Chapter 6. Conclusions and Future Work

6.1. Conclusions

We are in a new era of landscape connectivity conservation, one that goes beyond a focus on species-specific corridors to an approach that retains and restores linkages for wildlife and sustains ecological processes in the face of shifting land use and climate change. The statewide analysis of the Washington Connected Landscapes Project represents a vital, collaborative effort to describe current connectivity conditions, identify crucial wildlife habitats and habitat linkages, and set the stage for finer-scale analyses and consideration of future scenarios as part of our state's contributions to the Western Governors' Association Wildlife Corridors Initiative.

Besides the findings specific to our study area presented in previous chapters, our analysis process led us to several conclusions about conducting connectivity analyses in general. First, an analysis area that includes an ample transboundary buffer is essential for understanding broad-scale connectivity patterns for wide-ranging species and ecological processes. Focal species and landscape integrity analyses revealed many linkages across geopolitical borders that likely connect populations and processes in Washington to a broader regional network. Climate change and widespread loss of habitat call on us to explore options for conserving connectivity that transcend jurisdictional boundaries and sustain natural processes.

Second, our unique approach of combining focal species with landscape integrity-based modeling allowed us to evaluate how these methods are complementary and to contrast the strengths and weaknesses of both. The correspondence analyses we've included represent our first step in this evaluation. We intend to continue exploring the insights provided by the integration of these approaches (See Future Work, below).

Third, automating the linkage modeling helped contain the financial costs of analysis while also improving the quality of connectivity models by allowing analysis of multiple species and landscape integrity approaches at the statewide scale. Connectivity model development is inherently iterative, and automation permitted greater exploration and refinement of candidate models. We expect these automated analysis tools will also accelerate completion of subsequent, finer-scale analyses.

Lastly, we cannot overstate the importance of collaboration for: (1) providing resources and expertise necessary for completing this analysis; (2) ensuring our products meet the needs of diverse partner organizations, thus promoting broad acceptance of, and familiarity with the products; and (3) identifying shared priorities, strategies, and implementation needs. Connecting people and organizations through their shared interests in wildlife connectivity has and will continue to be of paramount importance to the work of WHCWG.

Considerable work remains to be done (See below). Our focus has been to identify broad habitat and connectivity patterns; however, refinement is necessary for smaller analysis areas and for project-scale planning. We will be sharing GIS analysis tools we have developed, as well as focal species and landscape integrity models for others to use to refine linkage analyses for more localized needs. Chapters 4 provides information to help address questions potential users of this analysis might have, such as how to interpret the analyses, how to use the information we're providing, and where to obtain additional information. Finally, WHCWG is committed to supporting future connectivity work, and will additionally seek to engage and support others working on behalf of wildlife habitat connectivity.

6.2. Future Work

This statewide analysis is the first of multiple products within the scope of the overall Washington Connected Landscapes Project. We envision the development of additional products that will contribute to our understanding of landscape connectivity and support the development of strategic plans and specific projects to conserve connectivity for Washington's wildlife. We have identified several specific efforts where we expect to focus our energy in the short-term future.

6.2.1. Climate Change

From the start, we recognized the importance of incorporating climate change into our connectivity analyses. To address this need, a WHCWG Climate Change Subgroup was formed in winter 2010. The subgroup defined two fundamental goals for integrating climate change into connectivity assessments: (1) continue to provide habitat and connectivity as climate changes, and (2) accommodate climate-driven shifts in species' ranges. They developed a comprehensive analytical framework for integrating climate change into statewide and ecoregional analyses and began pilot modeling exercises. Early analyses are likely to emphasize modeling linkages along climatic gradients, identification of climatic refugia, and investigation of the capacity of riparian networks to meet connectivity conservation goals under climate change. Subsequent analyses may include investigation of linkages and refugia that are robust to different future climate scenarios, and modeling shifts in species-specific bioclimatic envelopes.

We will begin incorporating climate change model results into the statewide analysis in 2011, preparing additional map layers identifying those habitat areas and linkages most likely to provide connectivity for animal and plant species given climate change scenarios. We also believe that the ecoregional scale may be an appropriate and manageable scale for incorporating climate change into connectivity assessments. We expect to test this idea with the Columbia Plateau ecoregional analyses.

6.2.2. Ecoregional Analyses

Our first ecoregional connectivity analysis, with products anticipated 2011–2012, will focus on the Columbia Plateau and adjacent arid lands in eastern Washington, extending into neighboring states and provinces. This ecoregional assessment will benefit from our experience completing the statewide analysis, as well as from other connectivity assessments that have provided frameworks for conducting regional analysis (e.g., Spencer et al. 2010). The Columbia Plateau analysis will serve as a template for developing methods and tools for analyses of other ecoregions within Washington. From these ecoregional analyses we intend to produce finer-resolution products that complement the statewide analysis and include considerable outreach to local wildlife and habitat experts and local communities.

We believe the ecoregional scale of analysis will offer opportunities for exploring linkage quality in more detail. This enhanced information about linkage quality can provide the basis for identifying crucial or high priority sets of linkages that comprise a foundation for ecoregional networks resistant to climate change and other impacts (Spencer et al. 2010). We also expect ecoregional analyses to be a critical intermediate scale of analysis useful for identifying locations where detailed linkage designs are needed (See Spencer et al. 2010).

6.2.3. Assessing Focal Species and Landscape Integrity Approaches

We intend to delve deeper into focal species and landscape integrity approaches to connectivity analyses by: (1) reviewing literature about focal species and integrity-based approaches and compiling performance characteristics described by others for these methods, (2) examining our results to identify where they support or differ from those found in the literature, and (3) pursuing new analysis methods that quantitatively compare our focal species and landscape integrity results. We will use the findings from these evaluations to inform future analyses.

6.2.4. Model Validation and Adaptive Management

Our models are based on imperfect spatial and biological data. Evaluating the reliability of our results and refining them is important to predicting how species may respond to infrastructure development, land-use change, climate change, and other stressors, as well as to design effective conservation and mitigation strategies. Model validation followed by an adaptive management process that integrates improved species information are necessary components of connectivity analysis.

Resistance values for mountain goats (Shirk & Rice, Appendix A) were informed by a prior analysis of genetic data (Shirk et al. 2010) that linked genetic distances with resistance values in the Washington Cascades. However, for the remaining species we lacked data that could link model parameters and results explicitly to research that measured movement patterns or gene flow for the species we analyzed.

We are working on two research projects with WHCWG collaborators to begin addressing this need. The first is the Greater Sage-Grouse Project led by WDFW. This project has three elements: (1) examination of model predictions and movements by Greater Sage-Grouse using data from a large radio-telemetry study, (2) examination of model predictions and patterns of historical lek persistence, and (3) genetic analysis of Greater Sage-Grouse populations in Washington and the application of landscape genetic analyses to relate patterns of current and historical connectivity to patterns of landscape resistance. The second project is the Cascades Carnivore Connectivity Project led by the Western Transportation Institute and the U.S. Forest Service, which is evaluating barriers to carnivore movement in the North Cascades. The study employs remote camera monitoring and non-invasive hair sampling techniques (for genetic analysis) to provide information about carnivores and identify barriers to movement as well as potential linkages throughout the North Cascades. Inferred linkages and barriers will permit an informative comparison with the statewide analysis connectivity maps. We anticipate that results from both projects will help enrich our future work.