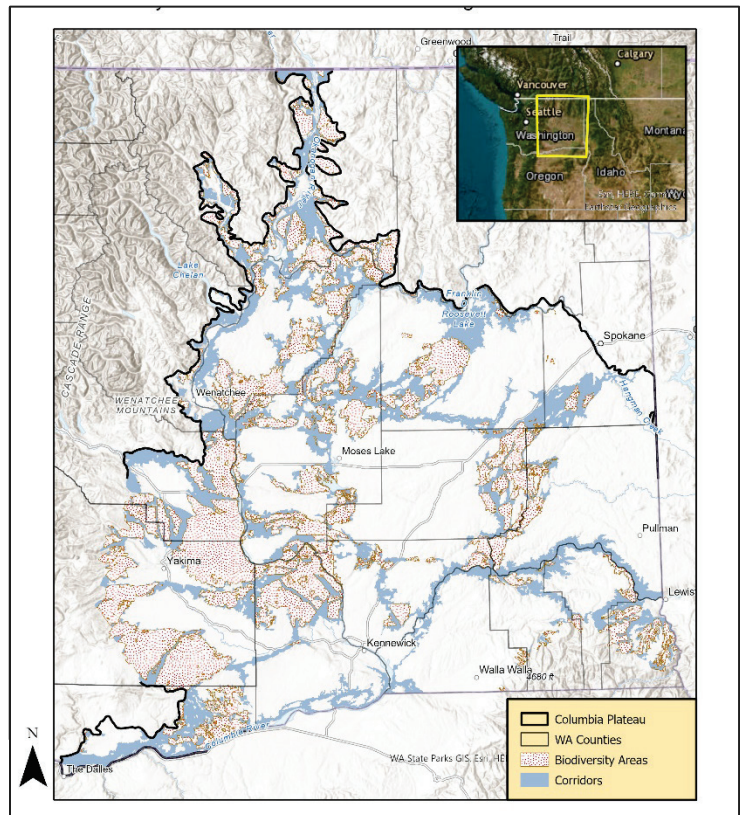# Priority Habitats and Species Technical Report

Biodiversity Areas and Corridors Map

Identifying Washington's Columbia Basin Biodiversity Areas and Corridors Priority Habitat

PHS Mission: To effectively communicate WDFW's conservation priorities via data driven maps, guidance, and technical assistance to influence terrestrial and aquatic land use decisions such that Priority Habitats and Species are protected and perpetuated.

Individuals who need this information in an alternative format or language may request accommodations at wdfw.wa.gov/accessibility/requests-accommodation, by phone at 360-902-2349, TTY (711), or email Title6@dfw.wa.gov.

Washington Department of **FISH & WILDLIFE**

May 12, 2023

Acknowledgements

Acknowledging the Indigenous People, Land, and Culture of the Pacific Northwest: Since time immemorial, Indigenous People have graced the Pacific Northwest with rich traditions of many diverse cultures, languages, traditional knowledge expressed artistically and practically with intricate principles passed down throughout generations. As the first stewards of this land, Indigenous People from this part of the world are ancestrally engrained in the very fabric of this region that is known today as Washington State.

Washington Department of Fish and Wildlife (WDFW) acknowledges the American Indian Tribes as the original occupants of this land enjoyed today by all Washingtonians. Their historic reliance to hunt, fish, and gather traditional foods defines their inherent responsibilities to protect and steward the precious resources on the waters and landscape shared today by all Washington residents.

The very survival of the Pacific Northwest Tribes is a testament of resiliency of what they have endured and continue to endure throughout generations on this very landscape. Through scarred valor, many historical encounters of massacre, renunciation of religious freedom, systemic racism, cultural assimilation of native children through institutional residential schools, and the fight for their inherent rights and liberties, they have prevailed. Throughout this tormented history brought by colonization, abrogated treaties, infringement of civil rights, and the salmon protests of the 1960s, the Northwest Tribes and WDFW have founded a commitment of respect, unity, and alliance taught by the realities of the past.

Today tribal governments and WDFW work collaboratively to conserve and manage aquatic and terrestrial resources across the State and practice sound science to ensure successful resource management decisions. The Tribes and WDFW work together to ensure the sustainability of fish, wildlife, ecosystems, and culture for the next seven generations and beyond.

Reviewer acknowledgment: Many people were involved with mapping the Priority Habitats and Species (PHS) Biodiversity Areas and Corridors Priority Habitats. The project authors extend our sincere appreciation to the following individuals that played important roles during development and/or review of the Biodiversity Areas and Corridors dataset:

- **Washington Department of Fish and Wildlife (WDFW) Habitat Program**: Carmen Andonaegui, Amanda Barg, Scott Downes, Keith Folkerts, Perry Harvester, Terry Johnson, Julia Michalak, Mike Ritter, and Elizabeth Torrey.
- **WDFW Wildlife Program**: Mike Atamian, Jason Fidorra, Janet Gorrell, and Mark Teske.
- **Natural Resources Conservation Service**: Tom Miewald.

While we acknowledge and appreciate all the review and comments provided by these advisors, this report's authors bear responsibility for this document and any errors contained herein.

User acknowledgment: The Washington Department of Fish and Wildlife recognizes and appreciates the significant role that local governments, tribes, conservation organizations, and others play in accomplishing our agency's mission. Indeed, we are certain that without their concerted efforts to designate and protect Biodiversity Areas and Corridors that are essential for many of the state's at-risk wildlife species, WDFW would be unable to fulfill its mandate on behalf of Washingtonians.

Citations:

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The recommended citation for the Biodiversity Areas and Corridors mapped data:

> Washington Department of Fish and Wildlife. 2023. PHS Columbia Plateau Biodiversity Areas and Corridors Map. Available from the Washington Geospatial Open Data Portal geo.wa.gov/ (Accessed <date>).

Cover photos: Canyon along Grande Ronde River by Alan L. Bauer and Wintering elk herd by Paul Wik.

Contents

Acronyms

BAC	Biodiversity Areas and Corridors
HCA	Habitat Concentration Area
LI	Landscape Integrity
NLCC	Normalized Least Cost Corridor
PHS	Priority Habitats and Species
RCW	Revised Code of Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WHCWG	Washington Habitat Connectivity Working Group

Background

Biodiversity Areas and Corridors are lands with comparatively rich and abundant wildlife that are connected to allow wildlife to move freely and safely between core habitat areas. Biodiversity Areas are large tracts of unfragmented and relatively undisturbed habitat. Large intact blocks of habitat are critical for biodiversity because they can support sensitive species, species that require large areas, and more resilient populations than smaller or more fragmented habitat areas (MacArthur and Wilson 1967, Watson et al. 2018). Corridors provide pathways for wildlife to move between Biodiversity Areas. This movement supports critical ecosystem functions including facilitating plant and animal movement in response to climate change, promoting gene flow, and to access food, water, shelter, and breeding habitat, all of which support healthy wildlife populations (Harris 1984, Frankham 2006, Nuñez et al. 2013).

In PHS, Biodiversity Areas outside of Urban Growth Areas are required to be mapped using "a scientifically based assessment conducted over a landscape scale" and Corridors are defined as "areas of relatively undisturbed and unbroken tracts of vegetation that connect fish and wildlife habitat conservation areas, priority habitats, or areas identified as biologically diverse" (i.e., Biodiversity Areas; see WDFW 2008). Although Biodiversity Areas and Corridors are defined and mapped separately here, they form a continuous network of habitat on the landscape. Corridors will provide core habitat for many species but tend to be more linear (i.e., have a higher edge to interior habitat ratio) and are of slightly lower habitat quality compared to Biodiversity Areas. We define these areas as Corridors because sensitive species may be willing to move through lower-quality habitat that would not be adequate for establishing a home range or breeding territory.

Methods

In June 2022, the PHS team formed a Technical Advisory Group to provide guidance for mapping Biodiversity Areas and Corridors (BAC) within the Columbia Plateau (Appendix A). The technical advisors reviewed available datasets and identified maps produced by the Washington Habitat Connectivity Working Group (WHCWG) as the best available science for identifying modeled core habitat and connectivity networks that also met the PHS definition requirements (WHCWG 2012). The WHCWG modeled core habitat and connectivity data form the basis for the BAC data.

Summary of Washington Habitat Connectivity Working Group Modeling Approach

We briefly describe the modeling methodology here; the WHCWG Columbia Plateau report provides more details (WHCWG 2012). The WHCWG developed both a "landscape integrity" model and a series of models for individual species of interest. Both were used to develop the PHS Biodiversity Area and Corridor data.

The WHCWG landscape integrity model identifies a network of lands with low levels of human modification that are in relatively natural or semi-natural condition. The landscape integrity core areas identified in this model are made up of large blocks (10,000+ acres) of contiguous habitat with relatively high landscape integrity (i.e., low human land use modification). The corridors were modeled using LinkageMapper software to identify routes between adjacent core areas with minimal exposure to human land-use impacts (McRae and Kavanagh 2011). The WHCWG modeled landscape integrity using land use/land cover (30-m satellite data), soils, topography (30-m Digital Elevation Model), housing density, roads, transmission lines, railroads, and irrigation canals (National Hydrography Dataset). Locations with more intense human modification were assigned lower values for habitat quality and higher values for resistance (i.e., were assumed to impede or block) to animal movement.

The species models were developed for 11 focal species. Focal species were selected both for their conservation importance and to represent a range of movement capabilities and habitat requirements (Table 1). Models for each species include Habitat Concentration Areas (HCA) connected by Corridors. The HCAs represent "areas…expected or known to be important for focal species based on actual survey data or habitat association modeling." The corridors represent "modeled movement routes or physical linear features on the landscape." Each species was modeled in a slightly different way depending on their ecology, physiology, and available data. See the WHCWG Columbia Plateau report for more details (WHCWG 2012).

Table 1. Modeled focal species.

Common Name	Scientific Name	Represents
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	Species associated with shrubsteppe, grassland, and riparian vegetation
Greater-sage Grouse	*Centrocercus urophasianus*	Species associated with shrubsteppe and grassland vegetation
Black-tailed Jackrabbit	*Lepus californicus*	Species associated with shrubsteppe vegetation
White-tailed Jackrabbit	*Lepus townsendii*	Species associated with shrubsteppe vegetation
Townsend's Ground Squirrel	*Urocitellus townsendii townsendii*	Species associated with shrubsteppe and grassland vegetation
Washington Ground Squirrel	*Urocitellus washingtoni*	Species associated with shrubsteppe and grassland vegetation
Least Chipmunk	*Neotamias minimus*	Species with low mobility associated with shrubby vegetation
Mule Deer	*Odocoileus hemionus*	Generalist Species
Western Rattlesnake	*Crotalus oreganus*	Species associated with cliff, canyon, and talus habitats
American Beaver	*Castor canadensis*	Species associated riparian and wetland habitats
Tiger Salamander	*Ambystoma tigrinum*	Species associated wetland habitat

PHS Biodiversity Areas

We used both the landscape integrity core areas and focal species HCAs to map PHS Biodiversity Areas (Appendix B). All locations identified as Landscape Integrity core areas were included as PHS Biodiversity Areas. In addition, we overlaid the HCA data for the 11 focal species and selected as PHS Biodiversity Areas any areas that were identified as HCAs for three or more focal species. We chose a minimum of three overlapping HCAs to ensure that we identified areas important to multiple species as PHS Biodiversity Areas.

PHS Corridors

We followed a similar process to identify PHS corridors (Appendix B). All locations identified as Landscape Integrity corridors were included as PHS corridors. In addition, we overlaid the corridor data for the 11 focal species and identified any additional areas outside the Landscape Integrity corridors that were identified as corridors for four or more focal species.

Mapping Results

This process of mapping BACs resulted in 3,336,990 acres mapped as Biodiversity Areas and another 3,147,391 acres mapped as Corridors. Table 2 summarizes the amount of BAC habitat within each of the counties where it occurs. Figure 1 shows the mapped extent of BACs across the Columbia Plateau Region of Washington. The resulting data layer is publicly available via a download on the PHS Maps website; it is also available via geo.wa.gov. For WDFW staff, this information is available through the enterprise database, GeoLib (called "file name PHS_ColumbiaPlateauRegionalBAC_SV").
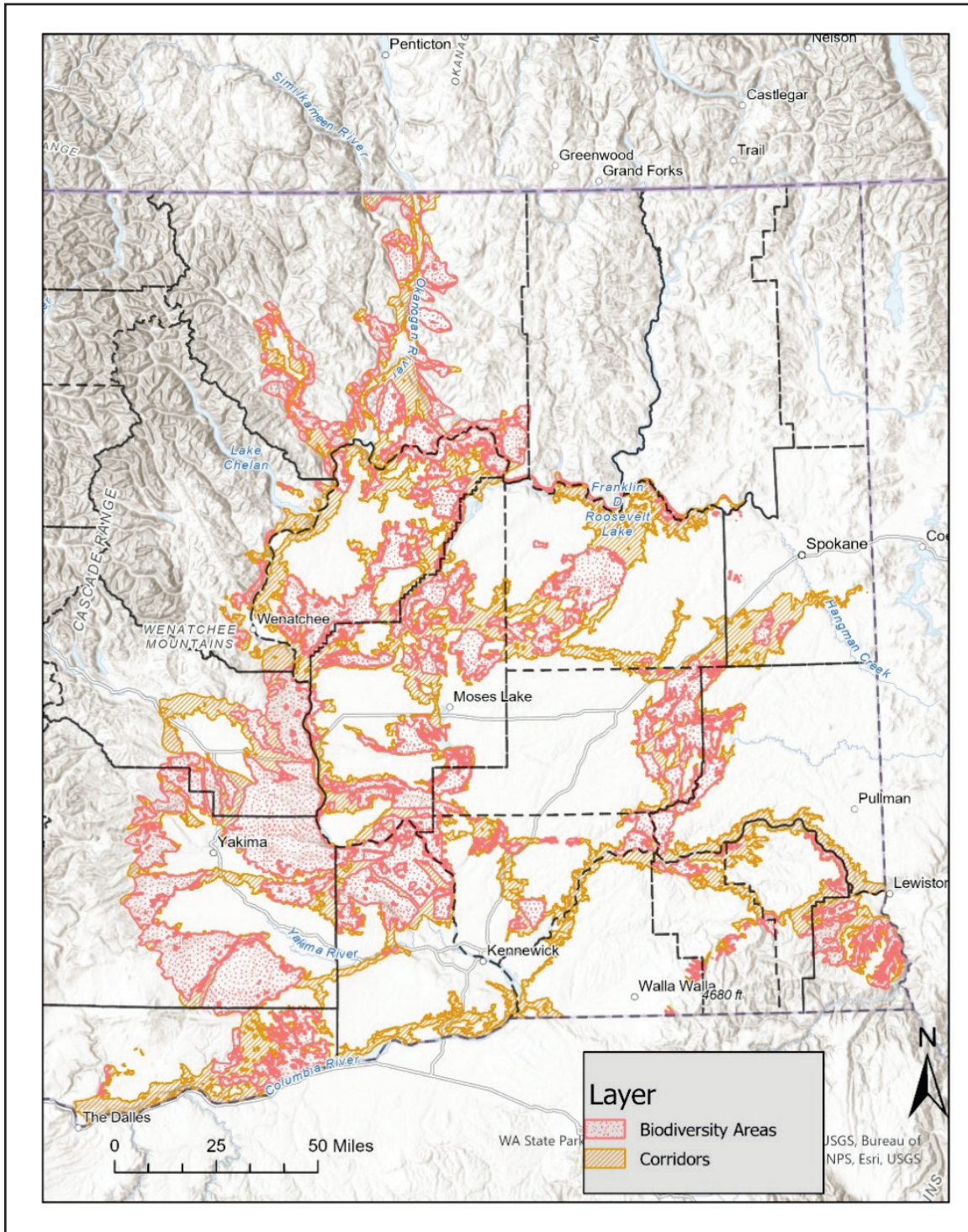
Figure 1. PHS Biodiversity Areas and Corridors within the Columbia Plateau Region of Washington.

Table 2. Results of Mapping BACs by County[1]

State / County	Acres classified as PHS Biodiversity Areas	Acres classified as PHS Corridors	Total BAC Acres	Total BAC on Private Lands	% County private lands within a BAC
Adams	195,152	102,801	297,953	237,344	20.7%
Asotin	94,393	83,834	178,227	133,864	48.5%
Benton	258,965	210,604	469,569	159,746	21.2%
Chelan	22,179	91,676	113,855	60,703	17.7%
Columbia	25,910	69,168	95,078	83,384	22.7%
Douglas	329,904	329,050	658,954	494,232	50.3%
Ferry	6,878	8,084	14,963	0	0.0%
Franklin	99,874	128,011	227,885	145,154	21.0%
Garfield	27,204	88,643	115,847	104,929	30.6%
Grant	384,315	383,673	767,988	391,677	30.4%
Kittitas	333,143	186,770	519,913	121,921	29.8%
Klickitat	129,920	238,880	368,800	334,459	34.4%
Lincoln	171,367	354,063	525,430	361,554	27.1%
Okanogan	228,444	196,046	424,490	262,228	9.5%
Spokane	18,750	122,280	141,030	117,504	11.3%
Stevens	2,112	9,026	11,138	8,186	0.8%
Walla Walla	6,086	76,472	82,558	73,322	9.4%
Whitman	91,879	136,598	228,477	196,762	14.7%
Yakima	349,528	141,985	491,514	181,739	11.6%

Data Limitations and Sources of Error

Users of this data should be aware of the following potential sources of error with the PHS Biodiversity Areas and Corridors:

Resolution. The WHCWG models that form the basis of the PHS Biodiversity Area and Corridor map used various input data layers. Many of these input data layers were produced with satellite generated imagery with a resolution of 30 meters (a pixel 30m on a side is 0.22 acres). In these types of data, each pixel is given a single value (e.g., identified as "urban" or "forest") associated with the majority characteristic within that pixel. The coarse nature of satellite imagery means there are inherent limitations in accuracy.

Temporal Errors. The WHCWG models that form the basis of the PHS Biodiversity Area and Corridor map were published in 2012 and the data used to develop the models were 5-15 years older than that date. Land cover changes due to factors such as disturbance, land use, or processes will not be reflected in the models. Further review of local landscape conditions and refinement of any boundary lines are necessary additional steps before designating distinct boundary lines. We will periodically evaluate the PHS BAC map to determine whether land use changes warrant a change or refinement in PHS BAC delineation.

Modeled Data. The WHCWG created models of habitat quality and connectivity to create the products that were ultimately used in the BAC map. These models make assumptions about what types of landscape conditions make good habitat for individual species and what types of landscape features facilitate or impede animal movement through the landscape. The landscape integrity model makes the general assumption that greater intensity of human landscape modification leads to lower habitat value and

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[1] Excludes tribal lands

reduced ability for species to move through the landscape. These assumptions are most reasonable for species that are sensitive to human development, which are also the species most negatively affected by human modification and that are generally of high conservation priority.

A few of the focal species models developed by the WHCWG were generated using observed species and habitat locations. However, most of the focal species models were generated solely through expert knowledge of species habitat requirements and how species respond to landscape conditions. In all cases, experts used best available science to inform these decisions.

Expert Review

The WHCWG models and data were extensively reviewed by both modeling experts and biologists with on-the-ground knowledge of habitats and species throughout the region (WHCWG 2012). Similarly, the process and resulting maps of PHS Biodiversity Areas and Corridors were reviewed by all the technical advisors (Appendix A). A revised version was then submitted for review to others outside the group of technical advisors. This revised version was reviewed by agency and non-agency representatives with extensive knowledge about the Columbia Plateau landscape and/or who had habitat connectivity science expertise. The output and methods received broad support from the reviewers.

Status of the Dataset as Best Available Science

The Growth Management Act (RCW 36.70A) provides criteria for qualification as "Best Available Science" in WAC 365-195. This guidance (WAC 365-195-905) says that scientific information can only be produced through a valid scientific process. It identifies characteristics generally expected in a valid scientific process to include (1) peer review, (2) clear, reproduceable methods, (3) logical conclusions and reasonable inferences, (4) quantitative analysis, (5) proper context, and (6) references. The WHCWG led modeling effort used to map BACs meets these criteria. The use of this source of data to produce BACs was reviewed and vetted with expert opinion of qualified individuals; that effort also meets the Best Available Science criteria. A valid scientific process produces "reliable information useful in understanding the consequences of a local government's regulatory decisions and in developing critical areas policies and development regulations that will be effective in protecting the functions and values of critical areas." By this measure, it is the professional opinion of the authors and the technical advisors that this dataset qualifies as Best Available Science.

Future Updates

PHS staff will review and revise the PHS Biodiversity Areas and Corridors map to determine whether land use changes warrant a change or refinement in PHS Biodiversity Areas and Corridors delineation or if improved data become available.

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Appendix A: Technical advisors and reviewers.

Advisor	Area of Background / Expertise	Role
Jeff Azerrad (lead)	Oversees development of PHS published products	Technical Advisor
Terry Johnson	Management of spatial databases	Technical Advisor
Elizabeth Torrey	Eastern Washington habitats and southcentral Washington landscapes	Technical Advisor
Mark Teske	Southcentral Washington landscapes and expertise in connectivity modeling	Technical Advisor
Scott Downes	Eastern Washington habitats and southcentral Washington landscapes	Technical Advisor
Janet Gorrell	Landscape conservation principles	Technical Advisor
Keith Folkerts	Oversees development of PHS spatial products	Technical Advisor
Perry Harvester	Eastern Washington habitats and southcentral Washington landscapes	Technical Advisor
Julia Michalak	Ecological and habitat connectivity modeling	Technical Advisor
Tom Miewald	Ecological and habitat connectivity modeling	Technical Advisor
Mike Atamian	Eastern Washington habitats, landscapes, wildlife, and ecological modeling	Reviewer
Amanda Barg	Eastern Washington habitats, landscapes, and local government planning policy	Reviewer
Carmen Andonaegui	Eastern Washington habitats, landscapes, and local government planning policy	Reviewer
Jason Fidorra	Eastern Washington habitats, landscapes, and wildlife	Reviewer

Appendix B: How BACs were Processed in GIS

Processing the Biodiversity Areas

1. The HCAs were downloaded from the Washington Habitat Connectivity Working Group website (see Table 1 for the list of species).
2. An attribute field was added to each HCA layer to specify what species was represented. This attribute field was named after the EOCODE of each species. Then the attribute field was set to 1 for each polygon. All other attribute fields were deleted.
3. The Union tool was used to combine the polygon features. Then the FID attribute fields of the input HCA layers were deleted.
4. A TotalSPP attribute field was added to the Union output. The value for this field was calculated by adding the values from the individual HCA attribute fields.
5. An attribute field called "LI" was added to the Landscape Integrity (LI) core areas and the value for this attribute field was set to 1 for each polygon. All other attributes in the LI core areas were deleted.
6. The LI core areas were then unioned to the combined HCA layer.
7. An attribute field called "Priority Level" was added to the combined LI core areas and HCAs layer to identify polygons that fit the criteria for a Biodiversity Area.
8. Polygons were then selected that were either (a) a LI core area, or (b) that had at least 3 overlapping HCAs. For these polygons we set the "PriorityLevel" attribute field to 1.
9. The next steps were, (a) ran a Dissolve on the "PriorityLevel" attribute field to aggregate the thousands of polygons, then (b) ran the MultiPart to Singlepart tool to break the one large multipart polygon into several, more manageable singlepart polygons.
10. The Eliminate Polygon Part tool was used to fill holes up to 80 acres within the Biodiversity Areas.
11. After a review, the Biodiversity Area polygons had the PHS attribute schema added to them, and any remaining non-essential attribute fields were removed. Finally, Biodiversity Area attributes records were added to the PHS attribute tables (PHSEO, PHSDSCRP, and PHSSRC) and associated the tables with the Biodiversity Area polygons in a spatial view.

Processing the Corridors

1. The Normalized Least Cost Corridor (NLCC) layers were used as the starting point for the corridors (see Table 1 for the list of species).
2. An attribute field was added to each NLCC layer to specify what species was represented. This attribute field was named after the EOCODE of each species. Then the attribute field was set to 1 for each polygon. All other attribute fields were deleted.
3. The Union tool was used to combine the polygon features together, then FID attribute fields of NLCC layers were deleted.
4. A TotalSPP attribute field was added to the Union output. The value for this field was calculated by adding the values from the individual NLCC attribute fields.
5. An attribute field called "LI" was added to the LI corridors and the value for this attribute field was set to 1 for each polygon. All other attributes in the LI corridors were deleted.
6. The Landscape Integrity corridors were then unioned to the combined NLCC layer.
7. An attribute field called "Priority Level" was added to the combined LI core areas and NLCCs layer to identify polygons that fit the criteria for a Corridor.
8. Polygons were then selected that were either (a) a LI corridor, or (b) that had at least 4 overlapping NLCCs. For these polygons we set the "PriorityLevel" attribute field to 1.

9. Four corridors that did not connect with BAs were deleted.
10. The Erase tool was used on the Corridor polygons using the Biodiversity Areas to remove any Corridor overlapping a Biodiversity Area.
11. The next steps were, (a) ran a Dissolve on the "PriorityLevel" attribute field to aggregate the thousands of polygons, then (b) ran the MultiPart to Singlepart tool to break the one large multipart polygon into several, more manageable singlepart polygons.
12. After a review, the Corridor polygons had the PHS attribute schema added to them, and any remaining non-essential attribute fields were removed. Finally, Corridor attributes records were added to the PHS attribute tables (PHSEO, PHSDSCRP, and PHSSRC).

Merging the Biodiversity Areas and Corridor Layers

1. The EOFORM number of each Biodiversity Area were set to 920900 and each Corridor to 920901.
2. The layers were merged into one data layer named PHS_ColumbiaPlateauRegionalBAC.
3. This layer was added to GeoLib, WDFW's corporate database and the PHS attribute tables in GeoLib were updated.
4. A spatial view was created for PHS_ColumbiaPlateauRegionalBAC, associating PHS attribute tables to it.

Appendix C: Frequently Asked Questions

What are Biodiversity Areas and Corridors?
Biodiversity Areas and Corridors are defined by WDFW's Priority Habitats and Species program. The PHS Biodiversity Area and Corridor map is composed of Biodiversity Areas, which are the best remaining large areas of habitat that have minimal disturbances from development or agriculture. The map also includes Corridors, which are pathways between Biodiversity Areas with minimal barriers to wildlife movement.

How can I access the Columbia Plateau map of Biodiversity Areas and Corridors?
The PHS Biodiversity Areas and Corridors map is available for download and is publicly accessible via a download on the PHS Maps website; it is also available via https://geo.wa.gov. For WDFW staff, this information is available through the enterprise database, GeoLib (called "file name PHS_ColumbiaPlateauRegionalBAC_SV").

Why are the BACs not mapped on PHS on the Web?
PHS on the Web is typically used to inform site-level land use decisions. Outside of major projects, we do not recommend using the PHS Biodiversity Area and Corridor map as a resource for site-specific applications.

What is this map's primary intended use?
The PHS Biodiversity Area and Corridor map is intended to inform regional-scale planning activities and land use decisions such as open space planning, changes to Urban Growth Areas, making land use and zoning designations, comprehensive planning, or siting major developments. In its current format, this mapped data is not well suited to address site-specific land use proposals (e.g., where to site buildings on a parcel), except for site-scale projects with an extraordinarily large footprint. Instead, the PHS Biodiversity Area and Corridor map is intended to flag regions with high-quality, intact wildlife habitat and corridors so that decision-makers can account for those values when making major regional land use decisions.

Is this map best available science?
Yes. The process used to develop the underlying source data for mapping PHS Biodiversity Areas and Corridors meets all the major characteristics of a valid scientific process as described in the Best Available Science chapter of the Growth Management Act (WAC 365-195). The map of PHS Biodiversity Areas and Corridors was produced with modeled source data. That source data depicted a network of large blocks of intact habitat as well as corridors of relatively intact lands that can support the movement of wildlife from one block of habitat to another. The highly qualified scientists who develop these models, relied upon widely used and accepted tools and methods. Their work to develop and refine these models received considerable expert review.

Can the BACs be validated on the ground through an on-site assessment?
Biodiversity areas and corridors are not discrete areas that can be clearly delineated by their physical characteristics because habitat value naturally changes as a gradient across the landscape. Further review of local landscape conditions and refinement of any boundary lines are necessary additional steps before designating distinct boundary lines. An informed use of the PHS Biodiversity Areas and Corridors map is best achieved when land use decisions are made in concert with a WDFW Habitat Biologist or another professional who understands the ecological functions and values provided by the PHS Biodiversity Areas and Corridors network.

Appendix D: Key Resources

General Resources

Priority Habitats and Species

- PHS homepage: wdfw.wa.gov/species-habitats/at-risk/phs
- PHS List: wdfw.wa.gov/species-habitats/at-risk/phs/list
- PHS on the Web: geodataservices.wdfw.wa.gov/hp/phs/
  - PHS on the Web User Guide: wdfw.wa.gov/species-habitats/at-risk/phs/maps/using

Washington Department of Fish and Wildlife

- WDFW Habitat Biologist areas of responsibilities map:
  wdfw.maps.arcgis.com/apps/MapJournal/index.html?appid=48699252565749d1b7e16b3e34422271
- WDFW values: wdfw.wa.gov/about
- WDFW conservation goals: wdfw.wa.gov/about/administration/strategic-planning

GIS Data

- WHCWG Columbia Plateau Report/Data: waconnected.org/cp_focalspecies_landscapeintegrity/
  Washington State Geospatial Portal: Homepage: geo.wa.gov