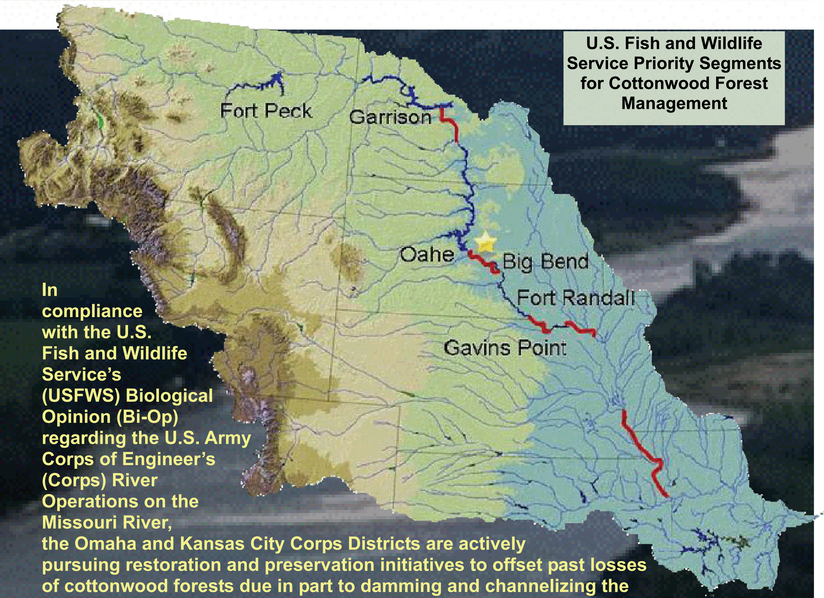
Coupling Conceptual Models with GIS to Develop a Community-based Index Model for the Missouri River Cottonwood Management Plan

Kelly A. Burks-Copes[1], Lisa A. Rabbe[2], Suzanne Boltz[3], Kristine Nemec[4], Antisa C. Webb[1], and Greg Kiker[5]

[1]U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory, Vicksburg, MS. [2]U.S. Army Corps of Engineers, Alaska District, [3]EA Engineering, Science and Technology, [4]U.S. Army Corps of Engineers, Omaha District, [5]Agricultural and Biological Engineering Department, University of Florida

Introduction



In compliance with the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Bi-Op) regarding the U.S. Army Corps of Engineer's (Corps) River Operations on the Missouri River, the Omaha and Kansas City Corps Districts are actively pursuing restoration and preservation initiatives to offset past losses of cottonwood forests due in part to damming and channelizing the Missouri River in the early 1950s. Because the study area encompasses an enormous geographic range (1,500+ river miles flowing through 7 states), a decision was made to divide the system into 13 segments (6 of which were designated as priorities by the USFWS) and address the restoration/preservation of each segment in an incremental (segment-by-segment) fashion. However, the functioning of the system's cottonwood riparian ecosystems can be affected by the current and future conditions at the local, regional and basin-wide scales. As such, the emphasis placed on a "systems" approach to the Missouri River Bi-Op's planning process has given rise to the need for methods to characterize habitat conditions now and in the future in a portable, adaptive manner with an emphasis on landscape-level sensitivity. As part of the cottonwood management planning effort, an extensive multidisciplinary ecosystem evaluation team has developed (and is currently applying) a community-based cottonwood index model to characterize the state of the ecosystem today, and evaluate and compare the outputs of proposed preservation and restoration plans in the first of the 6 segments in the study (Segment 10-a 59-mile stretch of "Wild and Scenic" Missouri River flowing from Gavins Point Dam to Ponca State Park in South Dakota and Nebraska).

Research Questions

Q1

What essential ecosystem components capture the ecological integrity of the Missouri River's cottonwood riparian community?

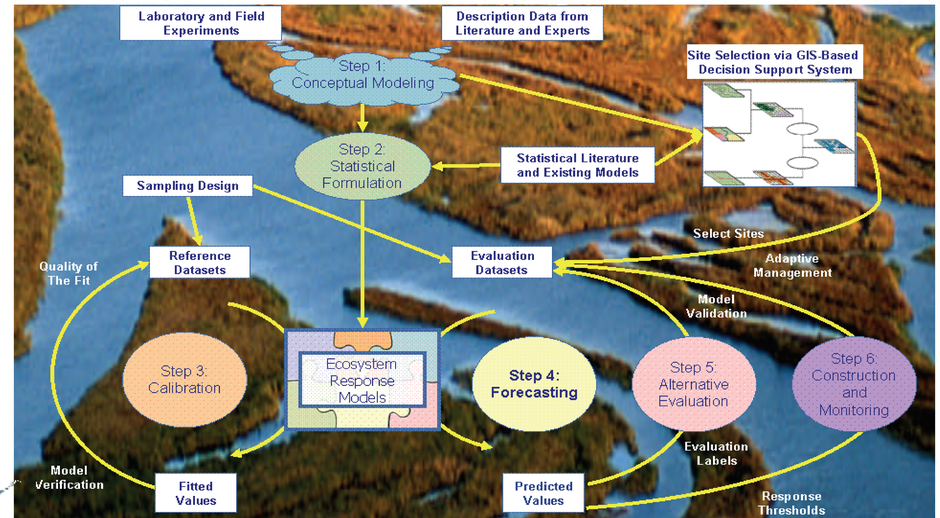
Q2

What variables are indicative and predictive of Missouri River cottonwood restoration and preservation success?

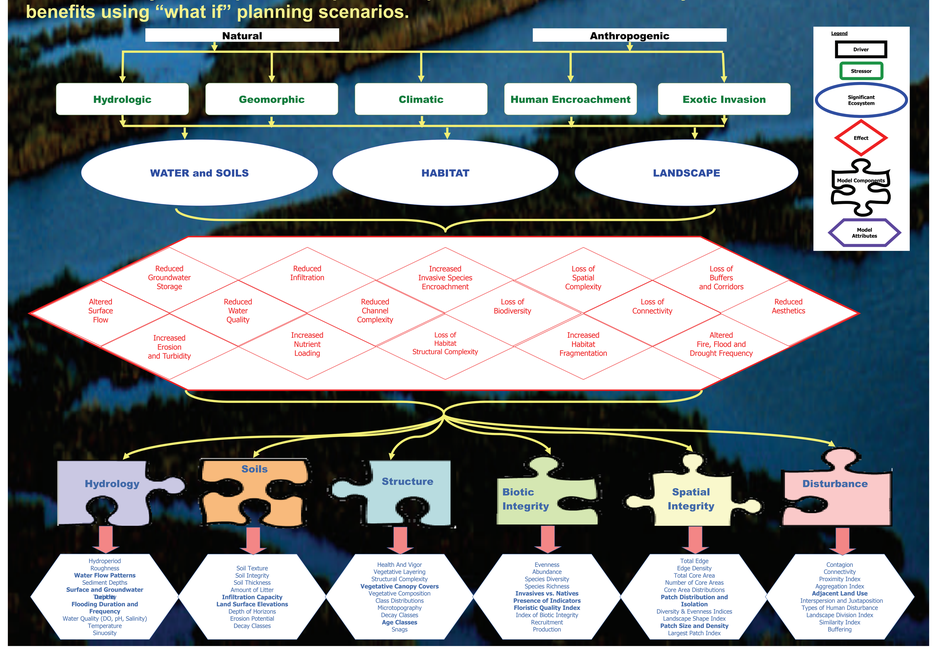
Q3

Can mathematical algorithms be developed to quantify the functional integrity of cottonwood communities system-wide?

Methodology

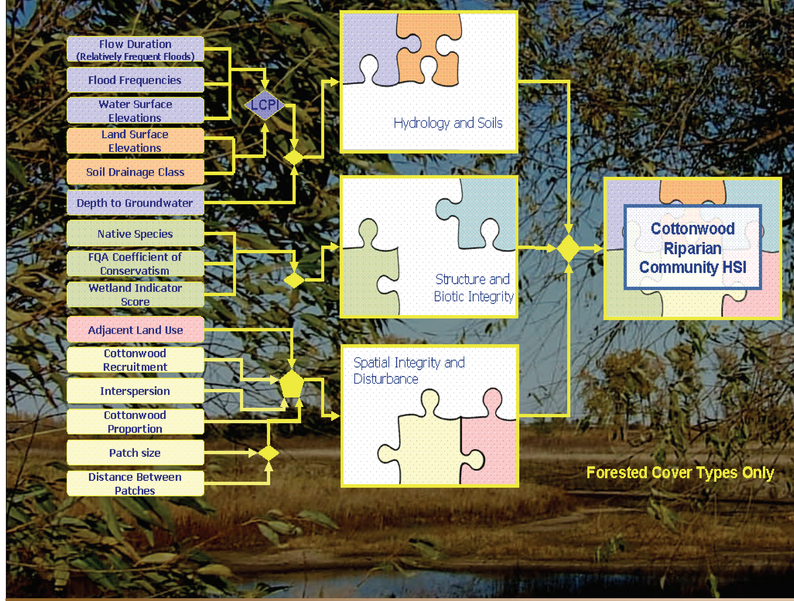


The U.S. Army Corps of Engineers and Development Center (ERDC) has developed an environmental benefits analysis framework that couples the traditional Corps planning process with ecosystem response modeling. Based on a sound conceptual understanding of ecological principles, the approach uses ecological risk assessment to characterize ecosystem integrity across spatial and temporal scales, organizational hierarchy, and ecosystem types, yet adapts to the project's specific environmental goals and objectives. The process begins with the development of conceptual models to derive ecosystem response and produces quantitative assessments of systematic environmental benefits using "what if" planning scenarios.



Results

Conceptual models lead to the choice of an appropriate scale for conducting the analysis and to the selection of ecologically meaningful metrics to facilitate environmental modeling efforts. Ideally, these models are calibrated using reference-based conditions and modified when the application dictates a necessary change. Alternatives are formulated and future conditions are then forecasted under both the No Action and Action scenarios. The ecological responses to these futures are quantified with model outputs and the planning process proceeds through plan comparison, selection and construction. Post-construction monitoring is initiated, and if response thresholds are triggered, adaptive management is engaged.



Future Research Directions

The Corps' intention has been to develop an index model that can be used in the future to evaluate and compare similar communities in the region, and to evaluate the benefits of proposed project management plans. The community model development process is anticipated to be iterative - as new information becomes available under the traditional Corps planning paradigm the team anticipates revising the model. The following areas of research are considered important to improving the veracity of the information "feeding" the community index model. Potential research opportunities include:

- Channel Migration Modeling
- Succession Modeling
- Land use Conversion Modeling

- Ecosystem Response to Climate Change
- Ecosystem Services Benefits
- Vegetation Succession Modeling

- Thalweg Modeling
- Automating a Site Selection DSS
- Google Earth Flyover Animations

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