

# Strategically Consistent Information Across Broad Areas for Planning Lands Administered by USFS



**193 Million Acres  
(10% of US)  
155 National Forests  
1,00,000 stream km**

**Diverse streams**

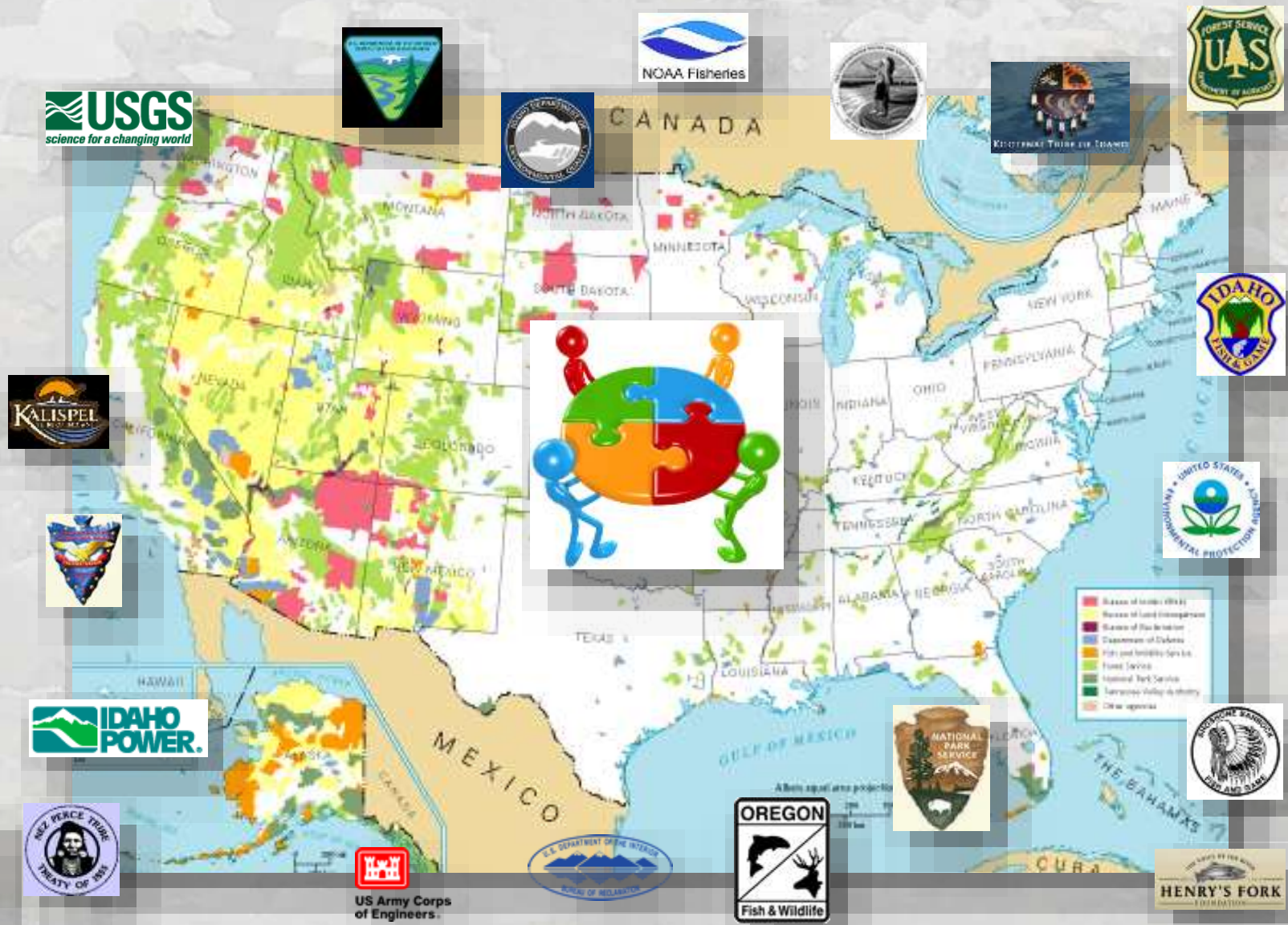


**Remote  
landscapes**



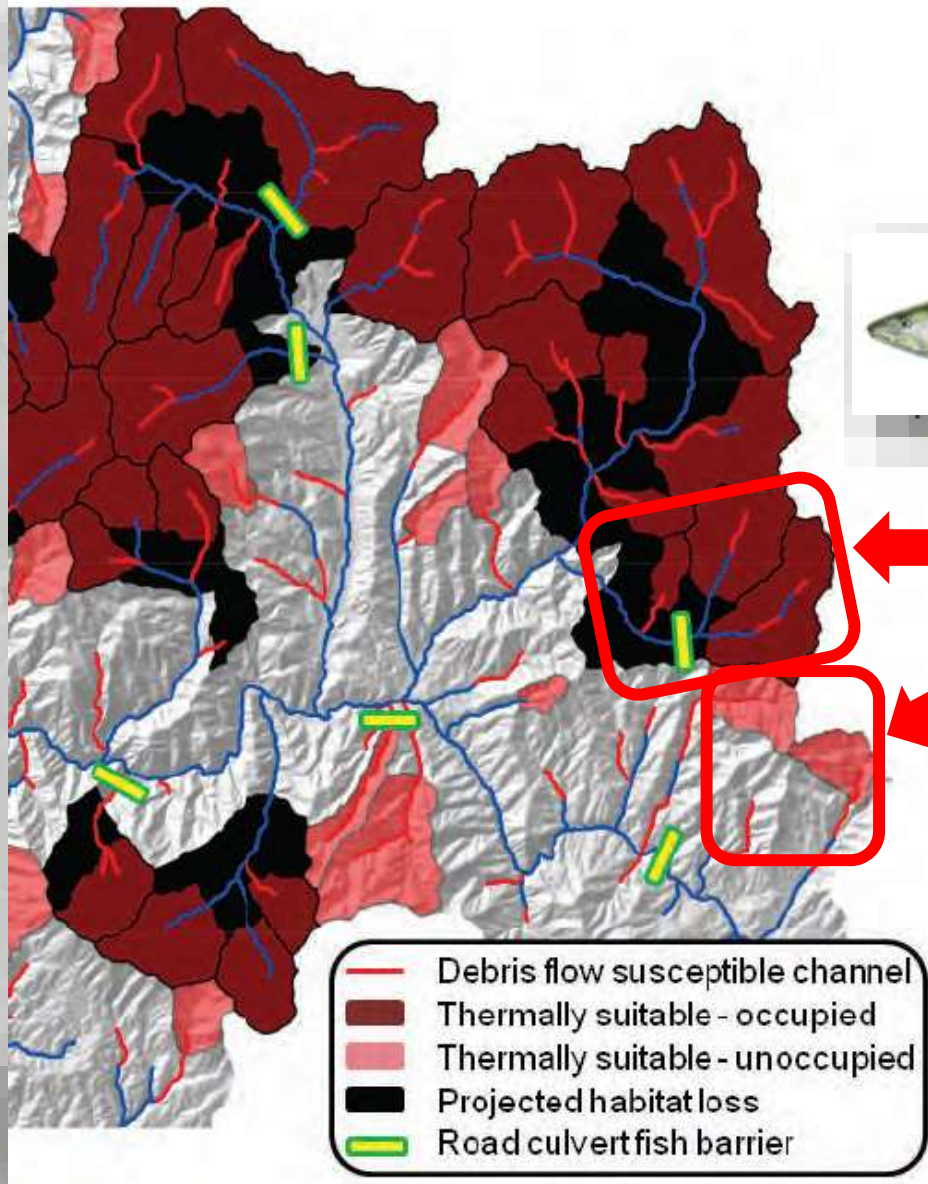


# Strategically Consistent Information Across Agencies for Coordination





# Tactically Precise Information for Local Decisions & Project Implementation



I'm going to invest here...

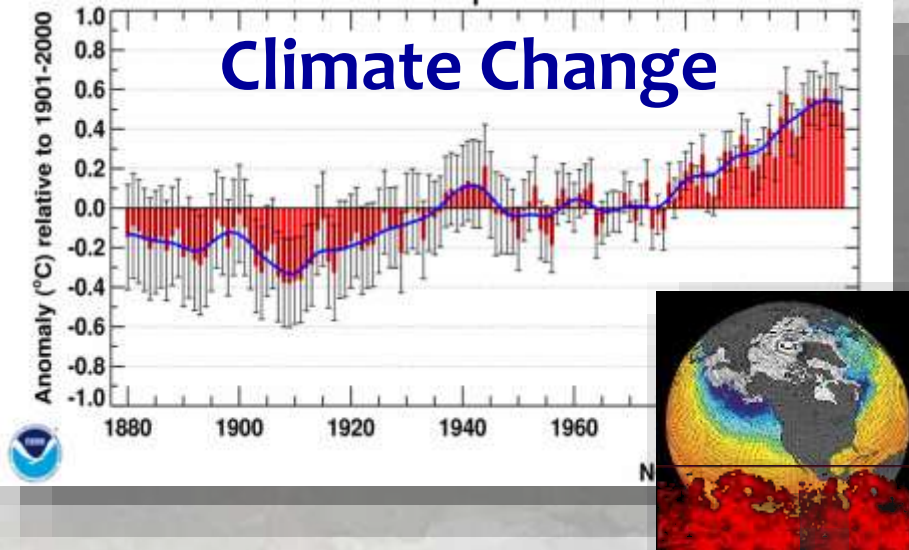
... instead of here





# More Pressure, Fewer Resources

## Climate Change



## Urbanization & Population Growth



## Shrinking Budgets

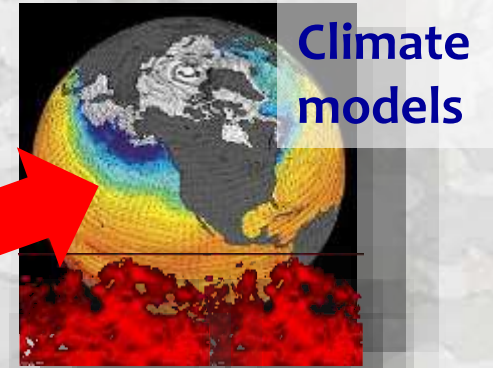
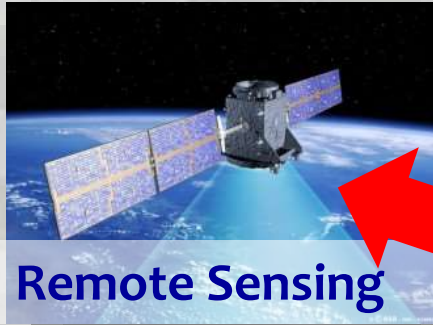


Need to do more with less



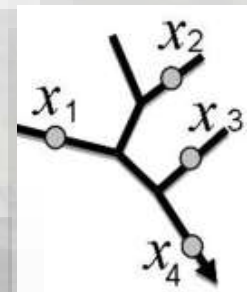
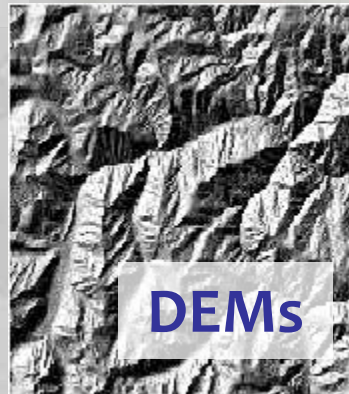


# Technology Is a Force Multiplier



Nationally Geospatial Frameworks

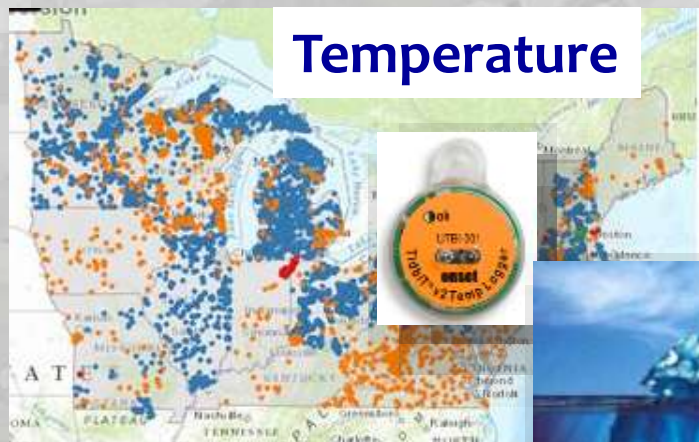
Spatial analyses



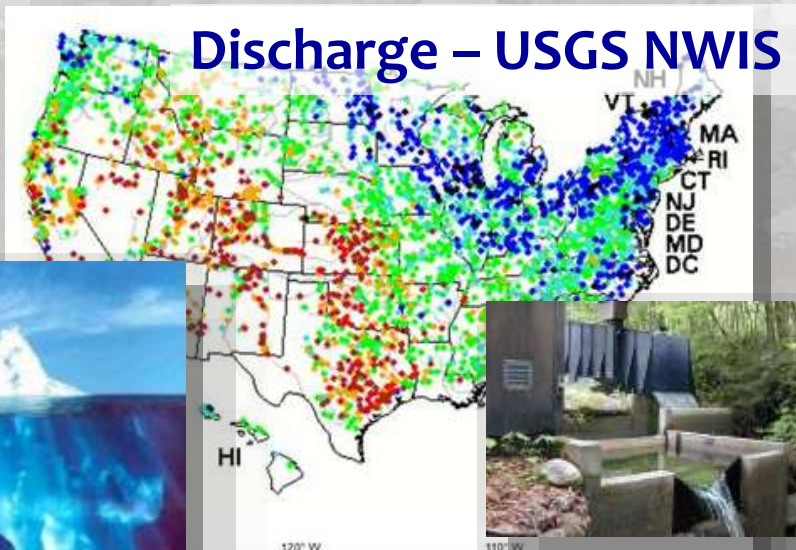


# Mountains of Messy Datasets

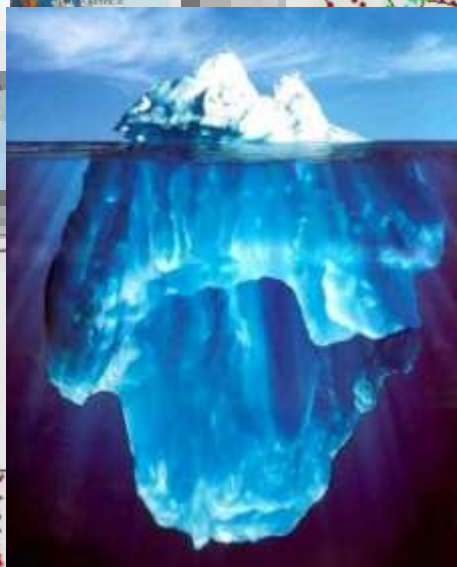
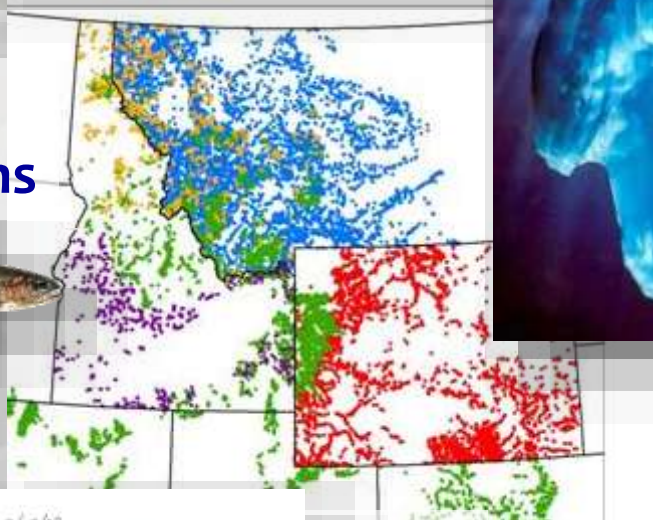
Temperature



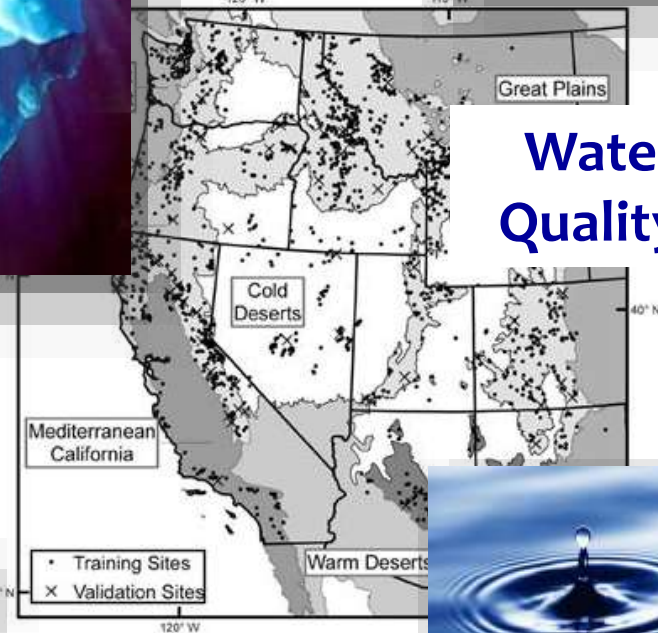
Discharge – USGS NWIS



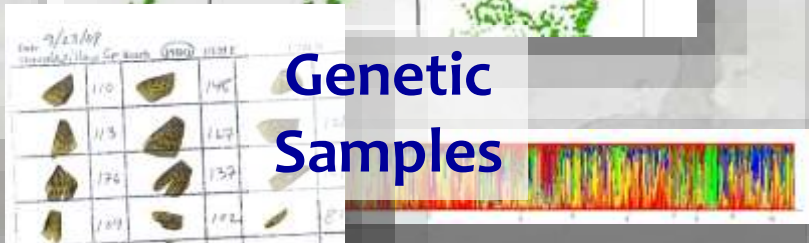
Species distributions



Water Quality



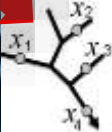
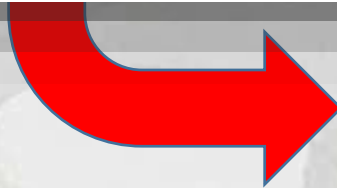
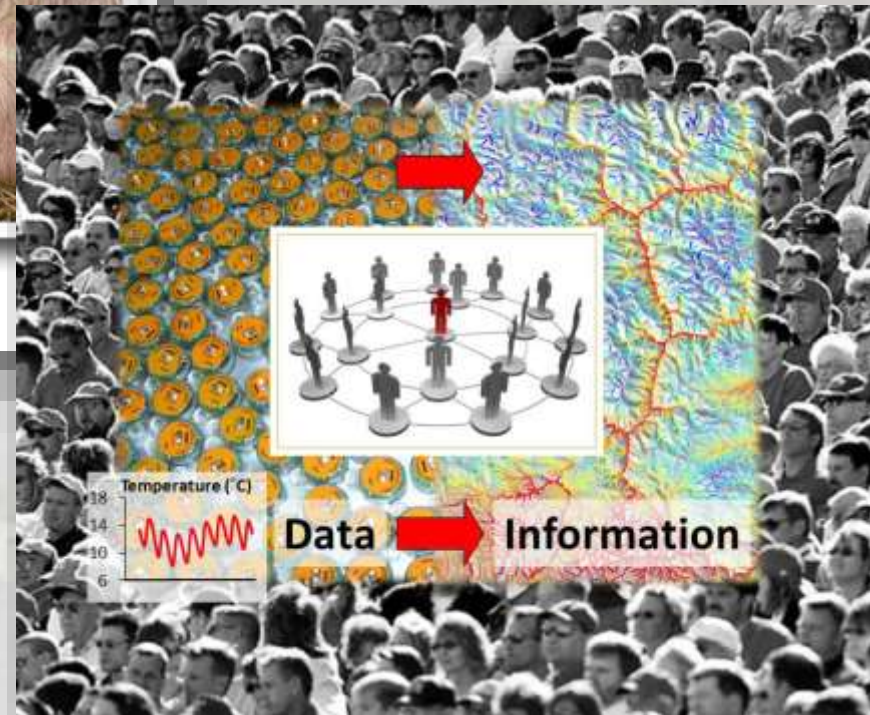
Genetic Samples





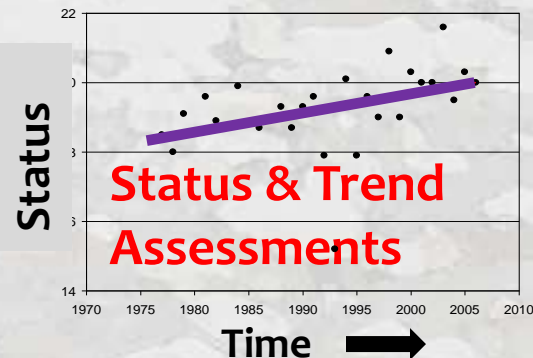
# Making silk purses from sow's ears:

## Big data mining & crowd-sourcing for natural resource science & management

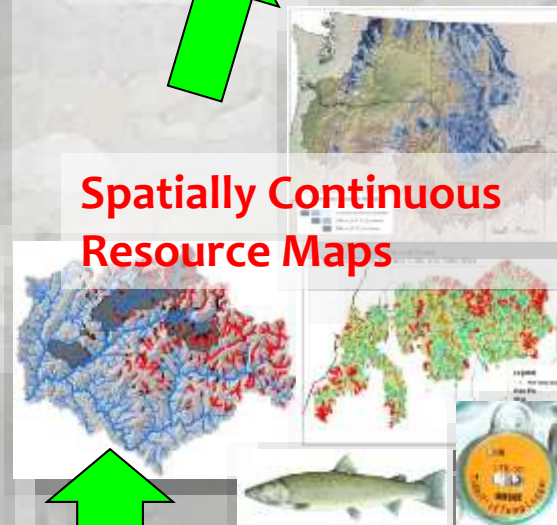




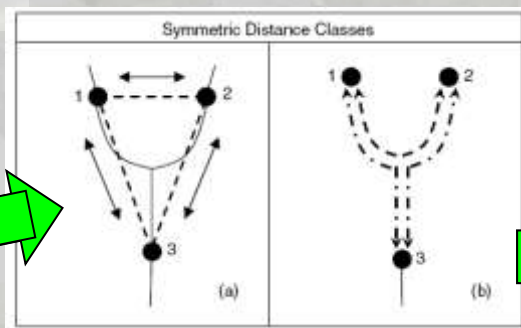
# Data $\neq$ Database



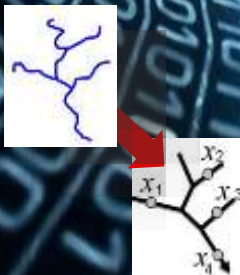
Spatially Continuous Resource Maps



Analysis



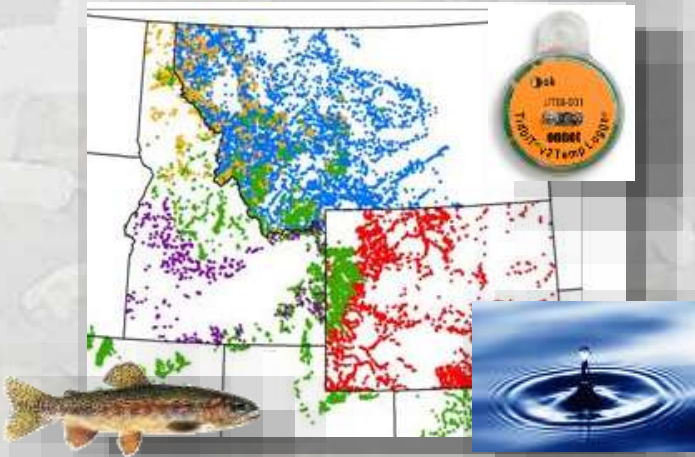
More data,  
monitoring  
design





# Steps in Database Development

## Data Aggregation



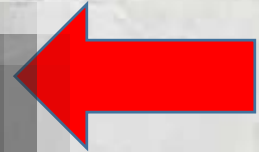
## QA/QC Data Cleaning



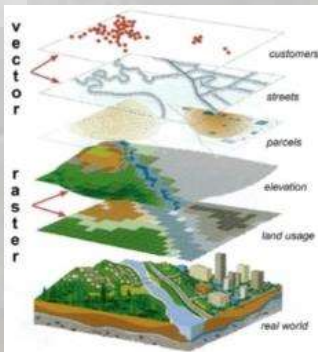
	A	B	C
1			
2	Stream: Elk Creek		
3	Georeference: 610234 E, 4402546 W		
	Date	Time	Temp (°C)
7	7/15/2005	21:23	15.59
8	7/15/2005	21:53	15.11
9	7/15/2005	22:23	14.64
10	7/15/2005	22:53	14.32
11	7/15/2005	23:23	13.86
12	7/15/2005	23:53	13.55
13	7/15/2005	0:23	13.24



## Data Summaries & Georeferencing



## Metadata & Digitally Archiving



Mean

Minimum

Maximum



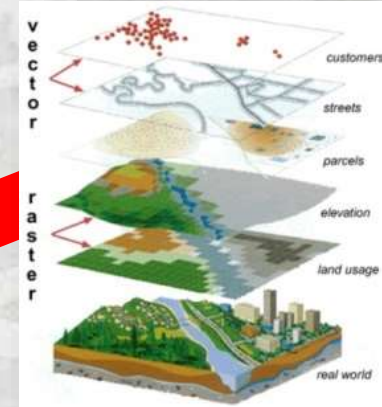


# Specialized Science-Data Teams Required

Managers



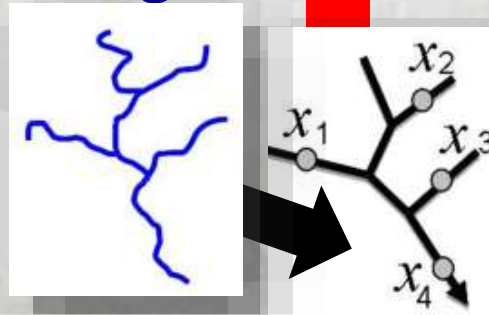
GIS analysts



Scientists



Ecological Modelers

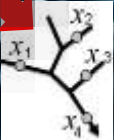


Database experts





# It Takes Teamwork & Camaraderie

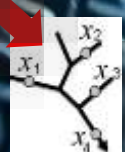
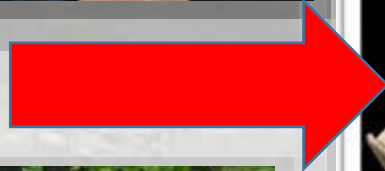
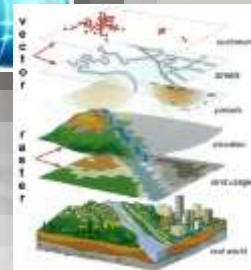
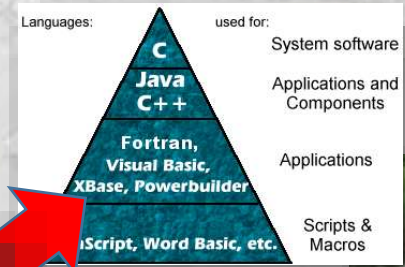




# Ongoing Learning is Required

Original skills

Current skills

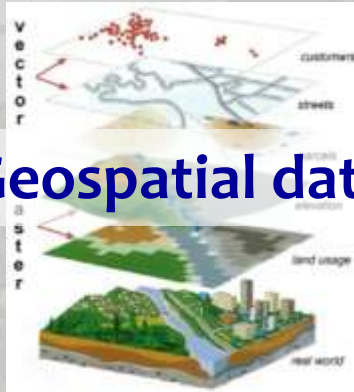




# Technology Is a Force Multiplier

## Information Dissemination & Adoption

Geospatial data



Email chat  
& BLOGs



Workshops



Publication



Digital media



Webpages



Forest  
Plans



United States  
Department of  
Agriculture

Forest Service

Northern Region

March 2007

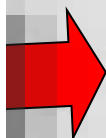
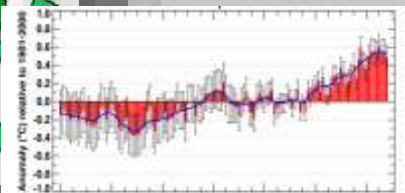


**Land Management Plan**  
Clearwater National Forest



# A Real-World Example

## Climate Boogeyman



## Recreational Fisheries

Low Flows Prompt Fishing Closure On Upper Beaverhead River And Reduced Limits On Clark Canyon Reservoir

Wednesday, September 29, 2004  
Fishing

High Water  
Temperature In Grande  
Ronde Kills 239 Adult  
Spring Chinook



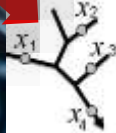
**\$4 Billion on Fish & Wildlife Recovery Efforts in PNW Since 1980 (ISAB/ISRP 2007)**



## ESA Listed Species



## Land Use & Water Development

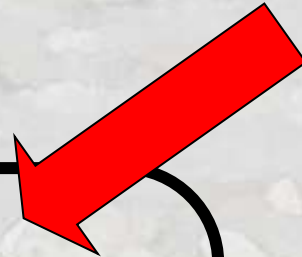
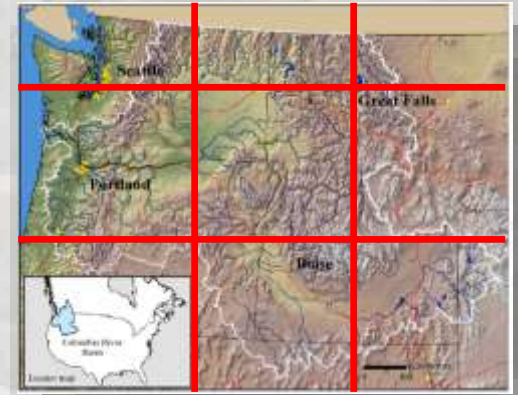
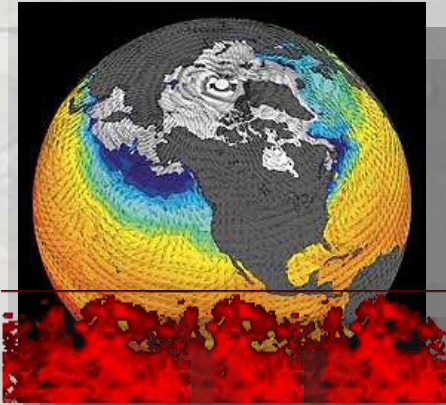




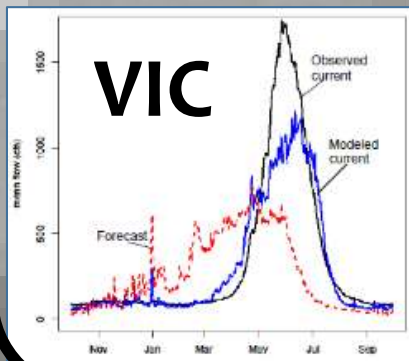
# Need: High Resolution Stream Scenarios to Provide Management-Relevant Information

Global climate models  
Resolution: 1000s of kilometers

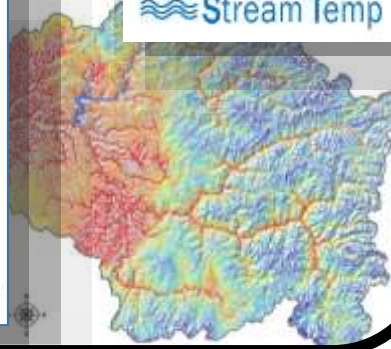
Regional patterns  
Resolution: 10s kilometers



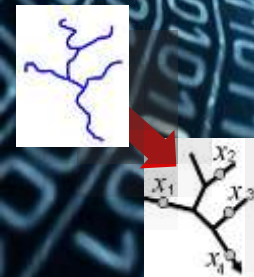
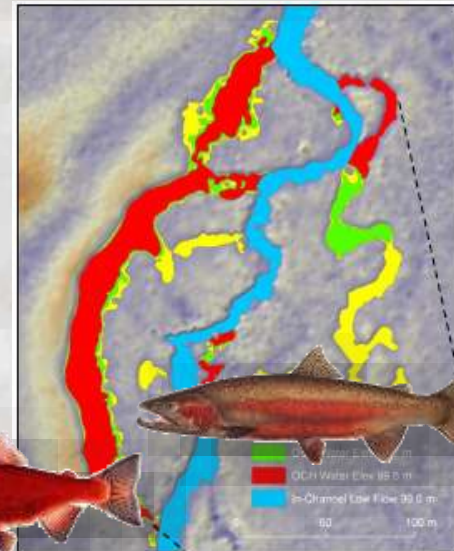
River network  
temperature & flow



**NorWeST**  
Stream Temp



Stream reach





# Step 1: Forge Disparate Data Into a Database

**Funding:**



+

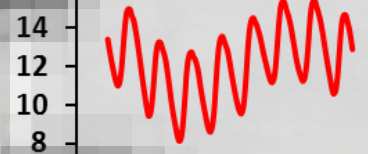


**Expertise**



**NorWeST**  
Stream Temp

Temperature (°C)



Time



**>100 agencies**

**>200,000,000 hourly records**

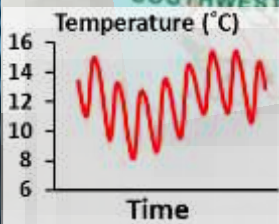
**>20,000 unique stream sites**

**\$10,000,000**



# Data Pulled/Uploaded From/To Aquatic Surveys Module in NRM

Close coordination with Callie McConnell's database team





# Step 2: Apply Data Mining Techniques

## Covariate Predictors

1. Elevation (m)
2. Canopy (%)
3. Stream slope (%)
4. Ave Precipitation (mm)
5. Latitude (km)
6. Lakes upstream (%)
7. Baseflow Index
8. Watershed size (km<sup>2</sup>)
9. Glacier (%)

10. Discharge (m<sup>3</sup>/s)

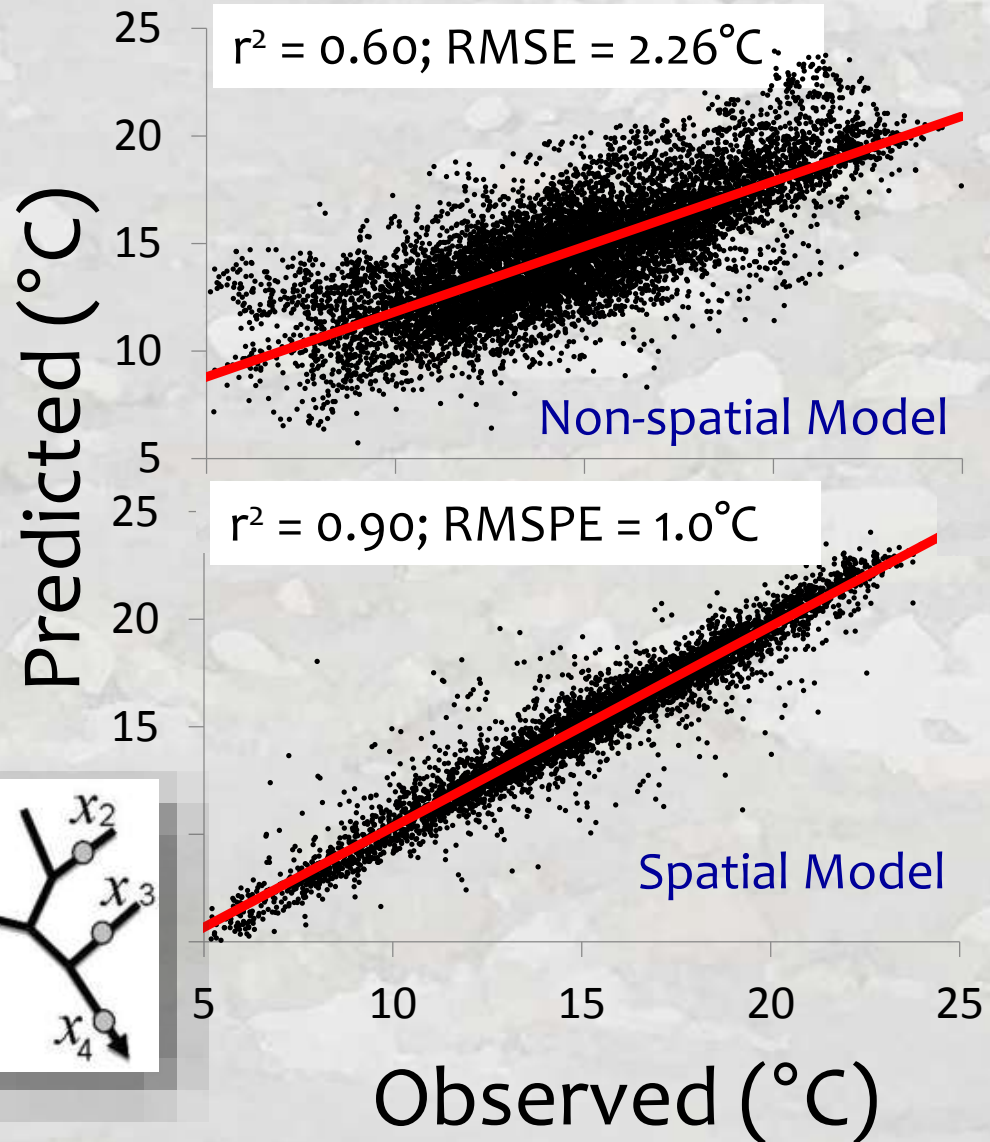
**USGS gage data**

11. Air Temperature (°C)

**RegCM3 NCEP reanalysis**

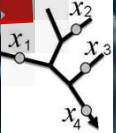
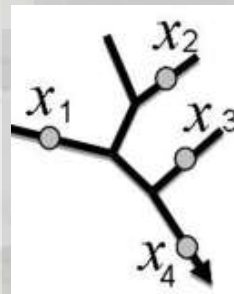
**Hostetler et al. 2011**

## Mean August Temperature



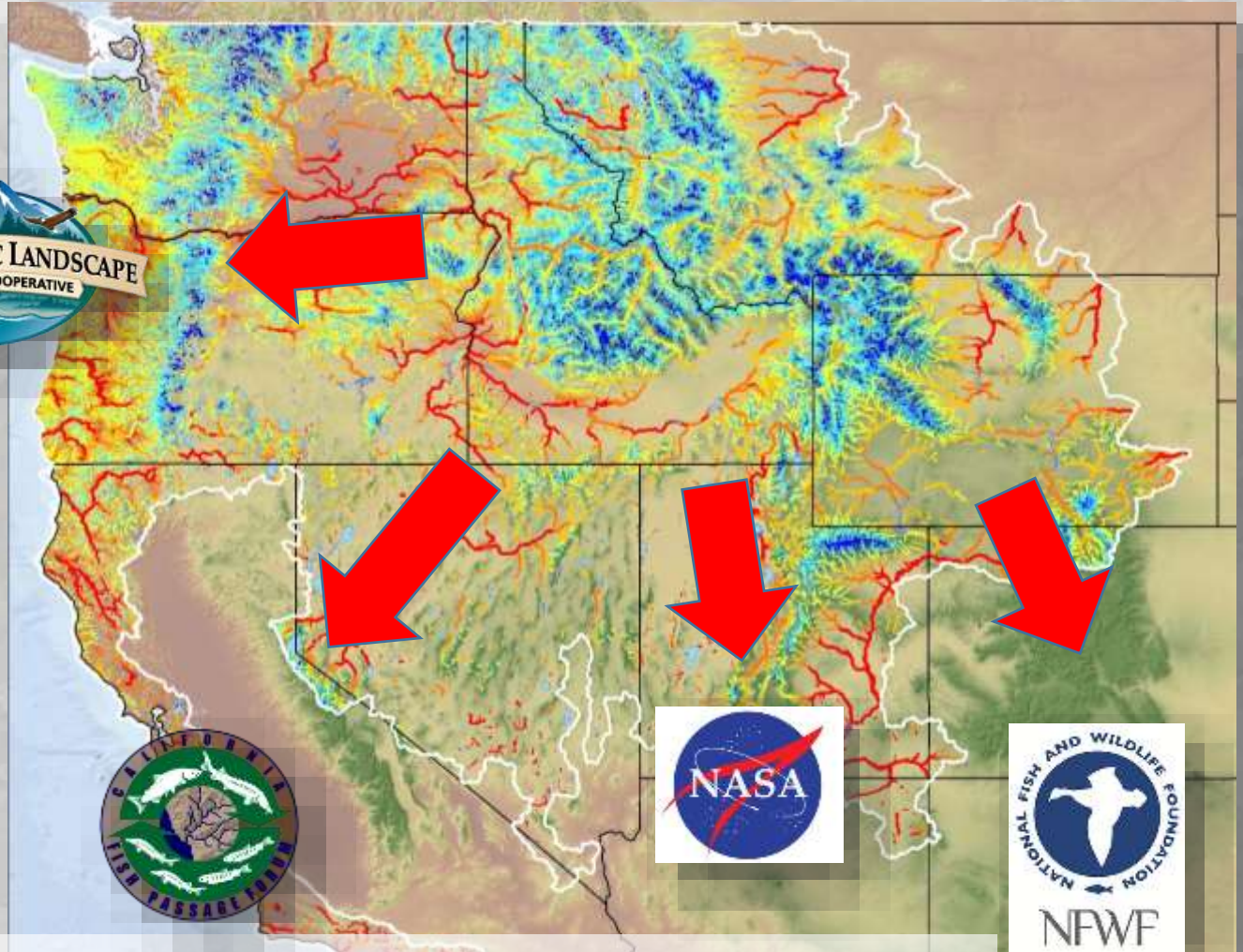
*Ecological Applications*

20:1350-1370.



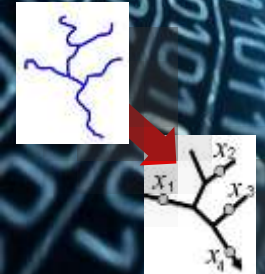


# Step 3: Map Interpolated Stream Scenarios



Organic expansion across the West

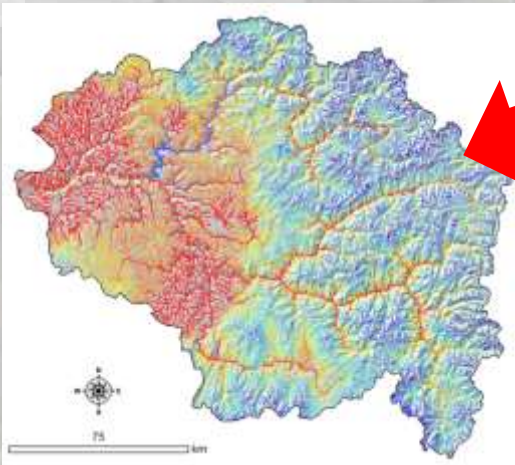
80 National Forests & All Other Lands



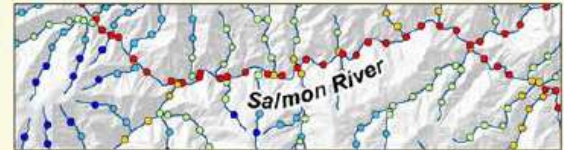


# Step 4: Design Custom Website to Distribute Information in User-Friendly Digital Formats

1) GIS shapefiles of stream temperature scenarios



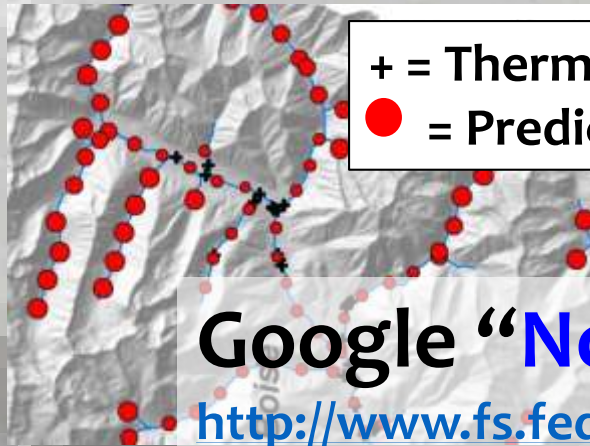
**NorWeST**  
Stream Temp



*Regional Database and Modeled Stream Temperatures*

3) Temperature data summaries

2) GIS shapefiles of stream temperature model prediction precision



+ = Thermograph  
● = Prediction SE

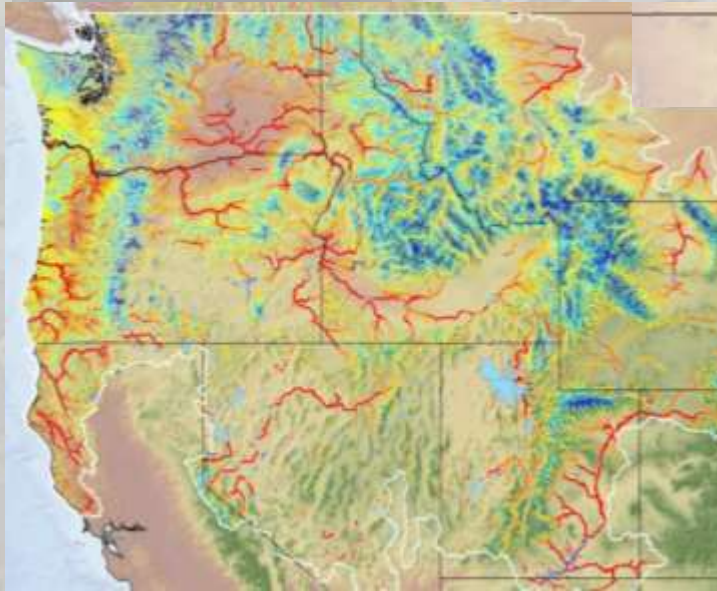


Google **“NorWeST”** or go here...

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



# Temperature Applications

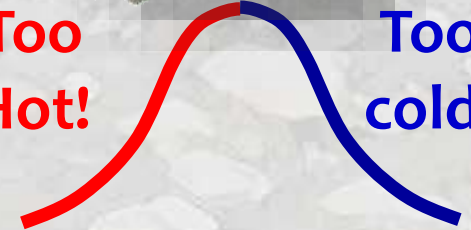


Regulatory temperature standards

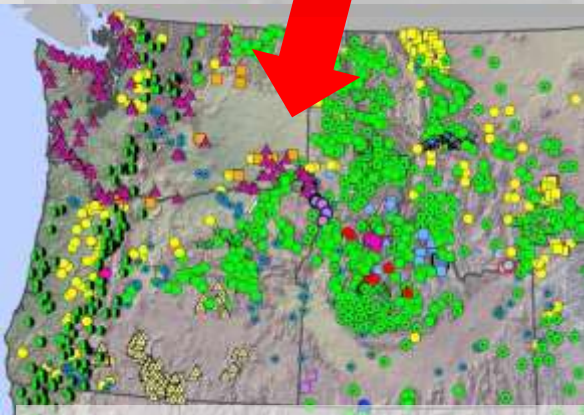


Too Hot!

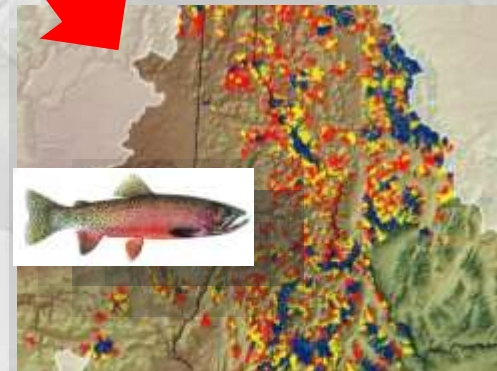
Too cold!



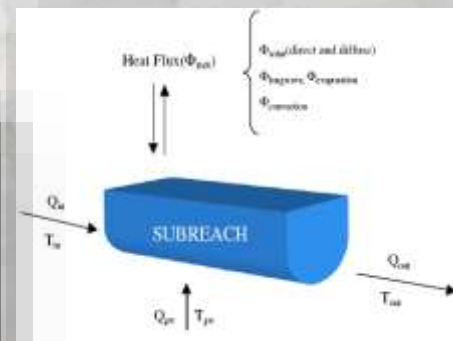
Data access accelerates temperature research



Coordinated Interagency monitoring



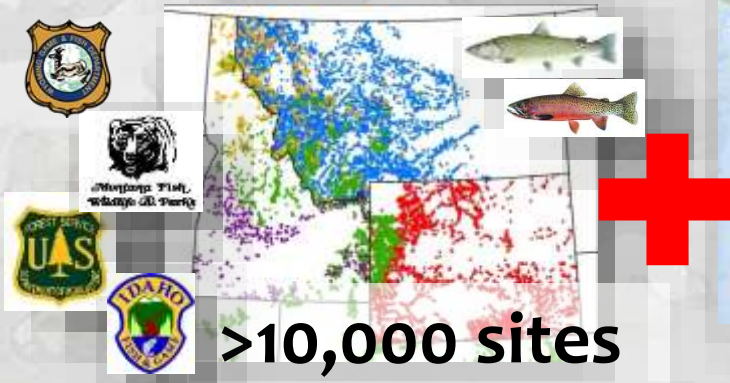
Species distribution models & climate assessments



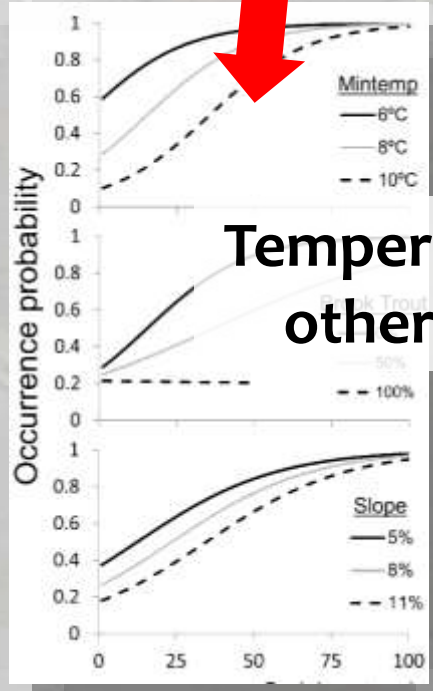
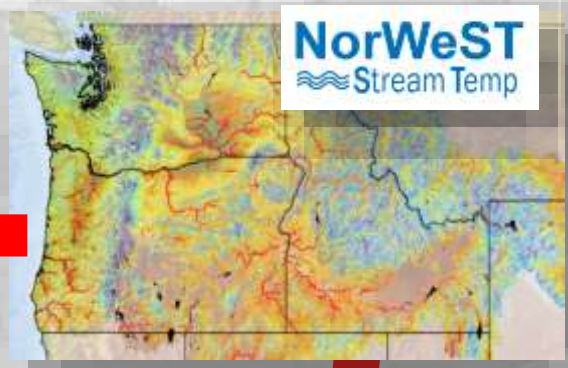
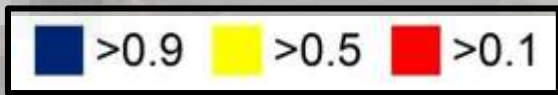


# Climate Refugia Maps for Cold-water Species

## BIG FISH DATA

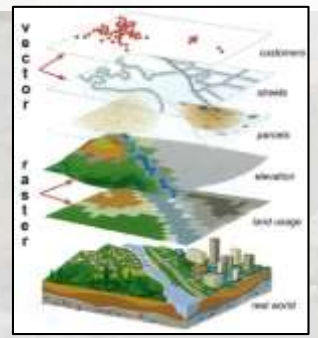


>10,000 sites



Temperature, flow & other predictors

Precise Species Occurrence Maps







# Website Provides Information in User-Friendly Digital Formats

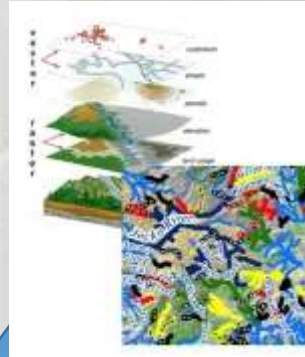


Just Google “Climate shield trout”

**Presentations & Publications**



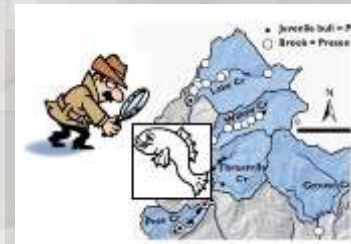
**Digital Maps & ArcGIS Shapefiles**



**Fish Data Sources**



**Distribution Monitoring**

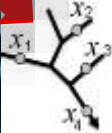


**File formats:**

- ArcGIS files
- pdf files

**15 Scenarios:**






- 3 climate periods
- 5 Brook invasion levels




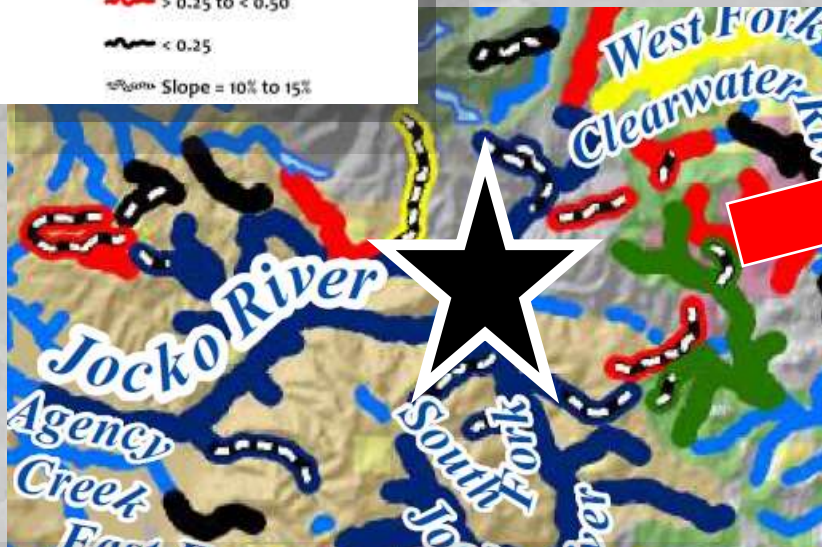


# High-quality Spatial Information Empowers Local Decision Makers...

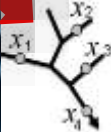
## Occupancy Probability

-  > 0.90
-  > 0.75 to < 0.90
-  > 0.50 to < 0.75
-  > 0.25 to < 0.50
-  < 0.25

 Slope = 10% to 15%



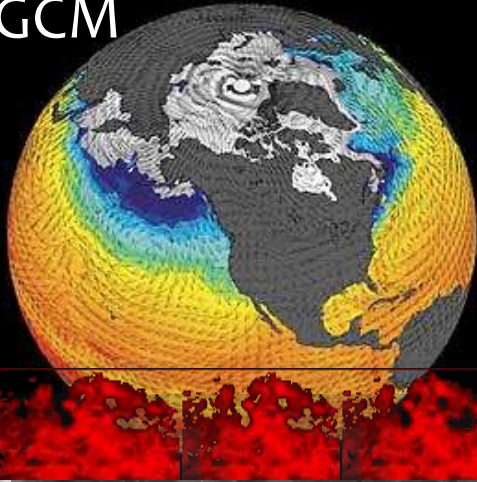
**Highest priority  
conservation  
investment!**



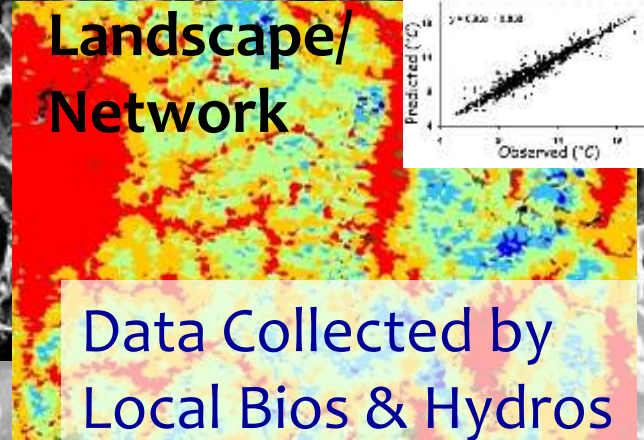


# Crowd-Sourcing Science Engages Everyone & All Agencies

GCM



Landscape/  
Network

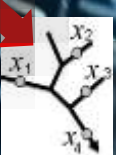


Data Collected by  
Local Bios & Hydros

Coordinated  
Management  
Responses



Management  
Decisions





# More Data Coming Faster...

## Inexpensive, Standard Data Protocols



### A Watershed-Scale Monitoring Protocol for Bull Trout

Dan Isaak, Bruce Rieman, and Dona Horan

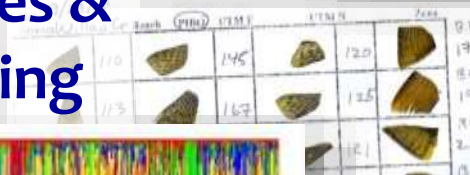
## Species distribution & abundance



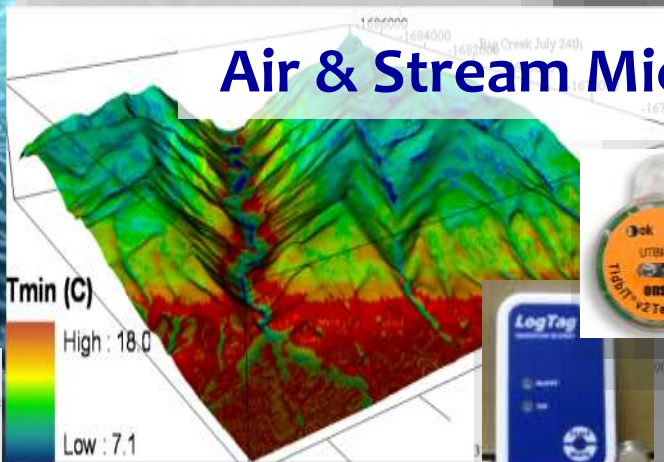
## Stream discharge



## Tissue Samples & DNA barcoding



## Air & Stream Microclimates



### A Simple Protocol Using Underwater Epoxy to Install Annual Temperature Monitoring Sites in Rivers and Streams

Daniel J. Isaak  
Dona L. Horan  
Sherry P. Wollrab



Short communication

Design and evaluation of an inexpensive radiation shield for monitoring surface air temperatures

Zachary A. Holden<sup>a,\*</sup>, Anna E. Klene<sup>b</sup>, Robert F. Keefe<sup>c</sup>, Gretchen G. Moisen<sup>d</sup>



# eDNA Revolution: Reliable biodiversity assessments



## USFS National Genomics Center for Wildlife & Fish Conservation

- Pioneered the technique for salmonids
- Species specific, highly reliable (1 trout / 100 m = 85% detection)
- Field-proven protocol
- Cost: \$70 sample



**Mike Schwartz**  
**Mike Young**  
**Kevin McKelvey**

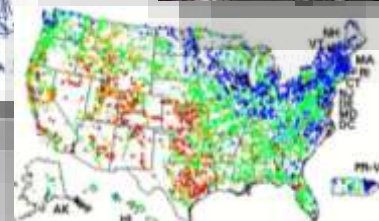
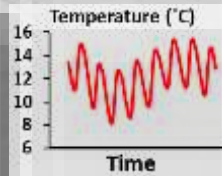


# The National Stream Internet

## An Analytical Infrastructure for Stream Data



LANDSCAPE  
CONSERVATION  
COOPERATIVES





# A Stream Internet is...

A network of people, databases, digital information systems & analytical techniques that interact synergistically to create & communicate massive amounts of information efficiently



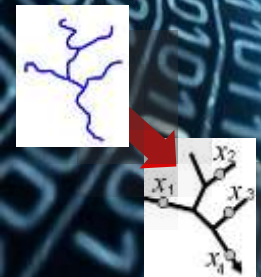
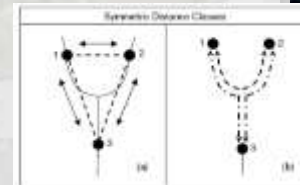
People on landscapes collecting data using standard protocols



Open access, comprehensive databases



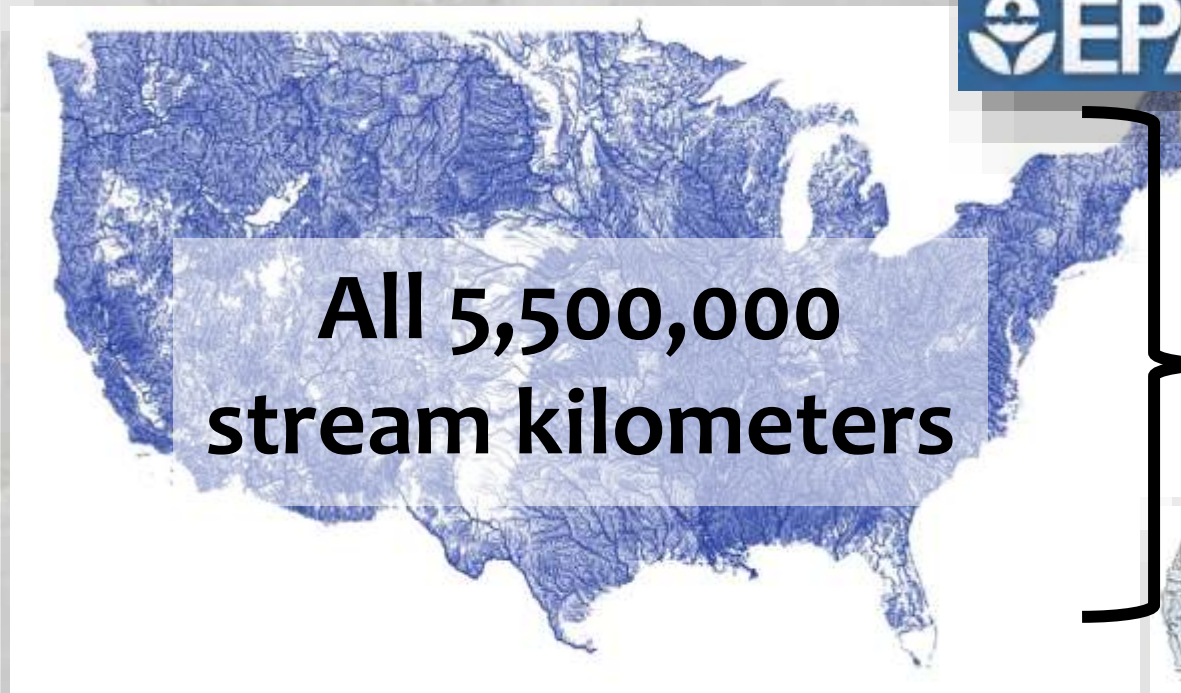
Analysis & new information





# Consistent Geospatial Framework

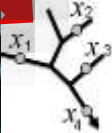
## National Hydrography Dataset



McKay et al. 2015. NHDPlus Version 2: User Guide.

Available at: [ftp://ec2-54-227-241-43.compute-1.amazonaws.com/NHDplus/NHDPlusV21/Documentation/NHDPlusV2\\_User\\_Guide.pdf](ftp://ec2-54-227-241-43.compute-1.amazonaws.com/NHDplus/NHDPlusV21/Documentation/NHDPlusV2_User_Guide.pdf)

Cooter et al. 2010. A nationally consistent NHDPlus framework for identifying interstate waters: Implications for integrated assessments and interjurisdictional TMDLs. *Environmental Management* 46:510-524.





# Website: The National Stream Internet Project



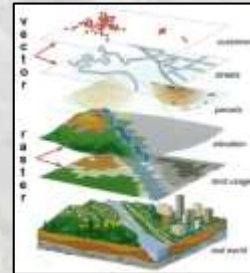
## NSI Resources



Workshop & presentations



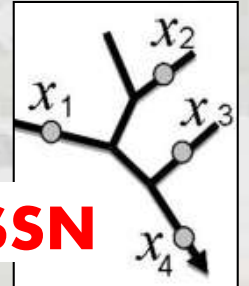
NSI hydrography network (shapefiles)



Databases of stream reach descriptors



Databases of stream measurements



Spatial stream-network models

Ideas



Data



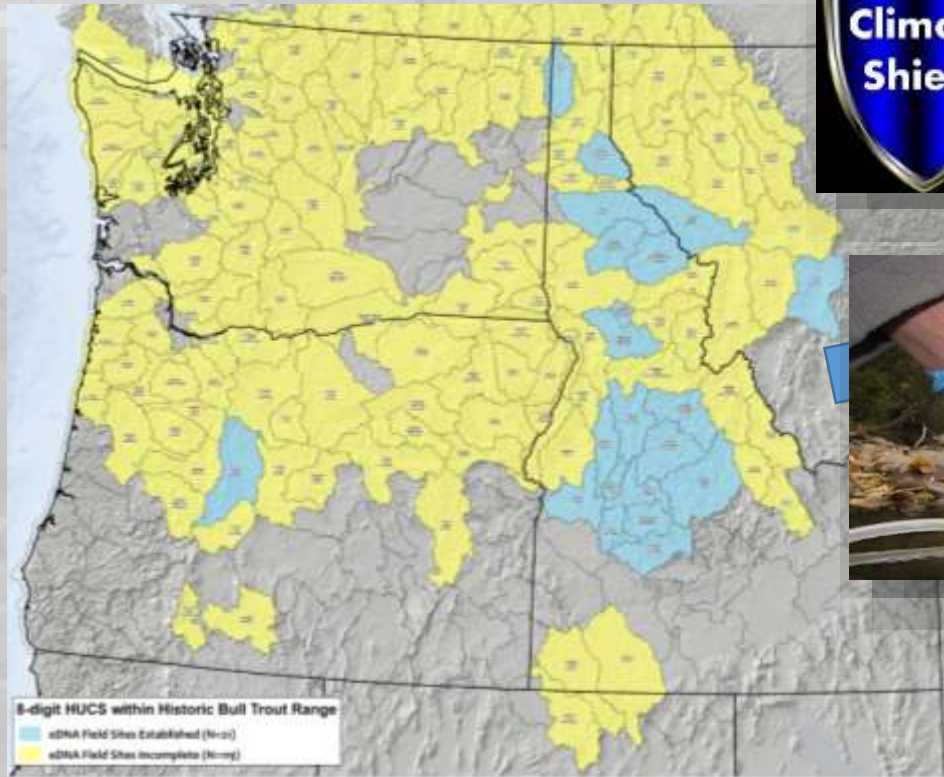
Analysis



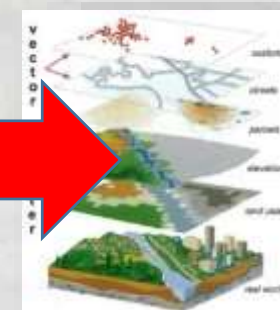
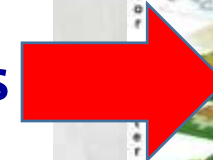
Information



# Rangewide eDNA Bull Trout Project: Industrial scale crowd-sourced field campaigns



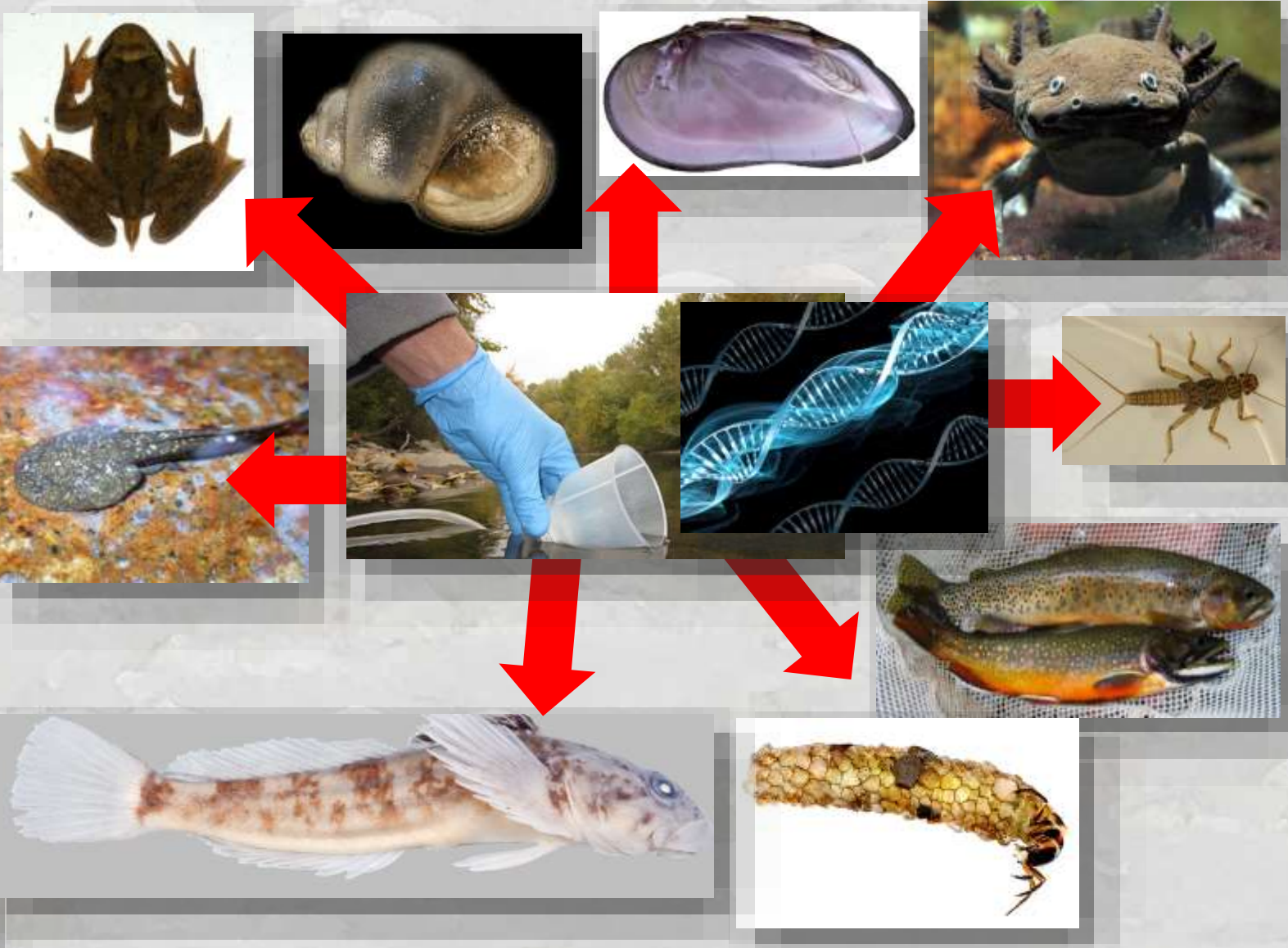
Sample sites have unique IDs & are part of digital geodatabases from day 1!





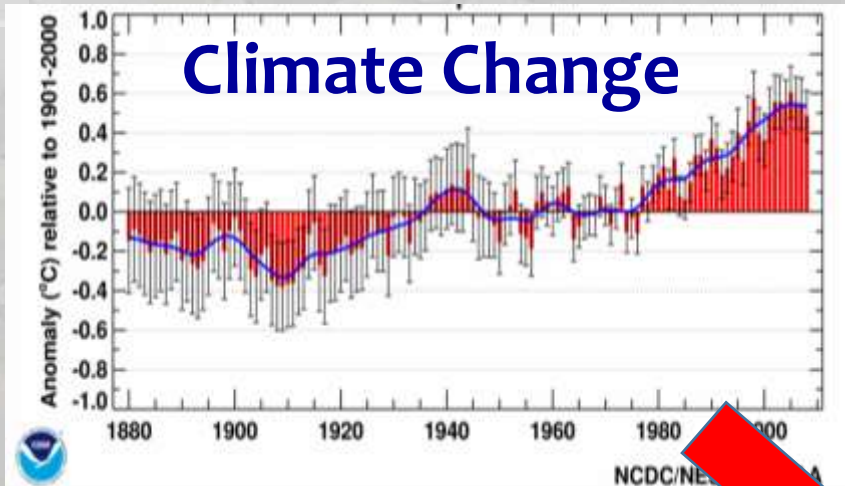
# Samples Contain eDNA for All Critters

## Key Byproduct: A Biodiversity Archive





# More With Less, but perhaps... Much More?



Urbanization & Population Growth



Shrinking Budgets

