection activities.

In conclusion, the GCPO LCC is pleased to offer this letter of support for the eDNA database and web site project. We believe that the project will offer our partners an excellent tool to

coordinate and collaborate on aquatic species monitoring projects through eDNA sampling, Furthermore, the data generated through the online product will facilitate the species-habitat modeling work that our scientists are currently engaged in.

Sincerely,

A handwritten signature in black ink, appearing to read "Greg Watten". The signature is fluid and cursive, with a prominent loop at the end of the last name.

Coordinator,  
Gulf Coastal Plains and Ozarks LCC



**File Code:** 6500  
**Date:** August 17, 2017

Ms. Michelle Pico  
Director for Marine Conservation  
1133 Fifteenth St., N.W., Suite 1100  
Washington, D.C. 20005

Dear Ms. Pico:

I am writing in support of the proposal from Dr. Dan Isaak and his colleagues to expand their eDNAAtlas aquatic species mapping project to include the eastern United States. Dr. Isaak and his team put to good use the funds the National Fish and Wildlife Foundation generously provided last year to initiate work on the western portion of the eDNAAtlas. The eDNAAtlas is a crowd-sourced, interagency environmental DNA (eDNA) database of freshwater fish point localities and also includes associated species distribution models. National Forests in the western United States are already using the eDNAAtlas to evaluate the distribution of high-priority aquatic species when conducting forest planning and management activities. Moreover, Dr. Isaak and colleagues are preparing several peer-reviewed scientific publications that further demonstrate the realized and potential value of the database for aquatic species conservation.

As the Director of Landscape Restoration and Ecosystem Services Research, I oversee the United States Forest Service's national research program for fish and aquatic ecology. A primary goal of our research program is to develop innovative protocols and databases to assess, monitor, and model fish habitat requirements and species distributions. These data and tools are then used to develop conservation strategies and prioritize restoration actions to maximize returns on conservation investments. Dr. Isaak and his collaborators have a successful track record of building and disseminating databases and tools that provide meaningful benefits for aquatic conservation. For example, in addition to the past year's work on the western eDNAAtlas, the team also produced the NorWeST stream temperature database (<http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>), which is the gold standard for such databases. The opportunity to have Dr. Isaak's team expand the scope of their efforts to include the eastern United States through the proposed Bring Back the Natives project is an exciting development that promises to produce a nationally consistent aquatic species distribution database.

This project will continue to build the framework for a consolidated online atlas of freshwater fish distribution for the entire nation. The Forest Service has been successful in working with partners to develop similar national atlases, including the Tree Atlas (<http://www.fs.fed.us/nrs/atlas/tree/>), the Bird Atlas (<http://www.nrs.fs.fed.us/atlas/bird/>), and the National Insect and Disease Forest Risk Map (<http://www.fs.fed.us/foresthealth/technology/nidrm.shtml>).

These tools have been essential to enhancing science-based, transparent allocation of resources for silviculture, bird conservation, and forest health. Similarly, the nationwide eDNAAtlas for



freshwater fish will allow numerous partners and cooperators to work together to create and use a massive and comprehensive database of fish distribution, revolutionizing the effectiveness of efforts to conserve native aquatic species.

I am confident that the eDNA database and distribution models the team proposes will be valuable to a wide range of natural resource managers, policymakers, private landowners, and funding organizations who seek to prioritize their investments to maximize benefits for native fish conservation. With continuing advances in the technology available to collect data from aquatic ecosystems (e.g., eDNA, remote sensing), the conservation community is reaching a tipping point where the limiting factor in our understanding of the environment is no longer data availability, but instead our ability to efficiently capture, organize, and analyze the vast stream of information such that it can be used to inform conservation decision-making more completely and meaningfully than ever before. Because of the consistent database structure, standardized protocols, and innovative statistical tools that the research team developed and refined during previous projects, and which they would bring to bear on this project, their proposed work is certain to address this challenge.

In funding this project, the Bring Back the Natives program will leverage significant investments by the Forest Service in the agency's Boise Spatial Streams Group (BSSG) and the National Genomics Center for Wildlife and Fish Conservation (NGC). The BSSG is a world leader in geographic information systems and spatial modeling of streams. The NGC is at the forefront of eDNA technology development and data acquisition and analysis. The extensive existing partnership networks of the BSSG and the NGC, as well as their skills in communicating science to broad and diverse audiences, will also contribute to the success of this project.

I look forward to seeing the eDNA Atlas grow. As it does, it will continue to revolutionize biodiversity data acquisition and management, and conservation planning. Please do not hesitate to contact me with any questions. Thank you for your consideration of this important work.

Sincerely,



CARL LUCERO

Director, Landscape Restoration & Ecosystem Service Research



August 25, 2017

Bring Back the Natives  
c/o National Fish and Wildlife Foundation  
1133 Fifteenth St, N.W., Suite 1200  
Washington, D.C., 20005

To The Review Panel,

As the Coordinator for the Peninsular Florida Landscape Conservation Cooperative (PFLCC), I am writing to express my enthusiastic support for the proposal entitled “*The national aquatic eDNA Atlas: A crowd-sourced environmental DNA database, website, and biodiversity archive of native and invasive species to facilitate strategic conservation and management investments,*” proposed by Dr. Dan Isaak *et al.*, of the US Forest Service National Genomics Center for Wildlife and Fish Conservation. From my years as Science Coordinator with the Great Basin LCC, I am intimately familiar with the effectiveness, efficiency, timeliness, and exceptional management utility of previous work completed by Dr. Isaak and his collaborators in the west (e.g., the NorWeST Stream Temperature and Cold-water Climate Shield projects). The PFLCC is currently half-way through a process to identify conservation targets for priority resources for the entire state of Florida. This proposed work will support and complement our monitoring and management efforts Florida’s many aquatic systems (e.g., springs, seeps, creeks, rivers). Our 30-member PFLCC Steering Committee is a diverse group of public and private organizations and would be very interested in the models output and distribution maps. I anticipate that the eDNA Atlas, eDNA Archive, the open-access database, website and biodiversity library will also be exceptionally popular in this era of limited funding for many organizations.

The PFLCC support this proposal and we are willing to help promote this effort (if funded) via multi-LCC webinars, on our website, FaceBook page, and other social media outlets.

Sincerely,

Todd E. Hopkins, Ph.D.  
Coordinator, Peninsular Florida LCC  
1339 20<sup>th</sup> Street, Vero Beach, FL 32960  
todd\_hopkins@fws.gov (772) 469-4289

[www.peninsularfloralcc.org](http://www.peninsularfloralcc.org)



August 31, 2017

Ms. Michelle Pico  
Program Director for Marine Conservation  
National Fish and Wildlife Foundation  
1133 15th Street NW, Suite 1000  
Washington, DC 20005

**RE: Letter of support to the Bring Back the Natives program for a national eDNA Atlas and database**

Dear Reviewers,

American Rivers strongly supports the efforts of the U.S Forest Service to develop a national open-access aquatic environmental DNA (eDNA) website and database exchange that will include the eastern United States and Great Plains states. This database will not only document species distributions, but will also enable data sharing and coordination of sampling efforts among resource managers. We imagine that such a database could be used to identify potential conservation targets based on the presence or absence of focal species (e.g., species of conservation concern or invasive species), to better characterize the aquatic communities where we work, and to supplement traditional biomonitoring studies. The applicants have proven the value of their approach in the western U.S., where an eDNA database already exists and is used by agencies to collect and share data at thousands of eDNA sites each year. They will expand upon this success by building a national database that includes all streams, rivers, and lakes and is accessible through a user-friendly website.

American Rivers was founded in 1973 to protect and restore our nation's rivers. We have worked to designate 12,000 miles of rivers across the country as "Wild and Scenic," safeguarded public health by helping eliminate sewage pollution in waterways, restored habitat for fish and wildlife, provided scientific and legislative expertise on behalf of rivers and clean water, and delivered advocacy leadership to the nation's growing river conservation movement. We see great value in supporting this project and are excited about the opportunity to have such a resource available to support our river conservation work in the eastern U.S.

We urge the National Fish and Wildlife Foundation to strongly consider this unique project for funding.

Laura Craig, Ph.D.  
Director, Science & Economics Program



NFWF

## Statement of Litigation

**Instructions:** Save this document on your computer and complete. The final narrative should not exceed two (2) pages; do not delete the text provided below. Once complete, upload this document into the on-line application as instructed.

**Litigation:** In the space provided below, state any litigation (including bankruptcies) involving your organization and either a federal, state, or local government agency as parties. This includes anticipated litigation, pending litigation, or litigation completed within the past twelve months. Federal, state, and local government applicants are not required to complete this section. If your organization is not involved in any litigation, please state below.

We are a federal applicant and are not required to provide this information.



322 East Front St., Boise, ID 83702  
Email: [disaak@fs.fed.us](mailto:disaak@fs.fed.us)  
Voice: 208-373-4385  
Fax: 208-373-4391

August 30, 2017

Bring Back The Natives/More Fish Grant

Re: Board of Trustees

To Whom it May Concern,

The Rocky Mountain Research Station of the U.S. Forest Service is a federal research organization and does not have a Board of Trustees.

Sincerely,

Dr. Dan Isaak, United States Forest Service  
Boise, Idaho, USA





322 East Front St., Boise, ID 83702  
Email: [disaak@fs.fed.us](mailto:disaak@fs.fed.us)  
Voice: 208-373-4385  
Fax: 208-373-4391

September 5, 2017

Bring Back The Natives/More Fish Grant

Re: GAAP Audited Financial Statement

To Whom it May Concern,

The Rocky Mountain Research Station of the U.S. Forest Service is a federal research organization and a GAAP statement is not required.

Sincerely,

Dr. Dan Isaak, United States Forest Service  
Boise, Idaho, USA

