



Air, Water and Aquatic Environments Science Program



Rocky Mountain Research Station

Decision Support Tools to Support Native Fish Management: Bayesian Belief Network & Supporting Website

Research

Technology Transfer

Science Application

Key Findings:

- In the tradeoff between invasion and isolation of non-native fish, context matters. There are strong gradients in the decision space, so a careful, consistent decision process can help managers support.
- The objective was to formally evaluate of tradeoffs between intentional isolation, invasion and conservation of native salmonids.
- A conceptual model was formalized using a Bayesian Belief Network (BBN) implemented using the software program NETICA.
- Downloadable NETICA software, Model, The BBN Decision Support Model User's Guide and other relevant resources can be found on our U.S. Fish & Wildlife Website.

Challenge

Habitat fragmentation and invasion of non-native fishes are primary contributors to the decline of native salmonids in the Western U.S., but attempts to ameliorate their different effects may elicit often conflicting management approaches. Methods for assessment of barriers to fish passage are widely available (Clarkin et al. 2003), but tools to evaluate relative risks and trade-offs or to prioritize work were not readily accessible—a formal decision process can assist.

Context

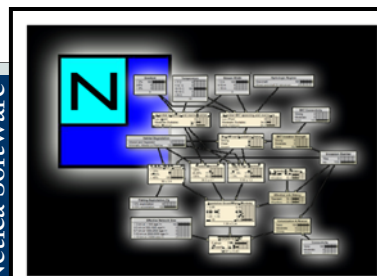
The Bayesian Belief Network (BBN) predicts the probability that westslope cutthroat trout will persist in a stream network at the end of 20 years given a set of habitat and environmental conditions affecting WCT and brook trout, their potential interactions, and the history and characteristics of the populations. Model output is best interpreted as relative predictions that can help a biologist or manager choose among management options for a particular stream (whether to remove, maintain or install a barrier), and help prioritize conservation actions among streams.

Actions

The goal was to formally evaluate tradeoffs between intentional isolation, invasion and conservation of native salmonids. The focus was on persistence of native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), potential invasion and later effects of non-native brook trout (*Salvelinus fontinalis*), and the primary environmental and anthropogenic factors influencing both species and their interactions. Our objectives were to develop and explore the application of a Bayesian Belief Network (BBN) as a decision support tool and highlight results that provide general guidance for biologists and managers. We focused this work on cutthroat trout and brook trout because they represent a widespread and well defined problem in central and northern Rocky Mountain streams (Fausch et al. 2006), but we believe our approach can be readily adapted to other species.

Results

The Bayesian Belief Network Decision Support Model can be downloaded along with a full user's guide on the U.S. Fish & Wildlife Service's BBN website. The site offers a description, example, NETICA software download and full-text publication resources. The BBN is represented by a conceptual diagram that describes the variables affecting both species and the conditional relationships among those variables. The decision support tool is executed using the software program NETICA. Both PC and Mac versions of NETICA can be downloaded free of charge at <http://www.norsys.com/download.html>. The "limited mode" (free) version of NETICA can open and run BBN models having up to 60 variables.



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NORSYS
Netica Software

The Bayesian Belief Network

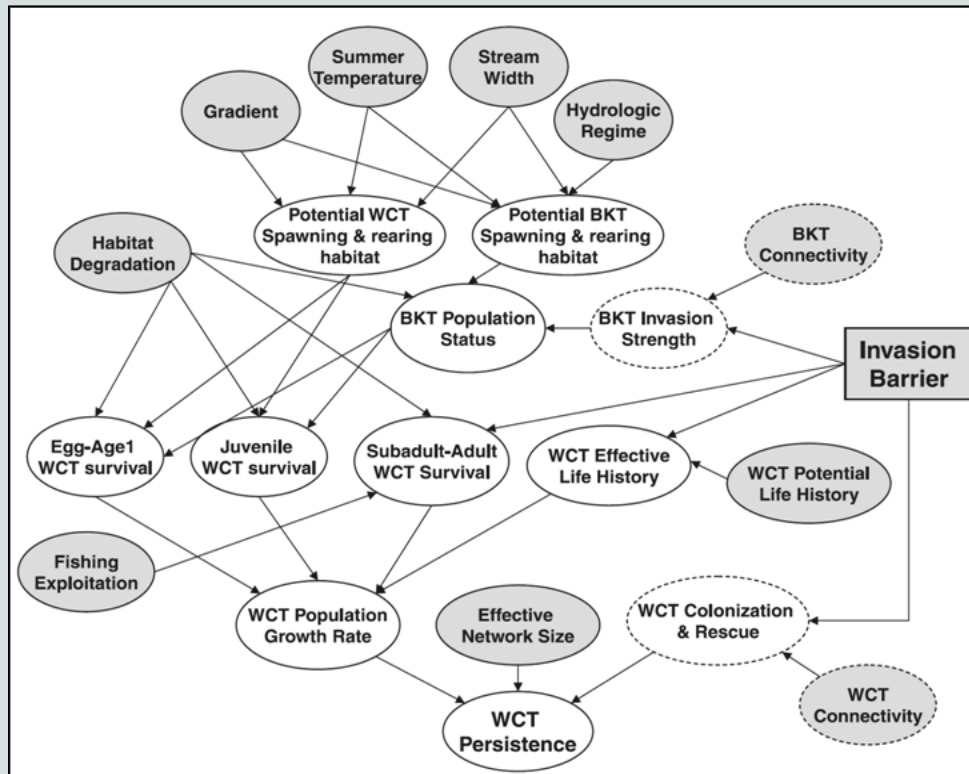


FIGURE 1. From Peterson et al. 2008. Conceptual model depicting environmental conditions and processes influencing persistence of westslope cutthroat trout (WCT) and the tradeoffs between intentional isolation and invasion by brook trout (BKT). Shaded ovals indicate input variables or nodes (prior conditions) believed to affect WCT and brook trout populations, dashed ovals indicate influences that originate outside the local stream network, the rectangle for invasion barrier indicates the primary management decision, and arrows indicate conditional relationships among variables (nodes). The conceptual model was formalized using a Bayesian Belief Network (BBN) implemented using the software program NETICA.

VISIT: [http://www.fws.gov/montanafieldoffice/Fisheries Research/Fisheries Helena BBN.html](http://www.fws.gov/montanafieldoffice/Fisheries%20Research/Fisheries%20Helena%20BBN.html)

Related Publications

Fausch, K.D., Rieman, B.E., Young, M., Dunham, J.B., 2006, Strategies for conserving native salmonid populations at risk from nonnative fish invasions - tradeoffs in using barriers to upstream movement. USDA Forest Service, Rocky Mountain Research Station RMRS-GTR-174. ([Full Text](#))

Peterson, D.P., B.E. Rieman, J.B. Dunham, K.D. Fausch, and M.K. Young. 2008. Analysis of trade-offs between threats of invasion by nonnative brook trout (*Salvelinus fontinalis*) and intentional isolation for native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). Canadian Journal of Fisheries and Aquatic Sciences 65:557-573. ([Full Text](#))

Fausch, K.D., B.E. Rieman, J.B. Dunham, M.K. Young, and D.P. Peterson. 2009. Invasion versus Isolation: Trade-Offs in Managing Native Salmonids with Barriers to Upstream Movement. Conservation Biology 23(4): 859-870. ([Full Text](#))

Peterson, D.P., B.E. Rieman, J.B. Dunham, K.D. Fausch, and M.K. Young. 2007. Analyzing Tradeoffs Between the Threat of Invasion by Brook Trout and Effects of Intentional Isolation for Native Westslope Cutthroat Trout Pages 51-57 in R. F. Carline and C. LoSapio, editors. Wild Trout IX: Sustaining wild trout in a changing world. Wild Trout Symposium, Bozeman, Montana. ([Full Text](#))

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