



EasyGrantsID: 54500

National Fish and Wildlife Foundation – Bring Back the Natives/More Fish 2016, Full Proposal
Title: The aquatic eDNAAtlas: a crowd-sourced, interagency environmental DNA database and high-resolution digital atlas of native and invasive fish distributions to support strategic conservation decisions

Organization: USDA-Forest Service - Rocky Mountain Research Station

Grant Information

Title of Project

The aquatic eDNAAtlas: a crowd-sourced, interagency environmental DNA database and high-resolution digital atlas of native and invasive fish distributions to support strategic conservation decisions

Total Amount Requested	\$ 89,362.00
Matching Contributions Proposed	\$8,600,400.00
Proposed Grant Period	01/02/ 2017 - 12/31/ 2018

Project Description

Develop a large environmental DNA (eDNA) database, website, and digital tools to coordinate monitoring and promote information exchange among all agencies with respect to aquatic species in rivers and streams in the western U.S. The project will use the database to develop models and precise maps that show distributions of native and invasive species to provide decision support for strategic investment strategies related to climate change, habitat degradation, suppression of invasive species, and preservation of native species.

Project Abstract

Conservation of native fishes during an era of climate change, species invasions, and habitat alteration requires interagency coordination and high-quality information to guide strategic investing. Technological advances in genomics, analysis of large biological datasets, and use of digital media for information dissemination provide the foundation to create a comprehensive system for monitoring and mapping aquatic species in streams of the West. We will develop such a system through an open-access, digital clearinghouse that makes available all information about sample locations and species detections from the National Genomics Center's archive of environmental DNA (eDNA) samples. The archive has grown to 5,000 samples in the last three years and 1000s of new sites are now routinely sampled each year. The archive is crowd-sourced through collaborations with state, federal, tribal, and private resource agencies that volunteer their personnel to collect samples. Open-access to the data will generate more contributions to the database and archive that will further enhance its value. As eDNA samples accumulate throughout species' ranges, we will construct species distribution models and detailed maps of native and invasive species to provide reach-level descriptions of distributions, climate-mediated boundaries, and habitats vulnerable to invasions. Species distribution models and maps will be summarized in user-friendly digital formats and disseminated through a project website

Organization and Primary Contact Information

Organization	USDA-Forest Service - Rocky Mountain Research Station
Organization Type	
City, State, Country	„

Region (if international)



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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	Freshwater eDNAAtlas_BBTN-NFWF_Narrative.docx	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#8_IDFG.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#7_TU Part 2.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#6_MTFWP.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#5_NezPerce Tribe.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#4_USFWS.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#3_BBN_Trout Unlimited_DanDauwalter.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#2_Region1_USFS.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#1_BLM.pdf	Isaak, Dan	07/24/2016
Letters of Support	SupportLetter#11_NPS.pdf	Isaak, Dan	07/25/2016
Letters of Support	SupportLetter#10_LCCs.pdf	Isaak, Dan	07/25/2016
Letters of Support	SupportLetter#9_USFS-R&D.pdf	Isaak, Dan	07/25/2016
Statement of Litigation	Statement%20of%20Litigation.doc	Isaak, Dan	07/24/2016



NFWF

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 fishes during an era of rapid climate change, nonnative species invasions, and habitat degradation will require unprecedented levels of interagency coordination and high-quality spatial information to guide decision-making. Strategic investment strategies and prioritization of limited resources will be required because conservation needs are likely to exceed available resources. These factors were the impetus for our earlier efforts to develop the West-wide interagency NorWeST stream temperature database (website: <http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>) and Climate Shield models that predict native trout population occurrence in climate refugia streams (Isaak et al. 2015; website: <http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html>). Fundamental to the success of those projects was the development of precise digital map information and consistent databases to facilitate data use, sharing, visualization, and interagency collaborations. Similar capabilities and databases are needed to monitor status and trends in aquatic species efficiently and to determine specifically where native fish populations are most robust or susceptible to decline. Unfortunately, the necessary data for most freshwater aquatic species are often lacking, whether at the scale a species' distribution 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 recently released recovery plan (USFWS 2016) emphasized the need for new surveys address geographical gaps and determine the status of populations throughout large numbers of historical habitats. Ironically, species distribution models like those developed for the Climate Shield project led to the same conclusion and have identified thousands of potential stream habitats for bull trout and cutthroat trout which lack data to determine species presence (Isaak et al. 2015).

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-only reports that largely preclude their efficient use in databases, or are so dated and imprecise as to offer little usable information. Quite often, significant amounts of new samples are necessary to provide adequate coverage for many species throughout portions of their ranges. Given that the perennial stream network in the American West encompasses ~1,000,000 kilometers, data collections must be efficient, cost-effective, and reliable. To realistically sample such a large area, data collection protocols should also be standardized so that field work can be crowd-sourced and shared among many agencies and stakeholder groups. Recently, environmental DNA (eDNA) sampling has emerged as a faster (McKelvey et al. 2016) and more sensitive (Wilcox et al. 2016) fish distribution sampling technique compared to traditional methods such as electrofishing, snorkeling, and angling. The collection of eDNA samples requires only the filtration of water samples in the field using small, portable water pumps and the subsequent processing of samples in a properly equipped laboratory. The promise of combining eDNA and crowd-sourcing is exemplified by the recently initiated range-wide bull trout inventory (Young et al. 2015; http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html), a project that is providing maps, survey location coordinates, field gear, and proven protocols (Carim et al. 2016; McKelvey et al. 2016) to facilitate a

coordinated, multi-agency survey of thousands of stream locations throughout the species' range in five western states (OR, WA, ID, MT, and NV). Although an ambitious project, it represents only one of dozens of eDNA surveys of freshwater species currently being conducted through partnerships with the National Genomics Center for Wildlife and Fish Conservation (NGCWFC) in the western U.S.

With the surge in eDNA sampling, tens of thousands of highly reliable species occurrence records will be generated in future years. Moreover, advanced genetic techniques allow each sample to be queried to determine the presence of dozens of species simultaneously. Converting those species inventory datasets into high-quality information for decision-making, however, requires three additional steps. First is the development of a database capable of organizing and efficiently summarizing and manipulating thousands of eDNA samples for reporting purposes or use in subsequent analyses. Significant value can then be added to eDNA samples by integrating them into status map summaries through the use of a nationally consistent geospatial framework like the National Stream Internet (NSI);

<http://www.fs.fed.us/rm/boise/AWAE/projects/NationalStreamInternet.html>). Once basic data summaries and maps are generated consistently from those database platforms, it is possible to partially automate and replicate the creation of similar information for large areas like the Western U.S. The second step is sharing this information in a variety of useful digital formats. Project investigators have extensive experience in these areas, as evidenced by their development and execution of the NorWeST project, which provides access through a website (<http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>) to a comprehensive interagency database with >200,000,000 stream temperature records contributed by >100 agencies. Lastly, the assembled eDNA data need to be integrated into models that predict the distributions of species across large river networks and species' ranges. Even with extensive eDNA surveys that are coordinated among many stakeholders, the large extent of the stream network in the western U.S. will always dwarf the sampled portion of the network so models are needed to predict the probability that species occur at unsampled locations. Another advantage of those models is that they can estimate how habitat characteristics affect species occurrence, which is necessary to describe ecological niches and predict where species are most vulnerable to climate change, nonnative species invasions, and other factors alter habitat suitability. Models developed from large numbers of eDNA samples will be both accurate and precise, especially when used with specialized forms of spatial statistical network (SSN) models with which the investigators are experienced (Isaak et al. 2014).

To accomplish these tasks and to ensure that new eDNA samples are utilized to their fullest potential, we propose to catalog and make available through a custom website eDNA-based surveys of species occurrence (the eDNAAtlas) for freshwater species across the western U.S. (**Outcome 1**). For a suite of priority species for which data densities are sufficient, we propose to integrate eDNA samples into habitat-based occurrence models following the approaches developed in Isaak et al. (2014, 2015) and to summarize these models as user-friendly digital data products made available from the same website (For an example see:

<http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html>; **Outcome 2**). Both outcomes will provide a template for efficient West-wide sampling of rivers and streams, provide precise information to inform aquatic species conservation strategies, and create significant synergies among and within dozens of natural resource agencies (**Outcome 3**).

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

Outcome 1: Website and database for eDNA-based samples of freshwater species in the western U.S.

Achieving this outcome rests on several components. First, all eDNA samples collected by the NGCWFC and its project partners must be cataloged for Bring Back the Natives/More Fish priority species in the western U.S., primarily bull trout, cutthroat trout, steelhead, and Chinook salmon in the Pacific Northwest, and federally listed spikedace and loach minnow in the Colorado River basin. The speed, sensitivity, and reliability of eDNA sampling (Wilcox et al 2013, 2016) have made it the method of choice for large-scale, high-resolution inventories of species occurrence (McKelvey et al. 2016). The NGCWFC has fostered these inventories by providing project partners—at no charge—the equipment, supplies, sampling protocol, and spatial sampling

templates required to conduct species inventories. Existing collaborations to collect eDNA samples involve hundreds of volunteer stakeholders representing dozens of state, federal, and tribal agencies, universities, NGOs, and consulting firms throughout the western U.S. As a result, the NGCWFC sample library presently includes over 5,000 locations and is growing by 1000s more each year. For the range-wide inventory of bull trout alone, we anticipate analyzing approximately 10,000 new samples by 2018. Added to these samples will be 1000s of samples collected by partners outside the bull trout range throughout the West. As the number of eDNA samples builds, the power to describe patterns in species distributions grows rapidly because each sample contains the DNA to characterize occurrence of multiple species for 1 km upstream.

Efficiently storing, manipulating, and summarizing results associated with thousands of eDNA samples requires the development of a custom relational database similar in design to the Oracle and Access databases we have previously developed for the NorWeST project. Moreover, subsequent development of digital map products requires that the eDNA relational database integrates seamlessly with the NSI hydrography layer to be consistent for all streams throughout the project area. The NSI layer also provides a valuable template on which a systematic grid of potential sampling points will be created at a 1 kilometer interval for all perennial streams in the western U.S. Sample points will be assigned unique identifiers and integrated with the existing eDNA samples to create a comprehensive relational database. To assist partners with future field sampling efforts, detailed maps of all 4th code HUC basins will be developed that show the stream network and 1 km sample locations with their identifier codes. Those maps will be formatted as .pdf files, sampling coordinates summarized in standardized Excel files, and distributed through the custom website described below (for examples of similar field sampling maps, see the map subpage at the regional bull trout eDNA project website: http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html).

A custom website will be developed to provide public access to NGCWFC eDNA datasets which partners agree to share, as well as the field sampling maps and coordinates to assist with future sample collections. At present, the NGCWFC 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 may also lead to the recruitment of new partners, more data contributions, and additional efficiencies of scale. Displaying this 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. Moreover, because all eDNA samples are archived indefinitely at the NGCWFC, they can be interrogated at a later date to determine the occurrence of other taxa, such as non-native species like brook trout, brown trout, smallmouth bass, northern pike, or walleye (among the many species for which the NGCWFC has built eDNA assays) or other native species that are, or may become, priority species. Cost savings are multiplied because biologists can identify which samples to analyze for additional species without the need for added fieldwork. 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 (e.g., .pdf, ArcGIS shapefiles, Googlemap tools, etc.) to facilitate convenient access, 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.

Outcome 2: Species distribution models and precise maps. As the number of eDNA samples becomes sufficiently large for some species, we will fit SSN models to the datasets and predict occurrence probabilities for focal species based on stream habitat characteristics, climate variables, and the presence of invasive species competitors. The occurrence models will then be used to interpolate species distribution maps at reach-scale resolution across broad areas such as river networks or species' ranges. The amount of data supporting these models would 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 are most susceptible to invasions. Focal species would include the priority taxa noted earlier, but could also include key invasive species like brown trout, brook trout, and smallmouth bass. To supplement the eDNA samples, we will also assemble historical datasets on the distribution of focal taxa from U.S. Forest Service sources and publically

available, digital datasets offered by some state agencies. Examples of those datasets include Montana's MFISH (<http://fwp.mt.gov/fishing/mFish/>), Idaho's BURP (<http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/burp.aspx>), and MARIS (Multistate Aquatic Resource Information System, <http://www.marisdata.org/>), which collectively house 20,000–30,000 samples in parts of the western U.S. As time and resources permit, we may further enhance these datasets with additional historical data if access is granted by project partners. Bull trout is the first species for which distribution models will be developed as it is currently the subject of an intense regional eDNA sampling campaign that will generate approximately 10,000 new samples throughout the northwestern U.S. from 2016-2018. Statistical codesets developed for the SSN distribution model of bull trout can be easily adapted to other species as those datasets develop. Model results and prediction maps of species occurrence probabilities will be summarized in multiple digital formats on the project website to provide strategic information that serves as a basis for conservation planning (the NorWeST and Climate Shield websites provide many digital map examples).

Outcome 3: Synergy. An important outcome of the eDNA Atlas will be the synergy that is created among and within dozens of agencies and resource organizations that share a common, open-access database structure. Based on our previous experiences and successes with organizing and delivering large interagency databases for projects like NorWeST and Climate Shield, an order of magnitude more value is provided by data once they are organized into functional databases and can be effectively visualized using digital maps and dynamic online tools. Field campaigns to collect eDNA data that provide definitive results can be efficiently designed such that redundancy with existing datasets is minimized and datasets from previous efforts used more efficiently. Once samples are collected using standardized NGCWFC protocols and processed in the laboratory, permanent database archiving will occur and species records can be linked to environmental descriptors associated with the NSI hydrography dataset to facilitate efficient report summaries, data sharing, custom mapping, or use in species distribution modeling efforts. The use of SSN models for species distribution models also enables the development of prediction maps that show spatial variation in uncertainty throughout a stream network or a species' range. Those uncertainty maps could then be used to refine subsequent sampling efforts so they are targeted at the most valuable locations needed to resolve species distributions, thereby achieving further synergies.

3. 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.

Monitoring – Miles being monitored. The miles of stream monitored relates directly to the number of samples in the eDNA database because each sample contains DNA from aquatic organisms in the upstream 0.625 miles (1 km) of channel. As a result, the number of eDNA site samples that are currently in the NGCWFC archive (5,000) equates to approximately 3,125 miles being monitored. At the currently growing rate of eDNA sampling, it is anticipated that the size of the NGCWFC archive will triple to 15,000 samples in the next two years and that ~10,000 miles will be monitored at the completion of the proposal. These are probably conservative estimates.

Volunteer participation – Number of volunteers participating. The large majority of eDNA samples currently within the NGCWFC archive were collected by approximately 200 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 NGCWFC archive triples in size during the next two years, then the number of volunteers would be approximately 600.

Outreach/ Education/ Technical Assistance - # people reached. The number of people currently reached and provided technical assistance is similar to the number of volunteers (200) that have been trained to collect eDNA samples and were provided results from the laboratory. Continued growth in eDNA sampling, coupled with the website and digital databases/map products developed through this proposal, would dramatically increase the number of people reached. The exact number is difficult to predict, but a conservative estimate of 10,000 people might be made given our previous experience with developing other websites and databases for similar aquatic user communities. To gauge that, we will monitor webpage traffic, data downloads, and originating URLs using the StatCounter software. No challenges are anticipated with tracking these reporting metrics as all are readily estimated from NGCWFC archive records or tracking software that PIs are familiar with.

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

Dan Isaak: PI on several projects that have developed fish species distribution models and climate forecasts for bull trout and cutthroat trout throughout much of the western U.S. Also PI on the National Stream Internet project and two projects (Climate Shield and NorWeST) that have developed large crowd-sourced databases and websites for distributing information to interagency aquatics communities. Co-PI on the range-wide, eDNA-based bull trout survey.

Mike Young: Expert on the ecology of native and introduced freshwater species in the western U.S. Founding member of the NGCWFC and expert in eDNA sampling development and applications. Principal investigator responsible for developing and overseeing the range-wide, eDNA-based bull trout survey. Co-PI on the Climate Shield project.

Kevin McKelvey: Expert in the development of broad-scale species surveys. Founding member of the NGCWFC 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.

Mick Schwartz: Expert in the development of genetic tools for the assessment of species distribution and status. Founding member and Director of the NGCWFC 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.

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

The sources below provide examples of principle investigator qualifications, previous projects, and data products that set the foundation for what would be achieved in the aquatic eDNAAtlas proposal.

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>

Regional Bull Trout eDNA project: http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html

Spatial Statistical Network models:

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

References

- Carim KJ, Wilcox T, Young MK, McKelvey KS, Schwartz MK. 2016. [Protocol for collecting eDNA samples from streams. Version 2.3](#). USDA Forest Service, Rocky Mountain Research Station, Missoula, MT. 12 p.
- Isaak, D., E. Peterson, J. Ver Hoef, S. Wenger, J. Falke, C. Torgersen, C. Sowder, A. Steel, M. Fortin, C. Jordan, A. Reusch, N. Som, and P. Monestiez. 2014. Applications of spatial statistical network models to stream data. *Wiley Interdisciplinary Reviews - Water* 1:277-294. Available at: <http://www.treesearch.fs.fed.us/pubs/45559>
- Isaak, D., M. Young, D. Nagel, D. Horan, and M. Groce. 2015. The coldwater climate shield: Delineating refugia to preserve salmonid fishes through the 21st Century. *Global Change Biology* 21:2540-2553. Available at: <http://www.treesearch.fs.fed.us/pubs/47740>
- McKelvey KS, Young MK, Knotek WL, Carim KJ, Wilcox TM, Padgett-Stewart TM, Schwartz MK. 2016. [Sampling large geographic areas for rare species using environmental DNA: a study of bull trout *Salvelinus confluentus* occupancy in western Montana](#). *Journal of Fish Biology*. doi:10.1111/jfb.12863.
- U.S. Fish and Wildlife Service. 2016. Final [recovery plan for the coterminous United States population of bull trout \(*Salvelinus confluentus*\)](#). Portland, Oregon. <https://www.fws.gov/pacific/bulltrout/>
- Wilcox TM, McKelvey KS, Young MK, Jane SF, Lowe WH, Whiteley AR, Schwartz MK. 2013. [Robust detection of rare species using environmental DNA: the importance of primer specificity](#). *PLoS ONE* 8:e59520.
- Wilcox TM, McKelvey KS, Young MK, Sepulveda AJ, Shepard BB, Jane SF, Whiteley AR, Lowe WH, Schwartz MK. 2016. [Understanding environmental DNA detection probabilities: a case study using a stream-dwelling char *Salvelinus fontinalis*](#). *Biological Conservation* 194:209–216.
- Young, M., D. Isaak, K. McKelvey, M. Schwartz, K. Carim, W. Fredenberg. 2015. A rapid range-wide assessment of bull trout distributions: a crowd-sourced, eDNA-based approach with application to many aquatic species. U.S. Fish and Wildlife Service, Great Northern Landscape Conservation Cooperative. Available at: http://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA/downloads/GNLCC_2015_eDNA_BullTrout_proposal.pdf.



IDAHO DEPARTMENT OF FISH AND GAME

600 S. Walnut/P.O. Box 25
Boise, Idaho 83707

C.L. "Butch" Otter/Governor
Virgil Moore/Director

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

July 20, 2016

Dear Bring Back the Natives Project Proposal Review Committee:

I would like to offer my support for the crowd-sourced, interagency eDNA database project proposed by the USFS, the National Genomics Center for Wildlife and Fish Conservation (NGC), and the Boise Spatial Streams Group. As the Chief of Fisheries for the Idaho Department of Fish and Game (IDFG), I believe this project has significant potential to increase coordination amongst resource management agencies, improve efficiency, and ultimately to better manage the state's native species.

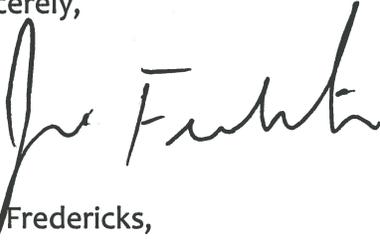
Like many fish and wildlife agencies, IDFG is increasingly recognizing the value of eDNA technology to better understand fish distribution, abundance, and habitat relationships. Environmental DNA, when combined with spatial statistical network models can be an invaluable element of native fish conservation in the face of climate change. Dan Isaak and the other project sponsors have a commendable track record of coordinating crowd-sourced data bases and developing models, but more importantly, they also have a record of making the tools available and communicating the information back to stakeholders. On several occasions IDFG has collaborated with the project sponsors, and I have every confidence that they will deliver the products described in the proposal.

While eDNA is an exciting tool, one of the concerns my staff and I have discussed is the production and distribution of inaccurate, unreliable (and therefore misleading) eDNA data from un-vetted labs. For this reason, I am strongly supportive of a centralized database and digital atlas comprised of data collected and analyzed using standardized protocols from a highly reliable lab. The lack of such a database will not only inhibit the ability of stakeholders

to access and share data, but it will hinder the use of eDNA as a tool and could lead to misguided management decisions. The integrity of the NGC and the demonstrated ability of the Boise Spatial Streams Group to handle spatial analysis of biological and hydrological datasets, and use of digital media for information dissemination make them uniquely well-suited to take on the role of development, management and promotion of a centralized, interagency, crowd-sourced database.

I appreciate the opportunity to express my support for this project and I hope you will give it your full consideration for funding.

Sincerely,

A handwritten signature in black ink, appearing to read "Jim Fredericks". The signature is fluid and cursive, with a large initial "J" and "F".

Jim Fredericks,
Chief of Fisheries,
Idaho Department of Fish and Game



Rob Roberts
Project Manager

National Fish and Wildlife Foundation
Bring Back The Natives
1133 Fifteenth St., N.W., Suite 1100
Washington, D.C. 20005
T 202-857-0166 | F 202-857-0162
November 22, 2015

Dear Sir or Madam:

Trout Unlimited fully supports the the Boise Aquatic Sciences Lab (BASL) and National Genomics Center for Wildlife and Fish Conservation's (NGC) proposal to assist all stakeholders in freshwater fish conservation in the West by building a multi-agency, open-access, eDNA-based aquatic biodiversity atlas for the West. This will make it possible for biologists to build status assessments or project reports for well-sampled areas, identify locations where new surveys could be helpful, and avoid sampling locations that have already been visited.

Trout Unlimited has worked with this collaborative group to collect eDNA samples in multiple subwatersheds of the Clark Fork River and those results have yielded important information for the prioritization of fish management activities and fisheries restoration projects in the area. TU will continue to use eDNA as an efficient and productive sampling methodology in the watershed, and the ability to use and access eDNA data from an online system – as well as the species distribution models that will result – will markedly improve our work in the future.

Trout Unlimited is actively work on both public and private land in the Clark Fork River watershed and believes this project is an important part of the overall effort to restore this fishery. Thank you for your effort to complete these improvements and please let us know if you have any questions.

Sincerely,

Rob Roberts



Montana Fish, Wildlife & Parks

Granting Agencies:

I am writing this letter in support of the National Genomics Center for Wildlife and Fish Conservation's (NGC) proposal to further their research using eDNA sampling. Environmental DNA is a technique which has proven very useful in determining ranges of native salmonids and other species in the west. It also appears to be extremely helpful in determining the presence of non-native species which can be particularly difficult to detect using typical fish sampling methods when in low abundance during their initial stages of invasion. Detection of non-native species early in their invasion is critical if measures are to be taken to control these populations, as traditional control measures typically require low abundance to be effective. It appears that eDNA also will be helpful in other facets of fisheries and wildlife management and the NGC are at the fore-front of developing these methods.

While eDNA techniques have provided valuable insights into fish and wildlife management, the availability of this data is also important. Researchers routinely share data, however data exchange is commonly tedious and difficult, often limiting the amount of manual data sharing that occurs. This project would facilitate the exchange of data between biologists and minimize redundancies in data being collected. It appears that this project also will facilitate many additional larger scale analyses via the Species Distribution Models and Maps portion of the project. These larger scale analyses of bull trout populations are key to better understanding factors that are limiting this species range-wide. I imagine these larger scale assessments facilitated by this project will be equally valuable for understanding limiting factors for other native fish and wildlife species.

Thank you,

A handwritten signature in blue ink that reads "Brad Liermann". The signature is fluid and cursive, with a long horizontal stroke at the end.

Brad Liermann

Fisheries Biologist, Montana Fish, Wildlife and Parks



Nez Perce Tribe



Department of Fisheries Resource Management

Administration • Enforcement • Habitat/Watershed • Harvest • Production • Research • Resident Fish
WATERSHED DIVISION

14054 Burr Road • McCall, Idaho 83638

Phone: (208) 634-3031 • Fax: (208) 634-4097

Mr. Michael Young
Research Fisheries Biologist

July 20, 2016

This is a letter of support for the proposal submitted by Boise Aquatic Sciences Lab and the National Genomics Center for Wildlife and Fish Conservation regarding the Bring Back the Natives program proposal. The McCall Nez Perce Tribe Watershed Division has been collecting eDNA for the last few years and supports the use of this data to build a multi-agency, open-access atlas for the west. The importance of determining the presence/absence of fish in water bodies is critical to the prioritization of the watershed restoration work we perform. We wish you the best of luck in your pursuit of this proposal and look forward to working with you and using this atlas to prioritize watershed restoration when it becomes available.

Sincerely,
Wesley Keller
Nez Perce Tribe
Project Leader
Watershed Division McCall Field Office
208-634-3031



United States Department of the Interior

Fish and Wildlife Service

Ecological Services
Montana Field Office
585 Shepard Way, Suite 1
Helena, Montana 59601-6287
Phone: (406) 449-5225; Fax: (406) 449-5339



July 20, 2016

Bring Back The Natives
c/o National Fish and Wildlife Foundation
1133 Fifteenth St., N.W., Suite 1100
Washington, D.C. 20005

To Whom It May Concern:

This letter is to offer the support of the U.S. Fish and Wildlife Service (FWS) for the BBN Grant Request from the USFS Boise Aquatic Sciences Lab (BASL) and National Genomics Center for Wildlife and Fish Conservation (NGC) in Missoula, Montana. Their purpose is to develop a multi-agency, open-access, eDNA-based aquatic biodiversity atlas. Its foundation will be the eDNA data analyzed at the NGC.

I am the FWS Bull trout Coordinator for Montana. The Service previously collaborated with these same applicants on development and refinement of the crowd-sourced mapping capability they developed and presented in their Climate Shield model. We applied that information directly to our Bull Trout Recovery Plan, which was published in the Fall of 2015. To date, the USFS group has delivered what was promised and beyond, and done so in an impressively short amount of time. We believe their online open-access approach sets these collaborators apart from some similar efforts.

I have personally worked with Dr. Michael Young to strategically prioritize e-DNA sampling for Bull Trout in Montana, to better emphasize the areas of importance to us in our Recovery efforts. The development of this e-DNA database is an important aspect of Bull Trout recovery and is highlighted in the plan. Please contact me at (406)758-6872 if you need further review or input.

Sincerely,

Wade Fredenberg
Fisheries Biologist



15 July, 2016

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

To whom it may concern:

I am writing to express Trout Unlimited's support for the Forest Service Boise Aquatic Sciences Lab (BASL) and National Genomics Center for Wildlife and Fish Conservation's (NGC) eDNA Database and Digital Map Atlas proposal to the National Fish and Wildlife Foundation's Bring Back the Native's program. The development of the eDNA Database and Digital Map Atlas on which eDNA and aquatic species occurrences can be revealed and future conservation decisions can be made will advance native aquatic species conservation across the West.

The BASL and NGC are pushing the boundaries on aquatic conservation science, and this project will continue to do so by building on their past work. The BASL has lead the way on development of spatial statistical models and serving model outputs, such as stream temperature model predictions across the West, via platforms that are easily accessed by end-users like Trout Unlimited for use in their own programs. Likewise, the NGC is a leader in understanding the genomics and taxonomy of native aquatic species and has been leading the way in better understanding the use of eDNA in aquatic conservation applications. Together, these two groups are poised to integrate these past tools and the use of crowd-sourced eDNA collection to develop an atlas of eDNA and native aquatic species distribution data, and updated models of species distributions, that is unparalleled in scope and delivered in a way that is easily accessible to a variety of end users. The nature of eDNA collection in aquatic systems also facilitates the ability for others to ask questions about the occurrence of other species from the same eDNA samples, something that cannot be done using traditional field sampling methods for aquatic systems.

I highly encourage the National Fish and Wildlife Foundation to fund the eDNA Database and Digital Atlas project proposed by the BASL and NGC as the project will have numerous benefits to the conservation of aquatic species and the programs of various conservation partners, including Trout Unlimited and the Foundation itself.

Sincerely,

Daniel C. Dauwalter, Ph.D.
Fisheries Science Director, Trout Unlimited



File Code: 2600: Fish Management and,
2610 Fish Coop Relations

Date: July 14, 2016

National Fish and Wildlife Foundation's
Bring Back the Natives Committee

Dear Bring Back the Natives (BBN) Committee members:

As the Northern Region's Fish program manager for the Forest Service I would like to testify to the benefits we have accrued from an ongoing relationship and partnership with staff from Rocky Mountain Research Station and the National Genomic Center (NGC). We have gained added insight into distribution of native vertebrate fish species across our management area of the Northern Rockies that has improved our management effectiveness. The RMRS scientists on this BBN proposal have developed new sampling tools and associated genetic analysis that when used at spatially relevant scales by them or collaborators has and will provide invaluable management utility. In fact their tools and data contributions go far beyond the topic of this proposal. We have used their organized data and visual outputs on a series of multi-scale conservation planning efforts. These include Forest Plan Revision and associated identification of watershed conservation networks, climate watershed vulnerability assessments, ESA consultation and recovery planning efforts, and strategic conservation and restoration investment.

In general, past aquatic management efforts have been hindered by tough-to-acquire aquatic data across geographic and managerial boundaries, inconsistent formats once acquired, and the temporal and monetary costs needed uncover and use these data. This proposal for accessible fish distribution data and associated display and interactive products from crowd-sourced eDNA data made broadly accessible allows fisheries managers to be proactively and strategically positioned for tackling systematic and novel management needs. We intend to continue to grow our partnership and collaborations with RMRS and the associated NGC and encourage your critical consideration of this proposal for what it has to offer the aquatic conservation and management community.

Thank You

Sincerely,

Scott Spaulding
Fisheries Program



July 22, 2016

To: National Fish and Wildlife Foundation – More Fish/Bring Back the Natives Grant Program

From: Dave Hu, National Fisheries Biologist, Bureau of Land Management

Subject: BLM Support for *Mapping native fish distributions for conservation success in the American West*

To Whom It May Concern,

The BLM Fisheries and Aquatics Resources Program fully support the proposal, *Mapping Native Fish Distributions for Conservation Success in the American West* submitted to the Bring Back the Natives grant program.

The BLM has been recently began and have been successfully applying eDNA technologies in our aquatic organism monitoring and resource management decisions. We have begun exploring agency next steps and independently identified a need and value of creating a multi-agency, open-access, eDNA biodiversity database as a greatest value to the agency in the near term.

Our understanding is that this proposal will also facilitate development of species distribution models and high resolution maps showing the occurrence of aquatic organisms that the Bureau can apply to identifying stream reaches that we can immediately incorporate into our planning and management decisions. We feel this would be of great value.

The BLM is committed to increasing our service and contribution to the aquatic science community and feel this project will provide to us a new venue and data to mutually gain benefit and better apply eDNA activities.

Feel free to contact me if you have any questions or would like further information.

Thank you!

Dave Hu

National Fisheries Biologist
Bureau of Land Management
20 M St. SE
Washington, D.C. 20003
202/912-7404
dhu@blm.gov

United States Department of the Interior

NATIONAL PARK SERVICE
Lake Chelan National Recreation Area
Ross Lake National Recreation Area
North Cascades National Park
810 State Route 20
Sedro-Woolley, Washington 98284-9394



IN REPLY REFER TO:
1.A.2

July 20, 2016

David Lawrence, PhD
National Fish and Wildlife Foundation
Bring Back the Natives
1133 15th Street, Northwest, Suite 1100
Washington, DC 20005

Dr. Lawrence:

I am writing a letter to support the proposal developed jointly by the Boise Aquatic Sciences Lab (BASL) and the National Genomics Center for Wildlife and Fish Conservation (NGC) to develop a multi-agency, open-access, eDNA-based aquatic biodiversity atlas for the Western United States.

The North Cascades National Park Service Complex (NOCA) has provided data to BASL for the NorWest Stream Temperature Project and is currently partnering with the NGC on the Rangewide Bull Trout eDNA Project. The NorWest Stream Temperature Project has been instrumental in helping NOCA plan for the effects of climate change on cold water fish species in the park and the data generated from the Rangewide Bull Trout eDNA Project will provide a key piece of information needed to recover bull trout in the Stehkin River and protect existing populations in the Skagit River watershed. It is not an overstatement to say that we will use these projects as cornerstones to help the National Park Service meet its management goal of preserving and restoring native communities of fish and amphibians and the stream and river ecosystems they depend on, especially in the face of climate change.

Developing an on-line open-access eDNA atlas that provides information about existing and future fish distributions is a logical progression that will provide cross jurisdictional information to federal, state, and local government agencies. This information will be crucial in facilitating cooperative management of highly threatened and valuable aquatic resources in a rapidly changing landscape.

Sincerely,

Karen F. Taylor-Goodrich

Superintendent



National Fish and Wildlife Foundation
1133 Fifteenth St., N.W., Suite 1100
Washington, D.C. 20005

July 25, 2016

To the National Fish and Wildlife Foundation,

On behalf the Great Northern and North Pacific Landscape Conservation Cooperatives (LCCs), we would like to express our support of the proposal "*Mapping native fish distributions for conservation success in the American West: A crowd-sourced, interagency eDNA database and high-resolution digital atlas to guide strategic investing*" submitted by Dr. Dan Isaak from the US Forest Service Aquatic Research Station for your Bring Back the Natives Program. This project would be directly beneficial to the aquatic conservation work both LCCs have supported in the past and partners throughout our geographies would benefit from the products developed.

A multi-agency, open-access, eDNA-based aquatic biodiversity database is one of the products that would be developed as part of this project. There is currently a great need for this product. In 2015 and 2016, the Great Northern LCC funded a regional eDNA project led by the U.S. Forest Service. This year, the North Pacific LCC is building on the work of the Great Northern LCC and will be funding eDNA efforts within the adjacent geography. There are a number of other eDNA projects underway or being developed by other organizations and agencies. The proposed database would provide any interested biologist access to samples already collected so redundant sampling is minimized, existing data can be better used, and limited resources can be focused where the need is greatest. The information will provide a shared source of information on presence of aquatic species in locations previously unsampled.

The Great Northern and North Pacific LCCs supported the development of the NorWeST stream temperature project over the past 5 years and have firsthand knowledge of the great success of this team's work that was a winner of a National Climate Adaptation Leadership Award for Natural Resources. Models that would be developed as part of this proposed project would be similar to work that was completed with LCC support.

Thank you for considering this proposal for funding. This project is well aligned with priorities of our LCCs and we strongly encourage the funding of this proposal.

Sincerely,

A handwritten signature in black ink, appearing to read "Yvette Converse".

Yvette Converse, Coordinator
Great Northern LCC

A handwritten signature in blue ink, appearing to read "Mary Mahaffy".

Mary Mahaffy, Science Coordinator
North Pacific LCC



File Code: 4200
Date: July 25, 2016

David Lawrence, Ph.D.
Director of Aquatic Conservation
Bring Back the Natives Program
National Fish and Wildlife Foundation
1133 Fifteenth St., N.W., Suite 1100
Washington, D.C. 20005

Dear Dr. Lawrence,

I am writing to express my full support for the crowd-sourced, interagency environmental DNA (eDNA) database and associated species distribution models for freshwater fish that Dr. Dan Isaak and his collaborators have proposed for your consideration. The goal of the U.S. Forest Service's national fish and aquatic ecology research program, which I oversee, is to study aquatic species and ecosystems to inform restoration actions and conservation strategies across large landscapes and watersheds. The development of the innovative protocols and databases to assess, monitor, and model fish species distributions that Dr. Isaak and his collaborators propose align perfectly with our organizational goals. Given their track record of success in developing and disseminating the NorWeST stream temperature database and models (<http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>), it is clear that this group is extremely capable and well-prepared to produce a database and models of freshwater fish distribution in the western United States.

I am confident that the eDNA database and distribution models the team produces 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. Instead, we are primarily limited by how efficiently we can capture, organize, and analyze vast amounts of information so that it can be used to inform conservation decision-making more completely and more meaningfully than ever before. Because of the consistent database structure, standardized protocols, and innovative statistical tools that this research team developed and refined during previous projects, and which they would bring to bear on this project, their proposed work is certain to contribute to meeting this challenge. Their project will continue to build the foundation necessary for a multitude of partners to work together to create and to use a massive and comprehensive database of fish distribution to revolutionize the effectiveness of efforts to conserve native species.

This project will focus on the western U.S., but I anticipate it will lay the groundwork for a consolidated online atlas of freshwater fish distribution for the entire nation. The U.S. 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 geospatial databases have been essential to enhancing science-based, transparent allocation of resources for silviculture, bird conservation, and forest health. This project would be instrumental in initiating work to produce a similar atlas for aquatic species.

By funding the development of the eDNA database, the Bring Back the Natives program would leverage significant financial and intellectual investments that the U.S. Forest Service has already made in the agency's National Genomics Center for Wildlife and Fish Conservation (NGC), which is at the forefront of eDNA technology development and data acquisition, and in the database team who created NorWeST and whose talents and experience would be applied to this project. The extensive partnership networks that the NGC and the NorWeST database team have already developed and their strength in communicating the scientific value and management relevance of their work are additional assets of the team that will aid with the success and high return on investment, in terms of improved conservation outcomes for years to come, of this project.

I look forward to the realization of the vision set forth in Dr. Isaak's proposal. I hope you will find it suitable to receive your financial support. Please do not hesitate to contact me with any questions. Thank you for your consideration of this important work.

Sincerely,



CARL F. LUCERO

Director for Landscape Restoration and Ecosystem Services Research



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.