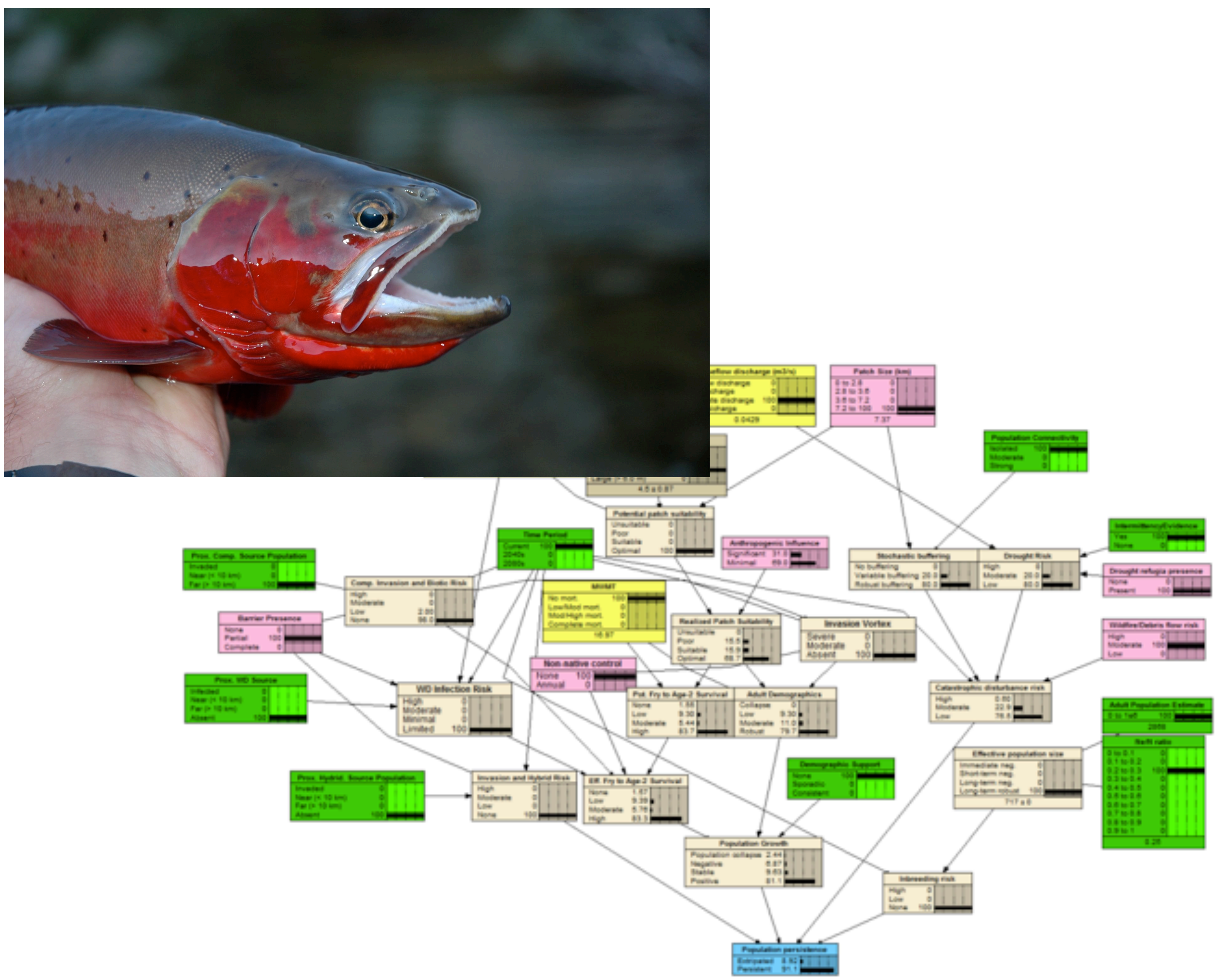
Rio Grande Cutthroat Trout Bayesian Network tutorial



A guide for estimating population persistence using the Rio Grande Cutthroat Trout Bayesian Network

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Overview

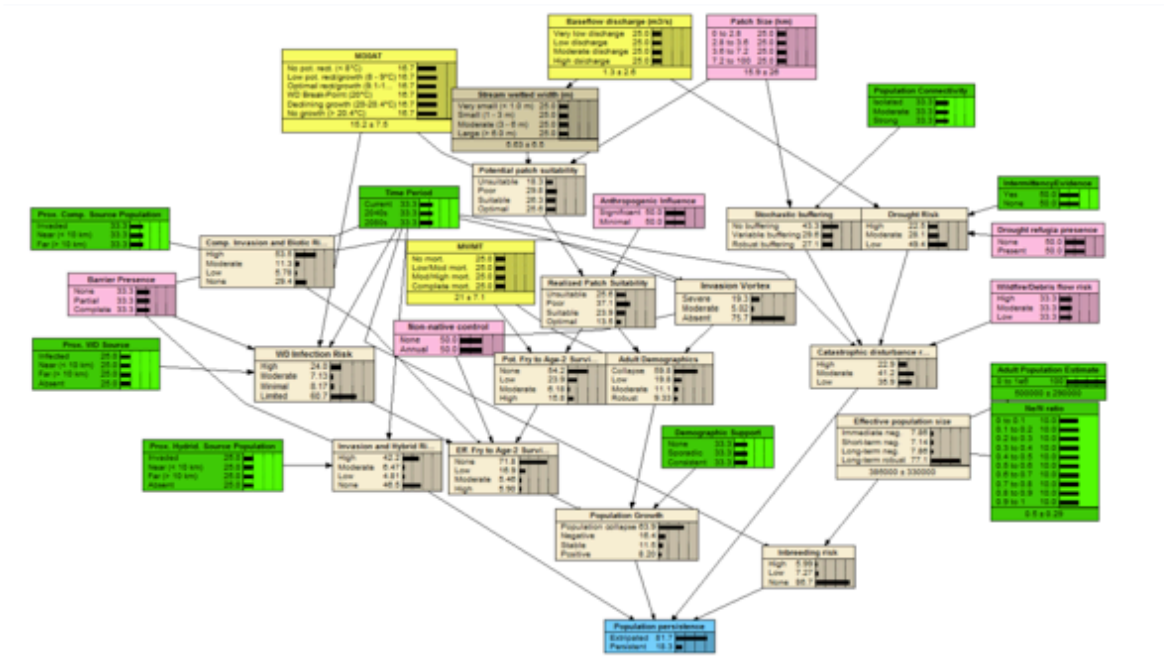
In the manuscript "Predicting persistence of Rio Grande Cutthroat Trout populations in an uncertain future" Ziegler et al. (*In press*) present a Bayesian network (BN) model for evaluating persistence in Rio Grande Cutthroat Trout (RGCT; *Oncorhychus clarkii virginalis*) populations. This model was developed using Netica software (Norsys Software Corporation, Vancouver, British Columbia) because of its straightforward and intuitive graphical user interface. It is designed to be used by managers to not only estimate probability of persistence at different time horizons, but also to evaluate the implications of employing different management strategies on future persistence. This manual is provided to help facilitate that process.

Installing Netica

The software needed to run the RGCT_BN model can be installed off the Norsys website: https://www.norsys.com/netica.html. Although there is a full featured free version of Netica for small BNs, our model is unfortunately too large to run on it. The full version of Netica must therefore be purchased online to run this RGCT_BN model.

Loading the model file

Contact the authors to obtain the .neta model file. Double clicking on the file on a computer with Netica installed will open the network which is ready to run (no further preparation necessary). The opened network should look something like:



where parent nodes are colored either green, pink, or yellow. Most (green) are derived from the RGCT assessment database (Alves et al. 2008). Those that can be influenced by management actions are shown in pink, while yellow ones are modeled climate related nodes (see Appendix A in Zeigler et al. *In press*). The final node shown in blue represents the probability of persistence for that population given input parameters.

Running the network

Network features are best explained with a worked example. Consider the Cat Creek conservation population of RGCT in the headwaters of the Upper Rio Grande GMU for which the following input parameters apply:

Patch Size (km) - 7.37 km

Barrier Presence - Partial

Population Connectivity - Isolated

Proximity of Competitor Source Population - Far (>10 km)

Proximity of Hybridizing Source Population - Far (>10 km)

Proximity of WD Source - Far (>10 km)

Nonnative Control - None

Demographic Support - None

Wildfire/Debris Flow Risk - Moderate

Drought Refugia Presence - Present

Evidence of Intermittency - Yes

Adult Population Estimate - 2868

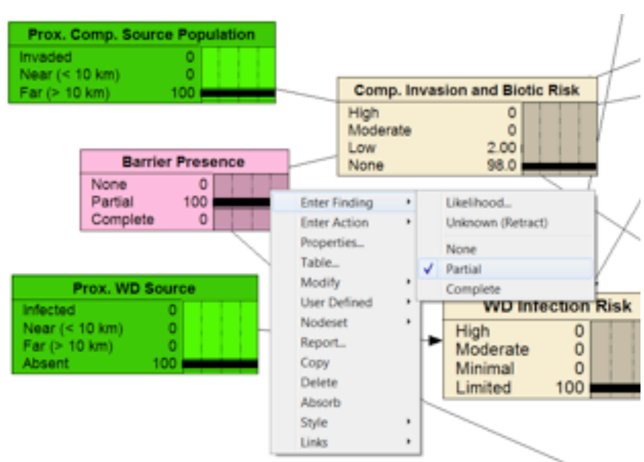
Ne/N Ratio - 0.25

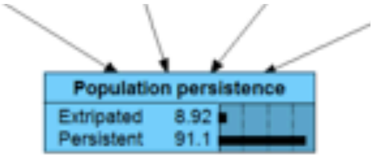
Baseflow Discharge - 0.0429 cms (Current); 0.0284 cms (2080)

M30AT - 13.16 C (Current); 14.16 C (2080)

MWMT - 16.97 C (Current); 17.38 C (2080)

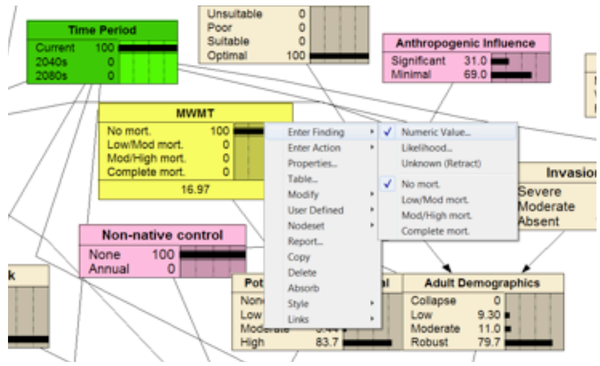
For each input node, right click (control click) on the node itself to bring up the contextual menu, then select "Enter Finding" and select the state that is appropriate for that node.

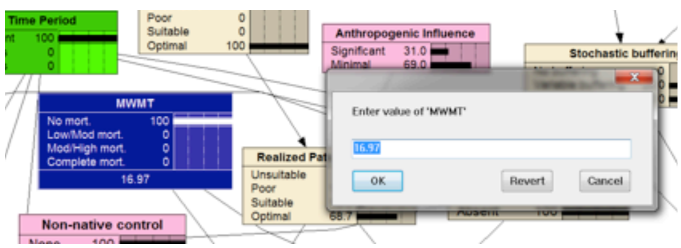




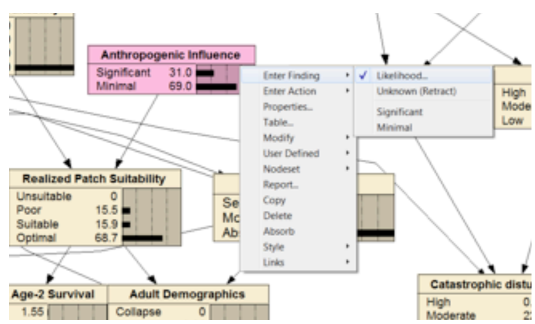
Once the state is changed, the ramifications of that change are perpetuated through the network immediately, and the effect of that change on the estimated probability of persistence can be observed.

If entering a continuous value (e. g. modeled maximum weekly maximum temperature - MWMT), select “Numeric Value” following “Enter Finding” from the dropdown menu and enter that value in the pop-up box.

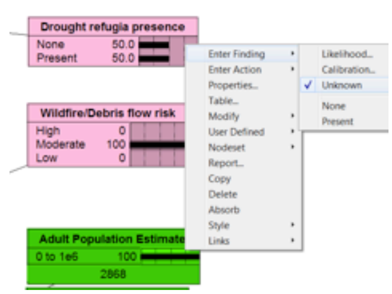




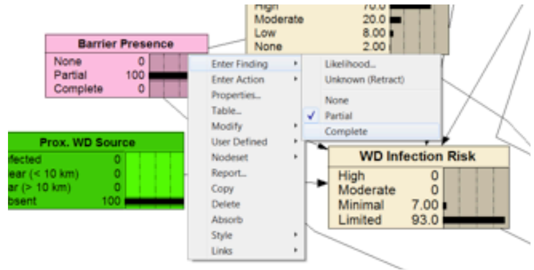
If there is some uncertainty as to which node state is appropriate, a probability for each state can be assigned by selecting “Enter Finding”, then “Likelihood”, then populating the resulting pop-up boxes (one for each state) with a value between 0 and 1.



Where no information for a node exists, you can leave the default of complete uncertainty (equal weight to each state), thereby perpetuating that uncertainty through the network. This can be achieved with the “Unknown (Retract)” command from the “Enter Finding” dropdown.



For the Cat Creek example, probability of persistence drops precipitously (down to 20.6%) when values for 2080 are entered. Changing the Barrier node state to “Complete” from “Partial” mitigates that drop with persistence remaining high (at 79.5%), illustrating the merits of employing that management action. Explore implications of additional management actions on persistence by modifying states of parent nodes shown in pink.



Batch mode

If population persistence needs to be estimated for many populations, a case file can be developed containing all the relevant information for each population. These are best prepared in Excel, then converted to ASCI text. Additional information on generating and formatting case files can be found on the web at : https://www.norsys.com/WebHelp/NETICA.htm. Once created, the file can be processed within Netica using the “Cases” dropdown menu. Every case (i.e., population) will be analyzed and the output saved to a text file.

Modifying or building your own network

Netica provides both a help system and context help from within the application to assist with developing your own Bayes network or modifying this one. Additional information on building networks can be found on the web at: https://www.norsys.com/WebHelp/NETICA.htm

Literature cited

Alves, J. E., K. A. Patten, D. E. Brauch, and P. M. Jones. 2008. Range-wide status assessment of Rio Grande Cutthroat Trout (*Oncorhynchus clarkii virginalis*): 2008. Colorado Division of Wildlife, Fort Collins. Available: http://cpw.state.co.us/learn/Pages/ResearchRioGrandeCutthroatTrout.aspx (March 2018).

Zeigler, M. P., K. B. Rogers, J. J. Roberts, A. S. Todd, K. D. Fausch. *In press*. Predicting persistence of Rio Grande Cutthroat Trout populations in an uncertain future. North American Journal of Fisheries Management.