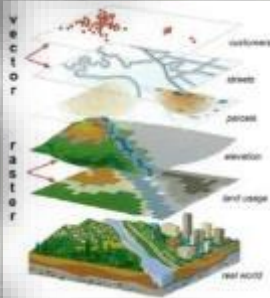


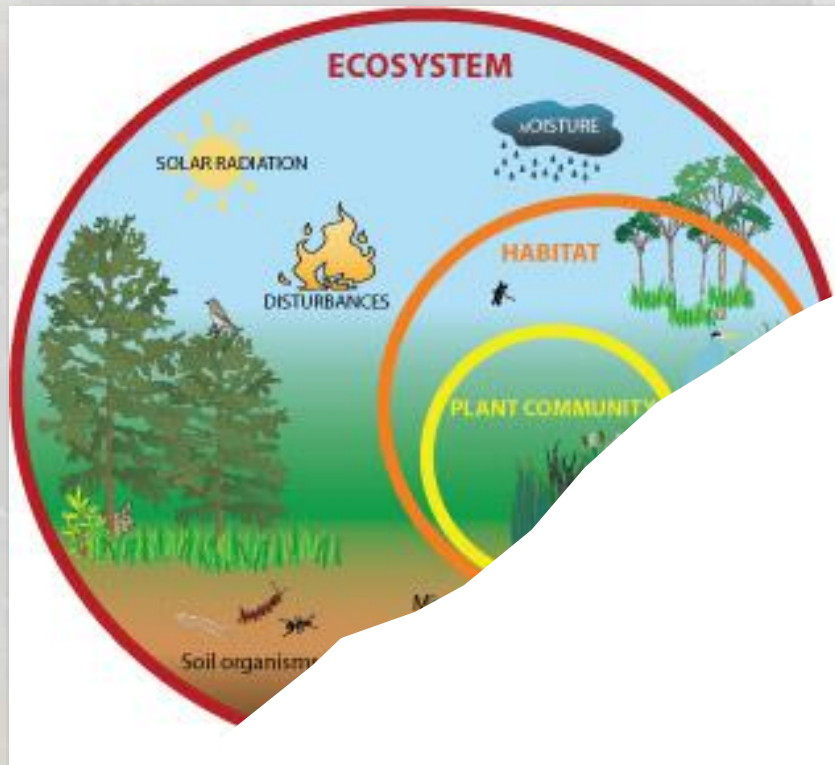
A Continent-wide Map of all Things Aquatic: The eDNA Atlas and Archive for North America

Mike Young, Dan Isaak, Mike Schwartz, Kevin McKelvey, John Rothlisberger*, Dan Shively, and a cast of hundreds...



“To keep every cog and wheel is the first precaution of intelligent tinkering”

Aldo Leopold



**What Are the
Cogs & Wheels in
Aquatic
Ecosystems?**

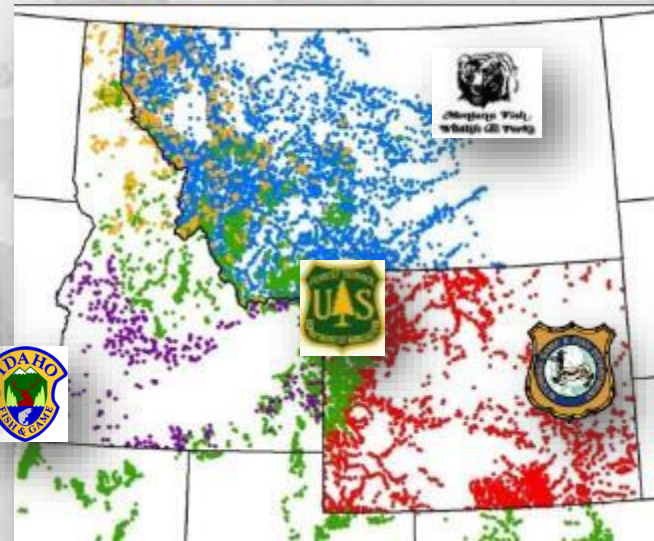
Most Species Information is Coarse

Limited Utility to Managers & Conservationists



& Our View is Skewed...

Lots of Data for a Few Species...



>20,000 sample sites

Little Data for Most...

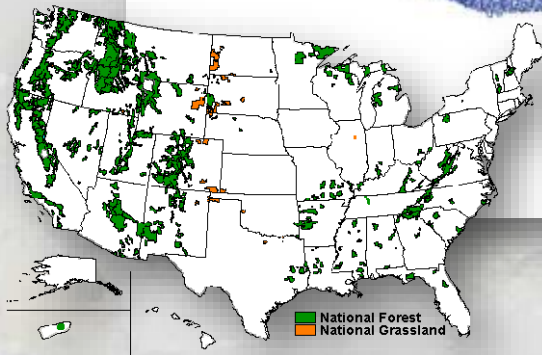
Species	Occurrences
Longnose dace	169
Speckled dace	52
Redside shiner	129
Longnose sucker	235
Whitefish	2,026
Cutthroat trout	11,543
Rainbow trout	3,977
Chinook salmon	1,728
Brown trout	1,228
Bull trout	2,809
Brook trout	7,036



Isaak et al. 2017. Big biology meets microclimatology. *Ecol. Apps.* 27:977-990.

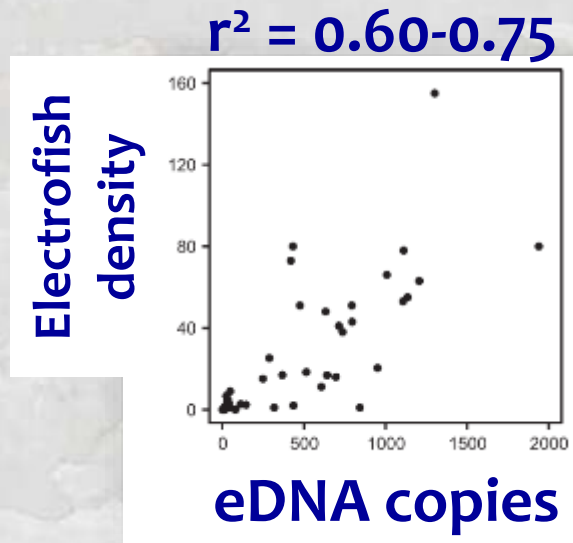
Ridiculously Large Area to Survey

- 3,000,000 km of perennial streams & rivers
- Thousands of lakes, springs, ponds
- >150 National Forests & Grasslands



A Solution: eDNA Sampling

- Fast & portable
- Rapid, broad-scale surveys are feasible
- Exceptionally accurate & specific
- Presence/absence estimates are robust (abundance estimates also possible)



Wilcox et al. 2016. Biological Conservation **194**:209–216



USFS National Genomics Center for Wildlife & Fish Conservation



Promoting eDNA sampling

- Design of species-specific markers (40 so far, another 50 in development)
- Field-proven sampling protocol
- Field equipment loans
- Sample processing @ Missoula lab
- Long-term sample archiving (eDNArchive)
- Peer-reviewed science

USDA
United States Department of Agriculture

A Protocol for Collecting Environmental DNA Samples From Streams

Kellie J. Carim, Kevin S. McKelvey, Michael K. Young, Taylor M. Wilcox, and Michael K. Schwartz



Conservation Genet Resour
DOI 10.1007/s12686-016-0548-5

TECHNICAL NOTE

An environmental DNA marker for detecting nonnative brown trout (*Salmo trutta*)

K. J. Carim¹ · T. M. Wilcox^{1,2} · M. Anderson³ · D. J. Lawrence⁴ · M. K. Young¹ · K. S. McKelvey¹ · M. K. Schwartz¹

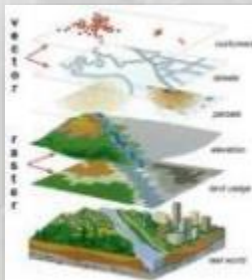
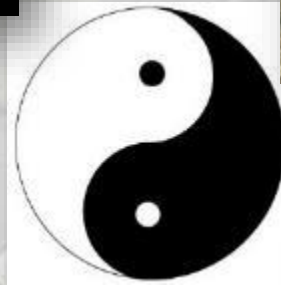
Why Crowd-Source eDNA Sampling?

Advantages: Cost-Effective & Broad Engagement

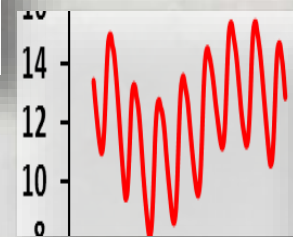
Many stakeholders



“Boots-on-the-Ground”



DATABASE



Robust scientific information

Standardized data collection protocol

Thousands of New Sites are Being Sampled Annually by Dozens of Partner Agencies

The eDNA Alliance

BLM

Bureau of Reclamation

Chehalis Tribe

Clark Fork Coalition

Coeur d'Alene Tribes

Great Northern LCC

Idaho Conservation League

Idaho DEQ

Idaho Fish and Game

Idaho Power Company

Kalispel Tribes

Montana Dept. Natural

Resources Conservation

Montana Fish, Wildlife & Parks

National Fish & Wildlife

Foundation

The Nature Conservancy



National Park Service

Oregon Dept. Fish & Wildlife

Shoshone-Bannock Tribes

Trout Unlimited

University of Washington

U.S. Fish and Wildlife Service

USFS National Forests:

Beaverhead-Deer Lodge, Boise,

Colville, Deschutes, Flathead,

Helena, Idaho Panhandle, Lolo,

Mount Baker-Snoqualmie, Nez

Perce-Clearwater, Payette, Salmon-

Challis, Sawtooth, Wallowa-

Whitman, Wenatchee

USFS Regions 1, 4, and 6

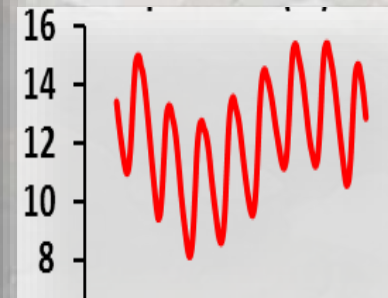
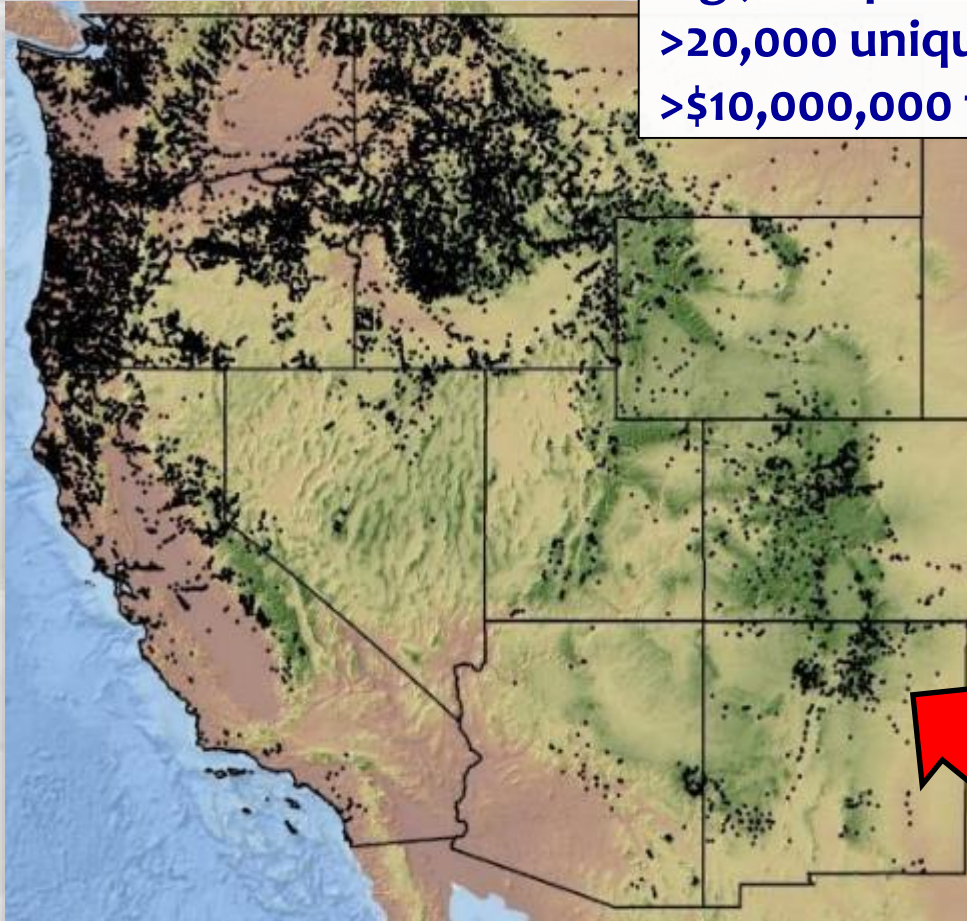
Washington Dept. Fish & Wildlife

Yakama Nation



If No Database, Result is Expensive Chaos

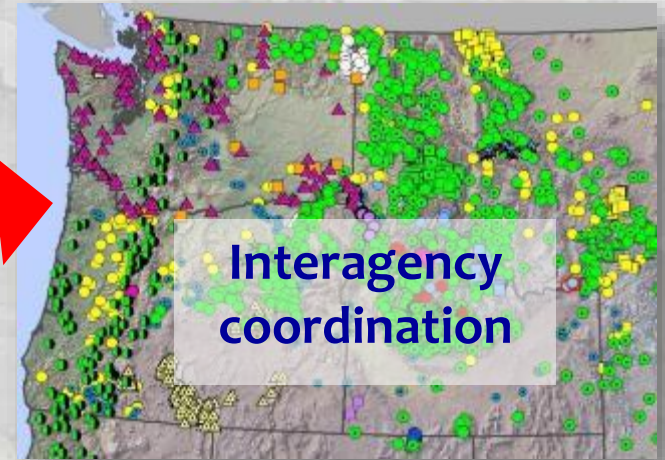
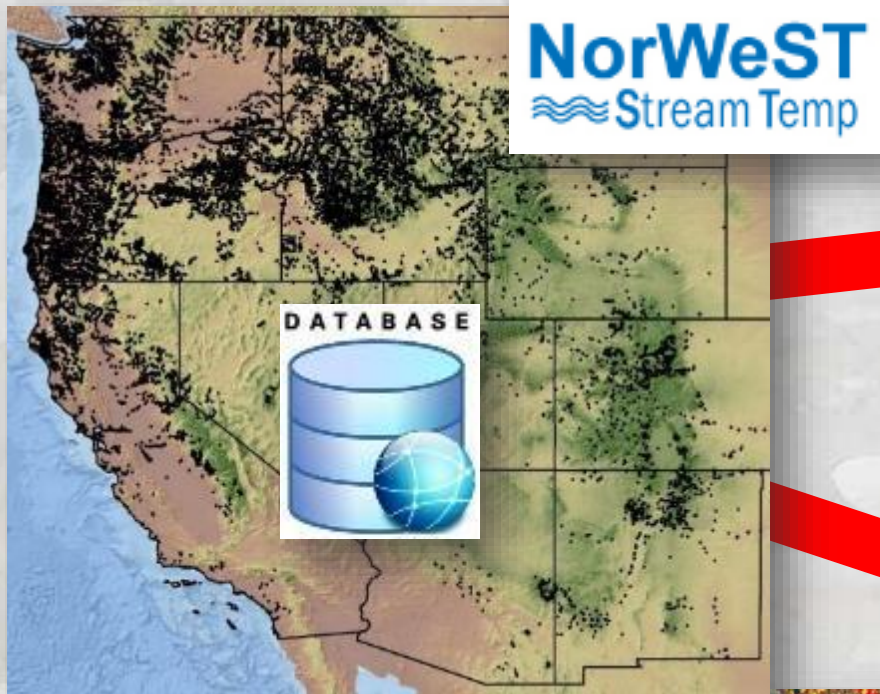
e.g., Temperature monitoring in the West
>20,000 unique stream sites
>\$10,000,000 to collect



>100 agencies

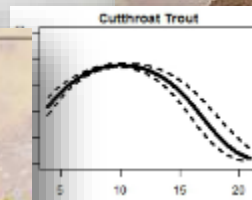
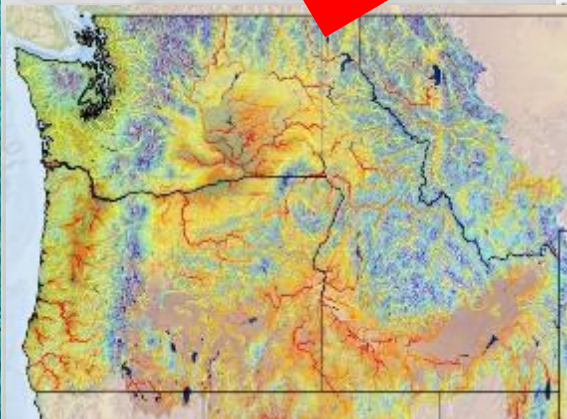
Significant redundancies, gaps in coverage, & difficulty using data

If Database, Result is Order & Efficiency

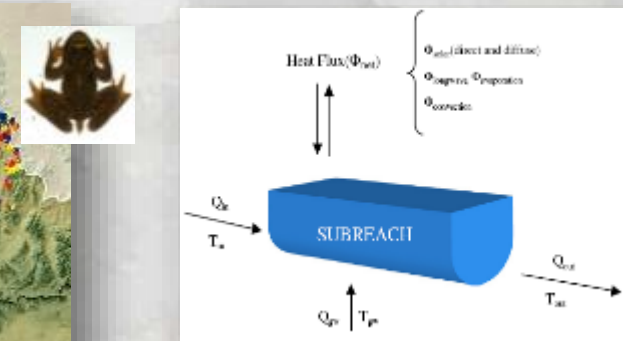


Stream temperature models

Temperature Scenarios



Thermal niche descriptions



Isaak et al. 2017. The NorWeST summer stream temperature model & scenarios for the western U.S. Water Resource Research 53:9181-9205.

eDNA Atlas Database Development

Data collected with standard protocol

QA/QC procedures
(laboratory & data)

A Protocol for Collecting Environmental DNA Samples From Streams

Kellie J. Carim, Kevin S. McKelvey, Michael K. Young, Taylor M. Wilcox, and Michael K. Schwartz

General Technical Report
RMRS-GTR-355

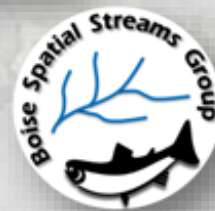
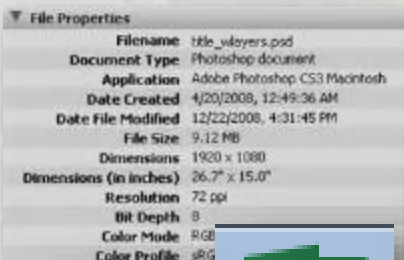


	A	B	C
1			
2	Stream: Elk Creek		
3	Georeference: 610234 E, 4402546 W		
4			
5	Date	Time	Temp (°C)
6	7/15/2005	21:23	15.59
7	7/15/2005	21:53	15.11
8	7/15/2005	22:23	14.64
9	7/15/2005	22:53	14.32
10	7/15/2005	23:23	13.88
11	7/15/2005	23:53	
12	7/16/2005	0:23	



Metadata documentation &
website delivery in user-friendly
formats

Database entry (relational
& geospatial)



Aquatic eDNA Atlas Project Website:

<https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAAtlas-project.html>



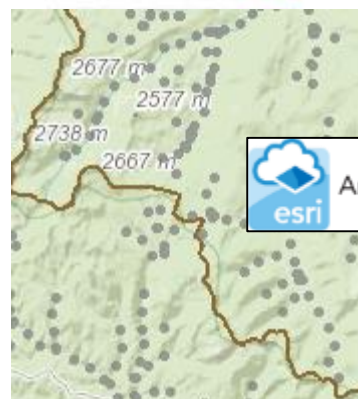
Subpage Resources



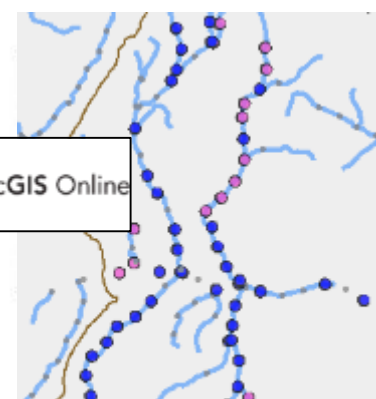
**Supporting
Science**



**FAQ &
Protocol**



**Field sampling
site grid**



**eDNA Atlas
Results**

Dynamic Maptool Delivers Data in User-Friendly Digital Formats w/Metadata



ArcGIS Online

Project - USFS RMRS

| The Range-Wide Bull Trout eDNA Project | National Gen

Legend

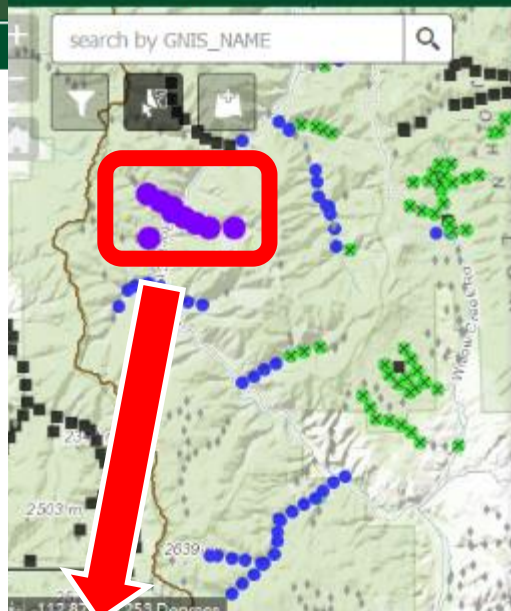
Points

eDNA Field Collection Sites (

- ◆ not sampled
- sampled, bull trout absent
- sampled, bull trout present
- sampled, being processed

Watershed Polygons

Bull Trout Distribution Watersheds



Select up to 1000 records

- Select Clear
- eDNA Field Collection Sites (9 ...
 - eDNA Field Collection Sites (0 ...
 - Climate Shield Natal Habitat Patches 0 ...
 - USFWS Spawning and Rearing Critical H... 0 ...
 - Bull Trout Distribution Watersheds 0 ...

Extract Points by Area of Interest



Feature Format*

Shapefile - SHP - .shp

[Help](#)

Execute

eDNA sample metadata

BT_Present	BTPresentT	Date_Coll	Datasou	GNIS_NAME	HUC8_Name	COMID	Site_ID	REACHCODE
2	sampled, bull trout absent	7/18/2016		Butte Cabin Creek	Flint-Rock	24310459	873-1	170102020003
3	sampled, bull trout present	7/18/2016		Butte Cabin Creek	Flint-Rock	24310455	885-4	170102020003

859 features 9 selected

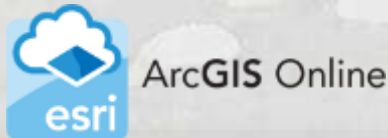
eDNA Atlas Samples are Also a Reusable Database (i.e., eDNA Archive)

One eDNA sample useful for many species



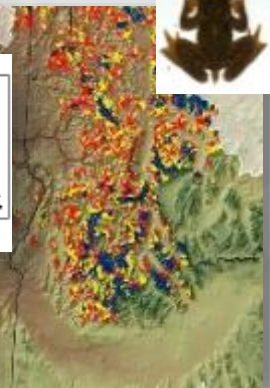
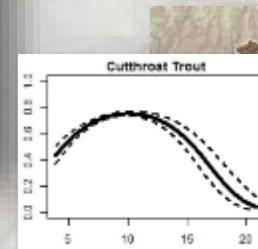
Filling in the **A**tlas: eDNA Sampling Site Grid for New Field Collections

- 1-km spacing of points with unique database IDs
- Snapped to 1:100,000 NHD streamlines
- Download point coordinates & load to GPS
- Collect sample & mail to NGC



eDNA Atlas Database Uses...

- 1) Species distribution models for prediction of climate refugia
- 2) Species status assessments (e.g., regional bull trout project, spikedace/loach minnow, Pacific lamprey...)
- 3) Trend monitoring at one or many sites (scalable extent & grain)
- 4) Detection & tracking of nonnative species invasions
- 5) Assessment of habitat restoration efforts (e.g., fish passage improvements, eradication of invasive species, etc.)



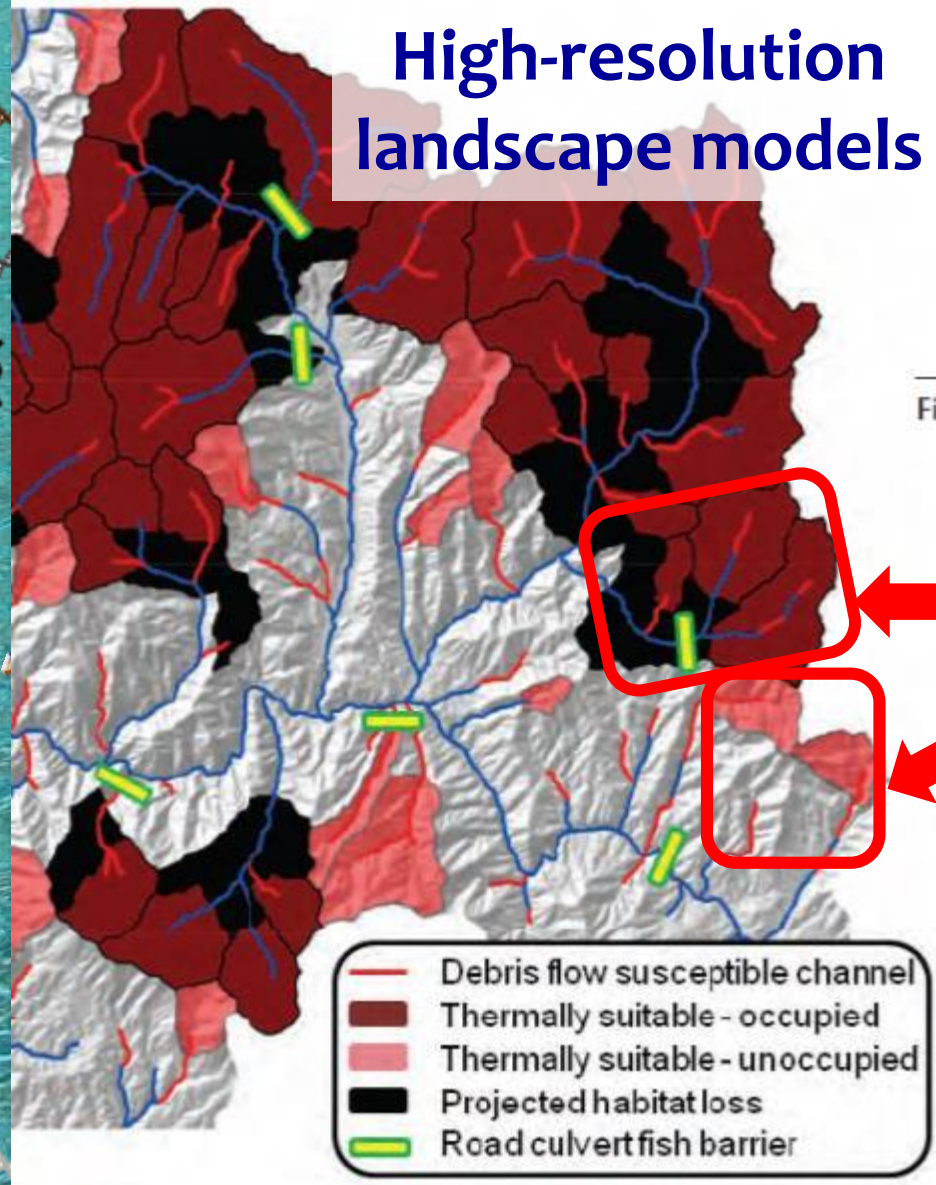
Advantages of Centralized, Open-Access eDNA Atlas Database:

- 1) Efficiencies of scale (i.e., you become part of a massive biological sensing network)
- 2) System gains efficiency as database size increases each year
- 3) System coevolves & improves from close collaborations between researchers & managers
- 4) Consistent data format & metadata documentation facilitates communication within & among agencies
- 5) Samples archived at NGC can be reused in the future
- 6) No reinventing of technical wheels (i.e., website/database design, geospatial stuff, etc.)



Goal: Big Databases & Good Information for All Species

High-resolution landscape models



I'm going to invest here...

... instead of here



If Interested in Joining the eDNA Alliance to Map Aquatic Biodiversity, Contact...



Mike Schwartz

**John
Rothlisberger**



Mike Young

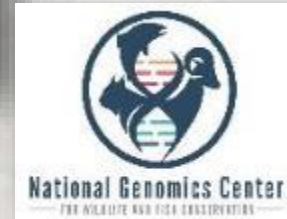


Dan Isaak

Dan Shively



**Kevin
McKelvey**



Atlas website: <https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAAtlas-project.html>

NGC Website: <https://www.fs.fed.us/research/genomics-center/>