Evaluating the Effectiveness of Conservation Strategies: Collaborative Scenario Building and Landscape Modeling

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Motivation: Changing Conservation

Figure 1. Local experts and conservation practitioners discuss forest dynamics during a workshop in the Wild Rivers Legacy Forest.

Conservation and land management organizations, including The Nature Conservancy (TNC), are developing conservation strategies to distribute protection efforts over large areas and a broad range of ownership and management techniques.

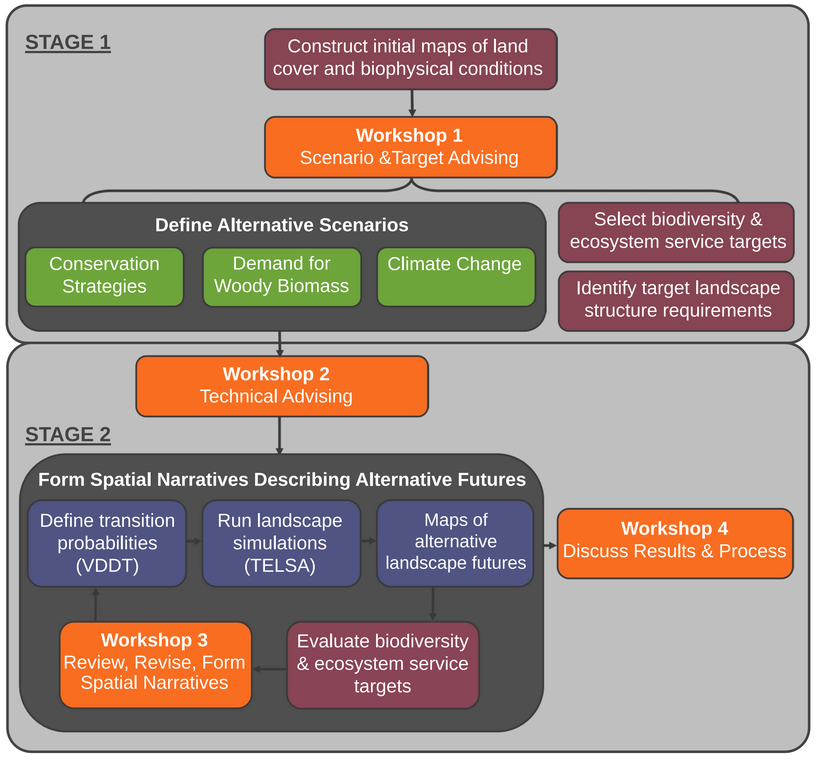
These '**distributed conservation strategies,**' such as working forest conservation easements, are based on the premise that blending resource extraction and conservation should yield socioeconomic benefits without compromising the conservation of biodiversity or the provisioning of ecosystem service.

However, it is unknown how these strategies compare to traditional conservation preserves, or if they will be robust to climate change and resource demand over time. Due to scarce financial resources and the relative difficulty of implementing some strategies, such as negotiating easement acquisitions, it is important for conservation and management organizations to know which strategies most effectively meet conservation goals. Meanwhile, the long duration required to evaluate most monitoring questions leads to a lag in transfer and delayed adaptive management.

To overcome these challenges, we developed an integrated **scenario-building and landscape modeling approach** (Figure 2) that provides insight into the potential outcome of different conservation strategies in response to anthropogenic and climate change pressures. We applied this approach in two large conservation areas in the Northern Great Lakes region of the U.S. (Figure 3), infusing the process with expert knowledge via four in-person (Figure 1) and web-based workshops (Figure 2, orange boxes).

Approach

Figure 2. A flow chart illustrating the two-stage, collaborative scenario-building and landscape modeling approach.



Study Areas

We are applying this approach in two study areas (Figure 3)— the Wild Rivers Legacy Forest in northeastern Wisconsin and the Two Hearted River Watershed in Michigan's Upper Peninsula. These areas are composed of largely northern hardwood forest types and wetland ecosystems along networks of rivers and lakes. Both have areas of different ownership and management strategies, including TNC preserve, privately owned lands under working forest conservation easements, and state owned and managed forests. This varied ownership and management scheme makes these areas ideal for studying the effects of different conservation strategies.

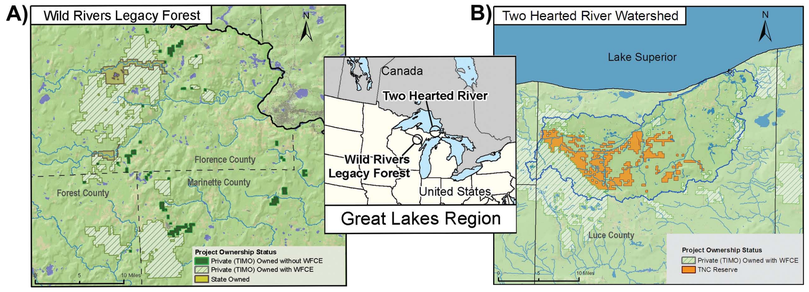
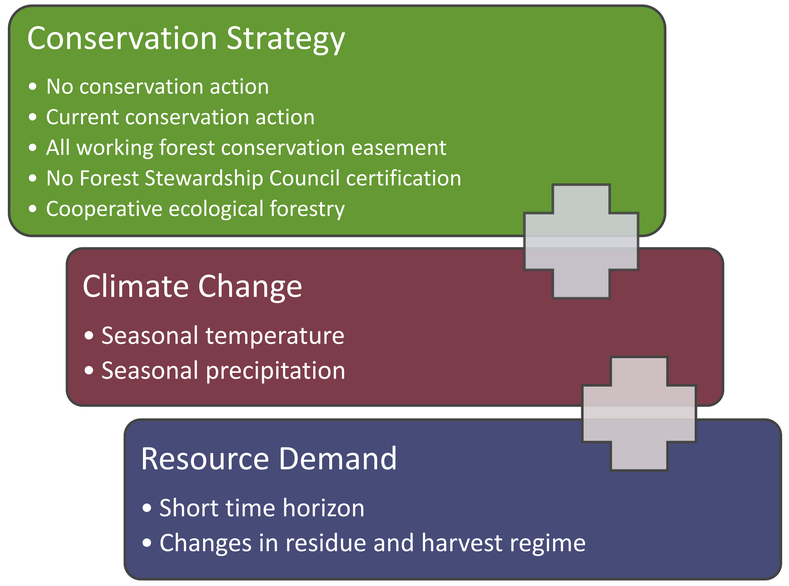


Figure 3. Maps of the Wild Rivers Legacy Forest in northeastern Wisconsin (A) and the Two Hearted River Watershed in Michigan's Upper Peninsula (B) showing the ownership status of specific areas. Maps courtesy of John Wagner, Wisconsin TNC.

Landscape Scenario Development

We developed exploratory (rather than normative) scenarios (Carpenter et al. 2006, Gustafson and Crow 2006, Mahmoud et al. 2009, Peterson et al. 2003) in collaboration with local experts and conservation practitioners in Workshop 1, an on-site workshop at each study location. Experts and practitioners included foresters and land managers from timber operations and the Department of Natural Resources, as well as TNC scientists.

To compose landscape scenarios, workshop participants were asked to identify the most important climate variables to consider and conservation or management strategies that might be applied in these landscapes, as well as to asses the demand for woody biomass for energy production in these areas. Then, they were asked how each of these components might influence forest dynamics.



Spatially Explicit Modeling

In Stage 2, we are using the VDDT/TELSA modeling suite (ESSA Technologies Ltd. 2010) to generate state and transition models and spatially explicit maps of possible land cover resulting from each scenario at 50, 100, and 150 years into the future (Figure 4).

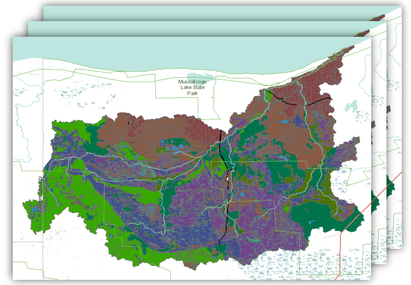


Figure 4. Each scenario will be modeled using the VDDT/TELSA software suite by ESSA technologies modeling suite to generate spatially explicit land cover maps for each scenario.

Local and regional experts will be engaged in an iterative process to evaluate and compare the maps of alternative scenarios to determine which scenarios are plausible and to build spatial narratives (Cork et al. 2006), or storylines, describing the human-ecological dynamics underlying the visible landscape change. Input from this workshop will also guide model refinement and additional simulations to produce more plausible alternative futures. Model outputs and narratives will be used to assess the effectiveness of each conservation strategy on biodiversity and ecosystem service targets in each study area.

Discussion

By enabling conservation decision-makers and scientists to understand the potential outcomes of the complex and simultaneous interactions of the diverse milieu of processes that influence landscape change over time, this approach can:

- Allow comparison of conservation strategies
- Reduce the risks associated with the implementation of innovative strategies
- Help determine when and where concentrated versus distributed conservation may be most effective
- Inform decisions about how to best utilize scarce financial resources
- Complement monitoring and adaptive management of ongoing conservation efforts to allow adjustment of strategies to anticipate future conditions
- Serve as a tool for pre-assessing future landscape scale conservation opportunities

In addition, cooperation and constructive communication among the conservation practitioners, foresters, and ecologists during the scenario building and modeling process builds trust, yields a more robust model and subsequent conservation strategies, and sets the stage for continued cooperative conservation planning and management.

Acknowledgements

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References

Carpenter S, Bennett E, Peterson GD (2006) Scenarios for ecosystem services: an overview. Ecology and Society 11(2):29.

Cork SJ, Peterson GD, Bennett EM, Petschel-Held G, Zurek, M (2006) Synthesis of the storylines. Ecology and Society 11(2):11.

ESSA Technologies Ltd. (2010) Vegetation Dynamics Development Tool and Tool for Exploratory Landscape Scenario Analysis. http://www.essa.com/tools/. Cited 24 June, 2010.

Gustafson EJ, Crow TR (1996) Simulating the effects of alternative forest management strategies on landscape structure. Journal of Environmental Management 46(1):77-94.

Mahmoud M, Liu YQ, Hartmann H, Stewart S, Wagener T, Semmens D, Stewart R, Gupta H, Dominguez D, Dominguez F, Hulse D, Letcher R, Rashleigh B, Smith C, Street R, Ticehurst J, Twery M, van Delden H, Waldick R, White D, Winter L (2009) A formal framework for scenario development in support of environmental decision-making. Environmental Modelling and Software 24(7):798-808.

Peterson GD, Cumming GS, Carpenter SR (2003) Scenario planning: a tool for conservation in an uncertain world. Conservation Biology 17(2):358-366.