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Providing scientific knowledge and technology to sustain our nation's forests, rangelands, and grasslands

Science
B R I E F I N G

A NATIONAL STREAM INTERNET

Keywords: *status and trend assessments, water quality, aquatic biotas, resource conservation and management*

BACKGROUND

Accurate, high resolution information does not exist regarding the status and trends of water quality and aquatic biota throughout the 5,000,000 kilometers of river and stream networks in the U.S. Without this information, prioritization of limited conservation resources within and among resource agencies proceeds inefficiently. Massive amounts of water quality data, biological surveys, and habitat condition assessments have been collected by state, federal, tribal, and private organizations across the U.S. Those data could be used to develop huge amounts of new information and precise status/trend assessments if they were used with new spatial-statistical network (SSN) that enable a suite of sophisticated analyses.
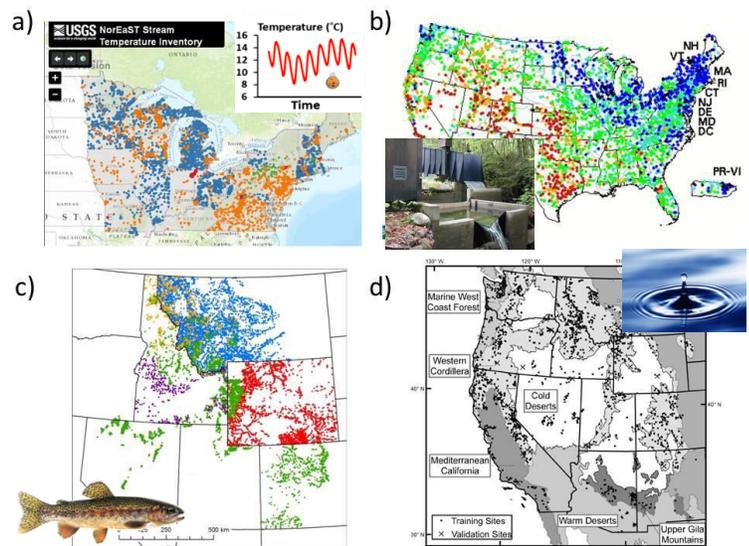
STREAM INTERNET COMPONENTS

The National Stream Internet (NSI) project was funded by the USFWS LCC program and led by researchers from USFS, CSIRO, NOAA, and USGS. The project developed a national analytical infrastructure for stream data that can be applied consistently anywhere in the country to develop new information at low cost. To create that infrastructure, the NSI project developed compatibility among key digital stream geospatial data and analysis tools. Those included the EPA/USGS NHD-Plus v.2 stream hydrography layer (Cooter *et al*. 2010), sets of stream reach descriptors (Wang *et al*. 2011), and tools for implementing spatial statistical network models (STARS/SSN website, Ver Hoef *et al*. 2014).

👍 KEY POINTS 👍

- Massive amounts of water quality data, biological surveys, and habitat condition assessments have been collected by natural resource organizations throughout the U.S.

- The National Stream Internet (NSI) project developed an analytical infrastructure that can be used consistently anywhere with existing stream databases.

- Status and trend assessments for the nation's aquatic resources can be greatly enhanced through application of NSI technologies at relatively low cost.

Example data for: a) stream temperature, b) stream flow (USGS NWIS database, c) fish population samples, and d) water chemistry.

A NATIONAL STREAM INTERNET
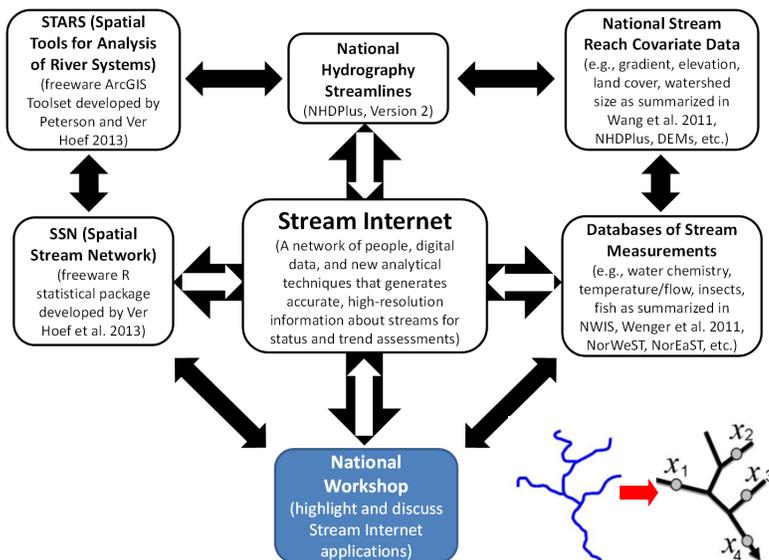
Elements composing the NSI that enables integration of existing databases (e.g., water quality parameters, biological surveys, habitat condition) and development of new information using sophisticated spatial-statistical network models. The NSI provides a nationally consistent framework for analysis of stream data that can greatly improve the accuracy of status and trend assessments. Realizing the full potential of the NSI will require developing a national grassroots user base in future years.

KEY REFERENCES

- 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.

- Isaak et al. 2014. Applications of spatial statistical network models to stream data. *Wiley Interdisciplinary Reviews -Water* **1**:277-294.

- National Stream Internet website: www.fs.fed.us/rm/boise/ AWAE/projects/NationalStreamInternet.html

- NorWeST: An interagency stream temperature database, model, and climate scenarios for streams and rivers in the western U.S. website: www.fs.fed.us/rm/boise/AWAE/ projects/NorWeST.html

- Peterson and Ver Hoef. 2014. STARS: An ArcGIS toolset used to calculate the spatial information needed to fit spatial statistical models to stream network data. *Journal of Statistical Software* **56(2)**:1-17.

- SSN/STARS: Tools for Spatial Statistical Modeling on Stream Networks. Website: www.fs.fed.us/rm/ boise/AWAE/projects/SpatialStreamNetworks.shtml.

- Ver Hoef et al. 2014. SSN: An R package for spatial statistical modeling on stream networks. *Journal of Statistical Software* **56(3)**:1-45.

- Wang et al. 2011. A hierarchical spatial frame-work and database for the national river fish habitat condition assessment. *Fisheries* **36**: 436-449.

IMPLICATIONS

The NSI enables consistent application of sophisticated analysis tools to many types of stream data throughout the U.S. Moreover, the spatial-statistical network models can be applied to databases characterized by non-random, clustered locations, which provides a strong incentive to develop comprehensive, inter-agency databases (Isaak *et al*. 2014). The spatial models outperform traditional techniques applied to stream data and enable predictions at ungaged/ unmonitored sites, which facilitates development of high-resolution status maps throughout full river networks (for a regional example of NSI technology applications, please visit the NorWeST website). Like the real Internet, a Stream Internet requires a user-base, so free statistical software have been developed (Peterson and Ver Hoef 2014; Ver Hoef et al. 2014) and annual training workshops are conducted in Boise, Idaho. A workshop for leaders of national aquatics programs was also held in 2015 to discuss potential future NSI applications. It is hoped that as better information is developed about stream resources and ecosystems, it empowers resource agencies and managers to make more efficient use of conservation resources and be more effective resource stewards.

MORE INFORMATION

For more information, please visit the project website: www.fs.fed.us/rm/boise/AWAE/projects/ NationalStreamInternet.html