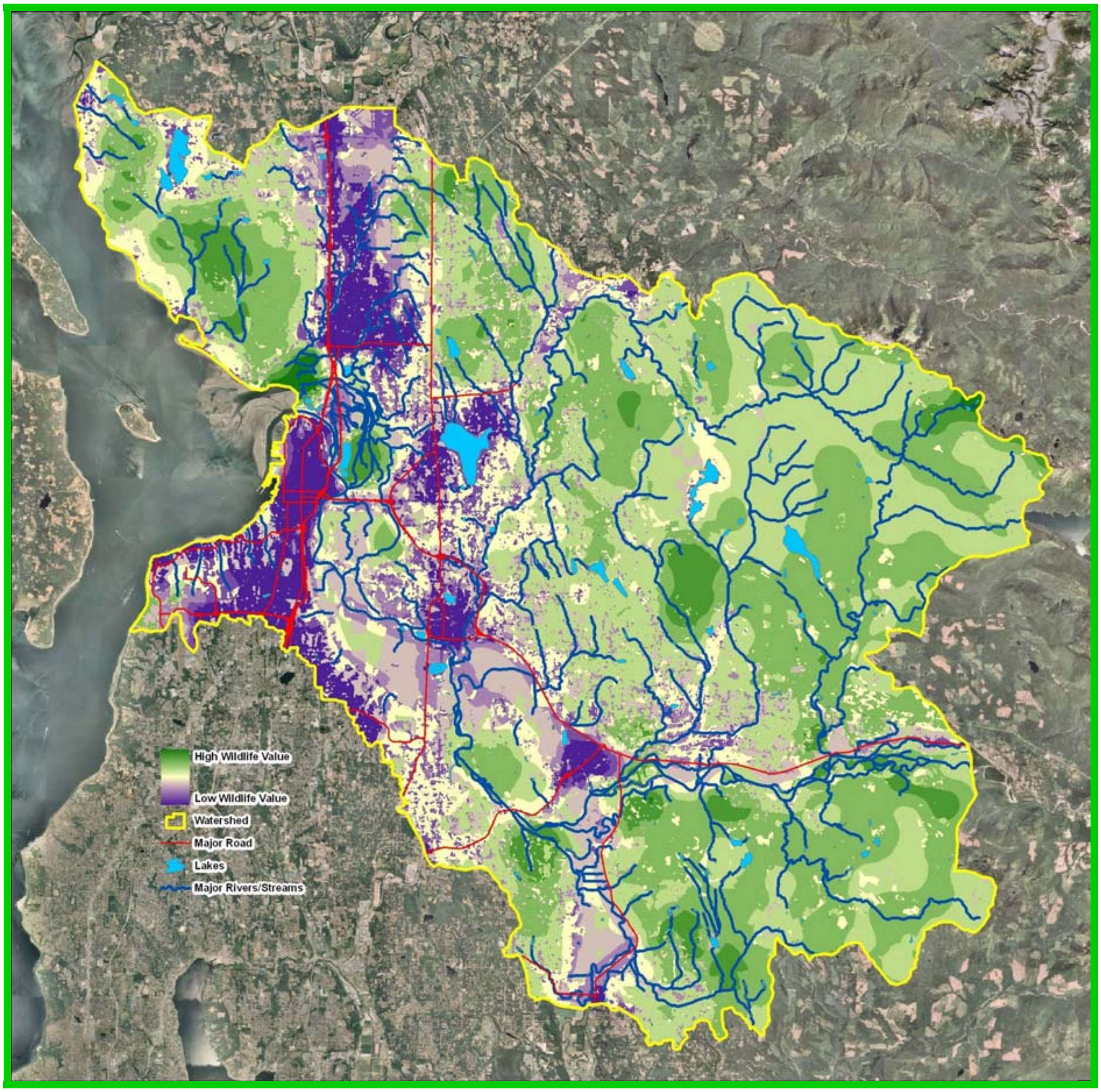
LANDSCAPE PLANNING FOR WASHINGTON'S WILDLIFE:

MANAGING FOR BIODIVERSITY IN DEVELOPING AREAS

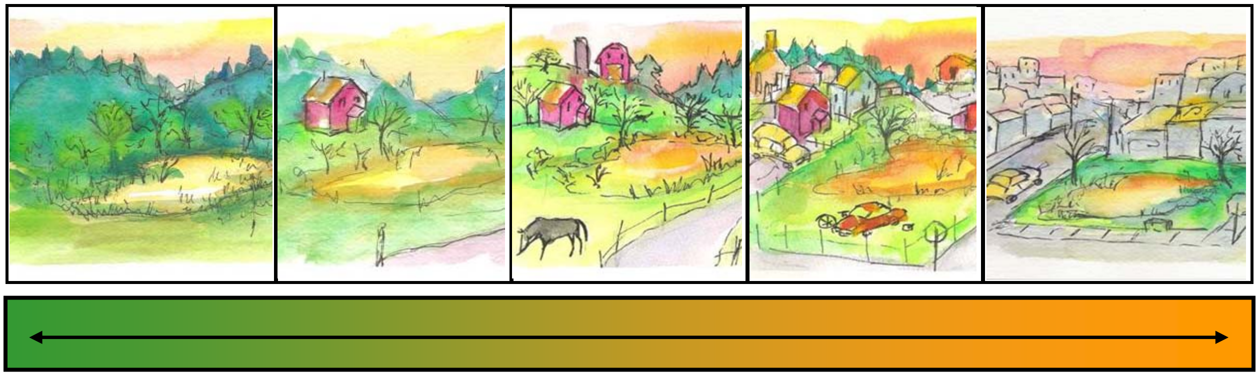


DECEMBER 2009

Washington Department of FISH AND WILDLIFE

A PRIORITY HABITAT AND SPECIES GUIDANCE DOCUMENT

Cover: WDFW. Wildlife landscape assessment of relative wildlife values for a broad-scale area.



LANDSCAPE PLANNING FOR WASHINGTON'S WILDLIFE:

MANAGING FOR BIODIVERSITY IN DEVELOPING AREAS

ARTWORK BY ROBIN SCHUETT-HAMES.

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PREFACE

Washington State is a biologically rich area composed of habitats ranging from arid shrub-steppe, temperate rain forests, mountain peaks, and the marine environments of the Pacific Ocean and Puget Sound. The state's varied geography, climates, and ecosystems support over 640 native vertebrate wildlife species.

While we are fortunate to have these habitats and species, many areas of the state are undergoing development that affects native wildlife. Washington's Comprehensive Wildlife Conservation Strategy (WDFW 2005) reports that habitat loss, fragmentation, and degradation are the major challenges to Washington's wildlife. Much of this challenge is associated with the state's increasing human population[1] and the residential development[2] that will support this increase.

> ***"Habitat loss, fragmentation, and degradation are the major threats to the persistence of Washington's fish and wildlife."***
> *Washington Comprehensive Wildlife Conservation Strategy (WDFW 2005)*

> ***The goal of this document is to provide information to planners and others that can be used to minimize the impacts of development to wildlife and to conserve biodiversity. Biodiversity can be defined as the range of physical (habitat) and biological (species, communities) components, the ways that species interact with the physical environment, and the processes necessary to maintain these interactions through time.***

How and where we develop on the landscape will determine which species will do well and which species will not do well in Washington's future. The Washington Department of Fish and Wildlife (WDFW) developed this guidance document to help local land use and conservation planners consider biodiversity in the planning process, while recognizing the many other planning considerations addressed by local communities.

We often use "conservation of wildlife habitat and/or species" as shorthand for the more complex idea of biodiversity (see box) and as a useful way to communicate information about important ecosystem processes. The goal of this document is to provide information for planners and others to use in minimizing the impacts of development to terrestrial wildlife, and to conserve biodiversity that supports healthy, native wildlife populations.

[1] Our state is predicted to grow by over 2.1 million people through 2030. (Source: Washington State Office of Financial Management, Forecast of the State Population, November 2006.)

[2] This document focuses on impacts to wildlife related to rural and urban residential development. Other land uses, such as conversion and management of land for agriculture, timber harvesting, and industrial development also affect wildlife and habitat, but these are not the focus of this document.

We will provide science-based recommendations stating, in general, that wildlife is best served by:

- Keeping large, connected patches of undeveloped native vegetation intact.
- Encouraging and maintaining low zoning densities within and immediately surrounding high-value habitat areas and encouraging maintenance of native vegetation.
- Managing road systems to minimize the number of new roads and new barriers to important animal movement corridors.
- Planning open space to incorporate high-value habitat and corridors for animal movement.
- Zoning for higher densities within urban and developed landscapes to avoid sprawl.

Biodiversity has aesthetic, cultural, educational, and economic value to people. The retention and restoration of wildlife habitat in the developing landscape provides ecological services important to humans and communities. These ecological services include improved water quality, improved water storage and availability, buffering and control of storm water and floods, pollination, food production, soil fertility, pest control and the reduction of carbon dioxide (a greenhouse gas that contributes to climate change). The focus of this document is on lessening adverse impacts to biodiversity as land uses change, thereby enabling more wildlife habitat and species, and the ecological services they do provide, to be retained in developing areas.

Partners in Planning: State and Local Roles Regarding Fish and Wildlife

Over fifty percent of the land in Washington is in private ownership. Cities and counties, working with their local citizenry, have primary responsibility for planning where and how this land may be developed. The Growth Management Act requires local governments to accommodate population growth *and* protect public resources, including fish and wildlife, from the potential impacts of population growth. This guidance document was developed to help local planners, consultants, and community groups approach this task in a holistic, science-based manner. Although WDFW has permitting authority over certain activities affecting fish and wildlife (e.g., hydraulic project approvals; hunting and fishing licenses; enforcement of endangered, threatened, and sensitive species regulations), its primary role in the protection of fish, wildlife, and habitat is in supporting and partnering with city and county governments. WDFW develops scientific information, monitors the locations and health of species and habitats, and provides information and technical assistance to local governments that have planning responsibilities and regulatory authorities over the developing landscape.

This Publication in the Context of Other Guidance Documents

This guidance document joins resource guidance documents provided by other state agencies for use in local planning and is intended to be used in concert with them. Some of these other documents are listed in Table P.1. Other planning resources available from local, state, and federal agencies as well as non-profit groups include mapping tools and databases, recovery plans, and county biodiversity maps available at a variety of planning scales.

Table P.1. Key Washington State natural resource agency guidance documents for local planning.

Agency	Document	Primary Focus
Washington Dept of Ecology	Wetlands in Washington State, Vol. 2: Guidance for Protecting and Managing Wetlands (Granger et al. 2005)	Wetlands
Washington Dept of Ecology	Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes (Stanley et al. 2005)	Watershed processes
Washington Dept of Transportation	Enhancing Transportation Project Delivery Through Watershed Characterization (Gersib et al. 2004)	Watershed processes and transportation mitigation
Washington Dept of Commerce	Technical Guidance Document for Clearing and Grading in Western Washington (CTED 2005)	Clearing and grading
Washington Dept of Commerce	Critical Areas Assistance Handbooks (CTED 2003)	Critical areas ordinance development and implementation
Puget Sound Action Team	Low Impact Development – Technical Guidance Manual for Puget Sound (Hinman 2005)	Maintaining hydrologic function
Washington Biodiversity Council	Washington Biodiversity Conservation Strategy (Washington Biodiversity Council 2007)	Biodiversity conservation
Aquatic Habitat Guidelines Working Group	Protecting Nearshore Habitat Functions in Puget Sound: An Interim Guide (Envirovision, Herrera, and AHG 2007)	Nearshore development and habitat protection
Washington Dept of Fish and Wildlife and Aquatic Habitat Guidelines Working Group	Land Use Planning for Salmon, Steelhead and Trout. Washington Department of Fish and Wildlife (Knight, K. 2009)	Consideration of salmon and trout in land use planning
Washington Dept of Fish and Wildlife	Priority Habitats and Species Management Recommendations (various)	Management recommendations for specific species and habitats
Washington Dept of Fish and Wildlife	*This document* - Landscape Planning for Washington's Wildlife: Managing for Wildlife in Developing Areas (WDFW 2009)	Wildlife in developing landscapes

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Chapter 1. Wildlife in a Developing Landscape

The Development Gradient

The spatial pattern of human settlement and land use affects the abundance and distribution of Washington's wildlife and their habitats. Human land uses affect wildlife across a gradient, from undeveloped areas to urban centers, with corresponding increases in human population density and infrastructure such as roads, buildings, and parking lots (Figure 1.1), and corresponding decreases in wildlife diversity and abundance.

Figure 1.1 An aerial depiction of the undeveloped to urban gradient.

Figure 1.2 provides our best understanding of how Washington's birds, mammals, amphibians, and reptiles respond to this gradient of development densities. Two predictive bars show the percent of native species expected to use habitat at different human dwelling densities. Both bars show an overall decline in species as dwelling densities increase.

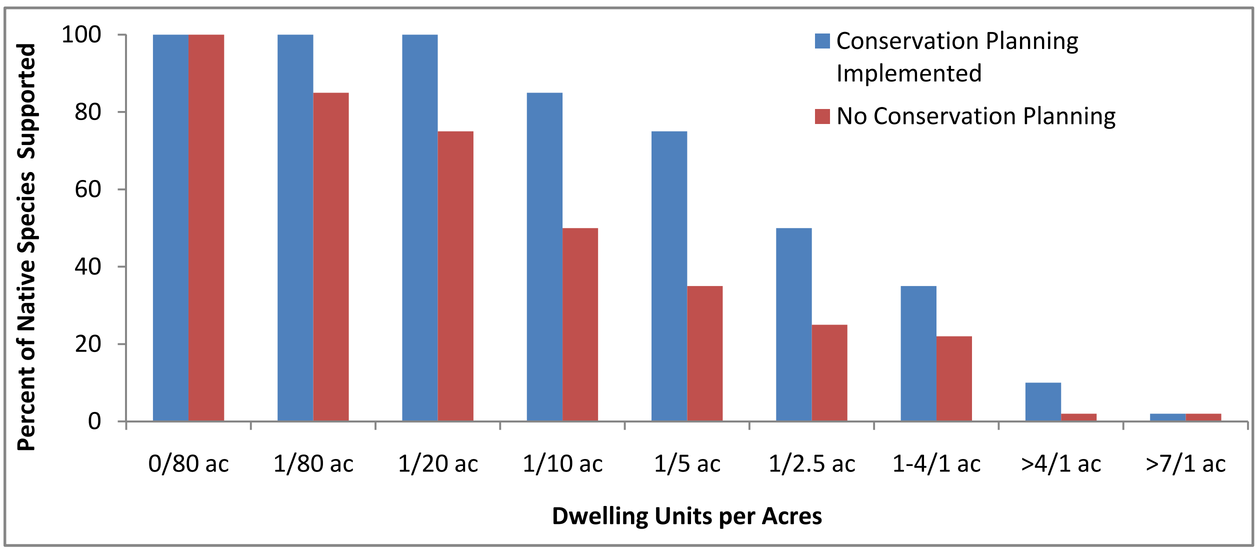


Figure 1.2 Percent of Washington's native bird, mammal, amphibian, and reptile species able to persist as dwelling density increases across the undeveloped to urban gradient. Based on data in the Species and Development Database in Appendix B of this document (some density categories are represented as ranges).

However, the blue bars in Figure 1.2 show a higher percentage of native species that can thrive if wildlife conservation planning measures are implemented across the undeveloped to urban gradient, compared with development that occurs with no conservation planning (red bars).

Information provided in this guidance document describes a variety of conservation planning measures that local communities might implement to increase the number of species that can co-exist in developing areas; i.e., moving the red bars toward the blue bars in Figure 1.2. These measures minimize the effects of development on wildlife habitat and species while still accommodating expected growth of Washington's population.

Conserving wildlife habitat is one of the goals of the Washington State Growth Management Act (GMA)[1], and this document is written to provide information that local planners, elected officials, community groups, and others might use to meet this GMA goal, along with other local planning mandates. While WDFW is interested in accommodating as many native wildlife species across the development gradient as possible, including keeping common native species common, we are especially interested in maintaining conditions that support at risk species (e.g., identified by our agency as Priority Habitats and Species or indentified as at-risk in other assessments). The habitats of these species can be improved by incorporating biodiversity conservation planning tools across all housing densities.

The Science of Wildlife in Urbanizing Environments

The information in this guidance document is drawn from wildlife science and matched with the current realities of planning in Washington State. However, our understanding of how wildlife responds to various land use patterns is uneven. Our understanding is greatest where habitat is least disturbed, and we know less in rural, developing areas where patterns of land use are most complex. Several studies have used a gradient of increasing development to provide information on factors such as the species diversity (Blair 1996, 1999), the number of species (species richness) (Fraterrigo and Wiens 2005), the density of animals (Hennings and Edge 2003), predation (Gering & Blair 1999), and impacts of urbanization (Alberti et al. 2001, Ferguson et al. 2001). The data presented in this publication and management recommendations are based on results from these and other studies and on discussions with leading wildlife experts (Appendix A).

Scientists have better come to understand or appreciate the role of humans in ecosystems if for no other reason than it is nearly impossible to find ecosystems that are not affected by humans in some way. Whereas early conservation efforts focused on the idea of protecting areas outside human influence (e.g., reserves, parks), current thinking among ecologists is also aimed at conserving ecological structures, functions, and processes across the landscape in ways that support ecological services (e.g., clean air and water, recreational activities, wildlife, etc.) upon which humans and all life forms depend. One application of this new thinking is recognizing

[1] RCW 36.70A.020 (9)

that all landscapes, from the human-dominated (e.g., urban) to the relatively undisturbed (e.g., managed forests), can contribute to maintaining ecological health.

Despite the fact that climate change is likely to affect many wildlife species, and some in dramatic ways, we do not address climate change directly in the document. Nonetheless, planning for wildlife and their habitat across the development gradient as described in this document will contribute to better biodiversity conservation despite climate change and the uncertainty associated with exactly how species and communities may respond.

Chapter 2. How Wildlife Responds to Developing Landscapes

Major Effects on Wildlife from Land Use Changes

The most common effects of human land use changes on wildlife include loss of habitat, the creation of smaller and more scattered remaining fragments or patches of habitat, loss of habitat quality within patches, increased road mortality, reduced water quality, and increased competition between native species and nonnative species. The effects of land use or stressors can result in the loss of species from an area.

> ***Stressors***
>
> ***The term "stressor" is used to characterize the effects of development on wildlife species. A stressor is the specific aspect of a development action that negatively affects the species. For example, clearing of vegetation is a development action; loss of habitat and inability of animals to move freely among their habitat areas are the resulting stressors.***

Land use planning that considers wildlife in the local decision-making process can minimize the effects of stressors on wildlife as the landscape is developed (see Figure 2.1).

Figure 2.1 Changes to the landscape along the development gradient. The bottom panel highlights how forest habitat (shown here in green) decreases, and how forest patches become smaller and more dispersed as development intensity increases. The three middle sections represent areas where wildlife can benefit the most from local planning that considers wildlife needs.

The primary "stressors" addressed in this document are:

Changes to Habitat Composition. Habitat composition includes the number, size, and quality of habitat areas on the landscape. Land development eliminates habitat, reduces the size of habitat patches, often reduces the quality of habitat by disturbing soils and vegetation, and by introducing non-native plants (through landscaping) and animals (e.g., cats and dogs) that may be detrimental to native species . Reducing or eliminating the number, size, and quality of habitat patches are stressors for many species of wildlife.

Changes to Habitat Configuration. Habitat configuration is the spatial arrangement and shape of habitat areas. Development tends to break up large contiguous habitat areas into smaller patches, and to change the spatial arrangement of patches and their shapes. Some species are particularly sensitive to changes in habitat configuration. For example, some birds are more vulnerable to nest predation in small patches than they are in large habitat patches, and as patches become very small they may not support some species at all. Habitat patches that become too isolated from each other may not be used by certain species even if they have otherwise suitable habitat conditions. For example, some pond-breeding amphibians breed in wetlands but spend the summer in upland forests. If forests are too distant from wetlands, otherwise suitable wetlands for amphibians may cease to be used as breeding habitat. Changes in habitat configuration can also affect other aspects of habitat quality. For example, smaller patches may be more susceptible to disturbance (e.g., trees blowing down or introduced species like English ivy outcompeting native vegetation).

Our definition of "habitat":
Habitat is the biological and physical conditions that support a particular species or group of species. These conditions are created and maintained by the interaction of physical, chemical and biological processes (i.e., ecosystem processes). By necessity we use a very simple definition of habitat in this document. Habitat is landcover types (e.g., areas with trees, sagebrush, dunes, grasslands) and aquatic areas (e.g., streams, rivers, lakes, wetlands) that support Washington's native species. Habitat quality is measured by the amount of human development in those landcover types and how that development affects composition and configuration, and in turn connectivity of undeveloped areas.

Changes to Habitat Connectivity. Habitat connectivity is the degree to which habitat patches in the landscape are connected and can facilitate movement of animals. Land development can create barriers to animal movement between suitable habitat patches and thus prevent the use of otherwise suitable habitat by a variety of species. Some animals will not or cannot travel through areas developed by humans, so isolated patches that are otherwise suitable habitat may go unused. Species are also more likely to be lost from small, isolated patches than large-connected patches because of fluctuations in birth, death, or survival rates. Roads and traffic affect connectivity by creating barriers to movement and fragmenting habitat. Roads also lead to wildlife mortality by vehicles.

Additional stressors that are briefly summarized, but not directly addressed in this document include:

Hydrological alterations refers to how land development changes the delivery and routing of water across the landscape. Changes to water delivery systems (e.g., more rapid stormwater discharge to streams as a result of development) can cause larger water level fluctuations, lower stream flows during certain seasons, and changes in flooding frequency and size. These changes act as stressors to many species of wildlife, especially those associated with aquatic systems. Such stressors are addressed in other publications focused on fish.[1]

Pathogens, nutrients and toxicants are substances released into the environment and can include bacteria and viruses, yard fertilizers, pesticides, and septic effluent containing nitrates, pharmaceuticals, and other chemicals. Animals may absorb toxic chemicals directly through their skin, through their lungs (tracheae in the case of an insect) or from their food. Excessive nutrients may also change habitat conditions, such as facilitating algal blooms and subsequent oxygen depletion in lakes, ponds, and in the Puget Sound that can lead to the death of aquatic animals. These changes are particularly important to fish and semi-aquatic species.

Interspecies interactions between native species and non-native or invasive species are often facilitated by humans and can cause declines in native wildlife. Examples include increased bird nest predation by eastern gray squirrels, crows, and raccoons that thrive in developed areas; displacement of cavity-nesting birds such as flickers and chickadees by the European starling; harassment or killing of wildlife by pets; and replacement of native plants by invasive plant species. Changes in interspecies interactions as a result of development can act as a stressor to

[1] See the Aquatic Habitat Guidelines web site, http://wdfw.wa.gov/hab/ahg/for links to WDFW guidance documents related to planning for protection of fish and aquatic resources.

many species of wildlife. This stressor will be addressed when discussing habitat composition, habitat configuration, habitat connectivity, and planning at the subdivision scale.

Changes in disturbance regimes as a result of human activity affect the creation and maintenance of wildlife habitat. For example, fires are important in maintaining some habitats (e.g., prairie, open forests such as ponderosa forests in eastern Washington) and habitat elements (e.g., snags, downed logs). Landslides (both large and small scale) provide sediment to stream and marine beaches. Removal of stream bank vegetation can increase the rate at which sediments are delivered to streams, which in turn can decrease the quality of fish spawning habitat. Alternatively, humans can slow the rate of sedimentation by armoring or protecting eroding banks along marine shorelines, which can starve beaches of sand and gravels and lead to their long-term decline as fish and wildlife habitat. These impacts are addressed in separate guidance documents offered by WDFW and others through the Aquatic Habitat Guidelines program.

Table 2.1 summarizes development activities, the wildlife stressors caused by these activities, potential effects of the stressors, and the main groups of species ("taxa") affected. This information is shown in greater detail in Appendix C.

Table 2.1 Major “stressors” that influence wildlife linked to activities associated with residential land uses.

Examples of major land uses associated with residential development	Major stressors to wildlife	Major species and population effects	Primary taxa affected
Habitat Composition			
Clearing and grading (in preparation for construction)	Habitat loss/conversion; Habitat isolation; Reduced patch size; Simplification of habitat structure; Spread of invasive plants; Soil disturbance; Loss of interior habitat; Loss of habitat connectivity; Altered disturbance regimes; Resource depletion; Extraordinary competition for limited resources; Changes in microclimate	Reduced fitness; Reduced survival; Changes in home range size; Local extinctions; Depressed reproduction; Altered community composition; Disrupted seasonal movements; Reduced abundance; Isolation from other populations	Amphibians, Birds, Mammals, Reptiles
Lawn maintenance and landscaping	Habitat loss/conversion; Introduction of exotic plants; Simplification of habitat structure; Habitat degradation; Resource depletion; Extraordinary competition for limited resources; Input of pollutants	Reduced fitness; Reduced survival; Changes in home range size; Local extinctions; Depressed reproduction; Altered community composition; Reduced abundance	Amphibians, Birds, Mammals, Reptiles
Removal of decadent (hazard) trees	Simplification of habitat structure; Habitat degradation; Resource depletion	Reduced fitness; Reduced survival; Depressed reproduction; Altered community composition; Reduced abundance	Birds, Mammals

Examples of major land uses associated with residential development	Major stressors to wildlife	Major species and population effects	Primary taxa affected
Habitat Configuration			
Development along riparian corridors creating narrow strips of habitat.	Habitat loss/conversion; Habitat isolation; Reduced patch size; Loss of interior habitat; Extraordinary predation effects; Resource depletion; Extraordinary competition for limited resources; Changes in microclimate; Altered disturbance regimes (flooding); Loss of habitat connectivity; Input of pollutants (into nearby waterbody)	Reduced fitness; Reduced survival; Local extinctions; Depressed reproduction; Altered community composition; Reduced abundance; Isolation from other populations.	Amphibians, Birds, Mammals, Reptiles
Development after large expansion of Urban Growth Area (i.e., habitat fragmentation)	Habitat loss/conversion; Habitat isolation; Habitat degradation; Reduced patch size; Simplification of habitat structure; Spread of invasive plants; Spread of nuisance animals; Loss of interior habitat; Loss of habitat connectivity; Altered disturbance regimes; Resource depletion; Extraordinary competition for limited resources	Reduced fitness; Reduced survival; Changes in home range size; Local extinctions; Depressed reproduction; Altered community composition; Reduced abundance; Isolation from other populations	Amphibians, Birds, Mammals, Reptiles

Examples of major land uses associated with residential development	Major stressors to wildlife	Major species and population effects	Primary taxa affected
Habitat Connectivity			
Small-scale fences and barriers	Habitat isolation; Loss of habitat connectivity	Reduced survival; Depressed reproduction; Isolation from other populations; Disrupted seasonal movements	Amphibians, Mammals, Reptiles
Powerline corridors	Habitat loss/conversion; Habitat isolation; Increased edge habitat; Extraordinary predation effects; Loss of habitat connectivity	Local extinctions; Reduced survival; Depressed reproduction; Isolation from other populations; Disrupted seasonal movements	Amphibians, Mammals, Reptiles
Construction of local residential street	Habitat isolation; Loss of habitat connectivity; input of pollutants (e.g., oil, road deicer); Spread of invasive plants	Direct mortality/injury; Reduced survival; Isolation from other populations; Disrupted seasonal movements ; Local extinctions; Depressed reproduction (these effects mainly will influence species with low mobility)	Amphibians, Mammals, Reptiles
Development of high capacity road	Habitat isolation; Loss of habitat connectivity; Creation of major animal movement barrier; Effect of noise; Effect of artificial light; Input of pollutants (e.g., oil, road deicer); Spread of invasive plants	Direct mortality/injury; Reduced survival; Isolation from other populations; Disrupted seasonal movements ; Local extinctions; Depressed reproduction	Amphibians, Mammals, Reptiles

Differences in Species' Sensitivities to Stressors

Species may be grouped by their sensitivity to development. Some species are better able to tolerate stress caused by development than others. For example, raccoons and house sparrows benefit from increased development due to an increase in the types of food and shelter they need. On the other hand, amphibians and ground-nesting birds are more sensitive to the stressors brought about by development. Table 2.2 summarizes how development generally affects different species groups.

Table 2.2 Major stressor categories and their effects on birds, mammals, amphibians, and reptiles. The most important stressors for each group are shown in red.

Stressor Category	**Group**		
	Birds	Mammals	Amphibians & reptiles
Habitat composition			
Habitat configuration			
Habitat connectivity			
Roads			
Hydrology		(aquatic mammals)	
Nutrients/toxicants			
Interspecies interactions			

Development response groups

With the aid of science experts and extensive review of the literature, we grouped species into "Development Response Groups", which are groups of species expected to respond to stressors in similar ways. Development Response Groups help reduce the complexity of dealing with a large number of species and were developed using published literature as well as consensus opinions of scientists (Appendix A). The Groups were formed as follows:

- Birds were placed into eleven groups based primarily on their sensitivities to availability of habitat and different levels of development.
- Mammals were placed in twelve groups by body size (small, medium, large) and by the distance they can move across a landscape. Similarly sized animals were further grouped based on their sensitivity to habitat fragmentation.

- Amphibians and reptiles were categorized into fourteen groups based on breeding habitat and life history characteristics, their ability to move across the landscape, and by their sensitivities to habitat disturbance.

Development Response Groups were classified into five classes based on their sensitivity to development, from "Very Low Sensitivity" to the "Very High Sensitivity." Sensitivities for each Group are based on the most sensitive species in the group. Table 2.3 summarizes these sensitivity classes. This information can inform landscape-level land use planning decisions related to zoning and comprehensive planning. For example, changing zoning to allow more density may result in the loss of some Development Response Groups. To understand the relationship of density, and other stressors, to these groups, detailed lists of species and their responses to stressors can be found in the Species and Development Database (Appendix B), which can be used to inform planning decisions at a variety of scales.

Table 2.3 Expected presence along the undeveloped to urban gradient for Washington's mammals, birds, amphibians, and reptiles. Development Response Groups are based on expected response to development. Color coding: dark green represents areas with no development; light green represents housing densities where species within the development response groups could occur; orange represents areas where species' persistence is not expected to occur, but could still occur if specific stressors are addressed; red represents dwelling densities where the species are not expected to occur. Refer to Appendix B1, Species and Development Database, for individual species sensitivities. (du=dwelling unit; ac=acre)

	Undeveloped	**Rural Densities**				**Suburban Densities**		**Urban Densities**	
Development Response Groups	0 du/ac	Rural/ Resource/ Conservation 1du/40ac to 1du/80ac	Rural Residential 20 1du/20ac	Rural Residential 10 1du/10ac	Rural Residential 5 1du/5ac	Suburban Density 1du/2.5ac	Med/ High Suburban 1du/ac to 4du/ac	Medium >4du/ac to 7du/ac	High >7du/ac to commer./ indust.
Very Low Sensitivity									
Birds, urban enhanced									
Mammals enhanced by development									
Birds, very high tolerance for development, low sensitivity to patch area									
Small mammals, low movement, high fragmentation tolerance									
Mid-sized mammals, low movement, high fragmentation tolerance									
Small mammals, low movement, moderate fragmentation tolerance									
Mid-sized mammals, low movement, moderate fragmentation tolerance									
Low sensitivity									
Small mammals, moderate movement, moderate fragmentation tolerance									
Large mammals with extensive movement, high fragmentation tolerance									
Birds, high tolerance for development, low sensitivity to patch area									
Pond-breeding amphibians, variety movement scales, breeding habitats short hydroperiods									
Terrestrial reptiles, relatively small spatial scales, live birth									
Forest, non-stream associated salamanders, low movement scales									
Moderate sensitivity									
Birds, high tolerance for development, moderate to high (or unknown) sensitivity to patch area									
Birds, moderate tolerance for development, low sensitivity to patch area									
Birds, moderate tolerance for development, moderate/very high/unknown sensitivity to patch area									
Moderate sensitivity (continued)									

	Undeveloped	Rural Densities				Suburban Densities		Urban Densities	
Development Response Groups	0 du/ac	Rural/ Resource/ Conservation 1du/40ac to 1du/80ac	Rural Residential 20 1du/20ac	Rural Residential 10 1du/10ac	Rural Residential 5 1du/5ac	Suburban Density 1du/2.5ac	Med/ High Suburban 1du/ac to 4du/ac	Medium >4du/ac to 7du/ac	High >7du/ac to commer./ indust.
Mid-sized mammals, moderate movement, moderate fragmentation tolerance									
Terrestrial lizards that lay eggs									
Cryptic (rarely seen) reptiles that lay eggs									
Terrestrial reptiles, utilize aquatic and terrestrial habitat, extensive spatial scales, live birth									
Pond-breeding amphibians, large/extensive movement, breeding habitats longer hydroperiods									
High sensitivity									
Birds, variable tolerances for development, low sensitivity to patch area									
Birds, low tolerance for development, moderate sensitivity to patch area									
Birds, low tolerance for development, high or unknown sensitivity to patch area									
In-stream breeding amphibians, moderate movement scale									
Streamside salamanders with low flow and low velocity requirements, low movement scale									
Shrub-steppe reptiles that use habitat at intermediate spatial scales									
Small mammals, low movement, low fragmentation tolerance									
Mid-sized mammals, moderate movement, low fragmentation tolerance									
Very high sensitivity									
Large mammals with extensive movement, moderately fragmentation tolerant									
Birds, very low tolerance for development, various sensitivities to patch area									
Stream-associated forest salamanders, low movement scale, require specialized habitats									
Birds, generally intolerant of development									
Pond-breeding amphibians, intermediate movement, breeding habitats with long hydroperiods									
Terrestrial reptiles, very large spatial scales, important overwintering requirements									
Wide-ranging mammals, fragmentation intolerant									

Stressors at Different Spatial Scales

Planning occurs at different scales, so the recommendations, tools, and information provided in this document to address stressors on wildlife are organized around three general spatial scales (Figure 2.2).

County or Hydrological Basin (Broad-Scale). The broad scale deals with a big-picture view, as in a comprehensive plan. Planning activities for wildlife might include trying to conserve some best remaining areas of habitat across a whole county.

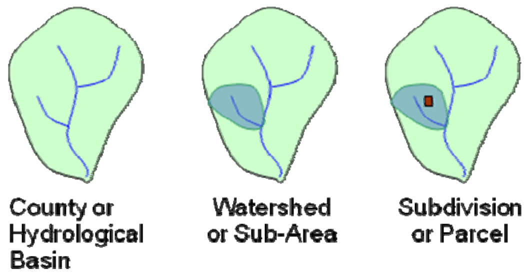


Figure 2.2 Different scales of planning for fish and wildlife.

Watershed or Sub-Area (Mid-Scale). At the mid-scale, more specific species information can be used to assess current conditions for wildlife. Recommendations for conserving wildlife at the mid-scale might include conserving a system of interconnected wetlands and upland habitat used by amphibians.

Subdivision or Parcel (Fine-Scale). At this scale, development proceeds according to local development regulations. These regulations may have provisions that address categories of wildlife, such as setbacks from nests of priority bird species. Planning at this scale may also include incentives to developers to preserve or enhance habitat by giving density bonuses in clustered development.

Biodiversity benefits most through early planning at broad scales. Here overall land use is determined through comprehensive plans, watershed or community plans, and zoning ordinances. Decisions made at these scales can then be implemented at the subdivision and parcel scale through specific design and performance standards for development and through site-specific decisions about lot design. The remaining chapters of this document will address planning for wildlife at all of these scales.

Chapter 3. Understanding the Importance of Habitat Composition and Configuration

Overview

Composition refers to parts that make up a landscape, that is, the number, quality, and aerial extent of cover or vegetation types in a landscape (Figure 3.1). One measure of composition is habitat heterogeneity or diversity. This measure describes the number of unique types (e.g., forests, meadows, shrub-steppe, prairies, wetlands, lakes and ponds, streams, talus slopes, caves) found in a given area. Another important measure of composition is the aerial extent of undeveloped land (i.e., habitat).

Figure 3.1 An example of habitat composition & configuration (green patches) in a developing landscape.

Habitat configuration (Figure 3.1) refers to the shape and arrangement of habitat areas. As areas that were once undeveloped become developed, changes in habitat configuration occur. These changes include increased distances between patches of remaining habitat (i.e., isolation), creation of transitional areas between habitat areas, closer proximity of disparate types (e.g., homes next to second growth forests), and changes in the proportion of relatively undisturbed areas to the built environment.

Impacts at Different Scales

Changes in habitat composition and configuration associated with development are relevant at all planning spatial scales. The negative effects of reducing patch size of habitat in developing landscapes have been well documented for birds and wide-ranging mammals (Gavareski 1976, Tilghman 1987a, Soule et al. 1988, Croos 2002, Tigas et al. 2003, Donnelly and Marzluff 2004).

> ***As patch sizes become smaller, the number of species that use these patches for habitat decreases.***

Changes in habitat diversity associated with development can influence wildlife communities (Blair 2004, Rodewald and Matthews 2005). As habitat diversity decreases, the number of species found in an area also decreases.

Another important factor is the ratio between the area of native vegetation to the area of built structures and impervious surfaces. The number of species in an area generally falls as vegetation is increasingly replaced by buildings and roads (Andren 1994, Fahrig 1999, Villard et al. 1999). Changes in configuration associated with development influence wildlife by altering movement patterns and by exposing species to new impacts (e.g., introduced species may compete with native species for limited resources, such as starlings competing with woodpeckers for limited tree cavities for nesting). The amount of edge habitat created by development is an element of configuration that can impact wildlife. For example, some breeding birds are more vulnerable to predation as they get closer to edges created by land clearing (Paton 1994, Robinson et al. 1995, Hartley and Hunter 1998, Bolger 2002, Driscoll and Donovan 2004).

Many wildlife species, including small mammals and ground- and shrub-nesting birds (Ferguson et al. 2001), and reptiles and amphibians (Hayes et al. 2008) require complex habitat elements, such as layered tree canopies, shrub layers, ground vegetation, downed wood, and leaf litter. These elements are often removed or reduced by development (Adams et al. 2005). Changes in vegetation, including the replacement of native plants by introduced flora (Zipperer et al. 1997, Adams et al. 2005), and the loss of trees, snags, and understory vegetation between developed and undeveloped areas is well documented (Spirn 1984, Pickett et al. 2001, Hough 2004). These changes will adversely affect small animals that spend all or part of their lives on the ground.

Things to Think About: Key Measurements, Models, and Information

To plan for wildlife, it is useful to understand key measurements useful for looking at habitat composition and configuration across the landscape. A summary of these measurements are shown in Table 3.1. These measurements are arranged according to those that are most (left side) and least (right side) supportive of native species diversity.

Patch Size. The first three measurement bars in Table 3.1 summarize how numbers of species of birds, mammals, and amphibians are expected to respond to changes in habitat patch size. Minimum patch size requirements for specific species can be found in the Species and Habitat Database in Appendix B.

The low end values of the mammalian patch size spectrum (<25 acres) are useful for addressing habitat in high density suburban to urban landscapes, while the higher ends of the spectrum (> 450 acres) are most useful for addressing contiguous habitat areas in rural or undeveloped landscapes. Patch size numbers were developed using umbrella mammal species that, when combined, captured the needs of all mammal Development Response Groups (see Appendix D, Table D-4).

Research on birds indicates patch sizes between 100 to 125 contiguous acres appear to be a threshold where breeding bird species numbers peak (Foreman et al. 1976, Tilghman 1987a, Donnelly and Marzluff 2004, Drinnan 2005). Based on research in developing landscapes, patches of habitat >100 acres will often fulfill the needs of most birds. However, some bird species require patches of contiguous habitat of at least 500 acres (see Appendix D). Some other native bird species will thrive in smaller patches (e.g., in an urban environment) if the habitat structure includes enough undisturbed native landcover to support them (see Table 3.2).

Table 3.1 Summary measurements regarding habitat composition and configuration.

		Patch sizes		
Greater numbers of species	←		→	**Lesser numbers of species**
		Birds: patch sizes[a]		
>500 acres	>100 acres	>50 to 100 acres	12 to 50 acres	≤12 acres
		Mammals: patch sizes[b]		
>6,000 acres	450 to 6,000 acres	25 to 450 acres	>2 to <25 acres	2 acres
		Amphibians: patch sizes[c]		
>300 acres (*no data*)	>300 acres	>65 acres	2 to <65 acres	<2 acres
		Percent of natural land cover or urbanization		
		Mammals and % natural landcover[d]		
>>80%	>80%	55 to 80%	<55%	<<55%
		Amphibians and % forest or other natural landcover[e]		
≥80% (to ≥90%)	<80 to 50%	50 to 40%	40 to 30%	<30% (<20%)
		Birds and % urban landcover[f]		
<5%	5 to 30%	>30 to 50%	50 to 85%	>85%
		Amphibians and % of watershed with urbanization[g]		
<10%	10 to 25%	25 to 40%	40 to 75%	>7.5%

[a] Based on Forman et al. 1976; Tilghman 1987 a,b: Soule et al. 1988; Crooks et al. 2001; Donnelly & Marzluff 2004; Blewitt & Marzluff 2005; Drinnan 2005. See Appendix D, Table D-2 for additional information.
[b] Based on Bolger et al. 1997; Crooks 2002; Riley et al. 2003; Tigas et al. 2003. See Appendix D, Table D-4 for additional information.
[c] Based on limited information: Trenham & Shaffer 2005; Richter et al. 2008. See Appendix D, Table D-14 for additional information.
[d] Based on Kilpatrick & Spohr 2000a; Grinder & Krausman 2001; Riley et al. 2003; also see Appendix D, Table D-5.
[e] Based on Chin 1996; Gibbs 1998b; Reinelt & Taylor 2001; With 2002; also see Appendix D, Table D-11
[f] Urban land cover includes pavement, buildings, and lawns but not trees, pasture, or agriculture. Based on Lancaster & Rees 1979; Blair 1996; Berry et al. 1998; Blewitt & Marzluff 2005; Stratford & Robinson 2005; Donnelly & Marzluff 2006; also see Appendix D, Table D-3.
[g] Based on Richter & Azous 1995 (numbers rounded to simplify); also see Appendix D, Table D-12.

Interior versus edge species. Some species are adapted to the interior portion of a habitat rather than being spread evenly throughout the habitat, including the edge. For example, hermit and Townsend's warblers prefer the interior of a forest and will rarely be found at the edges (Rosenberg & Raphael 1986). Interior species often need to be a minimum distance from an edge. As a patch of habitat becomes smaller, the interior portion shrinks to a point where the innermost area is so close to an edge that the patch essentially has no interior habitat left for some interior species. These species have a minimum patch size; a small patch may essentially consist only of edge habitat and contain no "interior" habitat.

On the other hand, some species may be distributed throughout a given habitat type. The area where two habitat types blend (e.g., where a coniferous forest transitions to a deciduous forest or meadow) is called an "ecotone," (Fagan et al. 1999) and it will often support species from both habitat types and is therefore often relatively high in species numbers. In this guidance we are more interested in meeting the needs of patch interior species than edge species. Human development often creates edge habitat at the expense of interior habitat, and patch interior species tend to be at higher risk than edge species. Edge habitat allows more common species such as the American crow to thrive, which can adversely impact neotropical birds (through nest predation) and other, more sensitive species that need interior habitat.

Percent undisturbed habitat. Percent undisturbed habitat across the landscape is a useful indicator of habitat composition and configuration. This indicator can function as a surrogate measurement for other important parameters such as amount of edge habitat, proximity to homes, and amount of available habitat. It can also be an indicator for habitat connectivity (With 2002). The fourth through sixth measurements bars in Table 3.1 describe the expected response to a gradient of undisturbed landcover percentages for birds, mammals, and amphibians.

Many native birds can persist in landscapes where undisturbed land cover is greater than approximately 50% (Donnelly and Marzluff 2006). More sensitive animals, such as neotropical migrant songbirds and raptors, require 65% to 95% of undisturbed vegetation (Berry et al. 1998, Stratford and Robinson 2005). Many species of mammals and amphibians are expected to do well where natural vegetation covers over 80% of the landscape. Percent urban land cover, shown in the last two measurements bars of Table 3.1, can also be used to assess expected changes in species numbers.

Vegetation structure and quality. Table 3.2 summarizes key characteristics of habitat composition on bird communities inhabiting urban settings of western North America. The literature includes conservation targets relative to live tree composition and the presence of standing dead trees (snags) most beneficial to wildlife.

Table 3.2. Influence of key characteristics of habitat composition on bird communities inhabiting urban settings of western North America.

Habitat Characteristic(s)	Research finding	Research location	Reference
• Live trees • Understory vegetation	Freshwater streams, large conifers (>12 inches diameter), and large berry-producing shrubs (e.g., salmonberry, elderberry) consistently showed a significant relationship with the presence of a variety of bird species.	Greater Vancouver, B.C.	Melles et al. 2003
• Live Trees • Native landcover	Native forest birds tended to be present when neighborhoods had significant tree cover (>4/acre), urban landcover did not dominate the landscape (<52%), canopies contained abundant evergreen trees (>23%), and forest was not highly fragmented.	Metro Seattle, Wash.	Donnelly and Marzluff 2006
• Live trees	The distribution of trees greater than 20 feet in height was a significant habitat feature related to the population density of birds in residential areas.	Edmonton, Alb.	Edger and Kershaw 1994
• Live trees • Snags	When deciding which forest areas to set aside from development, target areas with high densities of existing snags (> 3 snags ≥10 inches diameter/acre), and live trees (>130 trees/acre).	Metro Seattle, Wash.	Rohila 2002
• Snags	Moderately decayed snags >15 inches in diameter are valuable to cavity-nesting birds.	Metro Seattle, Wash.	Blewett and Marzluff 2005
• Canopy cover	Evenness of species abundances, and numbers of species increased with foliage height diversity and total vegetation cover.	Vancouver, B.C.	Lancaster and Reese 1979
• Canopy cover • Native vegetation cover	Neotropical migrant conservation might include maintaining tree canopy cover within 1,475 feet from streams, and by conserving native tree and shrub cover.	Portland, Ore.	Hennings and Edge 2003
• Native vegetation cover	Recommend the retention and restoration of dense vegetation in forested and urban parts of the landscape to enhance postfledging survival and movement.	Metro Seattle, Wash.	Whittaker and Marzluff 2009
• Native vegetation cover	Maintaining native vegetation wherever possible contributes to landscape connectivity and the maintenance of avian biodiversity in urban settings.	Lake Tahoe, Calif	Schlesinger et al. 2008
• Understory vegetation	Reductions in understory vegetation and herbaceous ground cover were particularly strong determinants of bird community structure.	Fort Collins and Boulder, Colo.	Miller et al. 2003

Summary

In a developing landscape, planners will benefit the species most sensitive to changes in habitat composition and configuration by ensuring the availability of habitat that has:

- Larger rather than smaller patches.
- A higher rather than lower percentage of natural land cover.
- A low edge to interior ratio.

Chapter 4. Understanding the Importance of Habitat Connectivity

Overview

Habitat connectivity refers to the degree to which the habitat in the landscape is connected and can facilitate movement of animals. Animals often move between different areas on the landscape to meet different needs. For example, elk and deer typically move between high elevation areas in the summer to lower elevation areas in the winter and most amphibians move between wetlands for breeding and adjacent woodlands for summer and fall rearing. In a developing landscape, breaks in connectivity caused by housing, roads, and other development may preclude species that need to move between different areas (Figure 4.1).

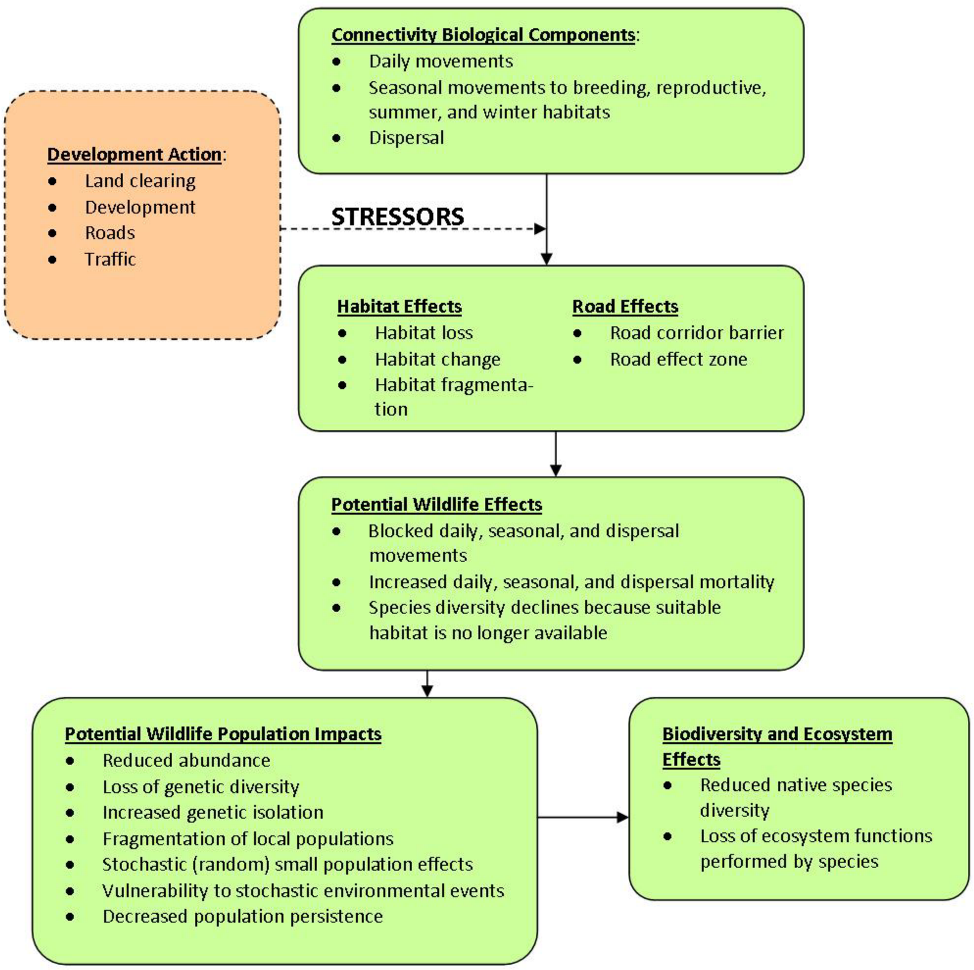


Figure 4.1 Potential impacts to wildlife from loss of connectivity in developed landscapes. Includes impacts of the "road effect zone," or area of impact extending beyond the roadway and including traffic noise and lights.

Changing ideas about connectivity

Early conservation approaches focused on protecting habitat patches (i.e., "islands") and assumed that the patches were set within hostile landscapes. Connecting corridors became the approach used to enable movement of animals between patches (Hobbs 2002). More recent work recognizes that areas within a developing landscape are complex mixes of different cover types, not all of which are necessarily hostile to all wildlife species. Perhaps a better way of thinking about connectivity as applied to urbanizing landscapes includes the concept of "permeability," i.e., how well an animal can pass through the landscape, including areas that may have varying levels of development (Hobbs 2002). Results from connectivity modeling can provide some reasonable ideas on percentages of habitat (i.e., the ratio of developed to undeveloped habitat in an area) that can assure connectivity/permeability through developed areas for certain species.

Planning that addresses connectivity might include a combination of riparian corridors, wildlife-friendly development measures, habitat patches that function as stepping stones, and connective linkages specifically designed to ensure connectivity between important habitat areas.

Connectivity at different scales

Connectivity issues occur at multiple scales and across the development gradient. At county-wide scales, planning can focus on major landscape linkages within and between basins, counties, and ecoregions. (An "ecoregion" is an area defined as having similar vegetation, soils, geology, hydrology, landforms, and natural disturbance that can be delineated geographically. Washington State has portions of nine ecoregions within its boundaries [Washington Biodiversity Council 2007]). Planning for connectivity is similar to planning a regional transportation network. This scope of planning is necessary for species such as elk and mule deer that must travel long distances between summer and winter habitats. A biodiversity network (i.e., areas of high biological richness connected by corridors) is an approach that can be integrated across a gradient of development densities.

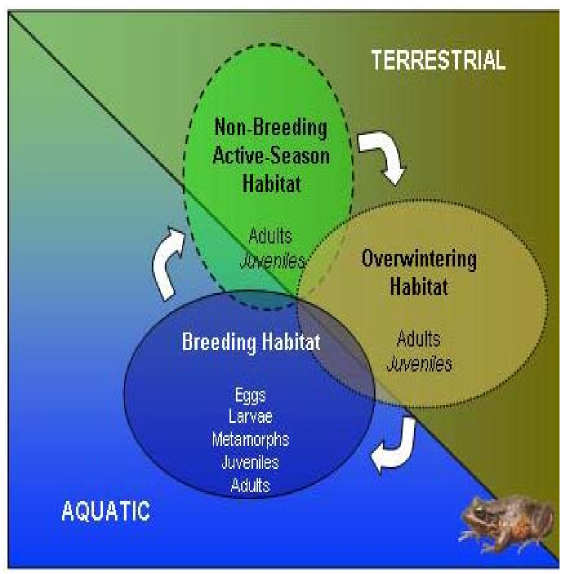


Figure 4.2 Seasonal rounds of the Northern Red-legged Frog. *Graphic courtesy of Marc Hayes and Klaus Richter.*

Watershed-scale connectivity is similarly important for animals such as pond-breeding amphibians that rely on dispersal between groups of wetlands (Figure 4.2). Rather than linear corridors, groups of large functional wetland complexes may function for connectivity.
At the parcel or subdivision scale, connectivity issues identified at the county and watershed scales are further refined. Corridors and connective linkages (for example between wetlands and uplands) can be addressed through zoning and transportation planning.

Things to Think About: Key Measurements, Models, and Information for Connectivity Planning

Based on connectivity modeling (With 2002), we conclude that:

- ≥80% contiguous, undisturbed land cover provides connectivity for most wildlife species.
- 50 to 80% undisturbed land cover may provide a good level of connectivity; however as the percent developed land increase the possibility of meeting connectivity needs for all species decreases.
- Areas with <50% undisturbed land cover need assistance to ensure connectivity is maintained.

A synthesis of connectivity measurements is provided in Table 4.1. These measurements are arranged according to those that are most (left side) and least (right side) favorable to native species, describing the percent forest or native vegetation within the habitat corridor and corridor width.

Table 4.1 Summary measurements regarding habitat connectivity.

Greater numbers of species	←		→	**Lesser numbers of species**
	Habitat connectivity: % forest or other native vegetation[a]			
≥80%	<80 to 50%	<50 to 40%	<40 to 30%	<30%
	Corridor width[b]			
>1,000 ft	1,000 to 500 ft	<500 to 300 ft	<300 to 150 ft	<150 ft

[a] Based on With 2002, these are modeled connectivity values and are therefore broadly usable across habitat types.
[b] Based on Cross 1985; Freel 1991; Beier 1995; Hull 2003; Sinclair et al. 2005; Richter et al. 2007. See Appendix D, Table D-26 for additional information.

In general, smaller mammals (except bats) tend to be more sensitive to changes in connectivity than large mammals, while birds generally have high to very high ability to cross gaps between their habitat areas. Amphibians and reptiles as a group are generally sensitive to gaps between their habitats, and planning for connectivity is particularly important to them.

Roads: significant barriers to connectivity

Wildlife species that must travel by ground to daily and seasonal habitats are often affected by roads and traffic. Road traffic takes an appreciable toll on wildlife: an estimated one million vertebrates per day are killed on roads in the United States (Forman and Alexander 1998). At the same time, public safety is at risk when vehicles collide with or attempt to avoid animals.

Effects of roads on wildlife include:

- Direct mortality by collisions with vehicles.
- Creation of barriers to movement for animals that will not cross roads.
- Fragmentation of habitat and interruption of movement from one habitat to another that some species must make to complete their life cycles.
- Fragmentation of populations, which may leave them more vulnerable to genetic isolation.
- An increase in the ratio of edge habitat to interior habitat, which is often harmful to species that use the interior portion of a given habitat, while enhancing species that use edge habitat.
- The spread of non-native plant and animal species that compete with native species.
- Introduction of pollutants and degradation of habitat from increased noise, light, heat, and the addition of exhaust, pavement de-icers, oil, heavy metals, and ozone.
- Disruption of the natural flow of water.

Forman et al. (2003) identified policy changes for reducing ecological impacts of road systems on wildlife. These changes include channeling traffic onto primary roads to reduce the dispersion of noise and barrier effects, and perforating road corridors with underpasses and overpasses to reduce road barriers and habitat fragmentation. For example, in Europe, "under-road toad tunnels" have been in existence for many years, and more recent work has expanded to landscape-based planning for roads, people, and wildlife. Many other designs and methods for assuring safe road crossings for wildlife in North America are discussed in Clevenger, T. and M. P. Huijser (undated).

Table 4.2 provides summary measurements useful for designing road and traffic conditions with wildlife impacts in mind. These measurements are: 1) road density based on literature specific to mammals, 2) traffic speed, 3) traffic intensity relative to amphibians and reptiles, 4) wetland radius distances, and 5) corridor width across roads.

Table 4.2 provides summary measurements to consider in evaluating road and traffic conditions for wildlife. These measurements are: 1) road density based on literature specific to mammals, 2) traffic speed, 3) traffic intensity relative to amphibians and reptiles, 4) wetland radius distances, and 5) corridor width across roads.

Fewest impacts to wildlife	←		→	**Most impact to wildlife**
Road density (mi/mi^2) and impacts on mammals[a]				
<<1.0mi/mi^2	<1.0mi/mi^2	>1.0 to < 2.4mi/mi^2	≥2.4mi/mi^2	>>2.4mi/mi^2
Traffic speed impacts[b]				
<<25 mi/hr	25 to 35 mi/hr		>35 mi/hr	>55 mi/hr
Traffic intensity (vehicles/hr) impacts on amphibians[c]				
<1 v/hr	1 to 5 v/hr	6 to 14 v/hr	15 to 25 v/hr	>26 v/hr
Distance (radius) from wetland complexes within which roads/traffic can impact amphibians[d]				
3.0 mi	1.5 mi	0.6 mi	0.3 mi	0.1 mi
Width of corridor available for animals to cross[e]				
>1,000 ft	1,000 to 500 ft	<500 to 300 ft	<300 to 150 ft	<150 ft

[a] Adapted from Forman et al. 1997; Woodley 2000; Beazley et al. 2004. The arrow indicates a threshold value of 1.0 mi/mi^2. See the Appendix D, Table D-24 for additional supporting information.
[b] Adapted from Dickerson 1939; Dickson & Beier 2002; Forman et al. 2003; Jaarsma 2004 (see Appendix D, Table D-24).
[c] This is within the habitat and connectivity zones and is applicable at the mid-to-fine scales of assessment, planning and implementation (see Appendix D, Table D-21 for supporting literature citations and additional information.
[d] See Appendix D Tables D-9, D-10, D-16 and D-22 for supporting literature citations and additional information. Some numbers rounded for simplification. Radius is measured from the center of the habitat out to its edges.
[e] Synthesized from Appendix D, Table D-26: Corridor width and response metrics.

Road density (linear distance of roads per square mile of land) is perhaps the best overall indicator of the impact of roads on wildlife (Forman 1995, Forman et al. 1997, Noss and Cooperrider 1994, Noss et al. 1999, Dickson and Beier 2002, Beazley et al. 2004). Densities of roads greater than 1 mi/mi^2, and greater than or equal to 2.4 mi/mi^2 are expected to result in fewer mammal species (Forman et al. 1997, Woodley 2000, Beazley et al. 2004, Mammal Science Team pers. comm.). An exception may be locations with limited traffic such as forest road networks.

Higher road densities within concentric distances from wetlands up to at least 1.6 miles are correlated with lower amphibian species richness (Findlay and Houlahan 1997, Vos and Chardon 1998, Lehtinen et al. 1999, Carr and Fahrig 2001, Pellet et al. 2004).

Key questions

When assessing connectivity and road issues, we recommend asking the following questions:

1. Are there large blocks of undeveloped lands in natural vegetation? Are they separated from each other, or do riparian corridors and/or areas of sparse development provide connectivity?

2. If the landscape area is largely rural and largely in natural vegetation, is there very low density zoning (i.e., <1du/20 acres) that provides permeability across the landscape? The level of planning for connectivity increases and becomes more complex as the development densities and zoning densities increase.
3. Are there current or proposed road locations that are known for high levels of wildlife road mortality or wildlife-vehicle collisions?
4. Has a wildlife road mortality study been conducted at suspected problem areas and, if not, should one be conducted? Problem areas might be those with repeated collisions with large ungulates, but they might also be locations of sensitive species or near wetlands where seasonal migrations by pond-breeding amphibians between wetlands and uplands occur.
5. Do the roads cross wildlife corridors, and if so, are wildlife passages incorporated along the length of high-volume roads? Are the passages sufficient for the crossing of a variety of animals that are known to inhabit the areas (e.g. slow-moving amphibians and reptiles, mid-size mammals such as bobcat, and wide-ranging mammals such as elk)?
6. Where the road crosses areas of high quality or biologically rich habitat, does existing vegetation or topography aid in reducing traffic noise and light that might affect the wildlife and affect the movement corridors? Can the site be altered by planting vegetation or other means to protect the habitat from traffic noise and light, including the connected movement corridors?

Summary

In a developing landscape, planning decisions will benefit the species most sensitive to changes in habitat connectivity when they:

- Assess key wildlife corridors at different scales, for different locally-important species.
- Locate new development in existing areas with already poor connectivity.
- Pay special attention to planning for traffic routing to prevent increased traffic associated with new development from creating barrier roads in connected areas.
- Where traffic levels are not able to be maintained at low levels, install overpass or underpass culverts, and fences along the length of the road that guide species to these safer passages. These measures will make the road more permeable to species. Correct existing undersized culverts where possible to enhance wildlife mobility.

Chapter 5. Putting it Together: Assessing Wildlife and Habitat Across the Landscape

Overview

Washington's landscape once was covered with large areas of native vegetation, but now contains significant areas where the landscape has become converted into vegetated patches, some connected and some isolated. Many areas of trees, shrubs, grasslands, wetlands, and other types of undeveloped wildlife habitat have been replaced with buildings, yards, playfields, and farms. Roads have been built across the land, further disconnecting patches of habitat. Within floodplains, many dikes and levees restrict the natural tendency of flowing water to meander resulting in the loss of dynamic habitat types associated with floodplains.

These changes have resulted in landscape-level changes to habitat composition, configuration, and connectivity. At this landscape scale (e.g., a county or watershed), planners and decision-makers can consider broad land use patterns including resource lands managed for commodities (agricultural and timberlands), lands managed for different levels of human development, and lands set aside for conservation or recreation (parks, trails, greenbelts, riparian easement areas). At the site scale, planners can also assess habitat suitability in the context of these larger landscapes. Assessment at all three scales, county, watershed, and site, are discussed in this chapter.

Components of a County and Watershed Analysis: Determining Habitat Suitability

To plan for terrestrial wildlife at the county and watershed scales, the first step is to assess the relative suitability of the land to provide habitat.[1] One indicator is where animals currently reside or have resided in the recent past, with emphasis on areas known to harbor greater numbers of species or greater numbers of a single, imperiled or locally important species. Planners should also look at factors that affect the *potential* of the land to provide high-quality habitat. These include the type and pattern of cover vegetation and assessing how connectivity has been maintained or interrupted across the land. Several sources of information can be used to characterize the quality of habitat across the landscape. WDFW offers technical assistance to assist communities with this work, and has worked with several communities (some highlighted below) to provide data, maps, publications, and technical expertise to assist in this process. [2]

Animal presence – Priority Habitats and Species data

The Washington Department of Fish and Wildlife developed the Priority Habitats and Species (PHS) program in 1989 as a technical assistance tool to inform land use planning. Priority habitats are those with a unique or significant value. This value may be based on high density

[1] The focus of the habitat assessments described in this document is terrestrial wildlife.

[2] See the WDFW "Local Habitat Assessment" web page at http://wdfw.wa.gov/habitat/lha/index.html.

or diversity of fish and wildlife, important breeding habitat or seasonal ranges, or important movement corridors. A habitat may also be considered a priority habitat if it is of limited availability (i.e., rare), highly vulnerable to habitat alteration (e.g., wetlands), or if it supports unique or dependent species (e.g., talus slopes that support the Larch Mountain salamander, or shrub-steppe that supports the pygmy rabbit).

Priority species are those that WDFW has listed as endangered, threatened, or sensitive, and those that are candidates for listing. Also included are species that commonly congregate into large groups that are vulnerable to disturbance, such as great blue heron nesting colonies. PHS also documents vulnerable species of recreational, commercial, or tribal importance, such as the Roosevelt elk or Rocky Mountain mule deer.

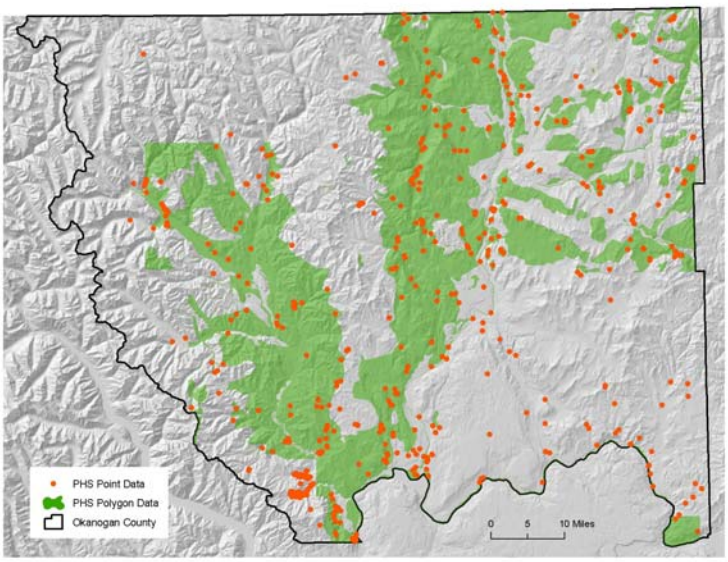


Figure 5.1 Priority Habitats and Species map of Okanogan County.

The process for obtaining PHS data can be found at the WDFW PHS website: http://wdfw.wa.gov/hab/phspage.htm. Figure 5.1 is an example of PHS data in Okanogan County, presented at a countywide scale.[3] The data is represented by "points" (known occurrences of species) and "polygons" (habitat areas).

Regional biodiversity – Ecoregional Assessments & Conservation Opportunity Framework

Ecoregional assessments (see Figure 5.2 example) are comprehensive, coarse-scale rankings of the relative importance of areas for supporting biodiversity over a very large area, typically consisting of several counties. For land use planning at the county scale, ecoregional assessments provide a regional context to the

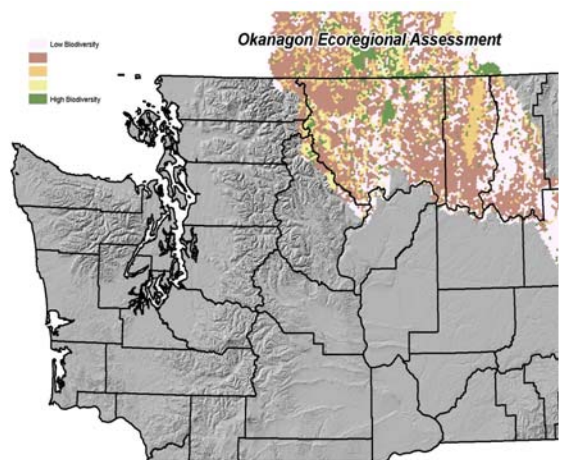


Figure 5.2 Okanagan Ecoregional Assessment biodiversity ranking.

[3] PHS data is updated periodically. WDFW recommends that counties and cities using PHS data for local planning purposes request updated GIS data at least every six months.

importance of certain areas for maintaining species and habitat types within a specific county's jurisdiction and across county lines. Descriptions of the nine ecoregional assessments in Washington State can be found on the Biodiversity Council website: http://www.biodiversity.wa.gov/ecoregions/index.html. These assessments have been used to develop a "Conservation Opportunity Framework" for Washington State, which is part of the state's Biodiversity Strategy, also found on the Council's website. This Framework is a useful tool to inform broad-scale planning activities and understand the relative importance of, and risk to, habitats that support diverse and unique species.

Local habitat quality – Land use/land cover data

The amount of native vegetation (often inversely related to the intensity of land use) in an area has a significant effect on the number of wildlife species that can be supported. Land use/land cover information, usually derived from satellite data, characterizes the kind and extent of vegetation and intensity of development.

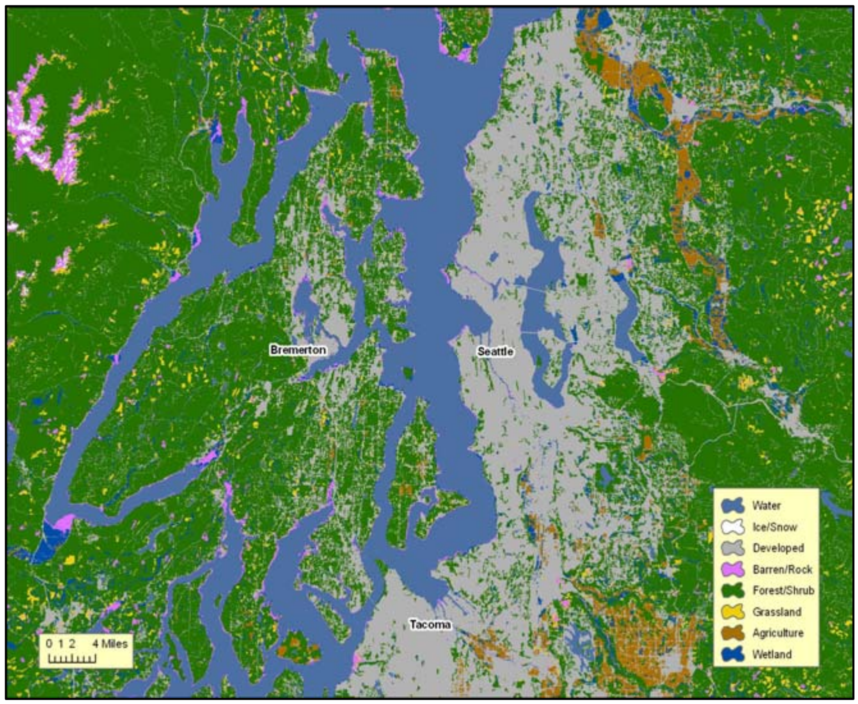


Figure 5.3 Land use/land cover in central Puget Sound.

Land use/land cover data are an indicator of habitat quality for the majority of wildlife species. The National Land Cover Database is available at http://www.epa.gov/mrlc/mlcd.html. Figure 5.3 shows an example of land use/land cover data for the central Puget Sound Region.

Putting Together a County-Scale Assessment

There are several ways to integrate data to provide guidance for addressing wildlife habitat in county-scale land use plans and decisions. Methods can be as simple as determining important areas for wildlife based on PHS, ecoregional assessment, land use/land cover maps, and road maps.

A more informative approach to planning for wildlife at the county scale is to apply scoring criteria to each of the underlying data sets, and then integrate this evaluation using GIS. This work will normally involve biologists, landscape ecologists, GIS experts, and others who can perform the more complex analysis needed. The Washington Department of Fish and Wildlife has applied this type of analysis in its broad-scale Local Habitat Assessment (LHA), and staff is available to provide technical assistance to this type of analysis.[4] LHA is a GIS-based process that integrates several terrestrial data sets (e.g., land cover, PHS, ecoregional assessments, roads) to identify areas that are particularly valuable to wildlife as well as areas that are less valuable. A detailed description of the LHA appears in Appendix E. A graphical example of the LHA method using Kitsap County is shown in Figures 5.4A-F.

[4] See WDFW's Local Habitat Assessment web site for more information, http://wdfw.wa.gov/habitat/lha/index.html.

The Ecoregional Assessment data is converted to provide a smoother transition between the assessment areas (Figures 5.4A, 5.4B).

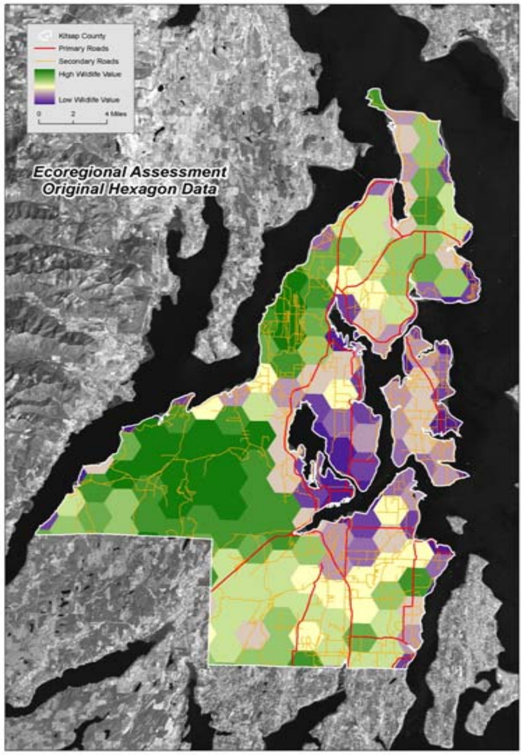


Figure 5.4A Ecoregional Assessment scoring for Kitsap County.

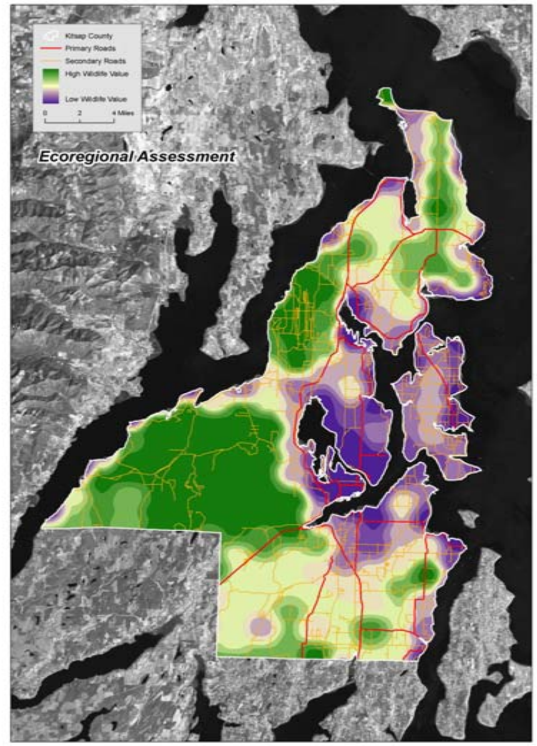


Figure 5.4B Smoothed ecoregional assessment layer for Kitsap County.

Land use/land cover data overlays are added, differentiating among natural vegetation, open areas/agriculture, and developed areas (Figure 5.4C), and road density information is added (Figure 5.4D).

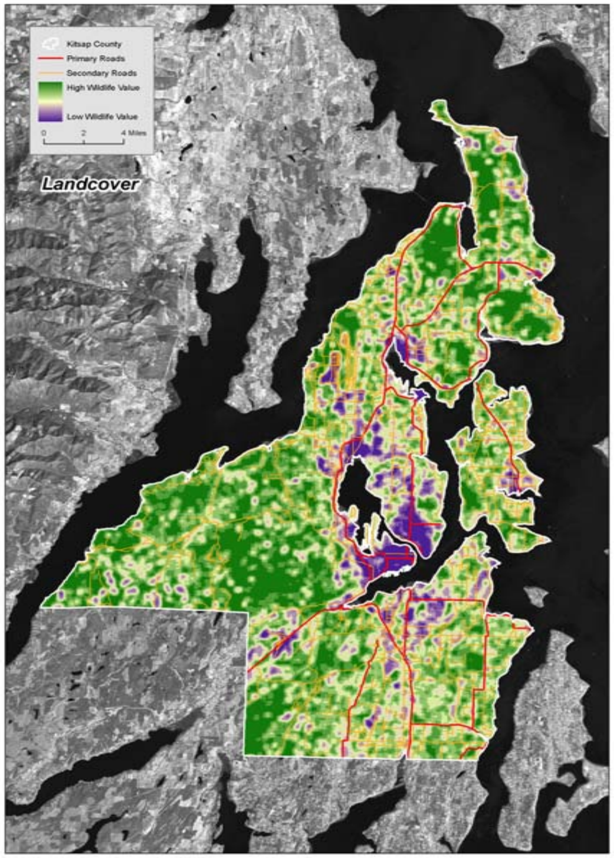


Figure 5.4C Land Use/Land Cover – dark green shows natural vegetation; yellow shows agriculture/pasture; purple shows developed areas.

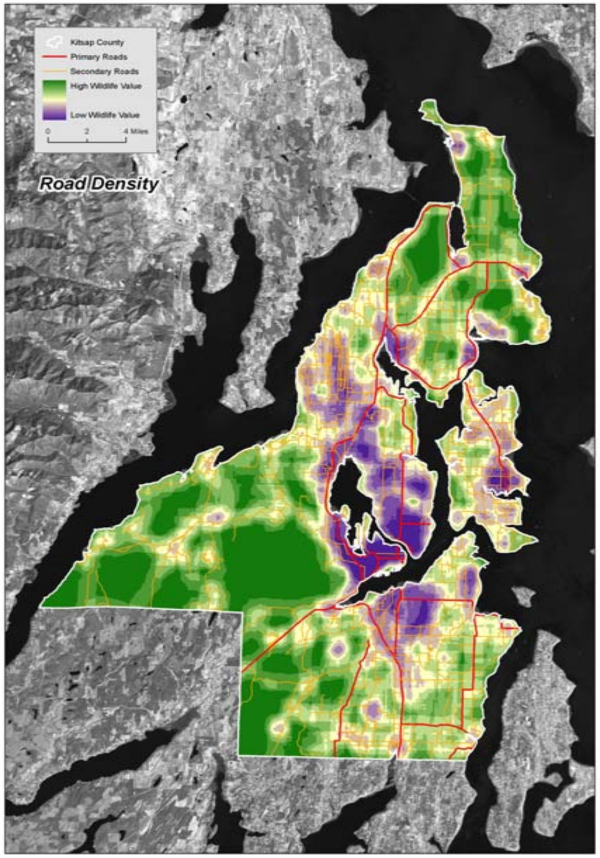


Figure 5.4D Road density layer for Kitsap County

Important biological areas defined by PHS and locally defined resource areas are added (Figure 5.4E). Combining the previous data layers in a GIS analysis provides a composite map (Figure 5.4F). Dark green represents the highest value habitat areas for wildlife, transitioning to purple as the least valuable habitat areas. Known sites of particularly valuable habitat are displayed in blue-green. The general pattern of habitat connectivity can be seen by inspecting this map to see whether the areas relatively valuable to wildlife are connected or isolated, as well as the degree to which isolation may have occurred.

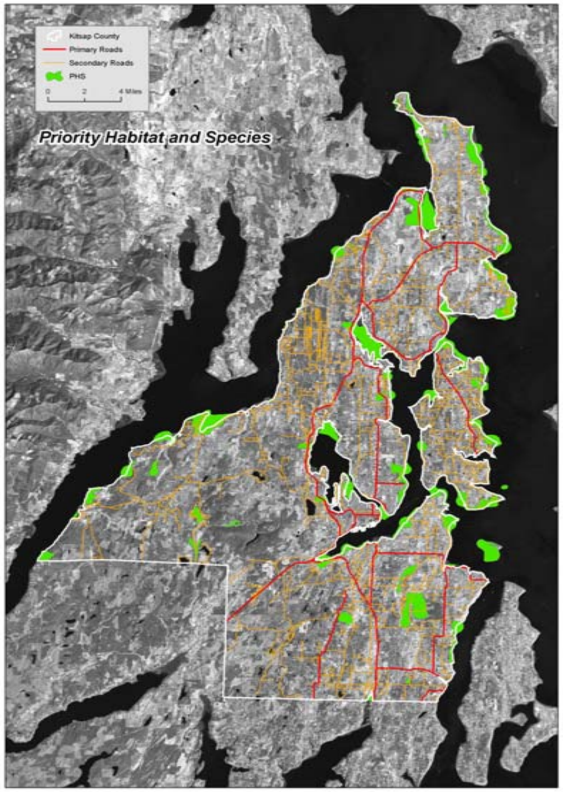


Figure 5.4E Important biological areas for Kitsap County – includes Priority Habitats and Species data.

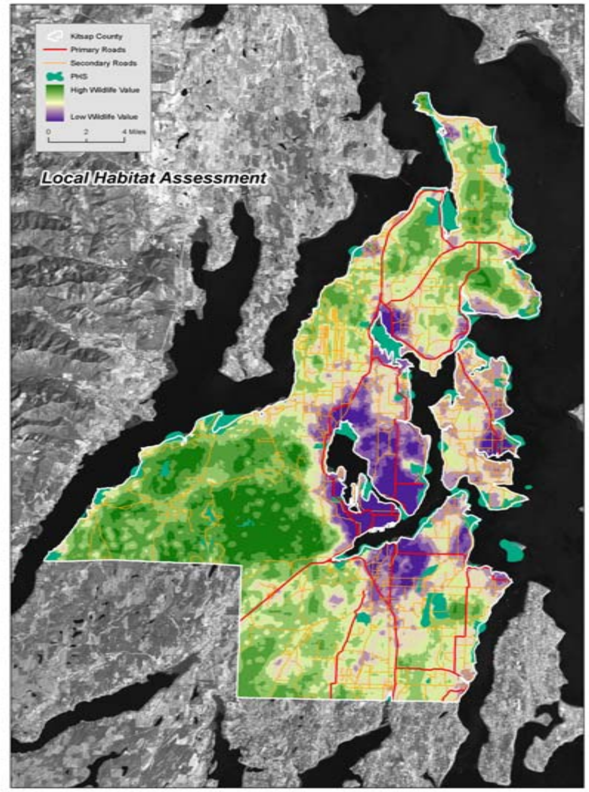


Figure 5.4F Local Habitat Assessment for Kitsap County. Dark green represents high value habitat; yellow shows agriculture/pasture; purple corresponds to developed areas.

Applying the county-scale analysis

The basic LHA map shown in Figure 5.4F can be used to inform a variety of land use planning decisions for wildlife at the county level that will be discussed in the next chapter, including:

- Designating rural and natural resource lands.
- Designating open space corridors or biodiversity networks.
- Evaluating comprehensive plan land use designations and rezones.
- Planning transportation networks, infrastructure and major capital facilities.
- Prioritizing acquisition and development of parks and open space.
- Identifying locally-important fish and wildlife habitat areas.
- Targeting incentive-based conservation programs, such as public benefit rating systems and transfer of development rights programs.
- Focusing conservation education and stewardship programs.

Planning for wildlife at the watershed scale starts with results from a county-wide analysis and then addresses the same issues but with more detailed information and more specific questions.

Watershed Scale Analysis

The basic principles in analyzing wildlife habitat at the county scale also apply at a watershed scale. At this finer scale of analysis, however, more detailed questions can be asked, such as:

- Stream riparian integrity: Do streams have intact riparian vegetation to protect water quality and to provide riparian habitat for wildlife? Where are priority areas for restoring riparian areas?
- Vegetation for mammals and birds: How fragmented are undeveloped areas, and where are the patches of vegetation located? What size are the remaining patches?
- Where are wetlands and how are they distributed across and beyond the planning area? What patterns of connectivity exist between wetlands, terrestrial habitat, and stream corridors used by species during their seasonal cycles?
- Roads as barriers to movement for animals: Is there a suitable number of crossing areas for mammals, and how are they distributed across the planning area? What are potential road concerns for mammals, amphibians and reptiles? Are there known or suspected high road mortality areas?
- Connectivity between patches: Is there connectivity between areas that will serve as conservation based lands over the long term? Where do corridors need to be maintained to ensure movement capability for mammals, amphibians, and reptiles?
- Zoning and dwelling unit densities: Are there incongruities with existing zoning and the needs of important species and/or Development Response Groups in the area?

These questions will typically be addressed by a GIS analyst working with a biologist and a local planner.

An example of watershed planning: Crescent Valley

WDFW assisted Pierce County with developing a stewardship plan for maintaining biodiversity within the Crescent Valley Biodiversity management Area. Agency staff worked with the County and property owners, who ultimately formed a long-term group referred to as the Crescent Valley Alliance. The Alliance has continued to acquire funding and to work on implementing actions. Details of this process are provided in Appendix F.

The Crescent Valley analysis focused on conserving mammals and birds while allowing for increased human development. The needs of birds and mammals were addressed by determining land cover types, and by determining the habitat composition, configuration, and connectivity across this landscape. The following steps defined the analysis:

1. Current digital land cover orthophotographs for the area were obtained.
2. Because the landscape was fairly fragmented, a GIS analyst digitized land cover patches on screen.
3. GIS analysis classified the patch sizes into three categories relevant to area sensitivities for selected bird and mammal species. These classifications were color coded to make the patch categories easily visible. Figure 5.5 shows the outcome of these steps.

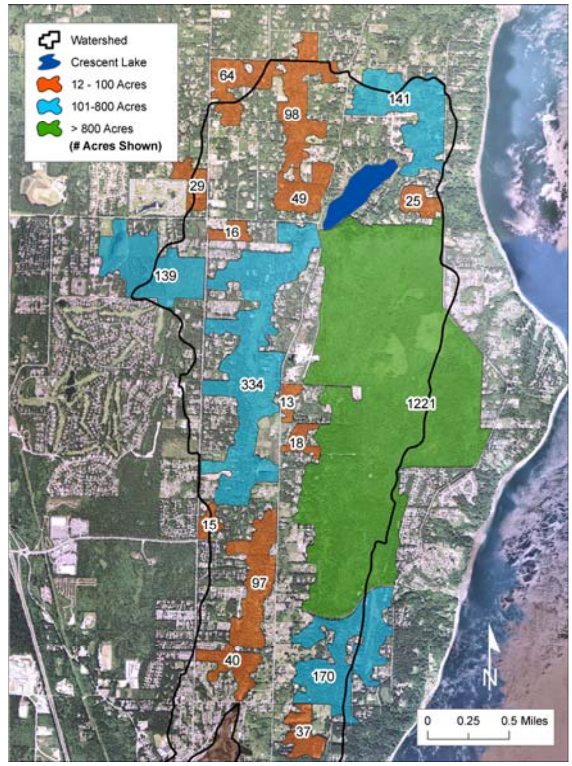


Figure 5.5 Natural vegetation patches 12-100 acres, 101-800 acres, and >800 acres that intersect or exist within the Crescent Creek watershed.

Recommendations based on the Crescent Valley analysis included:

Maintain patches for birds and mammals

- Birds: maintaining a variety of patch sizes (e.g., 12- 100 acres, and in particular >100 acres) throughout the watershed will benefit many bird species. Keep patches connected to other habitat areas to increase benefits to wildlife.
- Mammals: maintain a large core patch without development or roads, minimize fragmentation and habitat loss within this patch, connect the patch to the interior of the valley, and to external areas such as Puget Sound and the peninsula to the north. Encourage development along the east side of the patch, instead of the west side or internally.

Manage roads and traffic

- Use traffic softening methods (e.g., lower speed limits) to limit through traffic on the major road which runs through the heart of important wildlife habitat. Locate new development to minimize traffic in the interior areas of Crescent Creek watershed. Underpasses may be needed for amphibians. Maintain higher traffic volumes on roads further from wetland stream systems, and nearer the urban growth boundary.
- Minimize the building of new roads.
- Maintain or restore forest and natural habitat along roads. Pay special attention to connective linkages. Sign important areas where wildlife crosses roads.

Provide corridors and connective linkages

- Maintain linkages with ≥80% natural vegetation.
- Give special attention to road crossings in linkages: preserve forest/undeveloped habitat on both sides of road, route traffic away from linkages, sign for wildlife crossing, and lower speed limits.
- Throughout the rest of the habitat area, retain >50% natural vegetation (>80% is best).

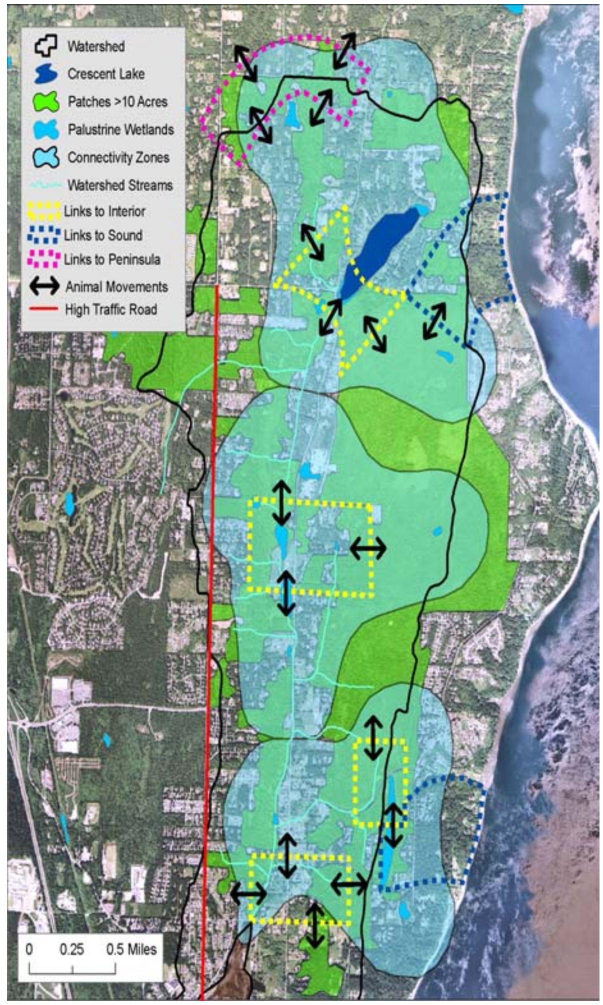


Figure 5.6 Overlay map from the Crescent Valley project indicates patches (green), amphibian and reptile connectivity and habitat zones (light blue), the Crescent Creek stream system, and a series of linkage areas to maintain connectivity between patches, and to external habitat areas.

Site-Scale Analysis

In addition to characterizing habitat quality at the county or watershed level, assessment at the level of a project site (a parcel or suite of parcels) is relevant because this is the scale at which many land use decisions are made (during the permit review process) and at which conservation measures can be required and implemented. Much of the remaining native habitat in urban areas is located on small parcels and private holdings. For cities in particular, a site-scale analysis tool can be useful to determining the wildlife value of smaller, remnant habitat patches. Site-specific analyses incorporate much of the information used in county- and watershed-scale analyses, but they are particular to an area as small as a residential parcel. Opportunity for habitat preservation and management exists at this scale through the permitting process. As Marzluff and Rodewald (2008) put it, "All urban areas have the potential to contribute to conservation of biodiversity."

City of Bellevue habitat assessment example

One model for site-scale habitat assessment analysis involves the use of scoring system. A "functional assessment form" (FAF) developed for use by the City of Bellevue, Washington considers first the relationship of the site to landscape level habitat functions, and then evaluates the quality of native habitats at the site (Tomassi 2009; see Appendix I). The FAF highlighted in this example was developed with the goal of assessing individual properties so that habitat could be given regulatory consideration during the permitting process. Four main steps occur in the habitat characterization process, followed by management and mitigation strategies (Table 5.1). First, the parcel or property being examined is classified by level of development and/or development potential. For a small jurisdiction such as a city, classification may be based on impervious surface or zoning, or some combination of the two. Whatever features are used should consider the present and potential future likelihood that development will impact the area. Percent impervious surface of the site itself is useful because in some jurisdictions this information is readily available, and it indicates the immediate potential of a site to provide habitat (e.g., a wholly impervious site will not likely ever support native vegetation), as impervious surface is rarely removed from a private parcel and replaced with native vegetation.

Table 5.1 Steps in a site-scale habitat assessment.

Step 1: Define property's habitat potential	The property is characterized based on some feature or features of a site or site's vicinity that act(s) as an indicator of the site's potential to provide habitat presently and in light of likely future conditions. Different "zones" can be applied through a set number of points or as multipliers of points earned in the following steps. Field testing may needed to determine the appropriate method of point allotment.
Step 2: What are the site's landscape-level habitat functions ?	As in Step 1, the property is characterized based on its potential to provide habitat presently and into the foreseeable future. Landscape level parameters are used, such as proximity to other habitats or critical areas. Again, different "zones" can be applied through a set number of points or as multipliers of points earned in the following steps. Field testing may needed to determine the appropriate method of point allotment.
Step 3 – What are the current habitats and future potential habitats at the site?	Measurements and observations are conducted on-site to address the site's present and potential future ability to support wildlife. These questions are also drawn from current literature and are specific to the jurisdiction or area.
Step 4 – Scoring	Points are awarded based on the scores from Steps 1 through 3. Higher-scoring sites are those that have both higher quality native habitats and make significant contribution to landscape conditions.
Step 5 – FAF results are used to drive permitting decisions, management recommendations, and mitigation	If site development is proposed, the FAF can be used to assure that specific site features that are important to habitat are preserved. For example, connectivity to critical areas or off-site habitat patches might be addressed by clustering development. Recommendations can be made for managing the remaining habitat. Mitigation for impacts can be planned on a site-specific basis, focusing on both landscape-level ecological processes that may be affected by action on the site and on-site habitat types and features. (See Chapter 7 for more information)

Habitat parameters measured on the FAF are habitat features and components that are important to one or more species during some point in their lifecycle. They are separated into landscape- and site-level. At the site level (Step 1), the presence of habitat and habitat features allows for wildlife to potentially use the site, or the ability of a site to provide habitat. However, a source of individual animals is needed for actual use to occur. The potential for a site to be used is best measured on a landscape scale (Step 2), as wildlife can be attracted to a site from the surrounding area if suitable conditions exist at the site and a source is present in the landscape. Consequently, the FAF uses landscape-level parameters (Step 3) and the same information sources that are employed on the county- and watershed-scales to determine the extent to which an area has the opportunity to function as habitat. Landscape-level scores are used to assess the magnitude of values of local-level measurements (Step 4). Step 5 of the analysis is its application to planning, making land use decisions, and implementing changes to the site, including development, habitat management and mitigation.

It is important to customize any functional assessment tool to the specific jurisdiction or land area. Features and parameters measured need to reflect local literature whenever possible. Field-testing and input from local experts are essential for revision. Landscape-level parameters assessed in the Bellevue model included amount of impervious surface, number of habitat types, proximity to critical areas, connectivity and size of habitat patches, and interspersion of habitat types. Site-level parameters used in the Bellevue model included the size and type of native trees, percent vegetative cover, foliage height diversity, species richness, proximity of water, snags, and other unique habitat features. These parameters are detailed in Appendix I.

Reporting standards

A site-scale habitat assessment would include a report detailing, at a minimum (and if not otherwise provided in the accompanying project application), the following:

- Property Information: parcel number or address; landowner contact information; actions proposed and permits pending; existing reports or surveys completed; existing development, including structures, utilities, impervious surface, and land use; description of existing natural conditions.
- Project description: proposed actions for the property, including demolition, construction, vegetation alteration, proposed increases or decreases in impervious surface, and planned uses. Explain any proposed deviation from building code, including why it is necessary.
- Habitat Assessment Information: completed FAF, if available; references and information sources consulted; evidence and documentation of wildlife use on the site; description of any critical areas on the site; survey or aerial photograph depicting locations and extents of habitat and habitat features presented in the FAF; site photographs; expected and possible impacts to habitat from proposed actions on the property; proposed mitigation measures (if any), performance standards, and contingency plans.

Management and mitigation

Management and mitigation implemented at the site would be associated with the with site and landscape conditions in mind. For example, if the FAF shows the nearest amphibian habitat to be more than a mile from the subject property, it would make little sense to manage habitat for amphibians. Conversely, if the site contains habitat connected to a wetland or stream, the processes supported by those critical areas could benefit from management or mitigation actions that enhance wetland or stream buffers. Management and mitigation goals on small-scale sites should therefore first consider the landscape, if appropriate, and goals should be determined. Actions taken on-site to meet conservation goals of the local jurisdiction should make ecological sense in the greater setting. Possible actions for a residential site can range from process-driven, landscape scale ("enhance habitat functions of off-site stream and maintain connectivity to the riparian zone") to species- and site-specific foci ("retain known red-tailed hawk perch tree and provide foraging habitat for wintering songbirds"). Site-specific management is further discussed in Chapter 7.

More to come: Evolving science, assessment and mapping resources

While the above examples describe real-world implementation of habitat assessments at various scales, this is an area of ongoing work amongst conservation groups, scientists, consultants, planners, and resource agencies. As of this writing, the Puget Sound Partnership has identified the need to complete watershed assessments for all of Puget Sound as part of a near-term action agenda to recover the sound.[5] The Washington State Department of Ecology offers watershed characterization tools focused on aquatic resources.[6] The Washington State Biodiversity Council is also developing its information to help support biodiversity mapping and planning throughout the state. The Council's web site provides links to numerous sources of data and information useful to habitat assessment at various scales, including data used in the local habitat assessments described in this chapter. Conservation groups including the Trust for Public Land, Conservation Northwest, and The Nature Conservancy, as well as local non-profit and citizens groups also work with local communities to develop habitat assessments for their areas. While this guidance document focuses on some of the tools available to plan for terrestrial wildlife needs, these other groups and agencies are also good resources for planners interested in working on habitat assessments that can inform a variety of planning decisions.

Summary

Planning for wildlife can help to ensure that future growth and development minimizes, to the greatest extent possible, further negative effects on remaining wildlife and its habitat features. In general, wildlife is best served by:

- Keeping large, connected patches of undeveloped native vegetation intact.
- Keeping zoning densities low within and immediately surrounding high-value habitat areas and encouraging maintenance of native vegetation.
- Managing road systems to minimize the number of new roads and new barriers to important animal movement corridors.
- Planning open space to incorporate high-value habitat and corridors for animal movement.
- Including a site-level habitat assessment to inform project conditions and management actions.
- Working with conservation groups and state agencies on collaborative habitat assessment projects tailored to local needs.

[5] For more information, visit the Puget Sound Partnership web site at http://www.psp.wa.gov/.
[6] See Ecology's web page on landscape planning at http://www.ecy.wa.gov/mitigation/landscapeplan.html.

These objectives for benefitting wildlife and biodiversity can be incorporated into the comprehensive plan and watershed plans, and they can provide the context for finer scale community and subdivision planning, which is discussed in the next chapter.

Chapter 6: Implementation through Comprehensive Plans, Development Regulations, and Incentive Programs

Overview

A goal of this chapter is to provide recommendations and examples for how wildlife needs can be included in local land use planning by planners, decision-makers, and citizens interested in planning for wildlife. By considering these recommendations, opportunities that allow development to take place in a manner that reduces the negative effects on wildlife or that enhances habitat for desirable native wildlife species can be discussed, evaluated, and made a part of the overall blueprint of local development.

Considering the needs of wildlife in context with other community development needs and property rights is an ongoing challenge for Washington planners and citizens as our landscape continues to develop. Nearly every land use decision will have an effect on wildlife. Sometimes wildlife is consciously included along with other priorities as the decisions are made. On the other hand, wildlife can be omitted from the planning process, often as an oversight, resulting in the needs of wildlife not being considered in land use decisions. Most of the more than 100 terrestrial species that are classified by the state as endangered, threatened, sensitive, or candidate on Washington's Species of Concern list are imperiled because wildlife needs have not been given the same level of attention as the many other planning issues facing local communities.

Creating planning policies for wildlife

A good place to start for cities and counties wanting to incorporate more wildlife needs into local planning is to create policies that guide the use of wildlife information in planning, zoning, regulatory, and non-regulatory decisions. Clear policies help remind elected officials, staff, and citizens of a community's priorities and expectations about addressing wildlife needs over time, as the community develops. Such policies can also enhance consistency between the planning decisions of cities and those of counties. Counties required to adopt countywide planning policies (CWPPs) under the Growth Management Act can include specific policies related to planning for fish and wildlife. For example, King County adopted the following CWPP regarding habitat connectivity:

> *Adjacent jurisdictions shall identify and protect habitat networks that are aligned at jurisdictional boundaries. Networks shall link large protected or significant blocks of habitat within and between jurisdictions to achieve a continuous County-wide network. These networks shall be mapped and displayed in comprehensive plans.*
>
> *King County Countywide Planning Policy, CA-7*

Additional suggested planning policies are included in Appendix G. Watershed-scale planning policies might be written to be more specific than countywide policies and be linked to a local watershed assessment (as described in Chapter 5). For example, a watershed planning policy might identify particular basins for conserving wildlife or suggest preferred types of wildlife-friendly development.

Comprehensive Planning: Creating a Landscape Blueprint for Wildlife

Cities and counties can incorporate wildlife and habitat assessment information into comprehensive plans, ranging from annual land use amendments to major, periodic reviews and updates required under the Growth Management Act (GMA; RCW 36.70A) and Shoreline Management Act (SMA; RCW 90.58). Communities not fully planning under the GMA and SMA are not subject to a particular update schedule for their comprehensive plans, but growth of the community and local interests may still necessitate such updates. All communities in Washington are required to designate natural resource lands as well as designate and protect critical areas and shorelines, all of which play a major role in wildlife habitat.

Designating natural resource lands

Natural landscapes include large wetland complexes and areas of undeveloped land and a variety of land cover types (forest, prairie, or shrub-steppe). Agricultural and forest lands designated as resource lands under GMA can also provide important wildlife habitat (e.g., act as winter feeding areas, wildlife movement corridors, and buffers from more intense residential development). WDFW recommends locating designated long-term forest and agricultural lands next to other large landowners (federal, state, private) whose lands are likely to remain undeveloped over the long term. By grouping relatively undeveloped parcels and "working" landscapes (i.e., farm and forest land), habitat value can increase for wildlife because this landscape more closely mimics a natural landscape. For example, working forests provide good wildlife habitat for numerous species, while also meeting social and economic needs for wood fiber. Many agricultural and forest lands provide opportunities for hunting game species and wildlife viewing, which are important parts of many local economies.[1] In resource lands where low density residential development is permitted (e.g., at 1 unit per 40 acres or lower), counties can encourage retention of forested areas and other natural habitats, and minimize clearing and new impervious surfaces.

Planning and zoning rural residential lands

An important factor for wildlife at the landscape scale is the determination of how and where to designate and develop rural residential lands - those areas in the middle of the undeveloped-to-urban gradient. Habitat for more than 100 wildlife species in Washington is adversely affected when rural residential dwelling density changes from 1 unit/20 acres to 1 unit/5 acres (based on the data in Appendix B).

Rural residential zoning can be coordinated with existing critical areas, shorelines, open space corridors and resource lands. Some communities have adopted special rural residential zoning

[1] For more details on the economic benefits of wildlife to Washington State, see the WDFW publication "Adding it Up" at http://wdfw.wa.gov/pubaffrs/adding_it_up.htm.

districts or overlay districts with low densities and special development requirements such as clustering or low impact development to better integrate wildlife and residential development. For example, Spokane County created a special "Rural Conservation" zoning district that encompasses many critical areas as well as important wildlife areas identified in a local biodiversity assessment (Westerlund 1998). This rural conservation district encourages low-impact uses, cluster development, and other open space techniques to protect sensitive areas. Pierce County has adopted special zoning for sensitive areas, including a "Residential Resource" zone, "Rural Sensitive Resource" zone, and "Urban Sensitive Resource Overlay." These zones apply various techniques such as reduced densities, Low Impact Development and native vegetation retention.

Planning for cities and urban growth areas

Habitat loss and fragmentation, stormwater pollution, noise and light impacts, road mortality, and invasive plants from yards and gardens combine to eliminate some species from urban and suburban neighborhoods. However, protecting habitat patches and connected corridors of undeveloped land through urban areas can help many species that are locally important to urban communities. Maintaining habitat in urban areas benefits wildlife and provides residents the opportunity to interact with nature on a daily basis.

Taking a conservative approach in planning for urban area expansion reduces impacts on wildlife habitat. Only six Washington counties are currently required under the Growth Management Act to conduct a "buildable lands" analysis to ensure adequate capacity to meet population growth targets (RCW 36.70A.215). But many jurisdictions may find it helpful to use land capacity analyses in long-range planning to determine how much more land might be needed to accommodate new population growth. The Department of Commerce's Growth Management Services Office may have resources to assist with conducting a local land capacity analysis, which can help ensure a thorough evaluation of urban growth area expansion needs.

Wildlife species and habitats can then be considered when making choices about where to locate urban growth area expansions. As described in Chapter 5, wildlife habitat assessment can help identify areas just beyond current urban growth areas that already contain fragmented habitats or barriers to habitat connectivity, and these areas might be the best choices for future urban growth. Appendix H illustrates how Kitsap County considered these factors in its urban growth area expansion choices for Silverdale.

Habitat corridors and biodiversity networks

Creating a network of habitat patches and connected corridors within and between urban and rural areas can benefit wildlife in developing landscapes. Networks have been recognized as the fundamental framework for the survival and movement of populations (Jongman and Pungetti 2004). Open space corridor plans, trail plans, and parks plans can all be knitted together to form a "green infrastructure" of linked open spaces that are beneficial to wildlife. The GMA recognizes the importance of these open spaces in one of its thirteen planning goals:

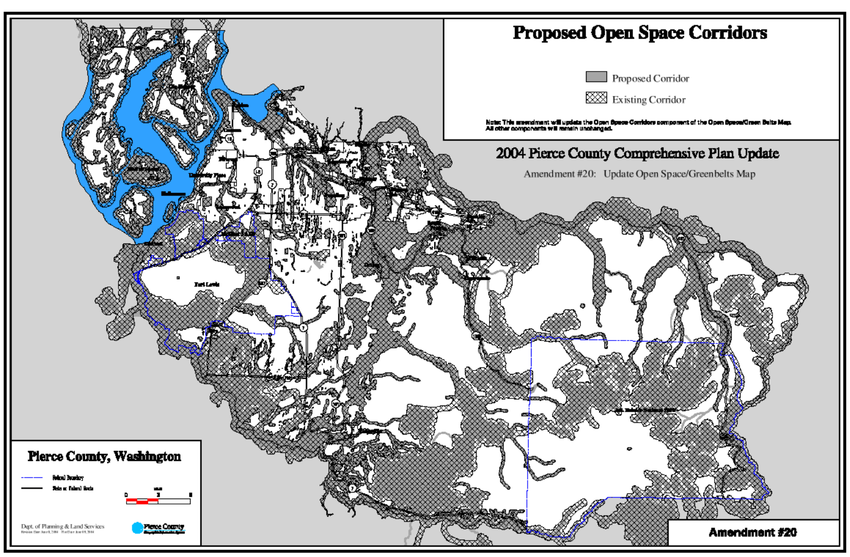
Open space and recreation. Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities. RCW 36.70A.020(9)

The public benefits of integrating open space and corridor planning include increased opportunity for positive human-wildlife interactions, better management of stormwater, and more certainty for developers and landowners about where habitats will be protected over the long term. The goal of open space corridors may be habitat protection alone or a combination of recreational access and habitat protection. Areas rich in species diversity may be planned for lower density residential development or open space, and they may be considered for special development standards such as low impact development.

Pierce County Biodiversity Network

Pierce County took a comprehensive look at open space planning by working with WDFW and the University of Washington to create a map of open space lands with the greatest biological diversity. This "Biodiversity Network" identified 16 biologically rich areas and connecting corridors that cover over 260,000 acres of land. The County used this basic information to conduct a finer scale assessment, published in a report titled "Pierce County Biodiversity Network Assessment, August 2004." Implementation of this work continues, and emphasizes protection of multiple species. To date, an Open Space Corridors map has been incorporated into the county comprehensive plan, and is used to guide decisions about zoning and development densities, as well as other development standards such as low impact development techniques. The map is also used in various county incentive programs such as the Conservation Futures program and Current Use Assessment program. For more information, see http://www.piercecountywa.gov/pc/services/home/property/pals/other/biodiversity.htm.

Figure 6.1 The Pierce County Biodiversity Network map.



Mapping the open space network

Communities may find that developing a map of open spaces, corridors, and potential acquisition areas can result in more streamlined permitting, inclusive decision-making and peace of mind for residents who value their local open spaces. Such maps are useful for planning when they are backed by a scientific methodology that evaluates habitat valuable for local species. The Pierce County Biodiversity Network is a good example of such an approach (see box). A well-developed open space plan and map can be coordinated with related planning decisions such as shoreline and critical area designation and protection, residential density amendments, and transportation planning. For example, Spokane County's draft regional trail plan links up a wide variety of urban, rural, and habitat corridors under an overall trail strategy to meet multiple planning goals. It includes a policy to "Ensure the preservation of ecological function when incorporating trails into greenways, wetlands or wildlife corridors." (Policy 3.4, Spokane County Regional Trails Plan, 2008 draft)

Planning a corridor

Retaining natural vegetation corridors will facilitate the movement of animals through fragmented habitat. Corridor locations can take into account these questions:

1. In light of potential future development, are some areas better than others for a permanent wildlife corridor?
2. What is the most beneficial route for the species of local concern?
3. Are there other important habitat features that will be maintained in a relatively undeveloped state, and can be linked in (e.g., wetland complexes, protected habitat patches)?
4. Where are the roads, and which roads have the least traffic and thus safer crossing conditions?
5. What provisions can be included in local development regulations and incentive programs to best help retain the greatest amount of natural vegetation in the corridor?

Figure 6.1 Dosewallips elk herd moving through summer habitat.

We recommend linking these landscape features through a corridor plan:

1. Aquatic features such as streams, wetlands, lakes, marine shorelines and the associated riparian areas. Inventories developed for the local shoreline master

program are a good source of information.
2. Ridgelines.
3. Large undeveloped habitat patches and open space areas, including those in public ownership.
4. Locations of WDFW's priority habitats and species. Locations likely used by elk and mule deer can also be found in WDFW's game management plans that show concentration areas (Figure 6.1). PHS maps also indicate locations used by large ungulates. For forest-dependent large carnivores, Singleton et al. (2002) have provided maps most useful at the county scale (see Literature Cited chapter for full reference).

Proper corridor widths will depend on the species or suite of species being targeted. Widths of >1,000 ft provide the most benefits for the most species, while narrower widths are important but for fewer numbers of species. Maintaining low dwelling unit densities adjacent to corridors can increase the effective width for wildlife. In some cases, areas of low dwelling unit density and a high percent (e.g., ≥80%) of natural habitat can act as an effective corridor.

Transportation, power and utility planning

The long, linear patterns of transportation and utility corridors have unique influences on wildlife. Roads can be a major barrier to animal movement and cause wildlife mortality. Utility corridors can sometimes facilitate animal movement, but they can also adversely affect habitat (Jackson 2000). Power lines and infrastructure can also directly impact species (bird and bat strikes) and avoidance behaviors (for example, sage-grouse avoid areas under power lines).

Transportation and utility infrastructure routes can be coordinated with the major travel routes of large mammals such as elk and deer in order to minimize or avoid major disruptions to important landscape linkages. Coordinating the transportation plan, including bicycle and pedestrian elements, with utility planning and trails and open space corridor plans may help prevent locating roadways and utilities that act as barriers to wildlife. In addition, this type of planning can avoid impacts from high-use trails, access points, and other recreational elements on highly sensitive habitat areas. Under the GMA, cities and counties can use capital facilities plans and concurrency planning to ensure efficiency in transportation and utility networks and avoid building or widening facilities speculatively.

Roadkill and safety issues

Higher densities of roads act to separate habitat patches and disrupt the movement of animals. Planners can minimize these effects by identifying places where high road density will conflict with high habitat values, or by developing policies to keep road densities below a certain threshold in some planning areas or watersheds. Wildlife underpasses and overpasses can be used to provide safe passage for wildlife across roads, and fencing or other barriers can be used to keep animals from entering a road at a location where they are likely to be hit by vehicles (Clevenger et al. 2003, Beazley et al. 2004). Wildlife passages have become a standard feature in Europe and Australia, and they are used in the U.S. as well (Forman et al. 2003). Several wildlife overpasses have been built for medium and large mammals in North America (Forman & Alexander 1998). These structures are generally combined with fencing and vegetation to enhance animal crossing. Washington State is currently planning wildlife crossing corridors on I-90 to help provide connectivity for animal populations in the north and south Cascades (Figure 6.2 is an artist's rendition of an I-90 overpass structure). In 2007, the Washington Department of Transportation (WSDOT) issued a policy that requires the Department to "assure that road and highway programs recognize, together with other needs, the importance of protecting ecosystem health, the viability of aquatic and terrestrial wildlife species, and the preservation of biodiversity" (WSDOT Secretary's Executive Order 1031). Implementation of this policy includes restoring habitat connectivity when building road projects. WSDOT plans to retrofit a portion of I-90 between Hyak and Keechelus Dam to build wildlife overpass and underpass structures, providing safe passage for elk and other wildlife and improve public safety.

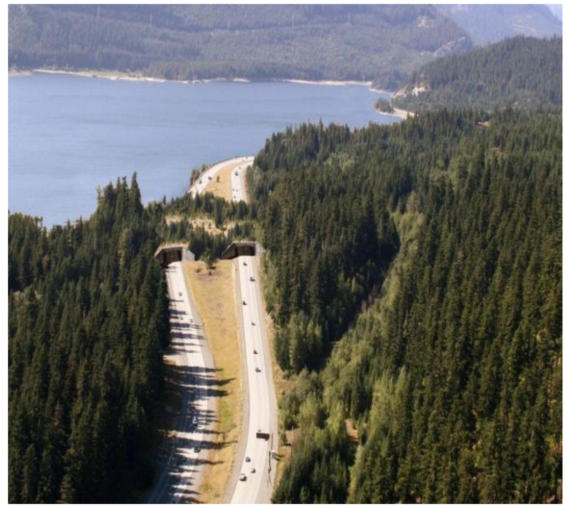


Figure 6.2 Artist's rendition of I-90 wildlife overpass structure.

At a finer scale, wildlife underpass culverts (below-road structures) can be installed approximately every 500 to 1,000 ft along busy roads. These culverts allow wildlife to safely pass underneath the road. Providing underpasses of various sizes is a good means of accommodating many wildlife species (Forman et al. 2003). A local wildlife inventory can determine which species would typically cross at a particular location.[1] Some animals prefer underpasses that are long and low in clearance; others prefer culverts with high clearance (Forman et al. 2003). Short sections of fence (e.g., 330-feet long) can be erected near passage openings to funnel wildlife into the passage (Cain et al. 2003). It is best to retain preferred habitat adjacent to the road near the passage opening. Another option is to erect V-shaped fence ends leading to a wildlife passage so that animals exiting the passage are directed back and away from the road (Clevenger et al. 2003). In Australia, this technique is termed "fence and funnel." Fencing is installed to prevent animals from accessing the road, with the only gaps in the fence system at locations where animals are either funneled to overhead or underground structures. Earth berms, vegetation, and concrete barriers are also proven means of leading animals to below-road passage entrances and to prevent them from traveling on the road (Bekker et al. 1995, Dodd et al. 2004). Locations where crossing techniques are implemented provide opportunities for education (e.g., signs) regarding wildlife crossings.

[1] An example of a wildlife inventory is the "Bioblitz" process supported by the University of Washington's Naturemapping program, http://depts.washington.edu/natmap/bioblitz/. Through this process, local citizens working with scientists can quickly (over 24 hours) inventory the species in their community for purposes of conservation planning.

Utility planning and siting

Within comprehensive plans, planners may be able to incorporate wildlife corridors while planning for utility corridors. Although utility corridors are not usually ideal habitat, they might be used by wildlife to travel between isolated patches of suitable habitat. In addition, local governments can encourage private utilities to adopt vegetation management schemes that add value to utility corridors for wildlife.

Wind power is an emerging technology in Washington. Wind power sites, usually located along ridgelines, can cause temporary (digging of foundations for wind towers, laying of power lines) and permanent (access roads, substations, footprint of the turbines) impacts on wildlife habitat. Wind farms have the potential to increase avian deaths, particularly raptors. WDFW has developed wind power siting guidelines to minimize impacts on birds and other wildlife. WDFW encourages local governments to consult these guidelines early in the planning process and incorporate the recommendations to the greatest possible extent.

Development Regulations

Development regulations can be written to create science-based minimum standards and thresholds to protect habitat and species, and regulations can also be written with flexibility to respond to site-specific circumstances important for wildlife. One of the greatest challenges in addressing wildlife at the subdivision scale is the balance between uniform standards and site-specific flexibility. This section provides an overview of the important development regulations that are used at the subdivision scale to address wildlife.

Habitat and species protection under Critical Areas Ordinances (CAOs) and Shoreline Master Programs (SMPs)

The Growth Management Act (GMA) and Shoreline Management Act (SMA) both require all Washington cities and counties to develop regulations to protect important habitat areas. Under the GMA, this means designating Fish and Wildlife Habitat Conservation Areas, including habitats and species of local importance, in a critical areas ordinance. Under the SMA, habitat functions may be assessed as part of a shoreline inventory to determine appropriate environment designations and shoreline development standards for the shoreline master program (SMP). Meeting these requirements can be easier if a thorough assessment of wildlife

> ***Drafting critical areas ordinances and shoreline master programs can be made easier if a thorough assessment of wildlife across the landscape has been completed through the comprehensive planning process.***

across the landscape has already been completed in the comprehensive planning process. CAOs and SMPs contain the primary regulations that implement habitat protection at the subdivision and site development scale.[1]

WDFW encourages the use of our PHS List in designating and protecting habitats under CAOs and SMPs. The Department's Management Recommendations for Washington's Priority Habitats and Species outlines detailed approaches to mitigating impacts to various species and habitats on the PHS List. These approaches may either be referenced in local ordinances or incorporated into project conditions.

Some communities choose alternative regulatory schemes that tailor buffers and other regulations to specific habitat functions. The city of Shelton updated its critical areas ordinance in 2006 with riparian area buffers that were based on a detailed study of the riparian functions, habitat condition, and level of development along specific reaches of each stream. The city of Mount Vernon provides the option of applicants to achieve compliance with riparian buffer regulations through a combination of on-site restoration and off-site mitigation for some development projects. Such flexible, science-based regulations can be effective and help respond to landowners frustrated with one-size-fits-all buffers. We recommend that such tailoring include monitoring, enforcement, and the flexibility to adapt over time to changing conditions. Approaches tailored to specific habitat functions work best when skilled staff is available to help implement them on the ground. When this is not possible, we recommend that habitat areas be assigned more conservative, standard buffers based on an area's functions and values. If site-specific flexibility is desired within these uniform standards, then habitat management planning done by a "qualified professional" (usually defined by local ordinance) can ensure that buffer adjustments are consistent with best available science (see Chapter 7 for a more detailed discussion of habitat management planning).

The regulatory framework for fish and wildlife

Critical areas ordinances and shoreline master programs work best for wildlife when coordinated with other development regulations (and incentive programs) operating at the site scale. Table 6.1 provides a list of regulations and the role they can play in implementing conservation-oriented planning for wildlife.

[1] This section focuses on residential development. It should be noted that at the time of this writing, new critical areas regulations cannot be adopted for agricultural lands and activities due to a deferral adopted by state legislation (SB 5248). See RCW 36.70A.550. A stakeholder process is underway to address agriculture and critical areas protection issues. Those issues are outside the scope of this document.

Table 6.1 The regulatory framework for residential development and wildlife.[1]

Ordinance /regulations	Key elements that affect wildlife	Works best for wildlife when…
Zoning code	Defines the densities and uses allowed in each zoning district.	• Densities are assigned with consideration to habitat and species within the district. • Overlay districts reflect planned greenways, open space corridors, and other biodiversity plans. • Intent/purpose statements are consistent with planning policies and comprehensive plans that reflect a commitment to incorporate wildlife considerations into the planning process. • Conditional and special uses are limited in areas with high wildlife diversity. • Flexible density and lot configuration is allowed to protect habitat areas.
Critical areas ordinance	Defines fish and wildlife habitat conservation areas, and specifies protection measures. The Department of Commerce, Growth Management Services office publishes guidance regarding "best available science" and sample ordinances for critical areas.	• All development activities (including clearing and grading) that alter the landscape trigger an initial assessment of wildlife and habitat on or near the site. This assessment can be done in the planning office if a complete and recent wildlife inventory has been done, and it should include a field visit by qualified staff if wildlife resources might be affected. • Variances and exemptions are limited to areas of low wildlife and habitat value, and include mitigation. • Project mitigation options are specific to habitat requirement of local species. • Project conditions are informed by information about migratory corridors and PHS management recommendations. • Buffers are tailored to protect specific habitat areas and functions, as supported by best available science.

[1] Chapter 7 provides more detail and examples of how these regulations can be implemented at the subdivision and site scale.

Ordinance /regulations	Key elements that affect wildlife	Works best for wildlife when…
		• Redevelopment/expansion of nonconforming uses and structures includes habitat enhancement or restoration. • The Priority Habitats and Species (PHS) List and management recommendations maintained by WDFW is referenced or incorporated. • Includes WDFW consultation for habitat management plan review. • The local permit includes provisions for ongoing monitoring and adaptive management if sensitive species are on or near the site.
Shoreline master program (use and modification standards)	Governs fish and wildlife habitat protection at the nearshore and shoreline. Regulates land use and modification based on shoreline environment designation. Requires vegetation conservation planning in shoreline development. Includes restoration planning.	• Standards are as protective for wildlife as in the CAO. • Shoreline environment designations consider habitat composition and connectivity between upland and nearshore areas. • Restoration plans reflect the need for habitat connectivity. • The site review process includes mitigation sequencing to ensure that least impacting alternatives are used for shoreline modifications.
Subdivision code	Regulates lot sizes, configuration, property line setbacks, and other elements of site design that play a role in how wildlife may be affected.	• Flexible subdivision design is allowed, such as cluster development or conservation subdivisions. • Flexibility in lot size and configuration is encouraged, including on-site density transfers to accommodate habitat patches and corridors. • Requires management plans for open space tracts. • Triggers a review process for a majority of rural subdivisions (e.g., does not exempt large lot segregations from review).
Clearing and grading ordinance	Regulates pre-development site preparation and level of habitat disturbance.	• Clearing and grading permits require an assessment of how to preserve important habitat patches and connectivity and minimize vegetation disturbance, consistent with the critical areas ordinance.

Ordinance /regulations	Key elements that affect wildlife	Works best for wildlife when…
Stormwater regulations	Govern the treatment and disposal of stormwater generated by impervious surfaces, which can be a source of pollution for aquatic species.	• Low Impact Development standards are incorporated to encourage limited impervious surfaces, retention of vegetation, and retention of natural soils and topography in site design.
Landscaping, tree and vegetation preservation ordinances	Protect significant trees or stands of trees and vegetation on individual lots. May require tree tracts to be managed for wildlife. Define planting and maintenance plans.	• Permits are required for tree removal, including "danger trees," and include options other than complete removal, such as leaving felled trees in place or topping them to create snags. • Vegetation management plans include use of native species used by local wildlife.
Road standards	Regulate the placement, width, length, and access of roads and other circulation infrastructure.	• Require use of pervious paving materials in basins with high aquatic species diversity or salmon-bearing streams. • Require an assessment of traffic impacts to wildlife as part of traffic impact analysis for major subdivisions. • Allow flexible road design in rural areas.
Building code	Governs the materials and systems used in building.	• Includes "green building" requirements for areas of high fish and wildlife diversity (can reduce water use and release of toxins from building materials).[1]
Floodplain management/flood hazard ordinance	Defines local flood hazard areas, special building requirements and restrictions.	• Integrates with critical areas regulations for frequently flooded areas. • New development is kept out of the floodway and 100-year floodplain.
Enabling ordinances for PDR or TDR programs, open space tax programs, use of conservation futures funds, or other incentive programs	Define sending and receiving areas (TDR) or other priority habitat areas. Create the legal framework for purchasing development rights, and define uses allowed on lands subject to purchase.	• Programs prioritize habitat areas based on size, function, and connectivity. • The programs are consistent with priorities of open space corridor and biodiversity plans.

[1] The International Code Council, which publishes the building codes adopted by local governments in Washington, has information on green building (http://www.iccsafe.org/). The US Green Building Council also provides resources and information about green building, http://www.usgbc.org/.

Incentive-based, Non-regulatory Programs

Voluntary and incentive-based conservation programs can be effective implementation tools when coupled with a commitment to follow planning policies, procedures, and ordinances. WDFW encourages the use of these programs whenever possible as an integral part of the local planning process. Some of the programs frequently used for wildlife and biodiversity are noted here, but other federal, state, and local programs can be promoted through local planning offices to encourage voluntary habitat protection by landowners. The Washington Biodiversity Council maintains an inclusive list of stewardship and conservation incentive programs, with information on how successful these efforts are in our state.

Open Space Tax Act and Public Benefit Rating Systems

A program of assessing land value based on its current use was enabled by the Open Space Tax Act of 1970 (RCW 84.34), and it is administered by county long-range planning departments or assessors' offices. This "current use" taxation program has potential benefit to benefit wildlife habitat, but is currently underutilized.[1] The program allows owners of land useful for conservation, recreation, agriculture, and forestry to receive a property tax reduction in exchange for voluntarily setting their property aside from development. Lands are enrolled in an open space land use classification, with a conservation or management plan which can result in lower property taxes. There are incentives to keep landowners enrolled in the open space program.

Counties may adopt a "public benefit rating system" (PBRS) to score properties eligible for this reduced property assessment. PBRS allows the jurisdiction to strategically direct the tax incentives toward key conservation properties. Points may be given for various criteria such as the size of the property, the quality of the wildlife habitat (e.g., a property with a threatened species might receive extra points), or whether the property has permanent conservation easements with, for example, a local land trust. Counties using PBRS may tailor the ranking process to provide higher tax breaks for landowners when their land contains "High Priority Resources" as defined by the county. A landscape-scale wildlife/habitat assessment as described in Chapter 5 can inform these decisions. Using the system, counties may also choose to rank and purchase high priority conservation or recreation lands from willing landowners using "Conservation Futures" funds that are collected by counties through a property tax levy enabled by the Open Space Tax Act. While PBRS systems are an efficient way of determining priorities for including properties in the open space taxation program, counties that have not adopted such a system can still include properties that provide important wildlife habitat in the program. This provides an incentive for maintaining valuable wildlife habitats.

[1] As of 2005, participation in this program was low, with only 15 of Washington's 39 counties implementing public benefit ratings systems. Source: Washington Biodiversity Council.

Purchase and Transfer of Development Rights

Development rights programs are effective tools for wildlife habitat protection and are encouraged under the GMA and other planning laws. Resources helpful to design and implement a Purchase of Development Rights (PDR) or Transfer of Development Rights (TDR) programs can be found at the Washington Biodiversity Council web site.

"Conservation futures" is a property tax levy that local governments may use to fund development right and property acquisitions if recreational, conservation, and agricultural properties.

To be beneficial for wildlife, areas targeted for development rights purchases or transfers can include areas of high quality habitat and species diversity that are vulnerable to development. The City of Redmond's TDR program includes fish and wildlife habitats as sending areas and has completed transfers of rights from those lands.

TDR programs have had mixed success throughout the state. Most programs currently target agricultural lands, but WDFW encourages local jurisdictions to also base these programs on wildlife considerations. Several counties have TDR programs in place, but they have had relatively low participation rates and few successful transfers. Barriers to success include lack of resources for outreach and administration, lack of interest by landowners, and perhaps most importantly, lack of a well-developed market for the transferred rights (Aken et al. 2008). Still, TDR holds the promise of a market-based, voluntary approach for willing landowners who want to permanently retire development potential on their land. As they are expanded and improved, opportunities to use broad-scale planning efforts like WDFW's Local Habitat Assessment can be built into TDR programs. In 2007 and in 2009, the

Purchased Development Rights in Nisqually Valley

In the mid-1990s, Thurston County identified the lower Nisqually Valley along the border with fast-growing Pierce County as a priority area for protection from development. The lower valley is a rich agricultural area along the Nisqually River, and includes a national wildlife refuge at its estuary and a national park at its headwaters. Faced with increasing development pressures from central Puget Sound, local planners developed an aggressive program to protect the valley's sensitive riparian area and farmland. The County borrowed against its Conservation Futures levy fund to purchase development rights on over 900 acres in the valley. Willing owners of lands zoned for low density development were awarded "extra" development rights credits that were then purchased by the county in exchange for permanent easements placed on the property that allow continued farming but no additional subdivision or residential development. Fish and wildlife downstream in the refuge, along the river, and throughout the valley have benefited from this effort.

Washington State Legislature passed legislation to further encourage the use of TDR in the state.

Cost-share and stewardship programs for forest lands

Forest landowners have access to two important incentive programs that provide financial and technical assistance to manage lands for the benefit of fish and wildlife. The Family Forest Fish Passage Program is a cost-share program administered by WDFW, the Washington Department of Natural Resources, and the Salmon Recovery Funding Board. It provides 75-100% of the cost of repairing, replacing, or removing fish barriers such as culverts, dams, weirs, spillways, or other artificial structures in the stream that block fish from moving to upstream habitat. The program also helps forest landowners meet state requirements to fix fish migration barriers before harvesting timber. Projects are prioritized for funding based on their benefits for native fish species, the quality and quantity of upstream habitat opened, and the presence or absence of additional upstream or downstream barriers. The Washington Department of Natural Resources also provides assistance for forest management through its Forest Stewardship Plan program, which can help small forest landowners qualify for tax and incentive programs. Planners can provide information about these programs to forest landowners in their communities as part of an overall incentive-based approach to fish and wildlife conservation.

Farm and Ranch Lands Protection Program

This program provides funds to help purchase development rights to keep productive farm and ranchland in agricultural uses. To qualify, farmland must be part of a pending offer from a farmland protection program, be privately owned, have a conservation plan for highly erodible land and be able to sustain agricultural production (large enough, access to markets, adequate infrastructure, supports surrounding land in long-term agricultural production). The U.S. Department of Agriculture (USDA), through the Natural Resources Conservation Service, partners with state, tribal, or local governments and others to acquire conservation easements. Landowners agree not to convert the property to non-agricultural uses. USDA provides up to 50% of the fair market easement value. More information on the program may be found at: www.nrcs.usda.gov/programs/frpp/

Grassland Reserve Program

This voluntary program helps landowners protect, restore, and enhance grassland, rangeland, pastureland, and shrub land on their property. The program focuses on maintaining grazing on the land, conserving lands vulnerable to conversion to other uses, and protects plant and animal biodiversity. Landowners can have easements or rental agreements. The minimum enrollment is usually 40 contiguous acres. Landowners follow a conservation plan, developed by the Natural Resources Conservation Service (NRCS) or a third party, to limit their use of their lands through conservation easements (30 years or permanent) or rental agreements (10-30 years). Grazing, mowing, and fire (rehabilitation, breaks, fences) are allowed. Practices that involve breaking the soil surface are not allowed unless approved as part of the conservation plan. If restoration is needed, the program covers 75-90% of the cost. The program covers all administrative costs for establishing easements. The Commodity Credit Corporation generally holds the easements, but another entity (state, land trust) can request to fill this role. For more information, go to the website: www.nrcs.usda.gov/programs/GRP/.

Wetlands Reserve Program

The purpose of this program is to offer landowners an opportunity to protect, restore, and enhance wetlands. Lands with a history of agricultural use and that contain wetlands that can be restored for wildlife benefits are eligible. Wetlands converted since 1985 are not eligible. Landowners voluntarily retire marginal agricultural land, limiting the land's use permanently while maintaining private ownership. There are three options: (1) permanent conservation easement (Natural Resources Conservation Service (NRCS) pays for the easement plus 100% of restoration costs), (2) 30-year conservation easement (NRCS pays 75% of the value of the easement plus 75% of restoration costs), or (3) cost-share restoration agreement (NRCS pays 75% of restoration costs). The land can be used for hunting, fishing, and other uses that are compatible with providing wetland functions. For more information, go to the NRCS website.

Wildlife Habitat Incentives Program (WHIP)

The purpose of this program is to assist landowners who want to establish and improve aquatic or upland wildlife habitat. Projects with declining wildlife species are given priority. WHIP provides assistance to conservation-minded landowners who are unable to meet the specific eligibility requirements of other USDA conservation programs. The NRCS works with the participant to develop a wildlife habitat plan that typically lasts 5 to 10 years. WHIP agreements between generally last from 5 to 10 years. The program provides up to 75% cost sharing. Participants voluntarily limit future use of the land for a period of time, but retain private ownership. Landowners have flexible options for 1 to 15+ year agreements. For more information, go to the NRCS website.

Summary

WDFW recommends that planners and decision-makers consider implementing the following elements when undertaking comprehensive planning for wildlife:

- Planning policies that reflect a commitment to incorporating wildlife information and considerations into the planning process. These policies form the foundation for wildlife considerations in the comprehensive plan, designation of natural resource lands, zoning rural residential lands, identifying urban growth areas, planning open space, planning transportation and utility corridors, and adopting development regulations.
- Land use designations that reflect the habitat needs of local species.
- Incentives and non-regulatory assistance in protecting wildlife habitat in a developing landscape. These include the open space tax act, public benefits rating system, purchase and transfer of development rights, and several federal assistance programs.
- A local critical areas ordinance and shoreline master program that protects priority wildlife habitat. We encourage the use of our Priority Habitats and Species program in these protection tools, and incorporating available biodiversity information.

- Integration of provisions to protect wildlife throughout other local development codes, including the subdivision code, clearing and grading ordinance, stormwater regulations, tree and vegetation ordinances, road standards, the building code, floodplain management, and enabling ordinances for incentive programs.

Chapter 7. Implementation through Subdivision and Site Development

Overview

At the subdivision scale, the vision captured in county comprehensive planning and watershed planning is implemented. Planning at this finer scale allows more detailed information regarding habitats and species to be used in development design and placement on the landscape. At the subdivision scale, factors such as the amount of vegetation to be cleared, size and placement of open space areas, retention of connecting corridors to adjacent habitats, and issues of water quality and flow can be addressed within the site development process. If a site-scale habitat assessment has been done, this can also directly inform project implementation and habitat management.

Residential development regulations can require projects to be designed to address local wildlife needs, and planners can condition projects to address those needs. One tool useful at the subdivision scale is a Habitat Management Plan (HMP). HMPs are most often triggered by critical areas ordinance requirements, although can be incorporated into other development review processes (e.g., triggered by a zoning overlay). A well-designed HMP can outline ways to minimize or avoid the negative impacts to wildlife associated with development.

The Habitat Management Plan

HMPs are designed to avoid or mitigate impacts to wildlife when land use is changed. These plans are most useful when written by or in consultation with a biologist qualified to evaluate the habitats and species in the area. An HMP's success depends on the use of relevant data as well as published guidelines when they are available. Science-based publications from natural resource agencies can help inform decisions made by developers and planners. Published guidelines, such as WDFW's Management Recommendations for Washington's Priority Habitats and Species, can serve as a reference to guide the development of an HMP.

Using the right data: What do we know about the site?

Sources that can help identify the significance of a site for wildlife and biodiversity are listed in Table 7.1. This information can help determine when an HMP is needed, assist planners in determining whether a critical area review process should be "triggered" by development proposals (see box), and can also guide SEPA review. Data generated from county and watershed planning are also useful when reviewing a site-specific development proposal.

This information is most effective when provided to a potential developer at the early stages of subdivision design, such as at a pre-application conference. Site visits will help give a more detailed picture of the habitat and species occupying or potentially using the site. By the time a development proposal or permit application is submitted to the planner for review, it is ideal if the applicant has reviewed the wildlife and habitat data and has already taken steps to avoid or minimize impacts to these resources.

Table 7.1 Data sources for the early stages of subdivision planning.

Data Source	Scale of this Data Source	How to Use this Data Source	Questions the Data can Help Answer
Countywide biodiversity assessment or local habitat assessment	County/ Watershed/Sub-area	As an overlay to determine if the site is a part of a broader system that has been rated high for wildlife, may function as a corridor, or otherwise be identified as high in biodiversity.	Is this subdivision in a sensitive area? Can the subdivision include open space that links to important habitat areas?
Ecoregional Assessment/State Biodiversity Plan, conservation opportunity maps	Region	As an overlay to determine if the site has elements that are important at the ecoregional scale.	Is this subdivision in a particularly sensitive area in the context of an ecoregion? Are there ways to preserve the important ecoregional elements?
Priority Habitat and Species (PHS) maps and data	Watershed, Subdivision, Site	As an overlay to determine if sensitive species or habitats occur on or near the site. If present, management recommendations may be available.	Can the subdivision be designed to avoid impacts to protected habitats or species? Are management recommendations available to help avoid impacts?
DNR Heritage Plant data	Subdivision	As an overlay to determine if rare or sensitive plants or plant communities are on or near the site.	Will the subdivision have to be designed around protected areas? Are management recommendations available to help avoid impacts?
Aerial photos or orthophotos	Subdivision	To map, preferably using GIS, all areas of native habitat in and around the site.	What are the habitat patch sizes and areas of ecological connectivity?
Species and Development Database (Appendix B)	All Scales	List the species that may use the site, based on habitat conditions and known local species.	What species might be lost if the site is built to the zoned dwelling density? Which species are of a special conservation status?
Site- scale habitat assessment (Appendix I)	Subdivision or site	Describes key wildlife habitats and functions at the site.	What functions or habitat elements will be impacted by the subdivision project? Can these impacts be avoided, minimized, or mitigated?

"Triggering" project review for wildlife

Residential development proposals that may affect important wildlife resources should undergo a review "triggered" by local regulations, usually the critical areas ordinance. A building permit application, preliminary plat, as well as large lot land segregations that are often exempt from extensive plat review processes should trigger a review for consistency with wildlife goals and open space or biodiversity plans.

Clearing and grading can have significant effects on wildlife habitat, and a clearing and grading ordinance is an important local tool in planning for wildlife. This ordinance can require pre-clearing site evaluation to identify sensitive wildlife resources. The goal of the evaluation is to avoid clearing sensitive areas and to avoid clearing more vegetation than is necessary for site development. Working with natural topography, hydrology, and vegetation will ensure minimal habitat disturbance and preserve important habitat patches and connectivity. Technical guidance for developing clearing and grading ordinances can be obtained from the Department of Commerce.

Understanding the site's context

Understanding a site's relationship to its surroundings is necessary to address wildlife issues. County and watershed-scale habitat assessments can provide this context by making planners aware of parcels that are part of broader landscapes identified for their importance to wildlife (e.g., biodiversity areas). If a site is located in such an area, a condition of approval may include additional conservation measures as part of an HMP. The landscape questions in a site-scale habitat assessment can also provide a picture of a site within the greater landscape and thereby offer guidance to planners in permitting future use of the site.

An example is illustrated in Figure 7.1. If one looked individually at each parcel, an important perspective would be missed because both parcels have wetlands that may be used in different ways by the same population of amphibians. These wetlands, adjacent forested uplands, and connectivity between the habitats may be important to this local amphibian population. If development occurred without understanding how the adjacent property functions as habitat, development could be sited where it would fragment this population and lead to its eventual loss. To address this issue, an HMP might locate development away from the amphibian movement corridor between the two wetlands and set aside some of the upland forest as key habitat for amphibians and open space for people.

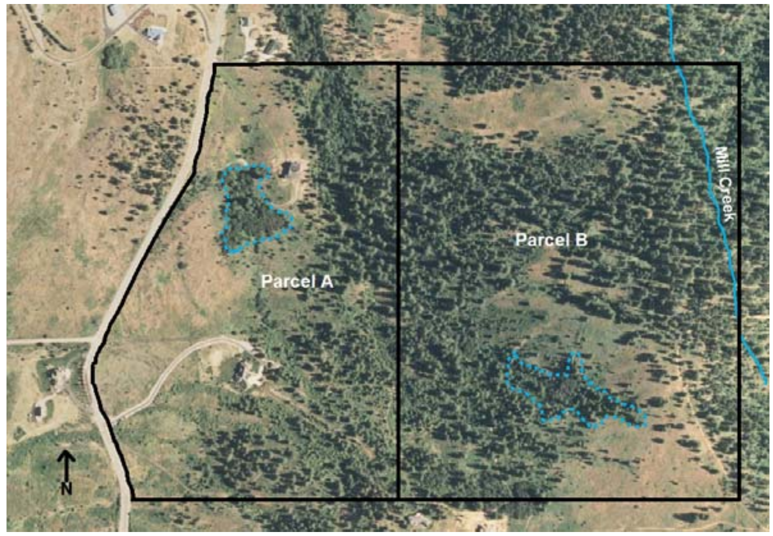


Figure 7.1 Fictional example of two parcels with wetlands (outlined in blue). Amphibians may use the Parcel A wetland for breeding, Parcel B wetland for overwintering, and the adjacent forested habitat during spring through fall.

Vegetation conservation and management

Aspects of vegetation (e.g., presence of large snags and native shrubs) important to wildlife are best examined at the subdivision scale. Information about the vegetation within a parcel usually requires a site to be surveyed by a qualified professional, often as part of developing an HMP, to adequately map important features. A habitat assessment (see model described in Chapter 5, and in Appendix I) can be employed to ensure that existing vegetation is accurately portrayed and that management and mitigation methods are appropriate for an individual site and are likely to be successful in contributing to conservation goals of the local jurisdiction.

Certain vegetative features are known to be valuable to wildlife. We recommend that areas dominated by native vegetation (e.g., shrub-steppe with native bunchgrasses and big sagebrush), forested areas with large trees and snags, and habitats with complex understory structure (e.g., fallen trees, deep leaf litter, dense native shrub layer) be retained to the greatest extent possible.

Dealing with "hazard" or "danger" trees

Many jurisdictions allow the removal of trees that are diseased, leaning, subject to blowdown, or that may pose a hazard to life or property. Removal of hazard trees is often exempt from permitting or local review. We recommend that removal of hazard trees begin with an assessment of the tree to verify there is a safety hazard and to explore options other than complete tree removal. Such an assessment can head off unnecessary loss of important habitat structure. Fallen trees are an important part of ecosystems and have many wildlife benefits. Depending on local conditions, danger trees that must be partly or totally felled should be left on the ground to function as a log to be used by wildlife. Cutting a tree but creating a snag by leaving a portion low enough to avoid a further hazard should be considered.

To avoid removing trees that might safely provide habitat benefits, building setbacks from the edge of forested habitat conservation areas (including buffers), resource lands, and other forested open space tracts can be implemented. Setbacks 1.5 times the future potential tree height will diminish the possibility of a tree falling on structures.

Many jurisdictions require a permit for the removal of otherwise protected trees. A permit can include a professional arborist's evaluation of the tree's condition, potential hazards, and a list of alternatives to tree removal to address safety threats. We recommend that topping a tree for other purposes (e.g., to create views) be avoided, especially because topping weakens a tree and makes it more likely to become a future hazard. If an emergency necessitates immediate tree removal, local regulations can require notification by the jurisdiction soon after removal of a protected tree to see if mitigation is necessary.

Flexible density and lot configuration

A strategy to incorporate wildlife considerations at the subdivision scale is to give planners and developers flexibility to help minimize impacts to species and habitats. This can include providing more flexibility in how lots are configured and lot size requirements. This flexibility may be a better alternative to rezoning an area if a planned density or a land use designation does not meet the landowner's needs or is difficult to meet given other development regulations. Such flexibility can be included in an HMP as one of the strategies to protect a site's wildlife resources.

Some zoning districts, especially in cities and urban growth areas, provide for a range of densities. The presence of important habitat and species on a particular site may require the lower end of that density spectrum. Allowing a transfer of density from one portion of the parcel to another or to a receiving area elsewhere can support flexibility and incentives in this decision-making process. Other techniques include cluster development, narrower

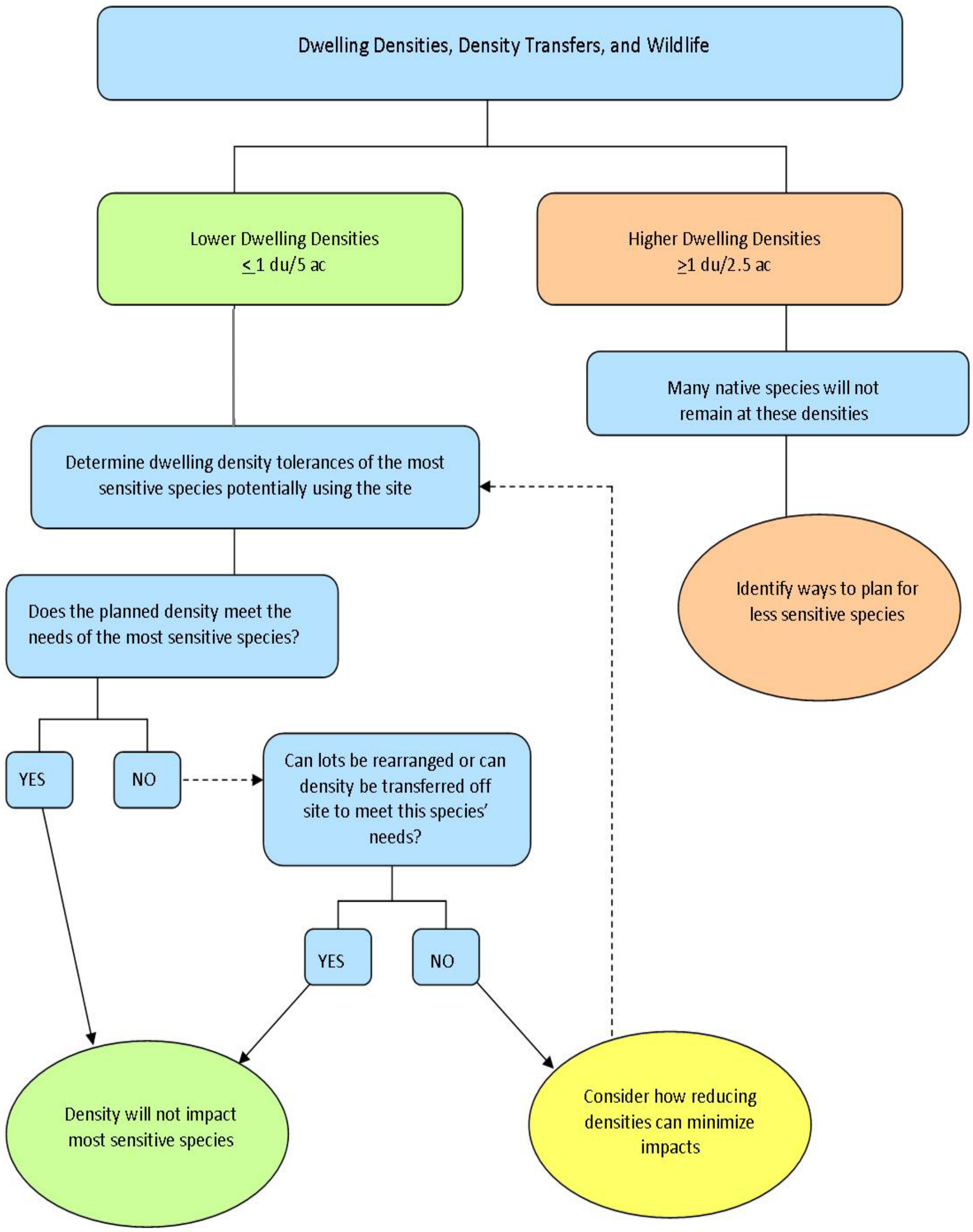


Figure 7.2 Flow chart for determining whether a proposed density will meet the needs of sensitive wildlife known to occur at a given site. The chart also identifies steps to determine the potential need for a density transfer.

streets, and smaller side-yard setbacks. These techniques can provide flexibility to meet landowner needs while protecting important wildlife resources. Figure 7.2 shows a systematic way to evaluate the effects of residential density on sensitive wildlife and can be used to identify when it is appropriate to consider the use of flexible densities and density transfers.

Roads and traffic

We recommend that the plat application or subdivision plan indicate how a road system will be designed to 1) minimize bisecting patches of important habitat, 2) avoid important animal use areas (e.g., ridges, stream corridors, wetland complexes), 3) cross streams only when alternative routes are unavailable, and 4) minimize amount of road (thus looking for most direct route). Traffic calming and fencing can also be used to limit wildlife impacts from new road development. Concentrating roads and traffic in a portion of the project area is more beneficial to wildlife than planning for an evenly distributed road network with moderate impacts over the entire landscape (Forman et al. 2003). As traffic increases, the road-effect zone[1] widens, but at a progressively slower rate.

Traffic calming

In rural areas bordering urbanizing areas, roads often absorb volumes of traffic higher than that for which they were designed (Jaarsma 2004). A high quantity of roads throughout rural areas can result in significant habitat fragmentation. When this is combined with comparably higher wildlife occurrences in these areas, the impacts on wildlife can be substantial. Traffic calming techniques can help mitigate these impacts. The basic concepts of traffic calming are 1) the strategic use of speed limits, 2) the modification of road widths or conditions and/or road closures to encourage greater traffic levels on main roads that have been identified for higher levels, and 3) reduction of traffic levels in locations where this is beneficial to wildlife and people (Jaarsma 2004).

By applying traffic calming in the Ooststellingwef region of Holland, road mortality for mammals was predicted to decrease as much as 79% (Jaarsma 2004). Without these methods, a traffic mortality increase of 25% was predicted due to expected development over the next 10 years.

In addition to traffic volume, speed can be regulated in biologically rich areas and near wetlands and other priority habitats. Speed limits of 25 to 35 mi/hr have been recommended for biodiverse areas (Jaarsma 2004). Higher speeds are associated with wildlife mortalities (e.g., >40 mph, Dickerson 1939; and >50 mph, Dickson & Beier 2002) and speeds ≥55 mph sharply increase chances for vehicle-animal collisions (Forman et al. 2003).

[1] "Road effect zone" is the area over which the road exerts its influence on the environment, including traffic noise and lights.

Fencing
Perhaps the most effective measure to keep wildlife off roads in unsafe locations and reduce wildlife road mortality is the strategic installation of fencing (Clevenger et al. 2001, McCall and Patterson 2004, Curtis and Hedlund 2005). In order to prevent large wildlife from crossing roads, we recommend exclusion fencing at a minimum of 8-feet high and made of wire-mesh fence material (Curtis and Hedlund 2005). In areas of high deer use, managers can consider installing out-riggers on top of and at a right angle away from the fence to deter deer from jumping and other wildlife from climbing over. Fences buried 5 feet underground will prevent wildlife from borrowing under the fence, or galvanized tin or aluminum flashing can be buried to a depth of >8 inches below the fence. At fence ends, slow speed zones can be implemented, traffic-calming devices installed, cattle guards placed across the road, and/or lighting increased to prevent mortality to wildlife. Mitigating gaps in fencing at interchanges can be accomplished through the installation of cattle guards or similar structures embedded within the road surface which deter wildlife movement, especially deer.

Designing in connectivity for small creatures
At the subdivision scale, connectivity for amphibians and small mammals can be considered in project design and review. Wetland species such as pond-breeding amphibians that must travel to distant seasonal habitats require more than just the traditional wetland buffer (Findlay and Houlahan 1997, Lehtinen et al. 1999, Richter and Azous 2001, Rubbo and Kiesecker 2005, Compton et al. 2007). Pond-breeding amphibians operate at four scales: 1) the breeding pool, 2) the breeding pool with surrounding upland habitat, 3) neighboring pools (wetland complexes) and upland habitats, and 4) clusters of wetlands (Compton et al. 2007). All of these scales are important when developing local plans for amphibians.

For wetland species such as pond-breeding amphibians that must travel to distant seasonal habitats, providing a wetland buffer without connectivity to the surrounding habitats will likely lead to loss of the population.

Canopy bridges are natural or artificial bridges in the forest canopy that allow the movement of arboreal animals such as tree squirrels (Figure 7.3). In biologically rich areas where roadside trees and shrubs are planned for removal or have been removed, managers can consider maintaining or

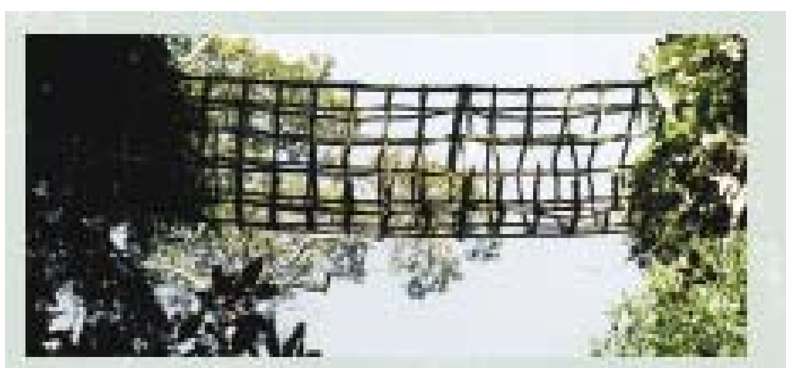


Figure 7.3 Canopy bridge installed near Lake Tinaroo, Australia, by Rupert Russell in 1995.

creating natural canopy bridges. Natural canopy bridges consist of ≥130 foot-long road segments where sections of the roadway or barrier area are narrowed to 25 feet. This distance allows for arboreal animals to jump from canopy to canopy to cross the road. Where natural canopies are not feasible, artificial canopy bridges consisting of lengths of thick (>4 inches) rope placed between two trees or poles high above the road can be employed. More elaborate canopy bridges (rope ladders 25 to 50 feet in length) positioned across gaps in the forest canopy may be considered where small and mid-sized arboreal species are affected by roads or clearings that reduce or remove natural forest canopy (Forman et al. 2003). Other designs for wildlife overpasses and underpasses are discussed in the Federal Highway Administration's "Handbook for Design and Evaluation of Wildlife Crossing Structures in North America" (Clevenger, T. and M. P. Huijser, undated).

Avoiding unwarranted variances and exemptions

Development regulations usually permit some variances and exemptions to deviate from minimum standards established to protect wildlife. These exceptions allow flexibility that can be important in the development of sites with major constraints. However, if granting variances is the normal way of doing business, a likely result may be cumulative impacts of inadequate buffers, severed wildlife corridors, and patches of habitat too small to maintain sensitive wildlife.

If the only feasible means for development (or redevelopment) requires an adjustment to a critical area buffer, wildlife corridor, shoreline setback, or other similar adjustment, we recommend that the variance criteria be specific. To support wildlife, variances can be conditioned with requirements to enhance habitat or protective measures commensurate with the level of impacts. For instance, if a 150-foot buffer cannot be reasonably maintained along a stream because of the property's shape or other development standards in place, then a variance could be conditioned by requiring invasive plant removal, planting of native riparian vegetation, and maintaining a connected patch of native vegetation elsewhere on the property. Requirements and conditions should have a relationship, or nexus, to the expected impacts of the development.

Innovative Subdivision Designs for Wildlife: Cluster Development and Low Impact Development

In rural areas, cluster development (also known as open space subdivision or conservation subdivision design), when carefully planned, can be beneficial to wildlife. Cluster development is particularly effective when planners and developers are given flexibility in determining the size and configuration of lots. In urban areas, elements that benefit wildlife can be integrated into low impact development (LID) designs. Cluster development and LID are not mutually exclusive. Elements of LID can easily be incorporated into a rural cluster subdivision (e.g., narrower roads, shared driveways), and clustering is a tool that is central to LID design.

Rural subdivisions: Cluster development for wildlife

Cluster development can maintain habitat on the majority of a parcel by grouping buildings and infrastructure in less environmentally sensitive areas. Clustering can allow important habitat to be permanently preserved through the use of binding, protective covenants or easements. For residents, clustering can provide nearby open space. There are economic incentives to cluster development; although clustered lots can be less than half the size of conventional lots, the economic value of clustered developments can be greater as a result of proximity to open space (Correll et al. 1978, Lacy 1990, Lutzenhiser and Netusil 2001). Clustering can be useful in areas that are zoned for rural densities (≤1 home/5 acres). However, there are potential pitfalls in cluster design, depending on the site and sensitivity of wildlife and the presence of other critical areas (Table 7.2).

Table 7.2. Fish and wildlife issues when planning a clustered development.

Issue	Potential solution
Set-aside habitat does not meet the needs of sensitive wildlife	- Increasing the patch size and managing for factors that affect connectivity, such as percent natural habitat retained and road traffic.
Lack of connectivity to other habitats	- Site open space adjacent to conservation lands, open space corridors, easement lands, and forest or other resource lands. - Site roads, homes, and other infrastructure so that open space is not cut off from adjacent areas of habitat.
Too much dwelling unit density near sensitive sites	- Buffer sensitive sites with buffer widths appropriate to the affected species. - Clustering and especially the use of bonus densities may not be appropriate for sites with highly sensitive species.
Inadequate long-term open space protection	- Require a permanent easement clearly defining restricted activities such as clearing, construction of infrastructure (e.g., roads, cell towers), as well as permitted activities (e.g., unpaved trails). - Clearly state restricted and permitted uses on deeds and in covenants.
Poor management of open space	- Develop a management plan through homeowner's association or a third party such as a land trust. - Distribute educational materials to the homeowners. - Place signs in and around open spaces clearly identifying permitted and restricted uses.
Incompatibility with rural/resource land uses	- Locate clustered homes away from intensive agriculture. - Maintain buffers to reduce impacts from odor, noise, and dust from farming/forestry. - Require a notice to be placed on the plat and issued with every building permit that the development is located next to agricultural or forestry areas, and that certain disturbances associated with those lands should be expected.
Inappropriate use of bonus densities	- Awarded bonus densities should take into consideration the sensitivity of local species.

A common pitfall in clustering is not reserving sufficient open space. If too much development is permitted, sometimes as a result of density bonuses (see box), too little space may be left as usable habitat. Information from a qualified biologist regarding habitat patch sizes and connectivity necessary to retain sensitive species can help determine the amount of open space needed for wildlife in a cluster development.

Density bonuses

Many jurisdictions offer density bonuses as an incentive to use cluster or open space subdivision design. A density bonus system awards additional lots within a subdivision using criteria such as the size of the open space set-aside area or the use of common areas, and/or original number of lots allowed. While the Growth Management Hearings Boards have generally supported clustering as an innovative technique in rural lands, all three boards have made findings that support limiting the level of bonuses and the overall size of clusters to avoid impacts to rural character and resource lands. Limits are also needed to avoid impacts to wildlife. Adding to the number of houses that normally would be allowed on a site will increase stressors on wildlife, including traffic on local roads, pets and invasive species, amount of pesticides and fertilizers applied on the site, and number of people using open space areas. These impacts, which are cumulative across the landscape, can negate the potentially positive effects of cluster design. Not allowing or limiting bonuses will reduce these impacts while retaining the inherent advantages of cluster development (e.g., savings on street construction costs, increased marketability of open space lots). If a local jurisdiction finds it necessary to provide bonuses, impacts from the additional density can be mitigated by adopting enhanced conservation measures, such as tailoring the amount of bonus to the sensitivity of a site's species (higher sensitivity species trigger lower or no bonuses), increasing buffers between clustered lots and aquatic or aquifer recharge areas, and/or requiring transferred development rights to trigger bonuses, thereby avoiding an increase in the overall number of houses built in the planning area.

Another pitfall is inappropriate placement of clustered development. For example, habitats that species use to move from one area to another are particularly important, and this function can be lost if development is clustered in or near the habitat used for species' movement. It is also not appropriate to locate dense clusters in areas with high-quality habitat features such as snags, large downed logs, or ponds and wetlands.

Examples: Conventional vs. cluster development

Figure 7.4 shows a fictional parcel proposed for development and an adjacent parcel to the east that was identified as having significant features that could be compromised by this development. In this example, a review of wildlife impacts was triggered by the local critical areas ordinance after a review of data in the county's GIS database. A primary issue was the presence of a wetland used by a sensitive amphibian species. Critical areas regulations required that the applicant hire a wildlife consultant to write an HMP, and WDFW was given the opportunity to review the plan. During an on-the-ground evaluation by the consultant and WDFW, the following features were identified:

- A wetland on the adjacent site.
- A forested riparian area along Mill Creek that acts as a wildlife migratory corridor.
- The presence of forest structural and vegetative features beneficial to wildlife around and between both wetlands as well as in the northeast corner of the western parcel.
- Habitat in the southern third of the western parcel with significant disturbance associated with the presence of an existing road and home, cleared vegetation, and impervious surfaces. Also, an area of shrub land, consisting of a dense layer of Himalayan blackberry (an invasive plant), to the southeast of the home.

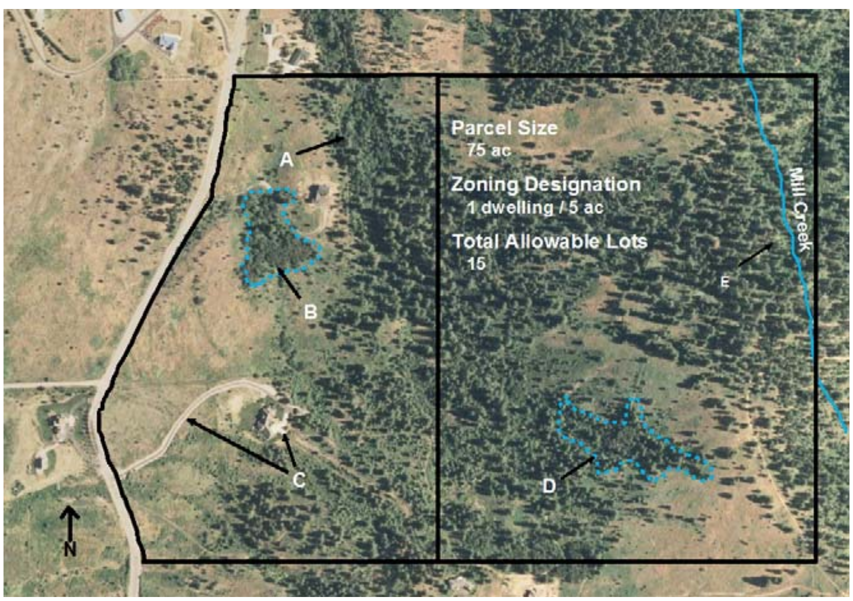


Figure 7.4 Example showing two adjacent parcels. Labeled features include mature upland forest habitat (A) and forested riparian area (E). Each parcel contains a single wetland (B, D), and the western parcel has an existing home with a driveway and areas of invasive blackberries (C).

Based on the evaluation, the HMP noted that the forested habitat near and between the wetlands was important to maintain for the seasonal migration of amphibians from wetland to upland habitat and between the wetlands. The HMP also noted that the forest in the northern portion of the western parcel has large snags and trees, which are important structural elements for wildlife. In summary, the northern two-thirds of the parcel contained most of the important habitat elements, while the southern third was relatively disturbed by the existing home, road, and invasive shrubs.

Conventional design

If this site were developed conventionally, all 75 acres would be divided into 15 equal-sized 5-acre lots with a home on each (Figure 7.5). Such a development could:

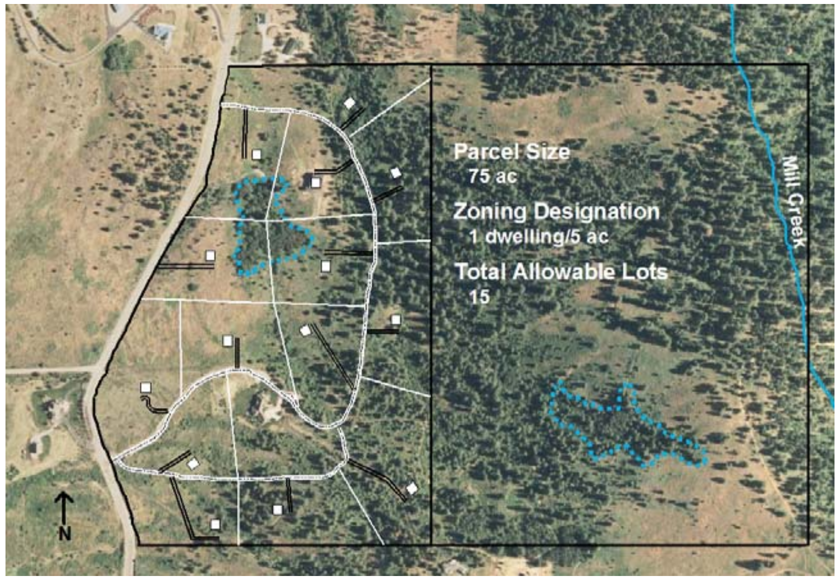


Figure 7.5 An example of a conventional layout for development of the western parcel.

- Sever habitat connectivity between wetlands and uplands.
- Remove forest used by the amphibians and other sensitive species that rely on the mature forest for seasonal habitat, as well as a connective link to the Mill Creek riparian area.
- Potentially remove most vegetation to accommodate dispersed development, eliminating habitat, increasing stormwater runoff, and negatively affecting the amphibian population.
- Increase the cumulative impacts of homeowner activities on wetland parcels.
- Increase likelihood of variance requests by homeowners of wetland parcels.

Conservation design

To minimize these risks to wildlife, two proposals were developed as part of an HMP. Each will do a better job at protecting wildlife than the conventional proposal. The proposal in Figure 7.6 develops most of the site, but lessens impacts on wildlife by:

- Allowing flexible lot sizes to retain an open-space around the wetland.

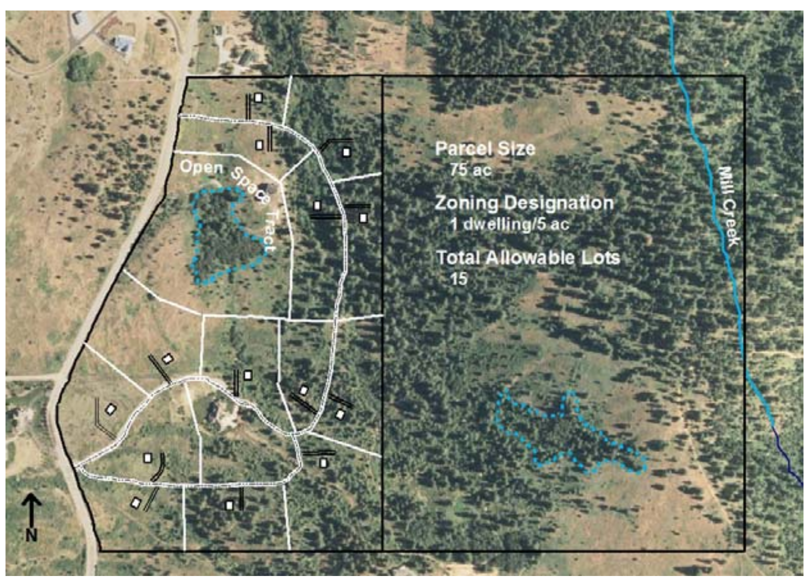


Figure 7.6 Example of a layout that has a slightly lower risk to wildlife (i.e., a limited conservation design) in the western tract. Flexible lot sizes allow for the designation of an open space tract.

- Placing under-road tunnels with fences to funnel amphibians under the road.
- Removing a limited number of trees on each lot. Tree removal by homeowners is limited by deed restriction, especially for densely forested northeast corner lots, with appropriate provisions for removing danger trees (see box, above).
- Shortening driveways and using pervious pavement to minimize impervious surfaces through LID practices.
- Placing signs around open space to identify important features and restrictions that are in place.

These conservation measures provide additional protection to the wetland by surrounding it with a designated open space area. It also provides limited wetland connectivity by placing tunnels beneath the road at key locations. By minimizing the area of manicured lawns, retention of native vegetation will reduce stormwater runoff and limit loss of wildlife habitat.

The lower-risk conservation proposal (Figure 7.7) adds additional conservation measures and was developed to keep the entire high quality forested habitat area intact for better protection for the amphibians and other sensitive species associated with the site's mature forest. Homes were clustered in the parcel's least sensitive location, thus protecting sensitive features to the north.

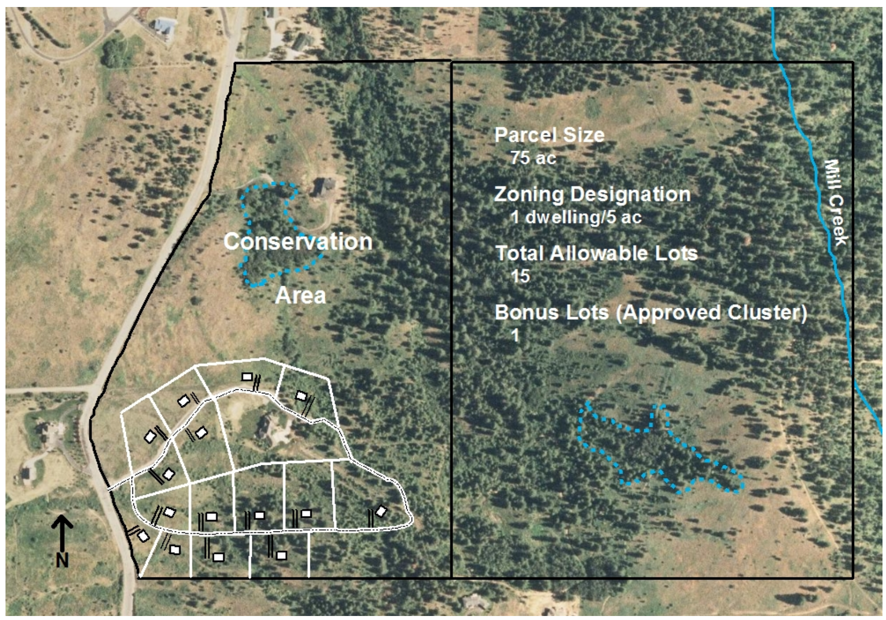


Figure 7.7 Example of a clustered layout that has a much lower risk to wildlife in the western parcel. It relies on conservation design strategies.

The county's critical areas ordinance allots one bonus home for every ten clustered in an approved plan. Hence, this developer received an additional building lot. The lower risk proposal also was entered into the county's conservation design database to track approved habitat management plans. If a development is proposed for any of the adjacent parcels, the new proposal will be flagged and reviewed to ensure connectivity is maintained with adjacent conservation areas and to ensure that the proposal works in concert with this existing HMP.

Urban subdivisions: Conventional vs. low impact development

Where development is planned in more urban areas, most approaches that we have discussed can be built into a proposal using low impact development (LID) as part of an HMP. The goal of LID is to prevent harm to streams, lakes, and wetlands from development. Although LID's main objective is the maintenance of natural hydrological functions, the secondary benefits of LID practices to wildlife are many. In particular, LID protection of native vegetation benefits habitat used by numerous species.

The publication titled "Low Impact Development: Technical Guidance Manual for Puget Sound" (Puget Sound Action Team 2005) is useful to planners and developers using LID in the design of a subdivision. This publication provides an overview of how to evaluate a site, and it describes tools and strategies to achieve established goals. The Low Impact Development Center provides additional resources useful in planning a subdivision or home using low impact practices. Due to existing constraints of properties in areas largely surrounded by higher-density development, LID is a primary strategy to protect wildlife in areas zoned at higher densities.

Example of LID

Figure 7.8 shows the boundary of a parcel in an area zoned for higher density development. This 24-acre parcel has forest to the north, and this forest is contiguous with a large forested area on the adjacent property. The parcel also has wetlands to the south. The wetlands are the only features that require protection under the local critical areas ordinance. All other features, including the forest, are developable.

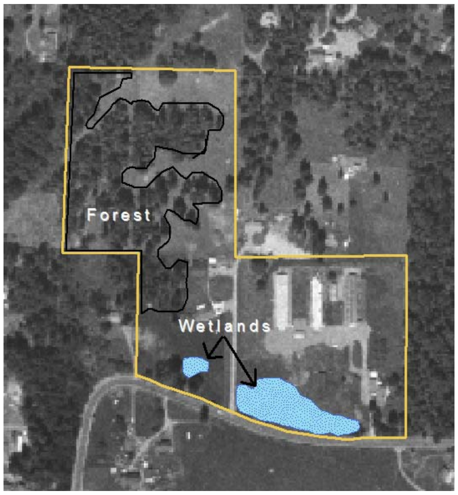


Figure 7.8 Urban parcel prior to development.

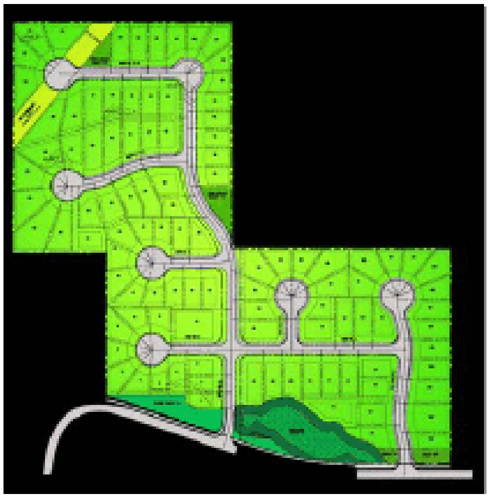


Figure 7.9 Urban parcel with a conventional lot layout. Illustration courtesy of AHBL, Inc.

Figure 7.9 shows the parcel conventionally developed at a density of 4 lots/acre. Less than an acre of vegetated open space near the pond and wetland is retained. Such a small reserve will likely provide habitat only for those few species that are most tolerant of disturbance. The ecological benefits of this reserve are further devalued because it will be fully isolated by a road and by new homes.

Figure 7.10 shows the same urban development with LID and urban clustering applied to expand the open space. By reducing lot sizes in half, the vegetated open space increases to about 10 acres. These 10 acres are connected to forest on adjacent properties, thereby making it suitable to sensitive species such as the evening grosbeak and ruby-crowned kinglet, both of which have a high tolerance to development but need patches of larger habitat to persist. By narrowing the streets, limiting the use of cul-de-sacs, and by using pervious paving materials, impervious surface area is reduced. This reduces surface stormwater runoff that would have impacted the wetlands.

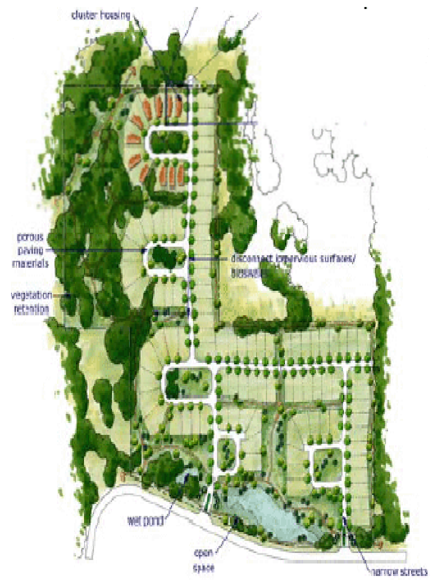


Figure 7.10   Same urban parcel conceptualized using LID design standards. Illustration courtesy of AHBL, Inc.

Once the Homes are Built: Encouraging Stewardship

An ongoing commitment by homeowners will help ensure that conservation strategies implemented in the subdivision design, review, and approval process remain intact. Maintenance of wildlife habitat is an ongoing process that does not end after the construction equipment is gone. The following are examples of what homeowners can do to ensure their properties support a diverse array of wildlife species.

Vegetation management

Homeowners should maintain or increase native vegetation that was called for during the planning of the subdivision and implemented during the clearing and construction phases. Homeowners often "simplify" vegetation around their homes by removing shrubs and low vegetation and by planting lawns. This will generally not benefit native wildlife. Planting with native trees and shrubs will benefit wildlife and will also require less maintenance by the homeowner (Booth et al. 2004).

Other landscape changes such as installing fences, curbs, and walls can inhibit animal movement. Residents may also add impervious surfaces or fail to maintain important LID features because they do not know about their value or proper maintenance, thereby rendering these design elements ineffective. The use of environmentally friendly yard and garden products and properly disposing of household hazardous waste are elements of good stewardship. Published resources are available to help homeowners maintain their yards in a wildlife-friendly manner (Table 7.3).

Table 7.3 Publications with information about landscaping for wildlife (click on publication for an online link to it).

Publication	*Subject(s)*
Landscaping for wildlife in the Pacific Northwest	Habitat design and maintenance, lists of plants that attract wildlife, constructing nest boxes/feeders.
Living with native plants: An illustrated planting handbook for the inland Pacific Northwest	Planting and maintaining local native plants, restoration projects.
WDFW backyard wildlife sanctuary program	Making property more attractive to wildlife.
Pacific northwest native wildlife gardening	Lists of useful books and references, lists of native plant nurseries, events calendar.
Identifying, propagating, and landscaping with native plants	Detailed information on many of the region's native plants.
Landscaping with native plants in the Inland Northwest	Information about native plants, planning a naturalized landscape, removing weeds, where to find native plants.
Restoring Shrub-Steppe in the Methow Valley	Planting and maintaining native shrub-steppe vegetation in your yard.

Pets

How pets are managed can make a significant difference to wildlife. The evidence regarding cats and impacts on wildlife is clear: they kill many thousands of birds, mammals, reptiles, and amphibians annually (American Bird Conservancy, not dated). Keeping cats indoors or on a leash when outside minimizes harm to wildlife. This approach benefits cats as well, as the average life expectancy of an outdoor cat is just 2 to 5 years (due to predation by coyotes and dogs, disease, and collisions with vehicles), while an indoor cat can live seventeen years or more (American Bird Conservancy 2006). Extensive educational information is available through the Cats Indoor Campaign.

Because dogs harass and kill wildlife, leashing or carefully controlling dogs near their homes can benefit local wildlife. Other pets such as fish, frogs, and reptiles should never be released outside of homes, as they may transmit disease, predate upon, or out-compete native species. Washington law prohibits the release of non-native wildlife except by permission of WDFW (WAC 232-12-017, WAC 232-12-271).

Avoiding conflicts with wildlife

Although many of Washington's residents treasure the opportunity to live near native wildlife, some species may not be tolerated in or near residential areas (e.g., elk, mountain lion, western rattlesnake). Through education, residents can be made aware of what species share their land and how to coexist with wildlife that may be a safety concern or a potential nuisance. Avoiding problems will require information about precautionary measures such as keeping garbage and compost piles securely covered and keeping pet food and water inside. Living with Wildlife in the Pacific Northwest (Link 2004) provides information to help landowners make the best decisions when taking measures to reduce wildlife-related conflicts.

Summary

- A habitat management plan is an important tool in planning for wildlife at the subdivision scale. A variety of data sources can be used when developing the plan.
- A subdivision or parcel must be examined in a larger context to adequately incorporate wildlife into the planning process.
- Specific aspects of vegetation are increasingly important at the subdivision scale.
- The design of the road system is important at the subdivision scale.
- We recommend that local jurisdictions avoid making exemptions and variances a routine part of the development process when it may affect wildlife.
- Cluster development and low impact development, if properly designed and implemented, can be very beneficial to wildlife at the subdivision scale.
- Stewardship by homeowners in a new subdivision will ensure that measures to lessen the impacts of development on wildlife are carried into the future.

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GLOSSARY

Bioblitz. A 24-hour survey of biodiversity led by scientists accompanied by local residents.

Biodiversity. The range of physical (habitat) and biological (species, communities) components, the ways that species interact with the physical environment, and the processes necessary to maintain these interactions through time.

Biodiversity network. A framework of biological/ecological components, e.g. core areas, corridors and buffer zones, which provides the physical conditions necessary for ecosystems and species populations to survive in a human-dominated landscape. (*See also ecological network.*)

Cluster development. Buildings concentrated together in specific areas to minimize infrastructure and development costs while achieving the allowable density. Allows the preservation of natural open space for recreation, common open space, and preservation of environmentally sensitive features.

Connective linkages. Locations within a planning area specifically identified to assure connectivity between habitat patches within the plan area, and external to the plan area are maintained.

Connectivity or permeability. The degree to which patches or landscapes are linked by the flow of organisms through intervening patch types possibly via habitat corridors or stepping stones. *See also Landscape connectivity.*

Core or interior. The inner portion of a patch where the environment differs significantly from the edge of the patch.

Corridor. A physical linkage between habitat patches within a landscape that may serve as a pathway by which organisms move or interchange, or as a habitat in which organisms can feed or breed en route from one patch to another.

Development action. A broad scope of actions that have to do with residential development that affect fish and wildlife. These actions include clearing of native vegetation and loss of habitat; ecosystem process changes such as altering of hydrology due to loss of natural cover; and, interspecies relationship elements such as effects from pets such as dogs and cats.

Development response group. A group of species within the same taxon, that respond similarly to stressors associated with development.

Dispersal. The one-way movement of an individual from its natal territory to a new potential breeding site.

Ecological network. A framework of ecological components, e.g. core areas, corridors and buffer zones, which provides the physical conditions necessary for ecosystems and species populations to survive in a human-dominated landscape. The purpose should be considered twofold: to maintain biological and landscape diversity, but also to serve as a network assisting policy sectors in the conservation of natural ecosystems.

Ecosystem engineers. These are species that through their actions on the landscape create conditions useful to other species. Examples are beavers which create dams and diverse wetland systems, animals such as rodents that create underground tunnels used in diverse ways by many species, and large mammals that create wallows.

Edge. The portion of a patch near the perimeter where the environment differs significantly from the core or interior of the patch. Edge width differs around a patch (e.g., wider on sides facing the predominant wind direction and solar exposure). The term is also used in reference to the periphery of a species' range.

Edge contrast. Degree of difference between a patch and the patch types surrounding it.

Effective impervious area (EIA). Impervious area not directly connected to a stream or drainage system.

Environment. A combination of biological, chemical, climatic, and physical conditions that supports an organism, population, or community.

Extirpation. A localized species extinction, such as from a former part of the animal's range.

Exurban. Typically one house per 10 to 40 acres.

Focal species. A species which is used to define different spatial and compositional attributes that must be present in a landscape, and their appropriate management regimes.

Functional connectivity. This is an "organism-based" approach to considering connectivity. Functional connectivity takes into account species specific needs such as habitat characteristics, how large of gaps in habitat an animal will cross.

Fractal dimension. This is a patch metric that indicates the complexity of a specific patch in the landscape. The metric can be from one to two. A patch with a fractal dimension of one, will have a simple shape such as a square; a fractal dimension ≥1 indicates a more complex shape.

Gap-crossing ability. The willingness and physical ability of an animal to cross habitat modified by human activity, such as an agricultural field, forest clearcut, or road.

Green infrastructure. Describes approaches to creating open space networks.

Greenway. A linear open space; a corridor composed of natural vegetation. Greenways can be used to create connected networks of open space that include traditional parks and natural areas.

Guild. A group of diverse species, especially animal species, that occupy a common niche in a given community, characterized by exploitation of environmental resources in the same way.

Habitat buffer zone. An area around a patch of interest that retains some degree of naturalness but allows sustainable economic uses that are compatible with the goals for the patch they surround; a transition zone that surrounds and protects natural core areas and primary corridors; an area that permits a greater range of human uses than do core reserves but that is managed with native biodiversity as the preeminent concern.

Habitat configuration. Habitat patch area and distance to the nearest comparable habitat patch.

Habitat fragmentation. The breaking apart of habitat into a number of pieces.

Habitat destruction. The loss of all structural features of the original vegetation and loss of the majority of species.

Habitat network. A habitat network can be defined as an interconnected set of habitat elements that together allow for movement of biota and enhance population survival probabilities.

Herbivore. Refers animals that feed on vegetation.

Herpetofauna. A term that indicates both amphibians and reptiles.

Home range. The area traversed by a species in its normal activities of food gathering, mating, and caring for young.

Home range compression. A situation where an animal is able to meet life history requirements in a habitat area smaller than it's original home range.

Impervious area. A hard surface area such as a parking lot that prevents or retards the entry of water into the soil, thus causing water to run off the surface in greater quantities and at an increased rate of flow.

Interspersion. The degree to which a given patch or landscape type is scattered rather than aggregated or clumped.

Invertivore. Term applied to fishes that consume invertebrates such as insects, their larvae, or snails.

Juxtaposition. Adjacency of different patch or landscape types.

Keystone species. A species that has a disproportionate effect on the ecosystem relative to its abundance or biomass.

Lacunarity. An index used to describe the gap-size distribution of landscape patterns.

Landscape. A mosaic of patches. The relevant scale depends on the organism (or ecological process) being studied and the questions being asked.

Landscape complementation. Landscape complementation addresses the proximity of habitat types and the degree to which organisms can move among them.

Landscape composition. The number and extent of different landscape elements, (e.g., habitat types), in a landscape.

Landscape configuration. The spatial arrangement of the landscape.

Landscape connectivity. The extent to which different elements of the landscape are functionally connected from the viewpoint of particular biotic elements.

Landscape linkage or corridor. A large connection that is meant to facilitate animal movements and other essential flows across and among regions.

Landscape permeability. The quality of a heterogeneous land area to provide for passage of animals. This definition incorporates the concepts that animal movements may be through different habitats and can be assigned estimates of relative potential for animal crossing.

Metapopulation. A set of local populations (number or density may vary with landscape or region) connected by processes of migration, gene flow, extinction, and colonization.

Metapopulation structure. Subdivided populations linked by dispersal that balances extinctions and recolonization of patches.

Migration. The seasonal round-trip movement between discrete areas not used at other times of the year. For example, a mouse that moves from a house in winter to the outside woodpile during summer and back again would be migratory, and the one-way distance traversed is between house and woodpile. By contrast, a mouse that moves 9 miles but not back again is not migratory. A wolverine covering a 400-square mile region between mountain ranges throughout the year would not be migratory because it fails to show seasonal use of discrete ranges.

Minimally disturbed standard. The best representation of wildlife communities that existed in an area prior to development.

Minimum area. The least amount of suitable habitat required for the long-term persistence of a species within a patch or landscape.

Natal. Refers to the location where a fish was hatched and reared.

Neutral landscape models. These are maps in which habitat patterns are generated by varying habitat amounts and randomizing the spatial distribution of the habitat.

Niche. Habitat that supplies factors necessary for existence of an organism; ecological role of an organism in a community, especially related to food consumption.

Omnivore. Refers to animals that feed on both plant and animal material.

Parts per million. Water quality measurement; 1 part per million equals 1 milligram per liter.

Patch. A relatively homogenous area that differs from its surroundings. Patches are described by their size distribution, including minimum, mean, and variance.

Pelagic. Living free in open water.

Permeability models. Grid-based models that consider energy expenses and mortality risks an individual experiences when it moves across the matrix.

Percolation. Percolation concepts in landscape ecology come from theory regarding flow of liquids in a matrix. Percolation theory has been adapted for use in landscape ecology to assess connectivity of habitat. A square (or other shape) grid system (i.e., lattice) is typically used to determine connectivity of random, fractal, or clumped neutral landscapes to determine important thresholds for movement, habitat usage, and population persistence.

Percolation cluster. Connected habitat that spans the landscape.

Persistence. For breeding populations, reproduction ≥ survivorship in most years. For non-breeding species and/or locations the appropriate life history needs are expected to be met, and there a high probability of seasonal survival.

Region. An area composed of landscapes with the same macroclimate and suite of human activity.

Resident. Life history strategy in which the entire life cycle occurs in a water body, such as that of resident coastal cutthroat trout, which occur in small headwater streams.

Road effect zone. The area over which significant ecological effects extend outward from a road.

Seasonal rounds. The yearly movement cycle of many species of animals that includes seasonally distinct habitat areas and connecting travel areas used for varied life history needs such as breeding, nesting, juvenile rearing, aestivation, hibernation, over-wintering, and active season survival. For example, the seasonal rounds of elk and mule deer typically include a yearly cycle of over-wintering in lower elevation areas, and a long migration to higher elevations for the summer season.

Sink habitat population. Not self-sustaining but persist due to immigration from outside source populations.

Source habitat population. Population where reproduction exceeds mortality.

Species richness. The number of species present in a community.

Species representation. Representation by a specific species.

Stepping stone. A patch of suitable habitat between larger patches of suitable habitat at landscape, regional, and broader scales.

Stressor. The aspect of a development action that affects native species. For example, clearing of vegetation is a development action; however, loss of habitat, snags, and connectivity are the stressors that affect species.

Subsidized predator. Native predators or nest parasites such as crows and cowbirds that may utilize urban sources of food allowing them to increase their population levels, and thus cause greater predation impact to other native species.

Taxon (singular), taxa (plural). A taxonomic group or entity, or the name applied to a taxonomic group in a formal system of nomenclature.

Total impervious area (TIA). The fraction of the watershed covered by constructed, non-infiltrating surfaces such as concrete, asphalt, and buildings. However note that some pervious surfaces may be compacted and thus have very similar runoff characteristics to impervious surfaces.

Traffic calming. The use of specific techniques such as speed bumps, lower speeds, narrower roads, that slow down traffic and assist with through traffic being focused to major, faster thoroughfares. These techniques are used for the benefit of humans and wildlife.

Trophic. Pertains to nutrition or to a position in a food web, food chain, or food pyramid.

Umbrella species. A species whose conservation will confer protection to many co-occurring species.

Unaltered habitat baseline. There is a continuum of modification between baseline unaltered habitat and destroyed habitat. The unaltered habitat baseline is defined as the point from which losses of species or ecosystem function occurs.

Watershed. Term applied to a catchment area of a sloping landscape that collects precipitation and drains the resulting surface and groundwater.

Wilderness. In this document the term "wilderness" is used to describe lands with little to no direct anthropogenic activity. This is different than the "wilderness" designation given to some USDA Forest Service lands.

Wildlands-to-urban gradient. The wildlands to urban gradient refers to the increases in human population density and land use intensity that one would witness while traveling from an area with no development towards an urban center.

Urbanization. This term is used both broadly: "…human settlement characteristics ranging from dispersed rural and exurban villages and homesteads to densely settled subdivisions and cities" to more focused e.g., "Changing land use from rural characteristics to urban (city-like) characteristics".

Urban sprawl. Current development patterns, where rural land is converted to urban uses more quickly than needed to house new residents and support new businesses, and people become more dependent on automobiles. Sprawl defines patterns of urban growth which includes large acreage of low-density residential development, rigid separation between residential and commercial uses, residential and commercial development in rural areas away from urban centers, minimal support for non-motorized transportation methods, and a lack of integrated transportation and land use planning.

Vagile species. A species that can move easily over the landscape.

Wildlands. Vast wilderness-like areas without roads, dams, motorized vehicles, which are protected and managed for conservation of nature.

Appendix A: The Roles of Science and Planning Experts in Developing this Guidance Document

The Washington Department of Fish and Wildlife (WDFW) assembled a group of project advisors in the spring of 2005 to help inform WDFW project staff of the most relevant planning and management issues. WDFW also sought to understand how to develop the guidance in a manner that would be most useful to planners and other persons involved in resource management and decision-making. We solicited answers to questions such as: What are the primary issues related to fish and wildlife being addressed by planners? Where are the biggest gaps in fish and wildlife information for land use planning? At what spatial scale(s) are planners, developers, and biologists struggling to accommodate fish and wildlife? At what spatial scale(s) is there a gap in information?

Early Project Advisors included[1]:
Jim Bolger, Natural Resource Manager, Kitsap County
Katherine Brooks, Senior Planner, Advance Planning Division, Pierce County
Karen Dvornich, National Director, The NatureMapping Program, U.W. Coop
John Garner, Education Coordinator, Tacoma Metro Parks
Dick Gersib, Watershed Program Manager, WDOT
Susan Grigsby, Shorelands Program, Ecology
Hal Hart, Planning Director, Whatcom County
David Howe, Habitat Biologist, Clark County
Bev Keating, Planning Commissioner, Spokane County
Tom Kantz, Habitat Protection and Restoration Biologist, Pierce County
Liz Lyman, Planning Commissioner, Thurston County
Doug Peters, Landscape Planner, CTED
Dave Seabrook, Pierce Conservation District Board Member
Jen Sevigny, Wildlife Biologist, Stillaguamish Nation
John Sonnen, Senior Planner, Thurston County
Steven Stanley, Shorelands Program, Ecology
Pat Stevenson, Environmental Manager, Stillaguamish Nation
Heather Trautman, Long-range Planner, City of Spokane
Daryl Williams, Environmental Liaison, Tulalip Tribes
Bruce Wulkan, Stormwater/LID Program Lead, PSAT

The project advisors discussed and provided opinions and recommendations on a number of topics relevant to the document, such as:

- Characteristics and types of information needed by planners.
- Recommendations for guidance needed at the scales of a county, watershed, and subdivision.

[1] The organizations or agencies with which the advisors were affiliated at the time of their work on the document are listed.

- Strategies for managing fish and wildlife in urbanizing areas.
- Important issues and ideas when addressing connectivity, impervious surface, stormwater, and water quality.
- Communicating with the public.
- Social/Political issues faced by planners.
- Negative interactions between humans and wildlife.
- Exotic species, including pets.
- Restoration, monitoring, and research.

WDFW also assembled three groups of science experts to fill gaps in the published scientific literature so that the agency could offer the most complete guidance based on best available science to local planners and decision-makers. The three science teams and their members were:

Avian Science Team Members:

Jeff Azerrad, WDFW (co-lead)
Robert Altman, American Bird Conservancy
Howard Ferguson, WDFW
Steve Herman, The Evergreen State College
Matthais Leu, USGS
John Marzluff, University of Washington
Erik Neatherlin, WDFW (co-lead)
Scott Pearson, WDFW
Martin Raphael, USFS
Jen Sevigny, Stillaguamish Nation

Mammal Science Team Members:

Jeff Azerrad, WDFW (co-lead)
Jeff Bradley, Burke Museum
Gary Koehler, WDFW
Jeff Lewis, WDFW
Chris Madsen, Northwest Indian Fish Comm.
Donny Martorello, WDFW
Jerry Nelson, WDFW
Tracie O'Brien, WDOT
Tim Quinn, WDFW
Michelle Tirhi, WDFW (co-lead)

Amphibian and Reptile Science Team Members:

John Carleton, WDFW
Stephen Germaine, Denver (formerly WDFW)
Marc Hayes, WDFW
Tiffany Hicks, WDFW
Aimee McIntyre, WDFW
Erik Neatherlin, WDFW (co-lead)
Ryan O'Donnell, Utah State (formerly WDFW)
Klaus Richter, King County (Ex-officio)
Lori Salzer, WDFW
Joanne Schuett-Hames, WDFW (co-lead)
Stephen Stanley, Ecology
Bob Zeigler, WDFW

Additional science information, assistance, and review were provided by:
Jeff Bernatowicz, WDFW; Joe Buchanan, WDFW; Dave Hayes, WDFW; Steve Jeffries, WDFW; Regina Joseph, State Librarian; Monique Lance, WDFW; Mary Linders, WDFW; Mike Livingston, WDFW; Kelly McAllister, WDOT; Michael McDonald, WDOT; Brent Norberg, NOAA Fisheries; Beau Patterson, WDFW; John Pierce, WDFW; Tim Quinn, WDFW; Rocky Spencer, WDFW; Derek Stinson, WDFW; Matt Vander Haegen, WDFW; Dave Ware, WDFW; Gary Wiles, WDFW.

Each of the science teams met individually three times during the summer and fall of 2005. A fourth meeting of all science teams and project advisors was held in December, 2005. The purpose of each science team was to identify important stressors and biological effects from development for their respective species group. This information was solicited for county, watershed, and subdivision scales for eastern and western Washington. Potential measurements useful for describing the relationship of the stressor to development issues were discussed, as were species or groups of species that might be most strongly associated with the stressor or biological effect. Using a consensus-based process, primary tasks of each science team included:

- Identify primary development actions that negatively impact the species group, and the top stressors caused by these actions.
- Review the literature to determine what strategies might be used to minimize the impacts of urbanization on the species group.
- Determine which species are affected by urban development (and which are not).
- Group species based on sensitivity to development.
- Identify an urban tolerance threshold for each species group.
- Identify numerical thresholds to help address impacts to species regarding roads, movement corridors, habitat configuration, and similar topics addressed in the guidance document.

The work of the science team, combined with a synthesis of the published scientific literature, resulted in the development of the Species and Development Database, shown in Appendix B, and stressor tables in Appendix C. This information was used as the basis for the recommendations contained in this guidance.

Appendix B: Species and Development Database

The Species and Development Database (Database) summarizes information collected from species experts and scientific literature to produce this guidance document. The Database is designed to provide information on how Washington species respond to stressors in the development landscape. The Database is in Excel format, and is posted online at http://wdfw.wa.gov/hab/phsrecs.htm. The Database lists all terrestrial wildlife species in Washington, by county where they are known or are likely to occur, and provides basic information on their protected status, if any, and their habitat needs and development sensitivities.

This Database will be updated over time. Please contact us at planningforwildlife@dfw.wa.gov or check the WDFW website to make sure that you have the most recent version. We would also like to hear from you if you find errors or would like to provide updates.

Using the database

The database can be used by a knowledgeable Excel user to:

- Develop a full list of species and a list of native species for a county. By using filter tools (some are created for you in the Database), you can sort species by county, and you can also select for only native species. These basic functions are useful to help determine what species may be in your planning area, for example to designate particular species for protection in a critical areas ordinance.

- Determine a species' conservation status. Each species is described in terms of its status, if any, under state and federal programs. Status categories include PHS (Priority Habitats and Species), SGCN (Species of Greatest Conservation Need), or protected by Washington State or federal laws. Species status does change over time, and while we will make every effort to keep the database updated, you may need to double-check current federal and state status.

- Make a county list of species that are organized by Development Response Groups (described in Chapter 2) and by Sensitivity Class. By filtering the data, an Excel user can answer questions such as "How sensitive is a given species to residential development?" This information can help determine which species might be retained at build-out for a given density of development, and which species might be lost.

- Determine the dwelling densities where special measures are necessary to help a particular species persist. For instance, for a specific species of local importance in your jurisdiction, it will be useful to know if the zoned dwelling density is expected to support the persistence of this species, or if conservation measures are needed.

- Determine the stressors to address for a species of local importance in a county. This may be important if it is unclear how a particular species might react to development density, and if more specific information on habitat impacts in needed for management purposes. For example, the Database shows that for Western toad, it is "unclear" whether the species will persist at a density of 1 unit per 10 acres. A user can use the Database to look further into what specific stressors might affect Western toad, finding that this species needs a lot of habitat connectivity between upland areas and breeding ponds, is very vulnerable to roads, and needs access to ponds for breeding in mid/late summer.

- Determine the habitat type(s) associated with particular species, and the habitat characteristics they need. For example, if a planning area contains Eastside Riparian-Wetlands, you can filter the Database to show what species to expect within this habitat type. Conversely, you can select particular species you know exist in your planning area, and find out what their habitat needs are, from the type of habitat they use to the patch sizes and percent of undeveloped habitat they need. This function can also be useful when tailoring incentive programs or designating fish and wildlife habitat conservation areas.

By helping professional planners and others answer these types of questions, the Species and Development Database supports the recommendations and information contained throughout this guidance document. It is a science-based companion to the numerous other species and habitat management recommendations provided by WDFW that can be consulted when making a variety of planning and management decisions at the local level.

LOCAL HABITAT ASSESSMENT: MAPPING HABITAT CONDITION FOR GREEN SPACE PLANNING

Erik Neatherlin, John Jacobson and John Carleton

June 2007

INTRODUCTION

Over the last decade, biodiversity conservation has become an important element of conventional land use planning across the United States (Cohen and Lerner 2003). Projects in Florida, Maryland, Massachusetts, Oregon, and California have worked to identify and prioritize lands for biodiversity conservation and green space preservation (Cohen and Lerner 2003). These projects have worked at different scales with an array of goals and objectives, and have employed a variety of strategies. However, a common theme among many of these projects has been the need for more effective communication of biological or ecological priorities early in the planning process, and in a manner that provides opportunities for collaboration and non-regulatory incentives (Cohen and Lerner 2003, Forman and Collinge 1997).

In Washington State, efforts to integrate conservation and land use planning reach back a decade or more and include plans for growth management, shoreline management, and watershed management, in addition to county comprehensive planning. Some counties, such as Spokane, King, and Pierce, have initiated efforts to integrate conservation planning with land use planning through the development of wildlife or biodiversity networks (Stenberg 2004, Brooks et al. 2004, Iolavera et al. 2000, Camacho 1998). The mapping of biodiversity networks and green space planning are attempts to maintain biological diversity across large landscapes by providing a network of extensive habitat core areas and connectors. Other counties such as Kitsap County have initiated Alternative Futures planning (Steinitz 1996), where communities, citizens, planners, scientists, and decision-makers participate in a process to review development alternatives that consider the use of water and natural resources within several different development scenarios. Having resource managers provide objective input early in the planning process can benefit fish and wildlife and landowners by increasing certainty at the outcome (Duerksen et al. 2001).

In response to growing interest and need, the Washington Department of Fish and Wildlife is working on tools and approaches that will help jurisdictions and citizens better evaluate their biological (fish and wildlife) resources. The purpose of this paper is to describe a GIS method that maps fish and wildlife habitat priorities at a county-wide scale. In addition, we describe a method to evaluate the compatibility of mapped priorities with future planned growth.

We present the methods for ecoregions in western Washington and are in the process of adapting methods for ecoregions in eastern Washington.

METHODS

Study Area

Kitsap County is located in the Puget Trough lowlands of Washington State, USA, approximately 20 km west of the city of Seattle. Kitsap County is the second most densely populated county in Washington, with a total population of 231,969 (OFM 2000). Primary land uses include military installations, residential development, light industry, and forestry. Bounded by Puget Sound on the east, Hood Canal on the west, and Admiralty Inlet to the north, Kitsap County is a peninsula approximately 102,000 ha in size that includes Bainbridge Island and Blake Island. Elevation ranges from sea level to approximately 500m above sea level, and precipitation ranges from 110-170 cm per year depending on elevation. The maritime climate is mild and wet in the winter and cool and dry in the summer.

Vegetation is characteristic of the western hemlock zone (*Tsuga heterophylla*) and consists primarily of Douglas-fir (*Pseudotsuga menziesii*), western hemlock, and western redcedar (*Thuja plicata*), which mix with red alder (*Alnus rubra*) and big-leaf maple (*Acer macrophyllum*) in mesic areas (Franklin and Dyrness 1973). Common understory plants include salal (*Gaultheria shallon*), Pacific rhododendron (*Rhododendron macrophyllum*), huckleberry (*Vaccinium spp.*), salmonberry (*Rubus spectabilis*), and vine maple (*Acer circinatum*).

Conceptual Framework

The assessment described in this paper is a type of suitability analysis or filter that combines spatial information by layering the data. This type of layering had its origins in the 1930s when the US Soil Conservation Service mapped soil types to assist with agricultural management practices (Steiner 1983). Land use planners later used acetate overlays to determine the "suitability" of an area for new construction relative to existing sewer, transportation, and building infrastructure. In the 1960s Ian McHarg (1965) improved upon this technique by incorporating ecological information such as soils and habitat types. Since that time, development of spatial analysis tools such as Geographic Information Systems (GIS) have supported suitability analyses of increased precision, flexibility, and sophistication.

Our assessment incorporated approaches from Maryland's Green Infrastructure Project (Weber 2003). We used individual data layers that are readily available and are also strong indicators of habitat suitability, consistent with general ecological concepts and principles. The layers were combined into a final composite map intended to represent the current relative importance or value of an area for fish and wildlife.

We believe that the assessment is easy to interpret, transparent, readily repeatable, and easily updated. Combining multiple layers of information into one source allows decision-makers and planners to consider fish and wildlife conditions in concert with other county priorities. The method is capable of informing a variety of land use planning activities at multiple spatial scales. This approach is a work-in-progress and will continue to be updated as we learn more.

Composite Data Layers and Relative Ranking

We developed four individual composite layers to generate the final composite current conditions map (Fig. 1). Each of the individual composite layers consists of varying levels of analysis and uses several data sources. We converted all data to grid format (i.e., raster data) stored at 25m resolution using an ArcGIS 8.1 platform (ESRI 2004). We assigned a corresponding ranking between 1 and 10 to each 25m grid cell for each composite layer. One represents the lowest relative contribution for fish and wildlife, and 10 represents the highest relative contribution.

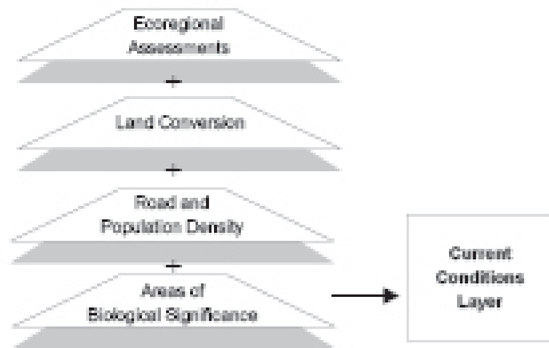

Figure 1. An outline of the process for assembling the composite GIS data. The final composite layer, current conditions, represents the local habitat assessment map.

Regional Biodiversity Priorities. We used the ecoregional assessment data to identify regional biodiversity priorities. Ecoregions are characterized by distinctive factors such as climate, geology, vegetation, soil, water, and fauna. Biodiversity, as defined in the ecoregional assessments, represents the full complement of plants, animals, and ecological communities within an ecoregion. Lands identified through the ecoregional assessment process were prioritized to collectively represent the full range of biological diversity within an ecoregion (Groves 2003). Regional priorities often represent locally important resources, but because of the spatial scale of the analysis, not all locally important resources are regionally significant. We used the Willamette Valley-Puget Trough-Georgia Basin (Puget Trough) Ecoregional Assessment (Floberg et al. 2004) for this analysis. The Puget Trough ecoregion is situated between the Cascades and the Olympic Mountains and extends into British Columbia, Canada in the north, to the Willamette Valley, Oregon in the south. The Puget Trough ecoregional assessments were conducted using hexagon-shaped analysis units of approximately 728 hectares in size, each assigned an irreplaceability value indicating the level of relative biological importance. We used a moving circular window with radius equal to the length of one side of the hexagonal tiles to interpolate between hexagon irreplaceability values. The resulting data were ranked from 1 to 10, producing a smoother gradient of values between tile centers.

Land Conversion. The Land Conversion layer represents the relative fish and wildlife contribution based on type and extent of land conversion. Lands that are converted to non-native habitat communities (i.e., development or agriculture) often disturb native fish and wildlife species through disruption of natural processes and habitat loss and degradation (Saunders et al. 1991, Forman 1995, Marzluff and Restani 1999, Fahrig 2002). We generated a detailed land cover/land use data layer derived from the Interagency Vegetation Mapping Project (IVMP; USDI 2001) and National Land Cover Dataset (NLCD; USDI, 1993) augmented with LiDAR data (PSLC 2002) and National Wetlands Inventory (USFWS) data. The numerous land cover/land use classes within this data layer were grouped into three categories of land conversion based on Marzluff and Ewing (2001): (1) Developed (industrial, commercial, and residential development including roads and lands with human structures and lawns surrounding homes), (2) Agriculture and Pasture (non-forested and non-developed lands that are actively being farmed for agriculture or passively grazed), and (3) Natural (all remaining non-developed and non-agriculture land including all seral stages of forests, wetlands, intertidal marshes and mudflats, rivers and streams, and open water, lakes and ponds). Developed lands are the most persistent type of land conversion and the least similar to natural habitat (Marzluff and Ewing 2001). Agriculture lands are more similar to natural habitat. Natural habitat provides the most benefit for fish and wildlife. We gave these land conversion class values of 1, 2, and 3, respectively, in the analysis data layer. Because larger areas of connected habitat support more species (McArthur and Wilson 1967, Harris 1984, Hanski and Simberloff 1997) we analyzed the size of converted and non-converted areas using a circular moving window with a radius of ¼ mile. The resulting data were ranked from 1 to 10, with 10 given to the areas having the least amount of land conversion.

Road Density. The road density layer prioritizes the landscape based on the miles of road per square mile. Road density is related to human activity and presence, which can have direct and indirect effects on fish and wildlife. Roads and higher densities of people can increase runoff (Forman and Alexander 1998), pollutants (Trombulak and Frissell 2000), invasive species (Blair 1996), as well as act as barriers to animal movement (Carr and Fahrig 2001, Clevenger et al. 2003, Forman et al. 2002). We used Washington Department of Natural Resources 1:100,000 road data to generate the road density layer. We used all roads in our analysis, including roads in forested areas, as the latter are an indication of human activity related to forestry and recreational use. Roads were grouped into either heavy traffic roads (value = 1) or light traffic roads (value = 2). A circular moving window with area equal to one square mile was applied to the weighted road data, and the resulting distribution of valued was ranked from 1 to 10. These data estimate a gradient of relative disturbance ranging from areas with relative low human use (low road and low human population density) to high use (high road and population density).

Local Areas of Biological Significance. The areas of biological significance layer depicts known locations of fish, wildlife, or habitat that represent Washington State natural resource agency priorities. We used data from the Washington Department of Fish and Wildlife Priority Habitats and Species Program, and the Washington Department of Natural Resources Forest Practices and Natural Heritage Programs. We reviewed each database individually and included only data elements that: (1) were stable or predictable in space and time (e.g., habitat features, rookeries, colonies), (2) were vulnerable as indicated by state or federally listing, and (3) provided habitat functions difficult to replicate elsewhere on the landscape (e.g., estuaries, riparian habitat). We buffered all point data by 300 feet to account for mapping inaccuracies and then converted all of these areas of biological significance to a raster and rank value of 10.

Current Conditions Layer. We created the current conditions layer by summing the ranked values from the ecoregional assessment, land conversion and road density composite layers, and rescaling the resulting data to a rank range of 1 to 10. We then embedded values from the areas of biological significance layer. Where biologically significant areas occurred, the current conditions pixel score was set to 10; for pixels with a score of zero in the areas of biological significance layer, no change was made in the underlying rescaled pixel value. This approach gave maximum value for areas with known biological significance, while avoiding penalties for areas that lacked documentation of their significance.

Future Development. We compared planned land use with the relative value of the current conditions composite layer to identify potential incompatibility. Land use zoning is a century-old method that identifies the type and location of planned development (Platt 1996). The development of a Comprehensive Plan is required under The Growth Management Act (RCW 36.70A.040 and WAC Chapter 365-195). Such plans provide information about where and how a county intends to allocate lands for commercial, industrial, natural resource, agriculture, residential, or transportation land uses over the next 20 years. Because areas with higher density zoning generally represent a higher risk of habitat fragmentation and/or a reduction in species richness (Douglas and Baker 2003), as well as increased disruption of natural or ecological processes and functions (Kline et al. 2003), we thought it would be a useful way to inform planning activities. To evaluate the interaction between current biological conditions and planned development, we generated a GIS layer for zoning designations from the Kitsap County Comprehensive Land Use Plan. We generated three broad ranking categories that included information about the number of dwelling units per acre as well as land use (e.g., open space, commercial, residential, etc.). Higher intensity land uses received a higher ranking (Table 1). To compare zoning with Current Conditions, we first separated the Current Conditions layer into three even categories (lowest current biological value = 0-3.3 ranking, medium current biological value = 3.4-6.6, highest current biological value = 6.7-10). We then overlaid the Land Use Plan layer and the Current Conditions layer and mapped each unique combination (e.g., high wildlife value and low density development) to identify those areas planned for greatest development that overlapped with areas with high current biological condition (Fig. 2).

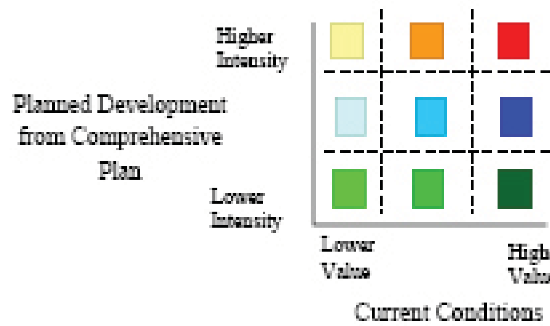

Figure 2. This figure illustrates the relative comparison betwee Planned Development and the Current Conditions Composite Layer. The four corners represent the extremes. The upper right corner identifies areas where high current biological value is least compatible with high intensity land use (i.e. urban areas). As the intensity of land use decreases, it becomes more compatible with high value current conditions, lower right corner. The lower left corner identifies areas of low compatibility for opposite reasons, where housing density is low but relative biological value is also low. As the intensity of land use increases, so does compatibility for wildlife, because few resources are being lost.

RESULTS

Ecoregional Assessments (Maps 1A, 1B). Kitsap County encompassed portions of 193 ecoregional hexagon analysis units totaling approximately 102,389 hectares. The ranking distribution was bimodal, with 11.5% (11,786 ha) of Kitsap County being selected 100% of the time (e.g., ranking = 10) as ecoregionally significant (Fig. 3A). Terrestrial areas in Kitsap County ranked in the top third (> 7 ranking value) for ecoregional value included lowland conifer forests in northern Tahuya Peninsula, Port Gamble area, Point Julia, Indianola Forest, and Bangor Naval Shipyard. Aquatic or marine ecoregional priorities included wetland complexes around Port Gamble, northern Seabeck Bay, northern Dyes Inlet, Ostrich Bay, Liberty Bay, Agate Passage, Rich Passage, and Port Gamble.

Land Conversion (Map 2). 38,905 hectares (38%) of Kitsap County has been converted to developed land cover and 720 hectares (2%) converted to agriculture or pasture. The southwestern portion of the county west of Dyes Inlet includes the largest blocks of land not yet converted to development, agriculture or pasture. Land conversion had a bimodal distribution (Fig. 3B). In Kitsap County, this bimodal distribution represents a patchy landscape with interface between development and non-developed lands occurring at two ends of the development gradient. At the developed end, ranking value 3 represents a sea of development with smaller patches of undevel-

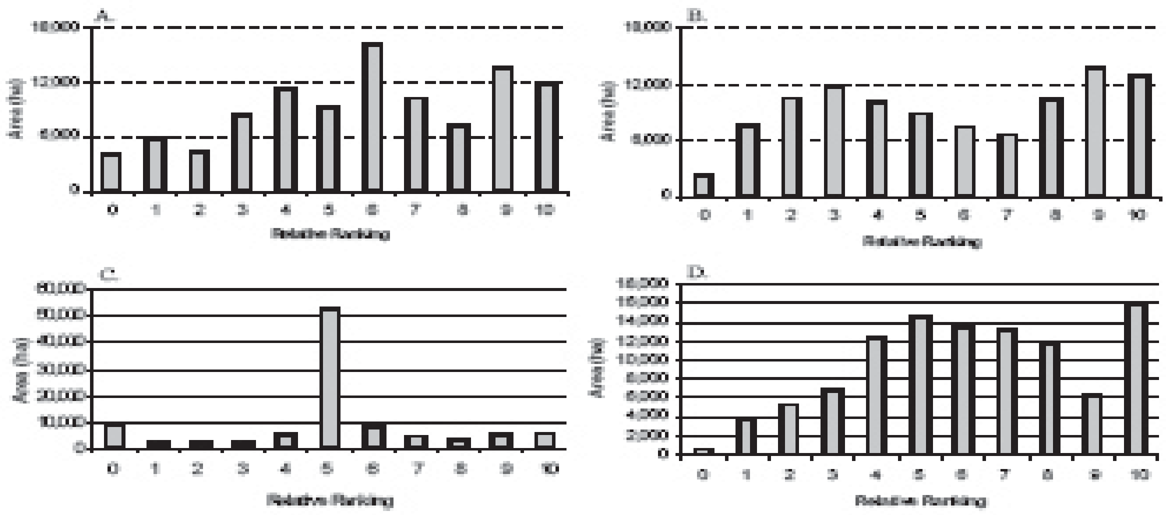

Figure 3. Frequency distribution of hectares of land for each ranking category for (A) ecoregional assessments, (B) land conversion, (C) road and population density, and (D) current conditions.

oped areas. At the non-developed end of the gradient, the higher-ranking value 9 represents a stretch of undeveloped lands (i.e., forests) with patches of interspersed development.

Road Density (Map 3). The distribution of road density across Kitsap County was between 0 and 27 miles of roads per square mile. Approximately 32% of Kitsap County fell below a road density of 2 miles of roads per square mile. Only 2% of Kitsap County had a road density above 9 miles of roads per square mile. Overall, a ranking of one (lowest relative value for wildlife) occurred in areas such as Bremerton, Silverdale, and Port Orchard. Medium rankings occurred on Bainbridge Island and other areas distributed around the county. Undeveloped areas with few roads received the highest ranking for fish and wildlife value.

Areas of Biological Significance (Map 4). Approximately 16% (16,377 ha) of Kitsap County includes wetlands (3,987 ha), salmonid-bearing streams (4,294 ha), or other significant biological features. Approximately 16,231 ha of Kitsap County shorelines, bays, estuaries, and open marine water are considered areas of biological significance.

Current Conditions Composite Layer (Map 5). The relative ranking for the current conditions layer was normally distributed, with the ranking value 10 slightly accentuated (Fig. 3D). Fifty-eight percent (60,450 ha) of Kitsap County received an above average rating (ranking >5) and approximately 13.2 % (15,952 ha) of Kitsap County land area received the highest biological value (relative ranking >9). The increased accentuation of the highest ranking value is the result of the addition of the areas of biological significance layer.

Planned Development. Of the 27,283 ha (26.6% of the county) zoned for high-density development in Kitsap County, 8,557 ha are considered high value (>6.6 ranking value) habitat based on the current conditions layer (Figs. 4, 5). Areas with coincident high-density zoning and high value habitat indicate potentially low compatibility between planned land use and current conditions. In contrast, areas of low-density development and high value habitat indicate potentially high compatibility. Approximately 19,235 ha of the 22,352 ha of Kitsap County that is zoned for low-density development is also ranked as high value habitat. Of the 52,962 ha that are zoned for medium-density development, 15,967 ha are considered high value habitat. Coincident areas of medium-density development and high value habitat can also indicate areas of potentially low compatibility.

DISCUSSION AND CONCLUSION

One of the primary purposes of developing this assessment was to provide citizens, local groups, agencies, and local governments with a starting

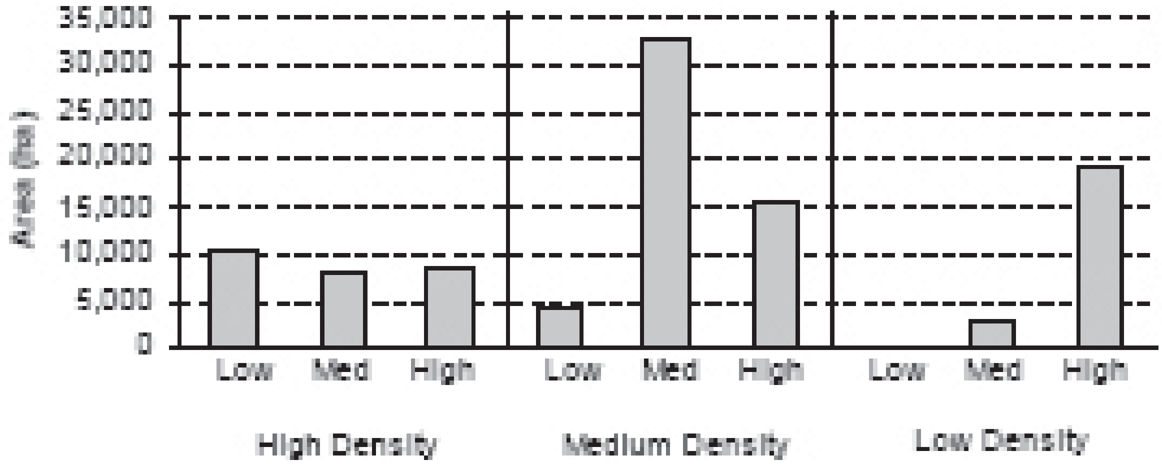

Figure 4. Frequency distribution comparing the low, medium, and high zoning densities with low, medium, and high ranking values from the current conditions layer.

point for prioritizing fish and wildlife habitats to achieve an appropriate level of protection at the county-wide scale. To conserve biodiversity, there is a growing need to ensure that consideration of the natural resources infrastructure is addressed simultaneously with that for the built environment (Ewing and Koystack 2004). Green infrastructure, as it is sometimes called, refers to the forests, wetlands, and other natural lands that provide ecological services such as cleaning air, filtering and cooling water, storing and cycling nutrients, as well as habitat function for myriad fish and wildlife species (Conservation Fund 2000). This assessment provides an organizing platform to initiate a green infrastructure evaluation, in a format that is user-friendly for land use planners and the public to review. It can serve as a collaboration tool to support far-reaching land use decisions.

Ultimately, creating an interconnected landscape of habitats will provide the most benefit for fish and wildlife species. Identifying regional and local contributions to biological diversity is often a daunting task for local governments. Fish and wildlife populations are dynamic and typically do not adhere to administrative boundaries. Moreover, animals often occupy distinct habitats at different times. For example, amphibians move between ponds, wetlands, and upland forests to meet different stages of their life history. Elk and other large mammals move seasonally between wintering and breeding habitats. Migratory birds that winter in South America may use local habitats for nesting, while other migrants may use individual patches of habitat as stopover or resting spots along their migration route. Anadromous fish move between freshwater and marine areas to fulfill their different life-history stages. The methods described here help to identify a connected network of habitats that encompasses a gradient of land use intensity.

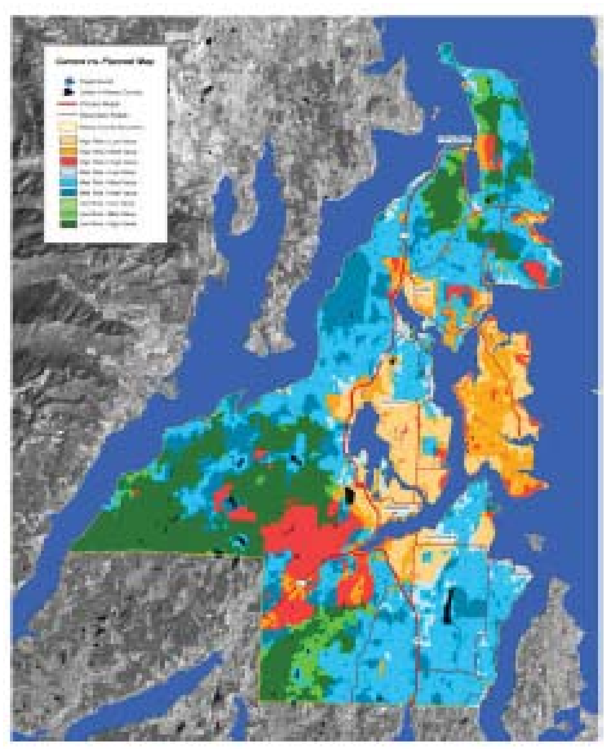

Figure 5. Map illustrating where areas of higher and lower potential compatibility occur within Kitsap County. Dark red represents areas of least compatibility (high biological value zoned high density). Dark green represents areas of higher compatibility (high biological value zoned lower density).

Limitations of this Information. This assessment characterizes current conditions for fish and wildlife based on existing levels of disturbance. It does not explicitly identify restoration opportunities, nor does it identify rare or unique species needs. As with any map, it is imperative that the information be applied and used at the appropriate spatial scale. We believe the methods to be most directly useful at the county-wide scale, and strongly informative at the mid-scale. While it is impractical and inappropriate to use this assessment as the sole piece of fish and wildlife information to address site-specific questions, the results can provide a landscape context for individual sites.

Potential Applications for the Assessment. Several aspects of comprehensive county land use planning can employ the results of this assessment as supporting information. First among these is setting or adjusting zoning density and land use intensity. The assessment can also inform the placement of new transportation and utility corridors, as well as the designation of natural resource lands and open space. The results work well with alternative incentive programs such as Conservation Futures, property tax reductions, or transfer of development rights. More fundamentally, the availability of credible, easy to use data supports the formulation of planning policies by cities and counties to guide the incorporation of fish and wildlife needs into future land use decisions.

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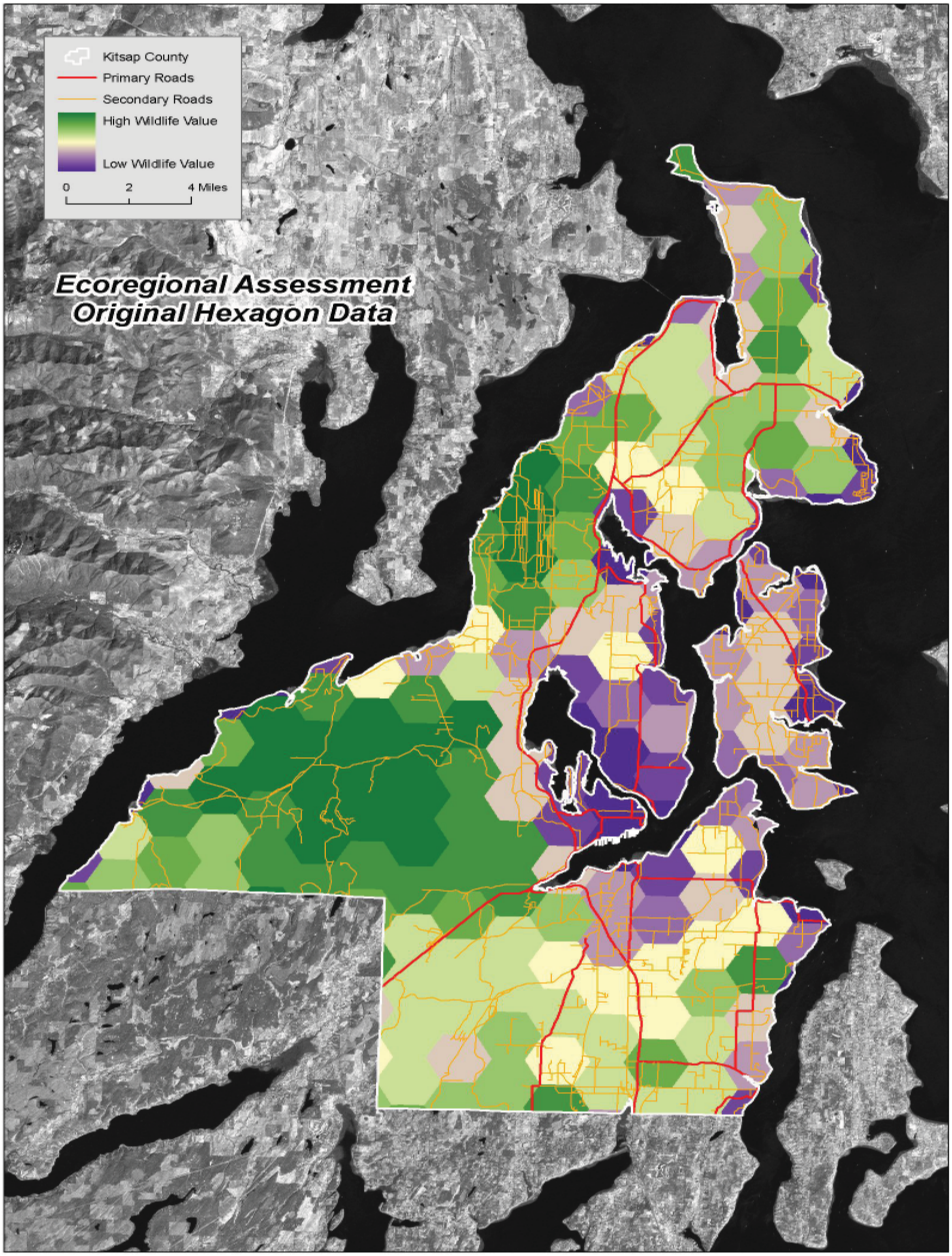
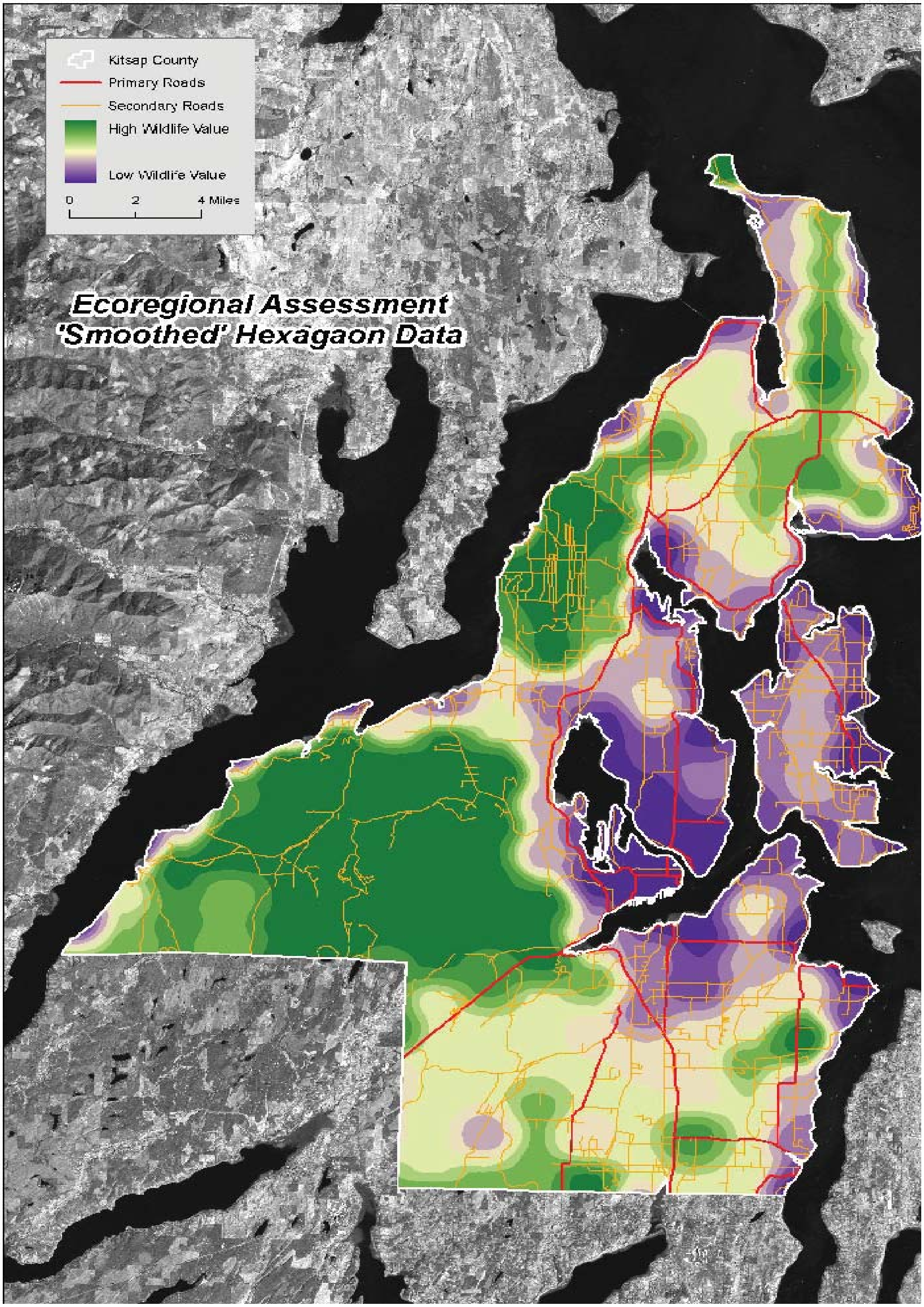
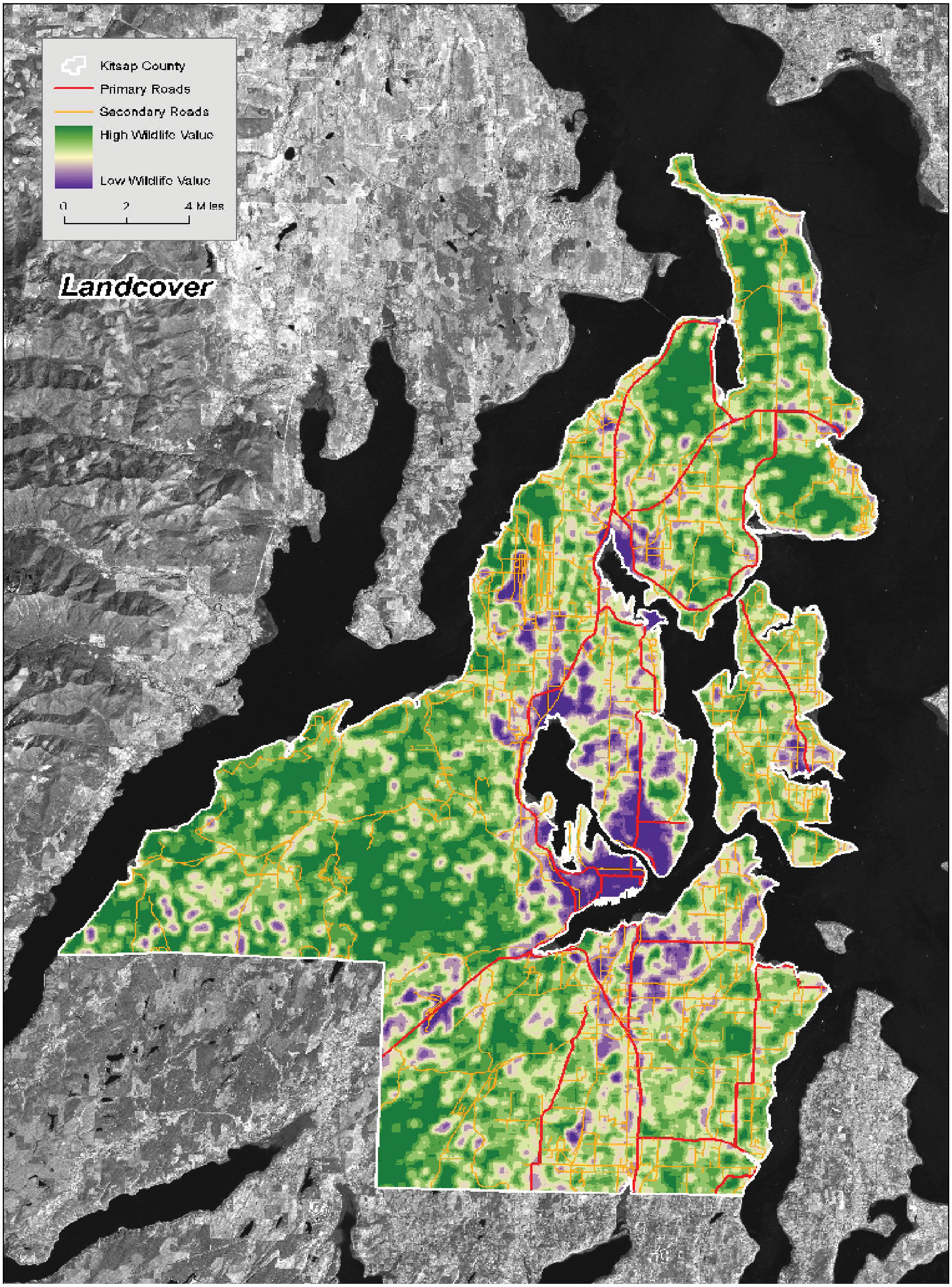


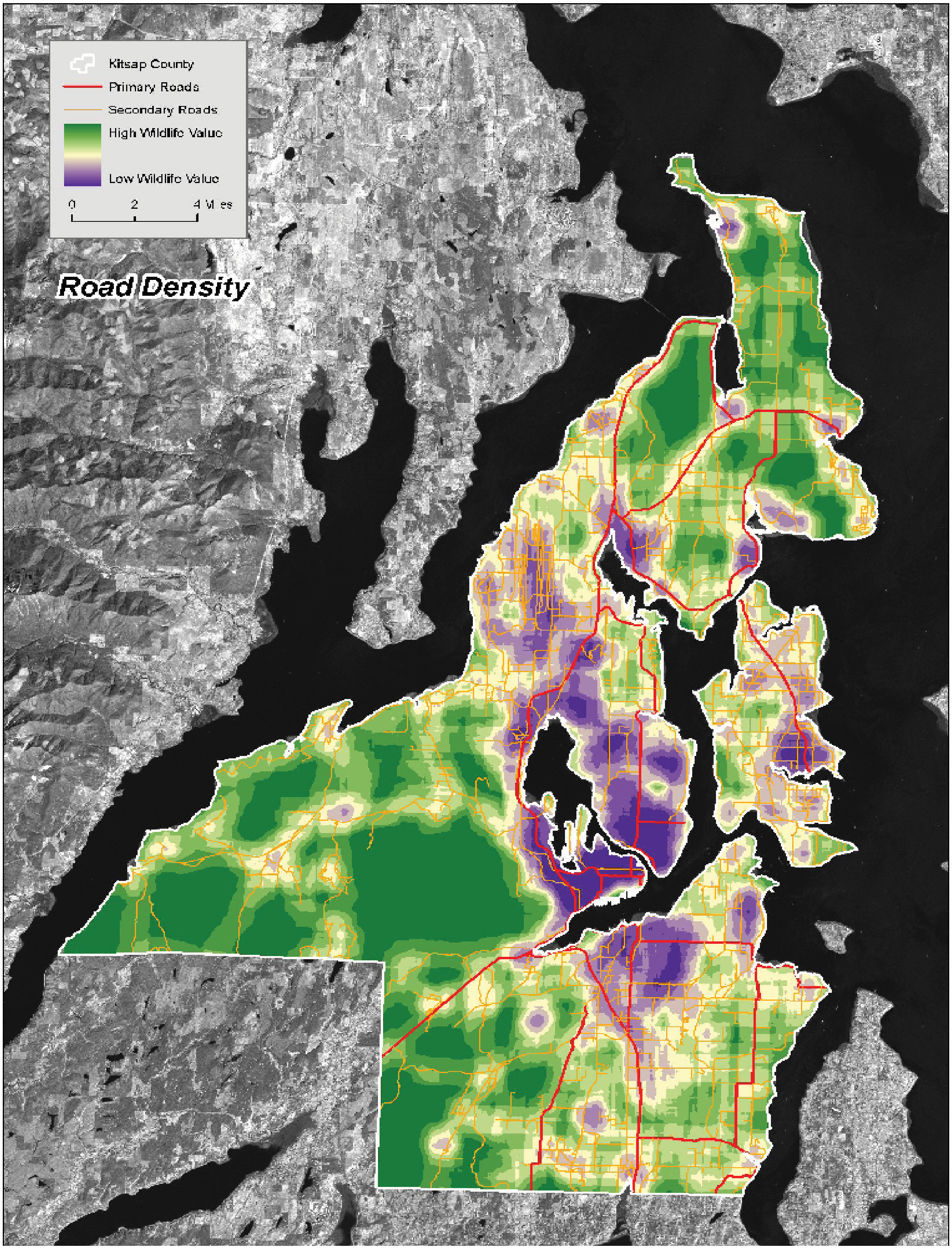
Map 1A. Ecoregional assessments, darker green represents areas of higher biological value (max ranking=10) for fish and wildlife. Dark purple indicates the least favorable (min ranking = 1) conditions for fish and wildlife. Areas from lighter green to light purple illustrate the gradient between high and low biological value.



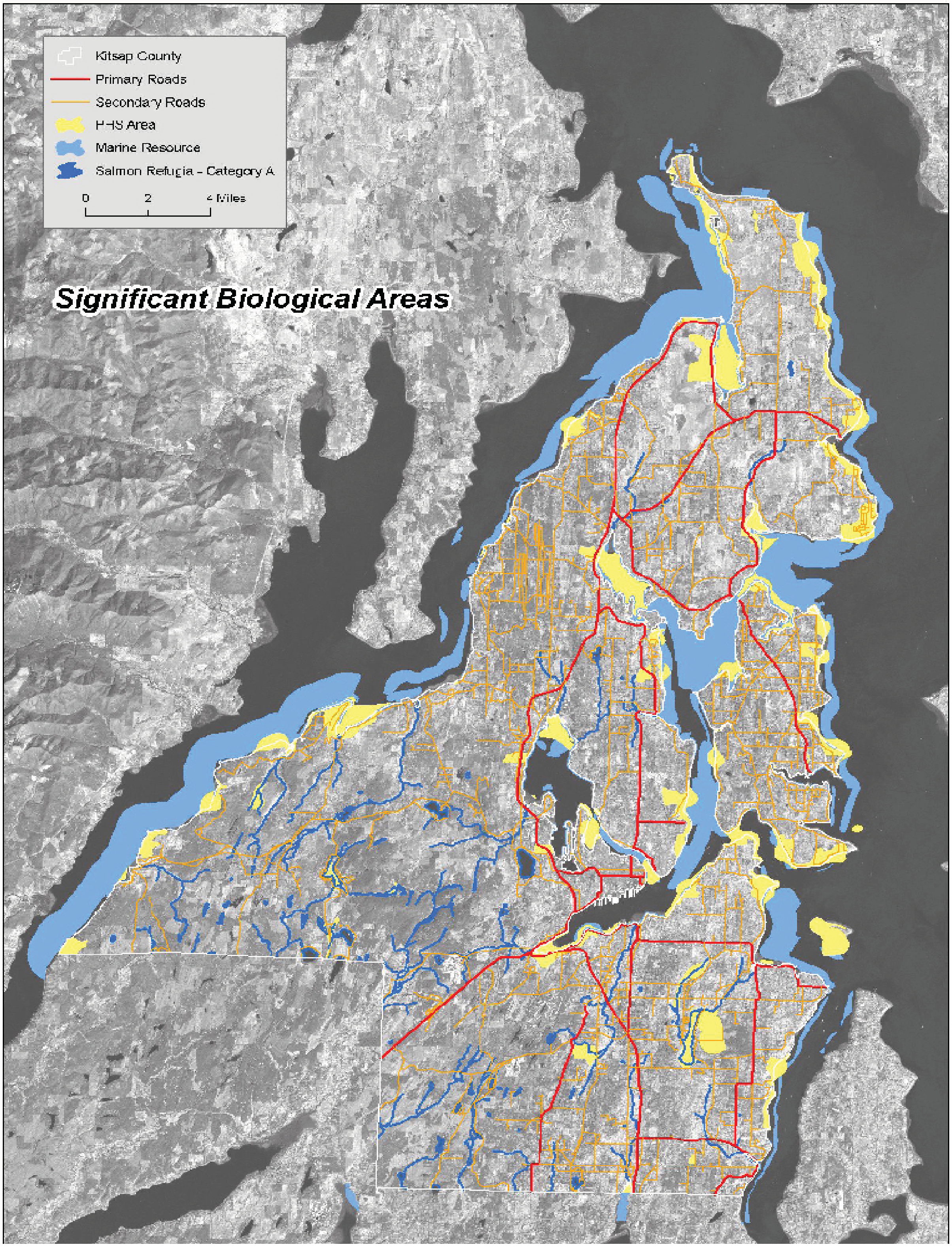
Map 1B. Ecoregional assessments, darker green represents areas of higher biological value (max ranking=10) for fish and wildlife. Dark purple indicates the least favorable (min ranking = 1) conditions for fish and wildlife. Areas from lighter green to light purple illustrate the gradient between high and low biological value.



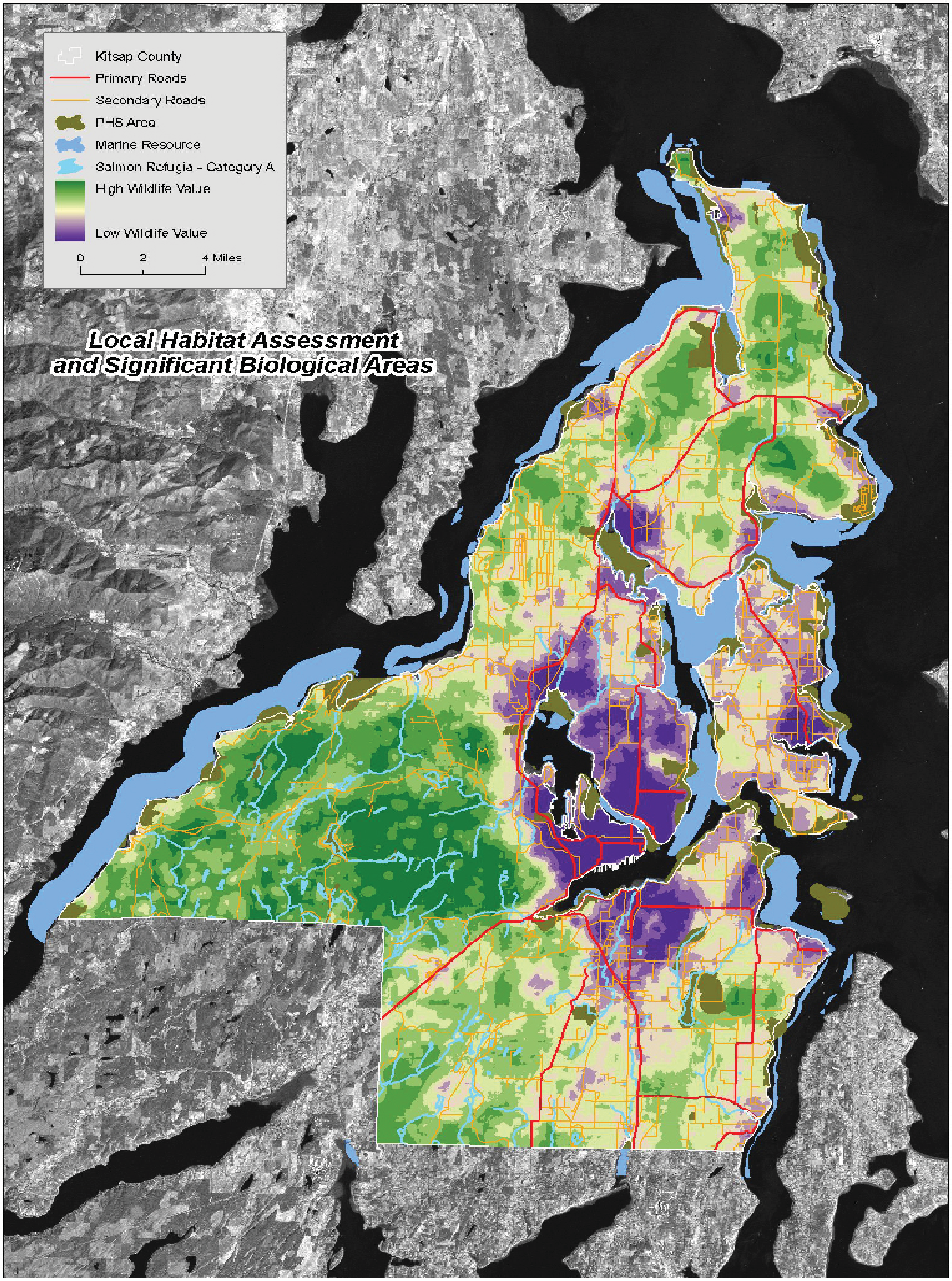
Map 2. Land conversion, darker green represents areas of higher biological value (max ranking=10) for fish and wildlife. Dark purple indicates the least favorable (min ranking = 1) conditions for fish and wildlife. Areas from lighter green to light purple illustrate the gradient between high and low biological value.



Map 3. Road density, darker green represents areas of higher biological value (max ranking=10) for fish and wildlife. Dark purple indicates the least favorable (min ranking = 1) conditions for fish and wildlife. Areas from lighter green to light purple illustrate the gradient between high and low biological value.



Map 4. Areas of biological significance, yellow represents PHS areas, light blue represents marine resources, and dark blue represents salmon refugia.



Map 5. Map of current conditions composite layer depicting the relative biological value at a county-wide scale. Darker green represents higher biological value (max ranking = 10). Dark purple represents the least favorable conditions for biological value (min ranking = 1). The gradient from light green to light purple indicate the transition between high and low biological value.

Appendix F: Crescent Valley Biodiversity Management Area Wildlife Analysis

This analysis focuses on an area containing biological diversity in a rapidly urbanizing setting—the Crescent Valley watershed and the included Gig Harbor Biodiversity Management Area (BMA), (Pierce County Biodiversity Alliance 2004; Figure E1). This area is located in Pierce County. In this analysis we use measurement and watershed-scale wildlife mapping approaches to develop information for local community decision-making.

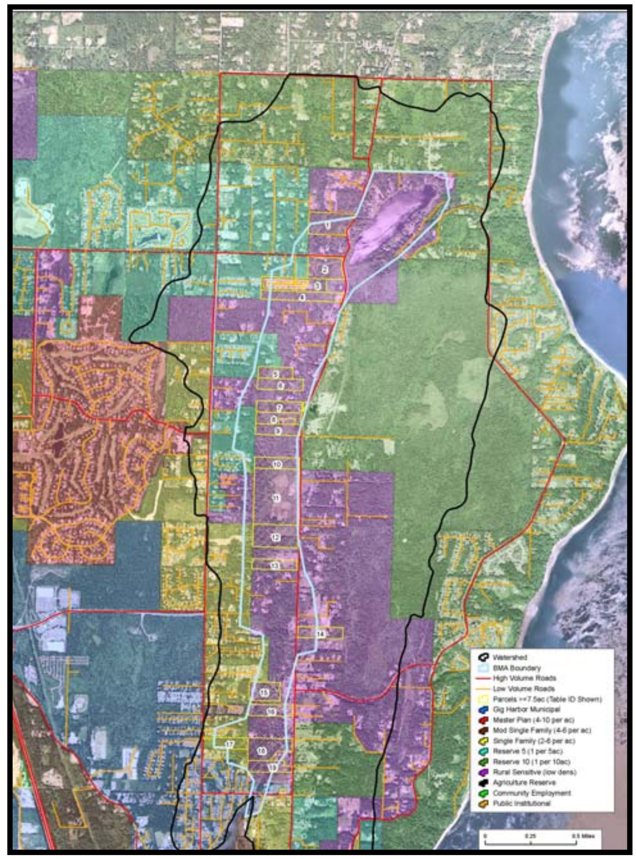


Figure E1. The boundaries for the Gig Harbor Biodiversity Management Area (blue), and the Crescent Valley watershed (black).

There are three predicted at-risk species, 14 state or federal-listed species, and 17 Washington Department of Fish and Wildlife (WDFW) priority species in the BMA. Six amphibians, 74 birds, 43 mammals, and five reptiles are predicted to inhabit this area, and 11 butterfly species have been confirmed. The confluence of Crescent Creek and Gig Harbor Estuary is a WDFW priority habitat; shorelines associated with the estuary are rated high quality, and chinook salmon (*Oncorhynchus tshawytscha*, federal threatened, state candidate) occur in Crescent Creek.

As more people move to Crescent Valley, some species such as the American robin (*Turdus migratorius*), raccoon (*Procyon lotor*), and Pacific treefrog (*Hyla regila*) will continue to thrive, but many more sensitive species will be retained only if management considers factors such as maintaining sufficiently large habitat patch sizes and conditions that allow safe movement between patches and seasonal habitats.

Planning Context

- Pierce County has adopted a biodiversity network into open-space classification (http://www.co.pierce.wa.us/pc/services/home/property/pals/other/biodiversity.htm).
- The Gig Harbor Biodiversity Management Area is a specific area within the network.
- Residents from the local community have developed a plan to retain the area's biodiversity with the assistance of Friends of Pierce County and the Pierce County Biodiversity Alliance.

- The information provided in this chapter was developed to assist the local community with their biodiversity planning.

Focal Species and Response Groups
WDFW Priority Habitats and Species data, species lists within the network document (Pierce County 2004), and additional data from an intensive wildlife survey held June 3-4, 2005, provided information on species expected or verified to be present. Through consideration of this information, we chose the following species and groups for analysis:

- Common garter snake, based on importance to the biodiversity network.

- Northern red-legged frog (*Rana aurora*), based on importance as a food source to the common garter snake, and as a species that, if its habitat needs are addressed, will also address the habitat needs of other amphibians (i.e., it acts as an "umbrella species" to other amphibians).

- Bobcat (*Lynx rufus*)and coyote (*Canis latrans*), umbrella species for mid-to large sized wide-ranging mammals.

- Bird development response groups based on patch sizes and dwelling density sensitivities.

Stressors to Evaluate
Table E1 provides an overview of development stressors associated with these species/groups.

Table E1. Development response groups, focal/umbrella species, housing density sensitivity, and primary stressors to wildlife to address for the Crescent Valley biodiversity management area.

Development Response Group	Focal/or Umbrella Species	Housing Density Sensitivity	Primary Stressors to Address					
			Habitat Composition	Habitat Configuration	Habitat Connectivity	Roads	Hydrology	Non-Native Species
Terrestrial reptiles, aquatic and terrestrial habitat, extensive spatial scales, live birth	Common garter snake	Moderate sensitivity (expected persistence at ≤1du/10ac)	- natural habitat	- breeding and active-season habitat different	- extensive movement by ground	- road mortality	- changes to hydrology	- domestic cats
Pond-breeding amphibians, intermediate movement scale, require breeding habitats with long hydroperiods	Northern red-legged frog	High sensitivity (expected persistence at ≤1du/20ac)	- natural habitat	- breeding and active-season habitat different	- extensive movement by ground	- road mortality	- changes to hydrology - need longer hydroperiod ponded habitat	- bullfrogs · non-native fishes - dogs
Mid-sized mammals with moderate movement capability, moderate fragmentation tolerance	Bobcat	Moderate sensitivity (expected persistence at ≤1du/10ac)	- patch size	- wide ranging	- patch isolation	- road density -road mortality		
Large-sized mammals with extensive movement capability, highly fragmentation tolerant	Coyote	Very low sensitivity (expected persistence at ≤1du/2.5ac)				- road density -road mortality		
Birds, high tolerance for development, moderate to high (or unknown) sensitivity to patch area	Suite of bird species[a]	Low sensitivity (expected persistence at ≤1du/5ac)	need: - patch size >12ac - well developed shrub layer - older conifer nest trees or snags	- patch shape				- domestic cats
Birds, low tolerance for development, moderate sensitivity to patch area	Suite of bird species[b]	Very high sensitivity (expected persistence at ≤1du/20ac)	need: - patch size >12ac - need riparian, conifer, hardwood, wetlands	- patch shape				- domestic cats

[a]Incuding: band-tailed pigeon (*Columba fasciata*), ruby-crowned kinglet (*Regulus calendula*), Cooper's hawk (*Accipiter cooperii*).

[b]Incuding: MacGillivray's warbler (*Oporornis tolmiei*), brown creeper (*Certhia americana*), red-eyed vireo (*Vireo olivaceus*), northern saw-whet owl (*Aegolius acadicus*).

Indicator Measurements for Stressor Analysis
Based on the stressors in Table E1 and available measurements and narrative parameters, we used the following parameters to evaluate current conditions for wildlife in Crescent Valley:

- Dwelling unit densities
- Riparian integrity (to support various aspects of habitat)
- Patch size for mammals
- Patch size for birds
- Habitat composition, connectivity and configuration (necessary for those animals with moderate to extensive movement, that must move along the ground)
- Roads (for traffic and amphibians; also road density and crossing issues for mammals)
- Non-native animals (bullfrogs, fish, cats, dogs)

Evaluation of Measurements and Narrative Criteria
For each parameter above, we show the questions we asked to guide the stressor analyses. We also include the applicable measurements or narrative parameters, measured results, and examples of the GIS maps produced.

<u>**Zoning and Dwelling Unit Densities**</u> **(Figures E2A-D).**
Questions:

- What is the existing zoning?
- Are there incongruities between existing zoning and the needs of focal species and development response groups?

Applicable measurements:

- Coyote has expected persistence at dwelling unit (du) densities of ≤1du/2.5 acres,
- Birds - high development tolerance with >12 acre patch size have expected persistence at ≤1du/5 acres,
- The common garter snake and bobcat have expected persistence at ≤1du/10 acres, and
- The northern red-legged frog and birds - low tolerance for development with >12 acre patch size have expected persistence at ≤1du/20 acres.

Measured values: Much of the watershed is zoned for maximum densities of 1du/5ac or 1/du/10ac. No areas are zoned at 1du/20ac or less.

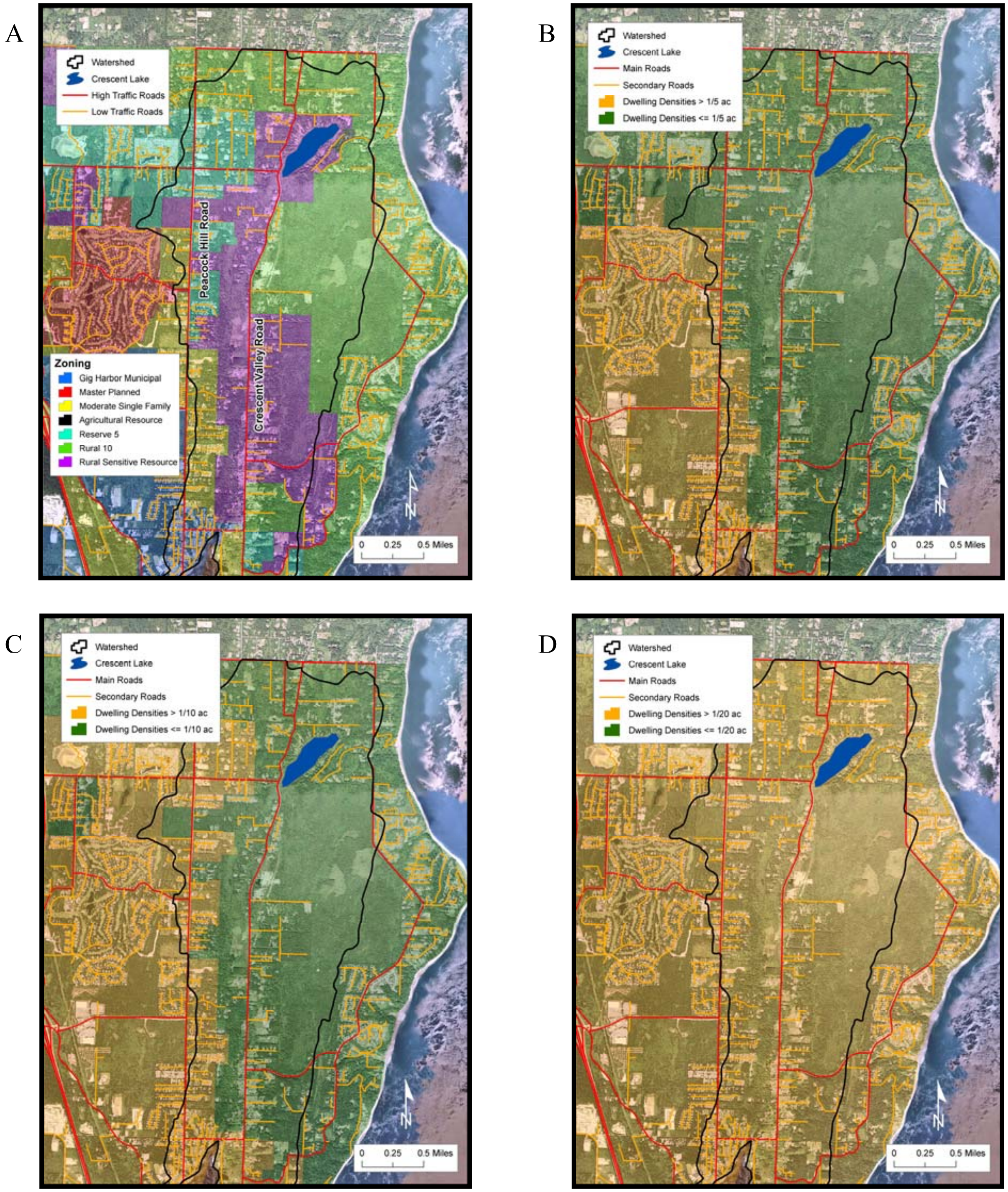


Figure E2 A-D. A. Zoning designations for the Crescent Creek drainage basin and surrounding areas. B. Dwelling densities that meet the needs of coyote and birds with high development tolerance (≤1du/5 acres), in green). C. Dwelling densities that meet the needs of common garter snake and bobcat (≤1du/10 acres), in green). D. Dwelling densities that meet the needs of the northern red-legged frog and birds with low tolerance for development (≤1du/20 acres); no green indicates dwelling densities are not expected to be suitable without special measures).

Crescent Valley Riparian Habitat Integrity (Figure E3)

Questions:
- Do streams have enough intact riparian vegetation to provide riparian habitat for wildlife?
- Where are locations where riparian restoration is needed?

Applicable measurements:
- % riparian corridor >100 ft wide & <35 ft wide,
- Number of road, utility, and path crossings in the corridor per mile.

Measured values: Mainstem Crescent Creek between the lake and the estuary has 44% >100ft and 20% <35ft-wide forested or wetland riparian area. The tributaries have 56% >100 ft wide and 21% < 35ft-wide forested or wetland riparian area.

There are two road breaks per stream mile along the mainstem, and one break per stream mile along the tributaries.

Figure E3. Riparian areas in the Crescent Valley stream network that meet the criteria for >100ft riparian habitat are shown in green.

<u>**Crescent Valley Mammal and Bird Patch Sizes (Figure E4)**</u>

Questions:
- How fragmented is the natural vegetation, and where are the patches of natural vegetation located?
- What size are the remaining patches?

Applicable measurements:
- Patches of natural vegetation 12-100 acres, and >100 acres for birds with sensitivity to patch size,
- Patches of natural vegetation >800 acres to support three female bobcats' persistence.

Measured value: Although the watershed is extensively fragmented by roads, homes, and associated clearings, there still exist large patches and opportunity to plan for the retention of wildlife. There is one patch large enough

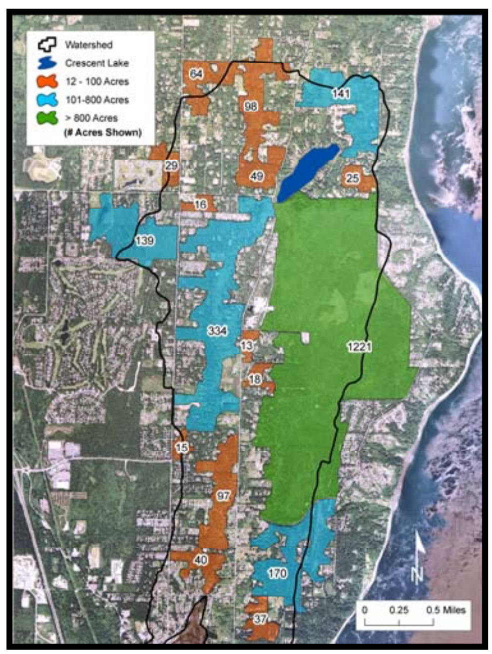


Figure E4. Vegetation patches 12-100 acres and >100 acres (for birds with sensitivity to patch size), and >800 acres (for bobcat) that intersect or exist in the Crescent Creek watershed.

for three female bobcats on the east side of the watershed (1221 ac); in addition, there are four patches >100 acres, and 12 patches 12-100 acres meeting the requirements for birds with sensitivity to patch size.

Crescent Valley Habitat Composition, Connectivity, and Configuration for Amphibians and Reptiles (Figures E5 and E6)

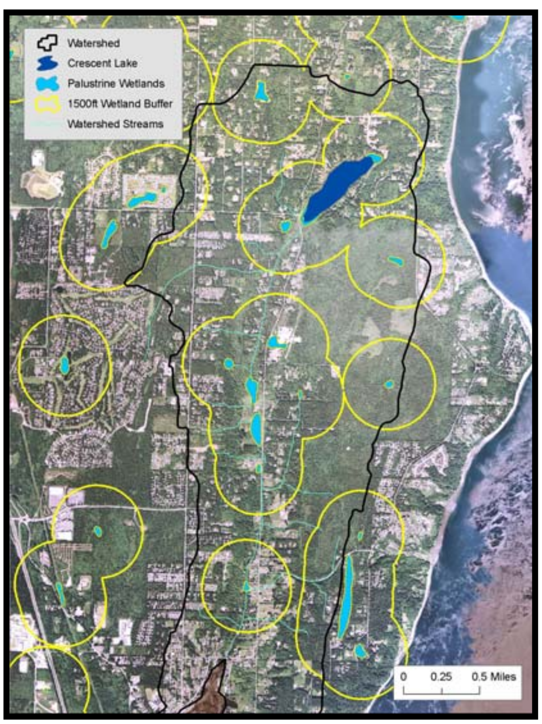
Questions:

- Where are palustrine wetlands and how are they spatially distributed?
- What are patterns of connectivity between wetlands, and between wetland habitat and terrestrial habitat (including streams) used by amphibians and reptiles during their seasonal cycles?

Applicable measurements:

- Connectivity and habitat zone (CHZ) radius from wetland,
- CHZ % forest/ vegetation.

Measured values: Percent vegetation within the three CHZ components is variable, but overall ranges from approximately 75% to 90%. The three CHZ components each have an approximately 0.5 mi radius (low protective level); however, the distance along the valley cumulatively is approximately 3 mi and therefore provides a higher level of protection.



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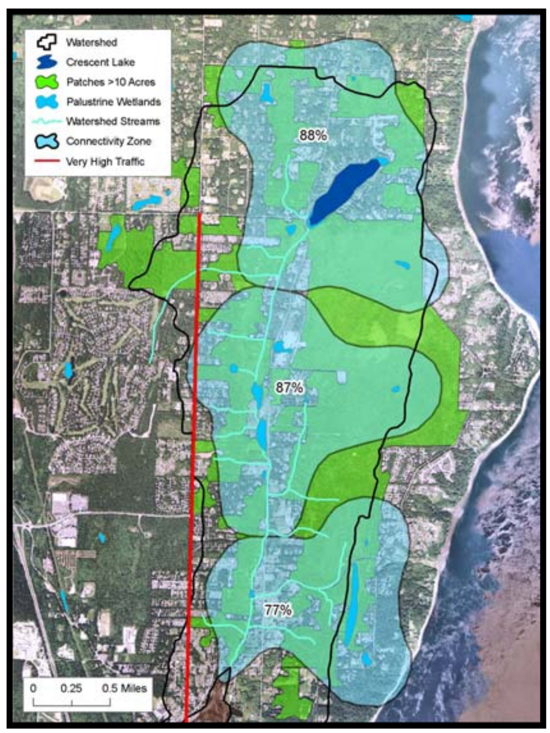

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Figure E5. Crescent Valley wetlands and connectivity patterns. This map uses a radius of 0.3 mi to highlight wetland habitat and potential connectivity patterns for pond-breeding amphibians.

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Figure E6. We have broadened the connectivity patterns to indicate linkages between areas along the riparian zone of Crescent Creek, and overlaid this pattern onto the patch map.

Roads (Figure E7)

Questions:
- What are potential road concerns for mammals, amphibians, and reptiles?
- Are there suitable numbers of crossing areas for mammals, and how are they spatially distributed?

Applicable measurements:
- Traffic intensity: average daily vehicles per hour,
- Road density,
- Roads and habitat connectivity: locations with undeveloped habitat on both sides of road.

Measured values:
- The overall density within the Crescent Valley Watershed is 5.9 mi of road/mi^2, 1.9 mi of high volume traffic roads/mi^2.
- Crossing areas exist; fragmentation is extensive.

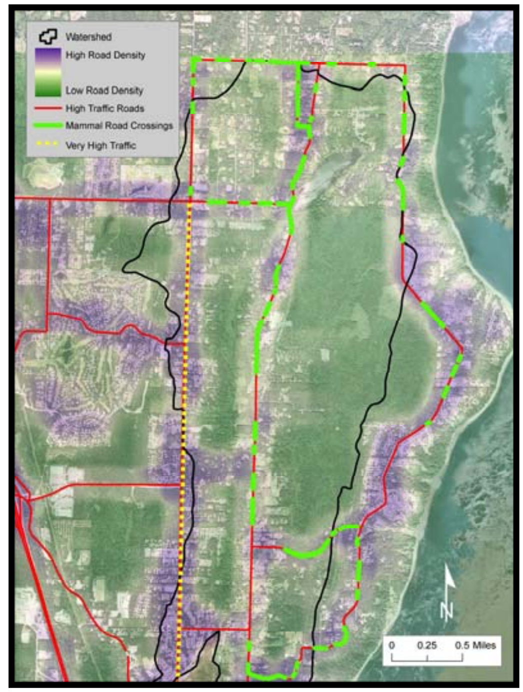

Figure E7. Road traffic volume, road density, and expected mammal crossing areas within Crescent Valley watershed and surrounding areas.

Non-Native Species (Figure E8)

Question: Are there issues that should be addressed related to bullfrogs, cats, and dogs?

Applicable narrative parameters:
- Bullfrogs - presence or absence and relative amount,
- Cats and dogs are expected where homes exist.

Measured values: Many bullfrogs were found in Crescent Valley during the 2005 intensive survey; cats and dogs are expected, especially near homes.

Figure E8. Bullfrogs were found during the 2005 intensive survey in two locations within the area of the dashed circle.

Summary of Analysis Information

Table E2. Summary wildlife measurements/parameters analyses and results for the Gig Harbor Biodiversity Management Area.

Analysis Parameter	Indicator	Crescent Creek Watershed	Discussion	Recommendations for Fish and Wildlife
Dwelling Unit Density	Zoning	Substantial areas are zoned for 1 du/5 and 1du/10 acres; some areas are zoned for higher densities, including Gig Harbor municipal	Both the coyote, and birds with high development tolerance, have zoning compatible with their needs throughout much of the Crescent Valley watershed. However, the lowest dwelling densities of 1 du/5 acres and 1 du/10 acres may be too dense to support the persistence of many: birds with low development tolerance, mammals, amphibians, and reptiles .	Adjusting zoning or obtain conservation easements or similar approaches to better meet the needs of the more sensitive species. Take into account locations of important patches, amphibian connectivity and habitat zone(s), and corridors or connective linkages.
Watershed Hydrology	% forest/natural vegetation in contributing watershed	Approximately 80%	Maintaining the aquatic habitat, water quality, and fish and wildlife species in streams and wetlands within Crescent Valley into the future will depend on maintaining ≥ 65% to 90% forest within the watershed. The current level of 80% forest cover provides for high quality hydrologic function for both wetland water level fluctuation and for stream hydrology. Important for pond breeding amphibians, and reptiles such as the Common garter snake that depend on the amphibians for food; also important for native fish species that utilize the stream, wetland and lake systems.	Maintain ≥65% to 90% natural vegetation throughout the Crescent Creek watershed, and use LID (low impact development) techniques for new development.
Riparian Integrity	% riparian corridor wider than 100 ft ; % corridor < 35 ft wide; number of breaks (road crossings) in the corridor	Crescent Cr. between the lake and estuary has 44% >100ft and 20% <35ft wide forested/wetland riparian area; tributaries have 56% >100 ft wide and 21% < 35ft wide forested/wetland riparian area. There are two road breaks/stream mile along the mainstem, and one break/stream mile along the tributaries.	Riparian integrity is high if >70% of the corridor is wider than 100 ft (each side of stream), and <10% of the corridor is less than 35 ft; and, there are <3 breaks in the corridor/stream mile. Streams with higher levels of riparian integrity have a greater potential for maintaining natural ecological functions (hydrology, bird, mammal, amphibian and reptile habitat, and natural corridor functions). Crescent Valley has variable riparian integrity, with many areas that are good, but overall the integrity does not meet a high quality condition. The mainstem is also impacted by Crescent Valley Road as it is located parallel to Crescent Creek within the riparian area for about 1/3 mile.	Maintain riparian integrity by keeping the riparian corridor intact, and maintaining <3 breaks in the corridor per stream mile. Restore the riparian corridor where opportunities exist. WDFW PHS Riparian Recommendations (Knudsen & Neaf 1997) recommend 150 to 250 feet wide riparian zones; based on this, maintaining or restoring riparian zones wider than 100 feet is recommended. Locations that provide connectivity between patches are a top priority for restoration.
Patch Size: Mammals	Patch size ≥800 acres (based on habitat for 3 female bobcats)	One patch this size exists in Crescent Creek watershed	This patch size indicates habitat needs may be met for mid-size wide-ranging mammals such as the bobcat. This large patch also provides habitat for species such as the long-tailed weasel, mink, and Western spotted skunk.	Maintain a large core patch without development or roads, minimize fragmentation and habitat loss within this patch, join patch to linkage areas that connect patch to interior of valley (first priorty), and to external areas such as the sound, and the penninsula to the north. Encourage development along the east-side of the patch, instead of the west-side or internally.
Patch Size: Birds	Patch sizes 12 to 100 acres, and >100 acres	These patch sizes exist in the Crescent Creek watershed	Crescent Valley includes a rich diversity of birds. Some examples of birds that are sensitive to patch sizes and require larger patches are the brown creeper, band-tailed pigeon, Cooper's hawk, MacGillivray's warbler, northern saw-whet owl, red-eyed vireo, and ruby-crowned kinglet.	Maintain patches 12 to 100, and >100 acres scattered throughout the watershed. Keep patches connected to other habitat areas to increase benefits to wildlife.

Table E2. Continued.

Indicator	Crescent Creek Watershed	Discussion	Recommendations for Fish and Wildlife
% forest/natural vegetation in amphibian and reptile connectivity and habitat zone	88% (upper area), 87% (mid-sections), and 77% (lower section)	Amphibians and reptiles move widely through the Crescent Valley watershed to utilize seasonal habitats (e.g., pond breeding habitat and upland distant summer habitat) and will be at significant risk from loss of habitat and connectivity as the area continues to develop. The measured values indicate connectivity is generally good, although at values below 80% careful attention is needed to ensure patches of habitat are connected. This is particularly evident in the lower CHZ where much of the development is clumped near the stream potentially creating a barrier effect.	Maintain a broad area within the Crescent Valley watershed as a connectivity and habitat zone (CHZ), where animals can easily move through to necessary habitats. Retaining or restoring 50 to 80% natural vegetation (good condition); >80% (best condition) will provide both habitat and connectivity to habitat. Below 80% natural vegetation careful attention to how natural habitat is located is important. Include careful consideration of roads and traffic levels.
Traffic intensity: daily vehicles per hour (v/hr): <15v/hr for amphibian persistence	Information is needed	Traffic levels greater than approximately 15 v/hr are expected to impact amphibian population persistence. Extensive literature indicates a strong relationship between traffic intensity, or road density out past 1 mile from breeding ponds, and amphibian and reptile species richness. In the Crescent Valley, main roads such as the Crescent Valley Road are likely to be impacting amphibian survival due to road crossing mortality. As traffic increases over time, this road could potentially become a complete barrier to movement.	Use traffic softening methods (e.g., lower speed limits) to limit through traffic on Crescent Valley Road which runs through the heart of important wildlife habitat. Locate new development to minimize traffic in the interior areas of Crescent Creek watershed. Underpassings along Crescent Valley Road may be needed for amphibians. Peacock Valley Road is very busy, further from wetland stream systems, and nearer the urban growth boundary. This road appears to be a better choice for higher traffic volumes.
Road density: threshold value = 1mi road/sq mi	The overall density within the Crescent Valley Watershed is 5.9 mi/sq mi overall, and 1.9 mi/sq mi of high traffic roads	Good conditions for mammals are predicted at <1 mi/sq mi; between 1 and 2.4 mi/sq mi special focus is needed to assure adquate conditions for mammals; at >2.4 mi/sq mi, extensive focus and planning will be necessary. The roads of highest concern will be those that carry high traffic loads. Roads are a significant issue for mammals due to direct mortality, noise related impacts, and causing movement barriers.	Minimize the building of new roads.
Roads and habitat connectivity: ca. 165 ft forest along road for mammal crossings	Road crossing areas exist, but fragmentation is extensive	Forest must exist on both sides of road for distances of ca. 165 ft. Note that this habitat needs to be linked up with other habitat blocks (see connective linkages above). Importance is very high for mammals that must cross roads.	Maintain or restore forest and natural habitat along roads. Pay special attention to connective linkages. Sign important areas where wildlife cross roads.
Presence of non-native species	Present	Abundant non-native fish and bullfrogs were found in the biodiversity management area during the 2005 Bioblitz. Non-native fish and bullfrogs can cause reduced abundance and decreased population persistence for pond breeding amphibians and species such as the common garter snake that depend upon the pond-breeding amphibians for food. Dogs and cats that are untended may kill large numbers of wild animals; and dogs running in the edges of ponds when there are developing amphibian egg masses may cause mortality through disturbance.	Utilize signs and other educational opportunities to address these issues. Undertake additional survey effort to determine how extensive the spread of the bullfrogs and non-native fish has been within Crescent Valley. Consider opportunities and methods for removal of the non-native fish and bullfrogs.

Synthesis Questions

We asked specific questions to better understand how recommendations for different species or issues might work together for planning purposes.

Patches, connectivity and habitat zone, and riparian areas:

- Where are commonalities between patch needs for mammals and birds, and where do these overlap with stream/riparian areas and amphibian connectivity and habitat zone (CHZs)?
- Considering the commonalities, where are priority areas to maintain patches and to refine boundaries for the CHZ?
- Where are priority areas for restoring riparian areas?

Roads:

- How do roads affect conditions in important patches, CHZs, and riparian areas?
- What specific road planning measures are needed?

Corridors and connective linkages:

- Where do connective linkages or corridors need to be maintained to ensure mammals, amphibians, and reptiles are able to move between patches within the watershed and to external areas?
- What are the recommendations for retaining or restoring corridors or linkages?

Dwelling densities:

- Where are zoning densities incompatible with maintaining species in the identified CHZs, habitat patches, and other important locations within the watershed?
- What are recommendations for areas where zoning densities may be incompatible?

Planning Recommendations Summary

Based on consideration of the synthesis questions and recommendations from Table 2, planning recommendations for maintaining wildlife in Crescent Valley are presented in Figure E9. Note that because the BMA (i.e., the central portion of the valley) is focused on aquatic and wet environments, a watershed-based set of recommendations is provided.[1] Figure E9 indicates one approach to visualize how some of the recommendations may work together.

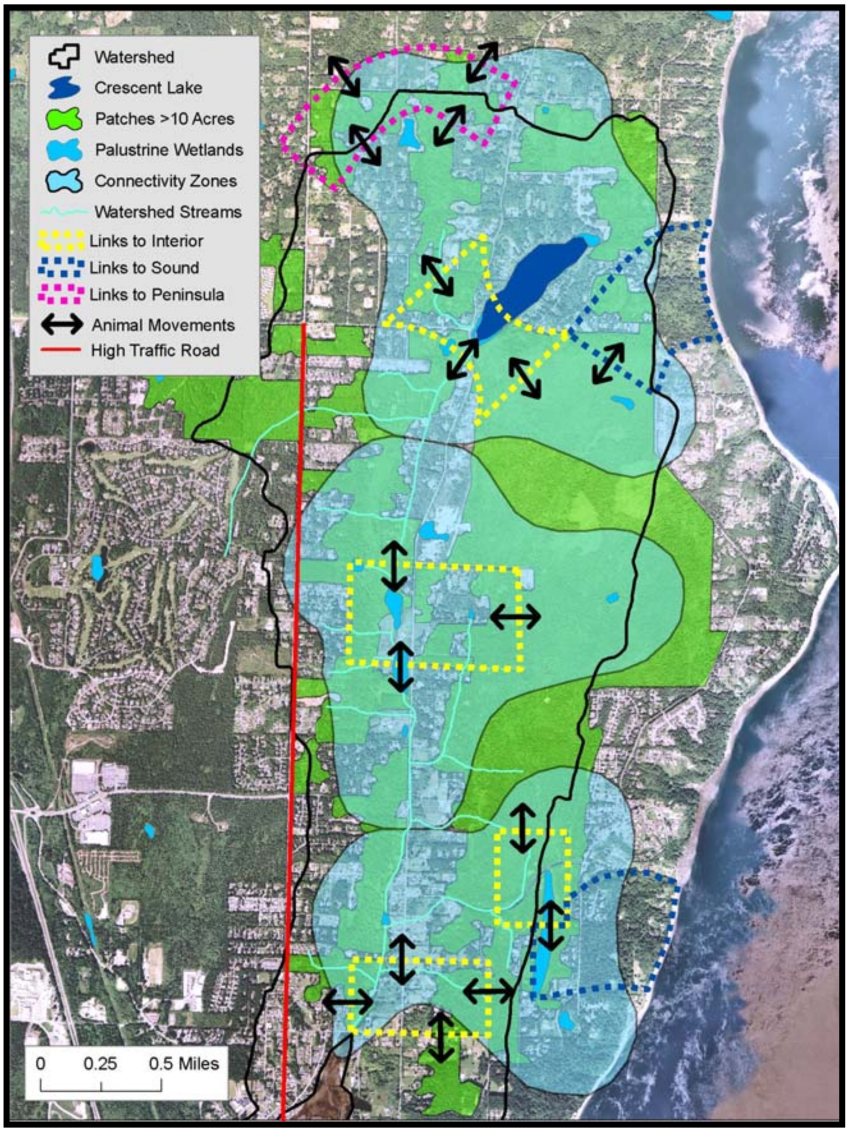

Figure E9. Summary overlay map indicating patches (green), amphibian and reptile connectivity and habitat zones (light blue), the Crescent Creek stream system, and a series of linkage areas to maintain connectivity between patches, and to external areas such as terrestrial areas to the north and to Puget Sound to the east.

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[1] With the best of stewardship solely within the BMA boundaries, much of the fish and wildlife that make this area special would be expected to be poorly retained over time.

Dwelling unit densities:

- Adjust zoning or obtain conservation easements (or other approaches) to better meet needs of the more sensitive species. Take into account locations of important patches, amphibian connectivity and habitat zone(s), and corridors or connective linkages.

Riparian integrity:

- Maintain existing areas of high integrity by keeping the riparian area intact and by maintaining <3 breaks in the riparian area per stream mile. Restore the riparian area where opportunities exist; locations within connective linkages are a top priority for restoration.

Patches for birds and mammals:

- Birds: maintaining a variety of patch sizes (i.e., 12- 100 acres, and >100 acres) throughout the watershed will benefit many bird species. Keep patches connected to other habitat areas to increase benefits to wildlife.
- Mammals/Bobcats: maintain a large core patch without development or roads, minimize fragmentation and habitat loss within this patch, join the patch to linkage areas that connect the patch to the interior of the valley (first priority) and to external areas such as Puget Sound and the peninsula to the north. Encourage development along the east side of the patch, instead of the west side or internally.

Habitat connectivity zone for amphibians and reptiles:

- Maintain a broad area within the Crescent Valley watershed as a connectivity and habitat zone where animals can easily move through to important habitats. Retaining or restoring 50 to 80% natural vegetation (good condition) and >80% (best condition) will provide habitat and connectivity between habitat patches. At levels <80% natural vegetation, attention to where natural vegetation is located is necessary. Include careful consideration of roads and traffic levels.

Roads:

- Use traffic softening methods to limit traffic on Crescent Valley Road which runs through the heart of important wildlife habitat. Locate new development to minimize traffic in the interior areas of Crescent Creek watershed. Underpassings along Crescent Valley Road may be needed for amphibians. Peacock Valley Road is very busy, further from wetland stream systems, and nearer the urban growth boundary. This road appears to be a better choice for higher traffic volumes.
- Minimize the building of new roads.
- Maintain or restore forest and natural habitat along roads. Pay special attention to connective linkages. Sign important areas where wildlife cross roads.

Corridors and Connective linkages:

- Maintain linkages with ≥80% natural vegetation. Give special attention to road crossings in linkages: preserve forest/undeveloped habitat on both sides of road, route traffic away from linkages, sign for wildlife crossing, and lower speed limits. Throughout the rest of the CHZ, retain >50% natural vegetation (>80% is best).

Non-native animals:
- Use signs and other educational opportunities to address these issues.
- Undertake additional survey efforts to determine the extent of bullfrogs within Crescent Valley.
- Consider opportunities and methods for removal of bullfrogs.

More information is available on the Pierce Biodiversity Network website: (http://depts.washington.edu/natmap/projects/bma/gig_harbor/).

GIS Mapping Methods for the Crescent Valley Case Study

<u>Zoning and Dwelling Unit Densities (Figures E2A-D)</u>. Use GIS zoning maps to depict zoning for the planning area. Make additional maps that portray where specific zoning densities meet the persistence measurements for the focal species and DRGs.

<u>Riparian Habitat Integrity (Figure E3).</u> Obtain the most spatially accurate digital layer depicting the stream network, and the most current digital orthophotograph. Use the GIS to buffer the streams out 100 ft, and display the buffer boundary over the digital photograph. Interpret where riparian vegetation extends the width of the 100 ft buffer, and digitize a line along the stream representing the length of those riparian areas. The ratio of the length of the stream segments of 100 ft-wide riparian areas to the total stream length will provide the percent of riparian habitat integrity at a 100 ft buffer width. Conduct a similar process for a 35 ft buffer width.

To determine breaks/mile, visually observe where breaks exist, and average the number of breaks over the length of the channel section being analyzed.

<u>Mammal and Bird Patch Sizes (Figure E4).</u> Obtain the most current digital landcover layer or digital orthophotographs for the area of interest. If natural vegetation patches are well-defined and separated from one another, a GIS could be used with a landcover layer to define patches with good success. However, if the landscape is fairly fragmented as is often the case in an urbanizing environment, a GIS has difficulty identifying spatially distinct patches. The GIS might automatically combine patches because of small areas of 'connectors' between larger area patches. Therefore, you often have to manually determine the patches by conducting on-screen digitizing using digital orthophotographs.

<u>Habitat Composition, Connectivity, and Configuration for Amphibians and Reptiles (Figures E5 and E6).</u> Obtain the National Wetland Inventory (NWI) digital data layer, and within the GIS extract all of the palustrine type wetlands, as those are the most typically utilized by still-water breeding amphibians during the breeding interval.

Use the GIS to buffer out from the palustrine wetlands at various distances to visualize where seasonal upland habitats surrounding the wetlands are likely to exist, and where wetlands may be sufficiently near each other to facilitate movement between wetlands by amphibians.

Using on-screen digitizing, draw polygonal boundaries to define CHZs using the wetland buffer boundaries as guides. Note that in Crescent Valley the stream corridor is a connectivity feature along most of the watershed, but we identify three descrete CHZs within the valley for analysis of % natural habitat to determine if specific areas along the valley have disparate connectivity characteristics.

Obtain the most recent digital landcover layer that has classes that can be grouped into a 'Natural Vegetation' class. Using the CHZs boundary layers as clipping layers, determine the area of natural vegetation values that exist within each CHZ. The ratio of area of natural vegetation to the area of each CHZ will provide the percent natural vegetation for each CHZ.

The CHZs can be shaded based on the percent natural vegetation as follows:

Dark Green = >80%
Light Green = 50 to 80%
Yellow = 40 to < 50%
Tan = 30 to <40%
Dark Orange = <30%

This gradient of colors indicates a spectrum of where the best to least opportunities for connectivity and habitat are likely to exist.

<u>Roads (Figure E7).</u> Obtain a current digital vector format road layer and identify the high traffic roads and the lower traffic roads, and weight each road as a value 2 (high) or 1 (low). Create a raster data layer from the vector layer using the weight value attribute, and process the data with a summation GIS function using a 1 mi by 1 mi analysis 'window' that moves across the entire road data layer. This provides a data layer whose values, when divided by 5,280 ft, represent the number of linear road miles per square mile, relative to the weighting by traffic road type.

<u>Non-Native Species (Figure E8).</u> Known locations of non-native amphibians can be mapped. In the case of Crescent Valley, the intensive survey identified two locations. Cats and dogs are not mapped in this example, but should be expected most places where there are homes.

<u>Summary Map (Figure E9).</u> This map is largely an overlay map. Connective linkages were located and added to the map based on visual identification of locations where connectivity appeared to currently exist, and based on maintaining connectivity between patches that would otherwise appear in danger of becoming isolated. We also focused on suggestions for connectivity within Crescent Valley in the lower, mid, and upper sections, and to external locations.

Appendix G: Suggested Planning Policies for Wildlife

Creating planning policies for wildlife

Cities and counties can help ensure that wildlife are an integral part of planning decisions by creating planning policies to guide the use of wildlife information in future planning, zoning, and regulatory decisions. In all jurisdictions with comprehensive plans, policies help remind future elected officials, staff, and citizens of a community's priorities and expectations about wildlife. Such policies can also provide consistency between the planning decisions of cities and the planning decisions of counties. Counties fully planning under the Growth Management Act are required to adopt countywide planning policies (CWPPs) with their cities to ensure consistency in accommodating future growth, provide orderly services, achieve economic growth goals, and protect rural areas, among other policy goals. Wildlife policies can be incorporated into these CWPPs. Consistency and coordination among city and county growth goals allows for coordination and consistency when addressing habitat, efficient use of roads and other infrastructure, and the ability to plan urban growth area expansions or the establishment of new urban communities with the least impact on wildlife habitat. Below are some suggested policies that address important aspects of planning for wildlife. These are written as countywide planning policies, but each can be adapted to be a planning policy for an individual jurisdiction's comprehensive plan.

> ***Consistency and coordination among city and county growth goals allows for contiguity in habitat protection, efficient use of roads and other infrastructure, and the ability to plan urban growth area expansions or the establishment of new urban communities with the least impact on fish and wildlife habitat.***

Intent to plan for wildlife

An overall guiding policy for wildlife and other natural resources that incorporates an intention to protect natural ecosystems through a jurisdiction's comprehensive plan and regulations can be made a central element of the planning document.

> *Suggested policy #1: Priority wildlife resources shall be protected through each jurisdiction's comprehensive plan and policies; each jurisdiction shall develop regulations that reflect natural constraints and protect sensitive features. Wildlife protection will be recognized as an integral component in the land use planning process.*

Supporting species recovery

Wildlife species are currently placed by WDFW in different categories reflecting their degree of vulnerability to possible extirpation from the state. The categories include endangered, threatened, sensitive, candidate, and other priority species. WDFW recommends a planning policy stating the county's intention to prevent species from becoming increasingly imperiled and to provide measures that will contribute to species' recoveries. This goal may be achieved, in part, by providing a policy that supports varying levels of protection consistent with the population status of a species.

> *Suggested policy #2: All jurisdictions shall strive to ensure that priority wildlife species do not become increasingly imperiled due to land use changes, habitat alteration, and other human activities. All jurisdictions will implement measures contributing to priority species' recoveries whenever possible.*

Working against extinction
The ultimate manifestation of a failure to adequately protect wildlife is extinction of a species. WDFW recommends each county adopt a planning policy with the goal that wildlife species will not become locally extinct within the county due to land use changes and habitat alteration.

> *Suggested policy #3: All jurisdictions shall work to ensure that no priority wildlife species become extinct within the county due to land use changes, habitat alteration, and other human activities.*

Protecting wetland and riparian area functions
Two of the most important habitat types in terms of the numbers and kinds of wildlife species dependent on them for survival are wetlands and riparian areas. These habitat types perform a number of human services as well, including enhancement of water quality, controlling stormwater runoff, reducing the threats and impacts of flooding, groundwater recharge and discharge, and recreation. WDFW recommends that each county consider a planning policy that recognizes the need to protect wetlands and riparian areas, especially as an integrated network over an entire natural drainage system.

> *Suggested policy #4: All jurisdictions shall adopt "no net loss" protection measures for wetlands and riparian areas to protect human service values and functions, protect water quality, reduce public costs, prevent environmental degradation, and protect wildlife habitat. Protection measures will reflect the importance and vulnerability of different classes of wetlands and riparian areas.*

Maintaining habitat connectivity
One of the greatest threats to many wildlife species and to overall biodiversity is loss of the ability for animals to move to different habitats used daily, seasonally, or over longer timeframes. A planning policy can call for protecting significant habitat and open space areas, as well as interconnecting corridors, to form a continuous network of wildlife habitat within and between jurisdictional boundaries.

> *Suggested policy #5: All jurisdictions shall maintain habitat connectivity by protecting priority wildlife areas, open space, and interconnecting corridors to form a continuous network of wildlife habitat.*

A good example is this adopted CWPP from King County:

> *"Adjacent jurisdictions shall identify and protect habitat networks that are aligned at jurisdictional boundaries. Networks shall link large protected or significant blocks of habitat within and between jurisdictions to achieve a continuous Countywide network. These networks shall be mapped and displayed in comprehensive plans."*
>
> *King County Countywide Planning Policy, CA-7*

Coordinating with state agencies

The Department of Fish and Wildlife has been given the mandate to "preserve, protect, and perpetuate" the wildlife resources of the state of Washington. As an agency with expertise, WDFW hopes to work closely and cooperatively with local jurisdictions in matters involving wildlife and habitat. WDFW suggests that counties adopt a planning policy expressing their intention to work cooperatively with WDFW (and other state resource agencies) where mandates, authorities, and program priorities may overlap.

> *Suggested policy #6: Recognizing that WDFW manages wildlife resources while local governments have authority for land use regulation, all jurisdictions shall coordinate with WDFW in land use planning and management of wildlife resources.*

CASE STUDY: SILVERDALE ALTERNATIVE FUTURES WILDLIFE ANALYSIS
June 2007

Erik Neatherlin, John Jacobson, and Chris Sato

INTRODUCTION

The Washington Department of Fish and Wildlife (WDFW) participated in the Silverdale (northern Dyes Inlet) Alternative Futures and Sub Area planning project to evaluate salmon and wildlife habitat for the study area. This report describes the wildlife habitat portion of the analysis. The salmon analysis is discussed in another report.

The Technical Teams were tasked with evaluating the effects on water, fish, and wildlife resources for 3 alternative urban growth area (UGA) boundaries: Existing, Conservative, and Expansive. The Existing UGA represents the planned boundary. The Conservative UGA and the Expansive UGA each represent potential future changes in the UGA boundary. The Technical Teams conducted their analysis and presented results to the Citizens Advisory Committee over the course of several public meetings. The Technical Team results represent just one of many considerations the Citizens Advisory Committee will use to inform their decision about UGA boundaries.

METHODS

Study Area

The study area is located in central Kitsap County within the Puget Trough ecoregion of Washington State, USA, approximately 12 miles west of the city of Seattle (Fig. 1). Primary land use within the study area is residential and commercial development with open space parcels. The maritime climate is mild and wet in the winter and cool and dry in the summer.

The native vegetation is characteristic of the western hemlock zone (*Tsuga heterophylla*) and consists primarily of Douglas-fir (*Pseudotsuga menziesii*), western hemlock, and western red cedar (*Thuja plicata*), which mix with red alter (*Alnus rubra*) and big-leaf maple (*Acer macrophyllum*) in mesic areas (Franklin and Dyrness 1973). Common understory plants include salal (Gaultheria shallon), Pacific rhododendron (*Rhododendron macrophyllum*), huckleberry (*Vaccinium spp.*), salmonberry (*Rubus spectabilis*), and vine maple (*Acer circinatum*).

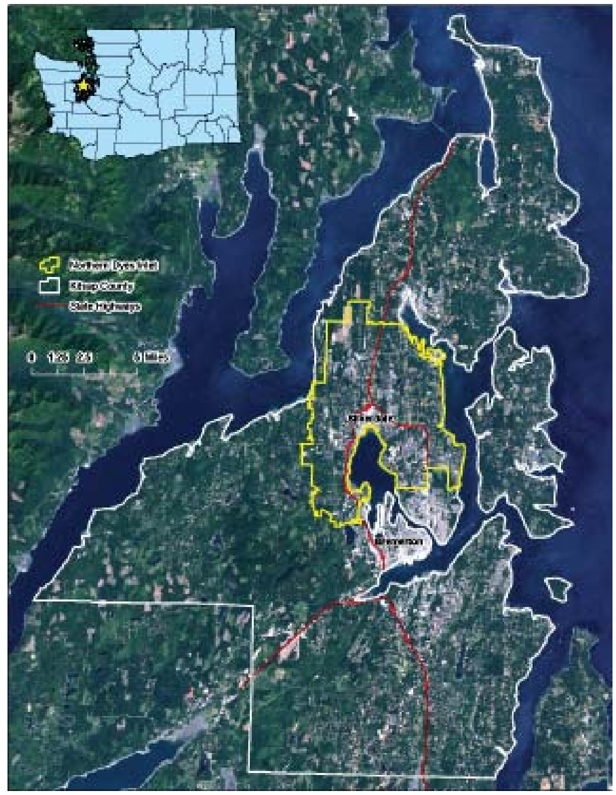

Fig. 1. Map of Kitsap County and the Silverdale Watershed area.

Data and Information

We used data that were compiled into three primary sources: (1) ecoregional assessments, (2) local habitat assessments, and (3) regional biologist knowledge. Each of these information sources is outlined in more detail below.

Ecoregional Assessments. Ecoregional assessments identify and prioritize lands that collectively represent the full range of biological diversity (biodiversity) within an ecoregion (Groves 2003). Areas identified as ecoregionally significant also represent locally important resources, but not all locally important resources are necessarily of ecoregional significance. Ecoregions are characterized by distinctive regional ecological factors including: climate, geology, vegetation, soil, water and fauna. Biodiversity, as defined in the ecoregional assessments, represents the full complement of plants, animals, and ecological communities within an ecoregion. The Washington Department of Fish and Wildlife, in partnership with The Nature Conservancy (TNC) and the Washington Department of Natural Resources, is conducting ecoregional assessments across the 9 ecoregions in Washington State. We used the Willamette Valley-Puget Trough-Georgia Basin (Puget Sound) Ecoregional Assessment (Floberg et al. 2004). The Puget Sound ecoregion is situated between the Cascades and the Olympic Mountains, and extends into British Columbia, Canada in the north through the Willamette Valley, Oregon in the south.

We used the recently completed Puget Trough Ecoregional Assessment to provide a landscape context for each of the UGA scenarios. Ecoregional assessments utilize empirical and modeled data to identify regional hotspots of biological diversity. Ecoregional assessments identify the most important areas for conserving biological diversity.

Local Wildlife Habitat Assessment. The local wildlife habitat assessment is a method developed by Washington Department of Fish and Wildlife to identify wildlife priorities at a county-wide scale (Neatherlin and Jacobson 2005). Usually, the local habitat assessment is used to identify county-wide priorities, in which case areas of ecological significance are included in the local habitat assessment. However, because the Silverdale analysis is at a much finer spatial scale (e.g. 1000s of acres vs. 1000,000s of acres), it was more useful and informative to evaluate the ecoregional data layer separately. Therefore, we used the remaining data elements of the local habitat assessment to evaluate the UGA scenarios: (1) percent of land converted -- the amount of natural vegetation, agriculture/pasture, and development within a 1/4 mile circle, (2) road density -- the amount of road miles per square mile, and (3) rare, unique, and biologically productive (e.g. salmon-bearing streams, wetlands) habitats as defined through Washington Department of Fish and Wildlife's Priority Habitats and Species Program (PHS).

Detailed methods can be found in Neatherlin and Jacobson (2005) but are described briefly here. We evaluated each layer (land conversion, road density, and rare and unique habitats) and assigned a relative ranking from 0 to 10 for each pixel for each layer, where zero represented the lowest habitat value and 10 represented the highest value. For example, 9 road miles per square mile translated to a zero wildlife habitat ranking (low value) for road density. As road densities decreased, they received a higher wildlife value. After ranking each layer, we combined all the layers so that a zero represented areas with highest percent pavement (i.e., no natural habitat), highest road density, and no rare or unique habitats. Conversely, a value of 10 represented the opposite, where there was 100% natural habitat within a 1/4 mile circle, low road density, and/or one or more rare or unique habitats present.

Regional WDFW Staff Assistance. We met with Washington Department of Fish and Wildlife regional biologists to augment the ecoregional and local wildlife habitat assessments. In addition, we met with internal and external scientists and biologists to review the assessments. All of these meetings helped to increase accuracy and capture pertinent biological information for the assessments.

Comparing UGA Scenarios. We used the ecoregional assessment and local habitat assessment to evaluate each of the UGA scenarios. We evaluated the current habitat value for each scenario and then evaluated the planned trend at build-out for each scenario.

Table 1. Summary of the relative ranking for land use zoning based on Kitsap County data.

Relative Ranking	Housing Density
1	>5du/ac
2	5du/ac - 3du/ac
3	<3du/ac - 2du/ac
4	<2du/ac - 1du/ac
5	<1du/ac - 1du/5ac
6	<1du/5ac - 1du/10 ac
7	<1du/15ac - 1du/20 ac
8	<1du/15ac - 1du/20 ac
9	1du/20 ac - 1du/40 ac
10	<1du/40ac

To evaluate planned trend, we used land use zoning data provided by Kitsap County. The county provided specific parcel data for future land use zoning for each UGA scenario (i.e., Existing UGA, Conservative UGA, Expansive UGA) for the study area. We ranked land use zoning from 0 to 10 based on its relative intensity. For example, areas with less intensive development (i.e., housing density) received a lower ranking and areas with higher housing densities received a higher ranking (Table 1).

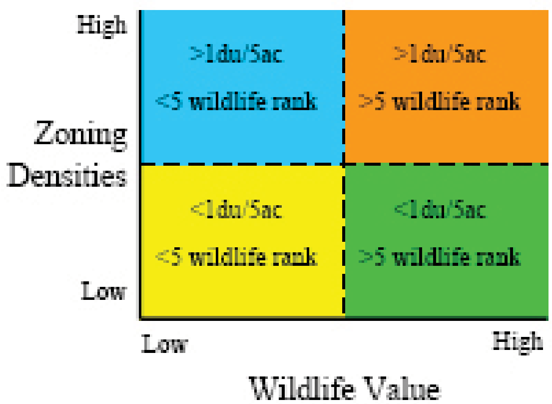

Fig. 2. This figure illustrates the relationship between zoning densities and wildlife value from the habitat maps. This same relationship is illustrated spatially in Figure 8. The orange areas illustrate high value wildlife hbaitat that is slated for high-density development. Conversely, the blue areas illustrate where high-density development is slated in areas with lower wildlife value.

Using this information, we created 2 categories of land use zoning, higher density (>1du/5ac) and lower density (≤1du/5ac). We then compared land use zoning with high value wildlife habitat (>5 ranking) and lower wildlife habitat value (≤ 5 ranking) for each UGA scenario (Fig. 2). This allowed us to evaluate the effect and calculate the amount of land (acres) of future zoning on current wildlife habitat for each UGA scenario.

RESULTS

Areas of Regional Significance

Dyes Inlet. Dyes Inlet provides regionally significant habitat for forage fish and water birds. Areas of highest importance are concentrated in northern Dyes Inlet adjacent to Silverdale and in the south within Ostrich Bay (Fig. 3). Both of these sites have important spawning habitat for Pacific herring (*Clupea pallasi*) and surf smelt (*Hypomesus pretiosus*), as well as habitat for Pacific sandlance (*Ammodytes hexapterus*) and 2 species of rockfish (*Sebastes spp.*). Dabbling and diving ducks, grebes, loons, and scoters are found all around Dyes Inlet, with highest concentrations in northern Dyes Inlet and Ostrich Bay.

Western Kitsap Peninsula. Western Kitsap Peninsula provides regionally significant marine and terrestrial habitats. The forests west and south of, and including, Camp Wesley Harris Naval Reservation contain the last remaining large habitat blocks of lowland conifer/dry evergreen forests (Douglas-fir, western hemlock, western red cedar) within Puget Sound (Fig. 3). The marine shorelines adjacent to Seabeck provide important kelp, seagrass, and saltmarsh and subtidal vegetation that provides habitat for forage fish such as Pacific sandlance, Pacific herring, and surf smelt, as well as for copper rockfish (*Sebastes caurinus*) and quillback rockfish (*Sebastes maliger*). The marine waters support concentrations of federal and state listed marbled murrelets (*Brachyramphus marmoratus*) as well as dabbling and diving ducks, grebes, loons, and scoters.

Fig. 3. Polygons indicated areas of high biodiversity value within the Georgia Basin/Puget Trough ecoregion. Excerpted from the ecoregional assessments by The Nature Conservancy and Washington Department of Fish and Wildlife.

Central and Northern Kitsap Peninsula. The forests in and around Bangor, Port Gamble, and Indianola also contain some of the last remaining large habitat blocks of lowland conifer/dry evergreen forests in Puget Sound (Fig. 3). Point Julia Forest and adjacent Port Gamble (Bay) contain wetland, estuarine, and marine habitats that support a host of species including concentrations of marbled murrelets, forage fish, and dabbling and diving ducks.

Existing UGA

The Existing UGA represents the current Urban Growth Area boundary and comprises the least amount of total land area of the 3 scenarios (Fig. 5). Covering approximately 10,921 acres, the Existing UGA extends from the Island Lake area in the north to Tracyton in the southeast (Fig. 5). The Existing UGA angles southwest towards NW Anderson Hill Road, then extends south to Chico along Dyes Inlet. The Existing UGA includes all of Barker Creek, but excludes the upper portion of Clear Creek and its western boundary.

Table 2. Summary of number of road miles per square mile of roads and percent of forest and natural lands.

Habitat Value Ranking		Avg. No. of Road Miles per Square Mile	Average Percent of Forest and Natural Lands
1	Low	32.87	5.59
2		27.79	12.80
3		23.11	28.75
4	Medium	18.96	38.94
5		15.74	50.94
6		12.19	59.04
7	High	9.03	66.97
8		6.33	76.37
9		3.73	86.75
10		1.11	96.91

In addition to encompassing the least amount of total land area, the Existing UGA affects the least amount of medium and higher value wildlife habitat (Fig. 6). Areas of highest wildlife value within the Existing UGA include lower Barker Creek, Illahee Forest, and the area around the Apex Airport. The highest ranking wildlife habitat (value >9) equates roughly to less than 9 miles of roads per square mile and greater than 66% forest and natural lands (Table 2). Areas of lowest wildlife habitat value include Silverdale and the Clear Creek Valley, northern East Bremerton, and areas with high-density housing development north of Illahee Forest and Meadowdale (Fig. 7). The lowest ranking wildlife habitat is characterized by greater than 23 road miles per square mile and less than 29% forest and natural lands (Table 2).

Within the Existing UGA, WDFW has documented bald eagle nests associated with one territory on the northeastern portion of northern Dyes Inlet, an important purple martin breeding area at the north end of Silverdale Bay, and an important water bird concentration area (also of ecoregional significance) in northern Dyes Inlet.

The Existing UGA encompasses approximately 27 stream miles of potential fish habitat, defined in WAC 222-165-030 as “...habitat that is used by any fish at any life stage at any time of the year, including potential habitat likely to be used by fish which could be recovered by restoration or management and includes off-channel habitat.”

Ecoregionally Significant Resources. The Existing UGA will directly affect Dyes Inlet, which as discussed above, provides regionally significant habitat for forage fish and water birds. The areas of highest importance within the Existing UGA are concentrated in northern Dyes Inlet adjacent to Silverdale (Fig. 3). This area provides important spawning habitat for Pacific herring and surf smelt, as well as habitat for Pacific sandlance and 2 species of rockfish. Dabbling and diving ducks, grebes, loons, and scoters are found all around northern Dyes Inlet.

Land Use Zoning Comparisons. The Existing UGA had the fewest (8,792) acres of land zoned at higher than 1 dwelling unit per 5 acres (Table 3; Fig. 8). The remaining 658 acres within the Existing UGA is zoned at less than 1 dwelling unit per 5 acres (Table 3; Fig. 8).

In total, the Existing UGA had approximately 2,467 acres were high housing density corresponded with high habitat value (see the orange section in Table 4). Areas with planned development densities $\geq$ 1 dwelling unit per 5 acres include all of the highest

Table 3. Summary of land use zoning and associated relative habitat ranking for each UGA scenario. The areas shaded in gray represent high housing density (>1du/5ac) and the areas with no shading represent low housing density (<1du/5ac)*.

	Acres Within the Study Area			
Relative Ranking	Existing	Conservative	Expansive	Land Use Zoning
1	1,334	1,326	1,479	>5du/ac
2	3,379	3,414	5,468	5du/ac - 3 du/ac
3	1,063	1,225	1,282	<3du/ac - 2du/ac
4	1,181	1,403	1,314	<2du/ac - 1du/ac
5	1,834	2,261	3,865	<1du/ac - 1du/5ac
Subtotal	**8,792**	**9,629**	**13,409**	**>1du/5ac**
6	460	1,054	796	<1du/5ac - 1du/10ac
7	121	227	461	<1du/10ac - 1du/15ac
8	38	86	113	<1du/15 ac - 1du/20ac
9	40	35	20	<1du/20 ac - 1du/40 ac
10	0	0	1	<1du/40 ac
Subtotal	**658**	**1,043**	**1,391**	**<1du/5ac**
Total	**9.450**	**11,033**	**14,800**	

* du/ac = dwelling unit per acre

value habitat within Barker Creek, Illahee Forest and the area around the Apex Airport (Fig. 9). In addition, medium-high value habitat northeast of the Silverdale Way and Highway 303 intersection, east of Windy Point, and along the eastern edge of the Existing UGA Boundary was also slated for development at levels ≥ 1 dwelling unit per 5 acres (Fig. 9).

Table 4. Summary of land use zoning compared with relative habitat value. High housing density is greater than 1 house per 5 aacres. Low housing density is equal to or less than 1 house per 5 acres. High habitat value equates to greater than 5 relative ranking, and low habitat value equates to less than or equal to relative ranking 5.

	Acres Within UGA Scenario		
	Existing	Conservative	Expansive
High housing density/ low habitat value	6,319	6,806	7,544
Low housing density/ low habitat value	76	5	4
Low housing density/ high habitat value	582	882	1,387
High housing density/ high habitat value	2,467	3,346	5,860

Conservative UGA

The Conservative UGA encompasses approximately 13,171 acres and is 21% larger than the Existing UGA and 26% smaller than the Expansive UGA (Fig. 4). The Conservative UGA excludes a forested corridor approximately 1/4 mile wide along the lower portion of Barker Creek that is included within both the Existing UGA and the Expansive UGA. The Conservative UGA expands beyond the northwest edge of the Existing UGA, but excludes the upper portion of Clear Creek (Fig. 5). The Conservative UGA also extends south along Dyes Inlet (Fig. 5).

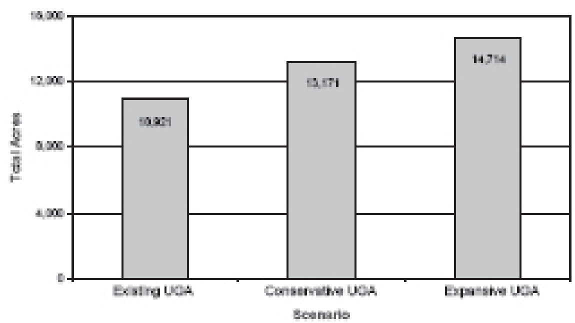

Fig. 4. The total amount of acres for each Urban Growth Area (UGA) scenario.

All UGA scenarios affect approximately 1,200 acres of low value wildlife habitat (Fig. 6). The Conservative UGA affects more medium value wildlife habitat than any other scenario (Fig. 6). The Conservative UGA affects 3,498 acres of high value wildlife habitat and 15% more (9,320) total acres) than the Existing UGA. The Conservative UGA affects 9,600 acres of medium value wildlife habitat and 2,300 acres of high value wildlife habitat (Fig. 6). Areas of higher wildlife value within the Existing UGA include Illahee Forest, the area around the Apex Airport, and the area around Bangor Station

(Fig. 7; Table 2). Areas of low wildlife value within the Conservative UGA include Silverdale and the lower Clear Creek, northern East Bremerton, and a couple of areas with high-density housing development north of Illahee and Meadowdale (Fig. 7; Table 2).

Within the Conservative UGA, WDFW has documented a bald eagle territory south of Silverdale Waterfront Park. In addition, as mentioned previously, there is a documented bald eagle territory, purple martin breeding area and water bird concentration area that are included in all UGA scenarios.

The Conservative UGA encompasses approximately 34 stream miles of potential fish habitat, defined in WAC 222-165-030 as "...habitat that is used by any fish at any life stage at any time of the year, including potential habitat likely to be used by fish which could be recovered by restoration or management and includes off-channel habitat."

Ecologically Significant Resources. The Conservative UGA will directly affect Dyes Inlet, which as discussed above, provides regionally significant habitat for forage fish and water birds. The areas of highest importance within the Conservative UGA are concentrated in northern Dyes Inlet adjacent to Silverdale (Fig. 3). This area provides important spawning habitat for Pacific herring and surf smelt, as well as habitat for Pacific sandlance and 2 species of rockfish. Dabbling and diving ducks, grebes, loons, and scoters are found all around northern Dyes Inlet.

Planned Land Use Zoning Comparisons. The Conservative UGA encompassed 9,629 acres of higher density land use of >1 dwelling unit per 5 acres (Table 3; Fig. 8). The Conservative UGA retains 1,431 acres of land zoned at less than 1 dwelling unit per 5 acres (Table 3; Fig. 8).

The Conservative UGA included approximately 3,346 acres where high housing density corresponded with high habitat value (see the orange section in Table 4). Under the Conservative UGA scenario, housing density in the lower Barker Creek is reduced to below 1 dwelling unit per 5 acres and housing density is increased in the northwest area of the UGA adjacent to Bangor (Fig. 9). In addition, the low value wildlife habitat west of Clear Creek is incorporated into the Conservative UGA (Fig. 9). The Conservative UGA also expands south towards Chico, but the land use zoning is not altered under this scenario.

Expansive UGA

The Expansive UGA is the largest scenario and comprises approximately 14,714 acres (Fig. 4). The Expansive UGA is 35% larger than the Existing UGA and 29% larger than the Conservative UGA (Fig. 4). The Expansive UGA extends to Bangor in the northwest and west of Chico in the south (Fig. 5). The Expansive UGA extends to the North Central Valley Road in the northeast portion and also includes all of Barker Creek and Clear Creek in the UGA boundary (Fig. 5).

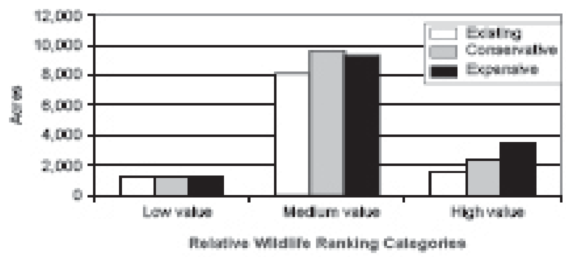

Fig. 6. Comparison of the overall ranking for each UGA scenario. Low value = relative ranking <3, medium value = relative ranking 4-6, and high ranking = relative value $\geq$7.

All UGA scenarios affect approximately 1,200 acres of low value wildlife habitat (Fig. 6). The Expansive UGA affects more high value wildlife habitat than any other scenario. The Expansive UGA affects 54% more (3,498 total acres) of high value wildlife habitat and 15% more (9,320 total acres) than the Existing UGA. Areas of higher wildlife value within the Expansive UGA include Illahee Forest, the area around the Apex Airport, and the area around Bangor Station (Fig. 7; Table 2). Areas of low wildlife value within the Expansive UGA include Silverdale and the lower Clear Creek, northern East Bremerton, and a couple of areas with high-density housing development north of Illahee and Meadowdale (Fig. 7; Table 2). The remaining areas represent medium wildlife habitat.

The Expansive UGA encompasses approximately 38 stream miles of potential fish habitat, defined in WAC 222-165-030 as "...habitat that is used by any fish at any life stage at any time of the year, includ-

A. B. C.

Fig. 5. Maps of the (A) Existing Urban Growth Area (UGA, (B) Conservative UGA, and (C) Expansive UGA.

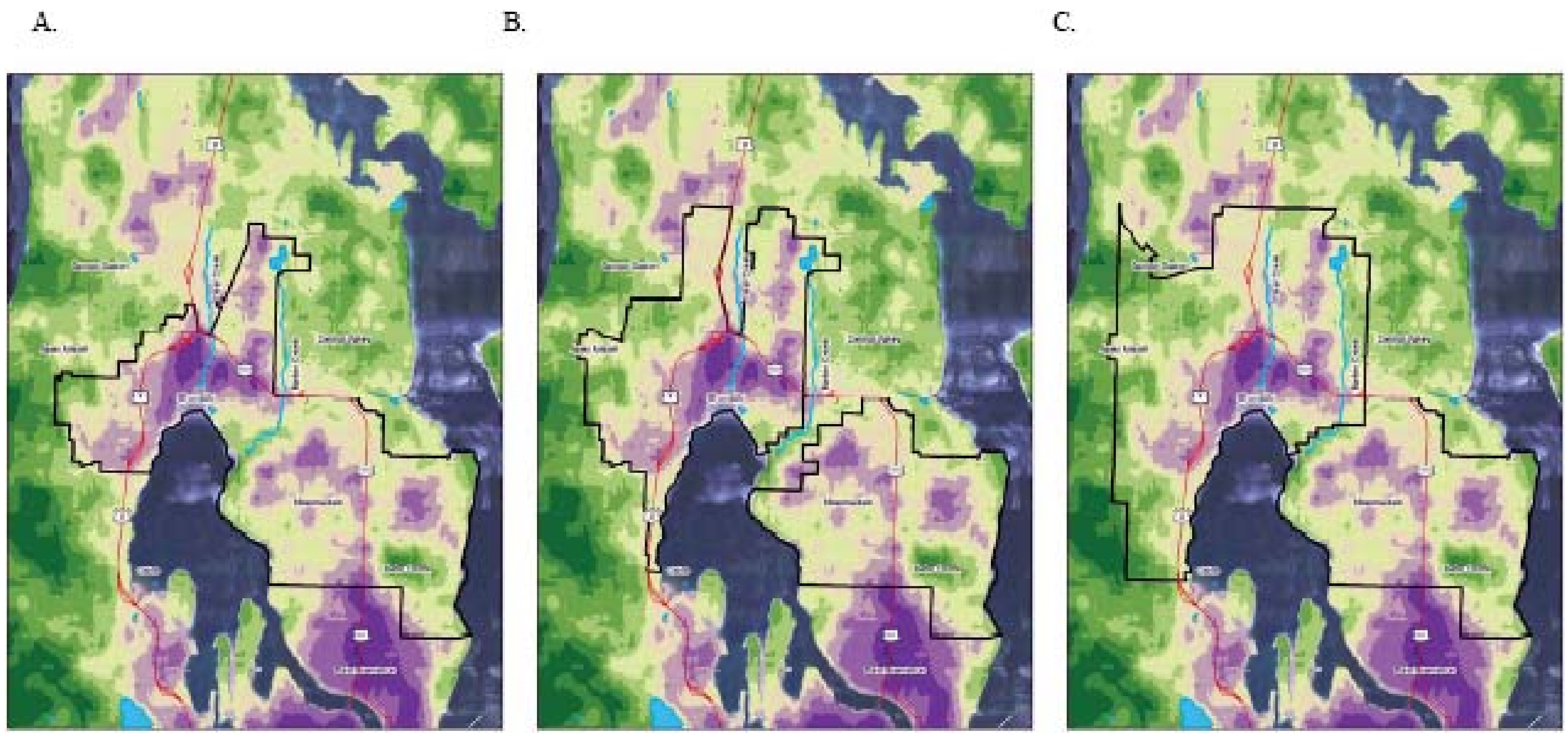

Fig. 7. Maps of the (A) Existing Urban Growth Area (UGA, (B) Conservative UGA, and (C) Expansive UGA identifying the relative habitat value. Dark green indicates the highest habitat value and purple indicates the lowest habitat value.

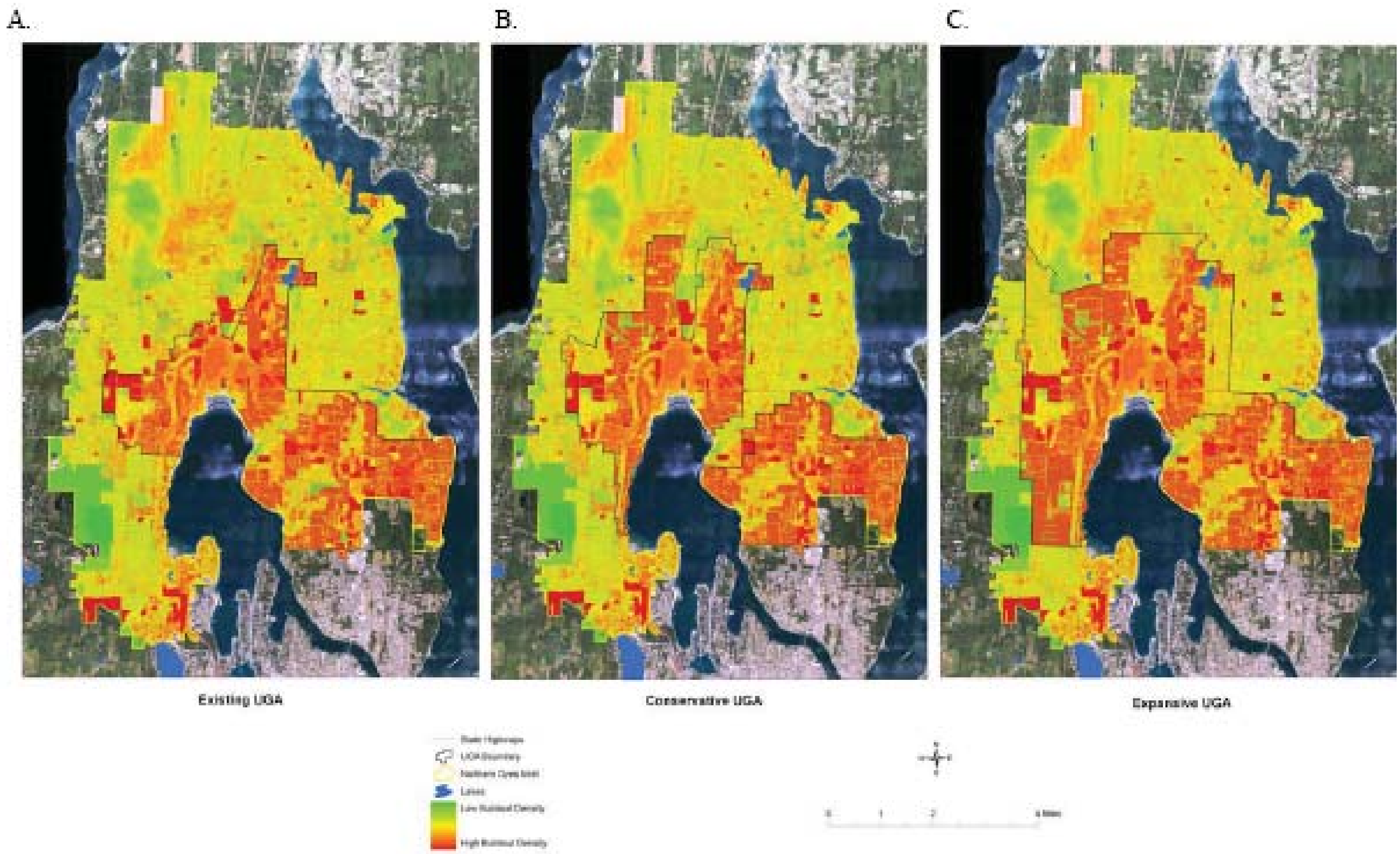

Fig. 8. Maps of the (A) Existing Urban Growth Area (UGA), (B) Conservative UGA, and (C) Expansive UGA identifying the relative housing densities. The spectrum of housing densites range from urban (e.g., > 5 houses per 1 acre) represented in the figure below as dark red, to natural resource and private forest lands (e.g., < 1 house per 80 acres) represented by green. The transition yellow colors represent suburban densities of 1 house per 5 acres.

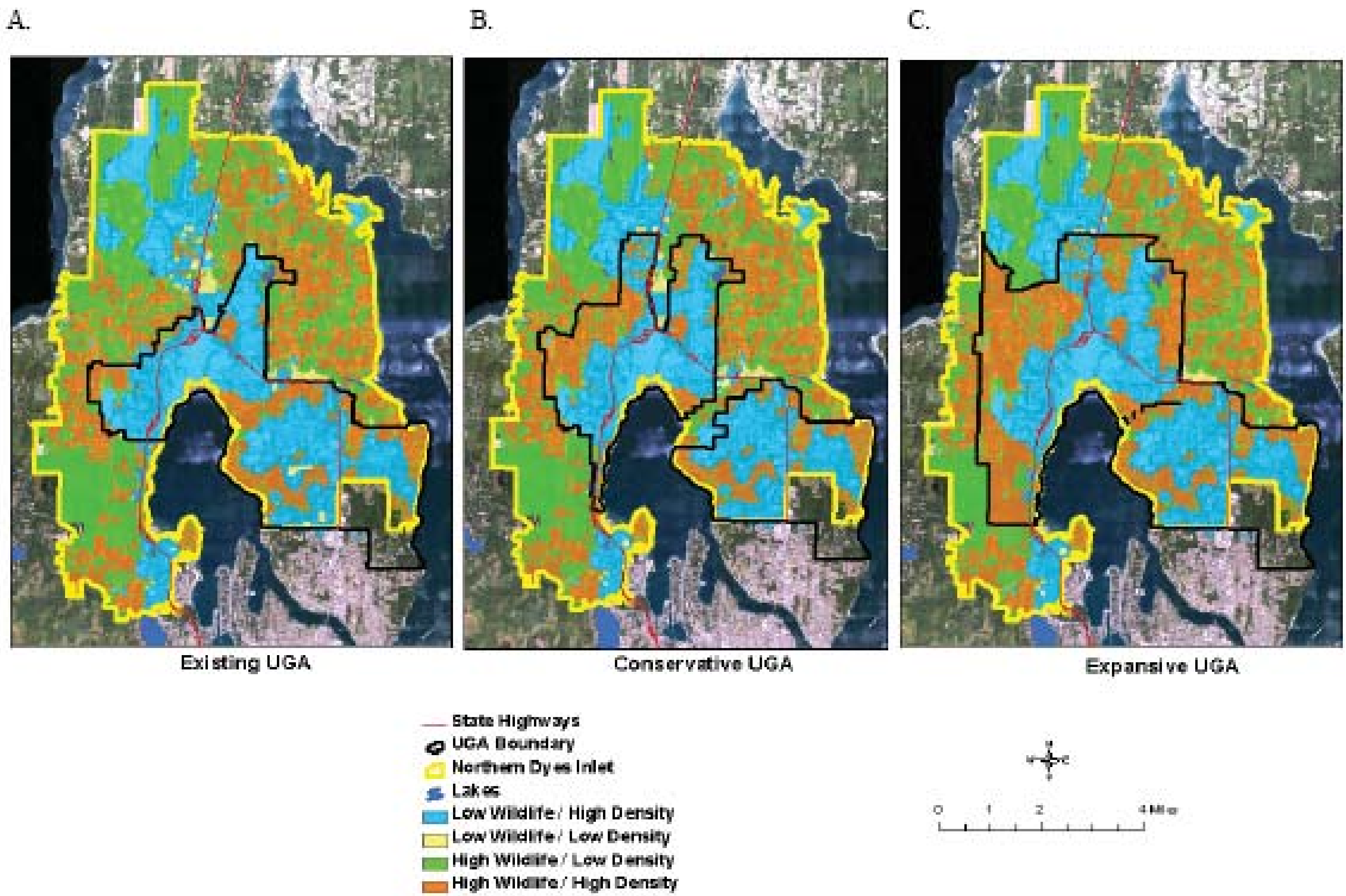

Fig. 9. Maps of the (A) Existing Urban Growth Area (UGA, (B) Conservative UGA, and (C) Expansive UGA comparing housing density with wildlife habitat value.

ing potential habitat likely to be used by fish which could be recovered by restoration or management and includes off-channel habitat."

Ecologically Significant Resources. The Expansive UGA will also directly affect Dyes Inlet, which as discussed above, provides regionally significant habitat for forage fish and water birds. The areas of highest importance within the Expansive UGA are concentrated in northern Dyes Inlet adjacent to Silverdale (Fig. 3). This area provides important spawning habitat for Pacific herring and surf smelt, as well as habitat for Pacific sandlance and 2 species of rockfish. Dabbling and diving ducks, grebes, loons, and scoters are found all around northern Dyes Inlet.

The southeast portion of the Expansive UGA extends into Camp Wesley Harris Naval Reservation, which contains regionally significant, large habitat blocks of lowland conifer/dry evergreen forests.

The Expansive UGA scenario extends approximately 2.5 miles northwest of the Existing UGA and into forest blocks that provide a patchwork of connectivity between regionally significant forests on the Kitsap Peninsula to the southwest and those to the north in central and northern Kitsap County.

Planned Land Use Zoning Comparisons. The Expansive UGA includes the most acres (approximately 13,409 acres) of higher density land use of >1 dwelling unit per 5 acres (Table 3; Fig. 8). The Expansive UGA retains a similar amount of land in lower density (< 1 dwelling unit per 5 acres) as the Conservative UGA (Table 3; Fig. 8).

The Expansive UGA included approximately 3,346 acres where high housing density corresponded with high habitat value (see the orange section in Table 4). Under the Expansive UGA, much of the 1,500 acres of higher density housing is acquired along the western edge of the expanded Expansive UGA (Fig. 9). In addition, the Expansive UGA does not exclude Barker Creek and retains the higher density zoning in that area (Fig. 9).

DISCUSSION AND CONCLUSION

Overall, the Expansive UGA will affect the largest amount of total land area and the highest amount of valuable wildlife habitat. The Existing UGA will affect the least amount of total land area, but will diminish the function of valuable riparian habitat along Barker Creek. The Conservative UGA is the medium-sized alternative, but excludes valuable riparian habitat in Barker Creek at the inclusion of medium value habitat northwest of Silverdale.

All 3 scenarios will affect Illahee Forest and the area south of Apex Airport. Illahee Forest and Apex Airport both have a high percentage of forest and natural land. Illahee Forest has lower road density, whereas the area south of Apex Airport has moderate road density.

The Expansive and Existing UGA scenarios will affect Barker Creek. Barker Creek is valuable riparian habitat and the last remaining non-developed riparian corridor within the study area. Barker Creek is characterized by a high percentage of forest and low to moderate levels of road density.

Only the Expansive UGA will affect upper Clear Creek and the area around Bangor. Neither the Existing UGA nor the Conservative UGA occupy upper Clear Creek or extend as far into the forests around Bangor as the Expansive UGA. Upper Clear Creek is considered moderate wildlife habitat because of its low percentage of natural and forested lands. Conversely, the habitat around Bangor provides valuable wildlife habitat because it has a high percentage of forest and natural land cover with low to moderate levels of road density.

All UGA scenarios will overlap a similar number of priority habitats or species identified by the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources. The exception is the portion of a bald eagle territory just south of Silverdale Waterfront Park. Both the Conservative and Expansive UGAs overlap this bald eagle territory.

The Expansive UGA affects the highest number of fish-bearing stream miles per square mile. The Existing UGA affects the fewest stream miles of fish-bearing streams.

Ecoregional Priorities

The Expansive UGA scenario has the greatest potential effect on ecoregional resources. It extends into large, contiguous habitat blocks of lowland conifer/dry evergreen forests adjacent to Camp Wesley Harris Naval Reservation. In addition, the Expansive UGA extends towards Bangor and potentially disrupts connectivity between regionally significant forests on the Kitsap Peninsula to the southwest and those to the north in central and northern Kitsap County.

All 3 UGA scenarios will affect northern Dyes Inlet, a regionally significant resource. The Existing UGA excludes the shoreline north of Chico Creek, whereas the Conservative UGA excludes shoreline at the mouth of Barker Creek.

Implications for Future Land Use

The Expansive UGA clearly affects the largest amount of total land area, increases housing densities in the most valuable wildlife habitat, and potentially disrupts forest habitat connectivity between regional biodiversity resources in the northern and southern Kitsap Peninsula. With the exception of the Central Valley area of the study area, most of the valuable wildlife habitat is included within the Expansive UGA boundary. Most of this added area corresponds to increases in housing density above 1 house per 5 acres.

The Conservative UGA and the Existing UGA affect different portions of the landscape in different ways. The Conservative UGA will increase housing densities to greater than 1 house per 5 acres in the area northwest of Silverdale at the exclusion of Barker Creek. However, housing densities in most of this area are already zoned at greater than 1 house per 5 acres. So there is actually a less than 50% change to zoning as a result of this inclusion. The area within Barker Creek is excluded from the UGA under the Conservative Scenario, but only portions of the area that is excluded from the UGA has land use zoning that is less than 1 house per 5 acres.

The Existing UGA includes all of Barker Creek and increases zoning in the entire corridor to housing density above 1 house per 5 acres. While the Existing UGA excludes the area northwest of Silverdale, as mentioned above, zoning in much of this area remains higher than 1 house per 5 acres. As a result, the exclusion from the UGA has less merit or impact.

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Appendix I: Site-Specific Habitat Assessment Example

Chapter 5 describes a site-scale upland habitat assessment model. This appendix includes a draft form for such an assessment developed for use by the City of Bellevue by Suzanne Tomassi at The Watershed Company. Below the form, an explanation of the parameters used to evaluate the site's habitat values at the landscape level and the site level is provided.

EXAMPLE UPLAND HABITAT ASSESSMENT FORM

Property address____

Location_____Range_________Township_______Section__________

Parcel number____

Property owner____

Telephone number (______) -_______ -___________

Project name ____

Project contact____

Telephone number(______) -_______ -___________

Address____

Staff____ Date(s) of site visit(s)______________________

Washington Department of Fish and Wildlife Priority Habitat and Species (PHS) data obtained? Y/N__________

1.0	**PROPERTY DESIGNATION**	**Zone A**	**Zone B**	**Zone C**	**Zone D**		**Zone**
1.1	**Existing impervious surface**	>90%	50-90%	20-50%	0-20%		
2.0	**LANDSCAPE PARAMETERS**	**No points**	**1 point**	**2 points**	**3 points**	**Additional points**	**Total**
2.1	**Land use/development density**	Zone A	Zone B	Zone C	Zone D		
2.2	***Occurrence (number) of habitat types**	0	1	2	3+		
2.3	****Proximity of known critical areas (distance to edge)**	>2,500 ft	<2,500 ft	<1,200 ft	<100 ft	+1 point if contiguous with critical area	

2.4	**Habitat connectivity and corridors**	No connection to other habitat areas	≥50-foot-wide connection to vegetated areas of at least 1 acre	≥50-foot-wide connection to vegetated areas of at least 50 acres but not listed parks***	≥50-foot-wide connection King County wildlife network or listed parks***	+1 point for ≥150-foot-wide connection King County wildlife network or listed parks***	
2.5	**Patch size**	<0.-1.0 ac	1.0-5.0 ac	>5-10 ac	10-42 acres	>42 acres = 4 points	
2.0	**LANDSCAPE PARAMETERS**	**No points**	**1 point**	**2 points**	**3 points**	**Additional points**	**Total**
2.6	***Interspersion of habitat patches (excluding patches <1 ac in area)**	No or isolated patch (no others within 0.5-ac circle)	Low	Moderate	High	+1 point if wildlife network or listed park is included	
3.0	**LOCAL PARAMETERS**	**No points**	**1 point**	**2 points**	**3 points**	**Additional points**	**Total**
3.1	**Size of native trees on site**	No significant trees on site	6-12” dbh tree(s) present	12-20” dbh tree(s) present	>20” dbh tree(s) present	+1 point if tree(s) >30” dbh are present	
3.2	**Coniferous component**	No conifers on site	Conifers very sparse or present in understory only	Conifers co- or sub-dominant in overstory	Conifers dominant	+1 point if conifers >30” dbh are present	
3.3	**Percent cover (sample vegetated areas only)**						
	Ground layer (0-2.3 ft) (5-ft radius)	0%	0-25%	25-50%	50%+	+1 point for cover >75%; -1 point if mowed grass is >50%	
	Shrub layer (2.3-25 ft) (10-ft radius)	0%	0-25%	25-50%	50%+	+1 point for cover >75%	
	Canopy (>25 ft) (30-ft radius)	0%	0-25%	25-50%	50%+	+1 point for cover >75%	
3.4	**Vegetative vertical**	FHD = 0	FHD < 0.70	FHD = 0.70-	FHD > 0.90		

	structural diversity (foliage height diversity)			0.90			
3.5	**Vegetative species richness**	0-1 species	2-5 species	6-19 species	20+ species		
3.6	**Invasive species component**	>75% cover	25-75% cover	10-25%cover	<10% cover		
3.0	**LOCAL PARAMETERS**	**No points**	**1 point**	**2 points**	**3 points**	**Additional points**	**Total**
3.7	**Proximity to year-round water**	>1.0 mi or artificial feature with maintained /invasive buffer present within 0.3-1 mi	0.3-1.0 mi or artificial feature with maintained/ invasive buffer present within <0.3 mi	<0.3 mi or artificial feature with maintained/ invasive buffer present within patch	Natural water feature present within patch with native buffer		
3.8	**Snags (≥4 in dbh)**	No snags on site	1/ac or fewer	2-6/ac	>7/ac	Add 0.5 point for each >20 in dbh and 1 point for each >30 in dbh	
3.9	**Other habitat features**	None	1	2-4	5 or more		
Landscape parameters points							
Local parameters points							
TOTAL POINTS							

* Use circle of the appropriate size for the property's zone:

Zone A – 0.5 ac
Zone B – 5.0 ac
Zone C – 100 ac
Zone D – 250 ac

** PHS data required for sites in Zone D

***Parks: Mercer Slough, Phantom Lake wetland complex, Larson Lake wetland complex, Cougar Mountain Regional Wildland Park, Weowna Park; King County wildlife network

Landscape-level parameters assessed in the Bellevue model included:

- *Impervious surface:* Categories are based on the percentage of impervious surface on the subject parcel and consider the present and likely future development density and intensity of the landscape surrounding a property. Totally developed sites contain 100% impervious surface; sites designated as urban are made up of >60% impervious surface; suburban sites comprise from 20% to 60% impervious surface; and exurban sites are covered by less than 20% impervious surface.

- *Occurrence (number) of habitat types:* The impervious surface category into which the subject property falls determines the required area to evaluate. The required evaluation area for each zone is measured as a circle, with the subject property located at the center of the evaluation area. Publicly available aerial photographs are used to count the number of different habitat types on the property and within the evaluation area. National Wetland Inventory (NWI) maps and local mapping resources like the King County Sensitive Areas iMAP online GIS information (iMAP) can be used to determine the existence of known wetlands. Any habitat patch that is wholly or partially within the evaluation area should be counted. Habitat types are based on groups of vegetation types or other features that sustain wildlife. They are structurally based and therefore do not generally differentiate between native and non-native species, with the exception of areas such as golf courses or large lawns that can be discerned at a large scale on aerial photographs. Habitat types found in the City of Bellevue are mature coniferous forest, mixed coniferous-deciduous forest, scrub-shrub, meadow and grassland, ponds and lakes, streams, and wetlands. Wetlands may be further divided into emergent, shrub-shrub, forested, or open water; however, if wetland areas are not apparent from aerial photographs or readily available public resources, they may be categorized by vegetative structure alone as meadow, scrub-shrub, etc. Wetlands should not be counted twice (e.g., as both wetland and as forest), but do count different wetlands individually (e.g., emergent wetland and forested wetland = two types).

- *Proximity of critical areas (wetlands and streams):* Distance from the subject parcel edge to the edge of known critical areas (streams, wetlands, wildlife networks, ponds, Priority Habitat and Species (PHS) polygons [required for exurban properties only]), and lakes is measured and points assigned based on their proximity. Location of these sensitive areas can be determined from NWI maps, the WDFW SalmonScape online database, and local tools such as iMAP to determine the location of sensitive areas. Distances can be measured using the distance function in mapping system, GPS, or aerial photographs. Sites containing a critical area receive an additional point, as do sites containing habitat patches that are contiguous with critical areas on- or off-site, regardless of whether the patch itself is a critical area.

- *Habitat connectivity and corridors:* For each patch of habitat on the site, determine connections to off-site vegetated areas using first on-site observation and then aerial photographs. Breaks in connectivity are based on the propensity of wildlife to avoid crossing them. Breaks include gravel roads used by vehicles daily, paved roads, paved multi-use trails that experience daily non-motorized traffic, maintained lawns or fields associated with structures, pasture, mowed rights-of-way, and solid fences or walls. Impervious foot trails, decommissioned or rarely used gravel roads, wildlife-passable fences, and unmaintained rights-of-way are not breaks in connectivity. Connections must be vegetated with trees, shrubs (native or non-native) or wetlands. Other cover (lawns, ornamental vegetation) may make up no more than 50% of the width of the connecting area at any point. Streams are included in the as part of the connecting area, but ponds, lakes, and other open water bodies are not.

- *Size of habitat patches:* Size of habitat patches is measured on-site for patches fully contained within a property, and using aerial photographs for patches extending beyond subject property boundaries. Count all patches in the appropriate area for the property, placing the property at the center of the circle. As with the occurrence of habitat types, the evaluation area depends on the impervious surface category into which the subject site fall. Point allotments for patch sizes are based on species-area curves and modified for relevance to an urban landscape. For the purposes of this question, a habitat patch is the total area of all contiguous cover types defined as habitat by the jurisdiction (City of Bellevue, in this case), with the exceptions of manicured lawns and other highly manipulated and maintained areas. Habitat patch boundaries are delineated by the edge of unmaintained low cover, shrubs, water body edge, or tree canopy. Score each patch individually and allot the total points.

- *Interspersion of habitat types:* This question assesses the variety of habitat available and the amount of edge habitat on a site. It is inversely related to the previous parameter, but because both aspects of habitat offer functions and values to wildlife, both are measured and score independently so that their values are both accounted for in the assessment. Using the appropriate size circle for the property's imperious surface category, overlay a circle on an aerial photograph with the property in the center. Include all vegetated areas ≥1 ac in size as habitat. Exclude paved areas, gravel, and structures. An additional point is awarded if high-value habitat in the form of a wildlife network or park is included in the matrix. The City of Bellevue awards for this additional point for large parks vegetated primarily with native species and for large wetlands or wetland complexes.

Site-level parameters used in the Bellevue model:

- *Size of native trees:* Points are awarded to sites containing trees likely to be used by wildlife for nesting or foraging. Higher points are given for trees of sizes preferred by or critical to species of local importance. On residential or other small parcels, measure the diameter at breast height (dbh) of the largest trees on the property. Allot points based on the largest tree on-site. Large sites may require a tree survey for some permit applications. In this case, tree sizes can be obtained from the survey.

- *Coniferous component:* Dominance, co-dominance and sub-dominance of conifers on a site determines points awarded, and the presence of conifers >30" dbh adds greater value and additional points.

- *Percent cover (ground/shrub/canopy):* Estimate the percent of vegetative cover on the site using plots, line-intercept, or another appropriate method. Sample only vegetated parts of the property. Include grass and lawns, but note that a point is subtracted if low grass represents more than 50% of the herbaceous layer. Measure cover in three strata: 0-2.3 ft (0-0.07 m), 2.3-25.0 ft (0.7-7.6 m), and >25.0 ft (>7.6 m). Each stratum is scored separately on the FAM form. Plot radii for sampling herbaceous, shrub and tree layers should be 5 ft, 10 ft and 30 ft, respectively. Adequate sample sizes may be calculated using Freese (1962), Stauffer (1983), or a similar method. Alternatively, 30% of <1-ac properties, 20% of <5-ac properties, or 10% of >5-ac properties may be sampled, provided it can be demonstrated that vegetation is adequately represented. Smaller sample sizes may be accepted for highly homogeneous sites, to be decided on a case-by-case basis.

- *Foliage height diversity:* Use a foliage height diversity (FHD) index such as MacArthur and MacArthur (1961) to measure vertical vegetative structure. Other authors have modified this index for ease of use and applicability (e.g., Hays et al. 1981, Berger and Puettmann 2000). The FHD index considers both the number of strata occupied by vegetation and the evenness of vegetation distribution in calculating diversity.

- *Vegetative species richness:* Count native vegetative species that make up at least 10 square feet of the property (cumulatively). Do not include species on the county noxious weed list in richness calculations.

- *Invasive Species Component:* Percent cover by invasive species can often be estimated visually, as these species tend to grow in mono-specific patches with clearly defined edges. If invasive species are scattered or dispersed as individual plants, use the methods described above to obtain percent cover. Include all species on the county noxious weed list (or other appropriate source).

- *Proximity of year-round water source:* Point categories are based on home ranges and dispersal distances of bird, reptile and amphibian species of local importance. Year-round water sources include perennial lakes, ponds, wetlands and streams, and artificial features such as reservoirs and detention facilities, provided they have vegetated buffers. Artificial water sources with buffers comprising solely low groundcovers or maintained vegetation receive scores reduced by 1 point. Scores of 0 points should not be reduced, however.

- *Snags:* Count all snags at least 4" dbh, or estimate average snags/acre on large sites. For sites smaller than one acre, extrapolate snags/acre. Additional points are added for snags of sizes preferred by or critical to species of local importance. Again, extrapolate large snags/acre on sites where a full count is not practical.

- *Other habitat features:* Features to be counted in this category are as follows:
    - downed wood at least 6" in diameter at any point
    - unused structures such as sheds, barns, houses, wells and chimneys
    - water-holding features (need not be a year-round source)
    - rockeries
    - rock piles
    - vertical banks
    - stumps at least 20" in diameter
    - trees with large (> 2" diameter entrance) cavities
    - active or inactive dens
    - active raptor perches and nests (defined by observation or documentation of use)