Chapter 4. Using the Statewide Connectivity Analysis

This statewide analysis provides the foundation of a three-tier connectivity analysis and planning framework which includes: (1) the statewide connectivity maps and products presented in this document and associated future web-based products, (2) future ecoregional connectivity maps, and (3) future detailed local ***linkage designs*** (Fig. 1.3). Importantly, this statewide analysis is not a plan and does not set priorities. It is a science-based document that provides information that can be used—in conjunction with other sources of information—to support conservation planning and prioritization efforts. Our products must be used carefully, and correctly interpreting our results particularly with respect to the coarse scale of our statewide-plus analyses, is critical to using them effectively. Some strengths and limitations of this analysis are as follows:

STATEWIDE CONNECTIVITY ANALYSIS STRENGTHS

- Serves as a resource for informing, implementing, and coordinating broad-scale connectivity conservation within Washington State and across our borders to neighboring jurisdictions.
- Highlights regional-scale landscapes in Washington State and neighboring jurisdictions that are important core habitats or linkages for wildlife. These landscapes allow us to prioritize where to look more closely with further analysis, field information, and local expertise and knowledge to ensure our state maintains a connected network of wildlife habitats.
- Creates a foundation for building future analyses that can provide priorities among linkages at finer scales such as ecoregions.
- Yields a foundation for analyses that address specific conservation challenges such as climate change, population growth, and energy development.
- Provides a broad-scale context for planning areas of smaller extent.
- Complements other broad-scale conservation maps.
- Provides information to help organizations incorporate connectivity into conservation efforts while meeting their own organizational needs and priorities.

STATEWIDE CONNECTIVITY ANALYSIS LIMITATIONS

- The broad-scale nature of the data and models means that not all important habitat areas and linkages have been mapped; additional detail and regional and local expertise are needed to ensure local connectivity needs are addressed.

- Habitat areas and linkages must be refined at a finer scale and/or validated through field research to create implementable linkage designs.

In this chapter we describe how to interpret and use our products, and how future analyses will build upon them. We also include a section on additional resources that may be of assistance to users of this statewide analysis.

4.1. How Base Data Affect Our Products: Scale and Age of Spatial Data Layers

The various base maps we used for modeling form the foundations of our analyses. All spatial data sets, especially those that cover such a broad geographic extent, have errors in them. Acquaint yourself with the base data for areas you are interested in: our base maps are described briefly in section 2.2, and in more detail in Appendix C. More importantly, comparing the data with other sources of information, such as aerial photography or Google Earth, can give one a good sense of their accuracy at different scales (Fig. 4.1).

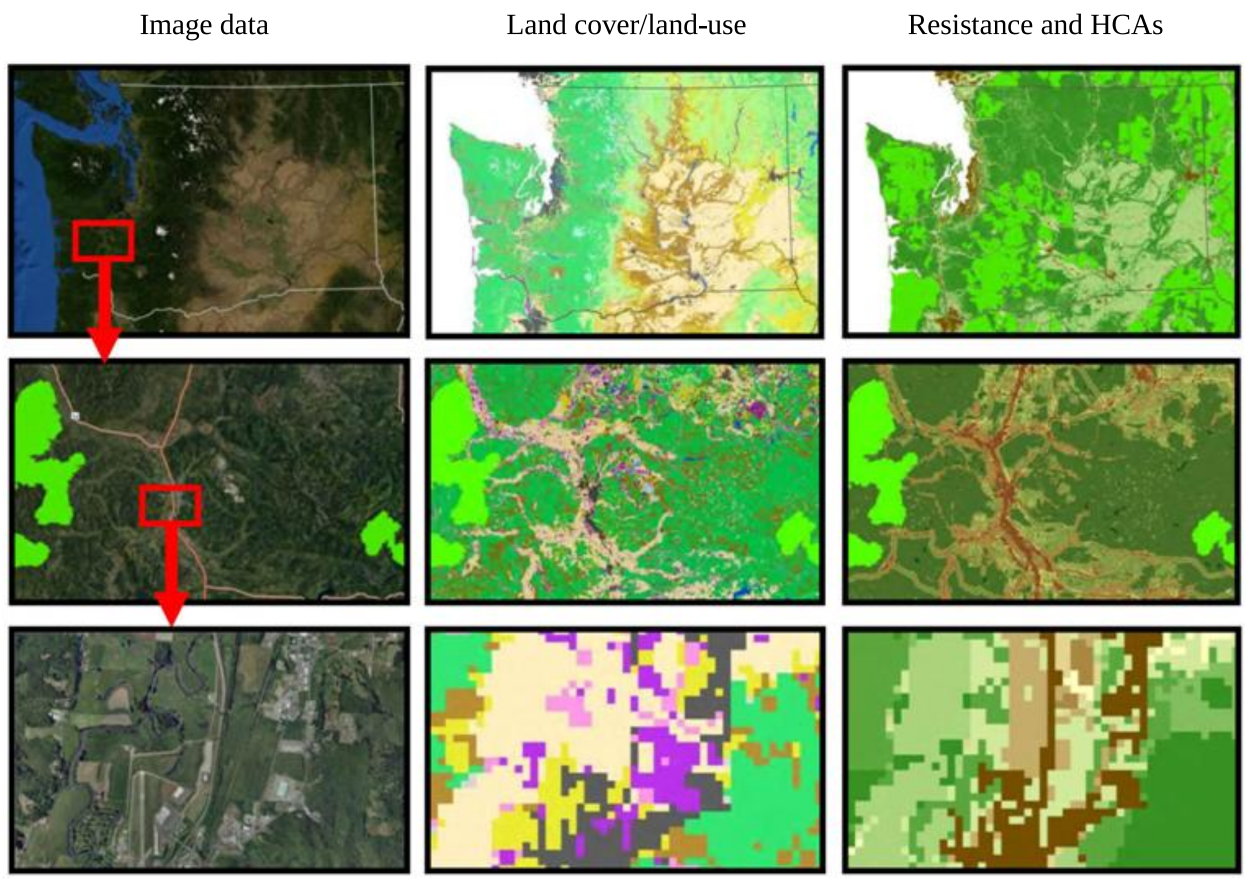

Figure 4.1. Effects of scale on accuracy and precision of base and derived data layers. Left to right: imagery from satellite and aerial photo sources, land cover/land-use data, and resistance and habitat concentration areas layers for elk. Top to bottom: statewide extent and increasingly smaller extents. Red boxes in top two rows show zoom extent for the next row. Our base maps capture reasonable levels of detail when viewed at the extents depicted in the top two rows. When zoomed to the extent in the bottom row (Chehalis-Centralia airport area), the limitations of the data become evident.

The coarse grain of the data layers used in our analyses limits the resolving power of all of our modeled outputs. We did not include important features that affect connectivity, such as power lines and fences, or details such as different crop types that are more or less suitable for wildlife movement. The broad extent of our statewide-plus analysis made it impossible to include this level of detail.

Our data sources in many cases won't include recent features on the landscape because the data are based on information that can be several years old (See Appendix C for dates of origin for data used to develop these layers). For example, GAP and LANDFIRE data are based on satellite imagery acquired between 1999 and 2003. That means if clear-cut logging has created gaps in northern flying squirrel habitat in the last 7 years, those gaps won't be reflected in our habitat concentration area (HCA) maps. Other new features on the landscape, such as wind farms, have also been missed by our models and would need to be considered separately in planning efforts.

4.2. Cost-Weighted Distance Maps: A Key Product

Our linkage maps tend to attract the most attention, but we urge readers to look closely at our cost-weighted distance maps. These show the cumulative cost—a measure of movement difficulty—that it would take for wildlife to move to any point in our study area from the nearest HCA.

Cost-weighted distance maps actually contain the same information as our linkage maps (a linkage map is created by adding the cost-weighted distances from the two HCAs it connects), plus something more. Cost-weighted distance maps allow you to compare the relative difficulty of moving through different linkages.

For example, a linkage connecting HCAs at the far ends of box 1 in Figure 4.2 would incur less cost (even though it is longer) than a linkage traversing box 2. Box 2 also includes a fracture zone, i.e., it passes through an area with significantly reduced permeability and would need considerable attention to serve as a reliable linkage. In a single map, you can see how isolated different parts of the landscape are from the nearest HCA, how isolated HCAs are from each other, and where some of the best movement routes between HCAs are likely to be. Linkage statistics (section 4.3.3; Appendix E) can also be used to estimate the degree of isolation between HCAs.

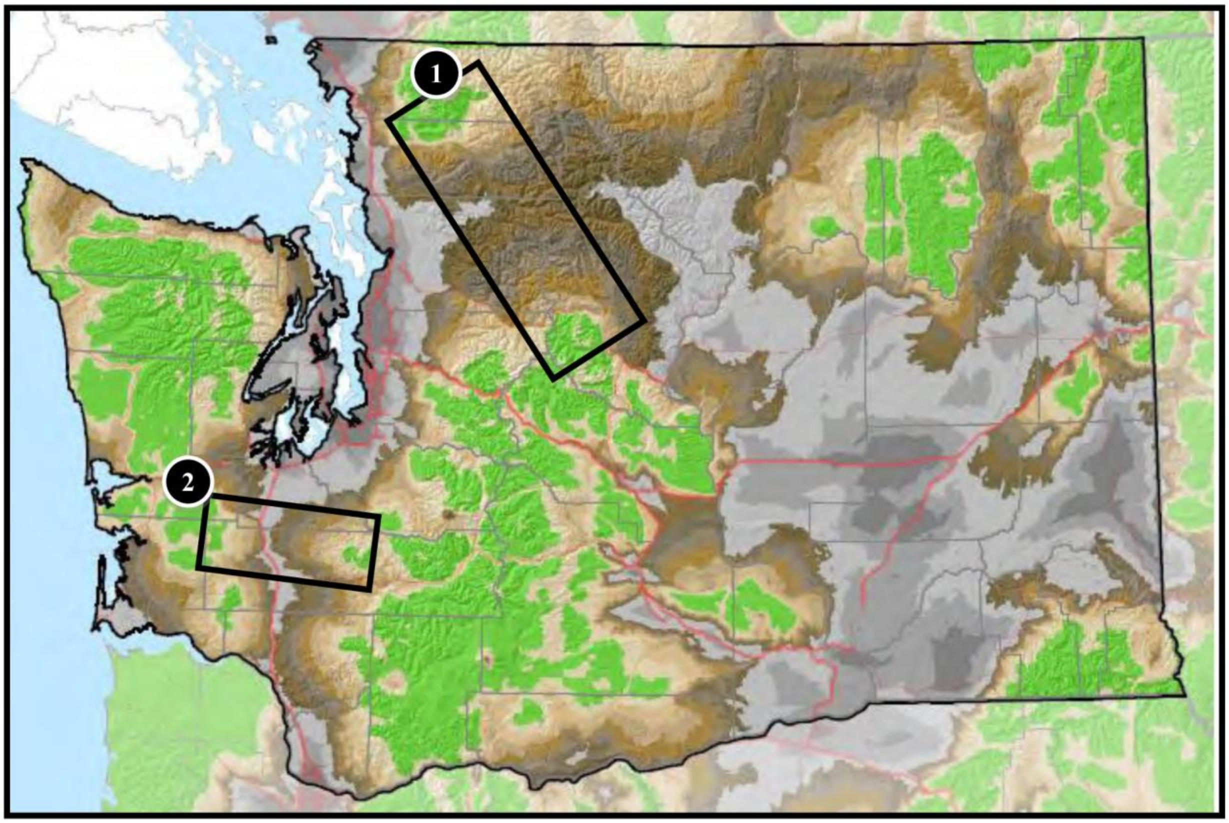

Figure 4.2. Cost-weighted distance map for elk. Even though box 1 spans a larger distance, the higher permeability of habitat means the length of this box is predicted to be easier and safer for elk to traverse than box 2, which spans a fracture zone.

This extra information comes at the expense of some detail: in other words, these maps have more of a fuzzy look to them than our linkage maps. This isn't necessarily a bad thing; in the opinion of our modeling team, this "broad-brush" appearance probably best conveys: (1) the broad array of paths animals will likely use as they attempt to move across the landscape, (2) spatial uncertainty associated with base data resolution, and (3) uncertainty associated with modeling how wildlife species perceive and respond to features that contribute resistance to the landscape.

4.3. Linkage Maps

Our linkage maps reflect our best estimates of potential movement pathway locations between adjacent HCAs given our data sources and models. As such, they provide powerful tools to support connectivity conservation planning.

These linkage maps can also be misused, because they appear to provide easy answers to connectivity conservation questions. They do not. In reality, they must be used with extra care because they are especially sensitive to our modeling assumptions and errors in our data layers. But they are valuable when used with a clear understanding of our models and data sources, and when combined with other conservation maps and additional information (such as from aerial photography, road kill records, or other field data).

We do not suggest that all mapped linkages should be conserved or even that all are important; some linkages may be impractical, and there may be other ways to keep habitat areas connected rather than focusing on direct linkages between them. Conversely, unmapped linkages may also be important, especially at more local scales or for species or systems that we didn't consider.

4.3.1. What Linkages Represent

A mapped linkage zone is not a known migration pathway. It depicts the easiest *modeled* movement routes between neighboring pairs of HCAs. Its existence, characteristics, and location are all dependent on the coarse-scale data layers that were available to us, our models of habitat suitability (reflected in our HCA maps), our models of dispersal habitat suitability (reflected in our resistance maps), and other factors such as our knowledge of maximum dispersal distances for each species (which informed maximum linkage lengths).

The map in Figure 4.3 shows dozens of linkages, all of differing lengths, qualities, and permeability to movement. Putting all linkages for a whole region on one map with one color scheme means yellow areas (the best portion of each linkage) can be in very good or very poor condition. For example, movement routes along ideal (yellow) pathways vary in cumulative cost-weighted distance by a factor of 10. Some routes are predicted to be as easy to traverse as moving through 2 km of ideal habitat, while others are predicted to be as difficult as moving 235 km, and include the crossing of highways and other hazards. Yet, each linkage has a central yellow band, indicating the best modeled movement pathway *for that linkage*. The important point is that one cannot compare *between* linkages using this map. Cost-weighted distance maps (See previous section and Fig. 4.2) and linkage statistics (See Appendix E and Fig. 4.4) must be used for this purpose.

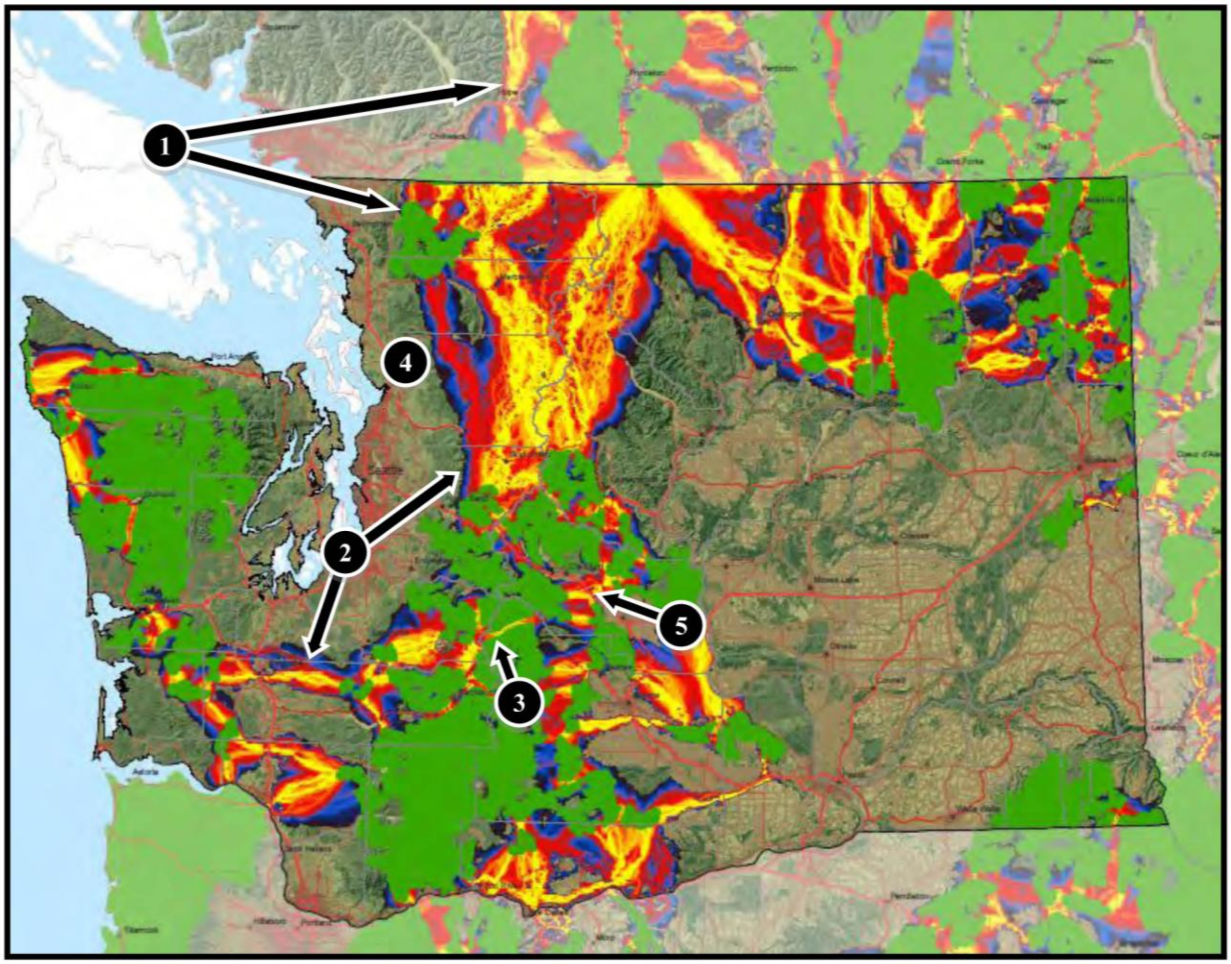

Figure 4.3. Linkage map for elk. See section 4.3.2 for points illustrated by item numbers.

4.3.2. Interpreting Individual Linkages

There are several points to be aware of when interpreting individual linkages. The items that follow are illustrated with corresponding numbers in Fig. 4.3.

- *Item 1. Confidence in map products inside vs. outside Washington State.* For many cases, we were able to find better datasets within Washington State than outside its borders (due in part to the fact that we had easier access to spatial data for Washington than for other jurisdictions). As a result, some of our data, particularly for local roads, were considerably more reliable inside Washington than outside. We thus have higher confidence in our modeled map results within Washington than for the rest of our project area.

- *Item 2. Wide vs. narrow linkages*. Wider linkages don't mean that more area is needed to conserve connectivity, they simply mean there are many options for movement that incur similar movement costs and risks. Normalized least-cost corridors typically become wider in high-quality movement habitat because resistances are low and cost accumulates more slowly there. The wider linkage identified by item 2 passes through low resistance habitat in the North Cascades. The narrower linkage navigates through areas with significant barriers and hazards along I-5 near Centralia, where conservation options are more limited.

- *Item 3. Wide yellow bands when two HCAs are separated along a broad front by a narrow, linear barrier*. When two HCAs are separated by a narrow barrier (like a highway), they are often connected by a linkage that is very wide and yellow along much of its width. This is a result of normalizing linkages so that they can be mapped with the same color scheme. For elk, any portion of a linkage that can be traversed while accumulating less than ~2 km extra cost-weighted distance relative to that accumulated along the easiest path will display as yellow. But in these very short, wide linkage zones, 2 km is a considerable extra distance, in some cases doubling the cost accumulated relative to the easiest route. Finer-scale analyses would be needed to determine where the best conservation options exist.

- *Item 4. Secondary corridors (independent stringers).* Recall that we mapped linkages with normalized least-cost corridor values up to a species-specific cutoff value (See section 2.6.2). In many cases, entirely independent corridors fell within this cutoff value. These should be given extra consideration because they may provide greater redundancy—alternative pathways—than the red and blue fringes of least-cost (yellow) corridors. Often these fringes represent nothing more than cases where it is relatively easy for an animal to take a short detour from the least-cost path into a fringe area and back again before continuing its journey. The key point is that the potential to provide a functionally independent linkage is clearer for secondary corridors than for fringe areas. Independent, redundant connections can be important in ensuring connectivity plans are robust to uncertainty in underlying data, species models, or habitat loss due to unpredictable events like wildfires (Moilanen et al. 2006; O'Hanley et al. 2007; Pinto & Keitt 2009).

- *Item 5. Important features we couldn't map.* We were surprised by the mapped elk linkage predicted to cross I-90 between Cle Elum and Ellensburg. If this was an important movement route, we'd expect higher numbers of elk to be killed on this stretch of road than have been recorded by Washington State Department of Transportation (WSDOT). More elk are killed on segments of I-90 that are upslope from this segment (towards Cle Elum) than on this segment. A little investigating revealed that an elk fence had been constructed along this segment in the 1970s, presumably because elk were moving through this area and creating hazards for drivers. Features like fences are too detailed to map at statewide scales, but are nonetheless important to consider when developing detailed connectivity conservation plans.

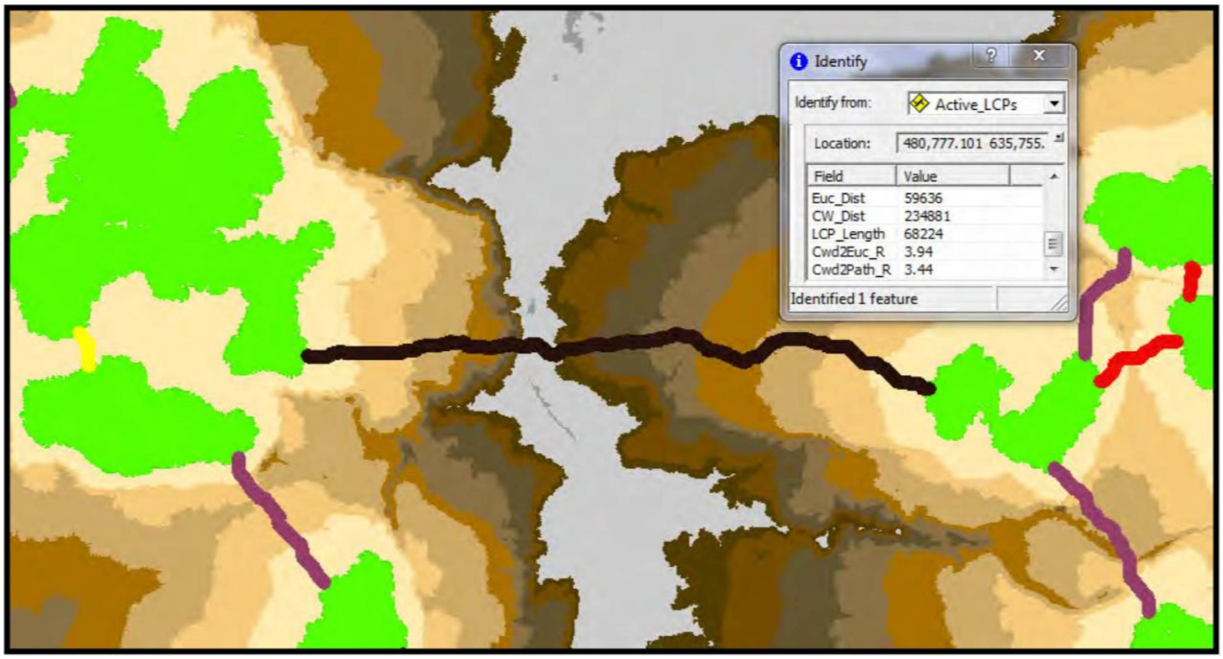

Figure 4.4. Cost-weighted distance surface and linkage statistics for elk linkages in Centralia area (See Fig. 4.1, middle row for approximate location). Here, least-cost path lines are used as placeholders for modeled linkages, and are colored to reflect cost-weighted distances for corresponding linkages (warmer colors are shorter in cost-weighted distance). Euclidean distances (Euc_Dist in query table) are the straight-line edge-to-edge distances between HCAs. Cost-weighted distances (CW_Dist) measure the total cost accumulated walking along the least-cost path. Least-cost path lengths (LCP_Length) are the actual (un-weighted) distance traveled walking along the least-cost path. The black linkage passing through the Centralia area connects HCAs that are 59.6 km apart, has a total un-weighted length of 68.2 km, but accumulates nearly 235 km of cost along that length because of barriers. Linkage quality information can be found in Appendix E.

4.3.3. Linkage Statistics

In addition to linkage maps, we provide basic statistics describing linkages (Appendix E). For each linkage, these include the Euclidean (straight-line edge-to-edge) distance between HCAs the linkage connects, the cost-weighted distance measured along the easiest movement route (i.e., the total cost accumulated walking along the least-cost path), and the un-weighted length of the least-cost path (i.e., the actual distance traveled walking along the least-cost path). Examples of each are shown in Fig 4.4. We also provide informative quality metrics, including a ratio of cost-weighted distance to Euclidean distance and cost-weighted distance to the length of the least-cost path.

Note that least-cost paths are calculated and mapped in Appendix E only to provide identifiable placeholders for each linkage, and to provide estimates of relative linkage quality. Given the limitations of our models and our base data (See section 4.1, Figs. 4.1 and 4.5), these 1-grid-cell-wide routes are not meaningful for planning purposes.

4.3.4. Limitations of Linkage Maps

WHAT OUR LINKAGES ARE CONNECTING

Remember that our habitat concentration area (HCA) maps are meant to capture the most important habitat areas for a species, not all habitat areas. Interpreting the habitat concentration area models requires an understanding of how they were intended to be used in our study and how they were derived. HCAs were not intended to identify critical habitats or to prioritize areas for conservation. Instead, HCAs in our study represent habitat areas as “seeds” on the landscape separated by sufficient space to allow for modeling connectivity between them. For focal species that occur in well-defined habitat areas (Greater Sage-Grouse, Sharp-tailed Grouse, mountain goats, and bighorn sheep), we delineated HCAs based on extensive survey data. For these species, HCAs approximated currently or recently occupied habitat within the study area (Chapter 3 species summaries; Appendix A), and their patchy distribution inherently allowed room to model linkages between them.

The species that are continuously distributed but perhaps at varying density across the study area (all other species aside from the four mentioned above) presented a challenge. Defining core areas based on a range map of predicted or actual species distribution did not allow for sufficient room between HCAs to model linkages and cost-weighted distance. Instead, we delineated HCAs for these species based on a subset of their range such that core areas were restricted to only the largest concentrations of the most suitable habitat. As such, HCAs for these species do not closely match the full range of their predicted GAP distribution (Chapter 3 species summaries; Appendix A). Moreover, the species with the broadest distribution required the most stringent definition of core habitat (i.e., the proportion of habitat within the home range radius moving window was greater) in order to restrict the number and extent of HCAs to a degree suitable for our connectivity models. Because the level of stringency defining HCAs varied across species, comparison of the number and extent of HCAs between species is not appropriate.

Importantly, HCA and landscape integrity core area locations that resulted from modeling decisions like these also defined where linkages could occur. As a result, if an area within a species’ GAP distribution contains no HCAs or linkages (e.g. for American black bears in much of western Washington; Fig. 3.33) that does not mean the area does not provide important local habitat or connectivity.

RELIABILITY OF LINKAGE MAPS AT DIFFERENT SCALES

Figure 4.5 illustrates scales appropriate—and inappropriate—for applying our results. The coarse data layers and broad scope of our analyses limit the resolving power of our map products, and this becomes evident upon close inspection of our mapped linkages. This is one reason why we feel the “broad-brush” appearance of our cost-weighted distance maps may best convey the level of certainty that can be ascribed to our results. Our linkage maps in many cases show modeled linkage locations that imply a higher level of precision in linkage locations than our data can support when viewed at scales that are finer than intended (e.g., Fig. 4.5, bottom row).

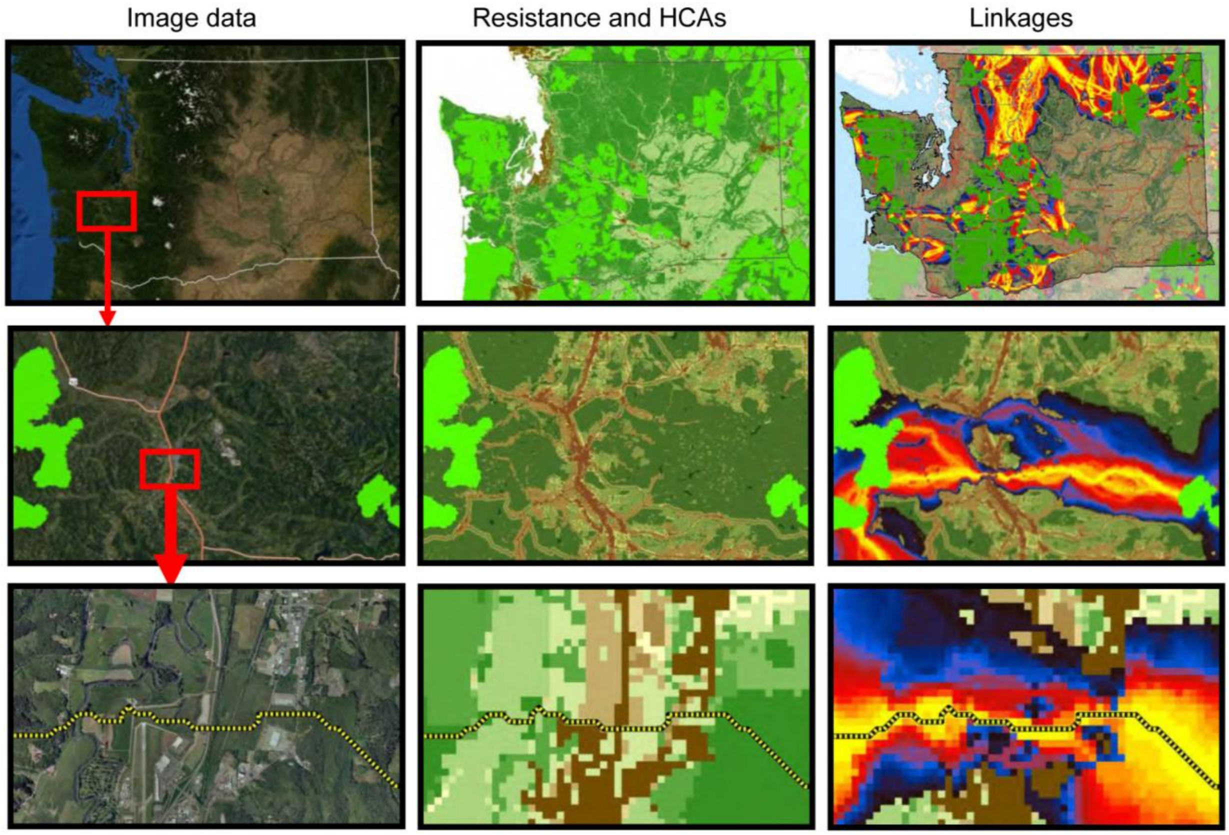

Figure 4.5. Effects of scale on reliability of linkage modeling results. Because base data layers do a good job of capturing patterns in land cover and other features at the extents shown in the top two rows, we consider our modeling results to be informative at these scales. Note the pinch point where options are constrained (I-5 crossing near Centralia, WA). However, linkage and resistance maps become unreliable at the finer scale depicted in the bottom row. The modeled location of the 'best' portion of the linkage (dashed line) actually crosses the northern tip of the Chehalis-Centralia Airport—hardly a good place for an elk to be. This illustrates the need for fine-scaled linkage analyses; a detailed linkage design would certainly reroute this linkage, assuming the linkage proved to be viable, cost-effective, and compatible with local planning goals after fine-scaled analysis.

4.4. Informing Priorities

Within the networks of connected habitats we've identified, conservation priorities can and should be established. However, while our maps provide important information to support connectivity conservation, they do not define conservation priorities on their own. Priorities and methods to set them will depend upon the missions and goals of the organizations that are using these products. For example, conservation priorities for the needs of an individual species could be different from priorities meant to conserve biodiversity or ecological processes. Similarly, priorities for investments in wildlife-friendly highways might take into account traffic volumes and highway geometry, factors that may be less important in other kinds of prioritization schemes.

We expect prioritization among linkages will typically be accomplished at ecoregional or local scales. At these scales, finer-resolution analyses that integrate regional and local information and consider local planning needs and constraints can be added, as can more detailed spatial data or field data on species movements. Information relevant to other conservation objectives, such as ecoregional assessments and salmon recovery priorities, can also be more easily integrated at these scales.

We have included corridor quality maps and data (see description in section 4.3.3; Appendix E) to assist with setting priorities. Focal species summaries (Chapter 3) provide biological interpretation for many of the linkages we've identified. In addition, we encourage users to pay particular attention when linkages coincide for multiple species and/or our landscape integrity models (Figs. 3.73–3.75).

4.5. A Foundation for Finer-Scale Analyses and Linkage Design

The WHCWG will follow this statewide analysis with ecoregional connectivity analyses that will build on this report while focusing on smaller planning areas. This has the benefit of allowing us to: (1) include spatial datasets unavailable for the statewide project area, (2) include more regional participation thus allowing the incorporation of regional knowledge, and (3) incorporate considerations that may influence connectivity unique to a regional landscape.

The ecoregional analyses are analogous to the "Regional Analysis" framework articulated in the California Essential Connectivity Report (Spencer et al. 2010); we encourage readers to refer to that report for what we consider an important resource for mapping and prioritizing linkage networks at regional scales and for completing detailed linkage designs at local scales.

Our first ecoregional connectivity analysis will be for the Columbia Plateau in eastern Washington, and an overview of how this report will inform the ecoregional analysis is given below in section 4.6.2. The result will be products that include refined habitat blocks and more detailed linkage maps to inform regional and local conservation efforts.

Local-scale linkage designs replace coarse-scale linkage maps. These linkage designs map finer linkage details and provide conservation actions needed to conserve and/or restore connectivity within identified linkages. Linkage designs will typically follow ecoregional analyses or more local level analyses that provide additional data and information useful for identifying priorities for the linkage design work.

The statewide analysis can be a useful resource before finer details are added, particularly when conservation opportunities arise or projects are proposed that may impede wildlife movement. In such cases, decisions may need to be made as to whether to proceed with a more local detailed linkage analysis before results of ecoregional analyses are available. If a proposed project, such as the widening of a stretch of highway, falls within an area identified by this report as a habitat concentration area or linkage, then this can be a trigger for further detailed analysis and potentially for a fine-scale linkage design. Although such analyses would require additional local knowledge, data, and field work, the base data and products from this report will provide valuable resources to build upon.

Such an example occurred at Stevens Pass Ski Resort in 2009. In 2009 the resort updated its Master Plan for Development, which outlines future plans for operation and growth. During the discussions surrounding this plan's update it was identified that the ski resort fell within an important habitat connectivity area for multiple montane species based on previous work (Gaines et al. unpublished; Singleton et al. 2002). These past analyses were coarse scale and did not provide the detail necessary for analyzing Master Plan impacts to connectivity. In response, the resort hired the Western Transportation Institute to conduct a detailed finer-scale analysis of connectivity in the Stevens Pass vicinity north and south of Highway 2 in Washington's Cascades Mountains. By conducting analyses at the appropriate spatial scale, the study allowed the ski resort, and the national forests upon which it operates, to better evaluate how their plans would affect habitat connectivity (Begley & Long 2009).

4.6. Example Uses of the Statewide Analysis

With attention to the caveats and the interpretive information we've provided above, the statewide connectivity analysis can be used in a variety of conservation planning contexts. For example, it can be used to inform:

- The Western Governors' Association Wildlife Corridors Initiative.
- The Washington State Department of Fish and Wildlife's Wildlife Action Plan.
- Implementation of safe wildlife passage structures and complementary measures by the Washington State Department of Transportation in accordance with Executive Order 1031 (e.g., enlarged culverts, wildlife overpasses, and fencing).
- Land management plan revisions and decisions for public lands in Washington State, including our national forests, state parks and forests, and state and federal arid lands.
- Decision making by conservation organizations.
- Local government efforts to protect habitat connectivity and initiate coordination on finer-scale analyses for comprehensive planning.
- Investments through state and federal grant programs for conservation of habitat and working lands (e.g.,Washington Wildlife and Recreation Program, Land and Water Conservation Fund, and Farm Bill incentives).

Below we provide details on two specific uses for our products. The first is by WSDOT for their wildlife-friendly highway program, and the second regards the scaling down of the statewide analysis to the ecoregional scale for the Columbia Plateau ecoregion in Washington.

4.6.1. Example use: Washington State Department of Transportation

WSDOT operates a state highway system composed of over 11,000 km of road. The agency has an expressed interest in reducing the effects of these roads on wildlife movements and reducing the risks of collision to make the highways safer for the traveling public. This statewide analysis puts WSDOT in an improved position for determining the best locations for investing in wildlife-friendly highway improvements. These maps, when integrated with other information, will enable WSDOT to make informed decisions about where to allocate limited funds available for habitat connectivity.

WSDOT's main anticipated use of these maps is to identify locations where highways intersect with connected linkage networks. What follows is a discussion of how WSDOT anticipates applying this information at the transportation corridor, project, and I4 (a highway improvement program) highway improvement levels.

Transportation corridor planning takes a long-range view of transportation needs for a specific area: planning considerations include many social and environmental factors. In this decision framework WSDOT has the greatest flexibility for considering different options to meet the needs of people and the environment. A wide range of ecological considerations might be included when establishing priorities for transportation improvements within the corridor. These could include, for example, maintaining landscape permeability for large carnivores, cultivating connectivity to provide for key ecological functions, and minimizing wildlife-vehicle collision risks for motorists. Many of the methods described in this chapter for using the data produced by this statewide analysis will be important for examining options and identifying best practices within the corridor planning framework. After all of the relevant factors have been considered, the corridor plan could indicate where to implement specific improvements such as wildlife underpasses, barrier fencing, wildlife guards on intersecting side roads, and more.

The I-90 Snoqualmie Pass East project is a good example of the application of similar information to a highway improvement project that benefitted from least-cost corridor analyses as well as extensive field work that included snow tracking, motion-triggered cameras, and other methods. The result is a highway design that includes wildlife crossing structures, extensive barrier fencing, and many subtle features intended to improve conditions for wildlife.

During the planning phases of the project, a broad coalition of public and private organizations engaged on connectivity issues in the broader I-90 corridor, including issues related to the "checkerboard" public-private land ownership pattern within the planning area. Conservation organizations from across Washington united in a campaign to address long-term conservation of habitat north and south of the I-90 Project area. Today, that campaign has conserved over 40,000 acres of land in the I-90 Project area, securing the habitat values that WSDOT's highway improvement plan also seeks to enhance.

Looking beyond the transportation corridor planning framework, highway projects usually come with a specific scope, a limited budget, and a well-defined timeline: opportunities for accommodating ecological needs are more limited. However, where linkage networks are identified as overlapping with a highway project, there are almost always opportunities to facilitate low-cost improvements. These include things like choices of median barrier types (cable barriers are generally better for wildlife than concrete barriers), improvements to passage conditions in existing bridges and culverts, and, possibly, new fencing. It will not normally be possible to create dedicated wildlife structures on most highway projects.

In another highway improvement arena, I4 projects are purposefully conceived and designed to rectify an environmental shortcoming. The categories of projects that fall under this section of WSDOT's budget are Fish Passage, Chronic Environmental Deficiencies, and Habitat

Connectivity. In each category, a method to establish priorities has been developed and is used to determine the order for project completion. The method for determining priorities within the habitat connectivity category has not been completed yet. The maps produced by this project, which provide detail on the intersection of the transportation system with linkage networks, will be among the factors used to develop I4 program priorities. Other factors, such as traffic volume, highway geometry, wildlife-vehicle collision rates, adjacent land ownership (an indication of the likely permanence of habitat values in the area), will also be used in WSDOT's prioritization.

4.6.2. Example use: Columbia Plateau Ecoregion

A review of the results from our statewide connectivity analysis in the Columbia Plateau ecoregion highlights the need for a finer scale analysis in this geography. There is a high degree of overlap in shrubsteppe species' and landscape integrity networks in our analysis, showing that potential movement routes are being limited to fewer and fewer portions of the landscape (Fig. 3.75).

At the time of publication, we are starting an ecoregional analysis in the Columbia Plateau. The results will include better-defined habitat blocks and more detailed linkage maps to inform regional and local conservation efforts. We are collaborating with the Arid Lands Initiative (ALI), a multi-partner effort working to develop and cooperatively implement a coordinated strategy for the conservation of Washington's arid lands. As part of this collaboration, the ALI core team is functioning as an ecoregional advisory committee for the WHCWG. The ALI will use the results of the Columbia Plateau connectivity analysis to identify shared priority areas for the implementation of strategic actions such as fire management, habitat restoration, and the identification of viable alternatives to development on working lands. While the ecoregional products are being developed, the statewide analysis will provide broad-scale guidance, and may be used to identify initial priority areas. It will also inform decisions on how to combine the connectivity analysis results with other analyses and knowledge to identify the full suite of shared priorities.

The ALI is already reaching out and engaging wildlife experts and stakeholders with interests in arid lands conservation. We are working with these experts and stakeholders to inform the modeling and usage decisions, including data availability and quality, best focal species, and size and habitat quality thresholds for defining core areas for both focal species and landscape integrity models. These contributors will also help define model parameters that reflect the available knowledge on species movements, determine what information is most useful for prioritizing linkage areas, and highlight what models need validation with on-the-ground data.

The statewide analysis is providing the analytical and methodological framework for the ecoregional scale analysis. At the same time, it provides coarse-scale results to guide and inform the development of ecoregional scale products. For example, the statewide analysis results highlight a north-south "backbone" of lands along the east slope of the Cascades in the Columbia Plateau that appear important for multiple species as well as for landscape integrity (Fig. 3.75). Selecting focal species that better represent the eastern areas of the ecoregion will likely provide better resolution in areas closer to the Idaho border. Incorporating information on wind development, such as has occurred around the Ellensburg area, will provide additional detail on areas to focus on for conserving connectivity. Similarly, the selection of focal species with more limited movement capacity will give more definition to the gradient of opportunities for implementing different strategies, including areas for restoration, or areas critical to protect from wildfire.

The improvements in the resolution and information we will obtain through the Columbia Plateau ecoregional analysis will, in turn, inform subsequent connectivity analyses at similar scales in other Washington ecoregions. Additionally, there will be areas or strategies where the ecoregional scale analyses do not provide sufficient detail for local decision-making. However, these intermediate scale results will again highlight priority areas where local parties or partnerships should develop fine-scale linkage designs. These designs can then be focused such that they complement the broader analyses while adding significant new information for that particular area.

4.7. Additional Resources

In addition to tools and information that we are providing, there are excellent free resources available to assist with planning, implementing, and prioritizing finer scale analyses and linkage designs. These resources include:

- California's recent statewide linkages report (Spencer et al. 2010), which includes chapters that describe how to step-down results from a broad-scale analysis to the greater detail needed for implementation.

- The Corridor Design website (www.corridordesign.org) is a valuable resource for developing an individual linkage design (Beier et al. 2010). The associated ArcMap extension includes features that allow comparison of multiple linkage designs (Jenness et al. 2010), and linkage design methods specific to climate change needs are also discussed (Beier & Brost 2010).

- The Connectivity Analysis Toolkit (www.connectivitytools.org) provides tools for linkage mapping and for centrality analysis, which focuses on the relative importance of sites for maintaining connectivity across a landscape (Carroll 2010).

We will be sharing GIS analysis tools we have developed, as well as focal species and landscape integrity models you might wish to use in more refined linkage analyses for local needs. The WHCWG is committed to supporting future connectivity work and will additionally seek to engage and provide support to others working on behalf of wildlife habitat connectivity. We encourage you to check our website at: www.waconnected.org for contact information, updated information, and new products as they become available.