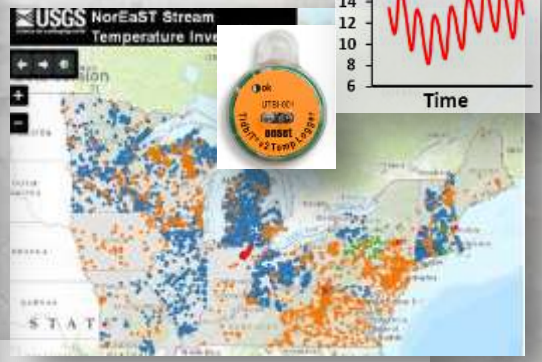
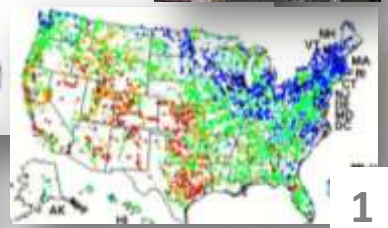
The National Stream Internet Project

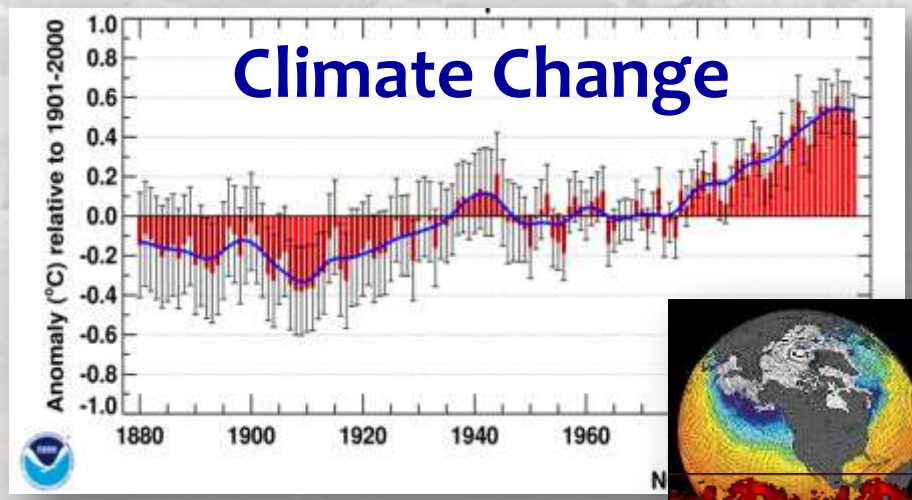
BIG DATA = BIG POSSIBILITIES

LANDSCAPE
CONSERVATION
COOPERATIVES



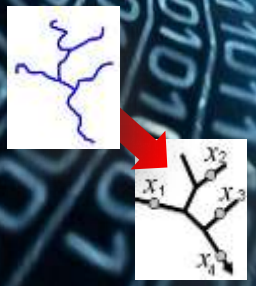


More Pressure, Fewer Resources



Urbanization & Population Growth

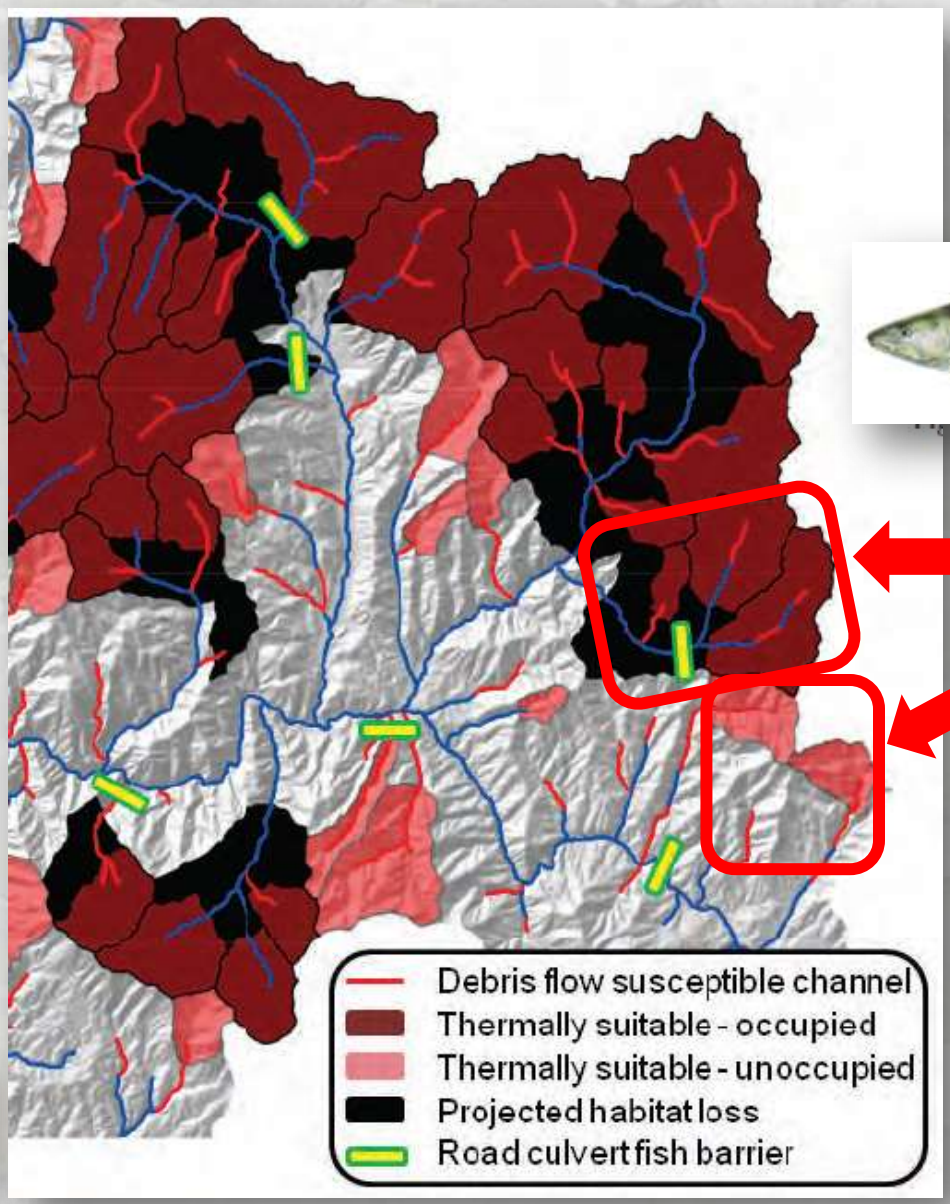
Shrinking Budgets



Need to do more with less

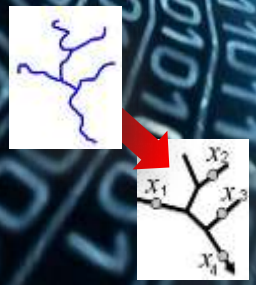
Strategically Consistent Information Across Broad Areas for Efficient Planning

Tactically Precise Information for Local Decisions & Project Implementation



I'm going to invest here…

…instead of here



A Stream Internet is…

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

People on landscapes collecting data using standard protocols

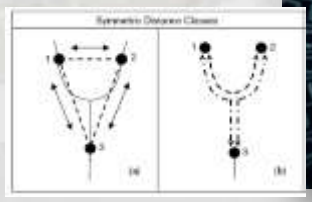
Open access, comprehensive databases

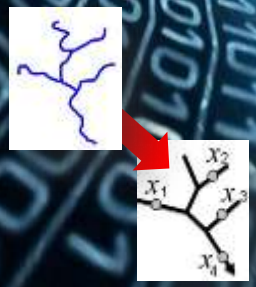
NRM

MARIS
Multistate Aquatic Resources Information System

WQX
WATER QUALITY EXCHANGE

Analysis & new information

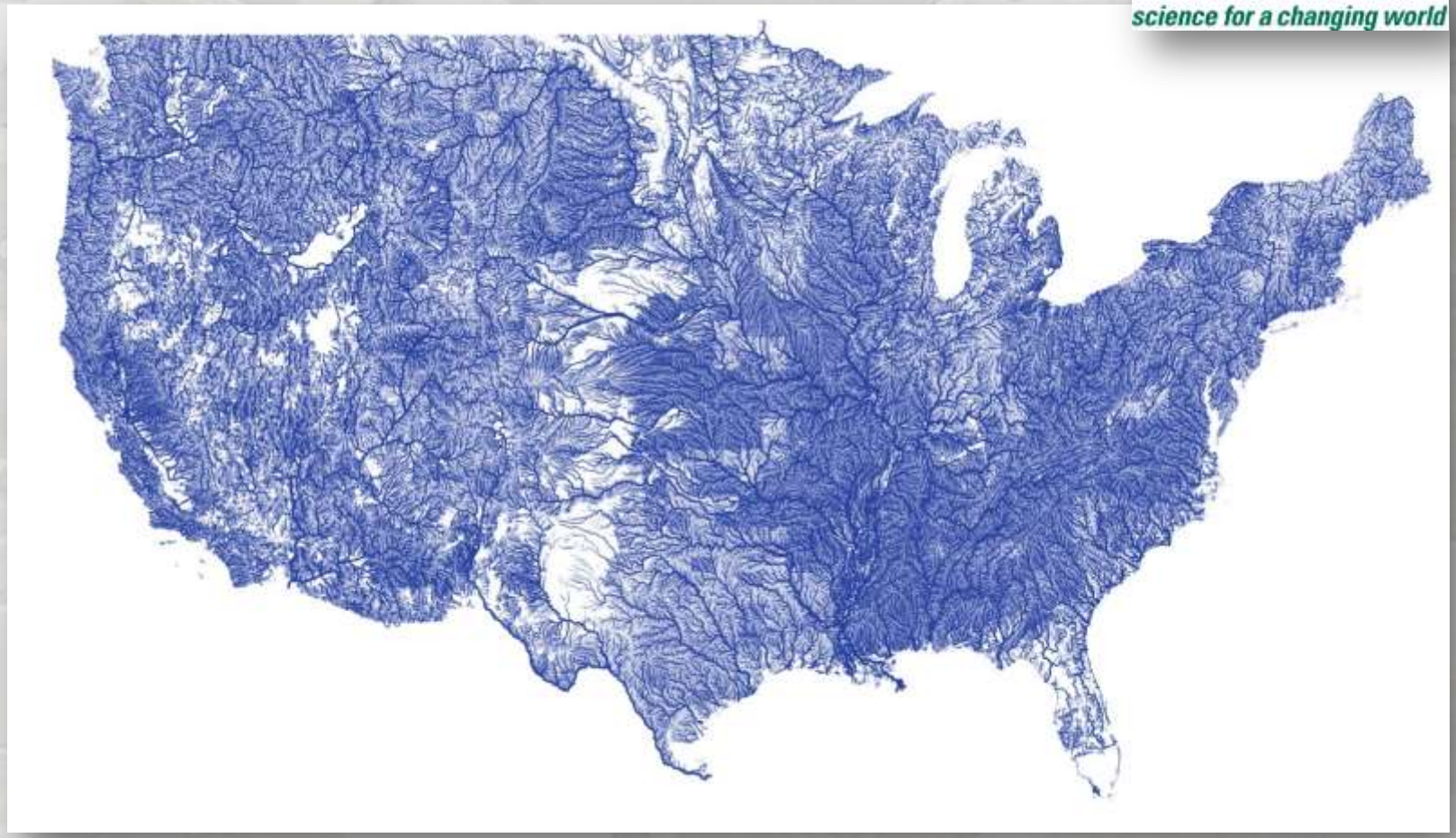


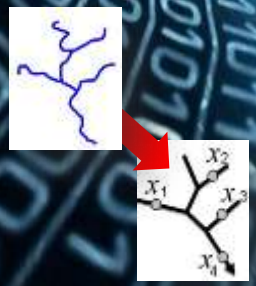


Inter-Compatibility is Key…

Key Ingredient #1: NHD Streams

Nationally consistent geospatial database



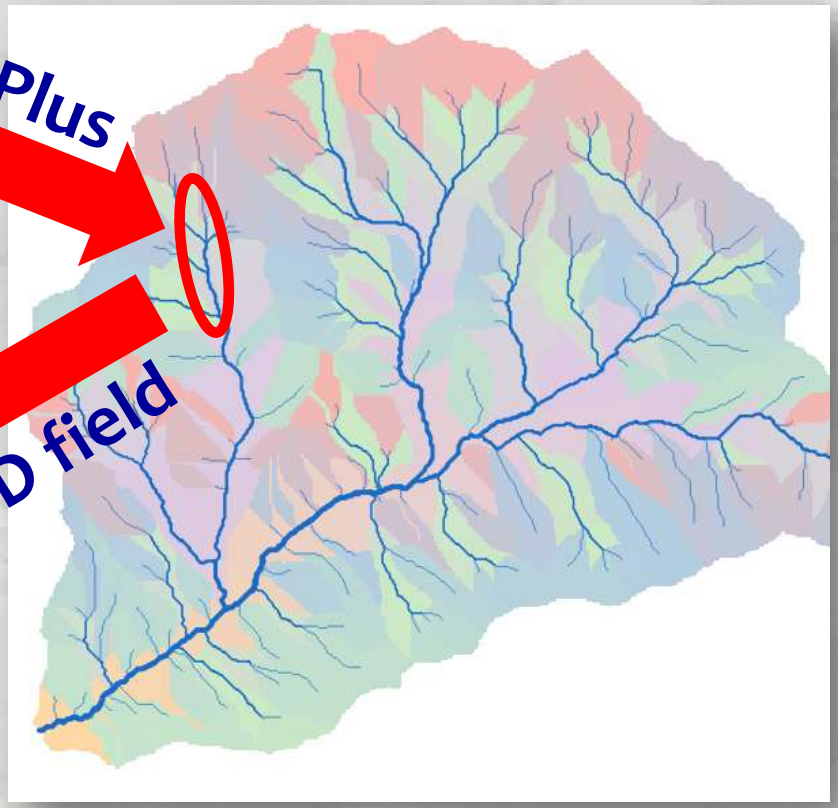


Cooter et al. 2010. A nationally consistent NHDPlus framework for identifying interstate waters: Implications for integrated assessments and interjurisdictional TMDLs. *Environmental Management* **46**:510-524.

Key Ingredient #2: The "PLUS" part of NHDPlus (Stream Reach Descriptors)

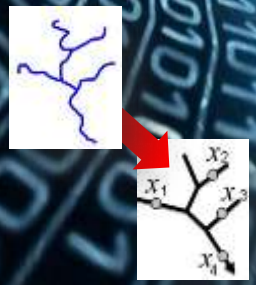
NHDPlus

COMID field



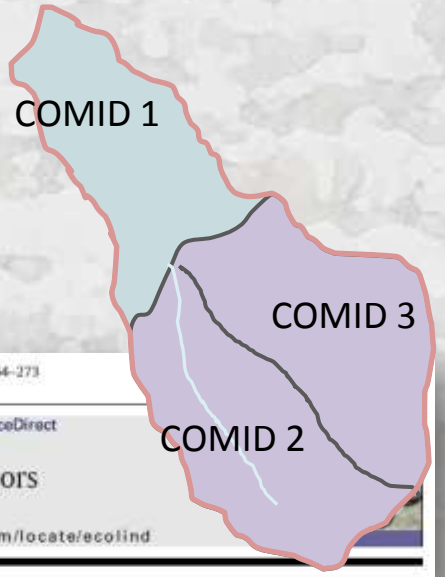
- Elevation
- Slope
- %Landuse
- Precipitation

100's more…



Wang et al. 2011. A Hierarchical Spatial Framework and Database for the National River Fish Habitat Condition Assessment. *Fisheries* **36**:436-449.

#2. more "PLUSs" coming…



Environ Monit Assess (2009) 151:143–160
DOI 10.1007/s10661-008-0256-z

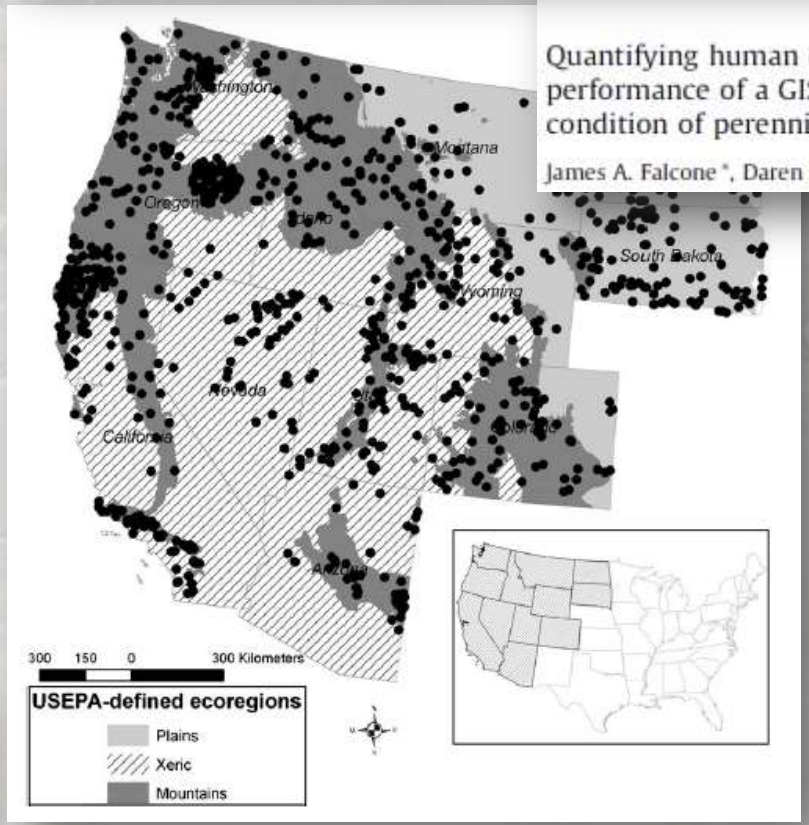
Predicting the biological condition of streams: use of geospatial indicators of natural and anthropogenic characteristics of watersheds

Daren M. Carlisle · James Falcone · Michael R. Meador

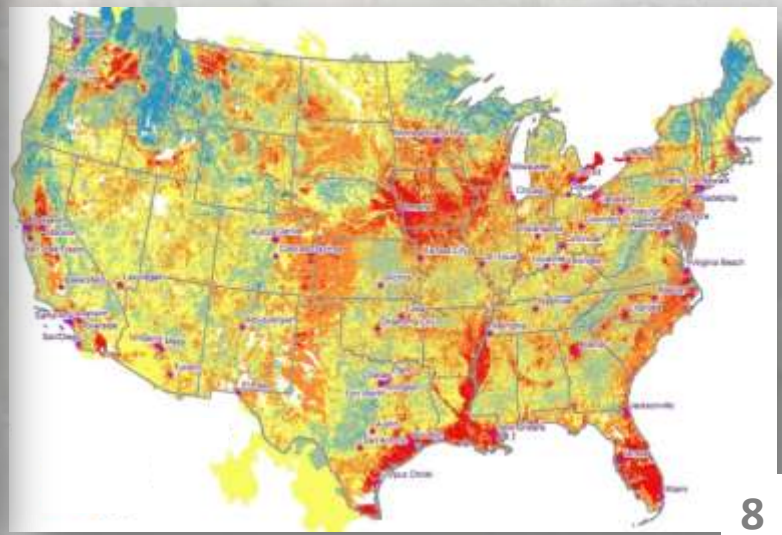
Ecological Indicators 10 (2010) 264–273
Contents lists available at ScienceDirect
Ecological Indicators
Homepage: www.elsevier.com/locate/ecolind

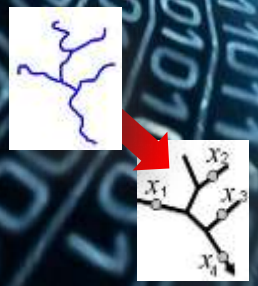
Quantifying human disturbance in watersheds: Variable selection and performance of a GIS-based disturbance index for predicting the biological condition of perennial streams

James A. Falcone *, Daren M. Carlisle, Lisa C. Weber

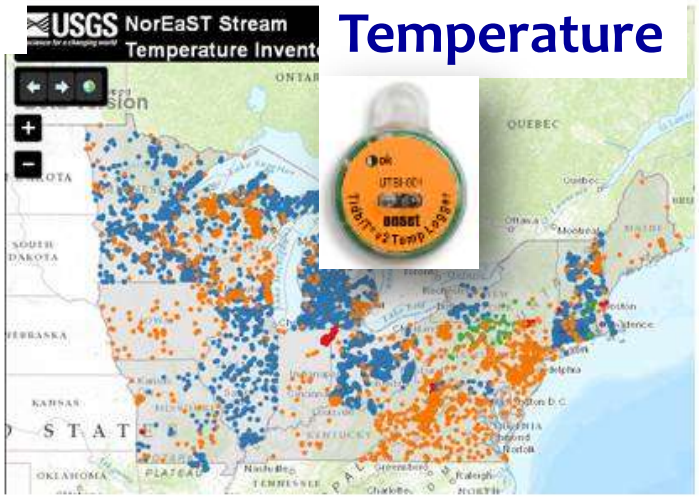


StreamCat



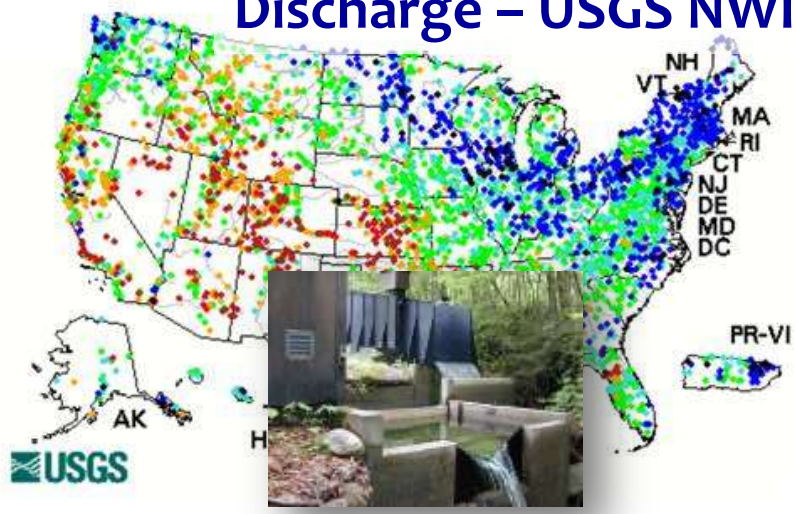


Key Ingredient #3: Mountains of Data Exist for Information Creation



Temperature

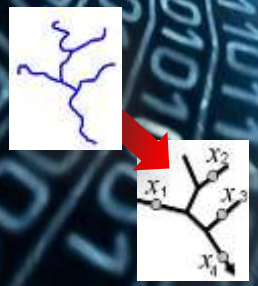
Discharge – USGS NWIS



Species distributions

Water Quality

Genetic Samples



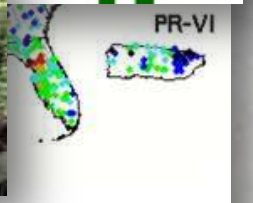
Key Ingredient #3: Mountains of Data Exist for Information Creation

Free millions!

Temperature

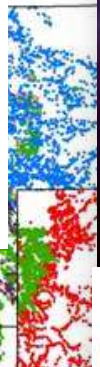
Discharge – U

Free millions!



Free millions!

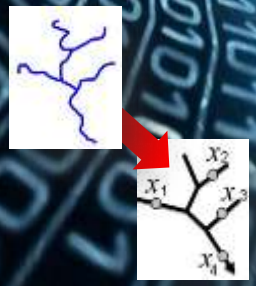
Sp
di



Water Quality

Genetic Samples

Free millions!



Key Ingredient #4: Statistical Models for Data on Stream Networks… FINALLY!

Environ Ecol Stat (2006) 13:449–464
DOI 10.1007/s10651-006-0022-8

ORIGINAL ARTICLE

Spatial statistical models that use flow and stream distance

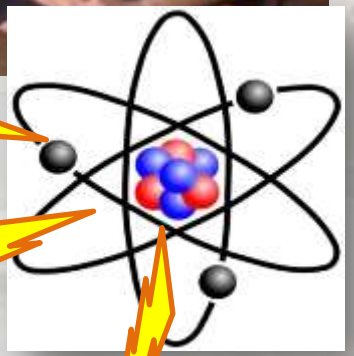
Jay M. Ver Hoef · Erin Peterson · David Theobald

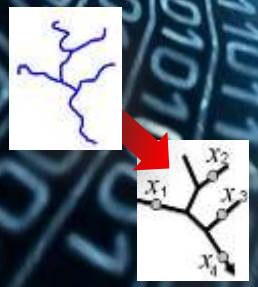
Journal of Statistical Software
January 2014, Volume 56, Issue 3. http://www.jstatsoft.org/

STARS: An ArcGIS Toolset Used to Calculate the Spatial Information Needed to Fit Spatial Statistical Models to Stream Network Data

Erin E. Peterson
CSIRO

Jay M. Ver Hoef
NOAA





SSN: An R Package for Spatial Statistical Modeling on Stream Networks

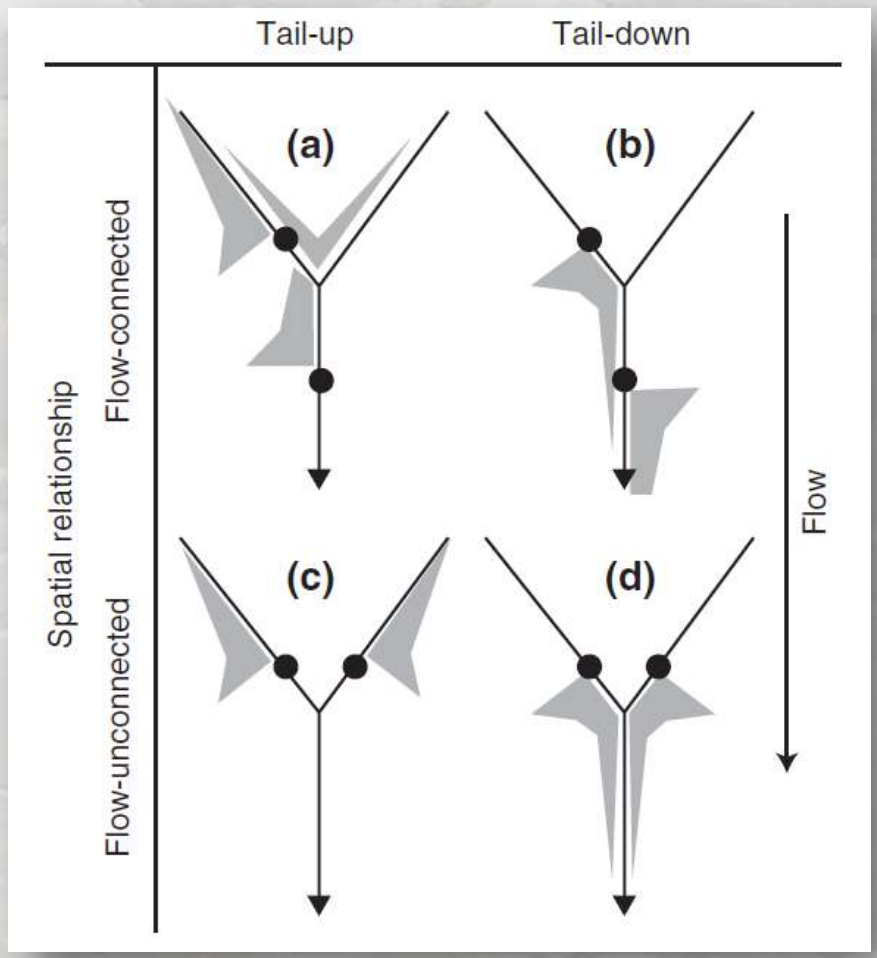
Jay M. Ver Hoef
NOAA National Marine Mammal Laboratory

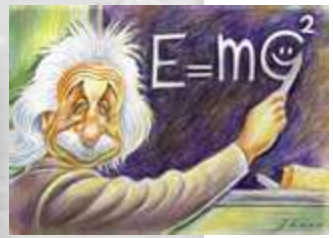
Erin E. Peterson
CSIRO, Brisbane

David Clifford
CSIRO, Brisbane

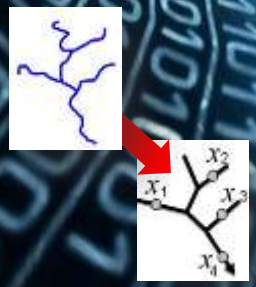
Rohan Shah
CSIRO, Brisbane

Key Innovation is Covariance Structure Based On Network Structure



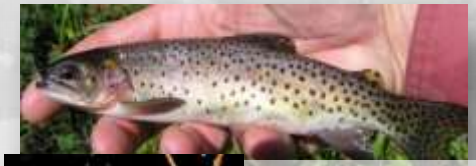


- **Models "understand" how information moves among locations**
- **Models account for spatial autocorrelation among observations**



Peterson et al. 2007. *Freshwater Biology* **52**:267-279;
Peterson & Ver Hoef. 2010. *Ecology* **91**:644-651.

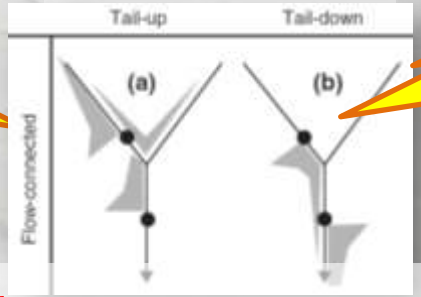
Stream Models are Generalizable…



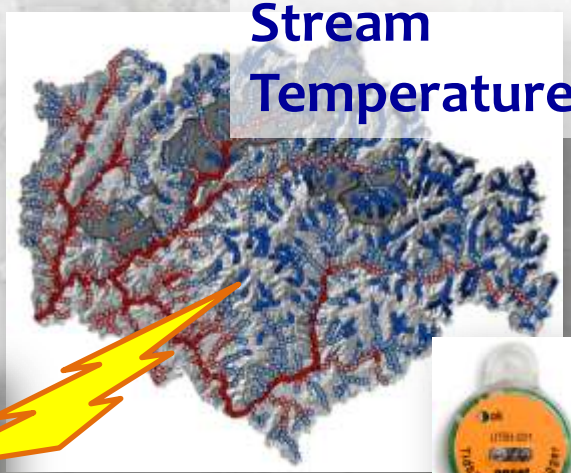
Distribution & abundance

Response Metrics

- Gaussian
- Poissan
- Binomial

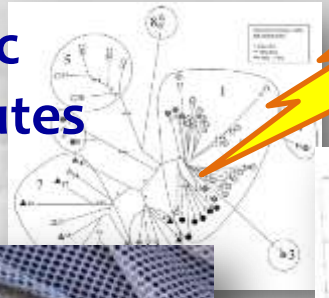


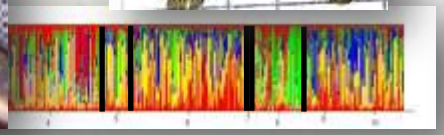
Stream Temperature

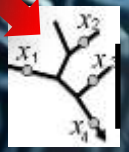


Statistical stream models

Genetic Attributes



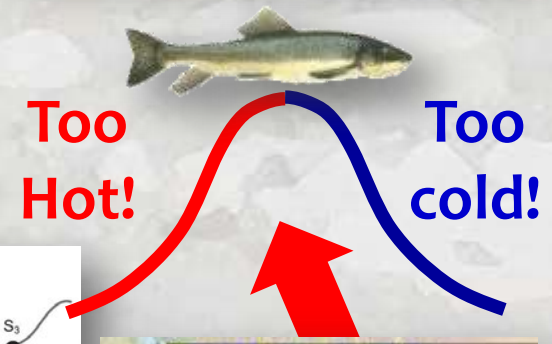


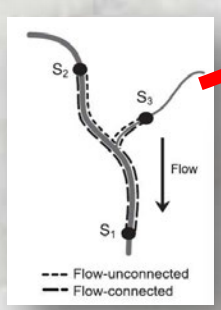


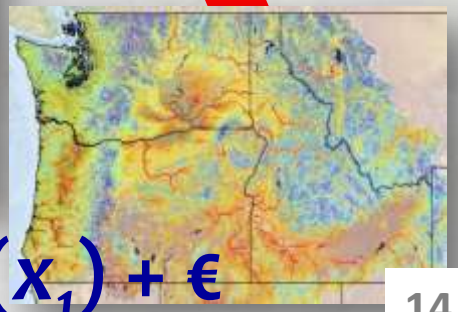
Water Quality Parameters

Applications of Stream Network Models

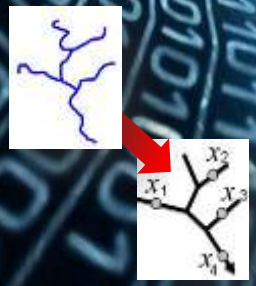
- Parameter estimation & prediction
- Status & trend assessments
- Efficient monitoring designs
- Block-kriging for reference site comparisons & fish population estimates
- Mining of BIG DATA databases
  - Climate scenarios
  - Temperature criteria
  - Species distribution models





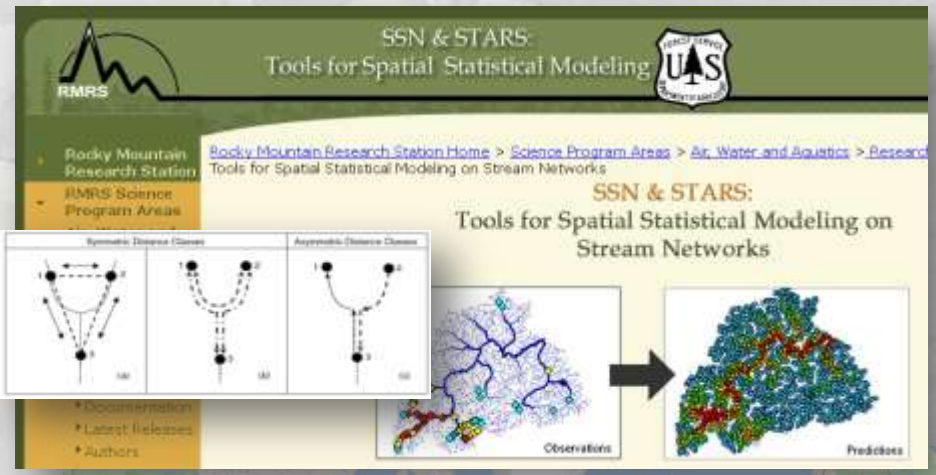


$$Y = b_0 + b_1(x_1) + \epsilon$$



User Community is Growing Rapidly…

SSN/STARS Website



>20,000 website visits in first 2.5 years

Free, high-quality software

>600 software downloads

Locations of visits to SSN/STARS website in last month

3nd Annual Stream Statistics Training Workshop in Boise

April 20 – 22

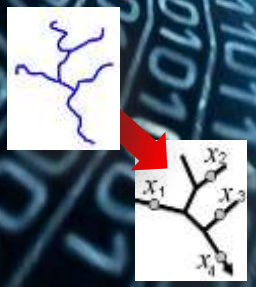
100 participants

~5 year waiting list…

3 day workshop

1st day: overview of spatial stream models (webinar)

2nd/3rd days: work 1-on-1 with Jay/Erin to model your data

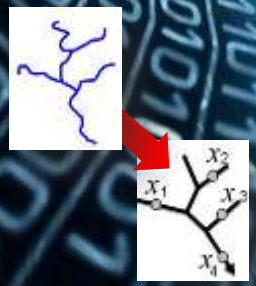


3nd Annual Stream Statistics Training

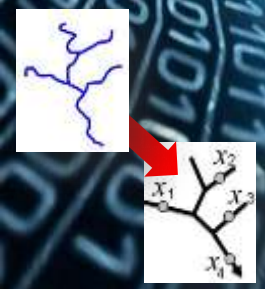
workshop

overview of spatial models (webinar)

days: work 1-on-1 with to model your data

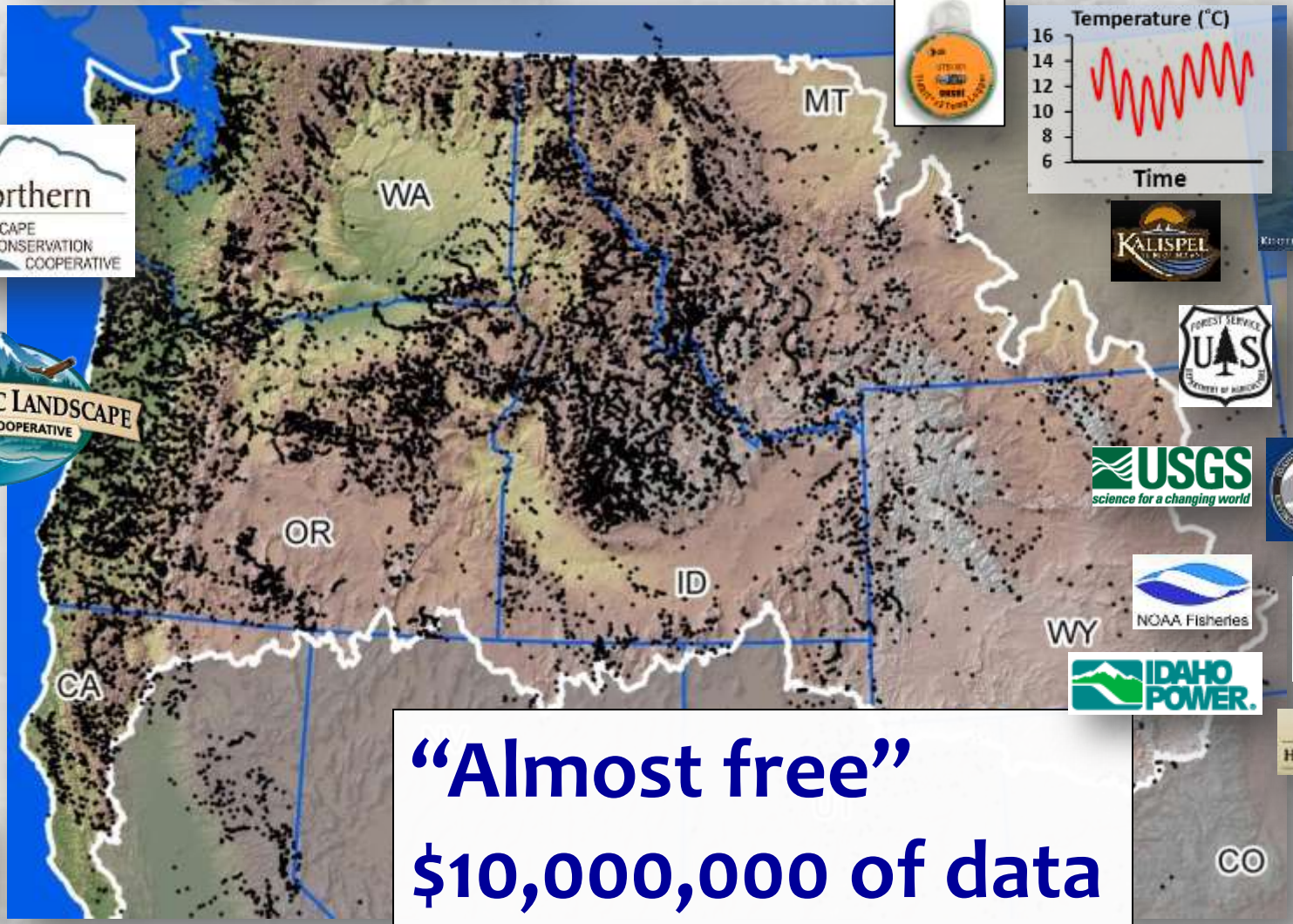


A BIG DATA Example of Stream Internet Technologies in Action

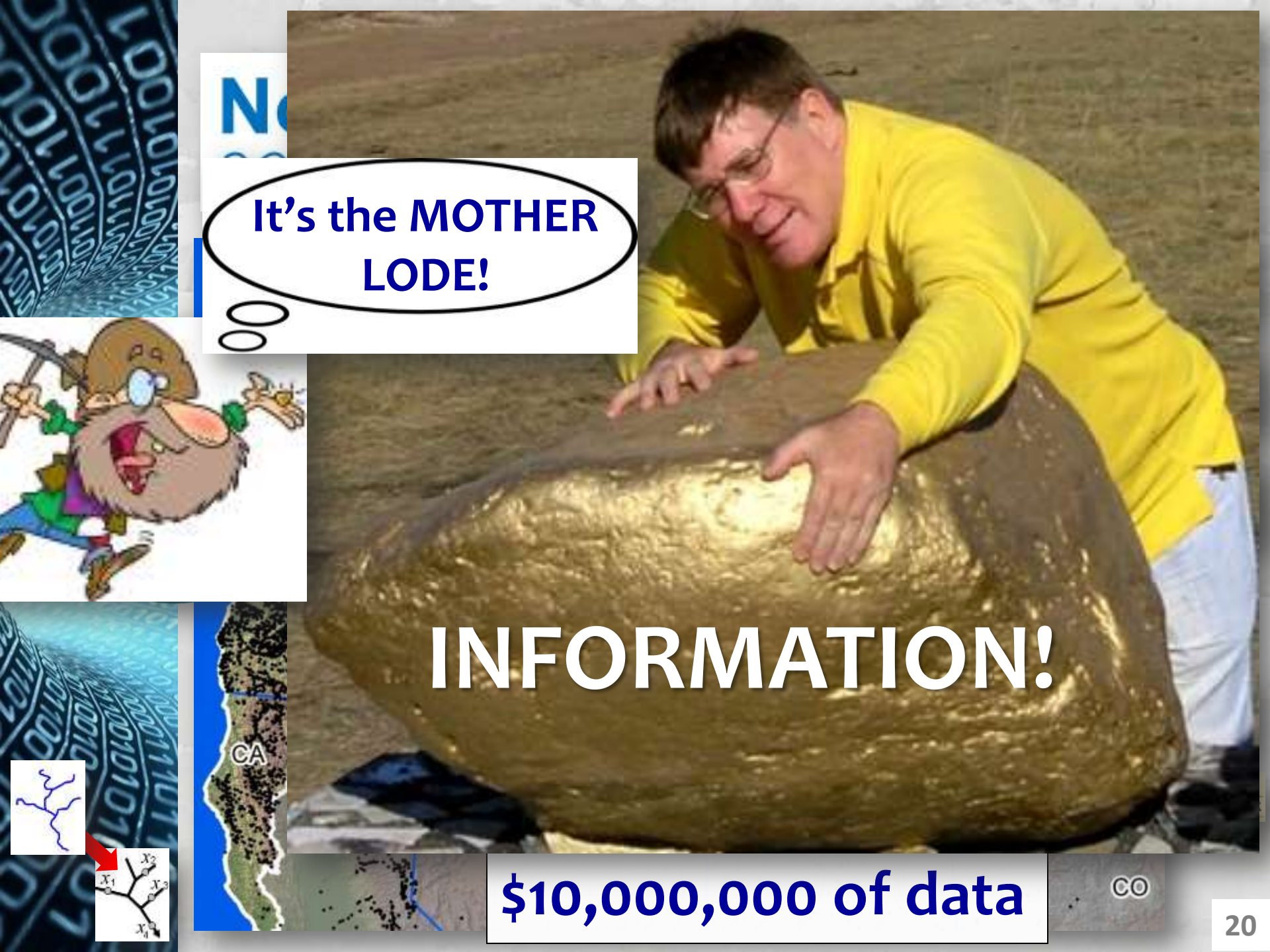


NorWeST Stream Temp

>80 resource agencies
>50,000,000 hourly records
>15,000 unique stream sites



"Almost free"
$10,000,000 of data

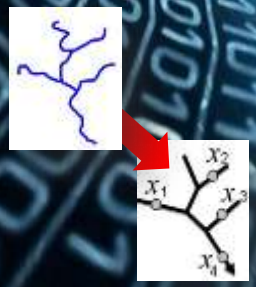

It's the MOTHER LODE!
INFORMATION!
CA
CO
$10,000,000 of data

Spatial vs Non-Spatial Temperature Model

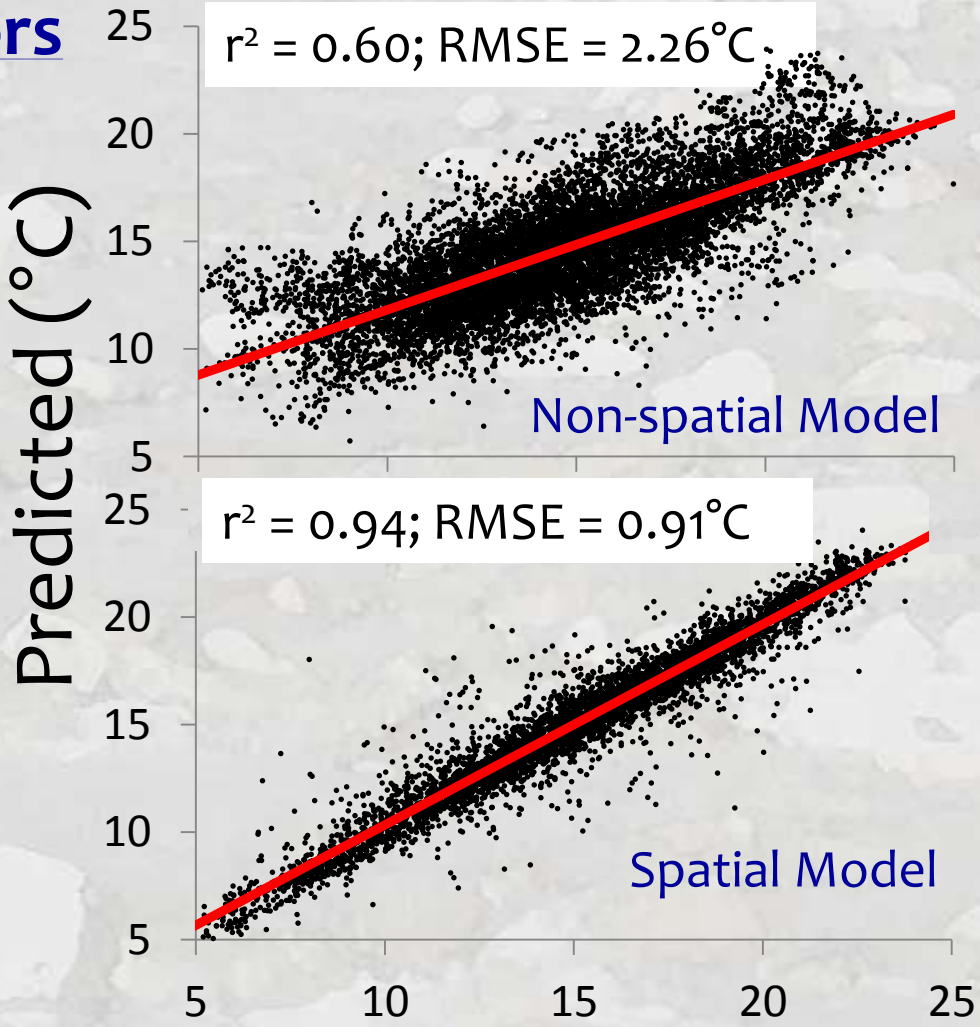
Covariate Predictors

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^2)
9. Glacier (%)

10. Discharge (m^3/s)
    USGS gage data
11. Air Temperature (°C)
    RegCM3 NCEP reanalysis
    Hostetler et al. 2011

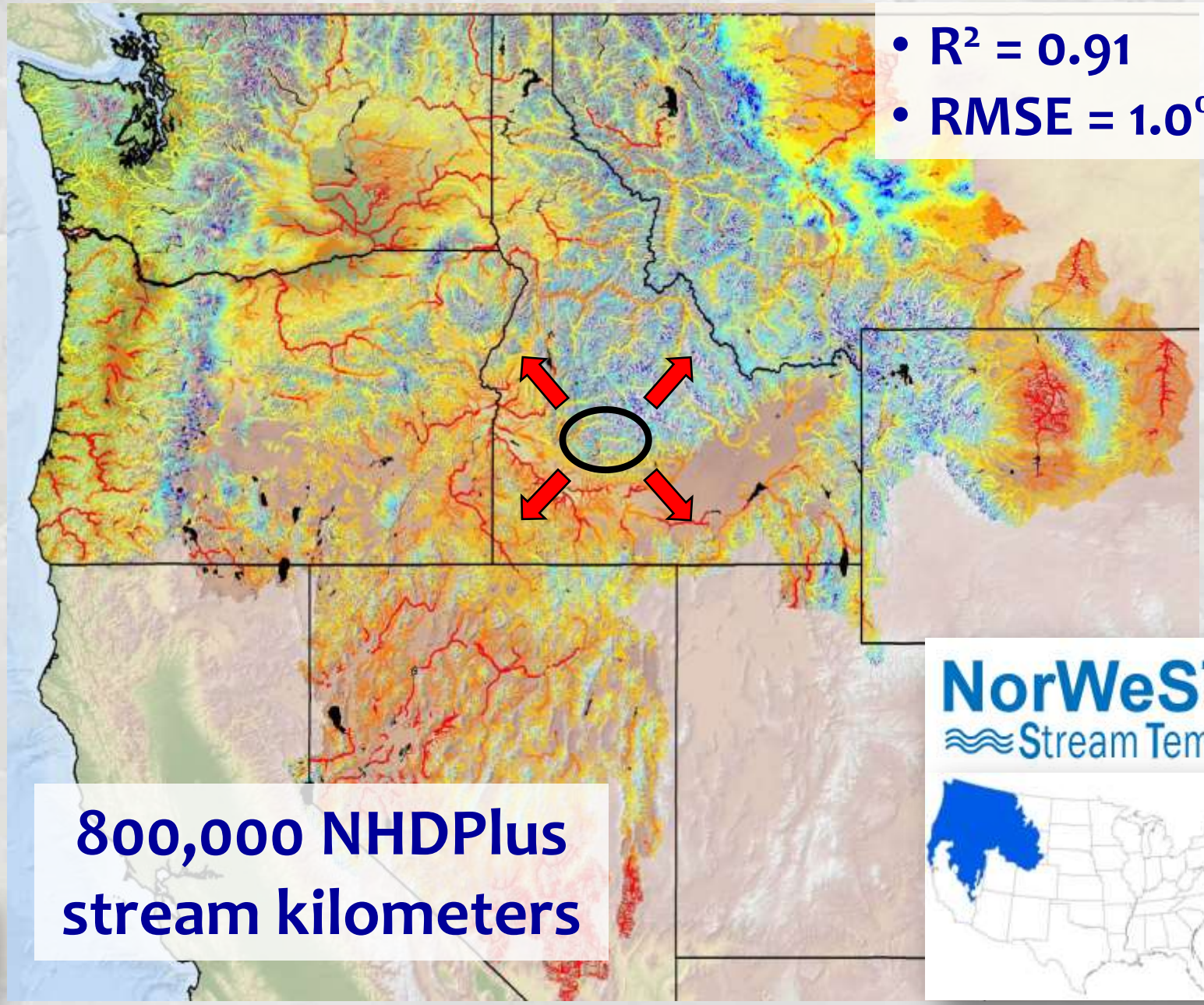


Mean August Temperature



Isaak et al. 2010. *Ecol. Apps* **20**:1350-1370.

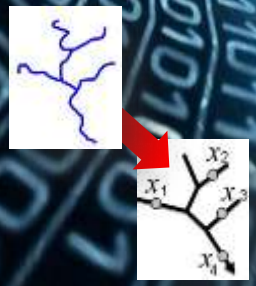
High-Resolution Stream Scenarios



- R^2 = 0.91
- RMSE = 1.0°C

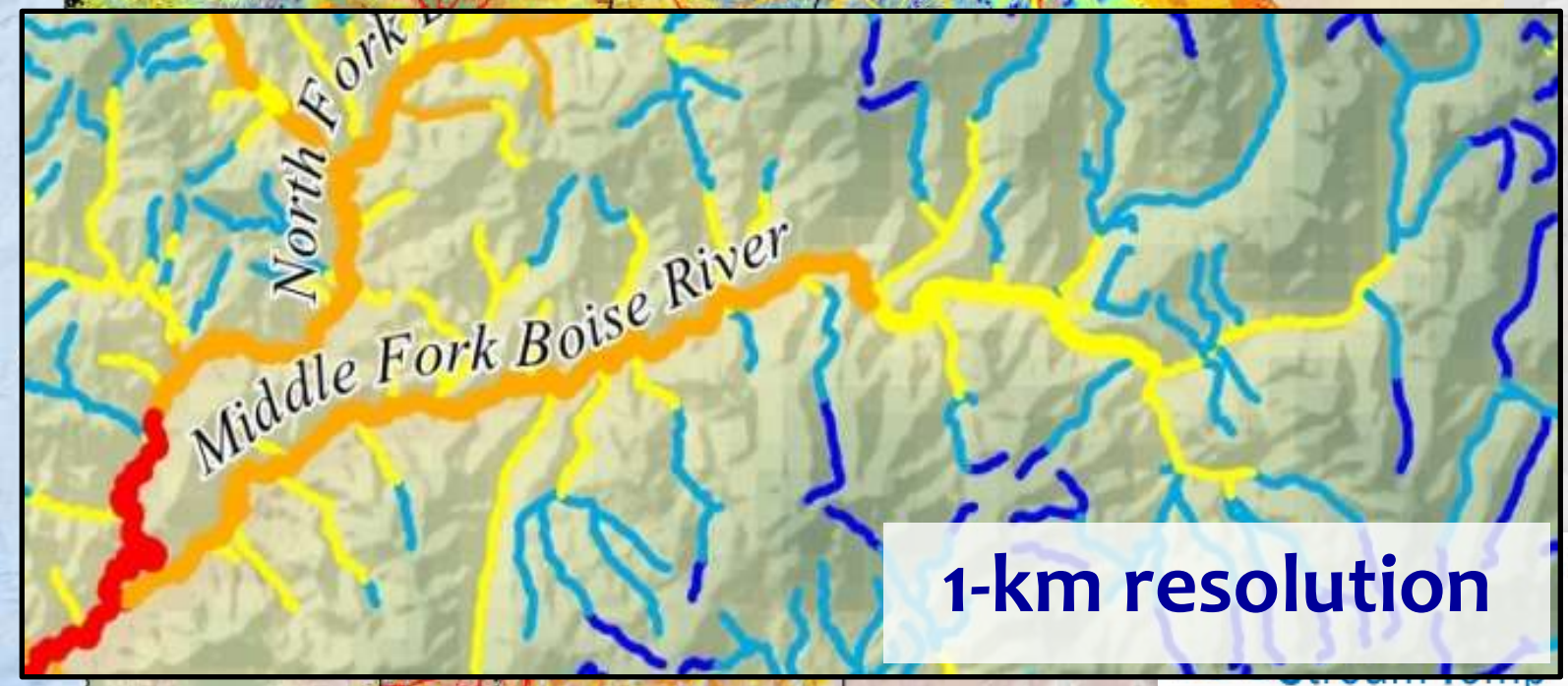
800,000 NHDPlus stream kilometers

NorWeST Stream Temp



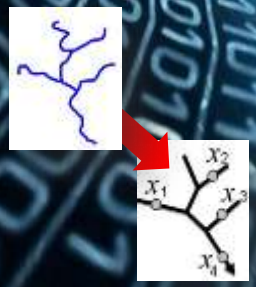
High-Resolution Stream Scenarios

- R^2 = 0.91
- RMSE = 1.0°C



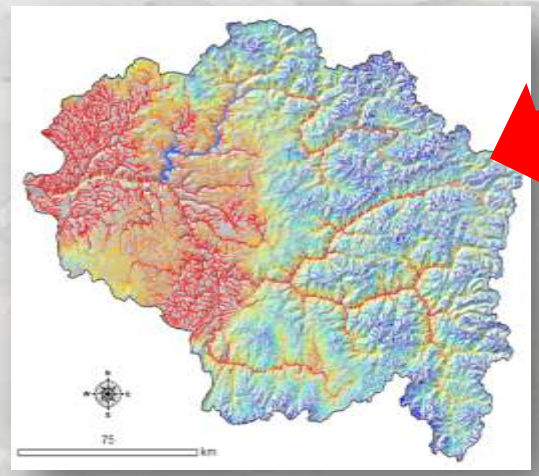
1-km resolution

800,000 NHDPlus stream kilometers

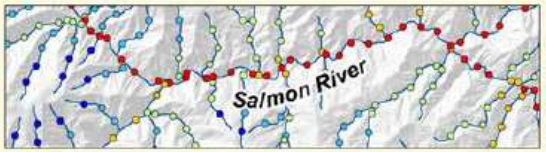


Website Distributes Scenarios & Temperature Data as GIS Layers

1) GIS shapefiles of stream temperature scenarios

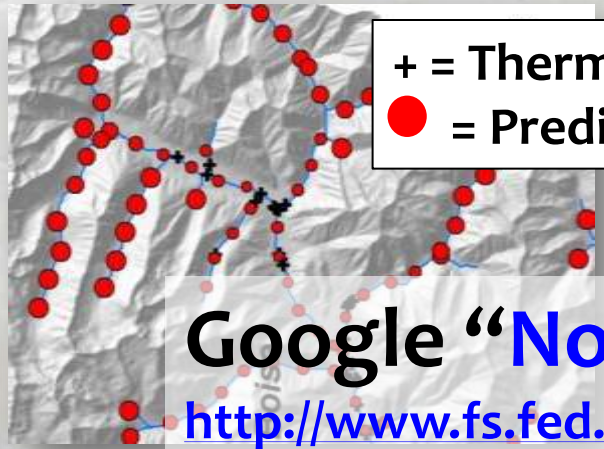


NorWeST Stream Temp

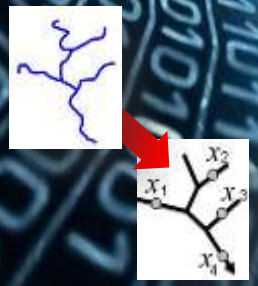


Regional Database and Modeled Stream Temperatures

2) GIS shapefiles of stream temperature model prediction precision



3) Temperature data summaries



Google "NorWeST" or go here…

http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.sht

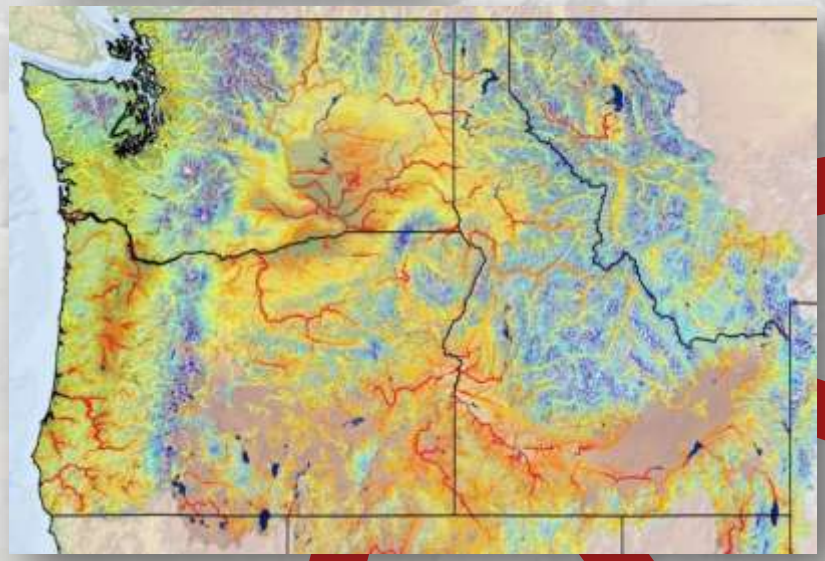
NorWeST User Community…

Website launched 3 Years Ago

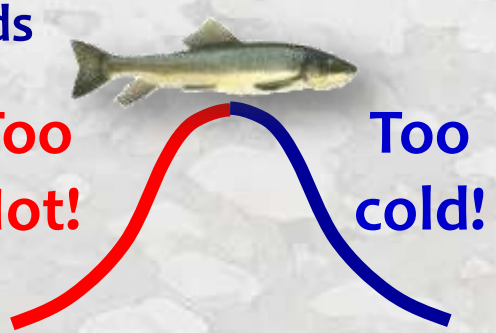
- 10,000 visits/year
- 1,146 downloads last 6 months

NorWeST Stream Temp

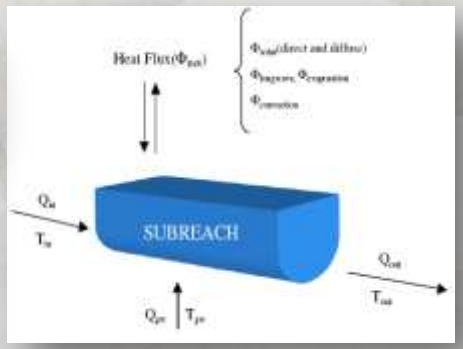
Temperature Synergies…

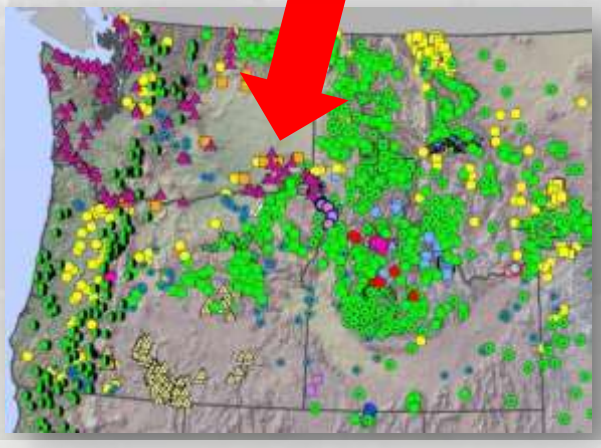


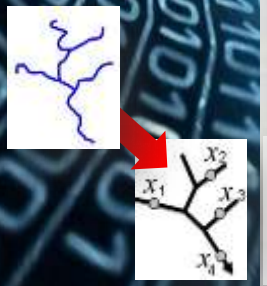
Regulatory temperature standards



Data access accelerates temperature research







Coordinated interagency monitoring

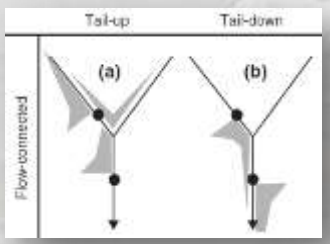
Species distribution models & climate assessments

Doesn't Matter How We Get There…

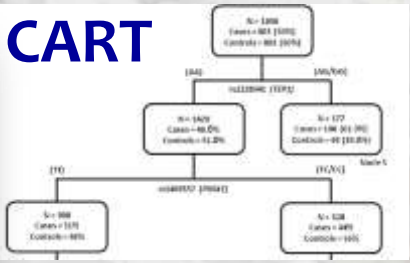
Many good models & designs…

SPARROW

GRTS



CART



Many good programs…

BUGLAB

NATIONAL FISH HABITAT PARTNERSHIP

WQX WATER QUALITY EXCHANGE

USGS science for a changing world

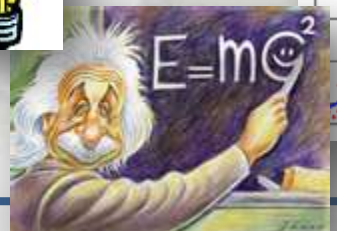
NorEaST

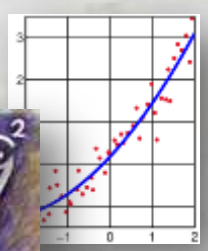
ISEMP

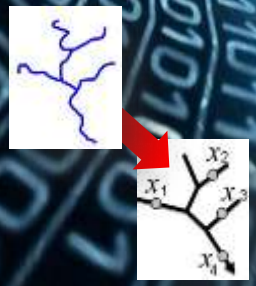
MARIS Multistate Aquatic Resources Information System

The National Rivers and Streams Assessment

Needs for new models & programs…



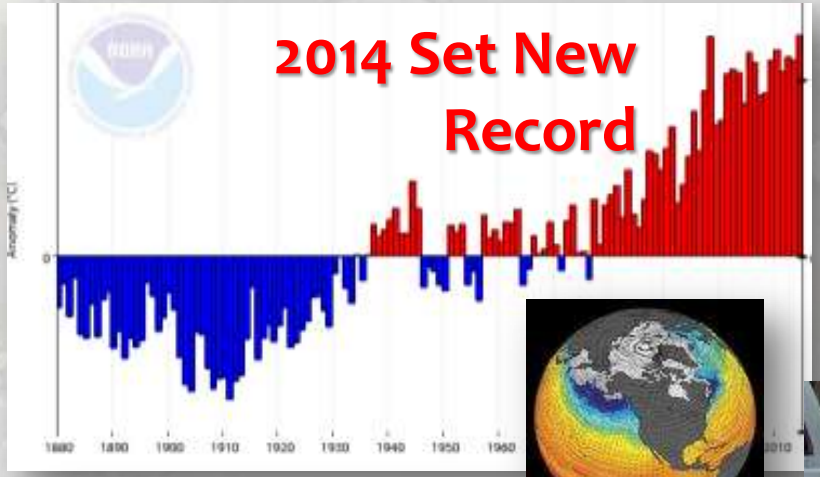


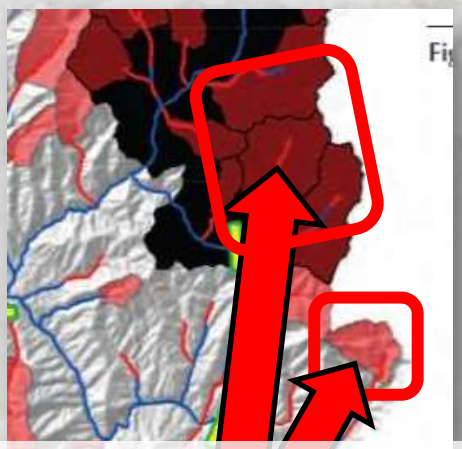


“Information” & Efficiency Are Key

Good Information for Decision Making is Critical

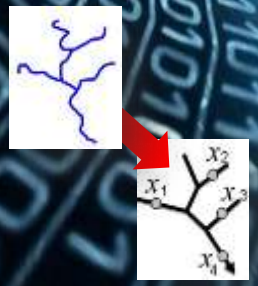
The 21st-Century will Be a Transitional One





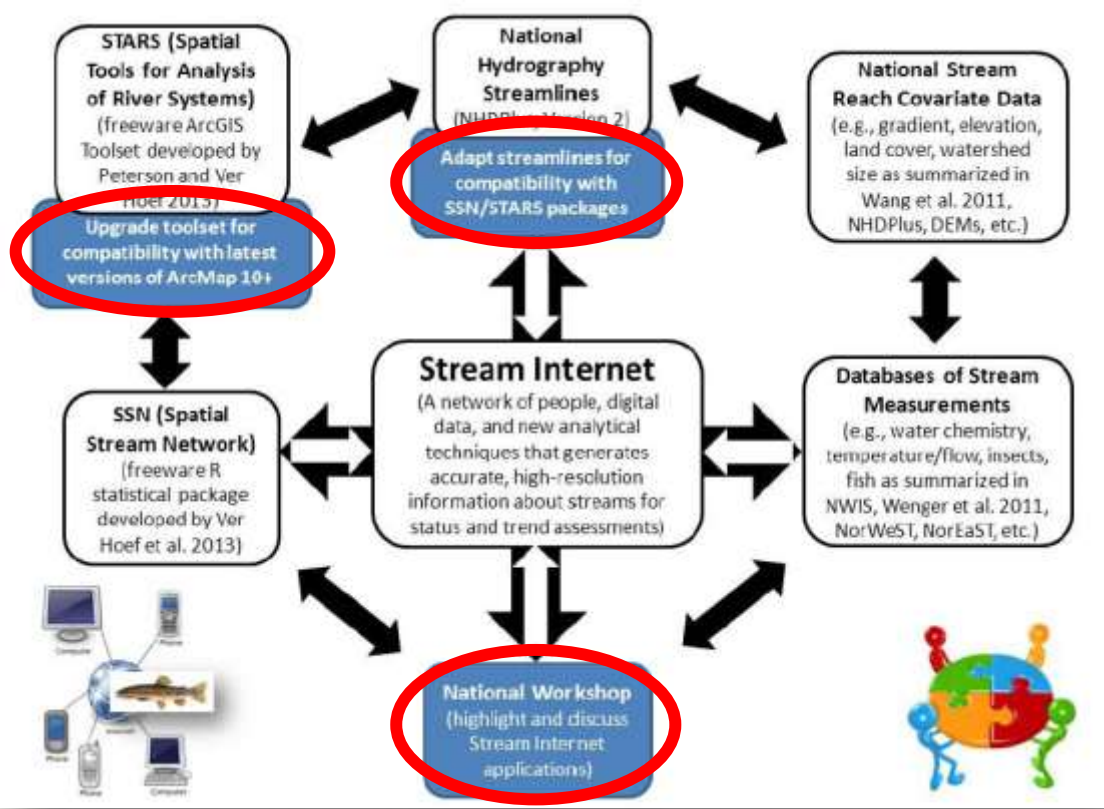
I’m going to invest here…

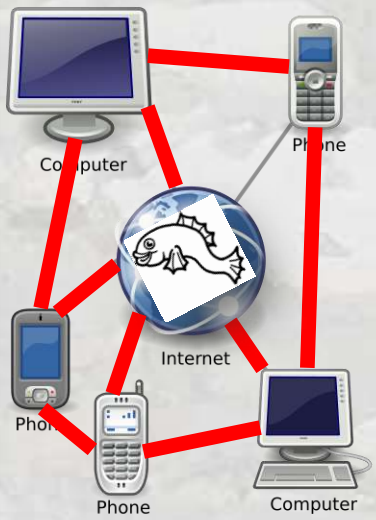
…not here



Stream Internet Project Tasks

1) Develop compatibility between spatial stream analysis tools and national hydrography layer (NHDPlus, v2)
2) Update STARS stream analysis tools to ArcMap 10.2
3) Host a workshop to brainstorm about possibilities that new analyses & databases provide to address key questions & information needs





Vision: TSI through the NSI

High-resolution space-time information for all stream things

3,000,000 stream kilometers