FINAL PERFORMANCE REPORT

South Carolina State Wildlife Grant [T-61-R-1]
Title: Decision Support Tools for Stream Conservation
South Carolina Department of Natural Resources
October 1, 2012 – December 30, 2013

GRANT OBJECTIVES

1. *Develop models using SC Stream Assessment measures as dependent variables and National Fish Habitat Assessment variables as predictors.*
2. *Predicted metrics and indices of stream condition based on the SCSA sample data models will be generated for all catchments across the state at the 1:100k NHD scale and be mapped in GIS.*
3. *All model outputs will be integrated into a GIS-based decision support system published on an interactive website allowing visualization of stream conditions and for use in forecasting and visualizing scenarios based on expected or proposed changes in anthropogenic stressors.*

ACTIVITY OVERVIEW:

The web-based South Carolina Stream Conservation Planning Tool enables a spatially-explicit understanding of how human activities affect the biological condition of wadeable streams. A web mapping application allows users to visualize predicted biological conditions based on their status and severity across all South Carolina wadeable stream catchments. Additionally, an interactive catchment management tool allows users to explore and forecast the impacts of customized land management scenarios on aquatic resource indicators at any user-specified stream location across South Carolina.

The application may be accessed and explored at this URL:
http://54.204.4.5/scsa

WORK PERFORMED:

Data— The South Carolina Department of Natural Resources (SCDNR) in conjunction with Clemson University created this application using data from the South Carolina Stream Assessment, initiated in 2006 to determine the status of native fish assemblages and aquatic resources throughout the state. The assessment of nearly 500 wadeable streams was completed in 2011, with a collection of biological, chemical, physical, and landscape-level data necessary to support proactive decision making with respect to aquatic resources in the state. Sample locations were selected with a known probability using a stratified random sampling design from a list frame of all stream segments in the state, with ecobasin and stream size as strata. This site selection procedure insured independence among samples and allowed for statistically defensible estimates of statewide aquatic resource parameters.

From these data, we derived biological response variables designed to reflect biological/aquatic health and respond to anthropogenic stressors. We associated our biological response variables with NHDPlus and National Fish Habitat Assessment spatial predictor data (USEPA and USGS 2005, Wang et al. 2011).

Modeling— We used Random Forests (Brieman 2001) with the R statistical software (R Core Team 2012) to develop predictive models from the sample data, from which we determined the most important spatial predictor variables that influenced each of the biological response variables. Using these modeled relationships from the sample data, we extrapolated to map current expected biological condition across the state based on spatial predictors.

Software—The application software design utilizes client- and server-side components. Dynamic 'R' prediction occurs on the server utilizing task parallelism. This allows simultaneous computation of predictions to occur. Client-side components use HTML5 and Javascript, which run entirely in the web browser. The mapper utilizes ArcServer 10.1 which allows for flexibility in geographic focus.

Capabilities—The Stream Conservation Planning Tool provides the following functionality:

- Map Viewer displays "static" predictions for South Carolina catchments based on extrapolations from random forest models. Each published predictive model includes a detailed PDF report describing response variable construction, random forest model results, model performance, and error metrics.
- Users can select catchments that drain an area of less then 150 sq km (wadeable).
- Anthropogenic variables that influence the model outcome are displayed.
- Users adjust these parameters using a sliding scale.
- Multiple catchments may be modified to scale up.
- The software recalculates attribute values for each selected catchment and conducts a downstream analysis (up until 150km^2 drainage limit is met).
- All downstream catchments impacted by modifications are returned to the user and displayed in the map.
- Users have access to prediction results for 24 hours and may export results in csv, or JSON formats.
- Administration privileges allow for application updates and revisions, including:
    - Upload prediction datasets.
    - Upload predictive models via a serialized R model using the native 'RDS' format.
    - Upload detailed model report as a PDF.
    - Set the attributes the user can modify (typically anthropogenic).

Significant deviations: None, the URL for the application is expected to be moved from its current location to a server within the dnr.sc.gov domain as soon as the Information Technology Program is able.

Estimated Federal Cost (grant level): $63,250 through end of grant ($1,100 unobligated balance)

Recommendations: Continue outreach and education activities to build awareness of the application to potential user groups.

References:

Breiman, L. 2001. Random Forests. Machine Learning 45:5-32.

R Core Team. 2012. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

U.S. Environmental Protection Agency and U.S. Geological Survey (USEPA and USGS). 2005. National hydrography dataset plus, NHDPlus Version 1.0. www.horizon-systems.com/nhdplus/.

Wang, L. , D. Infante , P. Esselman , A. Cooper , D. Wu , W. Taylor , D. Beard , G. Whelan and A. Ostroff. 2011. A hierarchical spatial framework and database for the National River Fish Habitat Condition Assessment. Fisheries 36(9): 436-449.